EXHIBIT E: ENVIRONMENTAL ANALYSIS

1 Introduction

Kenai Hydro, LLC (KHL), a wholly-owned subsidiary of Homer Electric Association, Inc. (HEA), is filing this Draft License Application (DLA) for an original license for the Grant Lake Hydroelectric Project (FERC No. 13212 [Project or Grant Lake Project]) under Part I of the Federal Power Act.

1.1. Purpose of Exhibit E

The purpose of this Exhibit E is to describe the following: (1) existing lands and waters; (2) the proposed Project facilities and operations; (3) proposed protection, mitigation, and enhancement (PM&E) measures and their benefits, by resource area; and (4) the incremental impacts of the proposed Project and its operation, including direct, indirect, cumulative, and unavoidable adverse impacts, based on information generated by the licensing study program. The resource analyses contained in this Exhibit E will provide the foundation for the Federal Energy Regulatory Commission's (FERC) National Environmental Policy Act (NEPA) analysis.

1.2. Traditional Licensing Process (TLP) Schedule

Table E.1-1 provides a summary of the major milestones of the licensing process, beginning with the Pre-Application Document (PAD) and ending with the DLA. The table also includes document filings associated with related mandatory processes, including the Alaska Department of Environmental Conservation (ADEC) Section 401 water quality certification process, the U.S. Army Corps of Engineers (USACE) Section 404 permit application process, the U.S. Fish and Wildlife Service (USFWS) Section 7 Endangered Species Act (ESA) consultation, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA). Following the filing of the Final License Application (FLA), FERC will establish a firm schedule for the processing of the License Application and evaluate KHL's licensing proposal through the NEPA process.

KHL conducted a series of baseline natural resource studies in 2009 prior to and during the Notice of Intent (NOI)/PAD submittal. The Environmental Baseline Study Report was submitted to stakeholders for review in March 2010 (KHL 2010a). In May of 2010, KHL distributed draft study plans for natural resource efforts that they felt were commensurate with the size and scale of the Project (KHL 2010b through 2010f). After review of FERC Scoping Documents 1 and 2 and receiving comments on the 2010 study plans from stakeholders, it was evident that natural resources studies would need to be modified to become more quantitative in nature. As such, KHL chose to make the requisite quantitative revisions. KHL utilized most of 2011 and early 2012 to assess the internal licensing effort, revise natural resource planning, and select a biological consultant team to conduct the studies. In the interim, KHL's first FERC Preliminary Permit expired. On March 23, 2012, FERC granted KHL's request for a second Preliminary Permit. Once secured, KHL advanced their natural resource planning effort and on December 12, 2012, KHL held a meeting with stakeholders to present the more robust, comprehensive and quantitative set of natural resource studies. While not required per the process, KHL accepted subsequent comments from the stakeholders and to a great extent, incorporated the requested revisions prior to starting the studies in earnest in March 2013 (KHL 2013a through 2013e).

Table E.1-1. Milestones associated with filing of the Project DLA.

Milestone	Date
Preliminary Permit Order	October 1, 2008
Notice of Intent (NOI) and Pre-Application Document (PAD)	August 6, 2009
Revised PAD	May 3, 2010
FERC Scoping Document 1 (SD1)	May 11, 2010
Draft Study Plans	May 2010
Partial Study Season (Pre-scoping)	2009–2010
FERC Scoping Meetings	June 2-3, 2010
FERC SD2	August 23, 2010
Preliminary Permit No. 2 Application	October 1, 2011
Preliminary Permit No. 2 Order	March 23, 2012
Final Study Plans	March 2013
Comprehensive Study Season	March 2013 – July 2014
Draft Study Reports	February 2014
Final Study Reports	June 2014
Cultural Resources Study, Final Report	February 2015
Draft License Application (DLA)	March 2015
Draft Section 404 permit application	Estimate April 2015
Draft Biological Evaluation for Plants (BE)	Estimate April/May 2015
Draft management and monitoring plans: • Operational Compliance Monitoring Plan (OCMP) • Biotic Monitoring Plan • Vegetation Management Plan (VMP) • Avian Protection Plan (APP) • Historic Properties Management Plan (HPMP)	Estimate April/May 2015

A comprehensive package of documents including the Draft Biological Evaluation (BE) for sensitive plants in the Project area and a series of management/monitoring plans is under development and will be distributed for comment between 30 and 60 days after the distribution of this DLA. This schedule will facilitate a seamless review in conjunction with the DLA and allow comments on all documents to be completed at the same time given the 90 day review period for this document. The intent and general objectives of the BE and management/monitoring plans are described in the representative sections of this document. All specific measures and associated timelines associated with proposed monitoring, enhancement and mitigation measures are detailed in the BE and management/monitoring plans themselves. Once the comment period is complete, KHL will revise the DLA, BE and management/monitoring plans and synthesize all documents into a comprehensive package prior to filing in which, the BE and management/monitoring plans are appended to the FLA.

1.3. Document Organization

This Exhibit E can be divided into two general parts: (1) Introduction, Proposed Action and Alternatives, and Consultation sections (Sections 1 - 3) and (2) the Environmental Analysis (Section 4), which makes up the bulk of Exhibit E. Following a general description of the basin, Section 4 has the following section headings for each resource area:

- *Affected Environment* – Describes the existing environment based on the results of licensing program studies.[1]
- *Environmental Analysis* – Describes the impacts of the Proposed Action, based on the results of licensing program studies.
- *Proposed Environmental Measures* – Describes KHL's proposed PM&E measures and their supporting rationales, based on study results and expected benefits of the PM&E measures.
- *Cumulative Impacts* – Indicates those resources for which cumulative effects have been identified and discusses whether or how the Proposed Action will contribute to such cumulative effects.
- *Unavoidable Adverse Impacts* – Characterizes any adverse impacts that will occur despite the implementation of the identified PM&E measures.

2 Proposed Action and Alternatives

2.1. Proposed Action

2.1.1. Proposed Project Boundary

The Project boundary will encompass the Project features, including an intake, bypass pipe, penstock, surge chamber, powerhouse, detention pond, switchyard, transmission line, and access roads. Each of these Project features are identified on Figure E.2-1 and described in detail in Section 2.1.2 of this Exhibit E. The corridors for the access roads, penstock, and transmission line will be approximately 50-75 feet from each side of the centerline. Grant Lake up to approximately contour elevation 703 feet National American Vertical Datum of 1988 (NAVD 88), and Grant Creek, flowing from Grant Lake to the Trail Lake Narrows, is entirely encompassed within the Project boundary.

The Project sits on state (Alaska Department of Natural Resources [ADNR]) and federal (U.S. Forest Service [USFS]) land, and is directly adjacent to two private property parcels, as shown on the Exhibit G, G-3 drawing. Approximately 250 feet of the Alaska Railroad and of the Seward Highway (AK-9) cross through the west side of the Project boundary.

[1] Many of the maps in this Exhibit E that accompany the corresponding text in the respective resource-specific sections were extracted directly from the previously filed natural resoures study reports to ensure consistency with study data. However it should be noted that some of the information on the Project infrastructure layer (such as the location of the detention pond drain and the tailrace location) and the Project boundary have since been updated as a result of the iterative engineering process and is not accurately depicted on some of these maps. Refer to Exhibit G of this DLA for an accurate depiction of the proposed Project boundary and infrastructure.

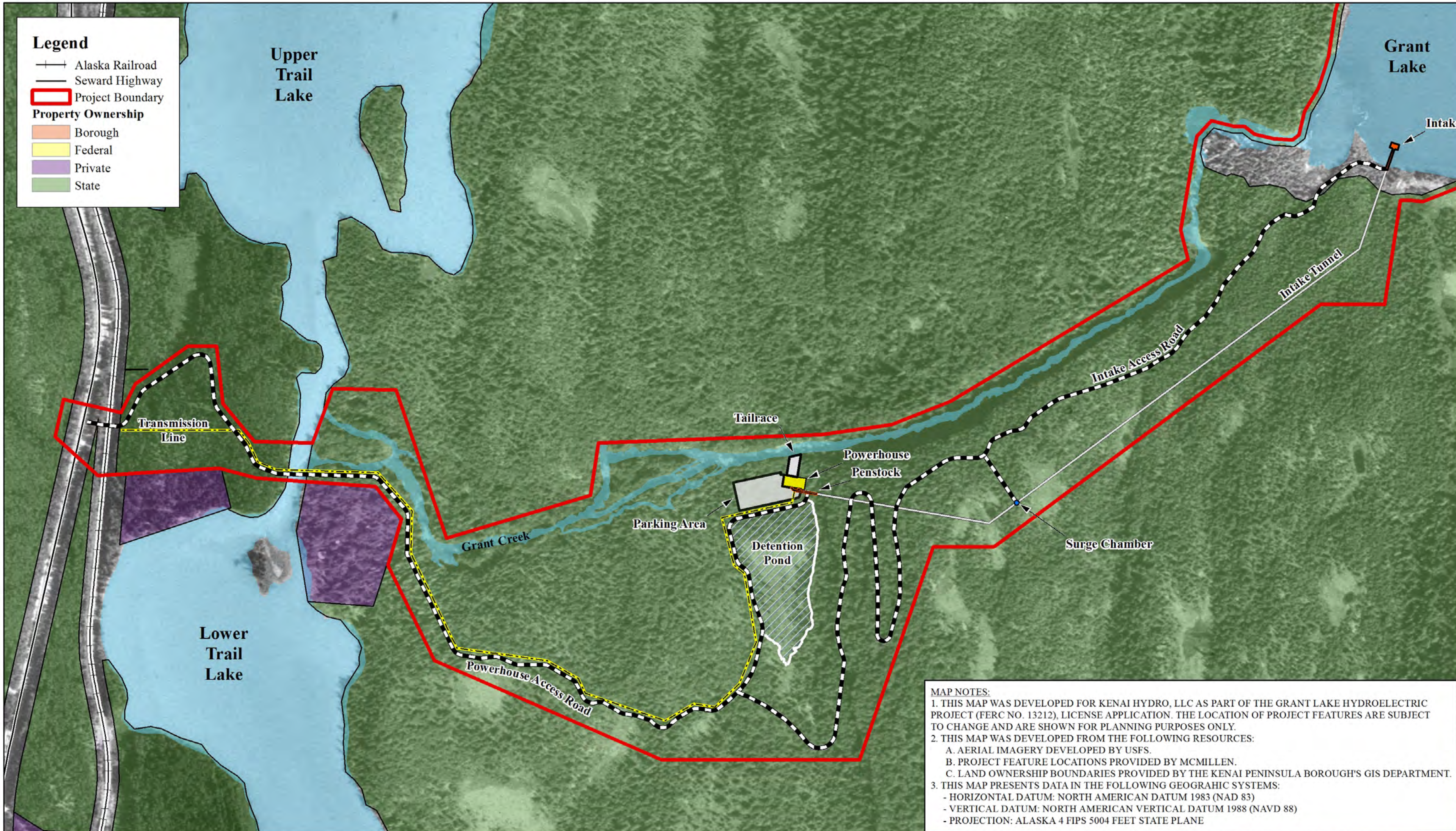
The proposed Project boundary is detailed in maps provided in Exhibit G of this DLA.

2.1.2. Proposed Project Facilities

KHL was issued a preliminary permit to investigate a proposed hydropower development on Grant Creek near the outlet of Grant Lake. The Grant Lake Project will consist of the Grant Lake/Grant Creek development, an intake structure in Grant Lake, a tunnel, a potential surge shaft, a penstock, a powerhouse, tailrace channel with fish exclusion barrier, access roads, a step-up transformer, a breaker, an overhead transmission line, and a switchyard. The powerhouse will contain two Francis turbine generating units with a combined rated capacity of 5 MW with a maximum design flow of 385 cubic feet per second (cfs).

The general proposed layout of the Project is shown in Figure E.2-1.[2] Specific proposed facility characteristics are listed in Tables E.2-1 and described in more detail in Sections 2.1.2.1 through 2.1.2.10 of this Exhibit. Individual proposed facility design drawings are provided in Exhibit F and proposed locations of facilities within the Project boundary are shown in Exhibit G of this DLA.

[2] The Project boundary alignment, in the vicinity of Grant Lake, follows the 703-foot contour line derived from USGS developed topographic data. Due to imprecision in the USGS topography, the Project boundary around Grant Lake does not currently align with the USFS-developed aerial imagery presented in some of the Exhibit A and Exhibit E figures. The Project boundary alignment will be refined as additional survey data of the Grant Lake shoreline becomes available. The updated Project boundary is anticipated to align more precisely with USFS imagery.



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATION OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. PROJECT FEATURE LOCATIONS PROVIDED BY MCMILLEN.
   C. LAND OWNERSHIP BOUNDARIES PROVIDED BY THE KENAI PENINSULA BOROUGH'S GIS DEPARTMENT.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

Drawing Scale: N
0 250 500 1,000 Feet

MCMILLEN, LLC
THE SONNA BUILDING
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Homer Electric Association, Inc.
A Touchstone Energy® Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.2-1
General Project Features And Facilities

DESIGNED Jake Woodbury
DRAWN Jake Woodbury
CHECKED C. Warnock
ISSUED DATE 2/18/2015
DRAWING
SCALE: 1:5,000

Table E.2-1. General characteristics of the proposed Grant Lake Project facility.

Number of Generating Units	2
Turbine Type	Francis
Rated Generator Output	
Unit 1	2.5 MW
Unit 2	2.5 MW
Total	5.0 MW
Maximum Rated Turbine Discharge	
Unit 1	192.5 cfs
Unit 2	192.5 cfs
Total	385 cfs
Minimum Rated Turbine Discharge	
Unit 1	58 cfs
Unit 2	58 cfs
Total	116 cfs
Turbine Centerline Elevation	526 ft NAVD 88
Normal Tailwater Elevation at Grant Creek at the confluence with the powerhouse and tailrace channel	
Minimum	517 ft NAVD 88
Maximum	518.3 ft NAVD 88
Average Annual Energy	18,600 megawatt-hours (MWh)
Normal Maximum Lake Elevation	703 ft NAVD 88
Normal Minimum Lake Elevation	690 ft NAVD 88
Gross Head	184.7 ft
Net Head at Maximum Rated Discharge	171.7 ft
Grant Lake	
Drainage Area	44.2 miles (mi)^2
Surface Area	1,703 acres
Active/Net Storage Volume	18,790 ac-ft (elevation 703 to 690 feet NAVD 88)
Gross Storage Volume	251,920 ac-ft
Average Annual Natural Outflow	149,140 ac-ft
Average Annual Natural Outflow	206 cfs
Water Conveyance	
Intake	Intake structure at lake
Approximate dimensions of intake structure	25 ft x 38 ft
Invert Elevation	675 ft NAVD 88
Bypass Pipe for Instream Flows	
Type	Directional bore with HDPE liner
Length	900 ft
Diameter	18 in

Table E.2-1, continued…

Lower Pressure Pipeline	
Type	Welded steel
Length	200 ft
Diameter	48 in
Pressure Tunnel	
Type	10-ft horseshoe
Length	3,300 ft
Velocity at Maximum Turbine Discharge	3.9 fps
Surge Chamber	
Diameter	120 in
Base Elevation (preliminary)	680 ft NAVD 88
Top Elevation (preliminary)	785 ft NAVD 88
Penstock	
Type	Welded steel
Length	150 ft
Diameter	72 in
Tailrace	
Type	Open channel
Length	95 ft
Fish Exclusion Barrier	
Type	Picket barrier at tailrace outfall
Maximum Design Flow	385 ft
Tailrace Detention Pond	
Approximate Acreage	5 acres
Approximate Capacity	15 ac-ft
Outlet Conveyance Length	200 ft
Powerhouse	
Approximate Dimensions	50 ft x 100 ft x 30 ft high
Finished Floor Elevation	523 ft NAVD 88
Transmission Line	
Type	Overhead
Length	Approximately 3.5 miles
Voltage	115 kilovolt (kV)
Powerhouse Access Road	
Type	Two-lane gravel surfacing with turnouts
Width	24 feet
Length	One (1) mile from Seward Highway to powerhouse
Intake Access Road	
Type	Two-lane gravel surfacing with turnouts
Width	24 feet
Length	One (1) mile from the powerhouse to the intake

2.1.2.1. *Grant Creek Diversion*

The proposed Project consists of a reinforced concrete intake structure located on the south side of the natural lake outlet. No structural modifications would be made to the existing lake natural outlet. The Project will divert water up to a maximum of 385 cfs into the intake structure. When the lake level exceeds the natural outlet of 703 feet NAVD 88, a maximum of 385 cfs will be diverted into the intake structure and routed to the powerhouse. Flow in excess of 385 cfs would pass over the natural outlet to Grant Creek.

2.1.2.2. *Grant Lake Intake*

The Project water intake would be a concrete structure located approximately 500 feet east of the natural outlet of Grant Lake and adjacent to the shore. The intake structure consists of a reinforced concrete structure extending from approximately elevation 675 NAVD 88feet up to a top deck elevation of 703 feet NAVD 88. The structure has an internal dimension of 38 feet by 15 feet. The structure includes intake trashracks, a selective withdrawal intake gates with wire rope hoist, and a roller gate located on the water conveyance intake. The intake is divided into three bays, each fitted with an intake gate to provide flexibility for delivering the full flow range of 58 cfs to 385 cfs. The gate position within the water column will be set to deliver the required water temperature to Grant Creek below the powerhouse. The roller gate would be 11 feet tall by 11 feet wide and fitted with a wire rope hoist lift mechanism. Electrical power will be extended from the powerhouse to the intake to operate the intake and isolation gates. Pressure transducers will be installed to monitor the water level at the lake as well as within the intake tower. An access bridge 16 feet wide would be installed from the lake shore out to the intake structure.

The intake would allow for drawdown of Grant Lake to elevation 690 feet NAVD 88 thereby creating approximately 18,790 acre-feet of active storage for the project between elevations 703 feet NAVD 88 and 690 feet NAVD 88. The intake can be designed to allow the Project to draw water near the surface at various levels of storage, if deemed necessary. The invert of the intake would be at elevation 675 feet NAVD 88 to provide for adequate submergence to the tunnel.

A bypass pipe would extend from the intake structure to the base of the existing water fall in Grant Creek. The installed pipe would be 900 feet long and approximately 18 inches in diameter allowing the minimum flow ranging from 5 to 10 cfs to be released. A control gate would be located within the intake structure to regulate and monitor the bypass flow releases.

2.1.2.3. *Tunnel and Surge Chamber*

The intake structure would connect to a tunnel extending to the Project powerhouse. The tunnel would be approximately 3,300 feet long with a 10-foot-horseshoe shape. Drill and shoot techniques would be used to construct the tunnel using an entrance portal at the powerhouse for access. The lower 900 feet of tunnel would be constructed at a 15 percent slope. This section of the tunnel will be concrete lined. The upper 2,400 feet of tunnel would be constructed at a 1 percent slope and would be unlined. This proposed arrangement provides a low pressure hydraulic conduit in the upper tunnel reaches suitable for an unlined tunnel. A surge chamber is located at the transition between the two tunnel slopes. This chamber is approximately 10 feet in diameter and would extend from the tunnel invert elevation of 650 feet NAVD 88 to the ground surface at approximately elevation 790 feet NAVD 88. The surge chamber provides a non-mechanical relief for hydraulic transients that could occur if a load rejection occurs at the powerhouse. Rock anchors and shotcrete stabilization techniques would be used to stabilize the tunnel where required. A rock trap would be located at the surge chamber location to collect dislodged rocks from the unlined tunnel section.

The tunnel would transition to a 6-foot diameter steel penstock approximately 150 feet from the powerhouse. The transition section would consist of a welded steel concentric structure which transitions from the 10-foot tunnel section to the 72-inch diameter penstock. A steel liner would extend from the downstream tunnel portal approximately 300 feet into the tunnel. The liner would be installed within the exposed rock surface with grout pumped behind the liner to provide an impermeable and structurally sound tunnel section. A similar steel tunnel liner section would be installed at the connection to the intake structure for a total distance of approximately 150 feet.

2.1.2.4. Penstock and Surge Chamber

A 72-inch diameter steel penstock extends 150 feet from the downstream tunnel portal to the powerhouse. The welded steel penstock would be supported on concrete pipe saddles along the penstock route. The penstock would bifurcate into two 48 inch diameter pipes feeding each of the powerhouse turbines. The penstock fitted with welded steel thrust rings would be encased in concrete thrust blocks at the tunnel portal as well as the powerhouse. These thrust blocks would be designed to resist the full hydraulic load associated with the Project operation. An interior and exterior coating system would be applied to the penstock providing full corrosion protection. An access manway would be provided on the exposed penstock section allowing access for future inspection and maintenance.

2.1.2.5. Tailrace

The powerhouse draft tubes would connect to a tailrace channel located on the north side of the powerhouse structure. The draft tubes would extend from a low point elevation of approximately 509 feet NAVD 88 up to the tailrace channel invert elevation of 515 feet NAVD 88. The channel would continue to the east bank of Grant Creek. Each of the draft tubes will be gated allowing the flow to be routed to the detention pond for spinning reserve. Isolation bulkheads would be provided allowing dewatering of the draft tubes for inspection and maintenance of the turbine. The tailrace channel would be trapezoidal in shape with a bottom width of 43 feet, side slopes of 2H:1V and a channel depth ranging from 13 feet at the powerhouse to 7 feet at the creek. A concrete structure would be constructed at the confluence of the channel and Grant Creek. A picket-style fish barrier would be placed on this concrete structure as well as provision for installation of stoplogs allowing the tailrace channel to be dewatered for inspection and maintenance. The channel would be excavated from native material and lined with riprap to provide a long term stable section. A staff gage and pressure transducer will be placed in the channel to monitor the water level in the channel.

2.1.2.6. Tailrace Detention Pond

An off-stream detention pond would be created to provide a storage reservoir for flows generated during the rare instance when the units being used for emergency spinning reserve are needed to provide full load into the electrical transmission grid. In this situation, the additional powerhouse flows would be diverted into the detention pond and then released slowly back into Grant Creek. It is anticipated that the discharge associated with a spinning reserve event would be dispersed via the tailrace channel which flows into Grant Creek. The detention pond would be located immediately south of the powerhouse and would have a capacity of approximately 15 acre-feet and a surface area of approximately 5 acres.

2.1.2.7. Powerhouse

The powerhouse would be located on the south bank of Grant Creek immediately west of the downstream tunnel portal and adjacent to the detention pond. The powerhouse would consist of a concrete foundation and a pre-engineered metal building superstructure. The building would be approximately 100 feet long (east to west) and 50 feet wide (north to south). The penstock would tie into the powerhouse on the south side and the tailrace channel on the north side of the building. The building floor would be set at approximately elevation 523 feet NAVD 88 and the centerline of the turbine runner at elevation 526 feet NAVD 88. The draft tube floor would be set at elevation 509 feet NAVD 88 with an operating tailwater inside the draft tubes ranging from 518.0 feet to 519.3 feet NAVD 88.

Two horizontal Francis type turbine/generator units with a rated total capacity of 5,000 kilowatt (kW) would be housed in the powerhouse structure. The powerhouse flow would range from a maximum of 385 cfs to a minimum of 58 cfs with each turbine operating flow ranging from 192.5 cfs to 58 cfs. Associated mechanical and electrical equipment would include hydraulic power units, turbine isolation valves, penstock drain, utility water system, lube oil system, oil water separator, battery system, and heating, ventilating, and air conditioning (HVAC) system. A control room housing the motor control center (MCC), communication rack, fiber optic panels, computers, and related equipment would also be provided. The Project switchgear would be located within the powerhouse. A standby generator, transformer, and fused pad mounted switch assembly would be mounted on an enclosed switchyard located on the south side of the powerhouse. Dewatering pumps would be provided to support dewatering of the turbine draft tubes. A 30-ton bridge crane would be provided for equipment maintenance. The crane would travel on rails mounted on the steel building support columns. An energy dissipation valve would extend off the penstock and provide bypass flows into the Project tailrace.

2.1.2.8. Transmission Line/Switchyard

An overhead 115-kilovolt (kV) transmission line will extend from the powerhouse to the existing 115-kV transmission line located on the east side of the Seward Highway. In addition to overhead transmission structures, the facilities would include a switchyard at the powerhouse consisting of a 115-kV fused pad-mounted disconnect switch and a pad-mounted 115-kV GSU transformer. The transmission line would run from the powerhouse parallel to the access road where it would intersect Chugach Electric's transmission line. The interconnection would have a pole mounted disconnect switch.

Wooden poles would be designed as tangent line structures on about 250-foot centers. Design of the line would also incorporate the latest raptor protection guidelines. Collision avoidance devices would be installed on the line at appropriate locations to protect migratory birds.

2.1.2.9. Appurtenant Facilities

The following pertinent mechanical and electrical equipment will be applicable to the Project:

- Intake selective withdrawal intake gate
- Intake trashrack system
- Intake roller gate used to isolate the tunnel and downstream generation facilities
- Control gate located on the bypass pipeline pipe
- A 30-ton bridge crane in the powerhouse
- Pumps located in the powerhouse used to dewater the draft tubes
- Pressure tranducers located throughout the project used to monitor the water level in the reservoir, tunnel and trailrace, as well as pressures in the tunnel and penstock
- Security cameras at the intake and powerhouse
- Sanitary waste holding tank at the powerhouse
- A power line extending from the powerhouse to the intake to supply electrical power to the gates and trashrack
- Temperature instrumentation at the intake structure and at various stream locations to monitor water temperature

This equipment along with other identified miscellaneous mechanical and electrical equipment will be developed during the final design and included in the construction documents.

2.1.2.10. Access Roads

The Project would require an access road to both the powerhouse located near the base of the Grant Creek canyon and to the intake at Grant Lake. The access road would be used to construct the Project and afterwards, to maintain the facilities. It is anticipated that the powerhouse would be visited approximately once a week and the intake visited approximately once a month beginning just after the ice melts and continuing until just before freeze up. The powerhouse access road would be maintained year around. The intake access road would not be maintained in winter.

The 24-foot wide access road would tie into the Seward Highway at approximately MP 26.9. The route would travel eastward to cross Trail Lakes at the downstream end of the narrows between Upper and Lower Trail lakes and then continue eastward to the powerhouse. This route would be approximately one mile long. It would cross the Alaska Railroad (ARRC) tracks near an existing railroad crossing for a private driveway. The road would cross the narrow channel connecting Upper and Lower Trail lakes with an approximately a 110-foot-long single lane bridge. This bridge is proposed as a clear span with the west abutment located on bedrock and the east abutment on fill. The proposed route would avoid cuts and travel along the base of some small hills on the south side of Grant Creek to the powerhouse. This proposed access road would have one 90-degree crossing of the Iditarod National Historic Trail (INHT).

The intake access road would be approximately one mile long, beginning at the powerhouse. The road would ascend a 230-foot bluff to get to the top of the southern lip of the Grant Creek canyon. A series of road switchbacks would be required to maintain a road grade of less than 8 percent. The road would then generally follow the southern edge of the canyon until it descends to Grant Lake. A small parking area and turn-a-round area would be provided at the intake structure. A 16 foot wide bridge will extend from the bank out to the intake structure.

The road would be gravel with a 16-foot top width. Maximum grade would be 8 percent. Periodic turnouts would be provided to allow construction traffic to pass. Fifty-foot radius curves would be used to more closely contour around the small steep hills of bedrock to limit the extent of the excavation and the height of the embankments.

2.1.3. Proposed Project Safety

Successful and safe construction of the Project will require an effective Site-specific Safety Plan which clearly outlines the construction activities, hazards associated with these risks, and measures required to mitigate these hazards. As a first step, the construction documents will require the engineer to prepare a detailed Site-specific Safety Plan which meets the state and federal guidelines for construction site safety. A detailed plan will be submitted and reviewed prior to the construction contractor being allowed to mobilize to the Project site. The engineer's plan will include all trade work and subcontractor specialty work. Within this plan, daily job site safety meetings will be required as well as full training and certifications. A full time safety manager will be required onsite during the Project construction. Periodic independent safety reviews will be conducted by the corporate level safety officer to ensure all safety program features are fully implemented.

Similarly, a Site-specific Construction Safety Plan will be required of the engineering and KHL staff which will be onsite during construction providing engineering support, construction oversight, and quality control functions. These entities will be required to have their own safety plans specific to their own work activities as well as work under the Site-specific Construction Safety Plan insuring integration of programs and a comprehensive Project safety program. All unaccompanied personnel entering the construction site will be required to complete a site specific project safety training and job site walk through. All safety training, certification, and inspections will be fully documented and available onsite for review.

2.1.4. Proposed Project Operations

The Grant Lake Project will have an average annual energy production anticipated to be 18,600 MWh.

The Project will operate to generate power throughout the calendar year based on inflow, available storage, lake elevation, and minimum flow requirements with Grant Creek. The lake will operate from the natural Grant Lake outlet elevation of 703 feet NAVD 88 down to a minimum lake elevation of 690 feet NAVD 88. The lake will be drawn down in the winter months utilizing a combination of Grant Creek inflows and stored water to meet the instream flows in Reach 5 while also maintaining power production. Water flow predictions will be used to estimate snowpack and the corresponding runoff volume. The Project operation will then be tailored to maximize winter power production while also ensuring the lake refills to elevation 703 feet NAVD 88.

2.1.5. Proposed Environmental Measures

Over the past year, based primarily on the results from the natural resource studies and preliminary engineering design discussions, KHL has collaborated with stakeholders to begin to establish a list of proposed PM&E measures. Table E.2-2 below represents an itemized listing of KHL's proposed PM&E measures and permit and land use requirements for the Project. Further detail related to each specific measure and resource area can be found in the respective subsection in Section 4 of this Exhibit E. If not incorporated into an individual measure, all efforts associated with PM&E measures will be documented in an annual, Grant Lake Project Compliance Report, to be reviewed by stakeholders and ultimately, filed with FERC.

Table E.2-2. KHL proposed environmental measures

Measure	Description	Proposed/Agency Request	Phase (Construction vs. O&M)
Overall Project Compliance			
Environmental Compliance Monitor (ECM)	KHL representative responsible for monitoring, confirming and documenting compliance with all environmental and construction measures	Proposed by KHL	Construction
Annual Compliance Report	Annual report summarizing all compliance activities for the previous year (may be accompanied by a meeting with stakeholders)	Proposed by KHL	Construction and O&M
Best Management Practices (BMP) for multiple resource areas	Minimize erosion potential and sediment deposition related to construction and maintenance of water quality, provide avian protection and ensure no impact to any sensitive plants or promotion of invasive plan species associated with construction	Proposed by KHL	Construction and O&M
Section 404	404 Permit	Required by USACE	O&M
Section 401	401 Permit certificate of reasonable assurance [1]	Required by ADEC	O&M
Alaska Pollutant Discharge Elimination System (APDES) Permit	APDES Permit	Required by ADEC	Construction and O&M
Hazardous Materials Containment/Fuel Storage Plan Measures	Required internally by KHL for all contractors	Proposed by KHL	Construction and O&M

Table E.2-2, continued…

Measure	Description	Proposed/Agency Request	Phase (Construction vs. O&M)
Spill Prevention, Control and Containment Plan (SPCCP) Measures	Required internally by KHL for all contractors	Proposed by KHL	Construction and O&M
Water Right – KHL	Water right application	Required by ADNR	Construction and O&M
USFS Land Use	Special Use Permit	Required by USFS	Construction and O&M
Fire Prevention Plan (FPP)	Required internally by KHL for all contractors	Proposed by KHL	Construction
Obtain easements	ADNR, USFS, Railroad	Land Owner Requirement	Construction and O&M
Geological and Soil Resources (Section 4.4)			
Erosion and Sediment Control Plan (ESCP)	Description of measures to be implemented during construction to minimize erosion and sediment deposition associated with construction activities	Proposed by KHL	Construction
Hazardous Materials Containment/Fuel Storage Plan	Required internally by KHL for all contractors	Proposed by KHL	Construction and O&M
SPCCP	Required internally by KHL for all contractors	Proposed by KHL	Construction and O&M
Water Quality and Quantity (Section 4.5)			
Operational Compliance Monitoring Plan (OCMP)	Describes methods to assess priority water quality parameters during and immediately after construction. Also defines procedures for monitoring water temperatures in Grant Lake and Grant Creek during "priority" periods.	Proposed by KHL	Construction and O&M
Grant Creek Stream Gauge	Continued monitoring and maintenance of stream gauge on Grant Creek	Proposed by KHL	Construction and O&M
Aquatic Resources (Section 4.6)			
Biotic Monitoring Plan	Describes methods to assess fish health during construction and the initial phases of Project operations	Proposed by KHL	Construction and O&M
Terrestrial Resources (Section 4.7)			
Vegetation Management Plan (VMP)	Describes methods to both minimize invasive plant development in the Project area and maintain existing populations of sensitive species documented during licensing studies	Proposed by KHL	Construction and O&M
Avian Protection Plan (APP)	Describes methods to minimize impacts to avian species both during the short-term construction period and operations	Proposed by KHL	Construction and O&M

Table E.2-2, continued…

Measure	Description	Proposed/Agency Request	Phase (Construction vs. O&M)
Recreation, Land Use and Aesthetic Resources (Section 4.8 & 4.9)			
Public Safety and Access Plan (PSAP)	Describes the methods to implement and monitor the chosen public access allowance to the Project Area via Project constructed corridors. Public input and stakeholder collaboration will define the appropriate amount of access availability (if any)	Proposed by KHL	O&M
INHT Re-route	Per Section 4.8.3.3 of this Exhibit E, stakeholder collaboration will continue to select an appropriate INHT re-route corridor through the Project area. A plan for successful implementation will be developed once agreement has been reached	Collaboratively developed between stakeholders and KHL	O&M
Iditarod National Historic Trail Re-routing Plan (INHTRP)	Once a re-route is agreed to, the INHTRP will document the methods for implementation and management of the trail through the Project Area	Collaboratively developed between stakeholders and KHL	O&M
Cultural Resources (Section 4.10)			
Historic Properties Management Plan (HPMP)	Describes the known historic resources that may be impacted by Project construction and operation and define the methods for minimizing those impacts.	Collaboratively developed between stakeholders and KHL	Construction and O&M
Socioeconomics (Section 4.11)			
No measures proposed			

Notes:

1. Given that the State of Alaska does not issue Section 401 Water Quality Certifications for hydropower projects, KHL will request a waiver of 401 Certification from the ADEC for the Grant Lake Project prior to filing the FLA

2.2. Requested PM&E Measures

PM&E measures requested by stakeholders that are provided as part of the formal DLA commenting period will be detailed in the FLA.

2.3. No Action

For an Original License, as is the case with the proposed Grant Lake Project, the no-action alternative would be denial of the license. Under the no-action alternative, the Project would not be constructed and environmental and human resources in the Project area would not be affected.

The Grant Lake watershed and surrounding area in the vicinity of the proposed Project is in relatively natural condition. While periodic and seasonal, recreation (hiking, fishing, hunting, etc.) does occur in the area to a limited extent, the general lack of easy access tends to minimize the overall level of activity on the east side of Trail Lakes. As a result, both terrestrial and aquatic habitats in the area are relatively undisturbed and natural processes tend to dominate. Under the no-action alternative, it would be expected that this scenario would continue as no development related to the Project would occur and it is likely that the level of human influence would continue to be minimal overall. Section 4 of this Exhibit describes the current biological conditions in the Project vicinity along with the potential impacts (positive and negative) associated with Project development.

From an environmental consequence standpoint, the no-action alternative would facilitate a continued commitment to fossil fuels as the primary driver of power generation and consumption for HEA's members. The continued and long-term implications of continuing to utilize fossil fuels include atmospheric greenhouse gas emissions which contribute to climate change, poor air quality, and degradation of the aquatic environment.

2.4. Alternatives Considered but Eliminated

2.4.1. Project Site Alternatives

2.4.1.1. Crescent Lake

On October 1, 2008, KHL received a preliminary permit from the FERC to study the potential development of a small hydroelectric projects at Crescent Lake (P-13209) on the Kenai Peninsula. Crescent Lake is located 4 miles south of the community of Moose Pass, Alaska and approximately 25 miles north of Seward, Alaska. KHL conducted a reconnaissance study to evaluate the feasibility of a hydroelectric project at this location. The reconnaissance study considered environmental conditions, recreation, subsistence use, cultural and historical resources, land ownership, mining claims and water rights, energy generation, anticipated development costs and an economic evaluation of the proposed project. Based upon the results of this evaluation, agency input and public comments the Grant Lake/Creek project was considered the more viable resource and selected for further evaluation.

2.4.1.2. Ptarmigan Lake/Creek

On October 1, 2008, KHL received a preliminary permit from the FERC to study the potential development of a small hydroelectric projects at Ptarmigan Lake/Creek (P-13210) on the Kenai Peninsula. Ptarmigan Lake is located 6 miles south of the community of Moose Pass, Alaska and approximately 25 miles north of Seward, Alaska. KHL conducted a reconnaissance study to evaluate the feasibility of a hydroelectric project at this location. The reconnaissance study considered environmental conditions, recreation, subsistence use, cultural and historical resources, land ownership, mining claims and water rights, energy generation, anticipated development costs and an economic evaluation of the proposed project. Based upon the results of this evaluation, agency input and public comments the Grant Lake/Creek project was considered the more viable resource and selected for further evaluation.

2.4.1.3. Falls Creek

On October 1, 2008, KHL received a preliminary permit from the FERC to study the potential development of a small hydroelectric projects, Falls Creek (P-13211) on the Kenai Peninsula. Falls Creek is located approximately 1.5 miles south of the community of Moose Pass, Alaska and approximately 25 miles north of Seward, Alaska. KHL conducted a reconnaissance study to evaluate the feasibility of a hydroelectric project at this location. Two alternatives were considered; a stand-alone project that would discharge water back into Falls Creek and a project that would divert water from Falls Creek north to Grant Lake, where water would be used to generate power from the Grant Lake Project. The reconnaissance study considered environmental conditions, recreation, subsistence use, cultural and historical resources, land ownership, mining claims, water rights, energy generation, anticipated development costs and an economic evaluation of the proposed project. Based upon the results of this evaluation, agency input and public comments the Grant Lake/Creek Project was considered the more viable resource and selected for further evaluation. Since the Grant Lake project was selected for further evaluation, the Falls Creek diversion into Grant Lake was carried forward for further evaluation. Additional investigation into the engineering feasibility and the economics associated with the Falls Creek diversion led Kenai Hydro to determine that the Falls Creek Diversion portion of the project was infeasible. On March 31, 2011 KHL petitioned FERC to surrender the Falls Creek project preliminary permit.

2.4.1.4. Grant Lake/Creek

Hydroelectric potential at Grant Lake has been evaluated several times as a potential power source for the Kenai Peninsula area. In 1954, R.W. Beck and Associates (cited by Ebasco 1984) prepared a preliminary investigation and concluded that a project at the site had significant potential. The U.S. Geological Survey (USGS) conducted geologic investigations of proposed power sites at Cooper, Grant, Ptarmigan, and Crescent Lakes in the 1950s (Plafker 1955). In 1980, CH2M Hill (cited by Ebasco 1984) prepared a prefeasibility study for a Grant Lake project and concluded that a project developed at the site would be feasible. The Grant Lake Project was referenced in the 1981 USACE National Hydroelectric Power Resources Study (USACE 1981). The most extensive study was performed by Ebasco Services, Inc. in 1984 for the Alaska Power Authority (now Alaska Energy Authority; Ebasco 1984). The studies included a detailed examination of water use and quality; fish resources; botanical and wildlife resources; historical and archaeological resources; socioeconomic impacts; geological and soil resources; recreational resources; aesthetic resources; and land use (Ebasco 1984). Two of the alternatives evaluated by Ebasco included the diversion of adjacent Falls Creek into Grant Lake to provide additional water for power generation.

During the 1986-87 periods a preliminary application document was filed by Kenai Hydro, Inc. (no relation to the current KHL) for a project at Grant Lake. Support for the application included an instream flow study. Because of competing projects, political considerations, and inexpensive natural gas the project was never pursued beyond the preliminary application phase.

On October 1, 2008, KHL received a preliminary permit from the FERC to study the potential development of a small hydroelectric project at Grant Lake/Creek (P-13212) on the Kenai Peninsula. KHL conducted a reconnaissance study to evaluate the feasibility of a hydroelectric project at this location. The reconnaissance study considered environmental conditions, recreation, subsistence use, cultural and historical resources, land ownership, mining claims and water rights, energy generation, anticipated development costs and an economic evaluation of the proposed project. Based upon the results of this evaluation, agency input and public comments the Grant Lake/Creek project was considered the more viable resource and selected for further evaluation.

On August 6, 2009, KHL filed a PAD along with a NOI to file an application for an original license for the Grant Lake/Falls Creek project (P-13211/13212) under Part I of the Federal Power Act (FPA). On September 15, 2009, FERC approved the use of the TLP for development of the license application and supporting materials.

2.4.2. Project Facility Designs, Processes, and Operations Alternatives

2.4.2.1. Configuration Alternatives

Grant Lake has been studied on multiple occasions since the 1950s as a potential hydropower site. The previous study efforts included:

- 1954 – R.W. Beck and Associates preliminary investigation (as cited in Ebasco 1984)
- 1955 – USGS geological investigations of proposed power sites at Cooper, Grant, Ptarmigan, and Crescent Lake (Plafker 1955)
- 1980 – CH2M Hill prefeasibility study (CH2M Hill 1980)
- 1984 – Ebasco Services Project Feasibility Analysis (Ebasco 1984)

Within these previous studies, development of the hydroelectric potential was considered under a range of alternative configurations. The alternatives analysis cumulated with a more robust evaluation by Ebasco in their 1984 engineering evaluation (Ebasco 1984). The Ebasco analysis included size alternatives. Alternatives A, B, and C (below) focused on building a dam on the Grant Lake outlet as well as a saddle dam on the north of the natural outlet. These alternatives were designed to provide storage for power generation as well as increase the operating head on the powerhouse. Alternative D consisted of a lake tap near the existing Grant Lake outlet with no dams proposed. The final two alternatives, E and F, re-routed the adjacent Fall Creek flow into grant Lake with a dam (Alternative A) and no dam (Alternative D) configuration. Alternatives A, B, C, and D would use only the natural inflow from Grant Lake. Alternatives E and F would use the Grant Lake inflow plus Fall Creek for power generation.

KHL utilized these same alternatives as the starting point in the current licensing process. The previous work efforts were reviewed and updated, where required, to provide a basis for the alternatives development and analysis. A seventh alternative, Alternative G, was developed to reflect the additional environmental baseline data and the operational criteria required to address specific identified issues. A brief description of each alternative is presented in the following subsections.

Further details regarding the configuration alternatives are provided in the Preliminary Supporting Design Report in Exhibit F (Attachment F-1) of this DLA.

2.4.2.1.1 Alternative A – Intake Upstream of Saddle Dam

Alternative A consists of raising Grant Lake from its existing natural outlet at approximately elevation 703 feet NAVD 88 to a normal maximum lake elevation of 745 feet NAVD 88. The lake raise would be accomplished by constructing a main dam at the natural outlet of Grant Lake. A second dam would be constructed across a low saddle area located north of the main dam. Water would be conveyed from Grant Lake to a power house located on the east shore of Upper Trail Lake via a power conduit approximately 3,840 feet long with an intake structure located upstream from the saddle dam. The intake to the power conduit would be a submerged circular vertical concrete structure with vertical trashracks would be located approximately 1,300 feet upstream from the toe of the saddle dam. A steel pipeline would extend from the intake to a surge chamber. A steel penstock would continue from the surge chamber to the powerhouse. The discharge from the powerhouse would be through a tailrace channel to Upper Trail Lake. The powerhouse would house a single vertical Francis turbine operating with a maximum hydraulic capacity of 385 cfs at a net head of 247 feet. The powerhouse would have an installed capacity of 6 MW.

The substation would be located adjacent to the powerhouse. The transmission line would extend from the powerhouse south to Grant Creek, then cross the Trail Lake Narrows to the existing 115 kV transmission line located adjacent to the Seward highway. A total of 5.1 miles of access road would connect the Project features to the Seward Highway.

2.4.2.1.2 Alternative B – Intake at Main Dam with Tunnel and Surface Conduit

Similar to Alternative A, the Grant Lake elevation would be raised from 703 feet NAVD 88 to a normal maximum operating elevation of 745 feet NAVD 88 by constructing the main dam and saddle dam as described with Alternative A. With this alternative, the intake would be located at the main dam location. Water would be conveyed from the Grant Lake intake to a power tunnel using a 7-foot-diameter low pressure penstock. The first 300 feet of penstock under the dam would be placed in a rock trench and encased in concrete. The remaining 400 feet to the power tunnel would be installed on the surface supported by concrete saddles. The power tunnel would be horse shoe shaped and 9-foot-diameter fitted with an underground surge chamber. At the downstream end of the tunnel, a 5-foot-penstock would extend to a powerhouse with an installed capacity of 6 MW. The powerhouse would have essentially the same mechanical and electrical configuration as described for Alternative A. A short tailrace channel would carry the water from the powerhouse to the east bank of Upper Trail Lake. Approximately 2.0 miles of access roads would be required for the Project. The transmission line would follow the same approximate route across Trail Lakes Narrows.

2.4.2.1.3 Alternative C – Intake at Main Dam with Surface Conduit

Similar to Alternatives A and B, Alternative C utilized the same two dams to raise Grant Lake from approximately 703 feet NAVD 88 to 745 feet NAVD 88. The intake would be located at the main dam using a similar intake configuration as Alternative B. A 6.75-foot-diameter steel power conduit would extend from the intake beneath the dam to a surge chamber located at the downstream toe of the main dam. A 5.35-foot diameter, 2,000-foot-long steel penstock would extend from the surge chamber to the powerhouse. The powerhouse would be located approximately 80 feet from the east bank of Upper Trail Lake. The powerhouse would consist of a concrete foundation and a steel superstructure. The mechanical and electrical equipment would be similar to Alternatives A and B as well as the 6 MW rated capacity.

2.4.2.1.4 Alternative D – Lake Tap with Powerhouse at Upper Trail Lake

With this alternative, the main dam and saddle dam as proposed with the Alternatives A, B, and C would be eliminated. Alternative D does not involve the water elevation at Grant Lake. A lake tap would supply water from a low level power tunnel and a short length of penstock to a powerhouse located on Upper Trail Lake. The lake tap would have an intake invert at approximately elevation of 643 feet NAVD 88. The lake tap would consist of an inclined 10-foot-diameter circular tunnel which would incorporate a rock trap located just downstream of the intake portal. A trashrack would be placed on the intake portal to exclude debris from entering the power conduit. A 9-foot-diameter horseshoe shaped power tunnel would extend approximately 3,300 feet from the lake tap to the powerhouse. A 5-foot-diameter, 500-foot-long steel penstock would then extend from the downstream tunnel portal to the powerhouse located on the east bank of Upper Trail Lake. A gate shaft would be located approximately 200 feet downstream from the lake tap. An isolation gate would be located in the gate shaft. A conventional powerhouse with a concrete foundation and steel superstructure would be located approximately 180 feet from the east bank of Upper Trail Lake. The powerhouse would have a single vertical Francis turbine operating under a net head of 198 feet with an installed capacity of 5 MW.

2.4.2.1.5 Alternatives E and F – Diversion of Falls Creek

These alternatives would divert runoff from the Falls Creek drainage, located directly south of the Grant Lake drainage, into Grant Lake for additional power production. For both of these alternatives, the diversion of Falls Creek would be accomplished using a diversion dam and conduit to convey water from Falls Creek into Grant Lake. For Alternative E, the diversion of Falls Creek is used in combination with raising Grant Lake from its existing elevation of 703 feet NAVD 88 to a maximum normal operating elevation of 745 feet NAVD 88. This is accomplished with the same two dam configuration as presented for Alternative A. The power conduits, powerhouse, transmission, and access would be similar to the configuration proposed for Alternative A. The powerhouse would have a rated capacity of 7 MW.

Alternative F consisted of the Falls Creek diversion coupled with the no dam Alternative D configuration. The power tunnel, powerhouse, transmission, and access would be similar to the configuration proposed for Alternative A. The powerhouse would have a rated capacity of approximately 6 MW.

2.4.2.1.6 Alternative G – Lake Intake with a Powerhouse on Grant Creek

Alternative G was developed essentially as an outgrowth of Alternative D with the basic features modified to address considerations raised as part of the environmental baseline studies completed in 2009 through 2014. These studies identified aquatic habitat and resources within Grant Creek from the confluence with Upper Trail Lake up to the outlet of the canyon area of Grant Creek (Reaches 1 through 4). The area within the canyon area (Reach 5), though not identified as productive habitat as the lower area of Grant Creek, provided limited habitat for specific species. Measures to protect and enhance these areas were then identified and incorporated into Alternative G. This alternative consists of a conventional intake tower located in Grant Lake fitted with a selective withdrawal intake gate and an isolation bulkhead gate. Water is conveyed via a 10-foot-diameter, 3,300-foot-long horseshoed shaped tunnel. The upper reach of the tunnel would be unlined and constructed on a 1 percent slope. The lower reach of the tunnel would be lined and constructed at 15 percent slope. A surge chamber is located at the junction between the two tunnel sections. A rock trap is located at the downstream end of the unlined tunnel directly under the surge chamber. Steel liners will be installed at both the upstream and downstream portals to provide structural strength of the tunnel through the transition areas. A 72-inch diameter steel penstock extends from the downstream tunnel portal to the powerhouse. The powerhouse would be a conventional concrete foundation with a steel superstructure. Two Francis turbines with a combined rated capacity of 5 MW at a maximum hydraulic capacity of 385 cfs and a net operating head of 171 feet. Water is conveyed from the powerhouse back to Grant Creek in an excavated tailrace channel with a fish barrier located at the outfall back into Grant Creek. The tailrace channel discharges into Grant Creek near the outlet of the canyon section of Grant Creek. A detention pond is located on the south side of the powerhouse providing the additional benefit of spinning reserve operation. The transmission line will extend approximately 1 mile from the substation located adjacent to the powerhouse west to the existing 115 kV transmission line. The transmission line will follow the powerhouse access road which extends from the Seward Highway across the Trail Lakes Narrows. An access road will also be provided to the intake structure.

2.4.2.1.7 Proposed Configuration

In the previous alternatives analysis (Ebasco 1984), Alternative D was the recommended alternative with a consideration for diverting Fall Creek as presented within Alternative F. With this alternative, the powerhouse was located approximately 180 feet from the east bank of Upper Trail Lake. Under most operating conditions, Grant Creek would have been dewatered.

As outlined in the alternatives description, development of Alternative G incorporated a number of design modifications which provided a net benefit in environmental conditions. These design modifications included:

1) Relocate the powerhouse for the bank of Upper Trail Lake on the north side of Grant Creek to the south side of Grant Creek to the outlet of the canyon reach (Reach 5).

2) Relocate the intake from the north side of the natural outlet of Grant Lake to the south side and replace the lake tap with a conventional intake structure with the capabilities of selective water withdrawal for downstream temperature considerations.

3) Re-align the access road to eliminate parallel alignment with the INHT.

4) Eliminate the 2-foot-tall diversion structure at the top of the Grant Creek natural outlet.

5) Provide a bypass pipe from the lake intake to the base of the existing falls at the Grant Lake outlet to provide a minimum flow of 5 cfs to 10 cfs in Reach 5.

6) Re-route the transmission line to follow the powerhouse access road directly west to the existing 115-kV transmission line.

7) Modify the proposed single Francis unit 5-MW powerhouse to a two unit configuration to provide more flexibility to release flows to meet downstream flow considerations for aquatic habitat in the winter months.

Alternative G has been selected as the preferred alternative for the Project. This site configuration was selected because it represented the optimum environmental configuration by eliminating the dams, placing the powerhouse tailrace upstream of the prime aquatic habitat, and eliminated the Falls Creek water diversion.

2.4.3. Alternative Energy Sources

South-Central Alaska has benefited from a surplus of natural gas discovered primarily in the 1960s as a byproduct of oil exploration in the Cook Inlet area. As a result of abundant and affordable natural gas, the heating and electrical infrastructure for South-Central Alaska was developed around this resource. Approximately 90 percent of the electrical needs of South-Central Alaska are met with natural gas fired turbines. However, gas production has dropped considerably since 2002 with a decline in annual production of 210 (billion cubic feet) Bcf to 103 Bcf in 2012. As a consequence of this precipitous production decline, the price of natural gas has gone from $2.50 to over $6.00/thousand cubic feet (Mcf) in that same time period. The current cost of gas in the region is about $6.90/Mcf in 2015, with the cost as high as $9.25/Mcf for contracted gas in 2019.

The Alaska Division of Oil and Gas estimates that there are still proven and conventionally recoverable gas reserves in the Cook Inlet Region. Additionally, Alaska continues to work on ways to get North Slope gas to South-Central Alaska but none of the potential solutions indicate a shrinking natural gas price for the region. HEA, like the rest of the electric utilities, will continue to generate a majority of its electricity from natural gas. That said, HEA has a strong desire to diversify its energy mix, reduce its dependence on fossil fuels and develop responsible renewable energy resources.

HEA's power supply portfolio primarily consists of natural gas-fired generation and some hydroelectric power. The generation facilities are summarized in Table E.2-3.

Table E.2-3. HEA generation facilities.

Generation Facility	Capacity	No Units/Age
Nikiski Combined Cycle Plant (Steam/Gas)	80 MW	CT 1984, ST 2014
Soldotna Combustion Turbine Plant (Gas0	48 MW	2014
Bernice Lake Combustion Turbine (Gas)	80 MW	3 Units 1971, 1978, 1981
Bradley Lake Hydroelectric Project (hydro)	14 MW	1991

HEA's gas-fired generation makes up 91 percent of its current generation portfolio, strongly influences HEA's rates and is subject to significant price volatility. HEA is seeking to diversify its generation portfolio. Part of this diversification is to develop renewable generation. The proposed Grant Lake Project would represent approximately 4 percent of HEA's energy needs, and would represent a 45 percent increase in its renewable energy portfolio.

2.4.4. Consequence of License Application Denial

Denial of the license application for the Grant Lake Project would mean that the Project could not be constructed as proposed by KHL. This would mean a continued reliance on an increasingly scarce and expensive Cook Inlet (Alaska) natural gas supply. Denial of the license application would result in the continued release of approximately 10,000 tons of CO_2 annually to produce the equivalent amount of carbon-based energy.

Denial of the license application would be a significant setback in the Cooperatives goal of generating 22 percent of its power from renewable energy resources. It would also result in a setback to the State of Alaska's renewable energy goal of 50 percent renewable energy by 2025.

Denial of the license application would mean the loss of approximately $5,100,000 to HEA ($3,000,000) and the State of Alaska ($2,100,000) in funds associated with the development of the Project.

Lastly, it would mean that this low impact hydroelectric resource would remain undeveloped and of no benefit to the citizens of the State of Alaska.

3 Consultation and Scoping

3.1. Consultation

KHL initiated consultation with federal and state resource agencies, Native Alaskan tribes, non-governmental organizations (NGO), and other interested parties in August 2009 with the filing of filing of the NOI and PAD (KHL 2009b). Stakeholders contacted as part of the consultation process are listed in Table E.3-1.

Table E.3-1. List of consulted parties.

Federal Agencies	
BLM	Unites States Bureau of Land Management
EPA	Environmental Protection Agency
NOAA Fisheries	National Oceanic and Atmospheric Administration
NPS	National Park Service
USACE	U.S. Army Corps of Engineers
	U.S. Department of Interior, Office of Environmental Policy and Compliance
USFS	U.S. Forest Service
USFWS	United States Fish and Wildlife Service

Table E.3-1, continued…

USGS	U.S. Geological Survey
State Agencies	
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
	Kenai Peninsula Borough, Kenai River Center
Native Alaskan Tribes	
	Chenega Corporation
	Chugach Alaska Corporation
CIRI	Cook Inlet Region, Inc.
	Kenai Native Association
	Kenaitze Indian Tribe
	Native Village of Eklutna
	Ninilchik Traditional Council
	Quekcak Native Tribe
	Salamatof Native Association, Inc.
Local Governments	
	Moose Pass Chamber of Commerce
NGOs	
ACE	Alaska Center for the Environment
	Alaska Conservation Alliance
	Alaska Conservation Foundation
	Alaska Fly Fishers
	American Rivers
	The Center for Water Advocacy
CIAA	Cook Inlet Aquaculture Association
	Cook Inlet Keeper
	Friends of Cooper Landing
	Kenai Area Fisherman's Coalition
KRSA	Kenai River Sportfishing Association
KRWF	Kenai River Watershed Foundation
	National Wildlife Federation
NHI/HRC	National Heritage Institute/Hydro Reform Coalition
RBCA	Resurrection Bay Conservation Alliance
	Sierra Club
	Trout Unlimited

Resource agencies and other stakeholders were consulted throughout the Project licensing process, both during engagement required by FERC's licensing regulations and during many additional consultation opportunities provided by KHL. The consultation record for the licensing (through March 1, 2015) is provided as a summary table in Attachment E-1, and with the official record available electronically on an accompanying compact disk. Table E.1-1 identifies the major filings to date and Table E.3-2 identifies the associated consultation engagements that have occurred thus far during the licensing process.

Table E.3-2. Major consultation engagements to date.

Engagement	Date
Information meeting with ADF&G and ADNR	December 16, 2008
Information meeting with USFS	December 18, 2008
Interactive stakerholder meetings	January 20-21 and 28, 2009
Instream Flow Technical Working Group (TWG) meeting in Moose Pass to discuss draft 2009 study plans	March 24, 2009
Instream Flow TWG meeting in Kenai to discuss draft 2009 study plans	April 21, 2009
Instream Flow TWG conference call to discuss revised 2009 study plans	May 19, 2009
Instream Flow TWG conference call to discuss 2009 baseline results	July 16, 2009
Instream Flow TWG meeting to discuss 2009 baseline results and an instream flow incremental methodology (IFIM) approach	September 22-24, 2009
Joint meeting	November 12, 2009
Public meeting	January 13, 2010
FERC site visit and scoping meetings	June 2-3, 2010
Natural Resources Studies meeting to discuss 2013 study plans	December 12, 2012
Cultural Resources Work Group (CRWG) conference call to discuss Area of Potential Effect (APE)	April 3, 2013
Grant Creek Site Visit	September 5, 2013
Iditarod National Historic Trail (INHT) meeting	November 13, 2013
Natural Resources Work Group (NRWG) meeting to review 2013 study results	March 18, 2014
Aquatic Resources Work Group (ARWG) meetings to review 2013 study results	March 19-20, 2014
CRWG meeting to review 2013 study results	March 21, 2014
Instream Flow Sub Group	March 27, 2014
Instream Flow Sub Group	April 18, 2014
Instream Flow Sub Group	May 22, 2014
Operations Workshop	July 7-8, 2014
INHT site visit	July 15, 2014
Instream Flow Sub Group	July 17, 2014
Public meeting	November 6, 2014

3.2. Scoping

The NEPA requires FERC to independently evaluate the environmental impacts of the Project as proposed and consider reasonable alternatives to KHL's Proposed Action. FERC has indicated its intent to prepare an Environmental Assessment (EA) that describes and evaluates the probable impacts, both site-specific and cumulative, of KHL's Proposed Action and any other action alternatives (FERC 2010b). The EA preparation is supported by the scoping process, which was undertaken to ensure that all potential issues associated with the Proposed Action were identified and analyzed.

Scoping is the process whereby issues, concerns, and opportunities associated with a Proposed Action are identified. The purposes of scoping process are to invite participation of federal and state resource agencies, Native Alaskan tribes, NGOs, and the public to identify significant environmental and socioeconomic issues potentially related to the Proposed Action; determine the significance and depth of analysis needed to address issues in the EA; identify how the Project would or would not contribute to cumulative effects; identify reasonable alternatives to the Proposed Action to be evaluated in the EA; solicit from participants available information on the resources at issue; and determine the resource areas and potential issues that do not require detailed analysis.

FERC issued Scoping Document 1 (SD1) (FERC 2010a) for the proposed Project on May 11, 2010. FERC conducted scoping meetings in Moose Pass, Alaska on June 2-3, 2010. During the meetings and subsequent comment period, FERC received comments on the Project's PAD and the SD1. In response to those comments, FERC issued Scoping Document (SD2) August 23, 2010 (FERC 2010b). In its SD2, FERC discussed its preliminary view of the scope of environmental issues, as follows:

- Geology and Soils Resources
  - Effects of Project construction and operation on erosion and sedimentation of Grant Lake and its shoreline
  - Effects of Project construction and operation on erosion or sedimentation of the existing Inlet Creek delta
  - Effects of construction of the proposed outlet works, diversion structure, intake structure, tunnel, penstock, surge tower, powerhouse, tailrace detention basin, tailrace, access roads and transmission line on erosion and sedimentation of Grant Creek, the Narrows and Lower Trail Lake
  - Disposal/dispersion methods of spoil material resulting from construction of the proposed project facilities and impact on the surrounding areas
- Water Quantity and Quality
  - Effects of Project construction and operation on the water quality of Grant Lake, Grant Creek, Falls Creek[3], Lower Trail Lake, and the Narrows
  - Effects of Project construction and operation on the hydrology of Grant Lake, Grant Creek, Lower Trail Lake, and the Narrows
  - Effects of project construction and operation on heavy metal leaking as a result of water level fluctuations of Grant Lake
  -
- Aquatic Resources
  - Effects of Project construction and operation on the fish and aquatic resources in Grant Lake, Grant Creek, Falls Creek, Lower Trail Lake, and the Narrows

[3] As noted in Section 2.4.1.3 of this Exhibit E, KHL petitioned FERC to surrender the Fall Creek project preliminary permit on March 31, 2011, and therefore, is no longer part of the proposed project.

  - Effects of diverted flows on fish and aquatic resources in the proposed bypass reach of Grant Creek
  - Effects of Grant Lake reservoir fluctuations on fish and aquatic resources
  - Effects of entrainment on fish populations in Grant Lake and Grant Creek
  - Effects of the loss of habitat connectivity and bi-directional passage on resident fish populations in Grant Lake and Grant Creek
  - Effects of project construction and operation on changes in distribution and abundance of aquatic insects
  - Effects of the proposed project construction and operations on sediment transport and materials recruitment downstream
- Terrestrial Resources
  - Effects of Project construction and operation on the distribution and abundance of plant species designated by the Forest Service as sensitive
  - Effects of Project construction and operation on the distribution and abundance of invasive plant species
  - Effects of Project construction and operation on forest/scrub, wetland, riparian, and littoral habitats used by wildlife on Grant Lake and Grant Creek
  - Effects of Project construction and operation on wildlife critical life stages, distribution, and abundance, including:
    - Wildlife species designated by the Forest Service as Management Indicator Species, such as brown bear, moose, bats and mountain goat
    - Wildlife species designated by the Forest Service as Species of Special Interest, such as Canada lynx, wolverine, river otter, marbled murrelet, Townsend’s warbler, Northern goshawk, bald eagle, and osprey
    - Wildlife species designated by the State of Alaska as Species of Special Concern, such as olive-sided flycatcher, gray-cheeked warbler, blackpoll warbler, and brown bear
  - Effects of Project operation on availability of fish as food for wildlife
  - Effects of Project construction and operation on wildlife movement as well as displacement and disruption of seasonal movement patterns through the project area
  - Effects of project construction and operation on increased access to harvestable wildlife
  - Effects of Project operation on littoral wildlife habitat at the narrows between Upper and Lower Trail Lakes
  - Effects of Project construction and operation on breeding and rearing habitat and nesting success of shorebirds and waterfowl and other avian use in and around Grant Lake and Inlet Creek
  - Effect of Project transmission lines on raptors and other birds, including electrocution and collision hazards
- Threatened and Endangered Species
  - No federally listed threatened and endangered species are known to occur in the Project vicinity. No issues regarding threatened and endangered species have been identified at this time.

- Recreation Resources and Land Use
  - Effects of Project construction and operation on existing recreation and land use in and around Grant Lake, Grant Creek, Falls Creek, Lower Trail Lake, and the Narrows
  - Effects of Project construction and operation on current and future (over the term of a license) recreation demand and use, including barrier-free access and the need for and benefit of interpretive opportunities (such as interpretive signs) at the Project
  - Effects of Project construction and operation on local residential land use
  - Effects of project construction and operation on the roadless character of the Kenai Mountains Roadless Area
  - Effects of the development of a project access road on the existing Vagt Lake Trail as well as the INHT right-of-way (ROW)
  - Effects of recreation use at Grant Lake on the potential to increase recreational use at nearby water bodies
- Aesthetic Resources
  - Effects of Project construction, facilities, and operation on the aesthetic values of the Project area, including noise and light pollution
  - Effects of the transmission line on Scenic Byway viewpoints from the Seward "All American" Highway and views from existing recreation trails such as the Iditarod National Historic Trail
- Cultural Resources
  - Effects of Project construction and operation on historical and archaeological resources and properties of traditional religious and cultural importance to Native Alaska tribes
  - Effects of Grant Lake reservoir fluctuations and reduced flows in Grant Creek on archaeological resources located along the reservoir shoreline
  - Effects of Project construction and operation on subsistence use (hunting, fishing, and gathering) involving Native Alaskan tribes and non-Native Alaskans
- Socioeconomics
  - Effects of Project construction and operation on local, tribal, and regional economies

Detailed information on the scope of the environmental analysis, including the spatial and temporal scopes of the cumulative effects assessment, can be found in Section 4 of this Exhibit E.

3.3. Response to Comments on the Draft License Application

KHL responses to comments submitted as part of the formal DLA commenting period will be detailed in the FLA.

3.4. REA Notice

KHL will be filing its FLA with FERC in late 2015. Once FERC has determined that the application meets all filing requirements, studies have been completed, any deficiencies have been resolved, and no additional information is required, FERC will issue the notice of acceptance and ready for environmental analysis (REA).

The acceptance/REA notice solicits comments, protests, and interventions – along with recommendations, preliminary terms and conditions, and preliminary fishway prescriptions – including all supporting documentation. Comments, protests, and interventions must be filed within 60 days of the notice. KHL then has 45 days to respond to submitted comments (105 days from the REA notice). KHL will direct responses to the entity providing the original comments and file a copy of the response with FERC.

When the application is accepted, FERC provides public notice in the Federal Register, local newspapers, and directly to resource agencies and Native Alaskan tribes. In its notice, FERC invites protests and interventions and requests the final fish and wildlife recommendations, prescriptions, mandatory conditions, and comments from the resource agencies and Native Alaskan tribes.

4 Environmental Analysis

The following sections describe the anticipated impacts of the Proposed Action on environmental resources, including discussion of resources that would not be affected by the action. The following topics are addressed for each resource: Affected Environment, Environmental Analysis, Proposed Environmental Measures, Cumulative Effects, Unavoidable Adverse Impacts, and Consistency with Comprehensive Plans.

4.1. Cumulative Effects

According to the Council on Environmental Quality's regulations for implementing NEPA (50 C.F.R. 1508.7), a cumulative effect is the effect on the environment that results from the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (FERC 2006). Based on preliminary staff analysis, FERC identified in its SD2 (FERC 2010b) the following resources that may be cumulatively affected by the proposed operation of the Project:

- Water quantity
- Water quality
- Fishery resources
- Recreation resources

4.1.1. Geographic Scope

The geographic scope of analysis for cumulatively affected resources is defined by the physical limits or boundaries of the Proposed Action's effect on resources and contributing effects from other hydropower and non-hydropower activities. In its SD2 (FERC 2010b) FERC tentatively identified the Kenai River Basin as the geographic scope of analysis for water quantity, water quality, fishery resources, and recreation resources.

4.1.2. Temporal Scope

The temporal scope of cumulative effects analysis includes a discussion of past, present, and future actions and their effects on each resource. Based on the potential term of a license, FERC determined in its SD1 (FERC 2010b) that the temporal scope will evaluate a period of 30-50 years into the future, concentrating on effects on resources from reasonably foreseeable future actions; the quality and quantity of information related to potential future actions will diminish as the analysis proceeds further into the future. The historical discussion will, by necessity, be limited to the amount of available information for each resource.

4.2. Applicable Laws

4.2.1. Section 401 of the Clean Water Act

As part of the licensing process, KHL is consulting with the ADEC regarding the development of an application for water quality certification under Section 401 of the Clean Water Act (CWA). The State of Alaska does not issue Section 401 Water Quality Certifications for hydropower projects. As such, KHL will request a waiver of 401 Certification from the ADEC for the Grant Lake Project prior to filing the FLA.

4.2.2. Section 404 of the Clean Water Act

As part of the licensing process, KHL is consulting with the USACE regarding the development of an application commensurate with Section 404 of the CWA. The USACE, through the Section 404 application process will evaluate the potential for and plan to regulate the discharge of fill materials in the waters of the United States with a particular emphasis on wetlands. KHL has been in consistent communication with the USACE representative, and will be developing its Section 404 permit application in parallel with its DLA and anticipates submitting it to the USACE for review and processing in April 2015. The USACE review is anticipated to take approximately 2-4 months.

4.2.3. Endangered Species Act

Section 7 of the ESA requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such sensitive species. A small population of the USFS sensitive plant pale poppy (*Papaver alboroseum*) was located during the sensitive plants survey on the north shore of Grant Lake. A Draft BE for sensitive plants in the Project area is under development and will be distributed for comment between late April and mid-May. Further description of the existing environment with specific respect to botanical communities along with species tables is discussed in Section 4.7 of this Exhibit E.

4.2.4. Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, commonly referred to as the Magnuson-Stevens Act, is the primary law governing marine fisheries management in the United

States. The Act was originally passed in 1976, amended by Congress in 1996, and reauthorized in 2006. Per the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes – Southcentral Region* (ADF&G 2014), Grant Creek is designated as having Essential Fish Habitat (EFH) for certain life stages of Chinook, coho and sockeye salmon. A significant amount of communication and collaboration between National Oceanic and Atmospheric Administration (NOAA) Fisheries and KHL has occurred throughout aquatic study development discussion of analysis and results and potential impacts (positive and negative) to the aquatic environment as a result of Project development and operation. This collaboration with NOAA Fisheries (and all stakeholders for that matter) has resulted in a PM&E package that KHL feels is consistent with stakeholder expectation. As stated previously, the detailed descriptions of these PM&Es and associated monitoring methods will be discussed in the management/monitoring plans to be distributed for comment between late April and mid-May.

4.2.5. Coastal Zone Management Act

Congress passed the Coastal Zone Management Act (CZMA) in 1972. The Act, administered by NOAA’s Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources and calls for balancing economic development with environmental conservation. The CZMA outlines two national programs, the National Coastal Zone Management Program and the National Estuarine Research Reserve System. The overall program objectives of the CZMA are to “preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone.” On July 7, 2011, by operation of Alaska State law, the federally approved Alaska Coastal Management Program expired, resulting in a withdrawal from participation in the CZMA’s National Coast Management Program.

4.2.6. National Historic Preservation Act

Section 106 of National Historic Preservation Act (NHPA) requires FERC to take into account the effect of licensing a hydropower project on any historic properties, and allow the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the Proposed Action. ‘‘Historic Properties’’ are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). The effect of the proposed Project on historic properties, as well as PM&E measures associated with historic properties, will be described in Section 4 of this Exhibit E and in the Historic Properties Management Plan (HPMP) to be filed in conjunction with this application. The HPMP will include documentation of consultation with the ACHP, the State Historic Preservation Officer (SHPO), the National Park Service (NPS), Tribal Historic Preservation Officer (THPO) and affected Native Alaskan tribes.

4.2.7. Wild and Scenic Rivers Act

Congress enacted the National Wild and Scenic Rivers Act to protect select rivers of the United States from development that would substantially alter their wild and scenic nature. Selected rivers are preserved because they possess outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, or other values. Designation as a wild and scenic river does not confer the same level of protections as a Wilderness Area designation; rather than mandatory conservation measures, the goal is often to preserve the character of the river.

National Wild and Scenic rivers are each managed by one or more agencies of the federal or state government. Based on current status, there are no river segments near the Project area designated as “wild”, “scenic” or “recreational”. As such, there is no action required with respect to the Wild and Scenic Rivers Act.

4.2.8. The National Trails System

The National Trails System is the network of scenic, historic, and recreation trails created by the National Trails System Act of 1968. These trails provide for outdoor recreation needs, promote the enjoyment, appreciation, and preservation of open-air, outdoor areas and historic resources, and encourage public access and citizen involvement. The INHT transits a significant portion of western Alaska from Seward to Nome. Certain portions of the trail are currently developed and in use while other sections are proposed, designed to various levels and have yet to be constructed. The section of the INHT through the Grant Lake Project area is proposed but not currently constructed, however, the USFS has secured an easement and initial delineation of the trail corridor has been conducted. A significant amount of communication and collaboration has occurred between the requisite stakeholders and KHL in regard to a potential re-route of the INHT through the Project area. KHL has modified certain aspects of its Project infrastructure to avoid multiple infrastructural interactions with the trail as it transits the Project area. However, under the current configuration, the trail would still bisect the powerhouse just prior to crossing Grant Creek. The aforementioned collaboration and associated effort toward reaching a re-route agreement that would avoid this interaction is discussed in detail in Section 4.8.1.3 and 4.8.2.3 of this Exhibit E.

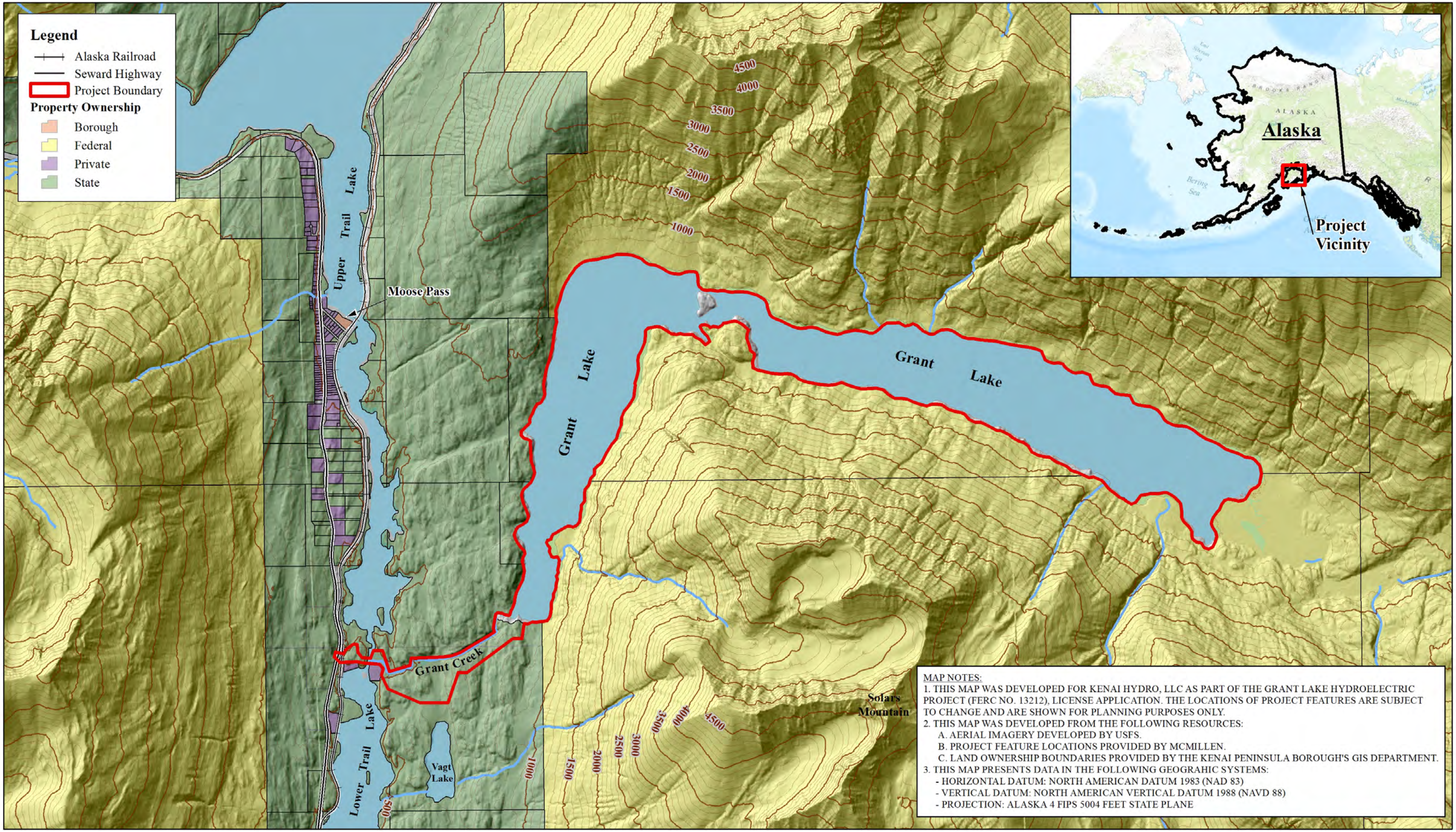
4.3. General Description of River Basin

The proposed Grant Lake Project will be located near the community of Moose Pass, Alaska (population 219) in the Kenai Peninsula Borough, approximately 25 miles north of Seward, Alaska (population 2,693), and just east of the Seward Highway (State Route 9)(Figure A.3-1); this highway connects Anchorage (population 291,826) to Seward. The Alaska Railroad parallels the route of the Seward Highway, and is also adjacent to the Project area. A map of Grant Lake and Grant Creek, including land ownership and the proposed Project boundary, is shown in Figure E.4-1.

4.3.1. Topography

Grant Lake is a glacier-formed lake surrounded by the Kenai Mountain Range in south-central Alaska. Its right-angle bend is indicative of the diversion of a side glacier at its intersection with the major southward moving glaciers, a morphology characteristic of the east-west trending Grant Lake and Kenai Lake valleys, which have nearly right-angle bends where they intersect the major north-south trending lowlands. The surrounding mountains rise to over 5,000 feet elevation and contain many small glaciers at the heads of most of the major valleys. The geology of the proposed Project site and vicinity is associated with the upper Cretaceous age of the Mesozoic era and is between 64 and 100 million years old. Most of Grant Lake is underlain by low-grade metamorphosed sedimentary rock, predominantly greywacke and slate. This area of Alaska is also one of the most seismically active regions in the world, being located above the

Alaska-Aleutian megathrust fault, which extends eastward along the Aleutian arc into south-central Alaska.



REV	DATE	BY	DESCRIPTION

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Drawing Scale: 0 0.25 0.5 1 Miles

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Homer Electric Association, Inc.
A Touchstone Energy® Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.4-1
Location Map of Project Vicinity

DESIGNED Jake Woodbury
DRAWN Jake Woodbury
CHECKED C. Warnock
ISSUED DATE 2/18/2015

DRAWING

SCALE: 1:35,000

4.3.2. Hydrology

Grant Lake is located approximately 1.5 miles southeast of Moose Pass, Alaska. It is located at an elevation of approximately 703 feet NAVD 88, with a maximum depth of nearly 300 feet, average depth of 91 feet, and surface area of 2.6 square miles. The lake is ringed by mountains of the Kenai Mountain Range to the east, north, and south, with elevations ranging from 4,500 to 5,500 feet. The Grant Lake and Grant Creek watershed has a total drainage area of approximately 44 square miles. Inlet Creek is the predominant stream in the upper portion of the watershed and drains melting alpine glaciers and snow from the nearby mountains into Grant Lake on the eastern banks. In addition, there are several intermittent, snowmelt-fed streams that drain the steep terrain adjacent to Grant Lake. Grant Lake encompasses two almost separate bathymetric lake basins, which are separated by a shallow submerged ridge at the "narrows" that connects the two basins at right angles near the lake's midpoint. The deepest point within the lower basin is approximately 262 feet deep and the upper basin is 283 feet deep (Ebasco 1984).

Grant Lake's only outlet, Grant Creek, runs west approximately 1 mile from the south end of Grant Lake to drain into the narrows between Upper and Lower Trail Lake. Trail River drains Lower Trail Lake, and then flows into Kenai Lake. Kenai Lake drains into the Kenai River at its west end near Cooper Landing (Ebasco 1984). Based on U.S. Geological Survey (USGS) data from 1947-1958, Grant Creek has a mean annual flow of 192 cfs with average monthly flows ranging from a low of 20 cfs in March to a high of 518 cfs in July (Table E.4-1).

Table E.4-1. Mean monthly and annual discharge data for Grant Creek in cfs. (Calculation period 9/1/1947-9/30/1958 at USGS Gage 15246000).[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1947									260	263	200	116	
1948	32	24	17	27	244	493	556	385	162	260	90	26	194
1949	15	12	15	17	137	409	474	325	446	194	197	71	193
1950	37	21	18	26	118	447	521	481	338	101	33	21	181
1951	19	16	14	27	124	325	519	376	505	88	52	30	175
1952	19	17	16	15	66	375	572	434	268	337	263	124	210
1953	58	45	30	61	281	928	711	513	294	257	69	40	275
1954	32	33	28	30	173	409	420	384	201	168	145	51	174
1955	42	24	18	18	72	291	643	407	273	82	42	25	163
1956	20	17	15	22	121	269	471	453	215	65	56	52	149
1957	22	19	20	29	166	449	359	370	565	207	161	56	202
1958	44	29	26	66	170	535	450	418	155				
Mean	31	23	20	31	152	448	518	413	307	184	119	56	192

Notes:
1 http://waterdata.usgs.gov/ak/nwis/uv/?site_no=%2015246000&PARAmeter_cd=00065,00060

In addition to the 10-year streamflow record from USGS gage 15246000, there has been intermittent streamflow monitoring at Grant Creek in 1981-1983 and from 2013 to present (Ebasco 1984 and KHL 2014b). Statistics were applied to these intermittent data as well as developing a correlation to USGS gage 15258000 (Kenai River at Cooper Landing) to create a composite streamflow record for Grant Creek that represents of 66 years of daily streamflow data for calendar years 1948 through 2013. The monthly and annual flow statistics for the 66-year composite record are provided in Table E.4-2. Similar to the 10-year USGS record, minimal and peak average monthly flows occur in March and July, respectively. However, the 66-year composite record indicates a higher mean annual flow of 206 cfs, an increase of 7.3 percent from the USGS record.

Table E.4-2. Mean monthly and annual discharge data for Grant Creek in cfs. (Calculation period 1/1/1948-12/31/2013 based on 66 year composite record).

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948-2013	52	43	33	36	146	409	503	444	367	233	123	73	206

Water level fluctuations within Grant Lake were studied from January 1982 through December of 1983 (Ebasco 1984). The maximum relative elevation difference observed during the 2 year period was 3.4 feet with a -5.3 foot elevation decrease from the maximum lake elevation of 703 feet NAVD 88. The greatest inter-monthly changes occur during ice breakup and snowmelt from late March through late June, with an average lake elevation increase of 0.8 feet per month. The maximum lake elevations were observed in July during both seasons with decreasing water levels in the fall and winter averaging about 0.33 feet per month.

Historical calculations of retention time at Grant Lake were 672 days based on an average outflow volume of 180 cfs (Ebasco 1984). Updated calculations indicate that retention time is closer to 617 days based on full lake storage capacity of 251,920 acre-feet and an average annual outflow of 206 cfs.

4.3.3. Climate

The proposed Project is surrounded by glaciated mountains that typically experience high average annual snowfall. Additionally, the Grant Creek valley can be affected by a maritime climate characterized by relatively warm temperatures and substantial rainfall events in the summer and fall. Historical monthly and annual precipitation data, as well as air temperatures are summarized in Table E.4-3. Compiled historical weather data from a NOAA weather station in Moose Pass, Alaska indicates average annual precipitation is 29.4 inches with an annual snowfall total of 77.8 inches that normally occurs from October through April. The mean annual temperature in Moose Pass and Grant Creek is 36.8°F and 34.7°F, respectively, with the winter months averaging ~22°F and summer months averaging ~52°F.

Table E.4-3. Mean monthly and annual precipitation and temperature based on NOAA records[1] and Grant Creek weather station (GC 200 – based on 9/15/2011-6/17/2014 period of record).

NOAA Moose Pass Weather Station 1981-2010 Monthly Normals						**GC200 Weather Station**	
Precipitation (inches)		**Snowfall (inches)**		**Temperature (F)**		**Temperature (F)**	
Month	**Mean**	**Month**	**Mean**	**Month**	**Mean**	**Month**	**Mean**
1	2.43	1	13.9	1	19.0	1	18.9
2	2.73	2	10.7	2	21.2	2	24.5
3	1.31	3	12.2	3	26.9	3	23.9
4	1.10	4	3.2	4	36.3	4	32.9
5	1.05	5	0.0	5	45.3	5	43.6
6	0.86	6	0.0	6	52.9	6	51.5
7	1.43	7	0.0	7	57.2	7	54.6
8	3.09	8	0.0	8	55.7	8	52.7
9	4.51	9	0.0	9	47.0	9	44.4
10	4.26	10	3.5	10	35.0	10	34.5
11	3.5	11	13.6	11	24.2	11	19.1
12	3.11	12	20.7	12	21.0	12	15.2
Annual	29.38	Annual	77.8	Annual	36.8	Annual	34.7

Notes:
1 Moose Pass 3 NW, AK US Station: www.nrdc.noaa.gov/cdo-web/datatools/normals

4.3.4. Land and Water Uses

ADNR records were reviewed to gather information on land status, mining claims, and water rights within the proposed Grant Lake Development (KHL 2008). Land status in the proposed Project area is shown in Figure E.4-2. Lands surrounding Grant Lake are primarily federally owned and are managed by the Chugach National Forest, with state ownership west of Grant Lake to the Seward Highway and along Grant Creek. State lands are managed by the ADNR. There is limited private ownership (mainly rural residential) in the lower portions of the Grant Creek drainage.

Four mining claims were identified on federal lands on the north side of Grant Lake's lower basin (Figure E.4-2), with active mining occurring at these locations. No documented water rights were found within the Grant Lake drainage area (KHL 2008).

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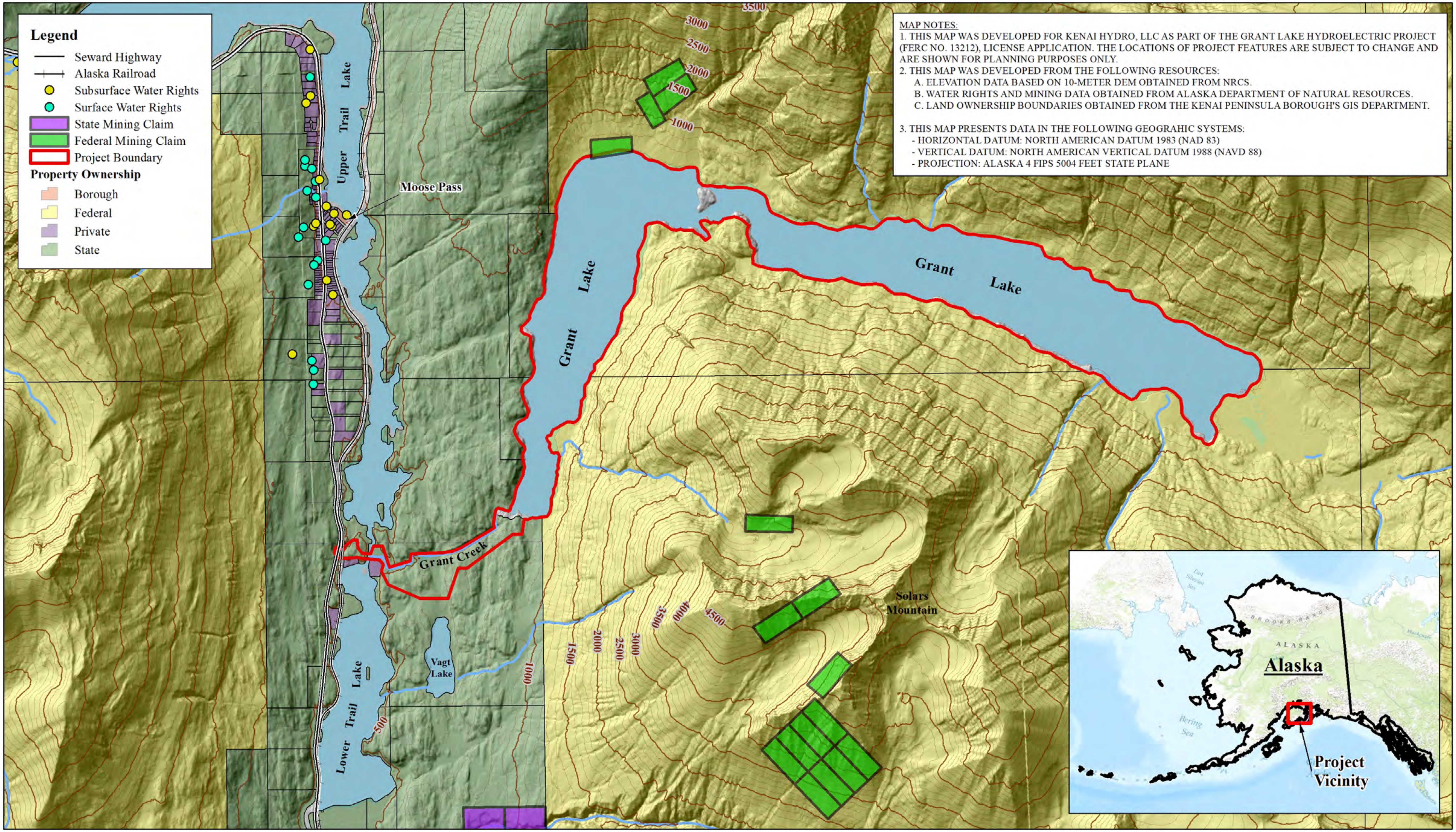

Drawing Scale:
0 0.25 0.5 1 Miles
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REV	DATE	BY	DESCRIPTION

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Figure E.4-2
Land Status, Ownership, Water Rights, and Mineral Claims in the Project Vicinity.

DESIGNED Jake Woodbury
DRAWN Jake Woodbury
CHECKED C. Warnock
ISSUED DATE 2/18/2015
DRAWING
SCALE: 1:35,000

4.4. Geological and Soil Resources

4.4.1. Affected Environment

The Grant Lake watershed is situated on the Kenai Peninsula within the Kenai Mountain Range. Metasedimentary and Metavolcanic rocks from the Valdez Group (Mesozoic Era) dominate the bedrock geology of the Grant Lake watershed and the Project area (Tysdal and Case 1979). The Valdez group within the watershed is composed primarily of greywacke, slate, and sandy slates (Ebasco 1984). The area bedrock includes a large number of structural features, and joints are common. Joint orientations vary, although there are minor maxima orientated north-south to Northeast-Southwest, dipping between 50 and 90 degrees to the south or southeast (Ebasco 1984). The Trail Lakes valley is a long, north-trending valley that extends from the town of Seward northward to Upper Trail Lake. It has been called the "Kenai Lineament" since it is obvious on satellite imagery as a long, linear feature (Plafker et al. 1993). The valley runs parallel to the N-NW fault, and the Kenai Lineament may represent one of these fault zones that was extensively eroded during the glacial period. It is unlikely that the Kenai Lineament represents a major active fault. More likely it is a glacial valley whose orientation and location followed the N-NW trend of the minor fault set observed in other areas (Ebasco 1984). Minor faults and fracture zones were discovered during the geologic studies of the area in the early 1980s (Ebasco 1984). Two fracture directions are dominant. One set trends NE and the other N-NW. Grant Creek follows the most obvious NE feature, which is identified as the Grant Creek Fault. Recent geotechnical studies provide a more detailed assessment of lineaments within the Project area and are presented in Figure E.4-3 (Jacobs Associates 2014).

The hillshade image included in Figure E.4-3 illustrates several strong lineament trends that are related to tectonic and bedding characteristics at the site. The primary lineament trend is to the east northeast, which includes the Grant Creek gorge lineament. These lineaments also form a number of the drainages feeding into the Trail Lakes system. The second primary lineament trend is a primarily north-south series of lineaments. These are subparrallel to bedding and in some cases may represent weak slate beds that were excavated through glacial scour. Others clearly cut across local bedding trends and are likely associated with tectonic deformation. One example of the latter is the lineament that crosses the tunnel alignment near the midpoint. This lineament is trending slightly north northeast and appears to cut across bedding.

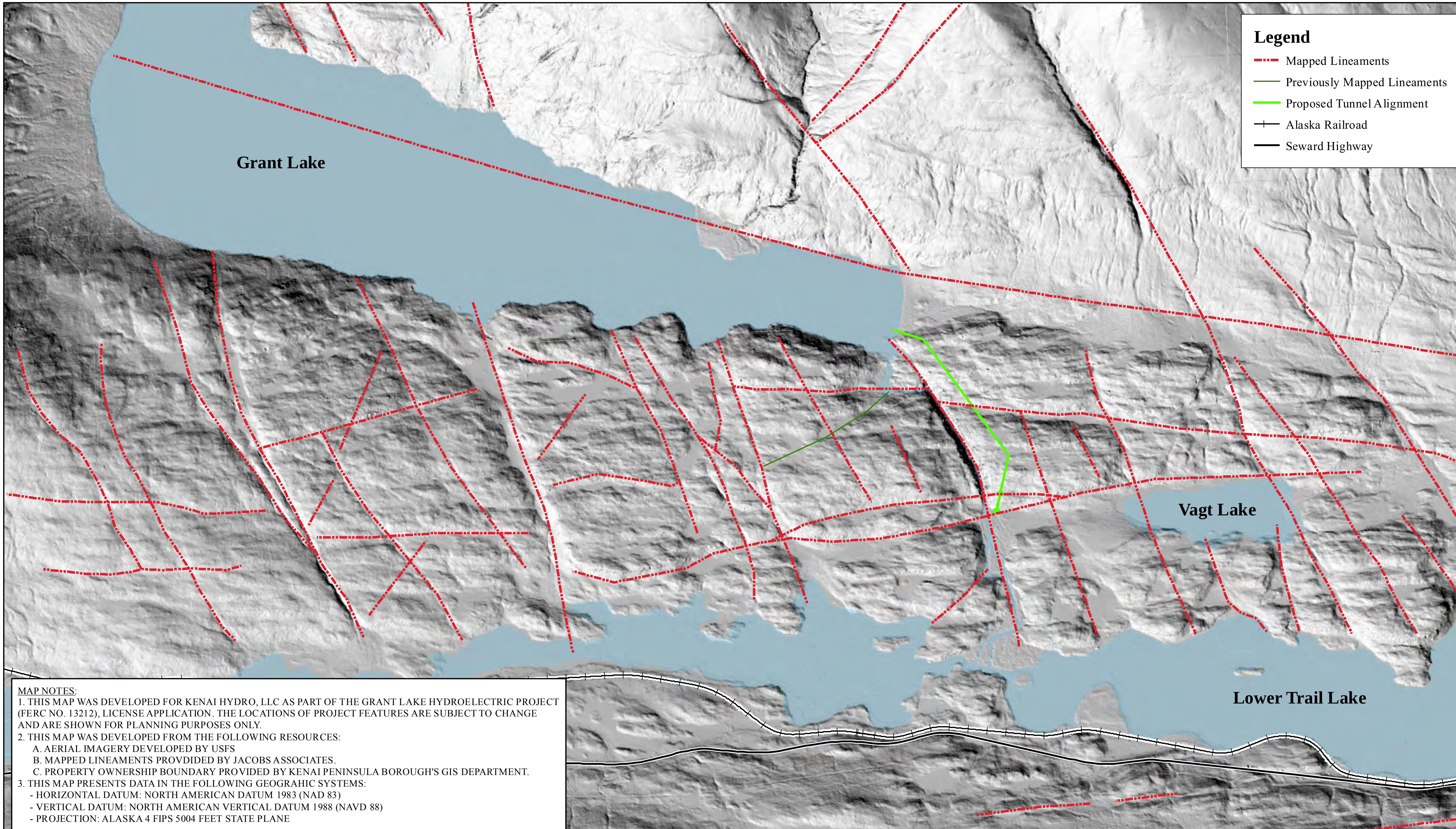
The Grant Lake watershed has been influenced by continental glaciers for much of its glacial history. However, the most recent glacial stade, the Elemendorf Stade, included mostly advances of Alpine glaciers that were concurrent with the continental glaciers. These glacial stades and interglacial periods have greatly altered the landscape by eroding bedrock, carving out the lake basin, steepening the valley walls, and depositing minor amounts of sediments. Glaciers have, for the most part, retreated to the upper limits of the watershed and only a few small alpine glaciers and snow fields are present today in the area near Solars Mountain. A map of all glacial features in the Project vicinity can be found in Ebasco (1984).

Unconsolidated surficial deposits are relatively rare in the proposed Project area. Alluvium is found at the head of Grant Lake, in the area between Lower Trail Lake and Kenai Lake, within a few of the coves around the Trail Lakes, and within the small bogs found in the low, bedrock ridges flanking the Trail Lakes valley. These deposits are typically mixtures of silt, sand, and gravel. Minor sand and gravel deposits are also found at the mouth of Grant Creek and Falls Creek.

Avalanche debris, the result of transport by snow avalanches during the winter and spring, consists of poorly sorted mixtures of cobbles, gravel, sand, and silt at the base of the major avalanche chutes. Avalanche debris is found on the north shore of Grant Lake where the lake bends to the east. Tallus deposits are rare in the proposed Project area, despite the steep slopes. A map of geologic features in the Project vicinity including glaciers and unconsolidated surficial deposits can be found in Ebasco (1984).

Historically, there are portions of the Project area that have been mined for gold. As detailed in Section 4.3.4 of this Exhibit E, ADNR records from December of 2008 identified four mining claims on federal lands on the north side of Grant Lake's lower basin (KHL 2009b).

The soils on Kenai Peninsula, including the proposed Project area, are derived from glacial and other deposits associated with heavily glaciated alpine mountains. The investigations reported in Ebasco (1984) indicate extensive glacial till deposits are absent in the Project area. Minor glacial till deposits may exist at the base of some of the bogs and lakes and within some of the coves along Upper and Lower Trail lakes. Two exploratory borings, conducted in an area of alluvial deposits in the valley on the east side of Upper Trail Lake, penetrated 28 feet and 18 feet of soils ranging from sand and silt near the surface to poorly sorted mixtures of cobbles, gravel, sand, and silt at depth. The lower material may represent glacial till or outwash, while the upper material is likely younger stream or lake bed sediment. None of the material is consolidated (Ebasco 1984).



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATIONS OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS
   B. MAPPED LINEAMENTS PROVDIDED BY JACOBS ASSOCIATES.
   C. PROPERTY OWNERSHIP BOUNDARY PROVIDED BY KENAI PENINSULA BOROUGH'S GIS DEPARTMENT.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV DATE BY DESCRIPTION

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Drawing Scale:
0 375 750 1,500 2,250 3,000 Feet

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GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

LICENSE APPLICATION

Figure E.4-3
Geologic Lineament, Grant Lake Project Area

DESIGNED P.Pittman
DRAWN J. Woodbury
CHECKED P. Pittman
ISSUED DATE 12/30/2014
DRAWING
SCALE: 1:16,000

Recent geotechnical investigations by Jacobs Associates (2014) provide the following description of soil conditions specific to the Project location:

> *"Soils at the site are generally considered shallow, mantling the glacially-scoured bedrock. Along the tunnel alignment soils are primarily limited to a thin (less than 5 feet) organic silt to sandy silt overlying bedrock. In low-lying areas along the alignment these soils make be in excess of 20 feet.*
>
> *Recent alluvial deposits associated with Grant Creek are present in the vicinity of the powerhouse and downstream end of the penstock. Based on proximity to the creek and surface exposures, these soils are likely to consist primarily of gravels and sandy gravels. Organic-rich fine-grained interbeds may also be present in this area. These soils may be in excess of 20 feet thick.*
>
> *Soft organic-rich fine-grained deposits are present in low lying areas south of the powerhouse. These areas have formed peat bogs and may be in excess of 20 feet thick. The current access road alignments contour around this area."*

Mass movements or slope failures, including landslides, rockfalls, avalanches, and slab failure, are discussed below as possible results of seismic activity. The rock cliffs along Upper Trail Lake from the east could be a source of small rockfalls, triggered either by seismic activity or seasonal freeze-thaw. Examination of the many cliffs in the area, however, suggests a high degree of stability (Ebasco 1984).

The detailed feasibility analysis contained in Ebasco (1984) considered the following potential occurrence of seismic hazards at the proposed Project area: vibratory ground motion, ground rupture, seismically-induced slope failure, and seiche. Information from Ebasco (1984) on each of these hazards is excerpted below.

Vibratory Ground Motion. Deterministic analysis of the sources of earthquakes, their distance from the proposed Project site, and the potential accelerations at the site indicate that the megathrust zone beneath southern Alaska and the random crustal event are the primary sources of seismic hazard. Random crustal events are then considered "floating" and potentially could occur anywhere. For calculation purposes, the random crustal event is considered to be directly beneath the Project site.

All known sources of earthquakes that were close enough to the proposed Project area to have significant impact were identified in the Ebasco (1984) analysis. The maximum credible earthquake (MCE) for a random crustal event was chosen as magnitude 6.0, a conservative upgrade from the maximum recorded magnitude of 5.5. As indicated in Ebasco (1984), the maximum calculated acceleration at the proposed Project site is 0.40 gravity from the random crustal event and 0.37 gravity from the 1964-type Aleutian Arc megathrust.

Return periods for these maximum earthquake events were established using historical and instrumental earthquake data. Based on the estimated return periods and the time since the last major event, the likelihood of such events was estimated by Ebasco for the life of the Project as proposed at the time. The likelihood of another 1964-type event on the megathrust was considered low for the life of that project. Because the return period exceeds 160 years, it is presumed that the calculations are still relevant and would apply to the currently proposed Project. The likelihood of a large random crustal event is moderate to high, with a recurrence interval of 50 to 100 years, and a low probability of such an event occurring in the proposed Project area.

Ground Rupture. There are no known active faults crossing the proposed Project site. No seismic events have been associated with known structures around the site, and no geologic data have been found to suggest the presence of active faulting. Ground rupture is not considered a hazard for the Project.

Seismically Induced Slope Failure. One of the most common features associated with moderate to large magnitude earthquakes is slope failure. Triggered by ground motion, naturally unstable slopes can fail. Slope failure can be broadly classified into landslides, rockfalls, avalanches, and slab or tumbling failures of rock faces. There is little material in the Project area that would be susceptible to landslides during seismic events. No evidence was found for the occurrence of major landslides or of their deposits (Ebasco 1984).

Rockfalls from the steep cliffs could occur during seismic shaking. Some evidence of minor rockfalls has been found in the area, but the triggering mechanism is unknown. The rock cliffs along the Upper Trail Lake valley on the west slope below Grant Lake are a potential source of rockfalls. A second rockfall area has been identified on the steep slopes south of the proposed powerhouse (Jacobs Associates 2014). The proximity of this hazard is near the proposed access road to the intake structure and will need to be addressed as part of the final design package.

Seismically induced avalanches could occur in the mountains above the Project. However, the topography around the proposed Project facilities does not appear to be subject to a hazard from avalanche.

Slab or tumbling failure of rock faces during seismic events is common in areas of unstable rock slopes. The western shore of Grant Lake is particularly susceptible to such failures, as the slopes are steeply dipping slopes of bedrock. Data from exploratory boring in this area in the early 1980s suggest that bedding-plane slides have already occurred here.

Seiche. Seiches are waves in lakes that are formed by water sloshing back and forth as the result of ground shaking during seismic events or the catastrophic inflow of material by slope failures around the lake's rim. There are several areas surrounding Grant Lake that could be sources of earth or avalanche material for mass movements into Grant Lake, which could generate seiche waves. Fieldwork associated with the Ebasco (1984) analysis did not reveal any areas along the shoreline of Grant Lake where wave damage above normal high water levels was noted. This observation suggests that significant wave run-up did not occur during the 1964 earthquake. Further, the volumes of material that could enter Grant Lake are probably not sufficient to generate very large seiche waves.

Investigations around Lower and Upper Trail lakes indicate that the surrounding topography coupled with the shallowness of the lakes present significantly less hazard from seiche. There are no areas of material that could generate large waves by mass movement into these lakes. The proposed Project's facilities would be designed so that they are not susceptible to damage by seiches that could occur in Grant Lake.

4.4.1.1. Grant Lake Shoreline Assessment

The primary study objective of the Grant Lake Geomorphology Study (KHL 2014a) was to provide a basis for predicting and assessing potential lake shore erosion in Grant Lake as a result of general reservoir operations. Operations will affect the timing, duration and range of water surface elevations (WSE), and thus change the Grant Lake shoreline geomorphic conditions. The Grant Lake shore geomorphic study was a qualitative inventory of shoreline conditions that affect erosion potential based on professional judgment.

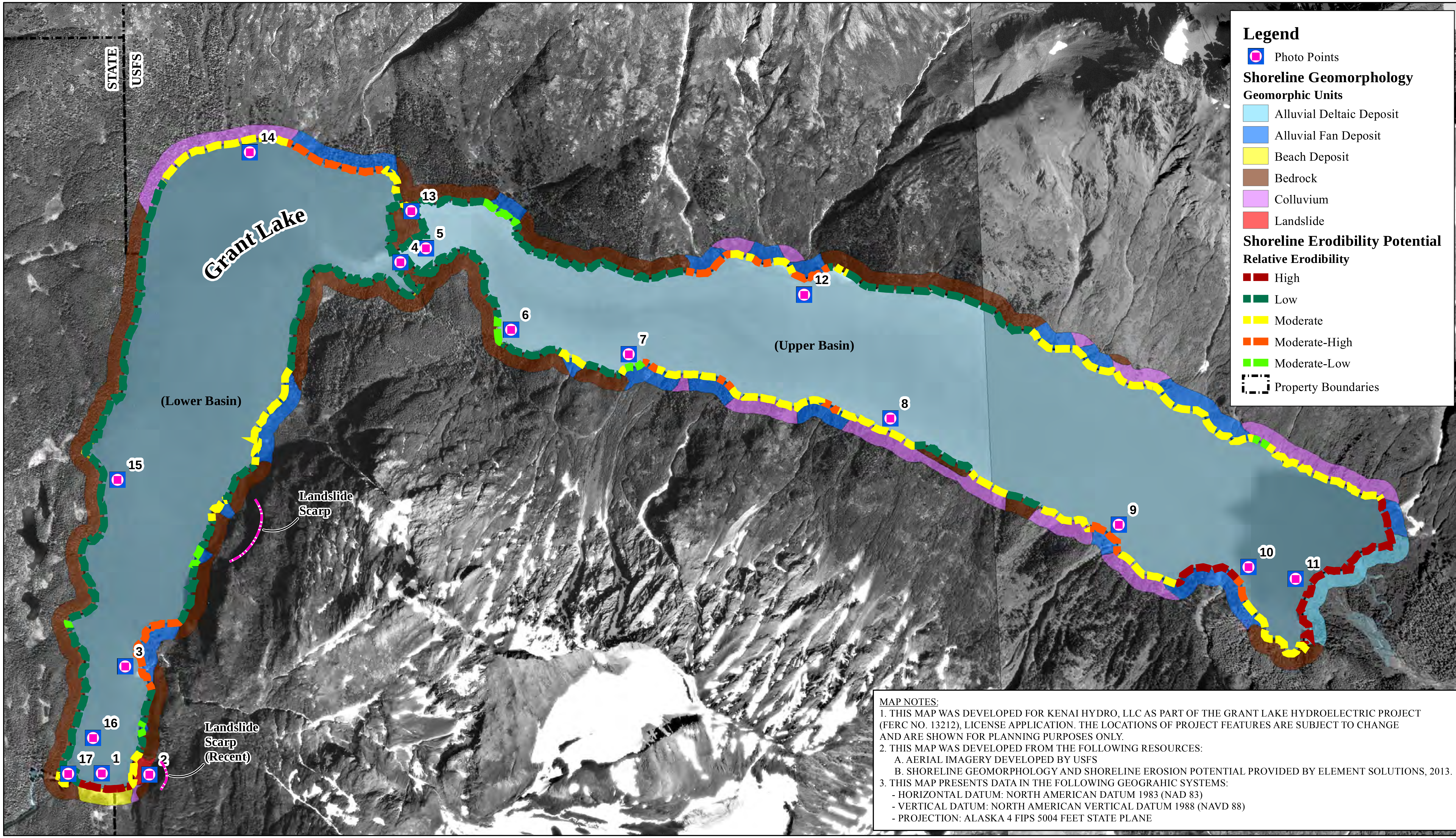
The erodibility assessment was initiated with a GIS desktop analysis. The analysis included remotely mapping the geomorphic features of the Grant Lake shoreline area. This was accomplished by evaluating a combination of spatial data sets in conjunction with historic studies and information and making an informed geological interpretation.

The interpretation of landforms involved analysis of slope/relief, shape, contributing upland area, fluvial/non-fluvial influence, vegetation, texture and previous geological assessments. A “Geomorphic Unit” was developed based on geomorphic process for the landforms along the shoreline and each Geomorphic Unit was mapped within 200-foot buffer from the shoreline in GIS. The following Geomorphic Units were established for this analysis:

- Alluvial Deltaic Deposits
- Alluvial Fan Deposits
- Beach/Littoral Deposits
- Colluvial Deposits
- Landslide Deposits
- Bedrock

The depositional units were characterized based on typical sediment size and character of depositional material (layered strata versus massive consolidated strata, sorted versus unsorted sediment) with the rationale that smaller sediment size and layered strata were relatively more susceptible to erosion than larger sediment sizes and massive consolidated deposits. As a result, a relative erodibility of the geomorphic unit was generated such that the aforementioned units are listed from most susceptible to erosion to least susceptible. The geomorphic units in the area buffering the shoreline were field validated. Mapping of geomorphic units is shown in Figure E.4-4.

Wind generated waves are likely the predominant erosional process acting on the Grant Lake shoreline during present conditions. To evaluate the wind-generated wave erosion potential, an overlay of relative fetch potential was applied with the rationale that larger waves had more energy and were more effective at eroding the shoreline area than were smaller waves. Field observations of wave run-up potential were made during the boat-based survey and documented with photographs.



MAP NOTES:

1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATIONS OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS
   B. SHORELINE GEOMORPHOLOGY AND SHORELINE EROSION POTENTIAL PROVIDED BY ELEMENT SOLUTIONS, 2013.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAPHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

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Developed For:
Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

LICENSE APPLICATION

Figure E.4-4
Geomorphology Relative Shoreline Erosion

DESIGNED P.Pittman
DRAWN J. Woodbury
CHECKED P. Pittman
ISSUED DATE 11/18/2014
DRAWING
SCALE: 1:20,000

4.4.1.1.1 Evaluation

The evaluation was initiated by compiling all existing spatial information into a GIS-based platform. The geomorphic units were integrated with the fetch parameters to determine relative erodibility (Table E.4-4). The resulting relative erodibility was mapped in GIS (Figure E.4-4).

Table E.4-4. Relative erodability integrating erosion susceptibility with wave energy potential.

Relative Fetch Distance	Geomorphic Unit					
	Alluvial Deltaic	**Alluvial Fan**	**Beach**	**Colluvium**	**Landslide (bedrock)**	**Bedrock**
Short	Moderate	Moderate	Moderate	Low	Low	Low
Medium	Moderate-High	Moderate-High	Moderate-High	Moderate-Low	Moderate-Low	Low
Long	High	High	High	Moderate	Moderate	Low

The integration of the relative erodibility susceptibility of the Geomorphic Units with the fetch distance to determine relative erodibility along the shoreline relies upon the following assumptions:

1. As the fetch increases the wave size increases, and therefore the wave-generated erosional processes increase with fetch
2. The geomorphology/geology within each mapped unit was assumed to be consistent throughout that individual unit.

In addition to wind-generated wave erosion potential, erosion due to changes in base elevation which could cause stream incision of streams that outlet along the shoreline during lower lake WSE conditions was considered.

The shoreline conditions of Grant Lake are influenced by geologic conditions, geomorphic processes, and climate. Alluvial, colluvial and mass wasting processes, including avalanche, deliver sediment to the shoreline area and deposits of sediment locally bound the shoreline. The upper basin receives the dominant sediment load being transported to the lake via hill-slope and fluvial processes.

While most geologic and geomorphic processes effecting the littoral zone occur at relatively slow rates, evidence of large mass wasting events in Grant Lake were observed, which can create punctuated change along shorelines and stream channels, including rapid change in sediment supply, shoreline boundary changes, and large pressure generated waves, and erosion. It is hypothesized that the alluvial plain morphology of Grant Creek was influenced by a relatively recent landslide generated wave originating from Grant Lake. Large mass wasting events can have dramatic effect on the landscape.

4.4.1.1.2 Natural Influences on Grant Lake Water Surface Elevations and Littoral Conditions

Grant Lake shoreline geomorphology is influenced by climate and seasonal variability. The lake remains ice free for approximately half of the year. During the ice-free period, WSEs fluctuate in response to snow melt, glacial melt, and precipitation. Wind generated wave processes erode, rework, deposit, and transport sediment in the littoral zone during the ice-free periods. The narrow confined valleys flanking the lake control wind direction and intensity. Wind direction from east or west will have the greatest effect on the upper lake basin whereas this wind direction will have little effect on the lower lake basin. Conversely, wind directions from north or south will have the greatest effect on the lower lake basin and only negligible effect on the upper lake basin. Because the lake orientation is divided by a 90 degree "bend" approximately mid-point, the effective maximum fetch is only approximately 3-miles. The largest wind-generated waves will be at the shorelines at the end of the fetch runs. The near shore bathymetric conditions also effect wave height and run up potential.

The highest WSEs typically occur in the summer months when snow melt and precipitation probability are highest or episodically in fall when transient snow and precipitation occur. WSE of Grant Lake is controlled by the Grant Creek outlet elevation (703 feet NAVD 88) and the hydrologic inputs from the watershed. The maximum WSE of the lake is at approximately 703 feet NAVD 88 based on previous estimates (Ebasco 1984). The ordinary high water mark has apparent elevation increases where wind generated wave run up occurs, including at the outlet at Grant Creek.

Grant Lake WSE is lowest in the winter months when the watershed is frozen, virtually halting hydrologic input. During ice-on conditions, the effect of wind generated waves is likely negligible except during ice break-up conditions.

4.4.1.1.3 Grant Creek Spawning Substrate Studies

The primary objective of the Grant Creek spawning substrate recruitment study was to provide a basis for predicting and assessing potential changes to material movement, sedimentation, and gravel recruitment that may occur in Grant Creek with proposed operational management, especially as related to the long-term maintenance of fish spawning substrate. Operation of the Project would alter the flow regime and create a situation where some amount of flow will bypass the canyon reach. The Grant Creek spawning substrate study combines quantitative and qualitative elements.

The methods identified in the study plan to evaluate the sediment transport effecting salmon spawning substrate conditions following operational scenarios, included the following tasks:

1. Assessment of the substrate at existing spawning areas including aspects of embeddedness and substrate size composition;
2. Quantification of material transport conditions under the existing and projected flow regimes; and
3. Qualitative geomorphic assessment of existing sediment supply conditions.

The general operational scenario for the Project would result in bypassing some amount of flow from the canyon reach and the potential for an alteration of the natural flow regime. Specifically, the current natural flows would be modified so that peak flows would be decreased as a result of Project operations.

The focus of this study was on the potential impacts to the spawning-size range of sediment. The following species of concern are documented to use Grant Creek for spawning: Chinook (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), coho (*Oncorhynchus kisutch*), rainbow trout (Salmo gairdneri *Oncorhynchus mykiss*) and Dolly Varden (*Salvelinus malma malma*). The range of documented preferred spawning sediment size classes that encompass these species can typically range from 5- 50 cm, with rainbow trout preferring the smaller substrate range and Chinook utilizing the larger substrate range (Russell 1974; Jones 1975; Suchanek et al. 1984; Milhous 1998; Bovee 1982; Swan 1989; Kondolf 1993).

Geomorphic interpretation of the alluvial plain landform indicates that relatively large hydrologic event(s) that are much larger than the historically observed hydrology have occurred and formed the broader alluvial plain. Substantial channel "rill" and fan topography near the canyon outlet and large alluvial transported boulders across a broad alluvial fan suggests a massive flow with sediment transport and deposition. The scale of the event(s) that formed the alluvial plain is likely substantially larger than snow-melt/rain flows where the largest recorded flow was 2,140 cfs (Ebasco 1984). It is hypothesized that the "event" was the result of an impact to Grant Lake that sent a surge of water over the Grant Creek outlet at the south end of Grant Lake. The event could have been a landslide or earthquake initiated seiche or an ice-jam dam break flood. The presence of very large sediment particles in the channel and on the alluvial plain that are beyond the transport capacity of the observed stream are relict of this event.

The alluvial plain channel has predominant substrate size that ranges from boulder to cobble and decreases from boulder-dominant substrate into a cobble-dominant substrate in the downstream direction (Ebasco 1984). The Grant Creek alluvial plain is bound by bedrock topography. The alluvial plain stream channel is approximately 25 feet at bankfull width on average, whereas the width of the alluvial plain is substantially larger than the bankfull and active channel which suggests that Grant Creek has historically occupied and eroded the alluvial plain margins.

Three generalized geomorphic channel form reaches currently exist in Grant Creek; the Canyon Reach, the Anastomosing Reach, and the Alluvial Fan Distributary Reach. The Canyon Reach (Reaches 5 and 6) is a confined bedrock channel and the primary source of sediment recruitment for Grant Creek. The channel in this section is steep and bedrock lined with limited sediment storage, both in volume and temporal duration. Most sediment is stored in the Canyon Reach sediment wedges formed behind boulder obstructions. Extremely large flows are capable of mobilizing these wedges and net incision into the bedrock is the trend. A series of headcuts (falls) are migrating up the stream in the direction of Grant Lake. In geologic time, these headcuts will migrate to Grant Lake and the lake water surface will drop to the new control elevation.

The Anastomosing Reach is within the partially confined alluvial plain and is net depositional zone with periods of incision occurring during low sediment input rates. Loss in hydraulic confinement and a change in gradient allow for sediment deposition within this reach when sediment input rates are high and transport capacity is low. It is anticipated that these conditions are episodic and driven by upper watershed conditions (hydrologic or geologic events) coinciding with a large sediment supply stored within the Canyon Reach. A low flow, primary channel carries the predominant flow and a series of side channel and floodplain channels are wetted at various flow conditions. The anastomosing reach changes relatively rapidly in both horizontal and vertical orientation depending upon the sediment load and is a more dynamic geomorphic reach than the Canyon Reach. Horizontal movements result from either lateral channel erosion or avulsion. It is anticipated the alluvial deposits overlay a bedrock base and that there is a robust hyporheic-ground water interaction, and that there is minimal hydrologic loss in this reach. The Anastomosing Reach channel and bedforms are sensitive to changes in flow regime and sediment load. Loss of side channel connectivity will result in a single thread channel, which decreases hydraulic complexity, concentrates stream power, and often results in increased channel incision.

The Alluvial Fan Distributary Reach is an unconfined, net depositional reach. Distributary channel networks that disperse flow to Lower Trail Lake and the Narrows are accessed at a wide range of flows. The Alluvial Fan Distributary Reach is likely the most dynamic reach in Grant Creek with respect to horizontal and vertical channel movements and avulsions. The reach is very sensitive to disturbances, particularly sediment supply and flow regime changes. Hydraulic complexity in the Alluvial Fan reach is hydraulically less complex than the Anastomosing Reach and it is probable that there is a slight hydrologic loss experienced in this reach.

The Anastomosing Reach of Grant Creek likely provides the greatest overall ecological function and salmonid productivity relative to the other reaches. The rationale for this hypothesis is that the reach has:

- the greatest hydraulic complexity;
- the greatest wetted channel length at moderate flows
- a more balanced wetted perimeter to depth at moderate flows;
- a higher probability of maintaining low and hyporheic connectivity in the winter;
- is more stable than the Alluvial Fan Reach; and
- lower velocity and stream power than the Canyon Reach.

4.4.1.1.4 Sediment Supply and Transport Influences on Grant Creek Geomorphology

A small amount of suspended and dissolved sediment load from the upper watershed reaches Grant Creek. However, Grant Lake acts to arrest all bedload sediment transport from the upper watershed area. Therefore, the sediment supply for Grant Creek, excluding the throughput suspended sediment load, is the Canyon Reach. With the majority of the sediment source for Grant Creek being derived from the canyon walls, the geological formations present along this length of stream channel play a critical role. The primary process for generating new bedload sediment in Grant Creek are the erosional forces that incise the canyon causing wall undermining and mass wasting (rock fall) from the canyon walls and exposing the geology to freeze-thaw and other surface erosion processes.

While Grant Creek within the alluvial plain exhibits net deposition over time, it is under "normal" hydrologic conditions a supply limited stream, meaning that the sediment transport capacity of the stream is greater than the sediment supply to the stream. A supply limited stream tends to migrate less laterally and vertically than a transport limited stream, and channel form is more "stable". Supply limited streams also tend to be armored, incised, and exhibit a straight versus meandering channel form.

4.4.1.1.5 Sediment Form Influences on Grant Creek Geomorphology

Of the three geological formations present along the creek channel, the greywacke is the most resistant rock type, whereas the sandy slate and slate are more friable and tend to supply the majority of sediment to the stream bed. The greywacke units control the base elevation in Grant Lake by creating the outlet sills and forming waterfalls. In geologic time, erosion of the greywacke and head-cut retreat of the canyon would lower Grant Lake.

The sediment being recruited to Grant Creek is angular, with the slate having a "platy" particle morphology (A-axis and B-axis are similar, disproportionately small C-axis) and the greywacke having long "blocky or brick-like" particle morphology (large A-axis, similar disproportionately small B and C-axes). The high stream power in the canyon and the relatively short transport distance from the sediment source in the canyon to the depositional areas downstream results in relatively large grain size with high degree of angularity of the particles compared to other streams of similar discharge with a greater spatial extent of bedload sediment inputs. Blocky and platy sediment morphologies with the same B-axes dimensions have different volumes (think of a dinner plate versus a watermelon that both have similar B-axis diameter), and therefore a different surface area to mass, which effects transport characteristics. Angular sediment also transports across the channel bed (rolling and saltating) and entrains differently than does rounded. The particle morphology of Grant Creek likely increases the armoring qualities of the bed and thus adds to the overall stability of the channel form.

4.4.1.1.6 Hydrologic Influences on Grant Creek Sediment Transport and Geomorphology

The hydrology of Grant Creek is predominantly driven by the cycle of melting snow and precipitation in the summer and frozen watershed conditions in the winter. It is the bankfull and peak flows that dominate the fluvial geomorphic processes at Grant Creek. The stream bed is comprised of large sediment particles and the bed is armored, so only the larger flows are able to mobilize the bed armoring, transport sediment en masse, and reorganize bedforms. The sustained flows offered by snow melt conditions allow for a longer duration of time for which to organize the substrate, construct and arrange the geomorphic channel bed structures, and allow channel form development.

A larger, but unmonitored hydrologic event likely occurred on Grant Creek in September 2012 when many other gauged streams in the vicinity of Grant Creek experienced flows of record. Some residual high water marks on Grant Creek were observed which showed that the 2012 event was larger than the highest 2013 flow of approximately 1,000 cfs. Using the existing stage gage and rating curve to estimate the flows, the 2012 flow was likely between approximately 1,500 and 2,000 cfs. The September 2012 flow was short duration and occurred late in the season and winter conditions set in soon after, therefore reducing the amount of time for flows following the event to process the transported sediment and adapt to the modified channel bed forms. As a result, the 2013 higher flow season responded to the disturbances from the 2012 event and there were several channel changes, including recapture of some floodplain channels, an avulsion, and partial abandonment of previously occupied low flow channels. The primary driver for these changes was likely a redistribution of bedload sediment and localized vertical channel bed changes, which affected localized WSEs. The observation shows that the channel form and bed forms and the interaction with the floodplain and floodplain side channels are dynamic, and thus habitat that relies on the availability, extent, and quality of substrate are related to sediment transport processes.

Non-climate driven hydrologic events likely occur within Grant Creek. The Grant Creek watershed is within an active seismic area and a large scale landslide, avalanche or earthquake caused seiche could occur. In the event that a large scale landslide did occur and deliver large volumes of material rapidly into Grant Lake, then large waves or seiches could propagate throughout the lake basin and into Grant Creek. It is probable that the hydrograph from one of these events, although brief in nature, would be substantially greater in magnitude than climate driven hydrographs.

4.4.1.1.7 Quantitative Sediment Characterization Summary

The Grant Creek channel bed is vertically stratified with at least two distinct layers; armored or pavement layer, and subsurface. A sub-pavement layer was not distinct. The surface is highly armored which is enhanced by angular particle forms and the surface has low embeddedness and is relatively low in fine grained sediment. The subsurface is well-graded cobble and gravel with sand and nominal fines (less than 1 percent of sediment by volume is 1 millimeter (mm; medium sand) or smaller. The subsurface material is anticipated to be easily remobilized when the armoring is removed.

4.4.1.1.8 Surface Analysis Results Summary

In summary, the wetted low-flow channel areas are substantially coarser and more armored than are the lateral and point bars. No trend in surface sediment decrease moving in the downstream direction was observed. It is hypothesized that local hydraulics and the two distinct particle forms (platy and blocky) influences particle size to transport relationship and deposition more than channel gradient in this turbulent system. The instream D50 is generally larger than literature referenced “preferred” spawning substrate size; however, in the case of Grant Creek the spawning species are utilizing the areas with large, armored surface substrate.

4.4.1.1.9 Subsurface Analysis Results Summary

The subsurface is less coarse than the surface, except at one of the eight sampling sites, where the subsurface had a higher percentage by size class of large particles and yet a similar D50 size. It is hypothesized that the subsurface at this one sampling location represented a hyperconcentrated flow deposit as it lacked sorting and imbrication structure that was apparent in the other subsurface sample sites. Subsurface sediment was overall well-graded cobble and gravel with sand with minimal fines. Similar to the surface analysis, there was not a general trend in decreasing D50 particle size in the downstream direction because of the influence of localized hydraulics and relict hyperconcentrated lag deposits. It should be noted that inaccuracies in bulk sampling can be pronounced in bimodal distributions containing large clasts and where lag deposits from hyper-concentrated/dam outburst type alluvial deposits are found, as is the interpreted conditions of Grant Creek.

4.4.1.1.10 Embedment Results

Field observations of embeddedness resulting from fine-grained sediment deposition in the interstitial spaces of the surface armoring were found to be extremely low. The reasons for this are hypothesized to be that: the Grant Creek system is relatively starved of fine sediment and that the current flow regime transports most fines through the system as throughput, and the low sediment delivery rate and high flows result in armored condition.

General clast-to-clast embedment was difficult to measure because of the particle forms, particularly platy, and the generally well armored conditions. Qualitatively, clast-to-clast embedment appeared relatively high because of armoring. Because of the high percentage of imbricated platy sediment particles, there is low confidence in the values measured, and therefore it is our opinion that quantitative results are not reliable. In general, there is not expected to be an increase in fines filling the interstitial spaces of the surface sediment within the spawning reach.

4.4.1.1.11 Sediment Incipient Motion Analysis Results

Grant Creek is an example of a complex system for the following reasons:

- Grant Creek is a high gradient, boulder dominated stream with turbulent flow. Bedform and channel bank irregularity, in addition to instream boulder and bedrock structures, create turbulence with secondary flow influences that can be much more influential on sediment transport than in planer bed conditions. Attempts to calculate or measure shear stress values in mountain rivers are complicated by the channel bed roughness and the associated turbulence and velocity fluctuations (Wohl 2000).
- Sediment particle shapes are unique and vary from referenced calibrated models. The sediment shapes present in the Grant Creek are angular platy particles and angular blocky or “brick” shaped particles. These two shapes will each mobilize and transport differently relative to each other. These two shapes are different from the assumed particle shape used to develop and calibrate models, which are spherical shapes. Spherical particle shapes will have a different transport characteristic than either platy or brick shapes. In addition, each particle form will lay and organize differently on the channel bed and each has a different mass to B-axis ratio; therefore, incipient motion will be different for each particle represented in Grant Creek as well as different than predicted by equations developed using spherical models.
- Sediment transport rates at Grant Creek are very low. There are three phases of sediment transport associated with very low bedload transport rates, also known as marginal transport. Incipient motion and net transport rates in these systems are very sensitive to changing hydraulic conditions and bed material moves only partially; thus entrainment is size-selective (Hassan et al. 2005; Wilcock and McArdell 1993).

- The Grant Creek channel bed is locally armored. Sediment transport characteristics, specifically incipient particle motion, in armored gravel-bed rivers is often controlled by patches of fine sediment and bedforms (e.g. Garcia et al. 1999). Bedload transport characteristics vary from the initiation of particle movement to the point when the breakup of the armor layer occurs when the channel becomes unstable at the reach scale.
- Inter-particle relationships are not represented in model assumptions, so hiding effect and "patches", which can have significant influence on particle movement are not considered.

The substrate particle forms, as previously described, are distinctly different and literature supporting Shield parameter values for both platy and blocky particle forms is extremely limited. It is hypothesized that platy particle forms in a cohesionless, heterogeneous particle shape planer bed will mobilize in lower flows and be more easily entrained than will blocky particle forms of similar B-axis dimensions in the same flow conditions if the platy particles are loose and unorganized. However, if the platy sediment has become highly imbricated in a more homogeneous particle shape grouping, thus increasing particle-to-particle contact forces and decreasing fluid forces acting on a given surface area (skin friction), then the platy particle will require a higher flow to initiate mobilization than the blocky sediment. Based on the lack of strongly imbricated, homogenous surface present at Grant Creek, it is anticipate that the platy particles will be mobilized more easily than the long axis blocky particles. It should also be noted that Grant Creek channel bed is, for the most part, not planer, thus bed shear stress is primarily associated with form drag rather than skin friction on individual particles, which is the force that moves particles.

The incipient motion calculation estimated that the proposed maximum operational flow (385 cfs) will likely initiate mobilization of surface sediment within the preferred spawning substrate range (10 mm – 50 mm). At 385 cfs, it is anticipated that substrate mobility will be partial, limited to only smaller particles and that movement of particles will be intermittent, localized, and primarily from the deeper channel areas or where turbulence is high. Mobilization of particles will also depend upon the degree of armoring, bedform, and particle shape. Table E.4-5 is a summary of the estimated upper particle size threshold being mobilized at 385 cfs.

Table E.4-5. Summary of incipient motion calculations at 385 cfs.

Sample Site	τ(blocky)	τ(platy)	τb (pounds/sf)	Ds(blocky) mm	Ds(platy) mm	D50 surface mm	D50 subsurface mm
1	0.06	0.03	1.85	92	183	59	52
2	0.06	0.03	0.79	39	79	48	21
7	0.06	0.03	1.32	65	131	77	28
8	0.06	0.03	1.12	55	111	83	74
			Average	62.8	126	67	44

Field observations, marker analysis, and professional judgment would suggest that the predicted particle sizes are high for the platy particle forms using the Shield's parameter of 0.03. It also is possible that the values obtained for the blocky substrate are too high as well. These outputs predict that there would be substantial bedload movement at a 385-cfs flow. Very little bedload sediment transport appeared to be occurring at flows near the proposed operational flow. Additionally, flows near the proposed operational flow also coincided with spawning activity. A point bar at sample location had only experienced minor sediment transport even with the 1,000-cfs flows, so it is unlikely that widespread surface sediment breakup occurred at 1,000-cfs flows. However, channel bed changes and resulting WSE changes occurred in 2013 occurred following the higher flows; therefore, some degree of local bedload transport does occur with flows between 350 cfs and 1,000 cfs.

4.4.1.1.12 Sediment Delivery Potential Results

Sediment delivery and transport in Grant Creek is divided between two transport characteristics: suspended sediment load; and bedload sediment. Suspended sediment load passes through Grant Creek with very little deposition in the alluvial reach as a result of the steep stream gradient, turbulence and low sediment load. The primary source of suspended sediment is from the glacial headwaters. Much of the suspended sediment load settles out into Grant Lake. The suspended sediment that passes through Grant Lake is extremely fine and has a very low settling rate, which also decreases the potential for deposition to occur within Grant Creek.

There are four primary sources of bedload sediment in Grant Creek; lakeshore littoral sediment input, Canyon Reach input, channel bed and channel bank remobilization (bank erosion, incision), and mechanical breakdown of instream sediment during mobilization. Field investigation determined that the bedload sediment supply in Grant Creek is extremely limited and that the canyon is the predominant source of bedload sediment. Bedload sediment delivery arrives episodically, either from a rock fall within the canyon, or a littoral contribution resulting from a large wind storm occurring at high lake WSEs. Remobilization of channel bank and channel bed sediment can provide a sediment input to lower reaches, but does not recharge or replenish the whole stream system. Large hydrologic events are necessary to mobilize and transport sediment from the canyon and deliver the sediment to the lower reaches as well as to mechanically breakdown instream sediment.

4.4.2. Environmental Analysis

4.4.2.1. Project Construction

The lack of significant soil cover or alluvial deposits indicates that erosion would be minimal during construction of the Project (KHL 2009b). Slope stability is not anticipated to be a constraint for the tunnel alignment or the portals. The east portal would be located in gently sloping terrain, which would require a temporary portal cut into alluvial/colluvial deposits and the underlying rock. The west portal appears to be located in a steeply sloping rock face, above a bench in the otherwise steep slope. During the site reconnaissance this slope was inspected and found to be in good condition (Jacobs Associates 2014).

Slope failure and rockfall hazards are a potential concern for the intake tunnel access road as it ascends the steep slopes south of the powerhouse. A rockfall area was observed at this location, where failure along adverse joints has produced historical rockfall and created an overhanging rock knob near the crest of the slope. Rock blocks associated with this slope extend beyond the toe of slope. The potential for future rockfall in this area is high and has the potential for producing rock blocks in excess of 5 feet in diameter. The proximity of this hazard relative to the access road will need to be addressed and mitigated for during final design. Another concern is the potential for major failures along the south side of the Grant Creek gorge. As viewed from the air during the 2010 feasibility study and as part of this investigation, the rock exposed in the side of the gorge appears sound. However, toppling failure along high angle joints trending sub-parallel to the canyon walls is possible. As summarized in the Geotechnical Report (Jacobs Associates 2014), the majority of the tunnel is quite a distance away from the gorge wall, and therefore it is considered unlikely that a failure of the slope would impact the proposed tunnel alignment.

4.4.2.2. Grant Lake Shoreline Erosion

The anticipated impacts to shoreline erosion potential from the operation of the proposed Project are likely to be relatively minor over the long term for the following reasons:

- The change in WSE range is a decreased WSE that occurs in winter during ice-on conditions when wave and stream erosion processes are less active.
- The shoreline littoral area is predominantly bedrock or coarse, angular boulders with a low susceptibility to erosion.
- Influence of wind-generated waves in Grant Lake is not a substantial erosional process because the open fetch was limited to a maximum of approximately 3 miles, and therefore wind wave heights were limited. In the areas where fetch was greatest and bathymetric conditions favored high wave run up, only a slight increase in the ordinary high water mark elevation demonstrating that maximum wind-wave heights were estimated to be a maximum of approximately 5 feet at Inlet Creek and 3 feet at Grant Creek outlet.
- In the areas where erosion potential was greatest, only minimal erosion; in part because of the depositional nature of the geomorphic units these areas and the apparent high depositional rate. With the exception of the Beach geomorphic unit, all other areas are actively delivering sediment to the shoreline area at rates that are greater than the erosion potential.
- It is anticipated the WSE fluctuations under proposed operational conditions will decrease the duration of time that the WSE holds at any one elevation, especially peak WSE levels, therefore decreasing the frequency of wave events occurring at any one elevation and reducing the effects of wave erosion at any one shoreline elevation.
- Because of the limited extent of littoral transport observed in the field, the effects on the Beach geomorphic unit and other isolated pocket beaches is anticipated to be relatively minor. It should be noted that an interruption of limited littoral-transported sediment supply to Grant Creek will occur following the construction of the gravity diversion structure (if this option is selected), but it is anticipated that the sediment volumes and delivery rates are relatively small and only occur episodically and likely infrequently.

- The areas most susceptible to erosion from stream incision caused by decreases in base elevation are the alluvial deposits (Alluvial Deltaic and Alluvial Fan geomorphic units). The potential effects of channel incision will be the steepening of stream gradient, coarsening of streambed sediments, straightening of stream channels, decreased floodplain connectivity, increased instream flow velocities and depths, and bank steepening and retreat.

The greatest ongoing potential for geomorphic impact is the potential incision of the inlet streams at the shoreline margin, Inlet Creek at the east end of the lake in particular. The degree of impact will be limited by the timing of high flows in combination with the extent and duration of low lake WSE conditions. As lake WSE increases, the probability and extent of stream incision impacts decreases.

4.4.2.3. Grant Spawning Substrate Recruitment

Grant Creek is a complex, steep stream that demonstrated a wide range of variability both with the substrate and bedform conditions and transport is not adequately captured using referenced Shield's parameter values (Yager 2012). Regardless, the proposed operational conditions have the potential to affect geomorphic responses as summarized in Table E.4-6.

Table E.4-6. Potential geomorphic responses from Project operational conditions.

Proposed Change	Potential Geomorphic Response
Decreased frequency and magnitude of Grant Creek peak flows	• Reduced shear stress potential resulting in decreased net sediment transport potential • Decreased movement potential for large sediment material • Continued sediment transport of smaller and intermediate sediment sizes from the surface or subsurface following bioturbation (specifically spawning) • Decreased potential for armor remobilization • Increased relative armoring trend over time resulting from smaller particle "winnowing" (migrating in a downstream direction) • Decreased remobilization of sub-surface sediment except in spawning areas • Increased potential for channel stability (decreased lateral migration, net increase for channel incision potential) • Increased potential for development of a single-thread channel • Loss of floodplain connectivity • Decreased potential for scour and organization of depositional channel bed forms • Decreased bedform quantity and associated loss of hydraulic complexity • Decreased sediment supply resulting from lateral migration
Decreased frequency and duration of Grant Creek low flows	• Decreased potential for fine-grained sediment deposition
Flow bypass of the Canyon Reach	• Reduced sediment supply availability • Decreased ice-jam dam outburst potential • Decreased potential for slope instability in Canyon Reach • Decreased potential for bedrock outlet control degradation (erosion) and long-term Grant Lake WSE reduction

Of the potential geomorphic responses listed above, the following geomorphic responses are anticipated to have impacts to spawning substrate. Many of the geomorphic response and the resulting impacts to spawning substrate are anticipated to occur incrementally over time measured in years and decades. It is anticipated that there will be potential for:

- An increased coarsening of surface bedload sediment as the sediment supply decreases from a bypass of the Canyon Reach and smaller surface sediment is transported out of the reach by operational flow. As a result, there is likely to be degradation spawning substrate quantity and quality resulting from this geomorphic response.
- Increased armoring and pavement depth in spawning areas as subsurface fines are mobilized and winnowed out of the system following bioturbation pavement breakup (from spawning). As a result, there is likely to be a degradation of spawning substrate quality resulting from this geomorphic response.
- Decreased geomorphic channel form complexity (loss of side-channel and floodplain connectivity, development of a single-thread channel) resulting from decreased sediment supply will increase primary channel incision and stream velocity. As a result, there will likely be a decrease in spawning substrate quantity resulting from this geomorphic response.
- Decreased quantity of channel bedforms (riffles and bars) resulting from decreased sediment supply and decreased sediment transport with a reduced flow regime. As a result, there will likely be a decrease in hydraulic complexity that is expected to degrade spawning substrate quality and reduce its availability resulting from this geomorphic response.

4.4.3. Proposed Environmental Measures

Global adherence to Best Management Practices (BMP) will be utilized in conjunction with all Project construction and operation related activities. A series of monitoring and management plans will be developed post-licensing to ensure that construction and operations of the Project do not change or adversely impact natural processes associated with erosion and sediment deposition. In addition, these plans will also address the methodologies associated with containment and avoidance of the spilling of all hazardous materials. KHL will develop these plans in advance of construction activities commencing and provide stakeholders with an agreed upon review and comment period prior to finalizing and filing with FERC. KHL will have an Environmental Compliance Monitor (ECM) on site monitoring construction activities during all phases to ensure adherence to all applicable BMPs and methods outlined in the monitoring and management plans. For reference, the proposed construction schedule is located in Figure C.2-1 in Exhibit C of this DLA. The plans are as follows:

- Erosion and Sediment Control Plan (ESCP)
- Hazardous Materials Containment/Fuel Storage Plan
- Spill Prevention, Control and Containment Plan (SPCCP)

In addition to the aforementioned implementation of BMPs and respective monitoring and management plan methodologies, KHL is committed to restoring all temporarily impacted areas associated with Project construction back to natural conditions. While it is not anticipated that these areas will be numerous or cover a large area, examples of areas to be restored may include temporary laydown areas for infrastructural materials or parking/pull-out areas for construction equipment. The list of areas to be restored will be refined as construction nears conclusion and will be reviewed with stakeholders prior to restoration occurring.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.4.4. Cumulative Effects Analysis

Consistent with FERC's SD2 (FERC 2010b), no cumulative effects were identified associated with geological and soil resources. Per Section 4.4.3 of this Exhibit E, a series of monitoring and management plans will be developed to ensure that construction and operations of the Project do not change or adversely impact natural processes associated with erosion and sediment deposition. In addition, these plans will also address the methodologies associated with containment and avoidance of the spilling of all hazardous materials. Given the remote nature of the Project and the fact that KHL intends to operate the Project remotely, use of the Project access road is expected to be minimal and will not have cumulative impact from an erosion or sediment deposition perspective. It is important to note that it is KHL's intent to allow public and stakeholder comment to dictate the availability of the access road for acceptable public recreation activities. If it is determined that public access is preferred, the Public Safety Access Plan (PSAP), as discussed in greater detail in Section 4.8 of this Exhibit E, would address monitoring and maintenance measures related to the Project access road and the associated recreation that may occur as a result of public access being allowed.

4.4.5. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process and the proposed monitoring and management plans, KHL has identified no geologic or soil-related unavoidable adverse impacts associated with construction and operation of the Project.

4.5. Water Quality and Quantity

4.5.1. Affected Environment

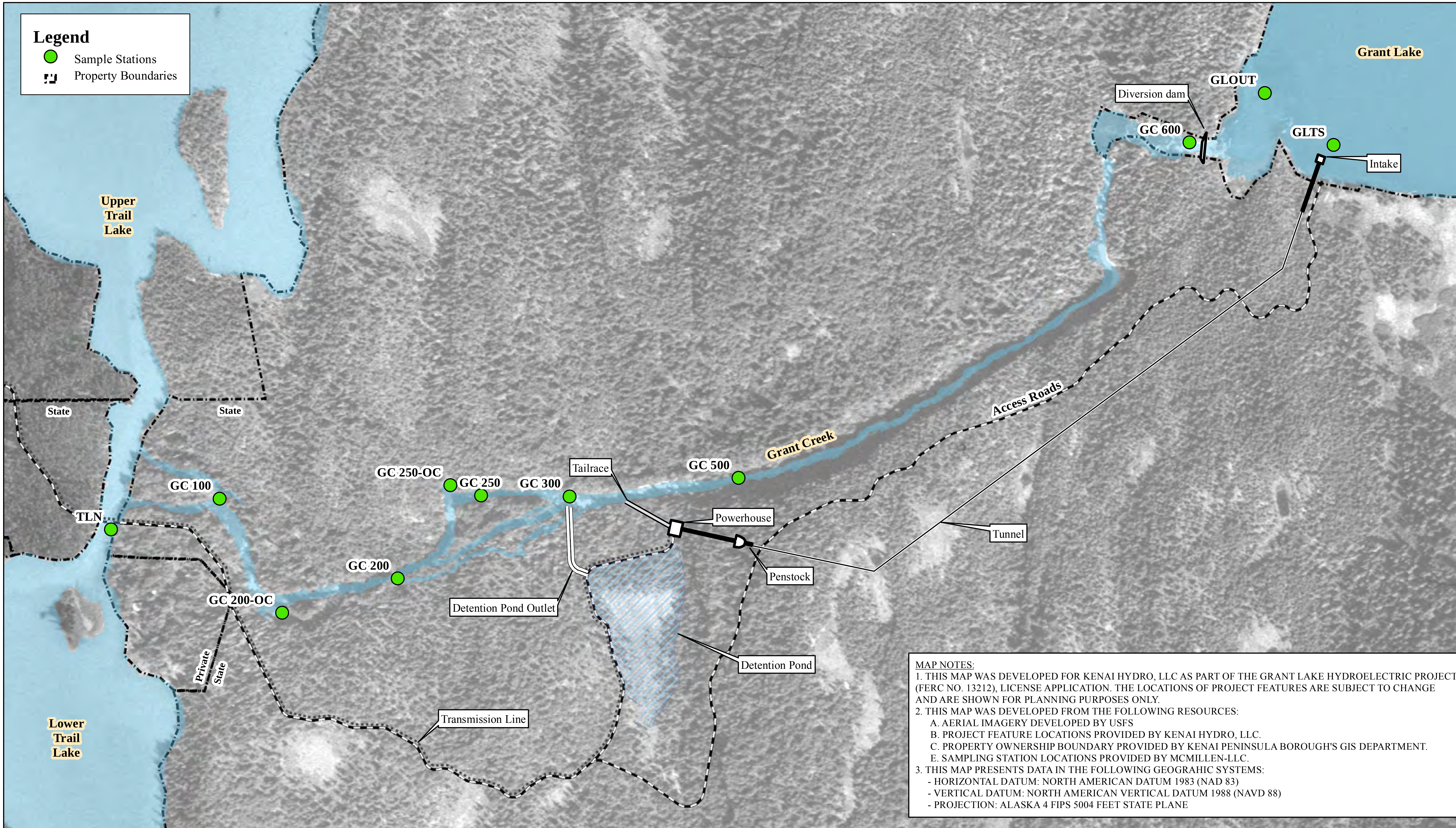
4.5.1.1. Water Quantity

The general study area and delineation of monitoring locations in support of 2013 water quality and quantity investigations is shown in Figure E.4-5.

Grant Lake is located at an elevation of approximately 703 feet NAVD 88, with a surface area of 2.6 square miles, a volume of almost 252,000 acre-feet, and a mean depth of 91 feet (Ebasco 1984). Grant Lake encompasses two almost separate bathymetric lake basins, which are separated by a shallow submerged ridge at the "narrows" that connects the two basins at right angles near the lake's midpoint. The deepest point within the lower basin is approximately 262 feet deep and the upper basin is 283 feet deep. Historical calculations of retention time at Grant Lake were 672 days based on an average outflow volume of 180 cfs (Ebasco 1984). Updated calculations indicate that retention time is closer to 617 days based on full lake storage capacity of 251, 920 acre-feet and an average annual outflow of 206 cfs. Shoreline length for Grant Lake is 100,487 feet with much of the littoral zone comprised of steep bedrock (Ebasco 1984).

Water level fluctuations within Grant Lake were studied from January 1982 through December of 1983 (Ebasco 1984). The greatest inter-monthly changes occur during ice breakup and snowmelt from late March through late June, with an average lake elevation increase of 0.8 feet per month. The maximum lake elevation was observed in July during both seasons with decreasing water levels in the fall and winter averaging about 0.33 feet per month.

Grant Creek itself is approximately 5,800 feet long and flows west from the outlet of Grant Lake to the “narrows” between Upper and Lower Trail lakes. It has with an average gradient of 207 feet per mile. In its upper half, Grant Creek passes through a steep bedrock canyon with three substantial waterfalls. In its lower half, Grant Creek becomes less steep with boulder and cobble dominant alluvial substrate. A detailed gradient profile of Grant Creek is provided in Figure E.4-6.



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATIONS OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS
   B. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
   C. PROPERTY OWNERSHIP BOUNDARY PROVIDED BY KENAI PENINSULA BOROUGH'S GIS DEPARTMENT.
   E. SAMPLING STATION LOCATIONS PROVIDED BY MCMILLEN-LLC.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

N

Drawing Scale:
0 100 200 400 600 800 Feet

MCMILLEN, LLC
1401 SHORELINE DRIVE BOISE, ID 83702 OFFICE: 208.342.4214 FAX: 208.342.4216

Developed For:
Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

LICENSE APPLICATION

Figure E.4-5
Water Quality, Temperature, and Hydrology Study Locations, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED C. Sauvageau
ISSUED DATE 11/17/2014
DRAWING
SCALE: 1:4,522

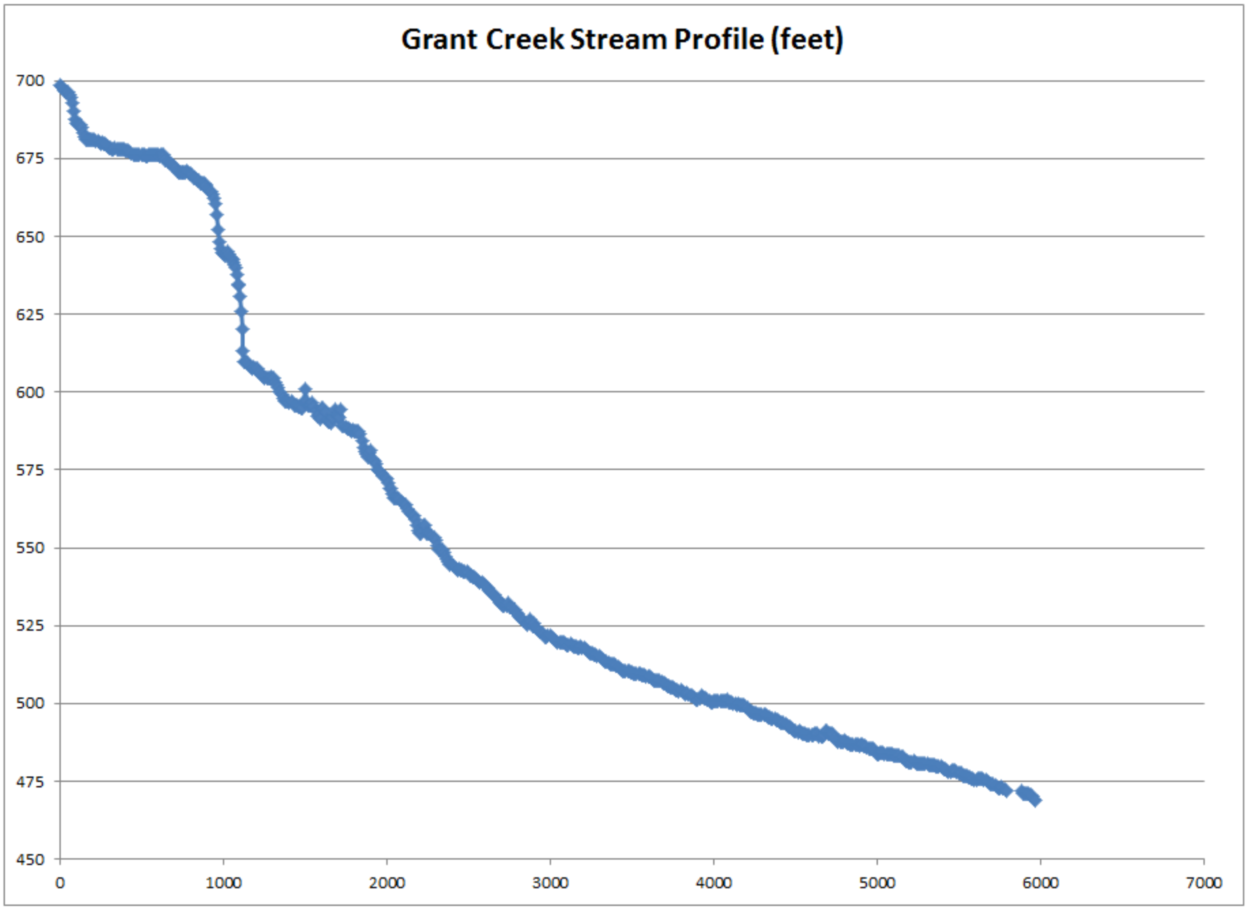


Figure E.4-6. Grant Creek stream profile generated from LiDAR (2002). Vertical axis is in feet NAVD 88 and horizontal axis is in feet as measured from the outlet at Grant Creek.

Grant Creek is a high energy stream with a wide variability in flow regime. Based on USGS data from 1947-1958, Grant Creek has a mean annual flow of 192 cfs with average monthly flows ranging from a low of 20 cfs in March to a high of 518 cfs in July (Table E.4-1).

Stakeholders requested that a component of the Water Resources Study Plan (KHL 2013a) include the re-establishment of a stream gage at Grant Creek to be located at the historical USGS station (gage 15246000). The stream gage at site GC 200 has been operational since April 2, 2013 and provides an on-site streamflow record through the end of the 2013 calendar year. A comparison of the 2013 streamflow record vs. the 10-year USGS record is summarized in Figure E.4-7.

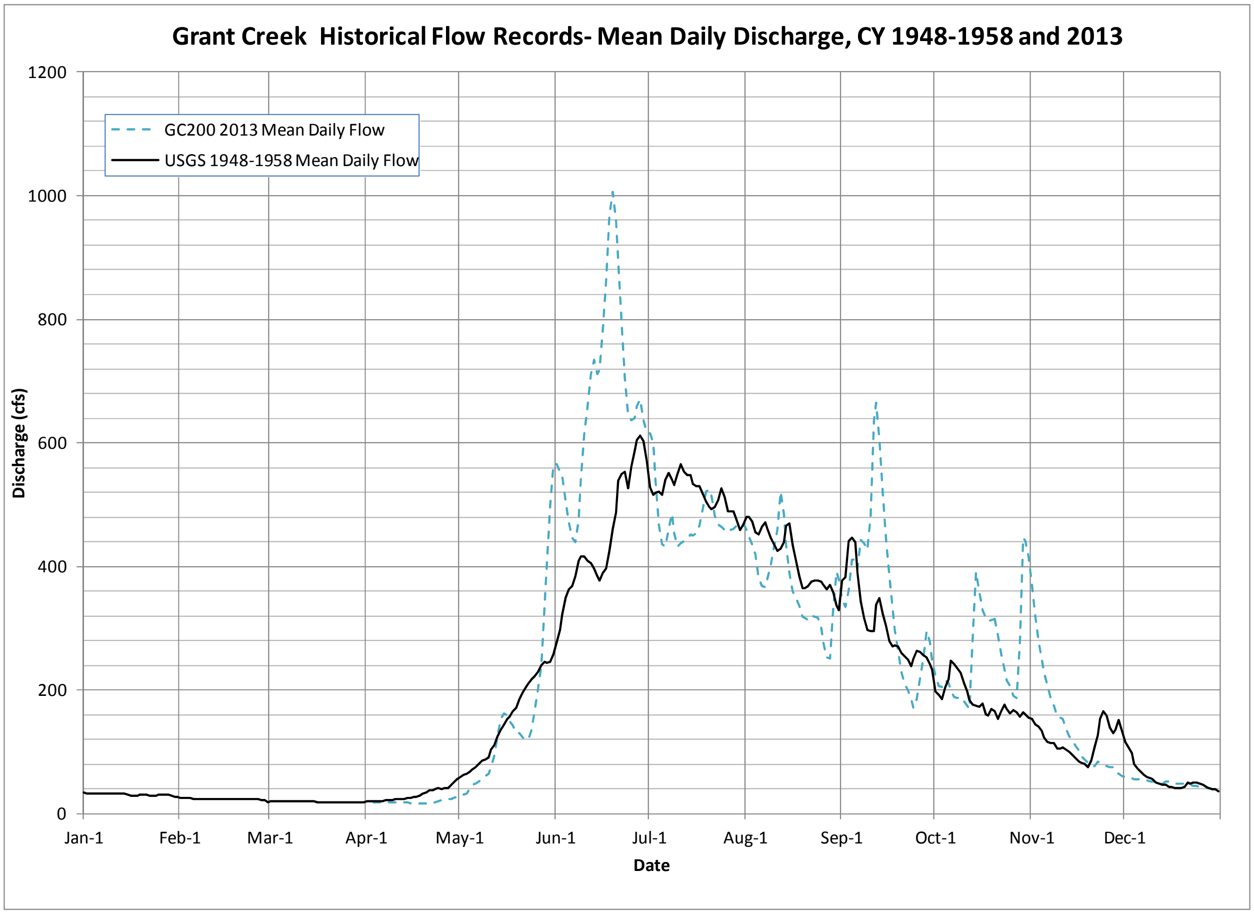


Figure E.4-7. Comparison of historical and 2013 mean daily flow records.

In addition to the 10-year streamflow record from USGS gage 15246000 and 2013 streamflow record, there was intermittent streamflow monitoring at Grant Creek in 1981-83 (Ebasco 1984). Statistics were applied to these intermittent data as well as developing a correlation to USGS gage 15258000 (Kenai River at Cooper Landing) to create a composite streamflow record for Grant Creek that represents 66 years of daily streamflow data for calendar years 1948 through 2013. The correlation between the Cooper Landing gauge and the Grant Creek record resulted in a coefficficient of determination (r^2) of 0.92, representing an excellent correlation between the two gauges. The monthly and annual flow statistics for the 66-year composite record are provided in Table E.4-7. Based on these updated results, the Grant Creek mean annual flow of 206 cfs represents a 7.3 percent increase from historical data.

Table E.4-7. Mean monthly and annual discharge data for Grant Creek in cfs. (Calculation period 1/1/1948-12/31/2013 based on 66-year composite record).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1947					79	359	466	422	260	262	200	116	
1948	32	24	16	27	244	493	556	385	162	259	90	26	194
1949	15	12	15	17	137	409	474	325	446	194	197	71	193
1950	37	21	18	26	117	447	521	481	338	101	33	21	181
1951	19	16	14	27	124	325	518	376	505	88	52	30	175
1952	18	16	16	15	66	375	572	434	268	337	263	124	210
1953	58	44	30	61	281	928	711	513	294	257	69	40	275
1954	32	33	28	30	173	409	420	384	201	168	145	51	174
1955	42	24	18	18	72	291	643	407	273	82	42	25	163
1956	20	17	15	22	121	269	471	453	215	65	56	52	149
1957	22	19	20	29	166	449	359	370	565	207	161	56	202
1958	44	29	26	66	170	535	449	418	155	250	74	41	189
1959	28	20	18	25	149	504	437	381	190	129	102	48	170
1960	30	27	19	19	233	409	506	458	258	125	96	92	191
1961	105	86	37	32	186	403	532	473	389	325	82	45	226
1962	30	27	21	28	77	349	469	336	200	107	152	71	156
1963	53	40	45	35	101	268	505	390	329	176	69	55	173
1964	50	35	23	42	85	533	524	538	483	238	114	84	230
1965	48	36	33	65	119	231	365	410	355	198	69	53	166
1966	37	25	22	28	71	345	415	578	547	273	91	51	208
1967	39	33	26	24	97	371	447	653	852	226	109	71	246
1968	51	49	56	36	159	369	441	402	205	99	58	36	164
1969	26	24	24	27	114	466	428	253	178	572	180	139	204
1970	96	65	67	65	152	395	496	514	450	129	197	63	225
1971	44	38	33	30	56	355	618	568	320	172	71	43	197
1972	31	22	20	21	53	225	466	468	360	152	85	47	163
1973	33	27	22	24	98	259	387	348	246	109	58	38	138
1974	30	22	21	26	98	317	400	337	678	182	145	62	193
1975	45	33	28	26	165	338	547	402	289	225	71	41	185
1976	34	26	21	21	96	336	462	426	586	258	222	200	225
1977	109	129	73	41	136	524	764	846	540	252	114	59	300
1978	47	47	46	36	148	334	462	458	465	255	113	67	208
1979	45	25	22	27	143	335	494	592	414	654	257	150	265
1980	82	111	57	69	219	535	772	585	294	412	175	69	283
1981	193	139	71	56	233	498	608	741	441	175	180	101	287
1982	59	44	30	23	80	308	456	372	414	221	93	100	184
1983	58	45	33	42	169	461	476	386	173	127	108	81	181
1984	61	53	58	59	131	330	442	424	279	329	85	54	193
1985	64	61	36	23	71	327	539	373	273	201	91	241	193
1986	107	65	41	29	98	368	496	384	292	419	142	144	217
1987	96	67	39	47	156	399	544	445	291	298	124	66	216
1988	48	39	37	33	183	498	588	544	373	328	151	70	242
1989	47	37	29	33	136	288	490	551	518	348	100	69	222
1990	51	43	39	58	243	492	476	456	406	156	210	49	224
1991	35	31	28	27	105	328	440	404	403	193	80	61	179
1992	53	44	34	41	149	447	519	441	191	93	100	102	186
1993	43	36	39	61	224	443	460	463	595	262	112	73	235
1994	62	60	39	46	161	440	510	484	315	149	67	49	199

Table E.4-7, continued…

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	38	31	30	48	241	435	559	423	687	261	90	45	241
1996	34	23	19	27	108	242	343	461	234	96	45	31	139
1997	24	27	24	27	128	319	462	388	427	154	113	67	181
1998	37	38	37	62	145	542	613	361	335	316	110	61	223
1999	46	38	30	31	126	431	501	439	457	205	82	66	205
2000	68	49	40	40	141	416	563	376	189	154	92	74	185
2001	130	73	42	44	123	581	722	552	663	233	65	49	274
2002	103	59	40	31	196	483	487	395	292	403	485	262	271
2003	80	136	68	47	147	370	505	401	230	421	264	82	230
2004	52	50	47	59	300	485	476	380	187	236	95	78	205
2005	49	33	34	46	278	452	443	388	314	228	161	97	211
2006	67	45	32	29	121	463	465	472	380	346	77	56	214
2007	41	33	24	44	160	414	400	378	237	93	254	97	182
2008	40	31	33	29	120	375	501	404	436	174	73	47	189
2009	48	46	28	21	155	342	514	411	317	331	95	72	200
2010	40	36	46	39	177	453	508	448	217	251	94	56	198
2011	43	33	23	25	100	306	372	413	608	296	251	71	212
2012	42	32	29	43	154	456	579	429	657	326	95	57	243
2013	59	43	32	20	152	673	477	371	356	263	139	49	220

KHL addressed an additional study concern by assessing whether Grant Creek gains or loses water within the canyon reach (Reaches 5 and 6) under low flow conditions. In April 2014, under stable stage conditions, discharges of 18.1 cfs and 18.3 cfs were measured at the upstream and downstream segments of the canyon reach respectively. This result verified that no water is lost or gained as it is conveyed down the canyon under low flow conditions. As snowmelt occurs in the spring and flows begin to increase rapidly, there may be some seeps or small runoff channels that enter the canyon reach. However, the accretion volumes of these seasonal channels are not expected to increase flows in the lower section of the canyon reach by more than a few cfs.

4.5.1.2. Water Quality

Field methods for the Water Resources Study (KHL 2014b) were designed to document current water quality conditions at selected locations and depths within Grant Lake, Grant Creek and Trail Lake Narrows (Figure E.4-5). Two sites were sampled in Grant Lake (GLTS and GLOut); three sites in Grant Creek (GC100, GC200, GC300); and one site in Trail Lake Narrows. Sampling frequencies varied for each site and included sampling one sampling event in August for the Grant Lake and Grant Creek sites and three sampling events (June, August and September) for the Trail Lake Narrows site. Parameters sampled at these study locations as well as ADEC criteria are specified in Table E.4-8.

Table E.4-8. Water quality parameters sampled in Grant Lake, Grant Creek and Trail Lakes Narrows, calendar year (CY) 2013.

Parameter	Units	ADEC Water Quality Standards [1]
Alkalinity ($CaCO_3$)	mg/L	no criteria
Total dissolved solids (TDS)	mg/L	≤ 1000 mg/L
Total suspended sediment (TSS)	mg/L	no criteria
Kjeldahl Nitrogen	mg/L	no criteria
Nitrate/Nitrite	mg/L	10 mg/L
Orthophosphate	mg/L	no criteria
Total phosphorous	mg/L	no criteria
Lead	µg/L	16.4 µg/l (acute); 0.64 µg/l (chronic)
Hardness	mg/L	no criteria
Calcium	mg/L	no criteria
Magnesium	mg/L	no criteria
Sodium	mg/L	<2.55 mg/L
Potassium	mg/L	no criteria
Low level mercury	µg/L	1.4 µg/l (acute); 0.77 µg/l (chronic)
Fluoride	mg/L	no criteria
Chloride	mg/L	860 mg/L (acute); 230 mg/L (chronic)
Sulfate	mg/L	no criteria
pH	S.U.	≥6.5 to ≤8.5
Temperature	°C	May not exceed 20°C at any time; maximum temperatures may not exceed, where applicable: migration routes: ≤15°C; spawning areas: ≤13°C; rearing areas: ≤ 15°C; egg/fry incubation: ≤13°C.
Dissolved oxygen	mg/L	>7mg/L and <17 mg/L in waters used by anadromous fish; >5mg/L and <17 mg/L for waters not used by anadromous fish
Specific Conductivity	mS/cm	no criteria
Oxygen Reduction Potential (ORP)	mV	no criteria
Turbidity	NTU	Not to exceed 25 NTU above natural conditions. For all lake waters, may not exceed 5 NTU above natural conditions.

Notes:
1 Based on the following water use class/subclass: (1) fresh water/(C) growth and propagation of fish, shellfish, other aquatic life, and wildlife.

4.5.1.2.1 Grant Lake

The 2013 sampling was repeated at the two original sites established in the lower basin from previous licensing studies (KHL 2010a; KHL 2014b). Station GLTS was located in the vicinity of the proposed intake structure and represents typical lake conditions of the lower basin while site GLOut represents outflow conditions into Grant Creek. All of the sampled water quality parameters exceeded ADEC standards during the August of 2013 sampling event. Results from 2013 as well as the 2009 and 2010 sampling events are presented in Tables E.4-9 and E.4-10.

Table E.4-9. Water quality sampling results for the Grant Lake GLTS site – 2009, 2010, and 2013. [1,2]

Hydrolab Readings		Jun-09	Jun-09	Jun-09	Aug-09	Aug-09	Aug-09	Jun-10	Jun-10	Jun-10	Aug-13	Aug-13	Aug-13
Depth	**m**	0-Surf	10-Mid	19-Bot	0-Surf	9-Mid	17-Bot	0-Surf	6-Mid	17-Bot	0-Surf	9-Mid	17 - Bot
Temp	**°C**	8.64	5.41	4.33	14.66	10.37	6.09	9.36	9.25	4.41	12.29	10.98	6.24
Sp. Cond	**mS/cm**	0.09	0.09	0.09	0.09	0.09	0.1	na	na	na	0.08	0.08	0.09
Dissolved Oxygen	**% Sat**	68.4	61.3	55.5	56.2	52.1	48.4	76.2	74.1	66.5	103.6	100.9	94.5
Dissolved Oxygen	**mg/l**	7.96	7.74	7.2	5.63	5.82	5.99	8.73	8.52	8.63	11.15	11.18	11.76
ORP	**mV**	na	na	na	na	na	na	91	26	65	319	320	327
pH	**S.U.**	7.43	7.49	7.06	7.56	7.2	7.06	6.68	6.82	6.43	7.26	7.42	7.42
Turbidity	**NTU**	0.6	na	na	3.87	na	4.8	0.81	1.14	1.17	3.9	7.8	4.8
Lab Analyses													
pH	**S.U.**	na	na	na	na	na	na	na	na	na	6.80	6.80	6.80
Turbidity	**NTU**	na	na	na	na	na	na	na	na	na	3.9	7.8	4.8
T. Alkalinity	**mg/l**	23.5	24.5	24	24.8	24.6	25.4	25.8	25.3	25.8	20.2	20.9	22.6
T. Hardness	**mg/l**	na	na	na	na	na	na	na	na	na	36.1	36.9	39.7
TDS	**mg/l**	75.0	68.8	61.3	46.3	48.8	45.0	67.0	64.0	63.0	43.0	45.0	49.0
TSS	**mg/l**	0.7	1.0	0.8	1.9	2.6	2.8	0.5	ND	0.7	2.7	2.6	4.2
T. Nitrate/Nitrite	**mg/l**	0.42	0.42	0.41	0.28	0.30	0.32	0.30	0.31	0.30	0.17	0.19	0.31
K. Nitrogen	**mg/l**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Orthophosphate	**mg/l**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01	ND
T. Phosphorus	**mg/l**	ND	0.021	ND	ND	ND	ND	ND	ND	ND	ND	0.02	0.04
Chloride	**mg/l**	na	na	na	na	na	na	0.30	0.29	0.47	0.22	0.22	0.27
Fluoride	**mg/l**	na	na	na	na	na	na	ND	ND	ND	ND	ND	ND
Sodium	**mg/l**	na	na	na	na	na	na	1.16	1.15	1.16	0.95	0.96	1.08
Calcium	**mg/l**	na	na	na	na	na	na	13.5	13.3	13.4	11.6	11.6	13.0
Magnesium	**mg/l**	na	na	na	na	na	na	1.3	1.3	1.3	1.2	1.2	1.3
Potassium	**mg/l**	na	na	na	na	na	na	0.53	0.51	0.52	0.51	0.53	0.52
Sulfate	**mg/l**	na	na	na	na	na	na	18.0	17.9	17.9	15.1	15.4	16.9
Lead	**µg/l**	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LL Mercury	**µg/l**	ND	ND	ND	0.0015	0.0016	0.0017	ND	ND	ND	0.0011	0.0015	0.0015

Notes
1 na: not sampled
2 ND: not detected

Table E.4-10. Water quality sampling results for the Grant Lake GLOut site – 2009, 2010, and 2013. [1,2]

Hydrolab Readings		Jun-09	Jun-09	Aug-09	Aug-09	Jun-10	Jun-10	Aug-13	Aug-13
Depth	**m**	0-Surf	4-Mid	0-Surf	6-Mid	0-Surf	6-Mid	0-Surf	3-Mid
Temp	**°C**	7.95	7.27	14.87	11.49	9.38	9.30	12.17	11.81
Sp. Cond	**mS/cm**	na	na	0.09	0.09	0.08	0.08	0.08	0.08
Dissolved Oxygen	**% Sat**	64.4	63.8	55.2	52.3	75.5	74.0	103.3	101.9
Dissolved Oxygen	**mg/l**	7.64	7.70	5.57	5.71	8.61	8.50	11.14	11.08
ORP	**mV**	na	na	na	na	73	29	334	332
pH	**S.U.**	7.27	7.37	7.24	7.24	6.98	7.06	6.28	6.59
Turbidity	**NTU**	0.82	na	4.18	na	1.46	1.14	4.50	5.10
Lab Analyses									
pH	**S.U.**	na	na	na	na	na	na	7.10	7.00
Turbidity	**NTU**	na	na	na	na	na	na	4.5	5.1
T. Alkalinity	**mg/l**	23.8	23.2	24.0	24.0	26.0	25.6	20.8	20.9
T. Hardness	**mg/l**	na	na	na	na	na	na	35.6	36.5
TDS	**mg/l**	51.3	40.0	32.5	47.5	57.0	64.0	46.0	52.0
TSS	**mg/l**	0.60	0.50	1.96	2.77	ND	0.75	2.08	2.75
T. Nitrate/Nitrite	**mg/l**	0.414	0.651	0.268	0.298	0.311	0.344	0.206	0.175
K. Nitrogen	**mg/l**	ND	ND	ND	ND	ND	ND	ND	ND
Orthophosphate	**mg/l**	ND	ND	ND	ND	ND	ND	ND	ND
T. Phosphorus	**mg/l**	ND	ND	ND	ND	ND	ND	ND	ND
Chloride	**mg/l**	na	na	na	na	0.298	0.291	0.221	0.220
Fluoride	**mg/l**	na	na	na	na	ND	ND	ND	ND
Sodium	**µg/l**	na	na	na	na	1.16	1.12	0.95	0.95
Calcium	**µg/l**	na	na	na	na	13.8	13.4	11.5	11.6
Magnesium	**µg/l**	na	na	na	na	1.32	1.27	1.18	1.2
Potassium	**µg/l**	na	na	na	na	0.53	0.53	0.51	0.51
Sulfate	**mg/l**	na	na	na	na	17.6	17.9	15.3	15.4
Lead	**µg/l**	ND	ND	ND	ND	ND	ND	0.24	ND
LL Mercury	**µg/l**	ND	ND	0.0014	0.0021	0.0011	0.0011	0.0011	0.0014

Notes
1 na: not sampled
2 ND: not detected

In situ sampling during 2013 at the GLTS site was done from the surface down to a bottom depth of 17 meters. Dissolved oxygen ranged from 103.6 percent saturation at the surface to 94.5percent saturation at the bottom. A mid-depth (8.0 meters) reading was 100.9 percent saturation. Dissolved oxygen concentrations for these same depths ranged from a surface reading of 11.15 milligrams/liter (mg/L), increasing to 11.76 mg/L at the bottom. A mid-depth concentration was 11.18 mg/L. The pH levels ranged from 7.26 S.U. at the surface to 7.42 S.U. at the bottom. Instantaneous temperature readings ranged from 12.3 °C at the surface to 6.24 °C at the bottom. A mid-depth temperature was 10.98 °C.

In situ sampling during 2013 at the GLOut site was done from the surface down to a mid-depth of 5 meters. Dissolved oxygen ranged from 103.3 percent saturation at the surface to 98.0 percent saturation at the mid depth. Dissolved oxygen concentrations for these same depths ranged from a surface reading of 11.14 mg/L to 10.69 mg/L at the mid depth. The pH levels ranged from 6.33 S.U. at the surface to 6.79 S.U. at the mid-depth. The instantaneous temperature readings ranged from 12.2 °C at the surface to 11.6 °C at the mid-depth.

Data for the two lake sites was initially collected in 2009 and repeated in June of 2010. Results are similar for nearly all parameters where three years of data exists. Differences in sampling results for dissolved oxygen between 2009/2010 and 2013 may be a result of poor equipment calibration or a faulty sensor with the equipment used in 2009/2010. The 2013 sampling used duplicate multi-probe instruments in an attempt to alleviate this problem and insure accurate results.

Differences at sites GLout and GLTS in dissolved oxygen and pH values were also noted between the 2013 results and the 2009-2010 results. It is unclear whether this is a result of fluctuating annual conditions or faulty sampling equipment. However, Grant Lake water quality data summarized by Ebasco (1984) indicate that the 2013 results are more in line with historical results.

4.5.1.2.2 Grant Creek

There were three sampling sites on Grant Creek, all located below the canyon reach (Figure E.4-5). Each site was sampled once in August 2013 (KHL 2014b). The 2013 results indicated all parameter levels were below ADEC standards. Little variability between these creek sites was observed in 2013. Turbidity values ranged from 4.0-4.6 NTUs, dissolved oxygen ranged from 10.95-11.02 mg/L, and pH values from 7.00-7.18 S.U.

Three 2013 sampling stations were initially established in 2009 and sampled again in June of 2010 (KHL 2010a). Since there is little longitudinal variation between the water quality sampling locations, results from the three years of sampling data are presented for the mid-station site of GC200 in Table E.4-11. Grant Creek results also show little variation between years for all parameters with the exception of dissolved oxygen. Differences in sampling results for dissolved oxygen between 2009/2010 and 2013 may be a result of a faulty sensor with the equipment used in 2009-2010. Given the steep gradient and turbulent conditions of Grant Creek, dissolved oxygen levels would be expected to be near 100 percent saturation, as reported in 2013. Historical and recent sampling of Grant Lake, the source water for Grant Creek, also indicate dissolved oxygen saturation levels near 100 percent.

Table E.4-11. Water quality sampling results for the Grant Creek GC200 site – 2009, 2010, and 2013. [1,2]

Hydrolab Readings		Jun-09	Aug-09	Jun-10	Aug-13
Temp	**°C**	7.4	11.26	8.51	12.46
Sp. Cond	**mS/cm**	na	0.07	0.09	0.06
Dissolved Oxygen	**% Sat**	60.9	75.1	92.3	101.5
Dissolved Oxygen	**mg/l**	7.31	8.22	10.79	10.89
ORP	**mV**	na	na	216	408
pH	**S.U.**	7.66	7.39	7.39	7.02
Turbidity	**NTU**	0.75	11.10	1.17	4.00
Depth	**m**	na	na	na	1.9
Lab Analyses					
pH	**S.U.**	na	na	na	7.00
Turbidity	**NTU**	na	na	na	4.0
T. Alkalinity	**mg/l**	25.0	23.5	25.5	20.6
T. Hardness	**mg/l**	na	na	na	34.4
TDS	**mg/l**	60	44	50	51
TSS	**mg/l**	0.8	3.4	0.7	2.9
T. Nitrate/Nitrite	**mg/l**	0.455	0.292	0.269	0.190
K. Nitrogen	**mg/l**	ND	ND	ND	ND
Orthophosphate	**mg/l**	ND	ND	ND	ND
T. Phosphorus	**mg/l**	ND	ND	ND	ND
Chloride	**mg/l**	na	na	0.284	0.225
Fluoride	**mg/l**	na	na	ND	ND
Sodium	**mg/l**	na	na	1.14	1.18
Calcium	**mg/l**	na	na	13.3	11.7
Magnesium	**mg/l**	na	na	1.26	1.25
Potassium	**mg/l**	na	na	0.52	0.54
Sulfate	**mg/l**	na	na	17.9	15.1
Lead	**µg/l**	3.09	ND	ND	ND
LL Mercury	**µg/l**	ND	0.0016	ND	0.0013

Notes
1 na: not sampled
2 ND: not detected

4.5.1.2.3 Trail Lakes Narrows

Three sampling events were conducted at this site (June, August, and September 2013; KHL 2014b). Table E.4-12 provides the results of 2013 sampling for this site. No parameter sampled exceeded water quality standards during any sampling event. Specific parameters of aquatic interest (dissolved oxygen, pH and temperature) met standards for all sampling periods. Compared to the Grant Lake and Grant Creek sites, Trail Lakes Narrows routinely had the highest turbidity readings of all sites in 2013. This site was also the only site sampled for diesel and gas components, both of which were below detection levels for all three sample events. Some minor variability was noted between *in situ* and laboratory pH values at the Trail Lake

Narrows site. This discrepancy is most likely due to the accuracy of pH field probes, which tends to be less reliable than laboratory measurements.

Table E.4-12. Water quality sampling results for the Trail Lake Narrows site – 2013. [1,2]

Hydrolab Readings		Hydrolab #1 June 2013	Hydrolab #2 June 2013	Hydrolab #1 August 2013	Hydrolab #2 August 2013	Hydrolab #1 Sept 2013	Hydrolab #2 Sept 2013
Temp	**°C**	9.05	9.08	11.81	11.94	8.39	8.51
Sp. Cond	**mS/cm**	0.08	0.08	0.07	0.04	0.07	0.07
Dissolved Oxygen	**% Sat**	102.5	102.5	102.9	102.1	87.4 [1]	102.6
Dissolved Oxygen	**mg/l**	11.88	11.85	11.19	11.09	10.8 [1]	11.82
ORP	**mV**	399	385	526	315	387	335
pH	**S.U.**	7.51	7.63	7.63	6.32	7.06	6.60
Turbidity	**NTU**	9.4	--[2]	--[2]	--[2]	9.4	--[2]
Depth	**m**	1.6	1.7	2.0	2.0	1.0	1.0
Analytical Lab Results			DUP				DUP
pH	**S.U.**	7.60	7.60	6.90		7.20	7.10
Turbidity	**NTU**	8.5	8.8	13.0		11.0	11.0
T. Hardness	**mg/l**	38.9	41.2	33.0		36.8	33.8
T. Alkalinty	**mg/l**	25.1	25.5	18.7		22.0	21.8
TDS	**mg/l**	44	49	43		54	50
TSS	**mg/l**	3.1	5.7	11.3		4.1	3.8
T. Nitrate+Nitrite	**mg/l**	0.35	0.39	0.14		0.27	0.25
K. Nitrogen	**mg/l**	ND	ND	ND		ND	ND
T. Phosphorus	**mg/l**	ND	ND	0.03		ND	0.01
Orthophosphate	**mg/l**	ND	ND	0.02		0.02	0.02
Chloride	**mg/l**	0.32	0.32	0.21		0.21	0.21
Fluoride	**mg/l**	ND	ND	ND		ND	ND
Sodium	**mg/l**	1.17	1.15	0.91		0.99	1.05
Calcium	**mg/l**	13.6	14.4	11.3		12.5	11.4
Magnesium	**mg/l**	1.2	1.3	1.2		1.4	1.3
Potassium	**mg/l**	0.53	0.59	ND		0.62	0.56
Sulfate	**mg/l**	16.0	16.0	13.1		15.0	15.0
Lead	**µg/l**	0.2	ND	0.40		0.30	0.23
Low level Mercury	**µg/l**	0.0017	0.0016	0.0036		0.0022	0.0022
Gas Range Organics	**mg/l**	ND	ND	ND		ND	ND
Diesel Range Organics	**mg/l**	ND	ND	ND		ND	ND

Notes

ND: not detected

1. Manufacturer confirmed faulty LDO sensor on Sept. 2013 sample event – Hydrolab #1 values not accurate
2. Faulty turbidity probe. *In situ* readings not collected.

4.5.1.3. Temperature

4.5.1.3.1 Grant Creek

Stream temperature data loggers were re-established at four previously monitored sites (GC 100, GC 200, GC 250, and GC 300) on Grant Creek (KHL 2010a; KHL 2014b). Two additional temperature data loggers were also established within the upper and lower canyon reach of Grant Creek (GC 500 and GC 600) as well as at two off-channel locations (GC 200-oc and GC 250-oc) where rearing salmonids were observed (Figure E.4-5).

Daily mean temperature hydrographs for the six main channel Grant Creek sites are presented in Figure E.4-8. Mean daily temperatures at all sites are very similar to one another throughout longitudinal profile of Grant Creek. The exception is GC600 from early to mid-April and mid-late December. GC600 is located less than 100 feet from the outlet of Grant Lake and may be less affected by changes in air temperature and reflects the temperatures of surface outflows from an ice covered Grant Lake.

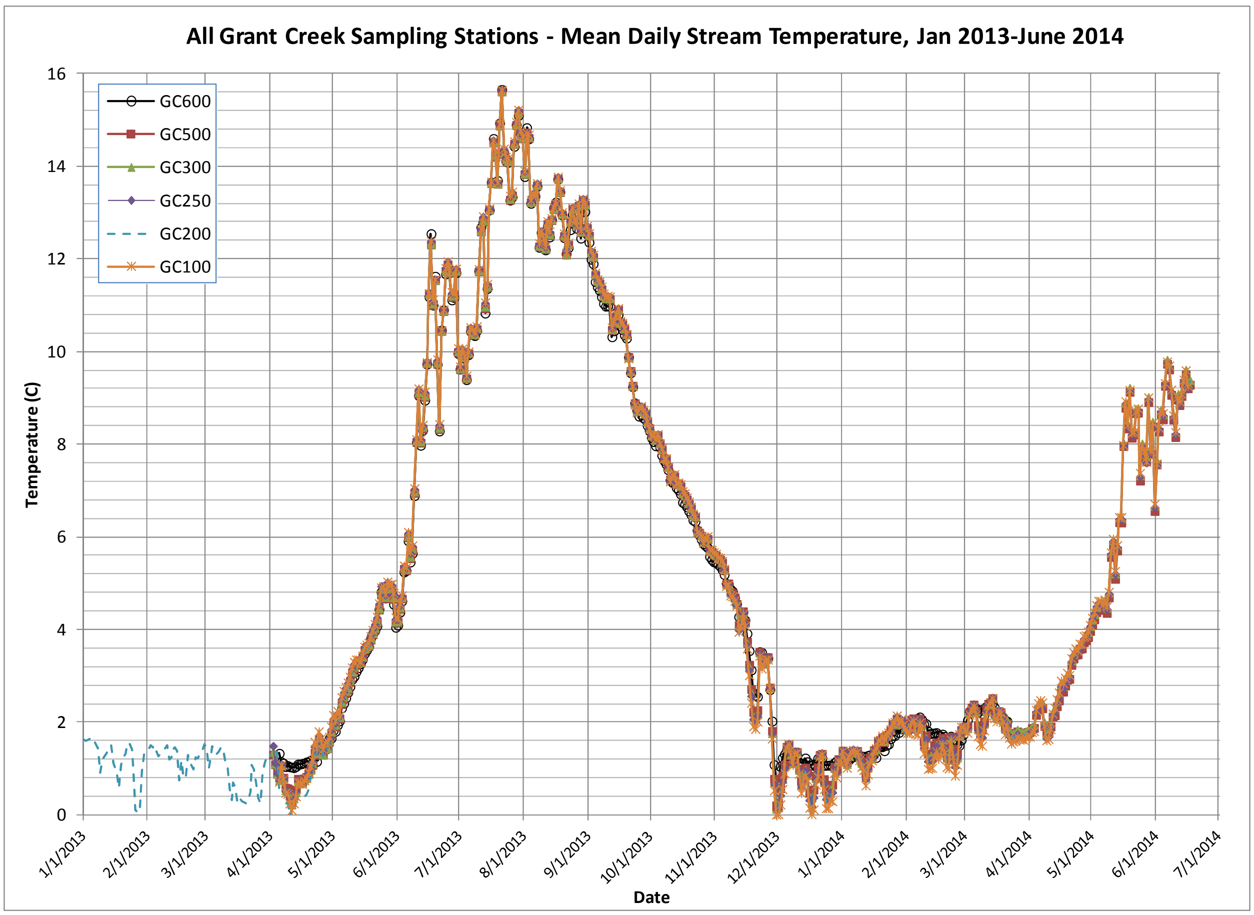


Figure E.4-8. Daily mean water temperatures all Grant Creek main channel sites – 2013.

Winter temperature data was collected at one site (GC200) for the entire 2013-2014 study period. The January-April and December 2013 record indicates that the minimum daily mean water temperature for this period approach 0.0 °C and the maximum daily mean water temperature for this period was 1.8 °C. The 2013 daily mean average temperature for January was 1.2 °C; for February it was 1.3 °C; for March and April it was 0.9 °C; and for December it was 0.8 °C. The January-April 2014 record indicates that the minimum daily mean water temperature for this period is 0.7 °C and the maximum daily mean water temperature for this period was 4.1 °C. The 2014 daily mean average temperature for January and February was 1.5 °C; for March it was 2.0 °C; and for April it was 2.8 °C. Following the month of April, mean daily temperature values increase through the summer, before decreasing once again in September.

Additional stream temperature data was collected at two off site channel locations. These backwater areas were selected in coordination with members of the Aquatic Resources study team that detected juvenile salmonids (resident and anadromous) rearing at these two locations. Figure E.4-9 shows the results of daily mean temperatures at both off channel sites (GC 200-oc and GC 250-oc) from June of 2013 through June 2014 in comparison to main channel temperatures. Site GC 200-oc temperatures remained cooler and more stable when compared to temperatures recorded at GC 250-oc. The cooler temperatures at GC 200-oc are likely due to different physical characteristics of site (greater depth, denser canopy cover, and more isolation from main channel flows) as well as more groundwater influence. In general, both off channel sites were slightly cooler when compared to main channel temperatures. Although GC 250-oc was slightly cooler than main channel temperatures, the inter-daily temperature fluctuations still appeared to follow patterns detected in the main channel.

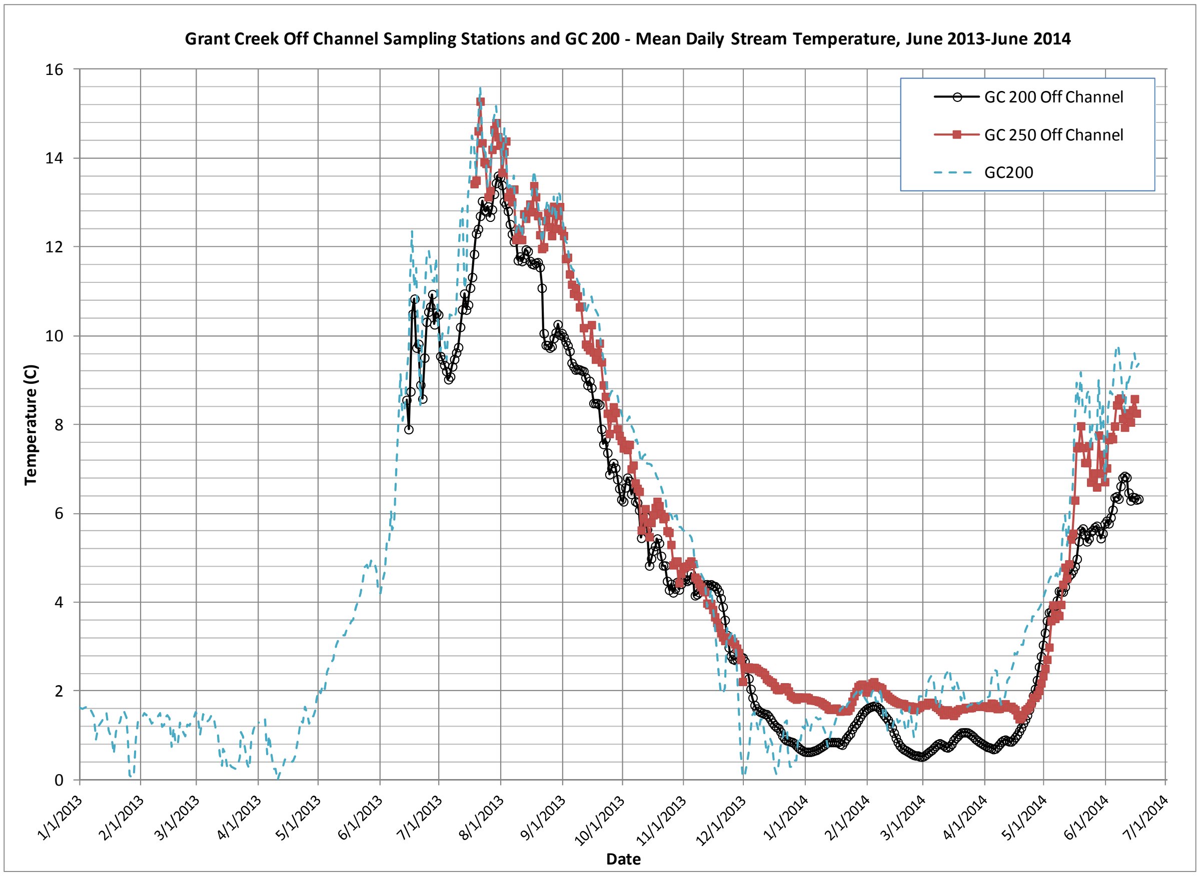


Figure E.4-9. Comparison of daily mean water temperatures between two off channel rearing locations and the main channel of Grant Creek – 2013-2014.

A thermologger recovered at station GC250 in April 2013 provides continuous temperature data for the fall of 2009, all of 2010, and for the first days 37 days of 2011. Site GC 200, approximately 450 feet downstream of GC250, has temperature data for last 21 days of December 2012 through mid-June of 2014. The consistent trend for Grant Creek temperatures is to be at or below 2.8 °C during the winter months (December through mid-April). Water temperatures begin to rise sometime in late April or early May depending upon ice break up in Grant Lake. Water temperatures continue to rise throughout June and July before peaking sometime between mid-July to mid-August. Figure E.4-10 summarizes all of the recent Grant Creek mean daily temperature records.

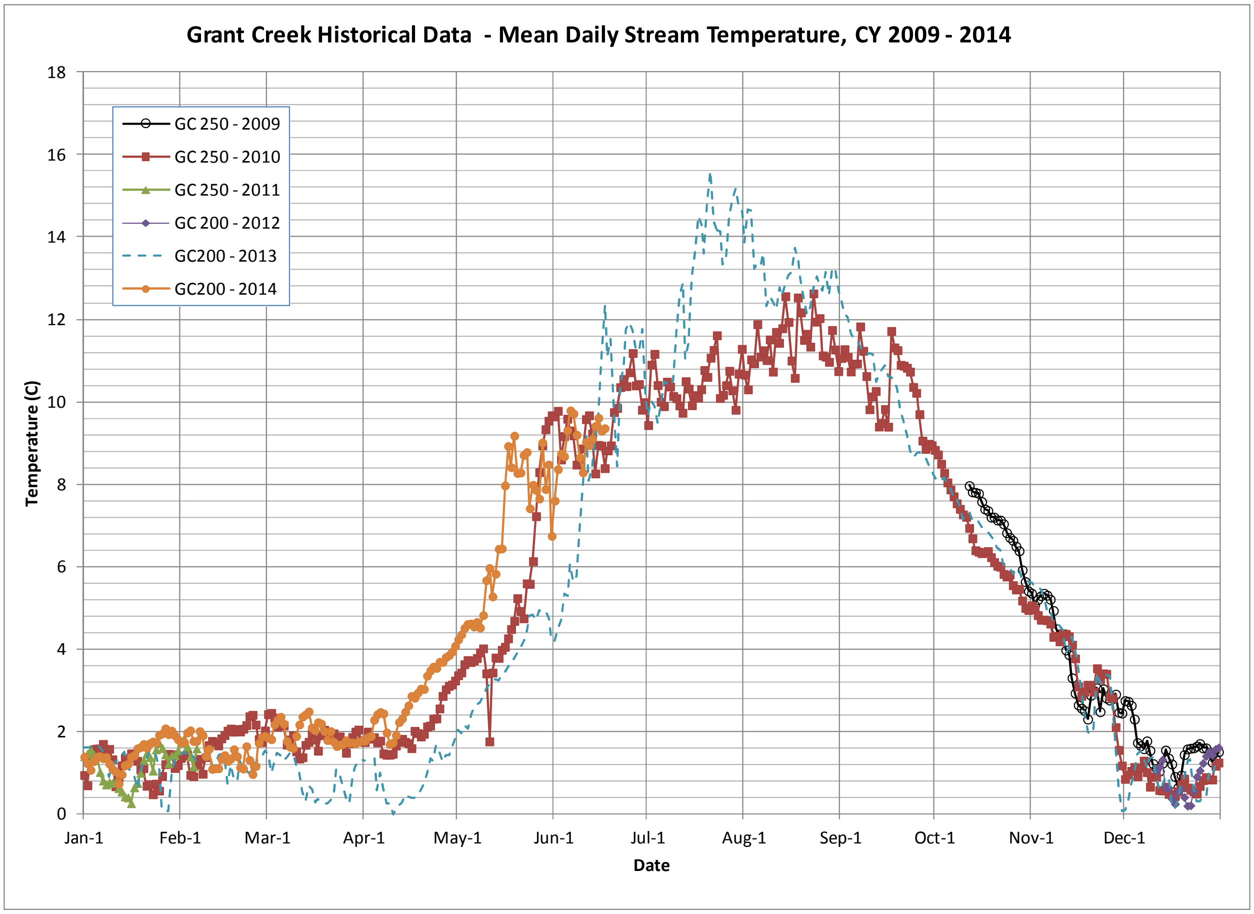


Figure E.4-10. A comparison of daily mean water temperatures for Grant Creek, CY 2009 – 2014.

Data indicates that Grant Creek water temperatures, on average in 2010, were warmer (+0.5 °C) in the winter months and cooler (-3.5 °C) in the summer months when compared to 2013 results. Winter data from 2014 were also warmer (+0.9 °C) than in 2013. Grant Creek water temperatures peaked in mid-August 2010 near 13 °C and in late July 2013 near 16 °C. The 2009, 2010 and 2013 datasets provide temperature data for the fall period. The 2010 and 2013 data show similar late summer trends of slowly decreasing mean daily temperatures through mid-September before beginning a steady decline. The 2009 fall data also mirrors this steady and consistent temperature decline from ~8 °C to ~2 °C though late November before freeze-up occurs.

4.5.1.3.2 Grant Lake

The historical continuous temperature monitoring site in Grant Lake (GLTS) was also re-established (KHL 2014b). At the Grant Lake site (GLTS), a thermistor string was installed in June 2013 along a vertical transect to a depth of 20 meters. HOBO® Pro v2 data loggers were attached to the string at ten distinct sampling depths of 0.2, 0.5, 1.5, 3.0, 6.0, 9.0, 12.0, 15.0, 18.0 and 19.5 meters. In addition to the installation of new temperature instrumentation, the thermistor string from earlier licensing studies (KHL 2010a) and last serviced in 2010 was recovered near GLTS. All data from the 2010 thermistor string was recovered and provides a temperature record at Grant Lake from September of 2010- June of 2013.

Figure E.4-11 displays the seasonal temperature profile of Grant Lake in 2013. A noted temperature difference from top to bottom does exist throughout the year, but changes appear subtly during periods of ice cover and become more pronounced throughout the most of the summer. By mid and late September, the temperature gradient is substantially reduced with a nearly isothermal profile from 0-15m on September 30. These temperature profiles patterns have been consistent based on historical temperature profile results from earlier study efforts (AEIDC 1983; KHL 2010a).

Grant Lake water temperature hydrographs are presented in Figure E.4-12. The temperature monitoring results show three distinct seasonal characteristics within Grant Lake. The first characteristic is that winter water temperatures increased with depth. This trend was noted from January through mid to late May. The second trend is that summer water temperatures decreased with depth, starting at ice breakup in May and extending through mid-October. A maximum difference of about 10 °C between the surface (0.2 meter) and the deepest sampling node (19.5 meter) was recorded in late July through early August. From mid-October to late November, Grant Lake water temperatures are similar throughout the water column. As ice begins to form on Grant Lake the winter temperature pattern becomes re-established.

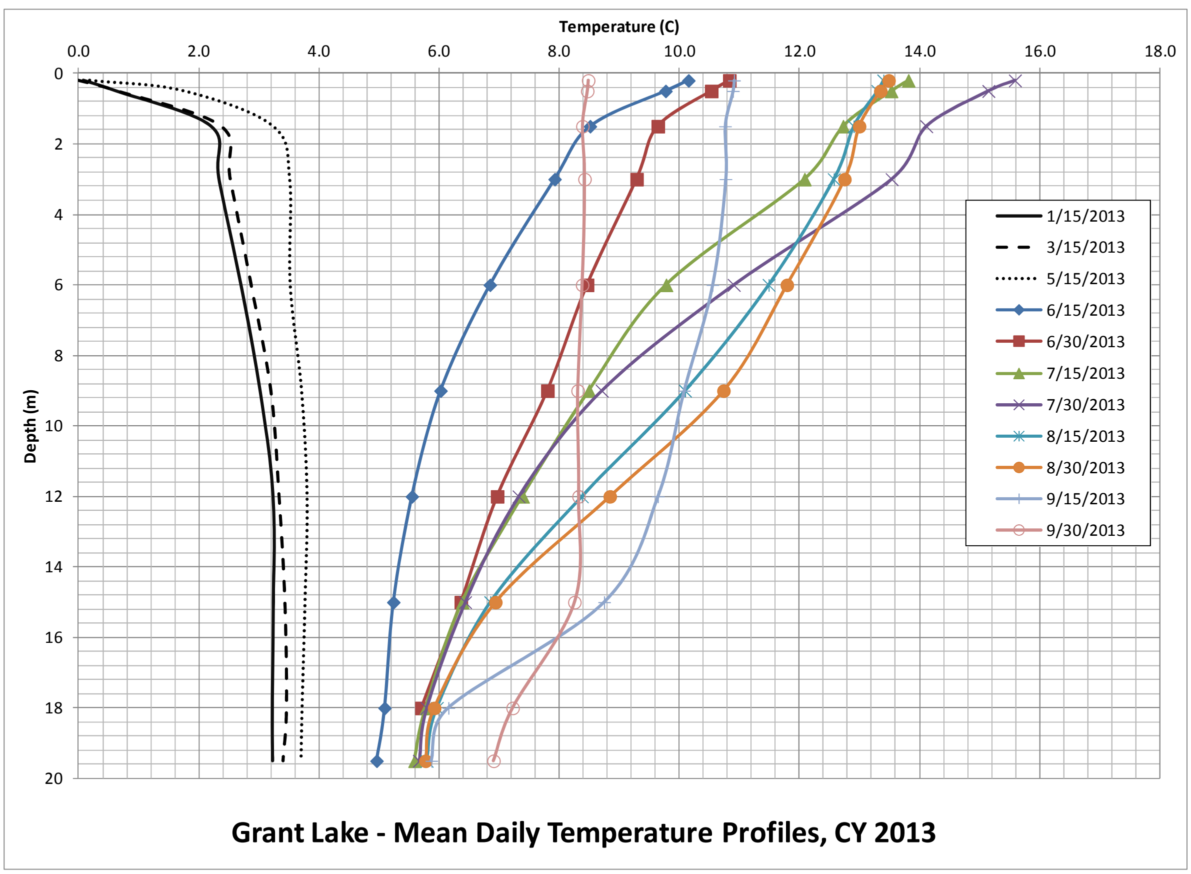


Figure E.4-11. Daily mean water temperature profiles in Grant Lake near the proposed intake structure.

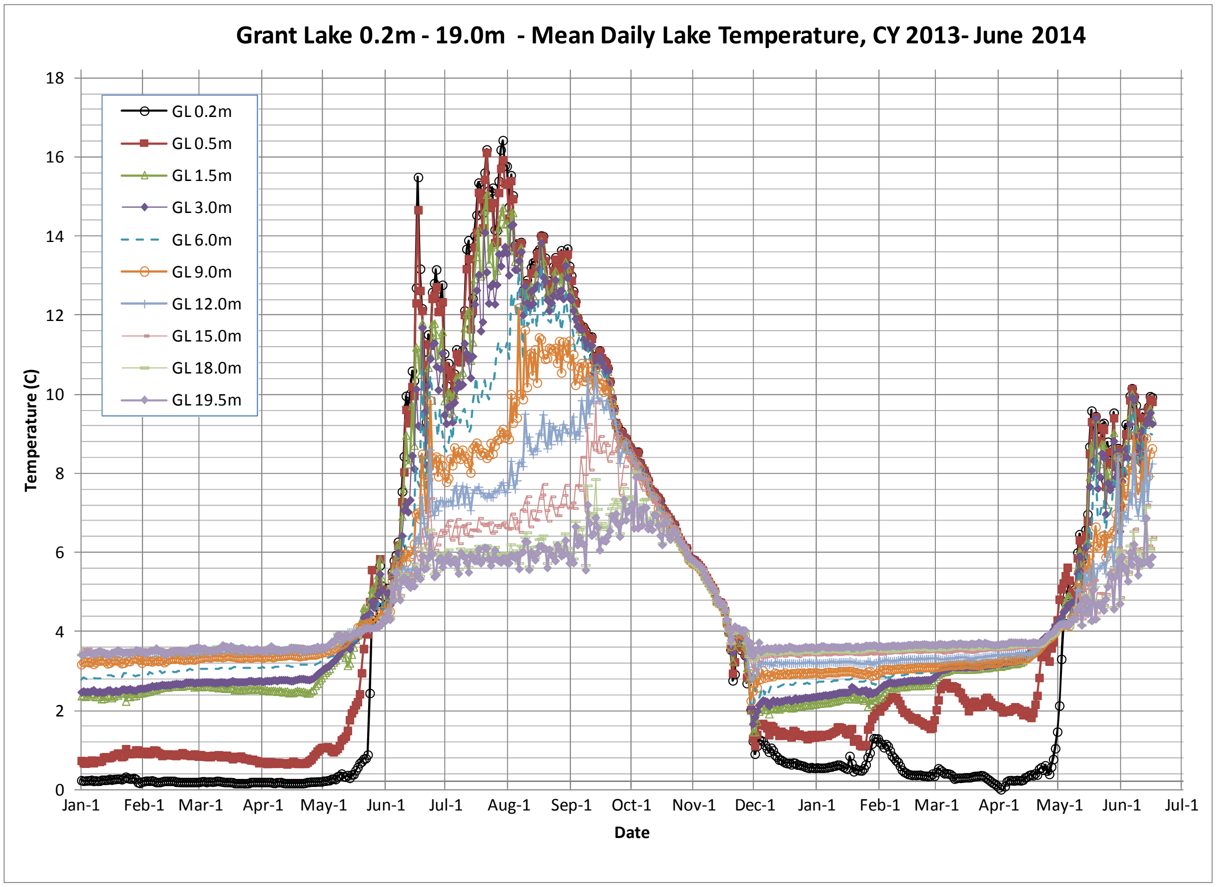
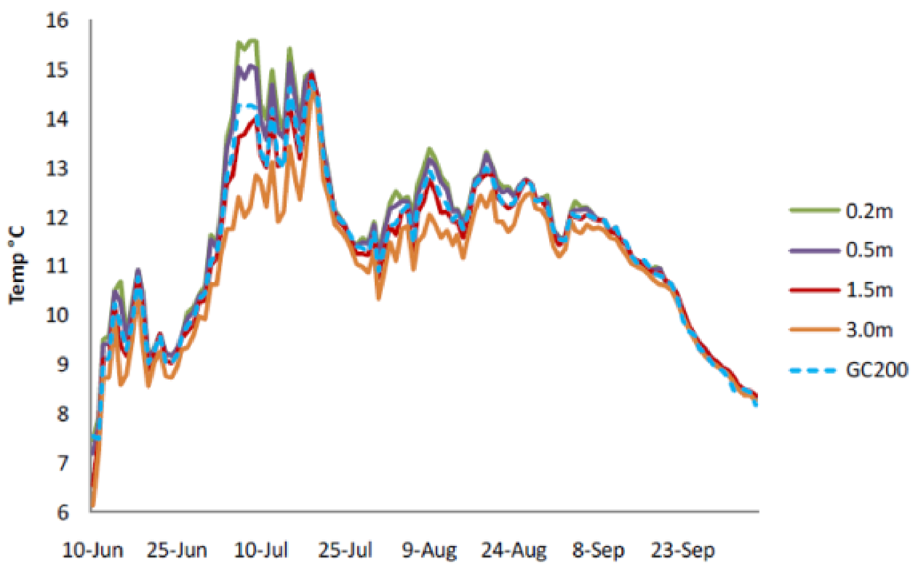
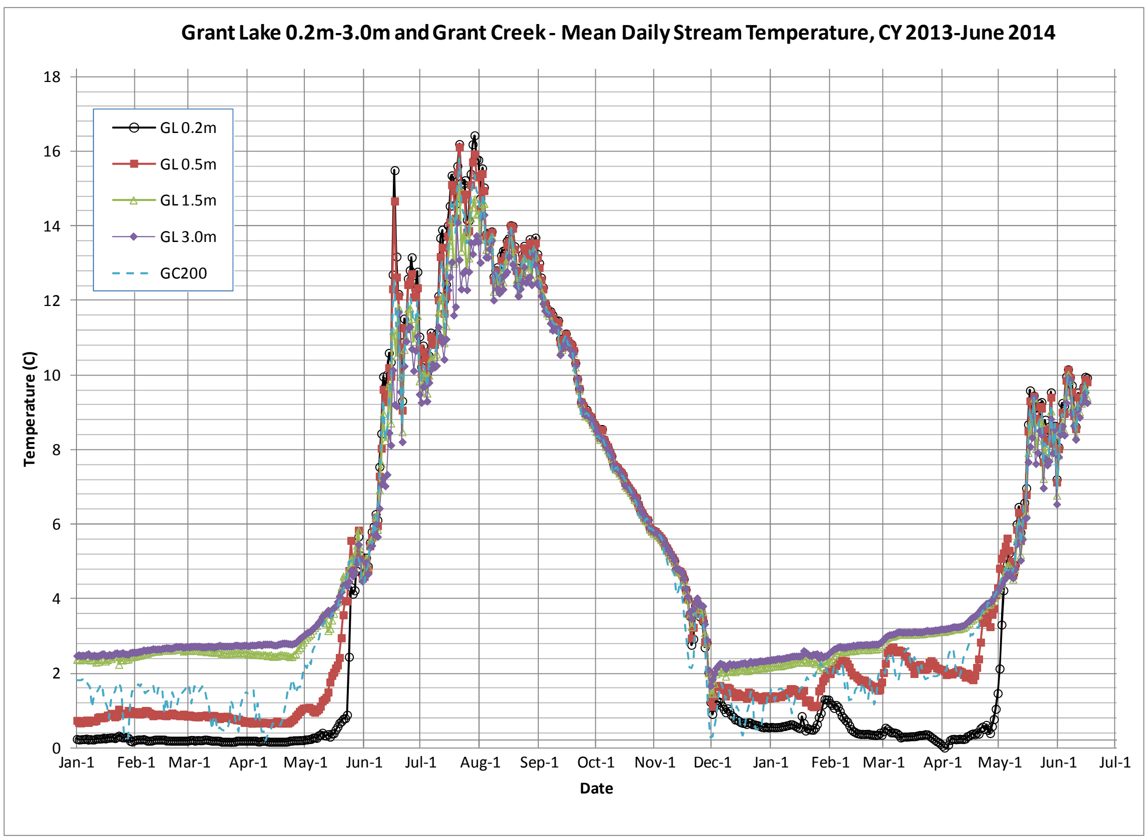


Figure E.4-12. Comparison of daily mean water temperatures in Grant Lake near the proposed intake structure – 2013-June 2014.

Temperature results from Grant Lake and Grant Creek indicate lake water temperatures closely mirror and influence creek water temperatures during periods when the lake is ice-free. The strongest correlation appears to be between creek temperatures and the upper surface lake depths (0.2 – 3.0 meters). Figure E.4-13 shows a comparison of Grant Lake water temperatures from the four shallow sampling depths compared to Grant Creek (GC200) in 2009 and 2013.



a)



b)

Figure E.4-13. A comparison of daily mean water temperatures for shallow depths (< 3 meters) of Grant Lake and Grant Creek in a) 2009 and b) 2013-2014.

During the winter period when Grant Lake is under ice cover, lake temperatures at a depth of 0.5 meters most closely match water temperatures in Grant Creek. During the ice-free period from May through October, Grant Creek temperatures are most similar to Grant Lake temperatures at a depth of 1.5 meters. Table E.4-13 summarizes mean monthly temperatures for all available data that simultaneously measure temperatures at Grant Lake and Grant Creek.

Table E.4-13. Comparison of mean monthly temperatures at shallow Grant Creek depths and Grant Creek – 2009-2013.

	Grant Lake 0.2m	Grant Lake 0.5m	Grant Lake 1.5m	Grant Creek - GC200 or GC250	Number of Mean Daily Temperature Records			
	Avg	Avg	Avg	Avg	0.2m	0.5m	1.5m	GC
January	0.3	1.0	2.2	1.2	79	124	93	124
February	0.2	1.2	2.4	1.5	59	90	62	90
March	0.1	1.4	2.6	1.6	60	93	62	93
April	0.1	1.4	2.8	1.9	56	90	60	90
May	4.0	4.8	5.2	5.1	62	93	62	93
June	9.5	9.3	8.7	8.9	46	49	46	49
July	12.1	11.9	11.4	11.5	62	62	62	62
August	12.4	12.3	12.0	12.2	62	62	62	62
September	10.9	10.8	10.7	10.4	60	60	60	60
October	6.9	6.9	6.9	6.8	62	82	62	82
November	4.0	4.0	4.1	3.6	60	90	60	90
December	0.5	1.3	2.0	1.0	83	114	83	114

4.5.2. Environmental Analysis

Based on available hydrology data, the Grant Lake Project proposes to utilize a mean annual flow of 200 cfs for power production and 6 cfs for bypass flows. Table E-4-14 summarizes the monthly and annual powerhouse and bypass flow volumes in comparison to natural inflows from the watershed.

Aside from power production, there are no other proposed or existing uses of Project waters. The proposed Project's facilities would be located on state land managed by ADNR. Currently, there are active mining claims on federal lands located on the north side of Grant Lake's lower basin in addition to a small parcel of private ownership in the lower section of the Grant Creek drainage. However, documented water rights were not identified within the Grant Lake drainage area (KHL 2009b).

Table E.4-14. Proposed monthly and annual powerhouse flows and watershed inflows for Grant Lake Project.

Proposed Monthaly and Annual Streamflows for Grant Lake Project							
Inflow (cfs)		**Powerhouse Flows (cfs)**		**Bypass Flow (cfs)**		**Total Flows (cfs)**	
Month	**Mean**	**Month**	**Mean**	**Month**	**Mean**	**Month**	**Mean**
1	52	1	94	1	5	1	99
2	43	2	85	2	5	2	90
3	33	3	75	3	5	3	80
4	36	4	77	4	5	4	82
5	145	5	163	5	5	5	168
6	408	6	282	6	5	6	287
7	502	7	376	7	5	7	381
8	444	8	367	8	11	8	378
9	366	9	369	9	8	9	377
10	233	10	228	10	5	10	233
11	124	11	166	11	5	11	171
12	73	12	113	12	5	12	118
Annual	206	Annual	200	Annual	6	Annual	206

4.5.2.1. Water Quantity

During construction of the Project there is expected to be limited to no impacts to water volumes. Construction of the intake tower will not require any dewatering activities. Construction of the penstock may require some near-shore coffer dams to be constructed, but any localized dewatering will be returned Grant Lake and conveyed downstream.

Two modes of operation are likely for the Project: 1) block loading; and 2) level control (run-of-river). The primary operational mode will be block loading at a specific output level. Level control, or balancing of outflow to inflow, will occur during periods of low natural inflow to Grant Lake when the reservoir is at or near minimum lake elevation. There will be no consumption of water resources to generate power, just a re-allocation of the timing and volumes of water to be conveyed downstream.

Operation of the Project is not expected to negatively affect the bypass reach (Reach 5). A consistent flow of water will be delivered to the Reach 5 based on volumes determined suitable to sustain fish habitat with Reach 5. Refer to Section 4.6 (Aquatics) for a more detailed discussion of bypass flow criteria. Reaches 1-4 of Grant Creek are not expected to have a negative effect from Project operations. In general, the higher winter base flows will maintain side channel flows that are typically frozen or dry during the annual low-flow winter period (December to April). In addition, minimizing some of the peak flow events in the summer will actually increase habitat availability for spawning and rearing salmonids. Section 4.6.1.2 of this Exhibit E provides a more detailed discussion of flow-habitat relationships in Reaches 1-4 or the powerhouse reach.

4.5.2.2. Water Quality

Ground disturbing activities and tunnel construction have the potential to add turbid waters contaminated with suspended solid particles, hydraulic fluid residue, small amounts of oil, grease and fuel. Additionally, pH fluctuations are possible due to cement in grout and concrete. It is anticipated that a system to treat waters affected by construction activity would be employed (e.g filtration or settling ponds). Erosion and sediment control measures would also be utilized to minimize stormwater runoff of disturbed soils and limit the potential for increasing sediment loads to Grant Lake and Grant Creek.

Operation of the Project is not expected to affect the water chemistry of Grant Lake or Grant Creek. The Project will utilize the natural inflowing water and diverting a portion of it downstream through a 3,300-foot portal system that includes a buried tunnel and penstock. The similarity of all water quality parameters between the shallow depths of Grant Lake and Grant Creek should not be affected by diversion through the portal system.

4.5.2.3. Temperature

Operation of the Project is not expected to affect the water temperatures of Grant Lake or Grant Creek. The diversion of Grant Lake from shallow depths mimics the natural outflow conditions of how water is conveyed downstream to Grant Creek. By carefully monitoring water temperatures, the delivery of water through Project facilities should be able to match natural/ ambient water temperature conditions within 1 °C. Details of how water temperatures will be monitored and maintained to the pre-Project conditions can be found in the Draft Operational Compliance Monitoring Plan (OCMP). As previously described, this plan will be distributed for comment with the rest of the BE and management/monitoring plans between late April and mid-May.

4.5.2.4. Groundwater

Based on results of the geotechnical exploration performed in 1982 as part of the Ebasco/R&M studies, groundwater depth is at or near the ground surface (Ebasco 1984). Groundwater along the current alignment may be lower due to the proximity of Grant Creek gorge, which acts as a natural groundwater discharge point.

Groundwater conditions (including rock mass hydraulic conductivity and groundwater head) along the Grant Lake tunnel are anticipated to be similar to conditions encountered within the Cooper Lake tunnel, and the Whittier tunnels wherein groundwater inflows were minor and did not cause construction problems. It is noted that ground cover, and therefore the height of groundwater, above the nearby Cooper Lake tunnel are similar to conditions expected for the Grant Lake tunnel (Jacobs Associates 2014).

There is expected to be limited effects on groundwater due to Project operations. The Project will only be diverting surface waters and stage levels will be maintained within typical bankfull condition of Reaches 1-4. In Reach 5 where surface water volumes will be substantially reduced, the steep-walled bedrock canyon has limited groundwater influence.

In addition to water quality and hydrology concerns, FERC listed the following environmental issue to address as part of the scoping process (FERC 2010b), effects of project construction and operation on heavy metal leaking as a result of water level fluctuations of Grant Lake. The Grant Lake Project is no longer proposing to raise lake levels beyond the maximum lake elevation of 703 NAVD 88 for construction or operation. Since shoreline vegetation shall not be inundated, the concern about heavy metal leakage (e.g. methyl mercury) is no longer relevant.

4.5.3. Proposed Environmental Measures

Global adherence to BMPs will be utilized in conjunction with all Project construction and operation related activities. In conjunction with License Application development, a Draft OCMP is under development by KHL and will be distributed for comment with the rest of the BE and management and monitoring plans between late April and mid-May. This plan will assess water temperature and quantity conditions during and after construction of the Project. Additionally, during construction, specific attention will be paid to assuring that construction activities are not having a detrimental short-term impact on Grant Creek. Methods for monitoring short-term water quality associated with construction will be documented in an ESCP to be developed after license issuance and in collaboration with stakeholders. Explicit in the OCMP will be methods for tracking lake and creek temperature conditions to insure no net impacts to the spawning, incubation, and rearing of fish species that utilize Grant Creek. In addition, a mechanism will be defined in the plan to monitor and confirm that bypass flows in Reach 5 are being adhered to per the license.

As mentioned in Section 4.4.3 of this Exhibit E, all construction work will be conducted per measures described in the ESCP to ensure that any soil disturbing activities have minimal impact on the water quality in Grant Creek. Once the license is acquired and prior to construction commencing, the ESCP will be developed by KHL and reviewed and commented on by stakeholders prior to filing with FERC. Additionally, all construction efforts will be carried out per the Alaska Pollutant Discharge Elimination System (APDES) Construction General Permit. These measures will be described in the ESCP.

KHL will have an ECM on site monitoring construction activities during all phases to ensure adherence to all applicable BMPs and methods outlined in the monitoring and management plans. For reference, the proposed construction schedule is located in Figure C.2-1 in Exhibit C of this DLA.

The stream gauge put in place on Grant Creek prior to the 2013 natural resource study season has continued to operate. KHL proposes to maintain and monitor streamflows on the creek utilizing this gauge for the life of the license. The data will be routinely collected, synthesized and provided to stakeholders and FERC as part of the Annual Compliance Report. Once the 10-year cycle has expired, KHL will meet with stakeholders to review the stream gauge data and determine if additional data is needed.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.5.4. Cumulative Effects Analysis

FERC's SD2 (FERC 2010b) identified potential cumulative effects related to construction and operation of the Project for both water quality and quantity. Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, KHL has identified no negative cumulative effects.

4.5.4.1. Water Quality and Temperature

Given the remote location of the Project site and general lack of human activity in the area to the east of the Trail Lakes Narrows, water quality in the Grant Creek drainage is very good. It is not anticipated that any activities associated with Project construction or operation will alter water quality or temperature attributes in the lake or creek. Similarly, given the proposed infrastructural layout of the Project, there should be no impacts to water temperature on the creek associated with riparian canopy removal. It is anticipated that the overall temperature relationship between the lake and creek will remain consistent. The intake design described in Exhibits A and F, and careful monitoring of the water temperatures in the lake and the delivery of water through Project facilities, should accommodate a matching of natural/ambient water temperature conditions within 1 °C. A detailed description of water temperature monitoring in Grant Lake can be found in the draft OCMPwhich will be distributed for comment between late April and mid-May.

4.5.4.2. Water Quantity

The primary impact associated with Project operations is the reduction of flows in Reach 5. While a limited amount of anadromous and resident fish habitat and associated use has been documented in Reach 5, the potential for eliminating a portion of the flow and associated habitat will be far offset in the positive direction by the additional habitat made consistently available in the Reach 2/3 side channels and the Reach 1 distributary. The increase in aquatic habitat availability in Grant Creek has the potential for higher populations of anadromous and resident species in Grant Creek and therefore, the Kenai River drainage as a whole. Further documentation of this positive impact can be found in Sections 4.5.2 and 4.6.2 of this Exhibit E.

4.5.5. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, the proposed monitoring and management plans, and collaboration with stakeholders, KHL has identified no water quality or water quantity related unavoidable adverse impacts associated with construction and operation of the Project.

4.6. Aquatic Resources

4.6.1. Affected Environment

4.6.1.1. Fisheries

Upper Grant Creek is impassable to salmon one mile upstream of the mouth (Johnson and Klein 2009), with most fish habitat concentrated within the lower portion of stream. Habitat for juvenile fish exists mainly in stream margins, eddies, deep pools, and side channels offering reduced velocities (KHL 2014c; Ebasco 1984). Substrate material is coarse throughout the entire length of the creek due to high water velocity that tends to wash away smaller gravels (Ebasco 1984). Isolated areas of suitable spawning gravels occur in the lower half of the stream (Ebasco 1984).

Grant Creek, for the purpose of research has been partitioned into six reaches (Figure E.4-14); with the lower half of Grant Creek comprised of four reaches (Reaches 1-4) each approximately 0.125 miles in length. Reaches 5 and 6 are within a confined canyon consisting primarily of plunge pool and cascade habitat of high gradient. Reach 5, the bypass reach, terminates at the upstream boundary with Reach 6 at the base of a series of waterfalls which preclude upstream passage of both anadromous and resident fish species, and is approximately 0.5 miles in length. Reach 6 extends from the base of the downstream waterfall to the lake outlet. Since the waterfalls pose a barrier to upstream migration of fish, Reach 6 and Grant Lake have not been included in recent research efforts.

Grant Creek has not been subjected to recent anthropogenic impacts other than recreational use, such as hunting, fishing, hiking, snowmachining, snowshoeing, and cross-country skiing (KHL 2014g). Historically, Grant Creek has been subjected to mining activity on a relatively small scale; including a single prospect pit on the south side of Grant Creek and an engraved tree stump which appears to be the corner marker of a mining claim (KHL 2015a). However, Grant Lake has been mined historically to a much greater extent (KHL 2015a). Other anthropogenic impacts include the remains of a fish sampling trap and a cable crossing and stream gage, which were associated with earlier hydrological and fishery studies (KHL 2015a).

The fish community within Grant Creek includes both resident and anadromous species. Resident species present includes Dolly Varden (*Salvelinus malma*), rainbow trout (*Oncorhynchus mykiss*), round whitefish (*Prosopium cylindraceum*), arctic grayling (*Thymallus arcticus*), two species of sculpin; the Coast Range sculpin (*Cottus aleuticus*) and the Slimy sculpin (*C. cognatus*), and three-spine stickleback (*Gasterosteus aculeatus*). In addition to resident species, a number of anadromous species have been documented within Grant Creek, which includes Chinook (*O. tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*) and pink (*O. gorbuscha*) salmon. These species utilize Grant Creek to spawn as adult fish, and to rear within Grant Creek for varying lengths of time as juveniles.

No species that reside within Grant Creek are currently listed, or are proposed for listing under the ESA.

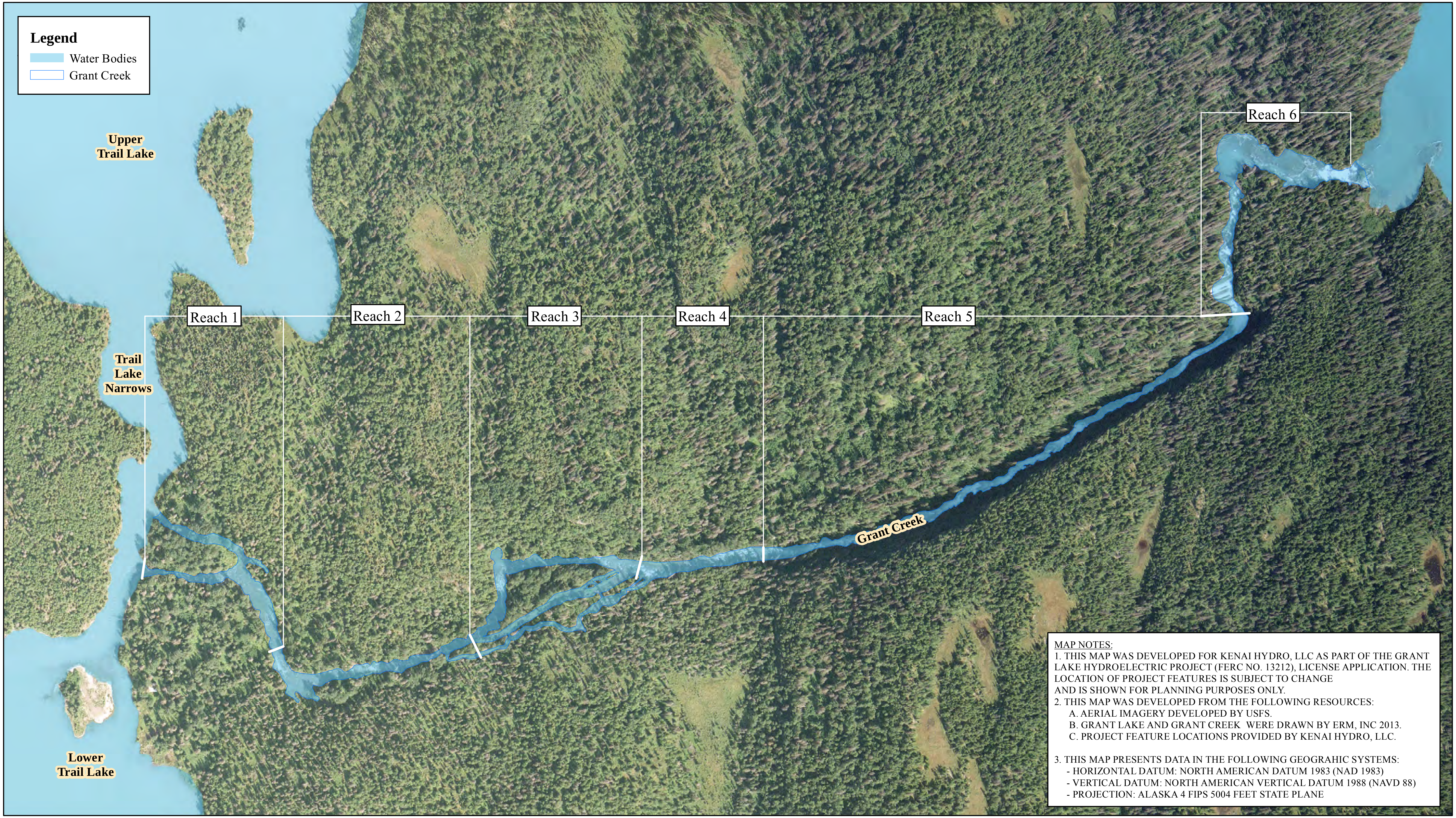
4.6.1.1.1 Summary of Previous Fishery Investigations

Historically, Grant Creek has been the subject of fisheries research of varying degrees of intensity. Periodic minnow trapping on Grant Creek from July 1959 through January 1961 captured juvenile Chinook salmon, coho salmon, Dolly Varden char, and sculpin (extent of sampling area unknown; USFWS 1961). Minnow trapping and electrofishing in the lower reaches of Grant Creek for week-long periods in October 1981 and March, May, June, and August 1982 yielded higher catches of trout, salmon, and Dolly Varden in the fall and summer than in winter and spring (AEIDC 1983). Catches of Dolly Varden were generally most abundant in the minnow traps, followed by juvenile Chinook, juvenile rainbow trout, and juvenile coho. Juvenile Chinook were the most commonly caught fish during electrofishing surveys (Ebasco 1984).

Ebasco (1984) estimated that Grant Creek supported 250 Chinook spawners and 1,650 sockeye spawners. The stream was also estimated to support 209 8-inch “trout” (including Dolly Varden and rainbow trout) (Ebasco 1984). Spawning coho were not observed (Ebasco 1984) but had been recorded as being present at unknown levels in the stream by the Anadromous Waters Catalog (AWC) published by the ADF&G (Johnson and Klein 2009). Maximum counts from intermittent stream surveys by the ADF&G were 76 Chinook (1963) and 324 (1952) sockeye salmon.

The 2009 aquatic resources study program was implemented to assist with the current FERC licensing effort. After collaboration with stakeholders, emphasis was placed on updating existing information, acquiring more complete data required for specific issue analysis, and providing background information needed to develop more focused studies after initiation of the formal FERC licensing process. The studies were continued in 2010 but the program was refined in July 2010 after further stakeholder collaboration in an effort to revise the study plans and make them more quantitative in nature.

Consistent with studies conducted by AEIDC (1983), Grant Creek was divided into study Reaches 1 through 6 (Figure E.4-14). Relative abundance and distribution of juvenile fish were determined by minnow trapping and calculating the catch-per-unit-effort (CPUE) for each reach. Dolly Varden were found to be the most abundant species in Grant Creek and distributed throughout Grant Creek Reaches 1 through 5, although they had a greater relative abundance in Reaches 4 and 5. Coho salmon was the next most abundant species and individuals were distributed throughout Reaches 1 through 5. However, coho appeared to have the greatest relative abundance in Reach 1. Chinook salmon was the next most abundant species. There was a noticeable decrease in Chinook abundance in upstream reaches, and they were not caught above Reach 4. Other fish present in small numbers were sockeye salmon, rainbow trout, sculpin, and three-spine stickleback. Most salmon captured were young-of-the-year with few larger juveniles present (KHL 2010a).



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. GRANT LAKE AND GRANT CREEK WERE DRAWN BY ERM, INC 2013.
   C. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.

3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 1983)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

N

Drawing Scale:
0 100 200 400 600 Feet

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GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212
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Figure E.4-14
Grant Creek Reaches

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED C. Warnock
ISSUED DATE 11/13/2014

DRAWING
SCALE: 1:4,000

Relative abundance of larger size resident salmonids (i.e., rainbow trout and Dolly Varden) was determined by calculation of angling CPUE (KHL 2010a). Rainbow trout (n = 68) were found to be more abundant than Dolly Varden (n = 9) and were caught throughout the creek, although their relative abundance was higher in Reaches 3 through 5 than in Reaches 1 and 2. Dolly Varden were captured in Reaches 1, 2, and 3; their relative abundance was highest in Reach 1.

This study was also aimed at determining the timing of spawning of adult resident fish; however, it appeared that spawning, if present, occurred before or after the 2009 study period, since little evidence of spawning fish was seen (KHL 2010a). Rainbow trout angling studies were continued in the spring and early summer of 2010 to confirm the presence of spawning and determine fish numbers. The progression of reproductive condition and the presence of adult rainbow trout in spawning condition confirmed that spawning did occur in Grant Creek in 2010. Capture success was too low to allow population estimates. Adult rainbow trout were observed in the upper portions of the canyon reach.

Abundance and run timing of spawning anadromous fish was estimated through data collected during foot surveys (KHL 2010a). Both sockeye and Chinook salmon were seen in the lower five reaches. Chinook salmon reached Grant Creek first around the beginning of August. Sockeye salmon did not arrive until the end of August. Escapement of Chinook salmon was estimated to be 231 fish, and escapement of sockeye salmon was estimated at 6,293; these estimates were based on the Area-Under-the-Curve (AUC) methodology (Bue et al. 1998). However, two critical components necessary to calculate abundance using the AUC methodology (stream life and observer efficiency) were based on professional judgment rather than empirical data, potentially biasing estimates.

4.6.1.1.2 2013 Fishery Investigations

In 2013, a multi-faceted fisheries research project was conducted, which was one component of an intense multi-discipline research effort. This overall effort included investigations into fisheries (including habitat and instream flow incremental methodology [IFIM]), hydrology, wildlife, botanical, wetlands, cultural, macroinvertebrates, geomorphology, and recreation. The fisheries component was structured to expand on previously collected fisheries information, and to continue investigations based on the scope of work and research developed and implemented in 2009 (KHL 2010a), with the addition of objectives geared towards filling information gaps identified by stakeholders.

In general, the objectives of the 2013 research effort focused on both adult and juvenile fish of anadromous and resident species within Grant Creek. For anadromous adults, the run timing, abundance, spawning distribution, and various biometrics were assessed (i.e., sex, length, weight, age, and egg voidance in females). In addition, genetic samples were collected and a sub-sample of fish was tagged with radio and Floy tags (genetic samples were provided to ADF&G and were not summarized within the study report). For adult resident species (i.e., rainbow trout and Dolly Varden), the objectives were to assess abundance, spawning and feeding distributions, and use of Reach 5. As with anadromous species, a sub-sample of resident adults were tagged with both radio and Floy tags and scales were collected in order to age the fish.

For juveniles of all species, both anadromous and resident, the objectives were to assess distribution by reach and habitat, and to assess overall abundance within Grant Creek, with an interest in partitioning those estimates into two segments; Reach 5 and Reaches 1-4. In addition to those primary objectives, overwintering by juveniles in Grant Creek was assessed as was fish use of the Narrows, downstream of where Grant Creek enters the Trail Lake system.

In order to accomplish the objectives for adult salmonids discussed above, a weir was placed about 150 meters upstream of the Grant Creek confluence (Figure E.4-15). Adult fish of both resident and anadromous species were captured at the weir, which allowed the collection of biological samples, enumeration by species, and the tagging (Floy and radio) of Chinook, sockeye, coho, rainbow and Dolly Varden adults.

Juvenile salmonids were sampled using a variety of methods, which included collection at two incline plan traps, minnow trapping, snorkeling and beach seining. The following sections summarize findings from the 2013 fisheries research. Detailed descriptions of the methodologies used to conduct the study can be found in KHL (2014c).

Figure E.4-15. The A-frame weir used on Grant Creek to count adult salmon, rainbow trout and Dolly Varden in 2013.

4.6.1.1.3 2013 Study Results

In the following sections, results of the 2013 fisheries study are provided KHL (2014c).

Grant Creek Salmon

Salmon Abundance

Weir Count

There were 1,439 salmon that passed upstream of the weir on Grant Creek while 52 of those salmon passed back downstream of the weir for a net passage of 1,387 salmon (Table E.4-15). Sockeye salmon were the dominant run of salmon entering Grant Creek with 1,117 counted above the weir. There were 10 pink, 23 Chinook and 237 coho salmon counted above the weir. The net passage of salmon across the weir does not include salmon that entered and potentially spawned in Grant Creek downstream from the weir.

Table E.4-15. Upstream, downstream and net passage of pink, Chinook, sockeye and coho salmon across the weir in Grant Creek, 2013.

Species	Upstream Passage	Downstream Passage	Net Passage
Pink Salmon	12	2	10
Chinook Salmon	35	12	23
Sockeye Salmon	1,153	36	1,117
Coho Salmon	239	2	237
Total	1,439	52	1,387

Escapement Estimate: Area-under-the-curve (AUC)

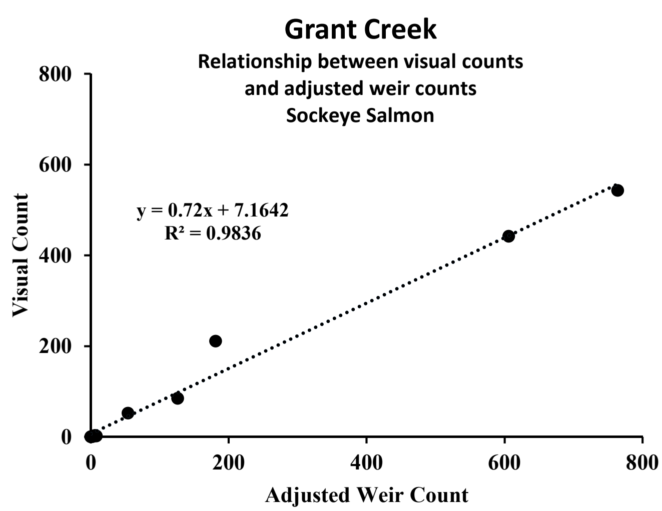
Several different types of surveys (i.e., visual, telemetry and carcass) were performed on Grant Creek to estimate escapement with the AUC methodology (Bue 1998). The information was used to document estimates for stream life, observer efficiency, and escapement for 2013 and 2009 (recalibrated count).

Stream life was estimated as the mean of the pooled recovery of Floy tagged and radio tagged salmon in Grant Creek. The pooled information was used because radio tags alone did not adequately cover the entire passage distribution of fish across the weir. Stream life estimates are provided for pooled data, radio tags only and Floy tags only. Mean stream life for the pooled data for Chinook, sockeye and coho salmon was 11 days, 14 days and 16 days, respectively (Table E.4-16).

Table E.4-16. Stream life estimates for the combined recovery of Floy tagged and radio tagged Chinook, sockeye and coho salmon in Grant Creek, 2013.

Species	Tagged	Recovered	Percent Recovered	Stream Life			
				Mean	SD	Min	Max
Combined Recovery							
Chinook	33	14	42	11	6.2	4	22
Sockeye	533	195	37	14	5.9	2	30
Coho	176	77	44	16	5.9	1	37
Radio Tags Only							
Chinook	9	7	78	8	3.9	4	14
Sockeye	65	40	62	9	2.6	2	15
Coho	50	32	64	14	4.6	1	22
Floy Tags Only							
Chinook	33	7	21	13	7.5	4	22
Sockeye	533	155	33	15	5.8	4	30
Coho	176	45	26	18	6.3	8	37

Observer efficiency was estimated from the relationship of visual survey counts to weir counts on Grant Creek. For salmon in Grant Creek, observer efficiency (slope of the line) was 0.60 for Chinook, 0.72 for sockeye, and 0.75 for coho (Figure E.4-16).



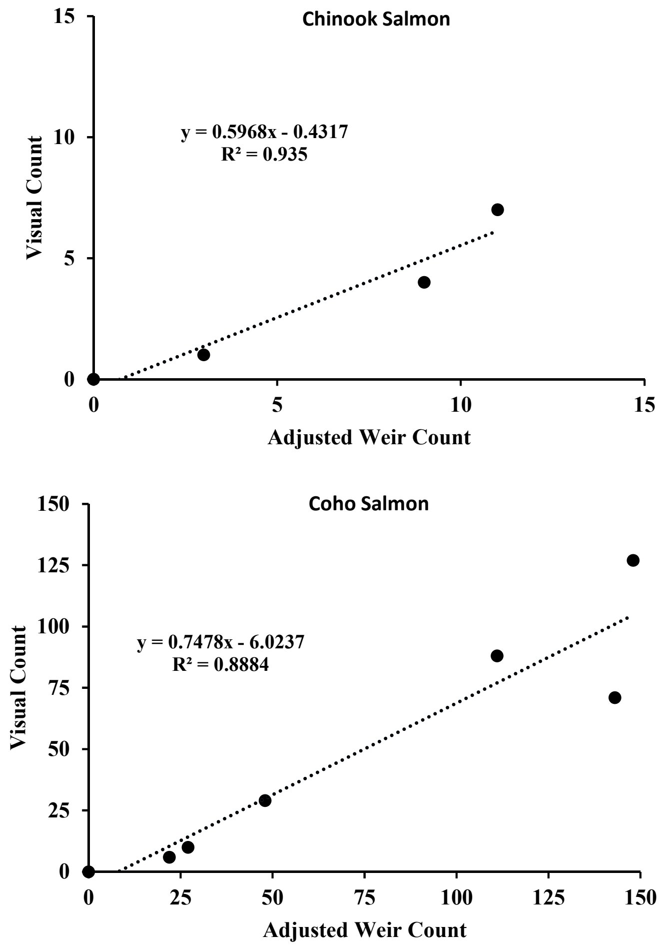


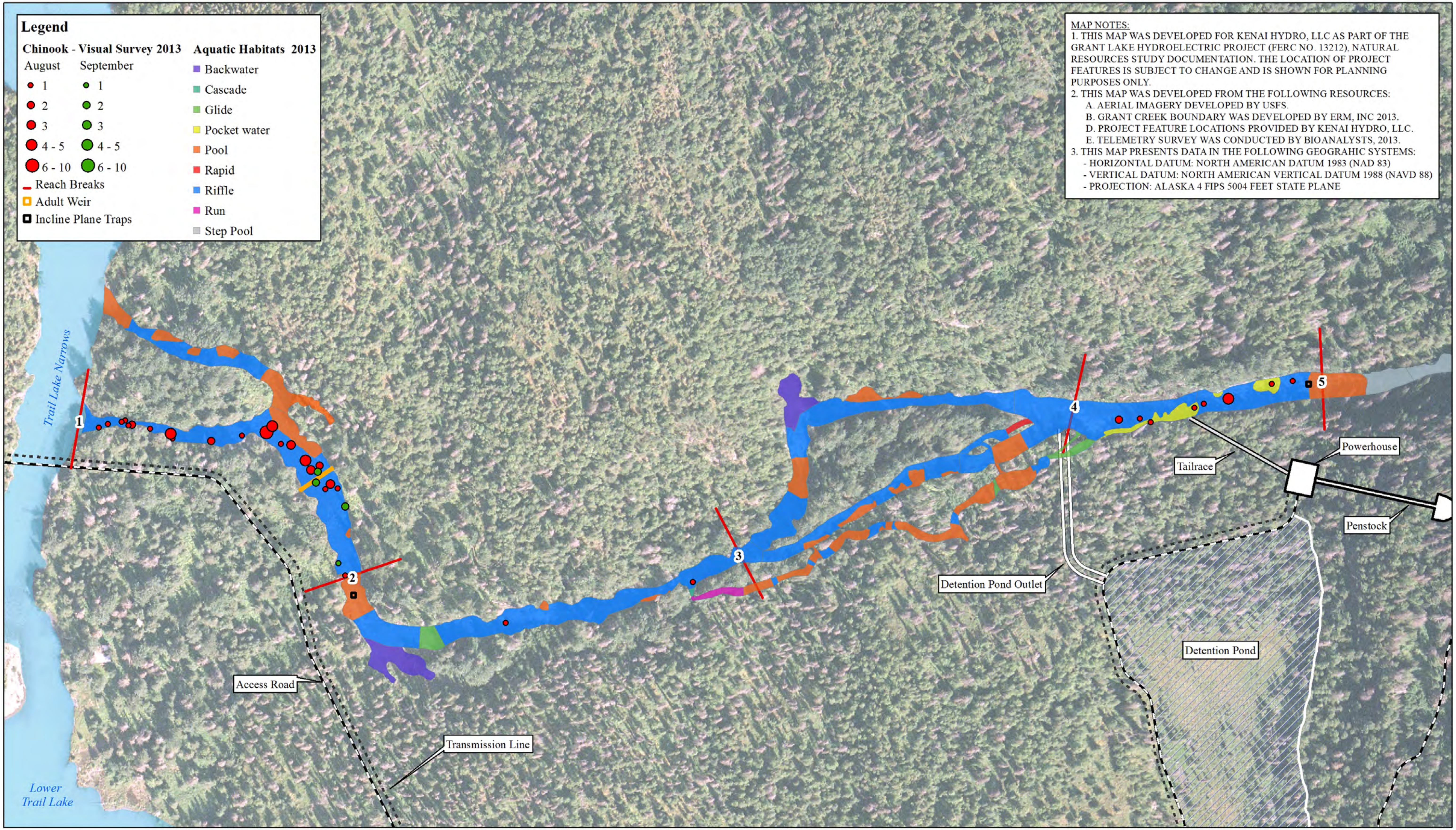
Figure E.4-16. Observer efficiency relationships for sockeye, Chinook and coho salmon in Grant Creek, 2013.

Stream life and observer efficiency estimates for salmon in Grant Creek were used to estimate total escapement to Grant Creek. Stream life and observer efficiency estimates were also applied to calculations of AUC estimates for Chinook and sockeye provided in the 2009 escapement (KHL 2010a). In the 2009 escapement estimates, outside literature sources and professional judgment were used to estimate both stream life and observer efficiency. No escapement estimates for coho in Grant Creek were provided in 2009.

Two escapement estimates were provided for Grant Creek based on visual counts (Table E.4-17; and Figures E.4-17 through E.4-19). The first estimate is the estimated escapement above the weir and the second estimate is for the entire stream. Peak visual counts (above the weir) for Chinook, sockeye and coho salmon occurred on August 29, September 6 and October 10, 2013, respectively (Figure E.4-20).

Table E.4-17. Visual counts of sockeye, Chinook and coho salmon above and below the weir in Grant Creek, 2013.

Date	Day of Year	Sockeye		Chinook		Coho	
		Below Weir	Above Weir	Below Weir	Above Weir	Below Weir	Above Weir
8/2/2013	214	0	0	0	0	0	0
8/9/2013	221	0	2	0	0	0	0
8/16/2013	228	8	3	14	1	0	0
8/23/2013	235	43	85	22	6	0	0
8/29/2013	241	59	442	19	11	0	0
9/6/2013	249	45	543	2	4	0	0
9/16/2013	259	12	211	0	0	0	6
9/21/2013	264	10	52	0	0	0	10
9/28/2013	271	0	2	0	0	14	29
10/4/2013	277	0	0	0	0	7	71
10/10/2013	283	0	1	0	0	8	127
10/18/2013	291	0	0	0	0	4	88
10/24/2013	297	0	0	0	0	3	63
11/1/2013	305	0	0	0	0	2	12
11/7/2013	311	0	0	0	0	1	2



REV	DATE	BY	DESCRIPTION

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Drawing Scale:

0 100 200 400 Feet

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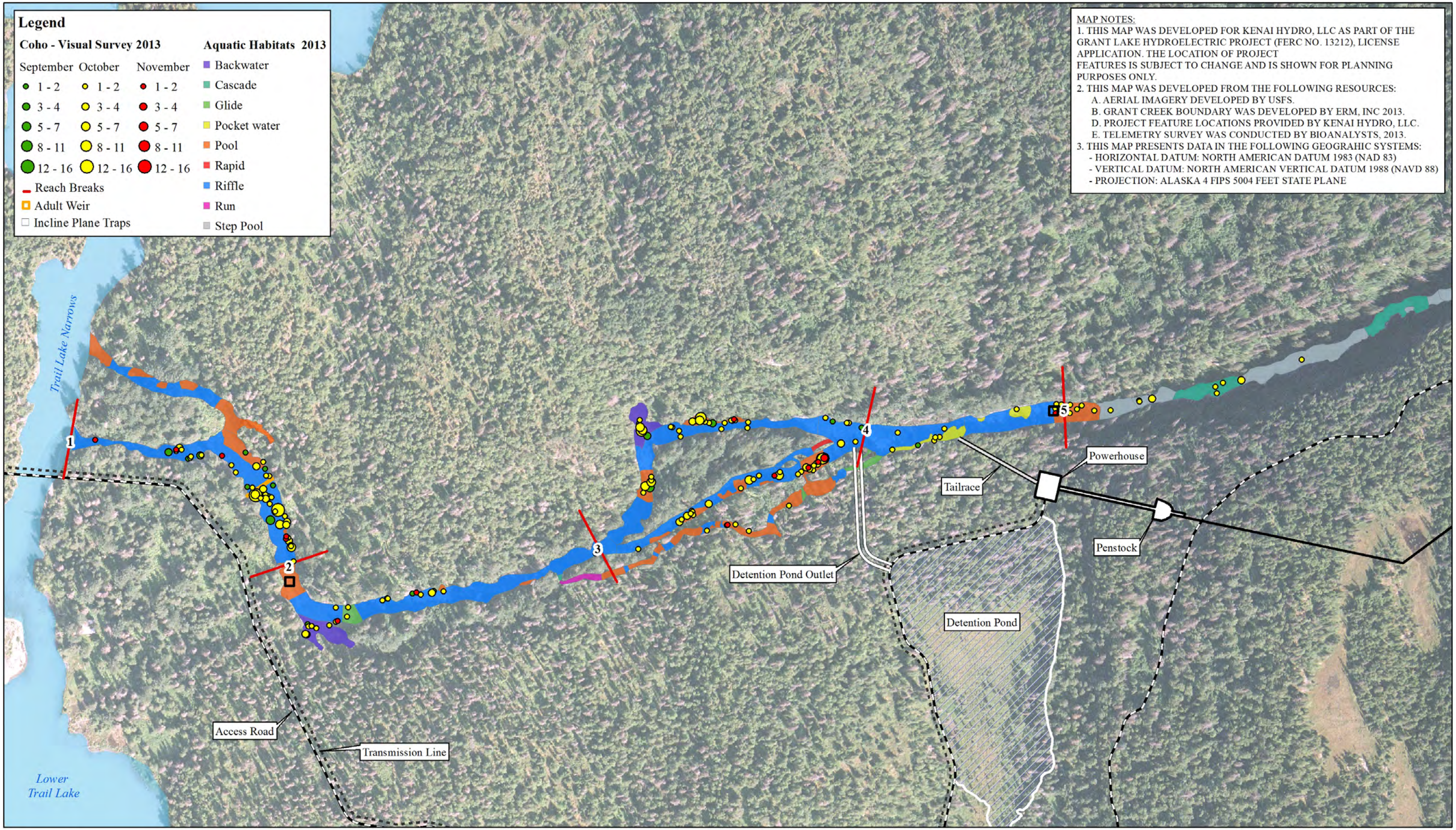
Figure E.4-17
Visual Surveys
Chinook Salmon

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:2,000



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Drawing Scale: 0 100 200 400 Feet

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Figure E.4-18
Visual Surveys
Coho Salmon

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015

DRAWING

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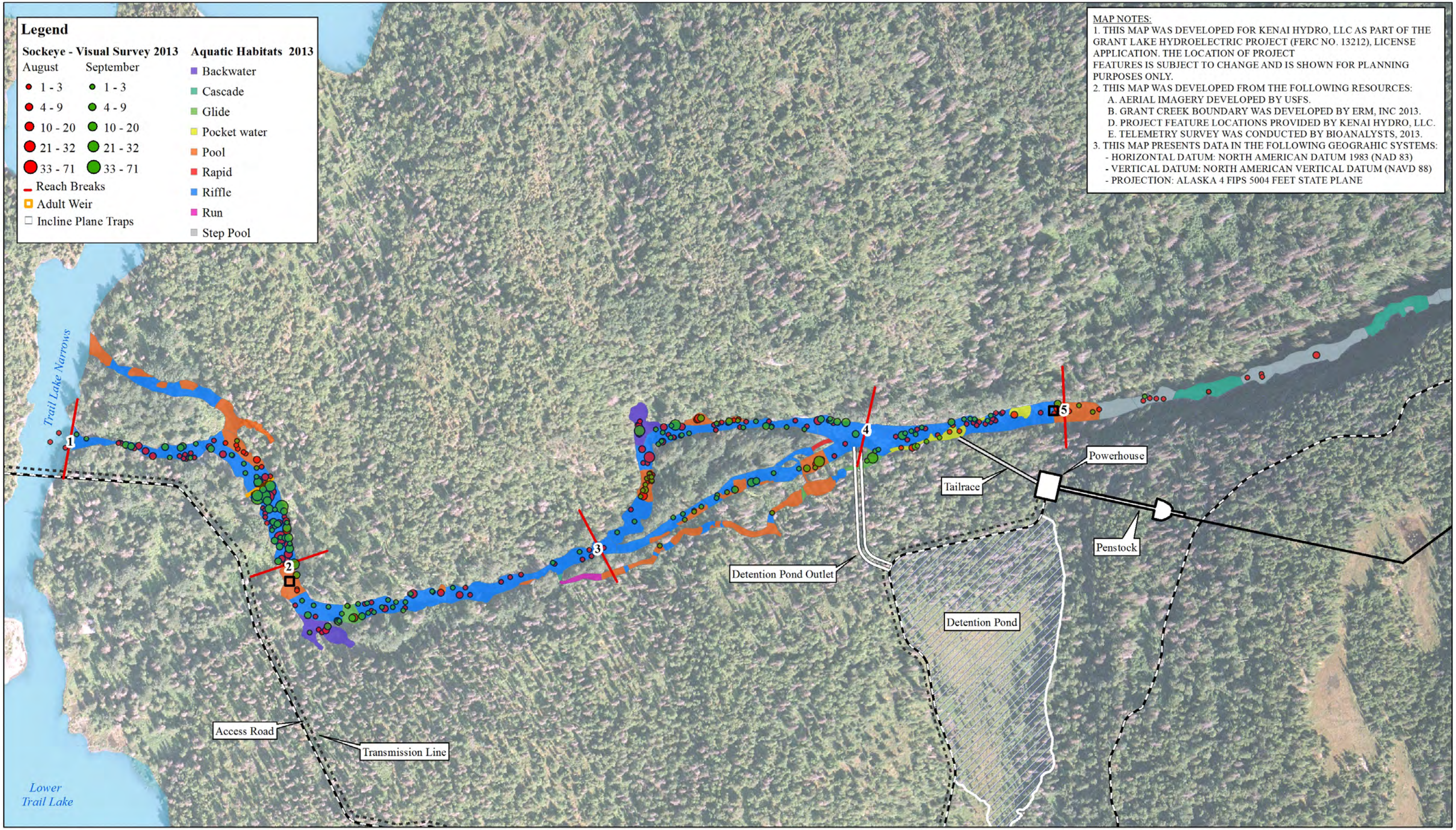

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Figure E.4-19
Visual Surveys
Sockeye Salmon

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:2,500

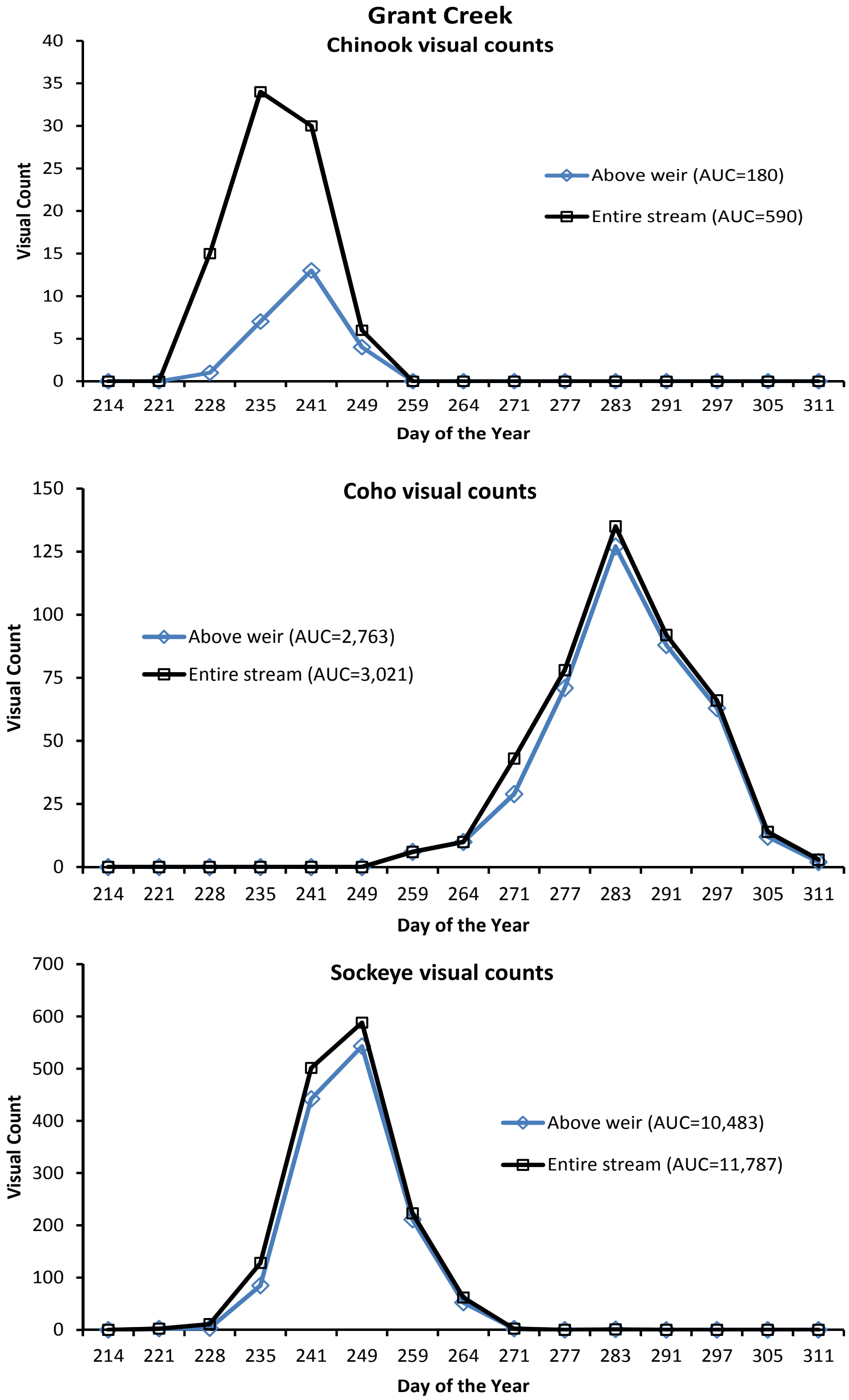


Figure E.4-20. Plots of visual counts used to estimate area-under-the-curve for Chinook, sockeye and coho salmon in Grant Creek, 2013.

Estimates of escapement above the weir based on visual counts (AUC) were within ±12 percent of the weir counts (Table E.4-18). Escapement estimates for the entire stream were 90 Chinook, 1,169 sockeye and 252 coho salmon.

Table E.4-18. Escapement estimates for salmon in Grant Creek at the weir and estimated from area-under-the curve with stream life and observer efficiency**.**

Species	Stream Life (s)	Observer Efficiency (v)	Escapement Estimates 2013			Escapement Estimate 2009	
			Weir Count	Above Weir (AUC)	Entire Stream (AUC)	Estimate	Adjusted
Pink	---	---	10	---	---	---	---
Chinook	11	0.60	23	27 (112%)	90 (391%)	231	148
Sockeye	14	0.72	1,117	1,040 (93%)	1,169 (105%)	6,293	2,705
Coho	16	0.75	237	231 (97%)	252 (106%)	---	---

The AUC estimates for sockeye and coho salmon for the entire stream add an additional 52 sockeye and 15 coho salmon to the weir count. These additional fish downstream from the weir fit within our expectation of the number of spawning fish for both sockeye and coho salmon. However, the difference in the Chinook weir count (23 fish) and the estimate for the entire stream (90 fish) implies that 67 additional Chinook spawned downstream of the weir. That estimate appears to be biased high since minimal additional spawning activity was observed below the weir. Given the level of movement (downstream) for Chinook across the weir, it is likely that the Chinook observed during visual counts downstream of the weir may have spawned in the Trail Lake Narrows or elsewhere. That is, the visual surveys counted fish that moved into lower Grant Creek but did not remain there to spawn, which inflated the number of fish in Grant Creek downstream of the weir.

In 2009, the estimated escapement using AUC methodology was 231 Chinook and 6,293 sockeye salmon (KHL 2010a), which relied on stream life and observer efficiency values based on professional judgment since empirical data was not available. Recalibrating those counts by stream life and observer efficiency from 2013 adjusted those counts to 148 Chinook and 2,705 sockeye salmon (Table E.4-18).

Life History Characteristics

Adult salmon were counted and subsampled at the weir and during carcass surveys to describe life history characteristic of the spawning population. The information documents the run timing, fish size, spawning success and age structure of returning salmon to Grant Creek.

<u>Run Timing</u>

Run timing for adult salmon to Grant Creek extended over a 13-week period beginning at the end of July and finishing near the end of October. Chinook and pink salmon both entered Grant Creek over a four week period (Table E.4-19). Pink salmon passed the weir on Grant Creek from the first week of August to the end of August. Chinook salmon passed the weir from the second week of August through the first week of September. Peak passage for pink and Chinook salmon occurred on weeks 32 and 33, respectively. The adult migration for sockeye occurred over a ten week period beginning the last week of July and ending the second week of October with a peak at the end of August. Two individual sockeye extended the run timing an additional three weeks after the majority of the run was complete. Coho salmon began entering Grant Creek the second week of September, peaked the first week of October and ended the last week of October when the weir was removed (October 24).

Table E.4-19. Run timing by week of the year for pink, Chinook, sockeye and coho salmon assessed at the weir on Grant Creek, 2013.

Week of Year	Dates	Pink	Chinook	Sockeye	Coho
31	Jul 28- Aug 03	0	0	5	0
32	Aug 04 - Aug 10	6	0	3	0
33	Aug 11- Aug 17	2	11	16	0
34	Aug 18 - Aug 24	1	3	220	0
35	Aug 25 - Aug 31	1	7	601	0
36	Sep 01 - Sep 07	0	2	201	0
37	Sep 08 - Sep 14	0	0	65	16
38	Sep 15 - Sep 21	0	0	4	17
39	Sep 22 - Sep 28	0	0	0	40
40	Sep 29 - Oct 05	0	0	1	96
41	Oct 06 - Oct 12	0	0	1	42
42	Oct 13 - Oct 19	0	0	0	21
43	Oct 20 - Oct 26	0	0	0	1
	Total	**10**	**23**	**1,117**	**237**

Size (length and weight)

Length and weight measurements were collected at the weir to describe the size of returning salmon to Grant Creek (Table E.4-20). Female Chinook salmon were larger than males (mean length and weight). Male and female sockeye were similar with males slightly heavier and longer than females. For coho salmon, the size of males and females was similar. On average, male coho salmon tended to be heavier than females but females were on average longer than males. For pink salmon, males tended to be longer and heavier than females.

Table E.4-20. Mean, maximum, and minimum length and weight of Chinook, sockeye and coho salmon measured at the weir on Grant Creek, 2013. [1]

Species	Sex	Length cm (mid-eye to fork)					Weight (kg)				
		Mean	SD	Max	Min	Number	Mean	SD	Max	Min	Number
Chinook	F	88	5.8	98	81	6	10.4	2.6	14.5	7.6	6
	M	71	13.7	104	38	27	5.9	3.8	16.4	0.6	27
Coho	F	59	4.0	68	45	116	3.3	0.7	5.0	1.4	116
	M	58	4.3	67	45	116	3.5	1.0	6.5	1.5	116
Sockeye	F	54	3.5	60	42	415	2.6	0.5	3.8	1.0	415
	M	55	4.6	77	33	361	3.0	0.7	4.9	0.5	360
Pink	F	42	2.3	46	39	9	1.0	0.2	1.3	0.8	9
	M	45	3.8	51	40	6	1.3	0.4	2.1	0.9	6

Notes:
1. Samples size for fish measured may include some fish that past upstream of the weir and subsequently passed back downstream.

Age Structure

Chinook salmon returned to Grant Creek at 3 to 6 years of age with most (84 percent) returning as 4 and 5-year old fish (Table E.4-21). Three year old fish made up about 4 percent and 6-year old fish made up about 3 percent of the fish sampled. The age structure of male and female Chinook salmon differed slightly with one male returning at three years of age. Coho salmon returned at three to five years of age with most (90 percent) returning as 4-year old fish. Three year old fish made up about 4 percent and 5-year old fish made up about 7 percent of the fish sampled. The age structure of male and female coho salmon was similar in age-at-return with slightly more male fish returning at five years of age than females. Sockeye salmon returned at four to six years of age with most (95 percent) returning as 5-year old fish. Female sockeye returned as 4 and 5 year old fish. Males returned as 4, 5 and 6-year old fish.

Table E.4-21. Age-at-return for coho, Chinook and sockeye salmon sampled in Grant Creek, 2013.

Sex	Total Age								Total
	Age-3		Age-4		Age-5		Age-6		
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	
Chinook Salmon									
Female	0	0.0	0	0.0	4	80.0	1	20.0	5
Male	1	5.0	12	60.0	5	25.0	2	10.0	20
Total	1	4.0	12	48.0	9	36.0	3	12.0	25
Coho Salmon									
Female	3	3.5	78	91.8	4	4.7	0	0.0	85
Male	3	3.6	73	88.0	7	8.4	0	0.0	83
Total	6	3.6	151	89.9	11	6.5	0	0.0	168
Sockeye Salmon									
Female	0	0.0	3	5.9	48	94.1	0	0.0	51
Male	0	0.0	0	0.0	47	95.9	2	4.1	49
Total	0	0.0	3	3.0	95	95.0	2	2.0	100

In general, mean length increased with age for returning salmon to Grant Creek. Mean length increased the most for Chinook between 3 and 4-year old fish (Table E.4-22). Female coho salmon were slightly larger than males as 4-year old fish, smaller as 3-year old fish and the same as 5-year old fish. Like Chinook, mean length increased the most for coho between 3 and 4-year old fish. For sockeye salmon, males tended to be larger than females and the largest increase in mean size was between 4 and 5-year old fish.

Table E.4-22. Length-at-age for returning coho salmon sampled at the Grant Creek weir in 2013. Length (cm) was measured from mid-eye to the fork of the caudal fin.

Sex	Age-3		Age-4		Age-5		Age-6	
	No.	Mean Length (cm)	No.	Mean Length (cm)	No.	Mean Length (cm)	No.	Mean Length (cm)
Chinook Salmon								
Female	0	---	0	---	4	86.0	1	97.5
Male	1	37.5	12	65.1	5	77.0	2	100.3
Total	1	37.5	12	65.1	9	81.0	3	99.4
Coho Salmon								
Female	3	52.1	78	59.0	4	60.3	0	---
Male	3	60.6	73	58.4	7	60.3	0	---
Total	6	56.4	151	58.7	11	60.3	0	---
Sockeye Salmon								
Female	0	---	3	48.6	48	56.1	0	---
Male	0	---	0	---	47	57.1	2	58.1
Total	0	---	3	48.6	95	56.6	2	58.1

The European method of age designation documents the general freshwater life history for adult salmon returning to Grant Creek. For Chinook, all fish spent 1 winter (1.x) in freshwater before migrating to the ocean (Table E.4-23). The amount of time that coho spent in freshwater varied the most of returning salmon. Most (88 percent) coho salmon spent two winters (2.x) in freshwater while about 2 percent migrated to the ocean in their first year of life (0.x). Coho salmon that had spent one winter in freshwater (1.x) made up 4 percent and fish that spent 3 winters (3.x) in freshwater made up about 6 percent. Most (97 percent) adult sockeye returning to Grant Creek spent one year in freshwater (1.x) before migrating to the ocean. A few (3 percent) sockeye remained in freshwater for two years (2.x) before they migrated to the ocean.

Table E.4-23. General freshwater life history of Chinook, coho and sockeye salmon returning to Grant Creek, 2013.

Species	0.x		1.x		2.x		3.x		Total
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	
Chinook	0	0	25	100	0	0	0	0	25
Coho	3	2	7	4	148	88	10	6	168
Sockeye	0	0	97	97	3	3	0	0	100

Notes:
European Age Designation
0.x = Juvenile fish migrated to the ocean in its first year of life (no freshwater annulus).
1.x = Juvenile fish migrated to the ocean in its second year of life (one winter in freshwater).
2.x = Juvenile fish migrated to the ocean in its third year of life (two winters in freshwater).
3.x = Juvenile fish migrated to the ocean in its fourth year of life (three winters in freshwater).

Egg Voidance

Female carcasses were examined to describe spawner success (egg retention). Table E.4-24 presents the number of carcasses recovered, mean egg retention and the number of females assessed.

Table E.4-24. Number of Chinook, sockeye, pink, and coho salmon recovered during carcass surveys on Grant Creek, 2013.

Species	Females	Males	Total Recovered	Mean Egg Retention	Number Females Assessed
Chinook	5	10	15	255	5
Coho	28	35	63	289	28
Pink	8	3	11	100	2
Sockeye	266	218	484	81	257

Timing, Distribution and Habitat of Spawning Salmon

Redd surveys and mobile telemetry surveys were used to assess the time of spawning, distribution and habitats selected by spawning salmon in Grant Creek. Redd surveys were conducted at least once a week during the spawning period to document the location, number, and time of redd construction in Grant Creek. Radiotelemetry surveys were conducted twice per week to track the movements of tagged fish within the study area. The number of new redds observed during each week of the study period was documented by week of the year (1-52).

Time of Spawning

Pink, Chinook, sockeye and coho salmon spawned in Grant Creek during the summer and fall of 2013. Salmon began building redds the first week of August and ended spawning activity at the end of October (Table E.4-25). Pink salmon began spawning in early August with only two redds constructed near the weir in Reach 1. Chinook salmon began spawning in mid-August and built six redds in a three week period. Sockeye began spawning at the end of August building 308 redds within the first two weeks. By the third week (week 37) new redds and old redds could not be distinguished in the mass spawning aggregates. Spawning activity (active digging) was observed until the last week of September. Coho began spawning the first week of October and were complete at the end of the month constructing 72 redds in Grant Creek.

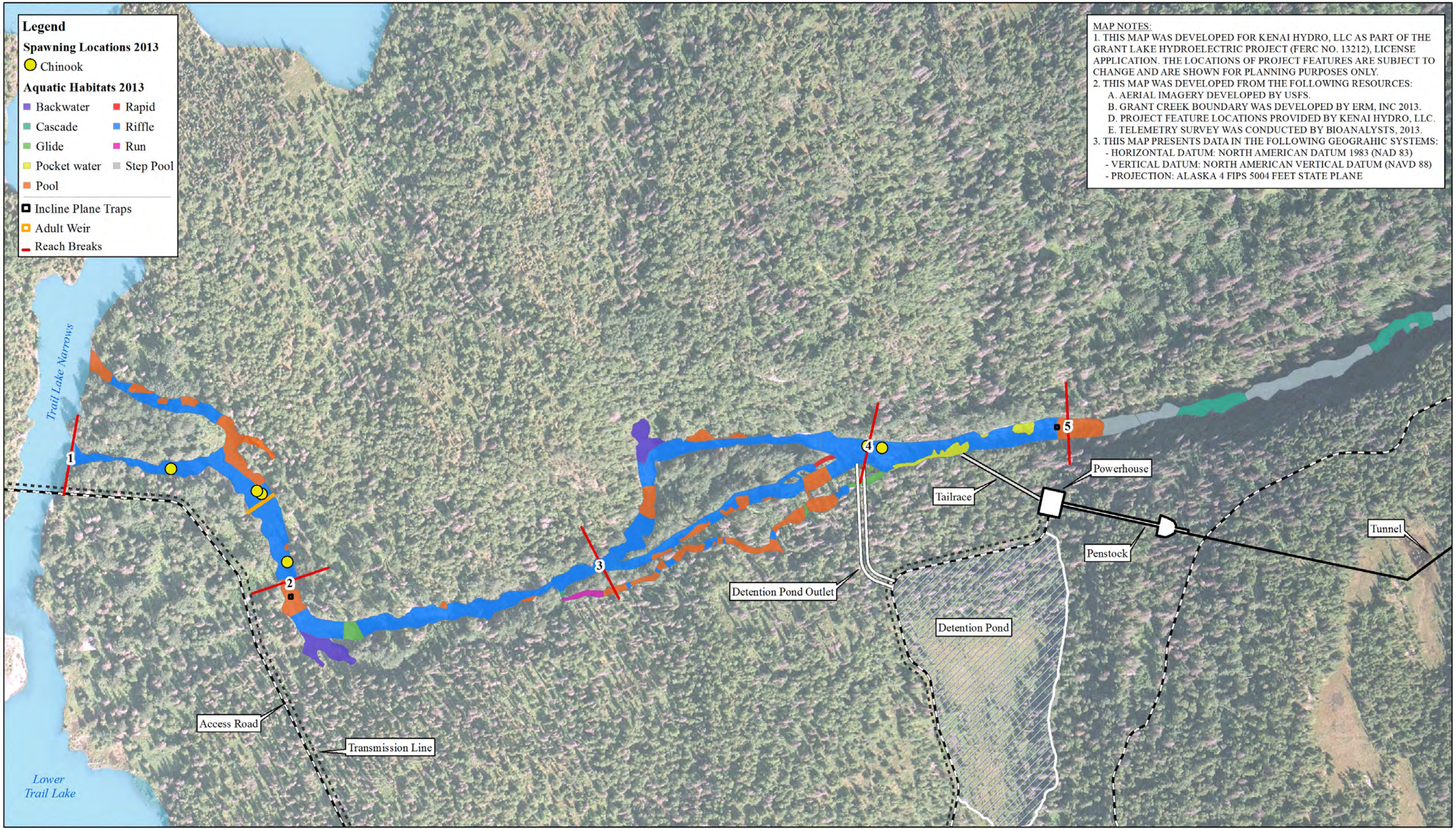
Table E.4-25. Number of new redds constructed in Grant Creek by week of the year for pink, Chinook, sockeye and coho salmon in 2013. A designation of "MS" (Mass Spawning) means that new redds and old redds for could not be distinguished in the mass spawning aggregates.

Week	Dates	Species				Total
		Pink	Chinook	Sockeye	Coho	
31	Jul 28 - Aug 03	0	0	0	0	**0**
32	Aug 04 - Aug 10	2	0	0	0	**2**
33	Aug 11 - Aug 17	0	0	0	0	**0**
34	Aug 18 - Aug 24	0	1	0	0	**1**
35	Aug 25 - Aug 31	0	3	200	0	**203**
36	Sep 01 - Sep 07	0	2	108	0	**110**
37	Sep 08 - Sep 14	0	0	MS	0	**0**
38	Sep 15 - Sep 21	0	0	MS	0	**0**
39	Sep 22 - Sep 28	0	0	MS	0	**0**
40	Sep 29 - Oct 05	0	0	0	5	**5**
41	Oct 06 - Oct 12	0	0	0	47	**47**
42	Oct 13 - Oct 19	0	0	0	13	**13**
43	Oct 20 - Oct 26	0	0	0	6	**6**
44	Oct 27 - Nov 02	0	0	0	1	**1**
45	Nov 03 - Nov 09	0	0	0	0	**0**
	Total	**2**	**6**	**308**	**72**	**388**

Spawning Distribution

The distribution of spawning salmon in Grant Creek was documented with both redd surveys and mobile telemetry surveys (Figures E.4-21 through E.4-24 and E.4-25 through E.4-27).

The distribution of salmon redds was concentrated (95 percent) within Reaches 1-3 of Grant Creek (Table E.4-26).



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:
0 100 200 400
Feet

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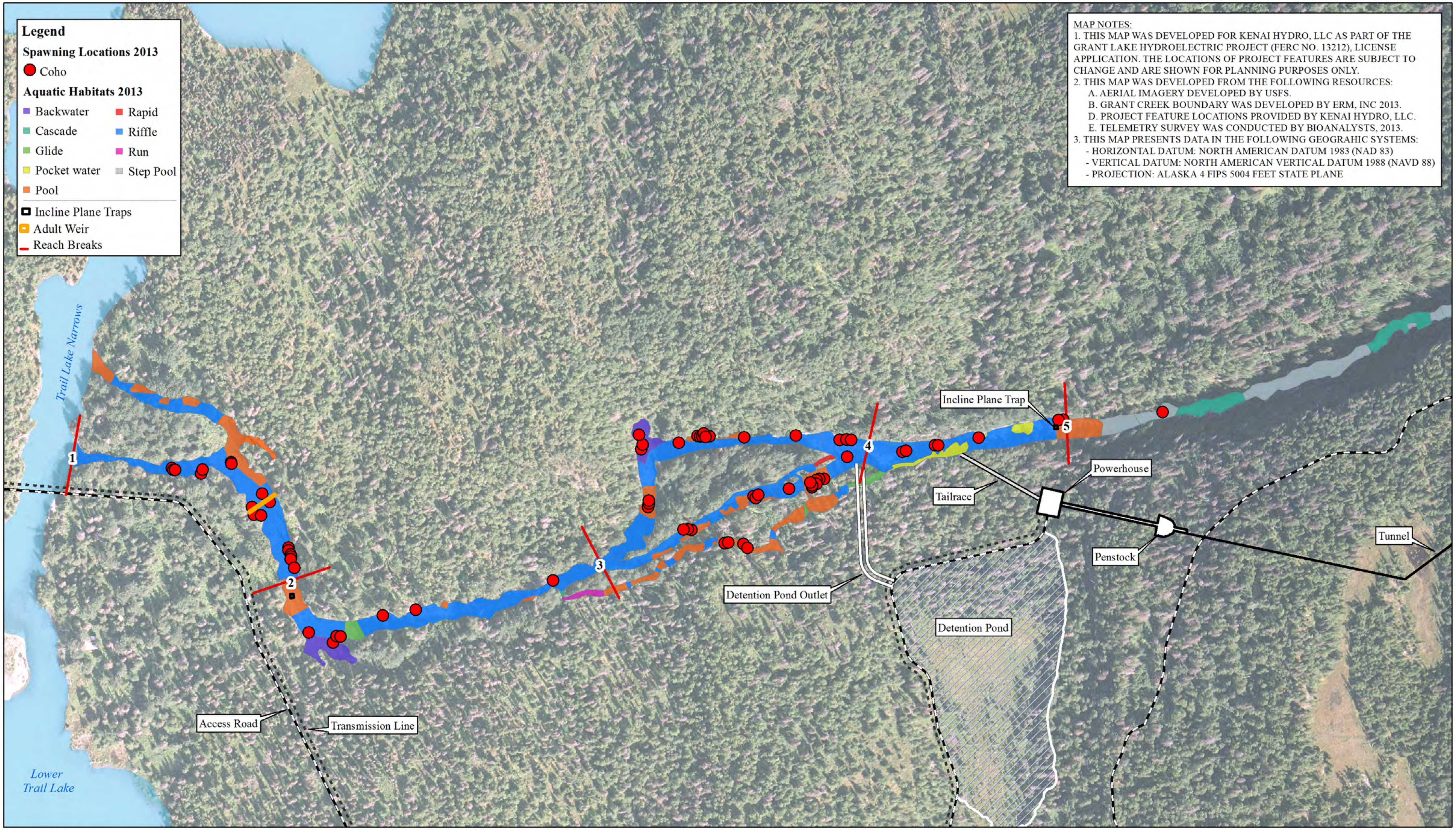
Figure E.4-21
Spawning Locations for
Chinook Salmon in Grant Creek, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:2,500



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 100 200 400 Feet

MCMILLEN, LLC

1401 SHORELINE DRIVE BOISE, ID 83702

OFFICE: 208.342.4214 FAX: 208.342.4216

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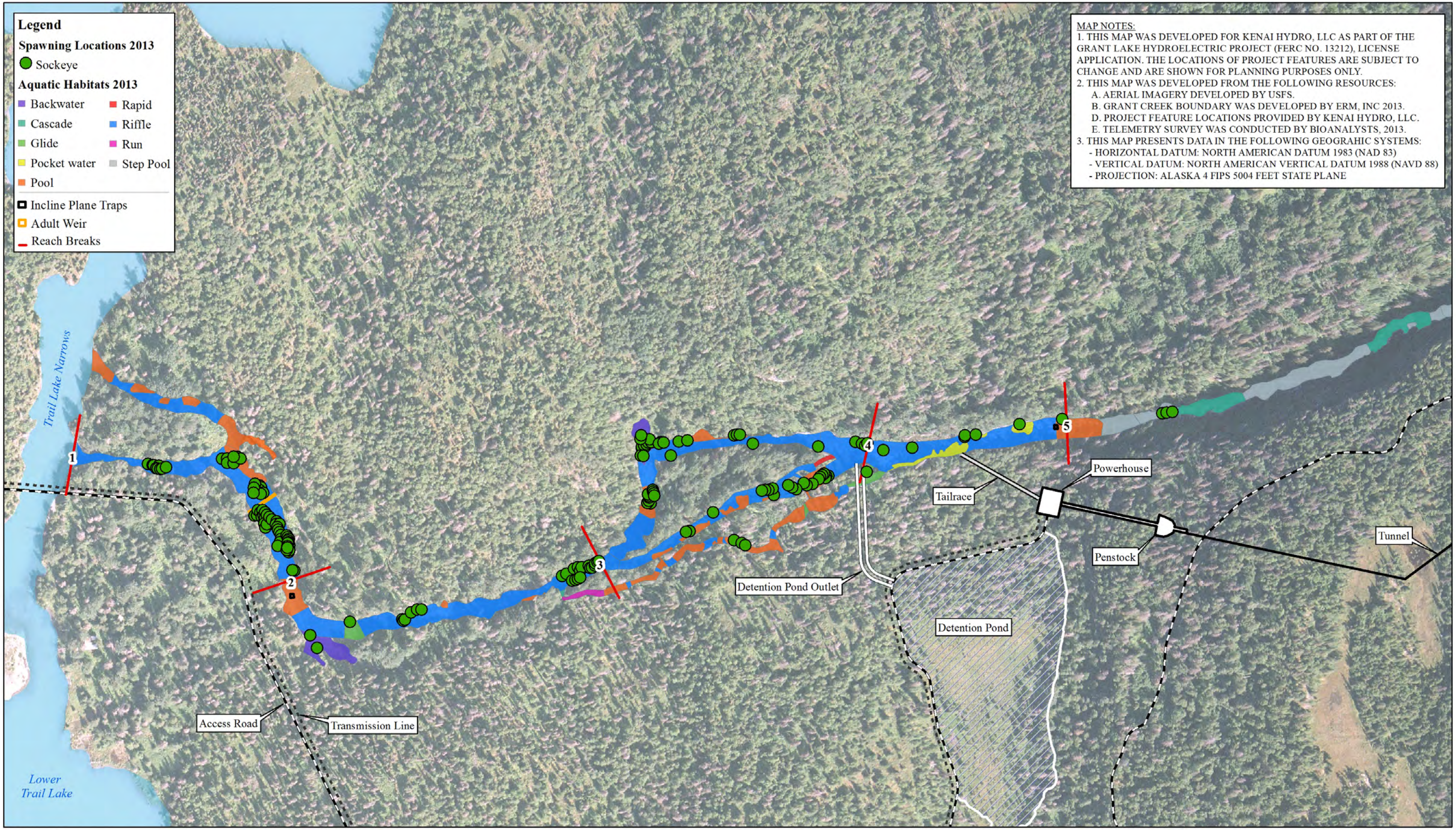
Figure E.4-22
Spawning Locations for Coho Salmon in Grant Creek, 2013.

DESIGNED	J. Woodbury
DRAWN	J. Woodbury
CHECKED	M. Miller
ISSUED DATE	3/3/2015

DRAWING

SCALE: 1:2,500



REV	DATE	BY	DESCRIPTION

Drawing Scale:

N

0 100 200 400 Feet

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Figure E.4-23
Spawning Locations for Sockeye Salmon in Grant Creek, 2013.

DESIGNED J. Woodbury

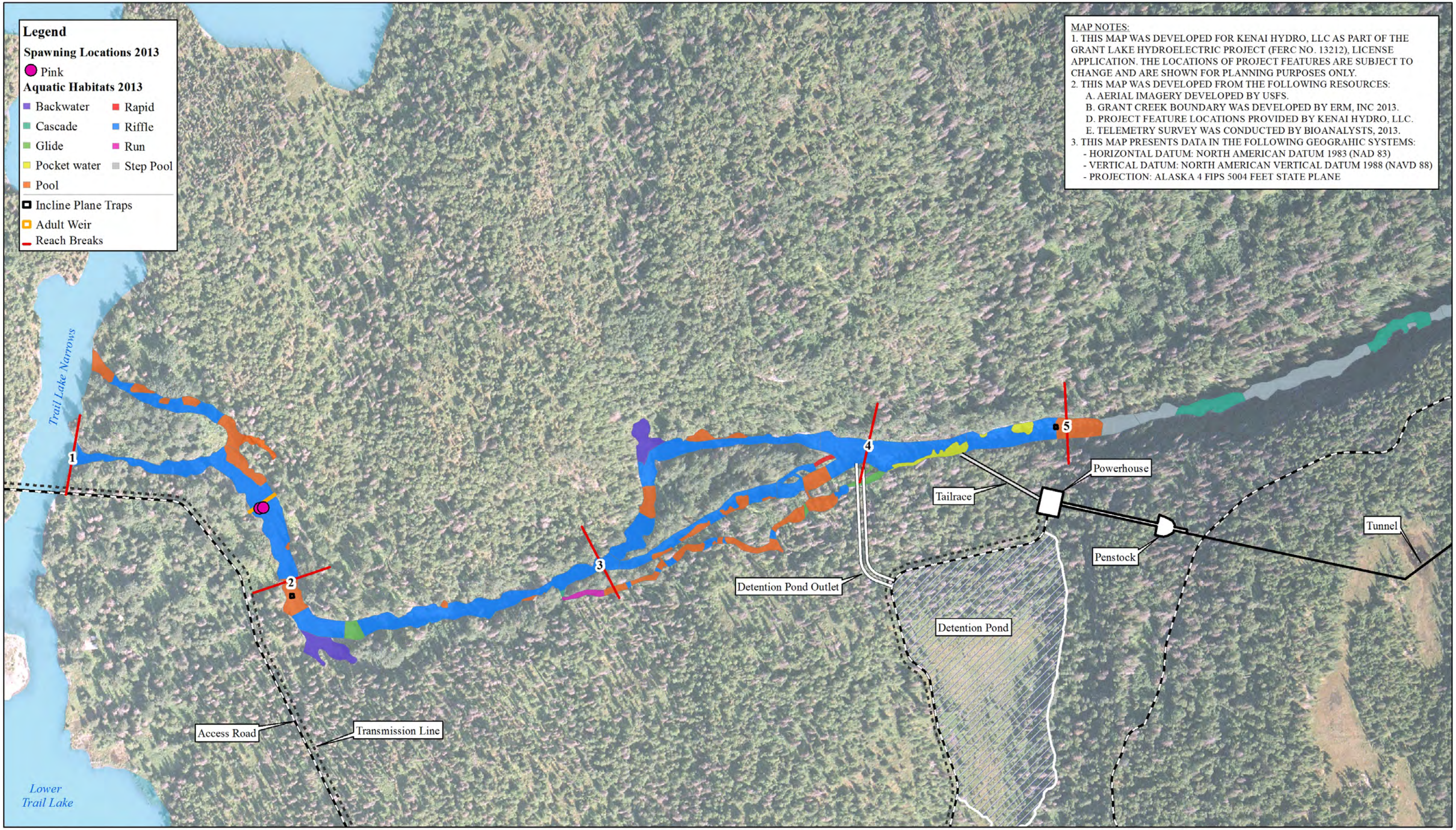
DRAWN J. Woodbury

CHECKED M. Miller

ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:2,500



REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 100 200 400 Feet

N

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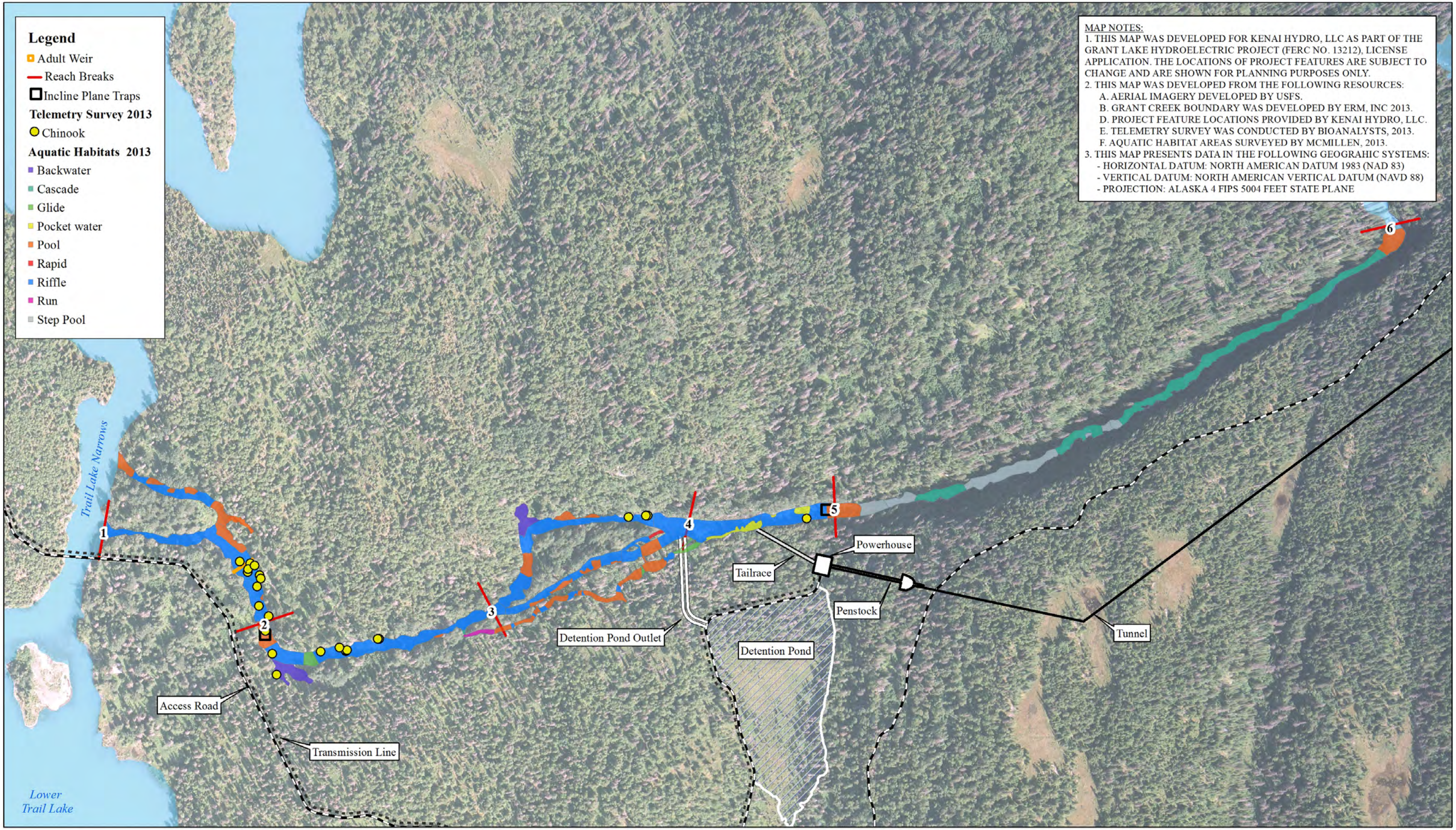
Figure E.4-24
Spawning Locations for Pink Salmon in Grant Creek, 2013.

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/20/2015

DRAWING

SCALE: 1:2,500



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 150 300 600 Feet

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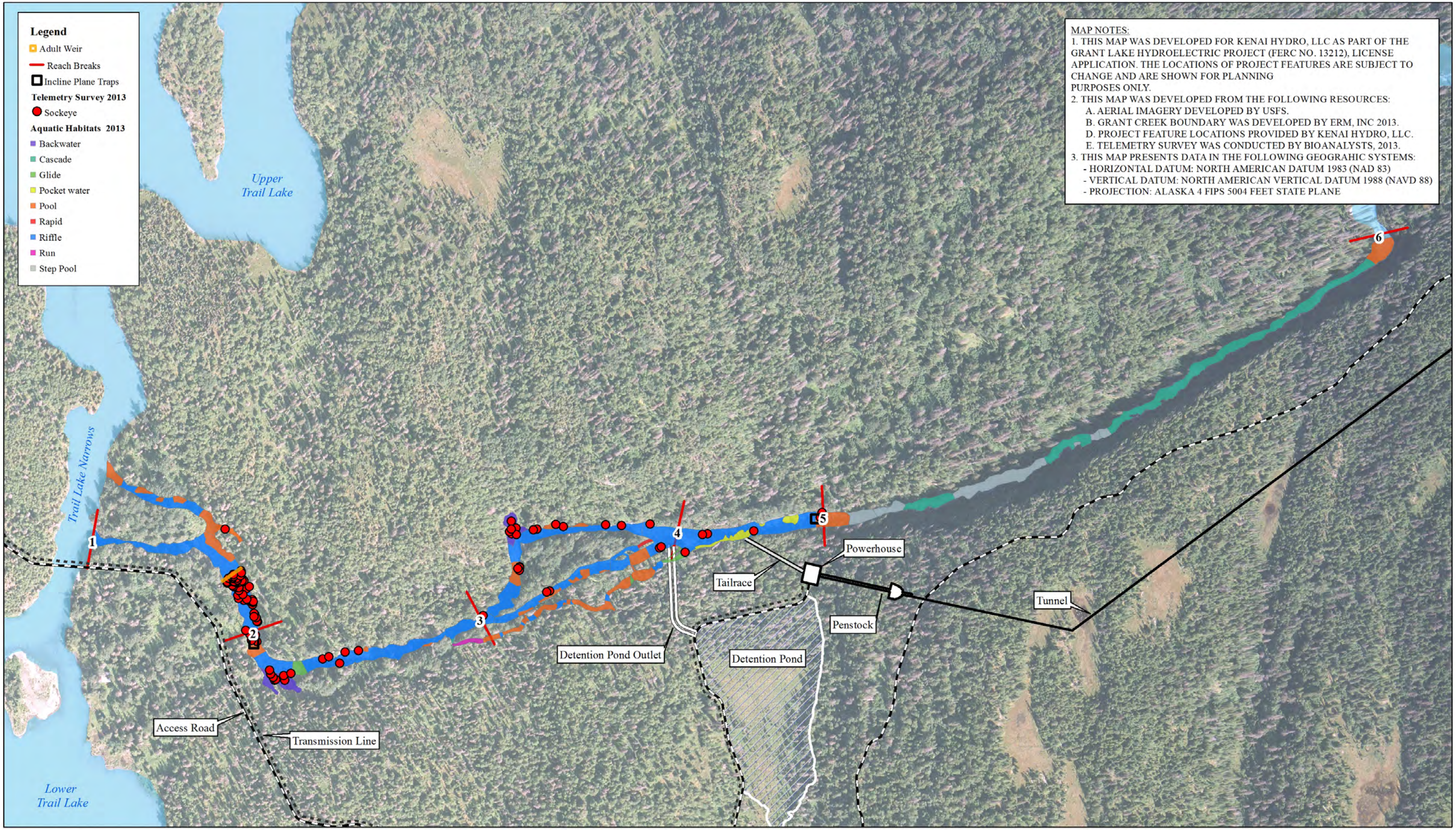
Figures E.4-25
Mobile Telemetry Detections for Radio Tagged Chinook in Grant Creek, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Stevenson
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:3,400



REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 150 300 600 Feet

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Figure E.4-26
Mobile Telemetry Detections for Radio Tagged Sockeye in Grant Creek, 2013.

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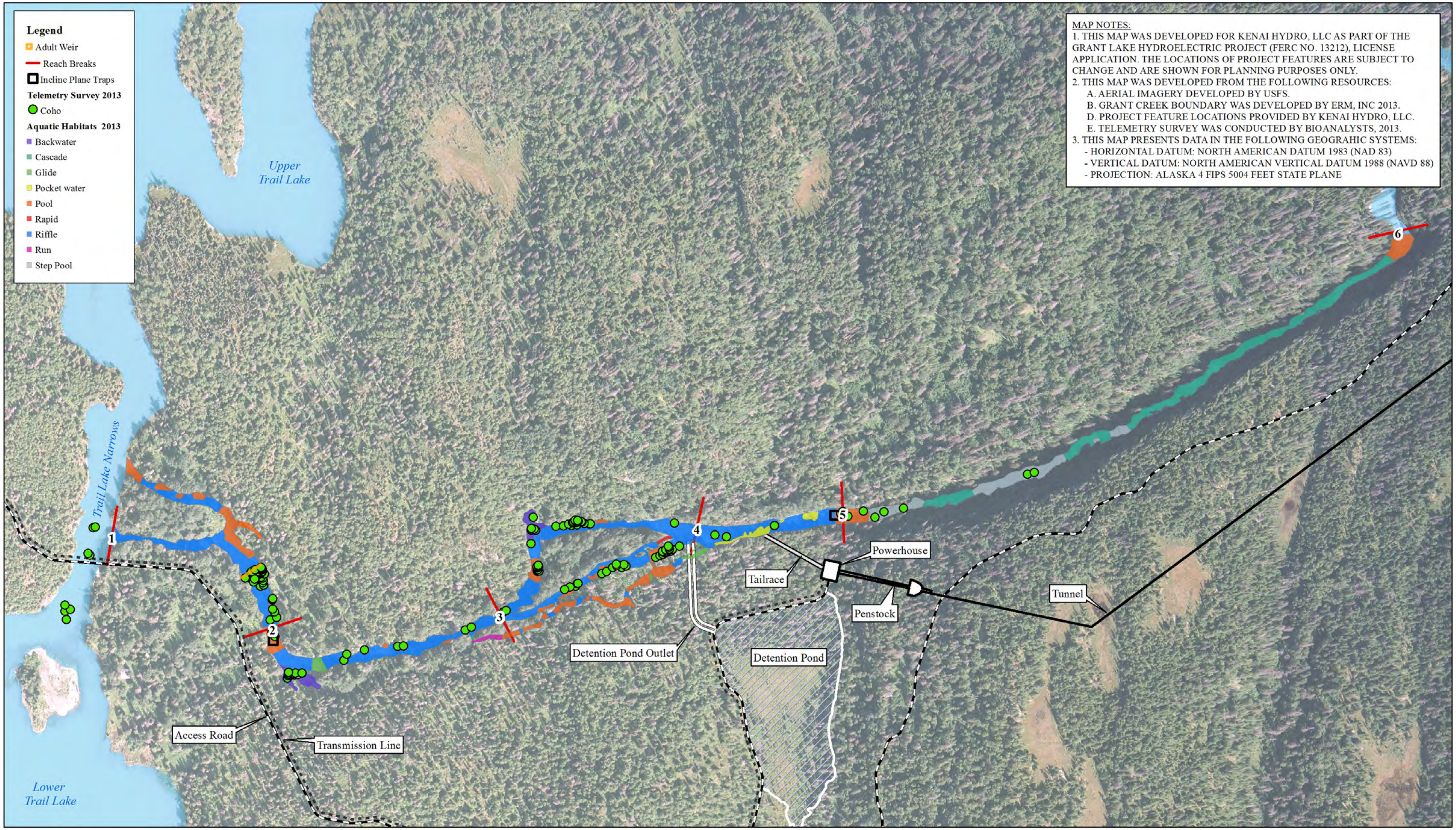
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:3,400



REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 150 300 600 Feet

N

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Figure E.4-27
Mobile Telemetry Detections for Radio Tagged Coho Salmon in Grant Creek, 2013

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DRAWN J. Woodbury
CHECKED J. Stevenson
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:3,400

Table E.4-26. Number and proportion of redds counted in each reach of Grant Creek for pink, Chinook, sockeye and coho salmon in 2013.

Reach	Species				Total	Proportion
	Pink	Chinook	Sockeye	Coho		
1	2	4	144	18	**168**	**0.433**
2	0	0	52	7	**59**	**0.152**
3	0	1	102	38	**141**	**0.363**
4	0	1	7	7	**15**	**0.039**
5	0	0	3	2	**5**	**0.013**
Total	**2**	**6**	**308**	**72**	**388**	**1.000**

Sockeye and coho salmon spawned in every reach of Grant Creek while Chinook only spawned in Reaches 1, 3 and 4. The spawning locations of sockeye and coho salmon often overlapped in several locations in Reaches 1 and 3. Pink salmon only spawned in Reach 1. There was less spawning in Reach 2 (15 percent), Reach 4 (4 percent) and Reach 5 (1 percent). Spawning only occurred in a few locations in Reaches 4 and 5. As expected, the distribution of redds closely follows the distribution of visual detections (Figures E.4-17 through E.4-19) and mobile telemetry surveys (Figures E.4-25 through E.4-27).

Radio telemetry tracking occurred throughout the spawning period for Chinook, sockeye and coho salmon. Radio tracking was used to determine the distribution of salmon within Grant Creek (Figures E.4-25 through E.4-27). Those distributions likely include migration (wandering), spawning and resting (pools) behaviors within Grant Creek.

Of the nine Chinook that were radio-tagged, seven were detected within Reach 1, three within Reach 2, none in Reaches 3 and 4, and five within Reach 5 (Table E.4-27). While five Chinook were detected within Reach 5, no redds were associated with these detections nor were any Chinook redds observed in Reach 5. In Reaches 3 and 4 there were no unique fish detections but at least two redds were observed in those reaches. In Reach 2 there were 3 fish detected but no redds were observed in that reach. In Reach 1 there were 7 fish detected and 4 redds observed.

Table E.4-27. The number of unique detections of radio-tagged adult salmon by species and reach within Grant Creek.

Reach	Chinook (n = 9)	Sockeye (n = 65)	Coho (n = 50)	Total	Proportion
1	7	48	40	95	**0.41**
2	3	14	12	29	**0.13**
3	0	18	30	48	**0.21**
4	0	3	6	9	**0.04**
5	5	20	26	51	**0.22**
Total	**15**	**103**	**114**	**232**	**1.00**

Unique detections by reach for sockeye more closely resemble observed redds by reach as presented in Table E.4-26. Of the 65 radio-tagged sockeye, 48 were detected in Reach 1, 14 in Reach 2, 18 in Reach 3, 3 in Reach 4, and 20 in Reach 5 (Table E.4-27). There were 20 sockeye detected in Reach 5 and at least 3 redds were observed. In Reach 3 there were 18 sockeye detected and 102 redds were observed. In Reach 2 there were 14 fish detected and 52 redds observed. Reach 1 had 48 fish detected and there were 144 redds observed in this reach.

Of the 50 coho salmon radio-tagged, 40, 12, 30, 6, and 26 tagged fish were observed in Reaches 1-5, respectively (Table E.4-27). Coho were detected in all reaches of Grant Creek and indeed spawned in all reaches of Grant Creek like sockeye salmon. The majority of coho salmon were detected in Reaches 1 and 3 and these were the areas where most of the spawning occurred.

<u>Spawning Habitat</u>

In Grant Creek, most redds were located in the mainstem areas, but also occurred in side channels and backwater areas (Table E.4-28). Sockeye and coho both spawned in mainstem, side channel and backwater areas while pink and Chinook only spawned in mainstem areas. In mainstem areas, spawning usually occurred along the stream margins or in areas protected from the main current. Chinook were the exception, building redds mid-channel within the stronger current. In side channels, salmon spawned throughout the wetted width of the channel and in backwater areas, salmon usually selected locations close to the mainstem where suitable stream velocity and substrate were present.

Table E.4-28. Location of salmon redds within different channel areas of Grant Creek.

Species	Backwater Areas	Mainstem Areas	Side Channel Areas	Total
Chinook	0	6	0	**6**
Coho	4	49	19	**72**
Pink	0	2	0	**2**
Sockeye	27	239	42	**308**
Total	**31**	**296**	**61**	**388**

The majority of redds in Grant Creek were located in riffle (71 percent) and pool (19 percent) habitat (Table E.4-29). In Reach 1, spawning for pink, sockeye and coho salmon most often occurred in riffle and pool habitat along the stream margins in the mainstem areas away from the thalweg and the highest stream velocities. Chinook spawned only in riffle habitat most often mid-channel where higher velocity and larger spawning substrates occurred. In Reach 2, most spawning occurred in mainstem riffle habitat along the stream margins for sockeye and coho salmon. Irregularities along the stream margin (large woody debris [LWD], bedrock, boulders) of riffle habitat created areas of lower velocity and suitable spawning substrate. Sockeye and coho also spawned in the stream margins of some pool habitat (lateral scour pool) of Reach 2. In Reach 3, most spawning occurred in pool habitat in mainstem (scour pools) and side channel areas (dammed pools). One large backwater area (pool habitat) was also used by sockeye and coho salmon. In Reach 4, spawning occurred in mostly riffle habitat along the stream margins of the right bank. Spawning also occurred along the left bank in pocket water (riffles w/ pockets) formed by velocity breaks such as boulders or tree roots that allowed spawning gravels to accumulate. In Reach 5, spawning occurred in step pool habitat along the stream margins often behind large boulders or bedrock outcroppings (velocity breaks) where gravels and cobbles accumulated.

Table E.4-29. Location of pink, Chinook, sockeye and coho salmon redds within reaches and aquatic habitats of Grant Creek. A designation of "NA" means that the habitat type was not available in that reach of Grant Creek.

Species	Reach - Area	Riffle	Pool	Back -water	Step Pool	Glide	Pocket Water	Total
Pink	1 - Mainstem	2						2
	2 - Mainstem							
	3 - Mainstem							
	3 - Predominate Side Channel							
	3 - Secondary Side Channel							
	4 - Mainstem							
	5 - Mainstem							
Chinook	1 - Mainstem	4						4
	2 - Mainstem							
	3 - Mainstem	1						1
	3 - Predominate Side Channel							
	3 - Secondary Side Channel							
	4 - Mainstem	1						1
	5 - Mainstem							
Sockeye	1 - Mainstem	129	15					144
	2 - Mainstem	47		4		1		52
	3 - Mainstem	18	19	23				60
	3 - Predominate Side Channel	27	11			1		39
	3 - Secondary Side Channel		3					3
	4 - Mainstem	6	1					7
	5 - Mainstem				3			3
Coho	1 - Mainstem	15	3					18
	2 - Mainstem	6		1				7
	3 - Mainstem	6	10	3				19
	3 - Predominate Side Channel	7	8					15
	3 - Secondary Side Channel	1	3					4
	4 - Mainstem	5	2					7
	5 - Mainstem				2			2
	Total:	**275**	**75**	**31**	**5**	**2**	**0**	**388**
	Proportion:	**0.71**	**0.19**	**0.08**	**0.01**	**0.01**	**0.00**	**1.00**

The majority of radio tagged salmon were detected in riffle (62 percent) and pool (24 percent) habitat (Table E.4-30). The proportion of detections in aquatic habitats of Grant Creek follows the distribution of redds.

Table E.4-30. Number of detections for radio tagged Chinook, sockeye, and coho salmon in aquatic habitats of Grant Creek, 2013.

Species	Reach	Riffle	Pool	Back-water	Step Pool	Glide	Pocket Water	Total
Chinook	1 - Mainstem	10						10
	2 - Mainstem	6	2	2				10
	3 - Mainstem		2	1				3
	3 - Predominate Side Channel							0
	3 - Secondary Side Channel							0
	4 - Mainstem							0
	5 - Mainstem				1			1
Sockeye	1 - Mainstem	49	2					51
	2 - Mainstem	6	4	7				17
	3 - Mainstem	9	7	4				20
	3 - Predominate Side Channel	4						4
	3 - Secondary Side Channel							0
	4 - Mainstem	3						3
	5 - Mainstem							0
Coho	1 - Mainstem	57	1					58
	2 - Mainstem	6	3	10				19
	3 - Mainstem	12	27	7				46
	3 - Predominate Side Channel	6	14					20
	3 - Secondary Side Channel					1		1
	4 - Mainstem	3	3					6
	5 - Mainstem		2		4			6
	Total:	**171**	**67**	**31**	**5**	**1**	**0**	**275**
	Proportion:	**0.62**	**0.24**	**0.11**	**0.02**	**<0.01**	**0.00**	**1.00**

Grant Creek Resident and Rearing Fish Abundance and Distribution

Adult Rainbow Trout Abundance, Distribution, and Spawning in Grant Creek

Dolly Varden and rainbow trout were intercepted at the weir to help facilitate radio tagging and to collect biometric data. Fish captured at the weir that were radio-tagged were also Floy-tagged. The migration period for rainbow trout lasted 6 weeks from May 24 to June 29 and resulted in the capture of 13 adult rainbow trout (Table E.4-31). The abundance of adult rainbow trout in Grant Creek based on weir counts may be biased low. Prior to July 5, when the weir was outfitted with 3 meter pickets, it was possible for fish to circumnavigate the weir either by swimming through a breach on the right bank (undercut bank), or at times of high flow, over the top of the weir.

Table E.4-31. Weekly passage of rainbow trout and Dolly Varden across the weir in Grant Creek, 2013.

Week of the Year	Dates	Rainbow Trout	Dolly Varden
21	May 19 - May 25	3	0
22	May 26 - Jun 01	1	0
23	Jun 02 - Jun 08	1	0
24	Jun 09 - Jun 15	1	0
25	Jun 16 - Jun 22	3	0
26	Jun 23 - Jun 29	4	0
27	Jun 30 - Jul 06	0	0
28	Jul 07 - Jul 13	0	0
29	Jul 14 - Jul 20	0	0
30	Jul 21 - Jul 27	0	0
31	Jul 28- Aug 03	0	0
32	Aug 04 - Aug 10	0	0
33	Aug 11- Aug 17	0	0
34	Aug 18 - Aug 24	0	1
35	Aug 25 - Aug 31	0	4
36	Sep 01 - Sep 07	0	6
37	Sep 08 - Sep 14	0	3
38	Sep 15 - Sep 21	0	0
39	Sep 22 - Sep 28	0	0
40	Sep 29 - Oct 05	0	0
41	Oct 06 - Oct 12	0	0
42	Oct 13 - Oct 19	0	0
43	Oct 20 - Oct 26	0	0
	Total	13	14

The migration period for Dolly Varden lasted 4 weeks from August 18 to September 14, 2013, with the capture of 14 Dolly Varden (Table E.4-31). Only one Dolly Varden was large enough for tagging, and which appeared to be in spawning condition.

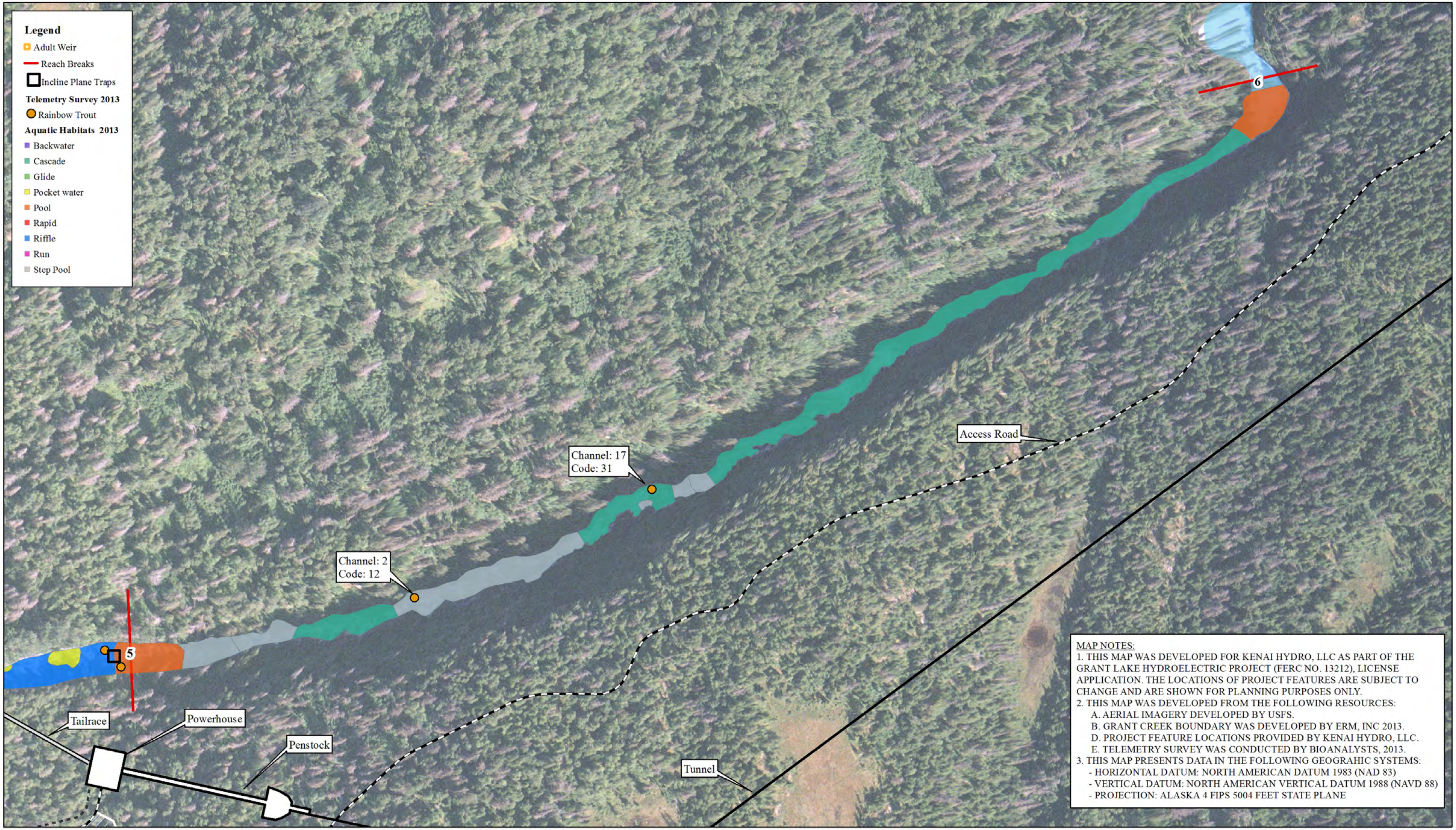
Resident and Rearing Fish Use of Reach 5

To monitor fish use of upper Grant Creek, adult rainbow trout were surgically implanted with radio tags to monitor their movements and use of Reach 5; a total of 20 adult rainbow trout were radio-tagged.

Of the 20 adult rainbow trout that were surgically implanted with radio-transmitters, three males and one female were detected within Reach 5 subsequent to their release (Figure E.4-28). On average, it took 9.9 days after tagging and release for the four fish to migrate upstream through Grant Creek and be detected by the antenna array located at the Reach 4/5 break (median of 6.6 days; range of 2.0 to 24.4 days; Table E.4-32). Three of the four fish made a single foray into Reach 5, spending on average 0.27 days within Reach 5. The fourth fish, a male, made three different forays into Reach 5; the first lasting 4.35 days, the second 0.72 days, and the last foray lasting 0.75 days, each venture into Reach 5 being separated by about 6 hours.

Table E.4-32. The travel time and length of residence of radio-tagged rainbow trout detected in Reach 5 of Grant Creek.

Fish I.D. (Channel/Code)	Sex	Travel Time from Release to Reach 4/5 Break (days)	Length of Time within Reach 5 (days)
2/12	Female	6.12	0.80
2/19	Male	24.37	0.01
17/31	Male	2.00	4.35
			0.72
			0.75
17/46	Male	7.05	0.01



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Drawing Scale: 0 50 100 200 Feet

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Figure E.4-28
Mobile Telemetry Detections for Radio Tagged Rainbow Trout in Reach 5 of Grant Creek, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Stevenson
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:1,675

Minnow trapping and snorkeling were used in upper Grant Creek (Reach 5 only) from April through October to document species diversity, relative abundance, and distribution of juvenile fish. Over the course of the study, there were 57 individual minnow traps (effort=1,318 hours) placed in different locations capturing 205 fish in upper Grant Creek (Table E.4-33; Figure E.4-29). Snorkeling was only conducted in April and May when stream flows and water clarity allowed. Three step pools were snorkeled in April and two were snorkeled in May identifying 16 fish in upper Grant Creek.

Table E.4-33. Number of minnow traps, total effort, and number of fish captured in Reach 5 of Grant Creek from April through October 2013.

Upper Grant Creek Minnow Trapping				
Reach	**Number of Traps**	**Total Effort (days)**	**Total Effort (hrs)**	**Number of Fish**
5	57	54.9	1,318	205

Dolly Varden and rainbow trout were the most numerous fish captured in minnow traps followed by Chinook, sculpins sp. and coho (Table E.4-34). Juvenile Dolly Varden comprised half of the fish captured in minnow traps.

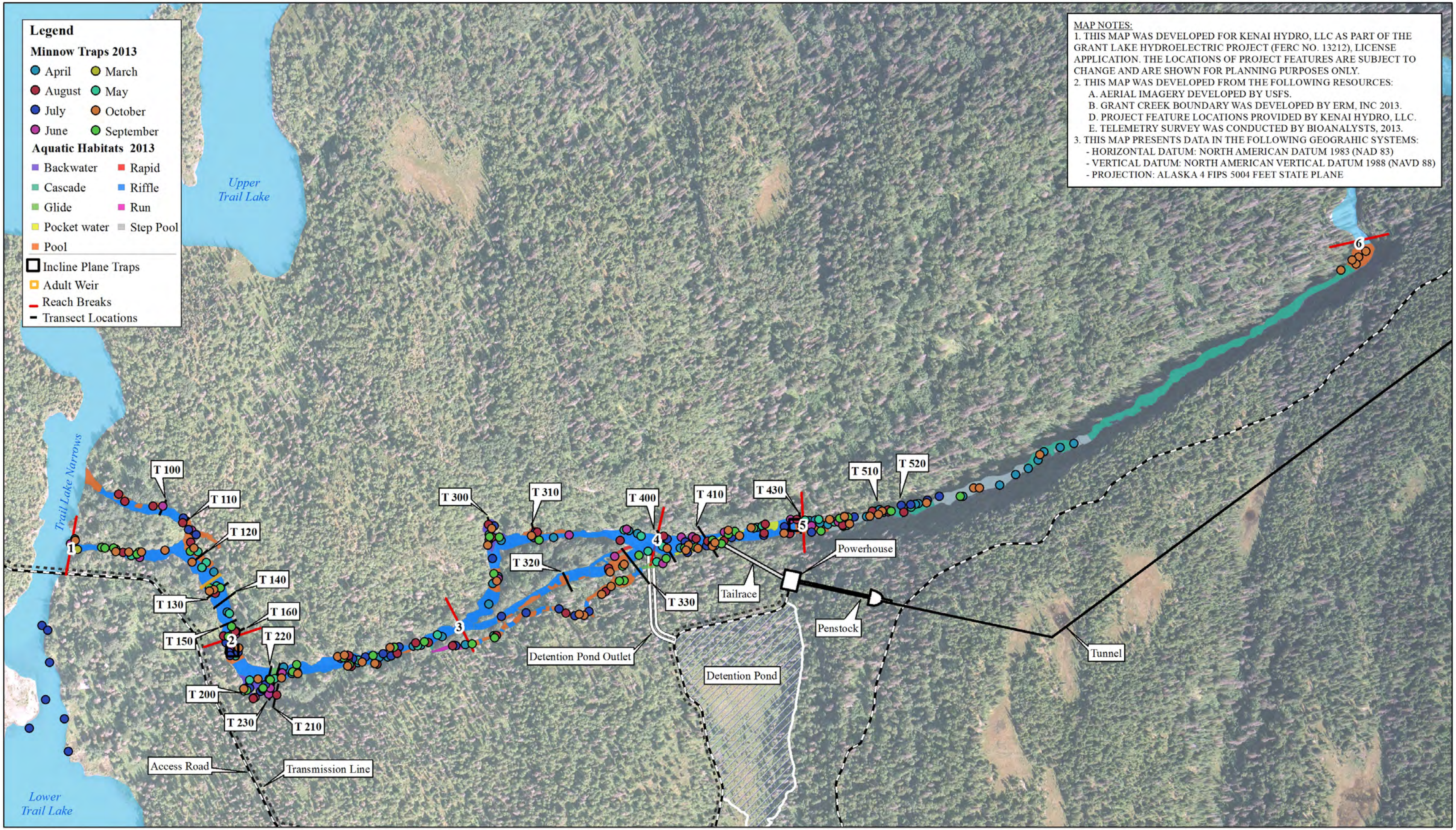
Table E.4-34. Number, proportion and CPUE of fish caught in Reach 5 of Grant Creek with minnow traps from April through October 2013.

Upper Grant Creek Minnow Trapping			
Species	**Number**	**Proportion**	**CPUE (fish/hr)**
Chinook	31	0.15	0.024
Coho	5	0.02	0.004
Dolly Varden	102	0.50	0.077
Rainbow Trout	48	0.23	0.036
Sculpin sp.	19	0.09	0.014
Grand Total	**205**	**1.00**	**0.156**

The relative abundance of fish observed in Reach 5 of Grant Creek varied over time (Table E.4-35). Repeated minnow trap sampling from April through October in upper Grant Creek showed that relative abundance was lowest in May and increased to September (Figure E.4-30; Table E.4-35). In general, peak abundance (catch) occurred from June through October. CPUE for juvenile Chinook increased from April to a peak in September and declined in October (Figure E.4-30). Juvenile Chinook varied in size from 68-118 mm fork length (FL). CPUE for juvenile coho salmon peaked in September and fish ranged in size from 60-95 mm FL. For Dolly Varden, the greatest CPUE occurred in August but was fairly stable during the summer (June-August). The size range of Dolly Varden captured in upper Grant Creek varied from 71-151 mm FL. Catch of juvenile rainbow trout peaked in September and October (Table E.4-35). Rainbow trout captured in upper Grant Creek varied from 54-143 mm FL. No fish were captured in the plunge pool downstream from the anadromous fish barrier in September when peak catch rates were generally highest for most other species (except Dolly Varden).

Table E.4-35. Number of fish captured in minnow traps by month for upper Grant Creek from April through October 2013.

Month	Number						
	Chinook	Coho	Dolly Varden	Rainbow Trout	Sculpin sp.	Three-spine Stickleback	Total
APR	2	0	1	5	0	0	8
MAY	1	0	1	4	0	0	6
JUN	0	0	18	1	0	0	19
JUL	1	0	23	3	1	0	28
AUG	1	1	20	4	3	0	29
SEP	18	4	17	16	5	0	60
OCT	8	0	22	15	10	0	55
Total	31	5	102	48	19	0	205



REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 150 300 600 Feet

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Figure E.4-29
Locations of Minnow Trap Observations in Grant Creek by Month, 2013

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DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015
DRAWING
SCALE: 1:3,400

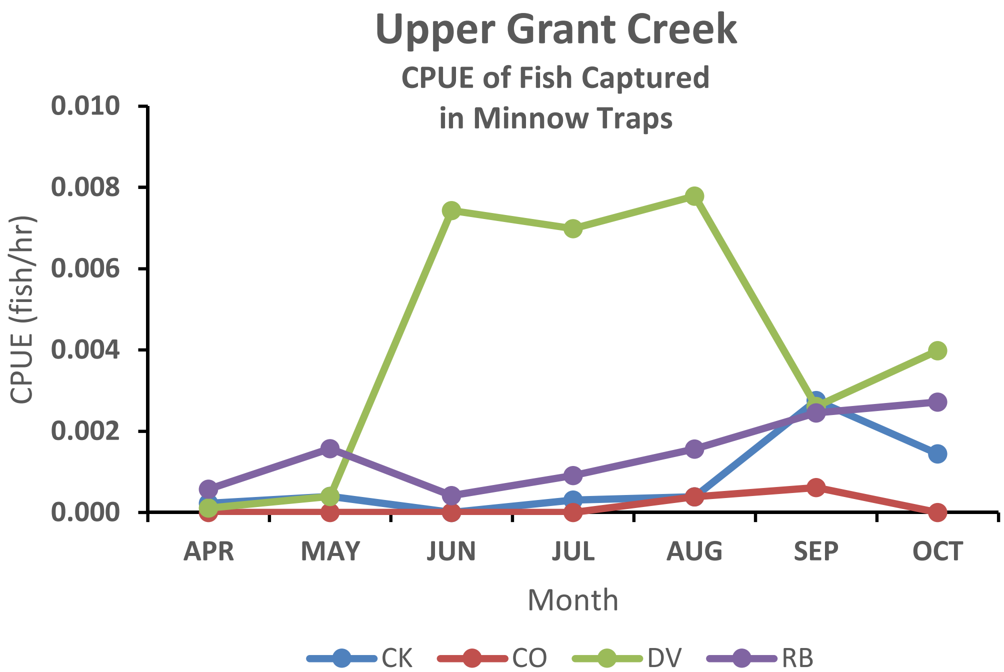


Figure E.4-30. Catch-per-unit-effort (CPUE) for juvenile Chinook (CK), coho (CO), Dolly Varden (DV) and rainbow trout (RB) from minnow trapping in upper Grant Creek from April through October, 2013.

Night time snorkel surveys in April and May within Reach 5 of Grant Creek documented 7 rainbow trout in April and 9 rainbow trout in May. These fish were observed in step pool habitat and varied in size from 60-280 mm FL.

The upper incline plane trap was installed within a scour pool, which was located immediately downstream of the Reach 4/5 break. Trap installation was completed on April 28, and the trap was permanently removed on October 16. During the period of May 30 to September 19 the trap was inoperable due to high flows. During the operation of the upper incline plane trap, a total of 172 fish were processed. Of those, there were 8 Chinook, 1 coho, 7 Dolly Varden, 5 rainbow trout, 19 sculpin, and 132 sticklebacks.

Resident and Rearing Fish Use of Open Water Habitats in Lower Grant Creek

During the period of May 24 to July 11, 2013, a total of 20 adult rainbow trout were surgically implanted with radio-transmitters; one in May, six in June, and 13 in July (Table E.4-36). Of those 20 fish, 8 were female, 11 were male, and the sex of one other was undetermined. The age of adult rainbow trout (>300 mm) varied from three to seven years old, which is similar to what has been observed in the Upper Kenai River (Hayes and Hasbrouck 1996). The mean weight was 543.5 grams (range of 252.6 to 1,571.2 grams), and the mean length was 358.4 mm, with a range of 300 to 500 mm (Figure E.4-31).

Table E.4-36. The date of tagging, transmitter coding, capture method, sex, weight and length of 20 adult rainbow trout tagging in Grant Creek, Alaska 2013.

Date	Channel	Code	Capture Method	Sex	Age	Weight (g)	Length (mm)
24-May-13	2	11	Angling	Unknown	---	462.6	343
6-Jun-13	17	31	Weir	Male	3	1571.2	500
15-Jun-13	2	17	Weir	Male	3	767.4	402
17-Jun-13	17	44	Weir	Female	6	548.2	357
17-Jun-13	2	12	Weir	Female	3	969.4	431
25-Jun-13	17	32	Angling	Female	7	406.2	345
28-Jun-13	2	18	Angling	Female	3	334.0	309
1-Jul-13	2	21	Angling	Female	3	634.0	382
1-Jul-13	17	25	Angling	Male	6	252.6	304
3-Jul-13	2	22	Angling	Male	7	269.2	309
3-Jul-13	17	45	Angling	Male	4	457.8	348
3-Jul-13	17	26	Angling	Male	4	551.6	373
4-Jul-13	2	13	Angling	Female	3	535.4	357
5-Jul-13	17	33	Angling	Female	3	724.8	411
5-Jul-13	2	19	Angling	Male	3	398.2	329
7-Jul-13	17	46	Angling	Male	3	582.6	385
9-Jul-13	17	37	Angling	Female	3	314.4	318
10-Jul-13	17	38	Angling	Male	5	487.2	335
11-Jul-13	2	23	Angling	Male	3	284.2	300
11-Jul-13	17	27	Angling	Male	3	318.0	329
					Mean	**543.5**	**358.4**

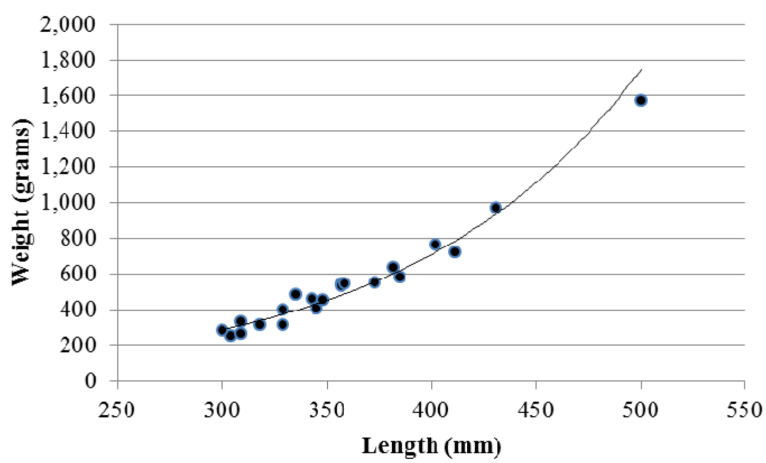


Figure E.4-31. The length-weight relationship of radio-tagged adult rainbow trout in Grant Creek, 2013.

During the course of 37 mobile surveys, a total of 198 contacts were made with radio-tagged adult rainbow trout within Reaches 1-4 of Grant Creek; 124 contacts in Reach 1, 40 in Reach 2, 31 in Reach 3, and 3 in Reach 4 (Figure E.4-32).

Mobile detections of rainbow trout can be assessed by their location within a reach (i.e., mainstem, backwater areas, and side-channels) and habitat type. Of the 124 detections within Reach 1, all were located within the mainstem, with 23 fish locations noted within pools, and 101 fish locations within riffle habitat (Table E.4-37). A total of 40 detections occurred within the Reach 2 mainstem, with 19 fish locations within pool habitat, 13 in riffle habitat, and 8 within backwater areas. Within the Reach 3 mainstem, 9 detections were observed in pool habitat and 11 in riffle habitat. Within the Reach 3 Predominant Side Channel, three detections were observed in pool habitat and 11 detections within riffle habitat, and three detections were recorded in the Reach 3 Secondary Channel within pool habitat. Finally, a total of three detections were observed in the Reach 4 mainstem; with 1 detection in each of the pool, riffle, and pocket water habitats.

Table E.4-37. Habitat use by location based on mobile telemetry surveys for radio-tagged rainbow trout in Grant Creek, AK, 2014.

Reach - Area	Riffle	Pool	Back-Water	Step Pool	Glide	Pocket-Water	Total
1 - Mainstem	101	23					**124**
2 - Mainstem	13	19	**8**				**40**
3 – Mainstem	11	9					**20**
3 – Predominant Side Channel	5	3					**8**
3 – Secondary Side Channel		3					**3**
4 - Mainstem	1	1				**1**	**3**
Total	**131**	**58**	**8**	**0**	**0**	**1**	**198**

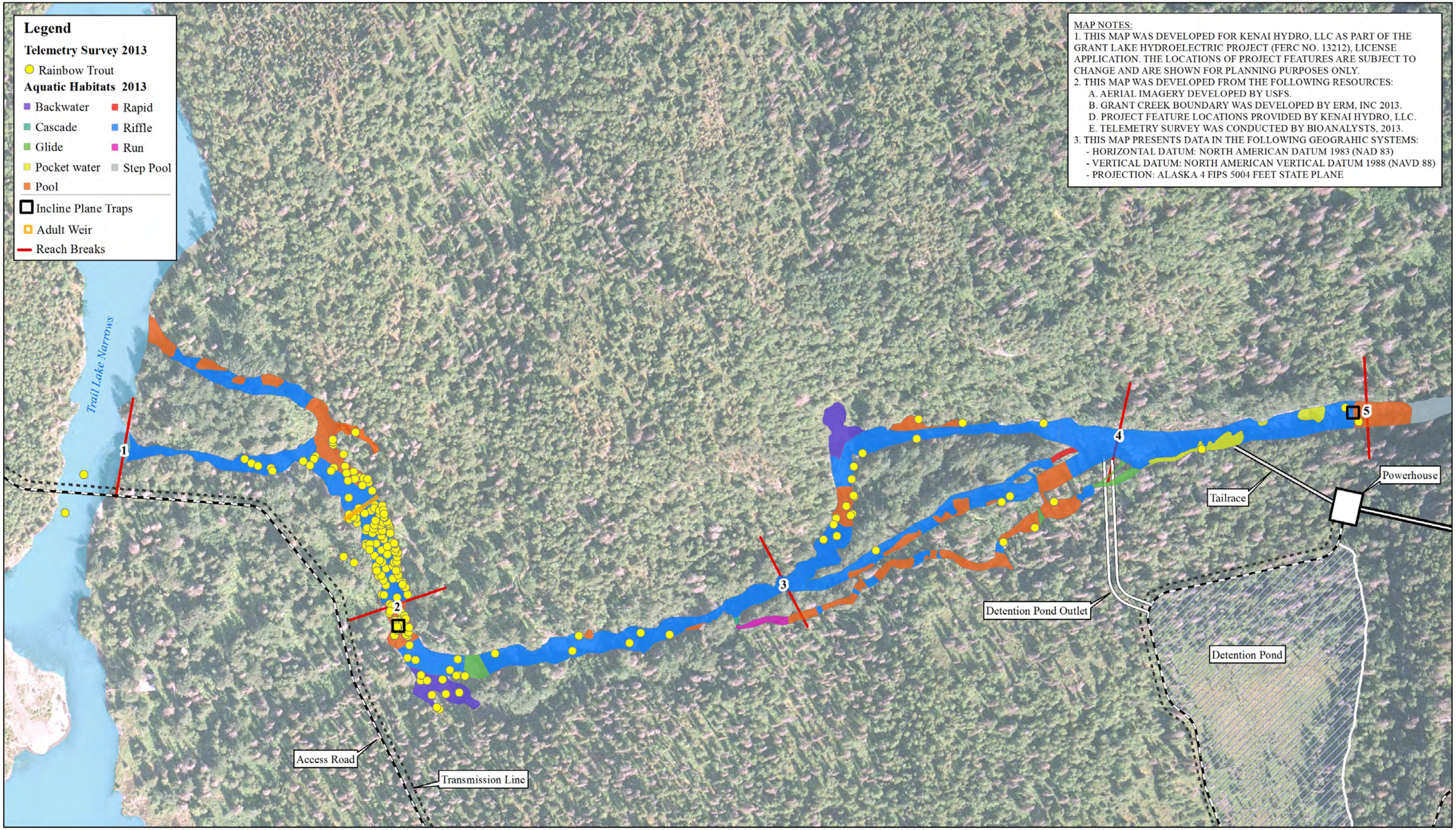
Furthermore, of the 20 radio-tagged rainbow trout, all 20 were detected at some point within Reach 1 (either by the fixed telemetry station or during mobile surveys). Fourteen of the twenty tagged rainbow were also detected in Reaches two and three, three in Reach 4, and as discussed previously, four in Reach 5 (Table E.4-38). The tagged Dolly Varden was not detected at any time after release.

Table E.4-38. The number of radio-tagged rainbow trout and Dolly Varden detected by reach within Grant Creek, Alaska 2013.

Reach	Rainbow (n = 20)	Dolly Varden (n = 1)
1	20	0
2	14	0
3	14	0
4	3	0
5	4	0

The detections of fish in Reach 1 and 2 occurred throughout the period radio-tagged rainbow trout were detected within Grant Creek (May 25 through October 17), whereas detections in Reach 3 occurred primarily shortly after tagging (June 20 through August 15); and the single detection in Reach 4 occurred on June 28. No rainbow trout redds were observed in Grant Creek in 2013. However, due to the poor water clarity and high flows, that was not unexpected. Detections primarily in Reach 3 shortly after tagging, coupled with suitable pockets of gravel at the locations of detection may suggest that rainbow trout spawning possibly occurred in Reach 3; including both the mainstem of Grant Creek and the secondary channel.

As can be seen in Figure E.4-32, the majority of rainbow trout detections were in Reach 1 and to a lesser extent, the lower portion of Reach 2. These areas were also where the greatest concentration of sockeye and coho spawned. Detections of rainbow trout in these areas occurred throughout the tracking period and toward the end of the study. Near the end of the study period, these areas were the only locations where tagged rainbow resided. These factors indicate that while it is possible that some rainbow spawned within this area, fish likely resided within this area to take advantage of feeding opportunities.



REV	DATE	BY	DESCRIPTION

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Drawing Scale:

0 75 150 300 Feet

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Figure E.4-32
Mobile Telemetry Detections for Radio Tagged Rainbow Trout in Reach 1 - 4 of Grant Creek, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Stevenson
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:2,000

Review of the last date of detection by either mobile surveys or the fixed-site telemetry system provides an opportunity to determine the date of exodus from Grant Creek. Mobile telemetry surveys continued until tagged fish were no longer detected in Grant Creek, which included tagged Chinook, sockeye, and coho. The last telemetry survey was conducted on October 29; however, the date of last detection for rainbow trout during a mobile survey in Grant Creek was on October 17. Some fish were detected later than October 17 by the fixed-site telemetry system near the confluence; but these detections were likely the result of tagged fish travelling downstream and exiting Grant Creek into the Trail Lake Narrows. For 18 tagged rainbow trout, the mean and median date of last detection in Grant Creek was September 1, with the earliest date of exodus being June 17, and the latest date being October 26 (Table E.4-39).

Table E.4-39. The date of last detection for 18 radio-tagged adult rainbow trout in Grant Creek, Alaska, 2013.

Channel	Code	Last Date of Detection
2	11	23-Oct-13
2	12	13-Jul-13
2	13	9-Sep-13
2	18	28-Jun-13
2	19	30-Jul-13
2	21	17-Oct-13
2	22	26-Oct-13
2	23	27-Jul-13
17	25	17-Oct-13
17	26	25-Aug-13
17	27	17-Aug-13
17	32	2-Oct-13
17	33	1-Oct-13
17	37	17-Oct-13
17	38	5-Aug-13
17	44	17-Jun-13
17	45	19-Oct-13
17	46	16-Jul-13
	Mean:	1-Sep-13
	Median:	1-Sep-13
	Min:	17-Jun-13
	Max:	26-Oct-13

A single Dolly Varden female was surgically implanted with a transmitter on September 10, and weighed 1,844 grams and was 545 mm FL. This fish was not detected during any mobile surveys, and was never detected by one of the fixed-telemetry sites.

Minnow trapping was used in lower Grant Creek (Reaches 1-4) from April through October to document species diversity, relative abundance, and distribution of juveniles. Minnow trapping was also conducted to help establish important or sensitive juvenile rearing habitat. Over the course of the study there were 273 individual minnow traps (effort=6,137 hours) placed in different locations describing fish in distinct reaches, channel locations, and habitat units. Over 3,468 fish were captured, measured and weighed to describe baseline conditions in lower Grant Creek (Table E.4-40). The following section discusses the results of this effort from a broad scale (reach) to a more focused habitat unit basis. The assumption is that CPUE at the reach, channel and habitat unit scale are a good indicator of relative abundance, distribution and fish-habitat associations.

Table E.4-40. Number of minnow traps, total effort, and number of fish captured in lower Grant Creek from April through October 2013.

Lower Grant Creek Minnow Trapping				
Reach	**Number of Traps**	**Total Effort (days)**	**Total Effort (hrs)**	**Number of Fish**
1	63	60.6	1,454.4	899
2	77	72.1	1,713.6	819
3	69	63.6	1,567.2	1,187
4	64	59.4	1,404.0	560
Total	**273**	**255.7**	**6,139.2**	**3,465**

In lower Grant Creek, relative abundance of fish caught in minnow traps expressed as both CPUE and proportion of total catch was highest in Reach 3 followed by Reach 1, Reach 2, and then Reach 4 (Table E.4-41). The CPUE in the lower gradient Reaches (1-4) of Grant Creek were more than two times the CPUE observed in the higher gradient section of Reach 5 (Table E.4-41). This information indicates that juvenile fish were most abundant in lower Grant Creek and in particular, Reach 3.

Table E.4-41. Number, proportion, and CPUE for fish caught in Lower Grant Creek from April through October of 2013.

Reach	Number of Fish	Proportion	CPUE (fish/hr)
1	899	0.26	0.62
2	819	0.24	0.48
3	1,187	0.34	0.76
4	560	0.16	0.40
Total	**3,465**	**1.00**	**0.56**

Juvenile Chinook and Dolly Varden were the most numerous fish captured in minnow traps on Grant Creek followed by rainbow trout, coho, sculpins species and three-spine sticklebacks (Table E.4-42). Few juvenile sockeye were captured in minnow traps in either Grant Creek (no fish) or Trail Lakes Narrows (1 fish) and is likely related to their early life history and behavior. That is, shortly after emergence sockeye generally tend to migrate into lakes as fry where they feed and grow (Burgner 1991). The size of post-emergent sockeye fry in Grant Creek would likely have been too small (<40 mm FL) to effectively capture in Grant Creek. Also, the period of exposure to minnow trapping would have also been very brief before they emigrated from Grant Creek.

Table E.4-42. Number, proportion and CPUE of fish caught in lower Grant Creek with minnow traps from April through October, 2013.

Lower Grant Creek Minnow Trapping			
Species	**Number**	**Proportion**	**CPUE (fish/hr)**
Chinook	1,244	0.359	0.20
Dolly Varden	1,142	0.330	0.19
Coho	420	0.121	0.07
Rainbow Trout	397	0.115	0.06
Sculpin sp.	258	0.074	0.04
Three-spine Stickleback	4	0.001	0.00
Grand Total	**3,465**	**1.000**	**0.56**

The relative abundance of fish observed in Grant Creek varied over time. Repeated minnow trap sampling from April through October in lower Grant Creek showed that relative abundance increased from fairly low levels in April and May representing late winter and early spring stream conditions to much higher levels in late spring, summer and fall (June-October) (Figure E.4-33; Table E.4-43). In general, peak abundance (catch) occurred during the summer. CPUE for juvenile Chinook increased from April to a peak in September and declined in October (Figure E.4-33). Recently emerged Chinook fry (<50 mm FL) were first noted in minnow traps in June but fry of this size were also noted in July and August. Juvenile Chinook varied in size from 45-110 mm FL. CPUE for juvenile coho salmon increased steadily from May to a peak in August and declined in September and October (Figure E.4-33). Recently emerged coho fry (<50 mm FL) were first noted in minnow traps in July but fry of this size were also noted in August, September (1-fish) and October (1-fish). Juvenile coho varied in size from 42-106 mm FL. For Dolly Varden, the greatest CPUE occurred in June and remained fairly stable in summer and fall. No Dolly Varden less than 50 mm FL were captured in minnow traps. Dolly Varden varied in size from 52-165 mm FL. Catch of juvenile rainbow trout decreased from April to June and remained relatively low into July and August. In September and October there was a noticeable increase in juvenile rainbow trout. Small rainbow trout fry (<50 mm FL) were noted in April (1-fish), May (2-fish) and June (1-fish). However, the majority of small rainbow trout fry were observed in September and October. Rainbow trout varied in size from 43-146 mm FL.

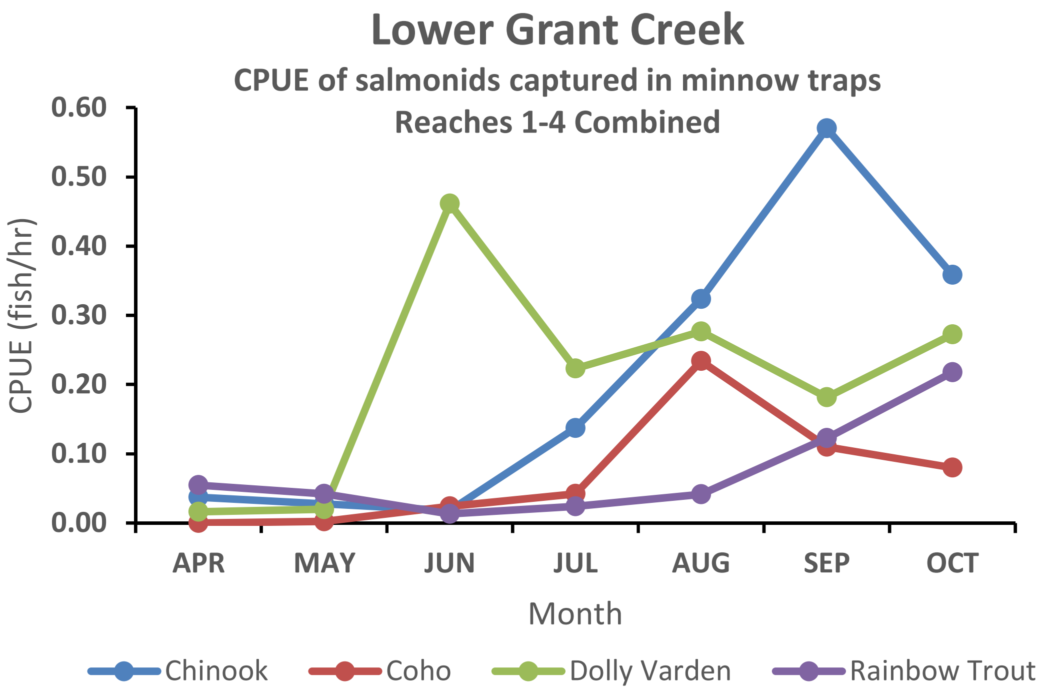


Figure E.4-33. CPUE for juvenile Chinook, coho, Dolly Varden and rainbow trout from minnow trapping in lower Grant Creek from April through October, 2013.

Table E.4-43. Numbers of fish collected from minnow trapping in lower Grant Creek from April through October 2013.

Fish Species	Month							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Chinook	33	24	15	120	280	484	288	1,244
Coho	0	2	20	37	202	93	66	420
Dolly Varden	14	17	371	174	220	143	203	1,142
Rainbow Trout	46	34	10	18	32	92	165	397
Sculpin sp.	19	7	35	40	50	29	78	258
Three-spine Stickleback	0	0	1	1	2	0	0	4
Total	**112**	**84**	**452**	**390**	**786**	**841**	**800**	**3,465**

Most fish that occur in Grant Creek were present in all reaches of lower Grant Creek (Table E.4-44). No juvenile sockeye or arctic grayling were captured in lower Grant Creek. There were a few three-spine sticklebacks captured in lower Grant Creek (Reaches 1 and 3). The number of Chinook and Dolly Varden captured in lower Grant Creek was similar as was the number of coho and rainbow trout.

Table E.4-44. Number of fish captured in minnow traps in different reaches of lower Grant Creek from April through October 2013.

Fish Species	Lower Grant Creek Reaches (Number)				Total
	1	2	3	4	
Chinook	370	351	390	133	**1,244**
Coho	89	116	176	39	**420**
Dolly Varden	306	150	418	268	**1,142**
Rainbow Trout	75	115	126	81	**397**
Sculpin sp.	57	87	75	39	**258**
Three-spine Stickleback	2	0	2	0	**4**
Total	**899**	**819**	**1,187**	**560**	**3,465**

In lower Grant Creek, CPUE was highest (0.758 fish/hr) in Reach 3 for all fish except sculpins (Table E.4-45). CPUE for juvenile Chinook was similar in Reaches 1 and 2, but for coho the capture rate was nearly twice as high in Reach 3 as other reaches. For rainbow trout, capture rates were fairly uniform in all reaches of lower Grant Creek. Similar to Chinook, Dolly Varden had the highest capture rates in Reaches 1 and 3. Unlike Chinook, Dolly Varden had a higher capture rate in Reach 4 than in Reach 2. In lower Grant Creek the capture rates for sculpins was fairly uniform across all reaches.

Table E.4-45. CPUE for fish captured in minnow traps in different reaches of lower Grant Creek from April through October 2013.

Fish Species	Lower Grant Creek Reaches (CPUE)				Total
	1	2	3	4	
Chinook	0.254	0.203	0.256	0.093	**0.203**
Coho	0.061	0.067	0.115	0.027	**0.068**
Dolly Varden	0.210	0.087	0.274	0.188	**0.186**
Rainbow Trout	0.052	0.066	0.083	0.057	**0.065**
Sculpin sp.	0.039	0.050	0.049	0.027	**0.042**
Three-spine Stickleback	0.001	0.000	0.001	0.000	**0.001**
Total	**0.618**	**0.473**	**0.778**	**0.393**	**0.564**

Capture rates were assessed for juvenile fish in lower Grant Creek by location within the active channel and habitat unit. Channel descriptors were used to describe the location of three broad categories: side channels areas, backwater areas or mainstem areas.

In lower Grant Creek, CPUE was highest in side channel areas followed by backwater areas and then locations within the main stream channel (mainstem) (Figure E.4-34). Side channels occur mostly in Reaches 1 and 3 and backwater areas occur only in Reaches 2 and 3. Aquatic habitats are discussed in more detail in the Instream Flow Study, Final Report (KHL 2014d).

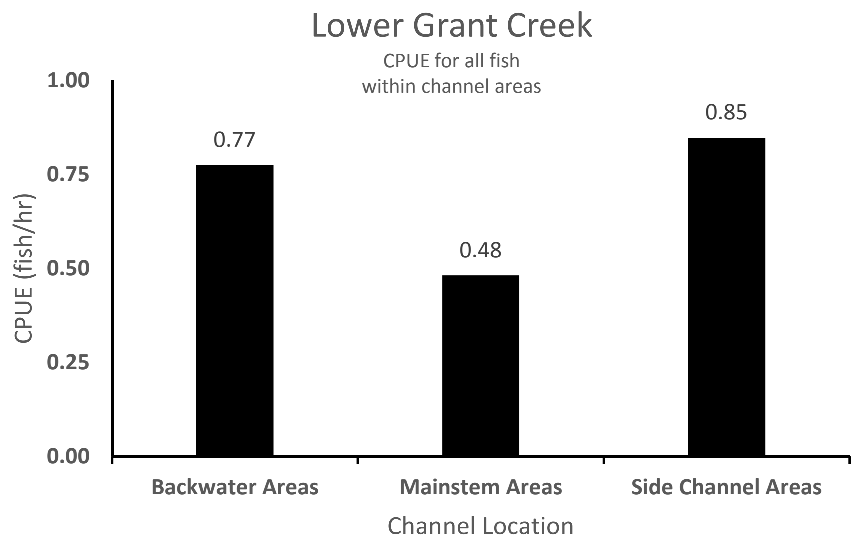


Figure E.4-34. CPUE for fish captured in minnow traps placed in backwater, side channel and mainstem areas of lower Grant Creek from April through October 2013.

Capture rates for salmonids varied within channel types on lower Grant Creek (Figure E.4-35). For juvenile Chinook and coho, capture rates were highest in backwater areas while Dolly Varden and rainbow trout CPUE was the highest in side channels. Mainstem areas dominated by riffle habitat had the lowest CPUE for juvenile Chinook and coho. Dolly Varden had the lowest capture rates in backwater areas and rainbow trout capture rates were the same in both mainstem and backwater areas.

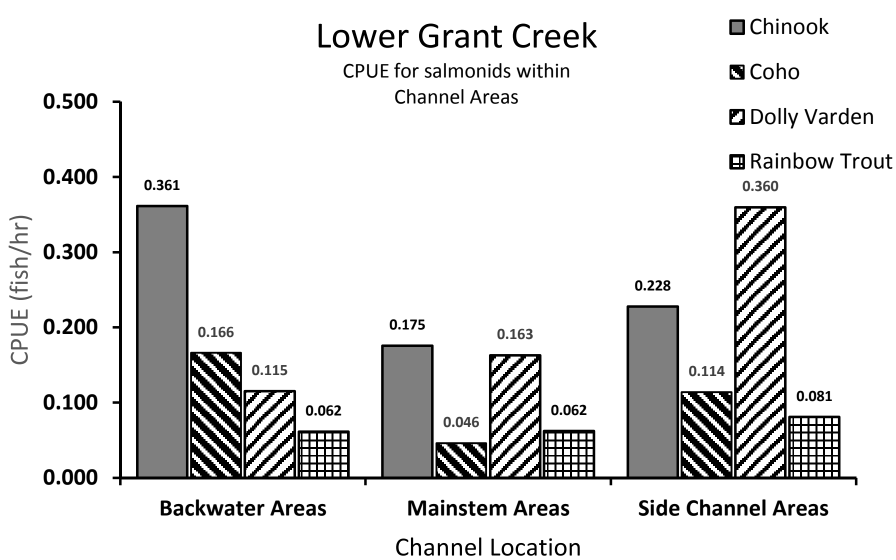


Figure E.4-35. CPUE for salmonids captured in minnow traps placed in backwater, side channel and mainstem areas of lower Grant Creek from April through October 2013.

In lower Grant Creek, CPUE for salmonids varied by species and habitat unit type (Figure E.4-36). Catch rates for juvenile Chinook were nearly equal between pools and glides and the least in riffles and pocket water. For coho, the catch rate was highest in pools followed by riffles. No coho were captured in glides. Catch rates for Dolly Varden were highest in glides and runs and lowest in riffle habitat. Juvenile rainbow trout had the highest catch rates in glides and pocket water and was the least in pool habitat.

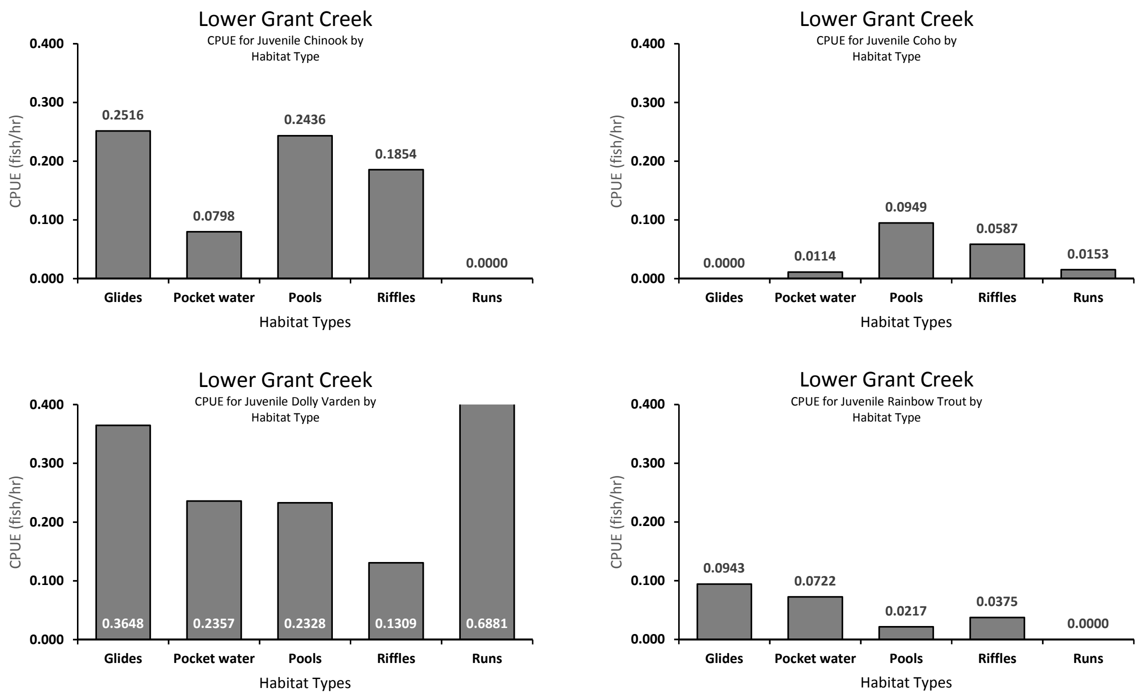


Figure E.4-36. CPUE for salmonids captured in minnow traps placed in different habitat unit types of lower Grant Creek from April through October 2013.

Minnow trapping in lower Grant Creek showed that salmonids were present in all reaches of lower Grant Creek with the highest catch rate (0.778 fish/hr) noted in Reach 3. Reach 3 contained all channel types (mainstem, backwater and side channels), which increases both channel and habitat diversity compared to other reaches. The capture rates of salmonids in lower Grant Creek indicate that side channel and backwater areas are important rearing areas (Figure E.4-35). In particular, catch rates for juvenile Chinook, coho and Dolly Varden were highest in these channel locations likely because large woody debris or greater depth and/or lower velocities provided good juvenile rearing habitat (Figure E.4-36). Juvenile coho and Chinook tend to prefer large, deep pools with abundant cover (McMahon 1983; Raleigh et al. 1986). Capture rates for rainbow trout were much more even by reach, channel and habitat designation. Rainbow trout, as generalist, appear to have similar requirements for abundant cover but depth (pool habitat) may be less important (Raleigh et al. 1984).

Nighttime snorkeling was used in both April and May to assess species diversity, distribution and relative abundance of fish in lower Grant Creek. From June through October, the water was too turbid to snorkel effectively. In April, low flows (18 cfs) and cold water (0.5-1.5°C) were the prevailing stream conditions. In May, both flow (150 cfs) and water temperature (4.0°C) had increased. These conditions are a good approximation of winter and early spring stream conditions in lower Grant Creek.

In mid-April, most salmonids were observed in pool habitat available in the mainstem and backwater areas of lower Grant Creek (Table E.4-46). The highest fish density (fish/100 m^2) occurred in backwater areas available in Reach 3. Backwater areas in Reach 2 were frozen over and inaccessible to snorkeling. Riffle habitat had the lowest fish densities in lower Grant Creek. Side channel habitat was covered in snow and ice and was not available for sampling via night time snorkel surveys. Pool habitat (mainstem and backwater) that occurs in lower Grant Creek provides important overwinter habitat.

Table E.4-46. Number and density of salmonids observed during night time snorkel surveys in lower Grant Creek in April 2013.

Month	Channel	Habitat	Species				Total	Total Area Sampled (m^2)	Fish Density (fish/100 m^2)
			Chinook	Coho	Dolly Varden	Rainbow Trout			
April	Mainstem	Glide	23	0	2	17	**42**	933.2	4.50
		Pool	202	0	15	140	**357**	7,192.6	4.96
		Riffle	5	0	2	32	**39**	8,462.5	0.46
	Backwater	Pool	46	1	1	35	**83**	793.6	10.46
		Total	**276**	**1**	**20**	**224**	**521**	**17,381.9**	**3.00**

Juvenile Chinook were the most abundant fish observed in lower Grant Creek followed by rainbow trout, Dolly Varden, and coho. Almost all juvenile Chinook observed were within the size range of 60-80 mm FL (Table E.4-47). A few juvenile Chinook (4 fish) were observed in the 80-100 mm FL size class. All juvenile Chinook observed in April were likely age-1 fish that overwintered in mostly pool habitats of lower Grant Creek. No juvenile Chinook fry (< 40 mm) or age-0 fish were observed in April. Rainbow trout varied in size from about 40-180 mm FL. Most were observed within the size class of 100-120 mm FL. It is reasonable to assume that several age classes overwintered in pool habitat of lower Grant Creek. There were few Dolly Varden and a single coho observed in lower Grant Creek in April. Dolly Varden varied in size from 40-160 mm FL and the single coho that was observed was within the 40-60 mm size class. There were probably several age classes of Dolly Varden overwintering in lower Grant Creek. Night time snorkel observations appear to comport well with minnow trapping that occurred in April. Juvenile Chinook and rainbow trout were the most abundant salmonids observed in April while Dolly Varden and coho were less abundant.

Table E.4-47. Abundance of salmonids observed in 20-mm increments during night time snorkels surveys in lower Grant Creek in April and May 2013.

Month	Species	Size Classes (20-mm FL increments)									Total
		40 (20-40)	60 (40-60)	80 (60-80)	100 (80-100)	120 (100-120)	140 (120-140)	160 (140-160)	180 (160-180)	>180	
April	Chinook	0	0	272	4	0	0	0	0	0	**276**
	Coho	0	1	0	0	0	0	0	0	0	**1**
	Dolly Varden	0	1	4	11	3	0	1	0	0	**20**
	Rainbow Trout	1	17	31	56	73	32	11	3	0	**224**
	Total	**1**	**19**	**307**	**71**	**76**	**32**	**12**	**3**	**0**	**521**
May	Chinook	0	2	161	42	0	0	0	0	0	**205**
	Coho	0	4	7	1	0	0	0	0	0	**12**
	Dolly Varden	0	0	0	1	2	2	0	0	0	**5**
	Rainbow Trout	0	7	1	9	55	48	20	17	21	**178**
	Total	**0**	**13**	**169**	**53**	**57**	**50**	**20**	**17**	**21**	**400**

In mid-May, as flows and temperature increased most salmonids were still observed in pool habitat available in the mainstem, backwater, and side channel areas of lower Grant Creek (Table E.4-48). Chinook and rainbow trout were still the most abundant fish observed in lower Grant Creek in May. There were a few Dolly Varden and coho observed. Pools in backwater areas had the highest fish density while riffles in the mainstem areas had the lowest fish density. Interestingly, riffle habitat in side channels had the second highest fish density in May. Glide habitat (non-turbulent fast water) classified in April had become turbulent and less glide-like with increased flows in May.

Table E.4-48. Number and density of salmonids observed during night time snorkel surveys in lower Grant Creek in May 2013.

Month	Channel	Habitat	Species				Total	Total Area Sampled (m^2)	Fish Density (fish/100 m^2)
			Chinook	Coho	Dolly Varden	Rainbow Trout			
May	Mainstem	Pool	98	1	2	99	**200**	6,138.6	3.26
		Riffle	0	0	0	2	**2**	1,226.3	0.16
	S. Channel	Pool	6	0	1	34	**41**	1,137.1	3.61
		Riffle	7	1	0	22	**30**	676.1	4.44
	Backwater	Pool	94	10	2	21	**127**	1,111.4	11.43
May Total			**205**	**12**	**5**	**178**	**400**	**10,289.5**	**3.89**

Three different size classes of juvenile Chinook were observed in lower Grant Creek (Table E.4-47). The 40-60 mm FL (2 fish) likely represent recent emerged age-0 fish while Chinook greater than 60 mm FL (203 fish) represent age-1 juvenile Chinook. Chinook emergence likely started in May. In May, the range in coho size was similar to Chinook but with fewer fish. Coho emergence may have also begun in May. Rainbow trout varied in size from about 40 mm to greater than 180 mm FL. Most (161 fish) were observed within the size classes greater than 100 mm FL. From April to May, there was an increase in the number of larger rainbow trout in lower Grant Creek. Some of the shift in abundance of larger rainbow trout might be explained by growth but it is likely that feeding and spawning opportunities were bringing larger fish into Grant Creek. The number of Dolly Varden observed from April to May decreased and there were fewer small fish observed. The low abundance of Dolly Varden observed by both snorkeling and minnow trapping in winter and early spring might suggest that the higher abundance of Dolly Varden observed later in the year might be the result of both new recruitment and immigration into lower Grant Creek.

The lower incline plane trap was installed on April 30, 2013 and was in operation until October 16, 2013, and operated continuously with a few minor exceptions (KHL 2014c). Trap outages due to high flows and debris, and initial poor trap efficiency for fry sized fish complicated the estimation of abundance ((KHL 2014c). As a result, estimates of abundance represent parr sized fish and larger, which excludes sockeye.

In addition to trap outages and the initial poor efficiency in capturing fry sized fish, another complicating factor hindered the trapping of juvenile fish at the incline plane trap as they migrated out of Grant Creek. Upstream of the incline plane trap, located on the left bank is a distributary that at higher flows becomes watered, and which juvenile fish can migrate downstream bypassing the incline plane trap. This channel begins to overflow at approximately 426 cfs. Because of this distributary, it was necessary to assess the need to block the juvenile migration into two periods; a period of relatively lower flow (≤ 425 cfs) when the distributary was “dry”, and a period of higher flow (≥ 426 cfs), when the distributary was “wet”.

As can be seen in Table E.4-49, ample numbers of marked Chinook, coho, and Dolly Varden were released to provide a season wide estimate of trap efficiency. However, collectively only 12 sockeye were released, with no recoveries. As such, it is not possible to get an abundance estimate for sockeye in Grant Creek. Likewise, only 13 rainbow trout were marked and released, with a single recovery. For rainbow, it is also not possible to estimate Grant Creek abundance.

Table E.4-49. The number of fish released and recovered by species for the two flow blocks and their corresponding trap efficiencies.

Species	Low Flow Condition		High Flow Condition		Trap Efficiency	
	Release	**Recapture**	**Release**	**Recapture**	**Low**	**High**
Chinook	380	45	68	10	0.118	0.147
Coho	169	19	110	13	0.112	0.118
Sockeye	3	0	9	0	0.000	0.000
Dolly Varden	248	2	571	41	0.008	0.072
Rainbow Trout	8	0	5	1	0.000	0.200

To determine whether it was necessary to block the data into the high and low flow periods, a test of homogeneity based on a chi-square test of 1 degree freedom using a 2 x 2 contingency table was performed.

The tests of homogeneity during high and low flow conditions found no difference for Chinook and coho salmon; however, there was a flow effect for Dolly Varden. Therefore, a single estimate of trap efficiency was used to estimate abundance for Chinook and coho (0.123 and 0.115, respectively), whereas two seasonal estimates of trap efficiency were used for Dolly Varden (0.008 during the low flow period, and 0.072 during the high flow period).

The following table presents estimates of abundance for Chinook, coho, and Dolly Varden in Grant Creek, which represents all of Grant Creek upstream of the lower incline plane trap, including Reach 5 (Table E.4-50).

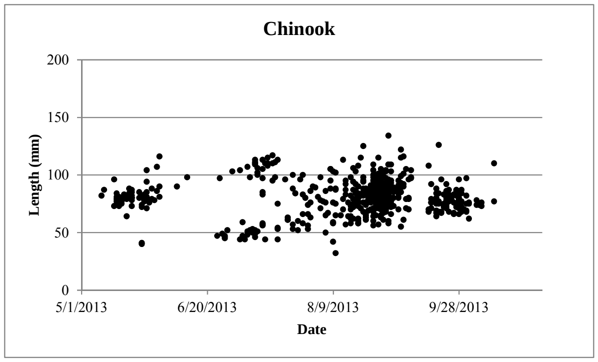
Table E.4-50. The number of juvenile migrants by species captured within the lower incline plane trap, and corresponding abundance estimates and standard errors based on capture efficiencies in Grant Creek.

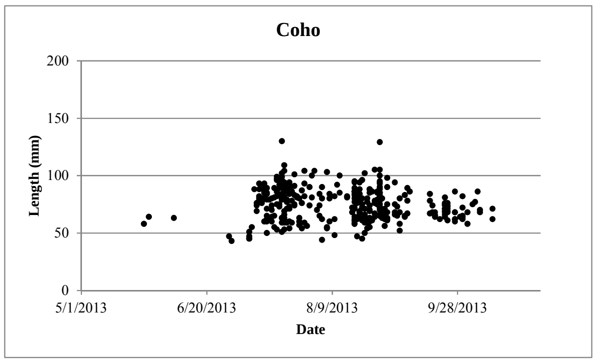
Statistic	Chinook	Coho	Dolly Varden		
			Low Flow	High Flow	Total
Observed n	577	360	296	673	
Est. N	4,797.6	3,164.9	36,766.0	9,665.2	46,431.2
S.E. N	603.2	546.2	25,979.5	1,470.9	26,021.1

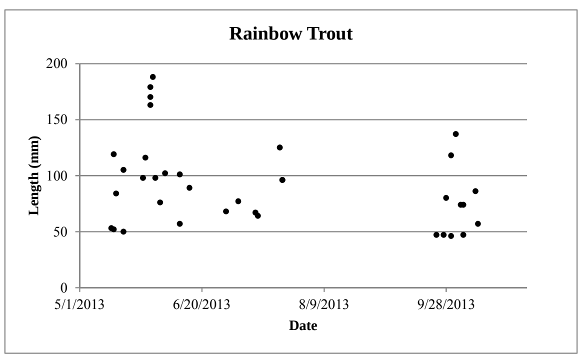
These values should be considered as estimates for parr sized fish only. That is, until the early part of July the incline plane trap was ineffective at catching fry sized fish (≤ 50 mm).

Based on fish size and time of sampling at the lower incline plane trap it is clear that juvenile salmonids of multiple age classes over-wintered in Grant Creek (Figure E.4-37). For juvenile Chinook, most fish were in the 80 mm range beginning about May 15. These fish are yearling Chinook that have overwintered in Grant Creek. This observation is supported by snorkel surveys conducted in April and May where juvenile Chinook (age-1) were commonly observed. Later, from June to the beginning of August, there appears to be two predominant size classes of juvenile Chinook captured in the trap. The larger individuals of the migration were in the 100-110 mm size class and represent yearling fish. The smaller individuals were around 50-80 mm, which would be consistent with sub-yearling fish. Later, in mid-August, there is a broad distribution of size for juvenile Chinook, and indicates a dominant subyearling migration with fewer yearling fish migrating out of Grant Creek.

For coho salmon juveniles, very few individuals were captured in the trap until the latter part of July (Figure E.4-37). The fish that were captured earlier in the migration (end of May), however, were in the 60 mm range, and were likely over-wintering yearling fish. Later (early July through early September), coho juveniles ranged in size of 50-100 mm, and likely represent both sub-yearling and yearling fish. From these data, it appears that there were a few coho that over-wintered in Grant Creek. This observation is supported by few juvenile coho being observed during snorkel surveys in April and May.







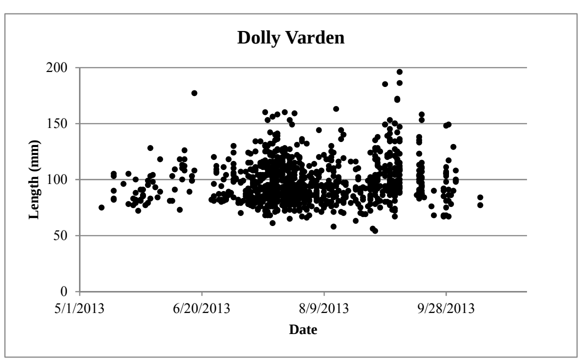


Figure E.4-37. The distribution of size by date for Chinook, coho, rainbow trout, and Dolly Varden captured in the lower incline plane trap, Grant Creek, Alaska 2013.

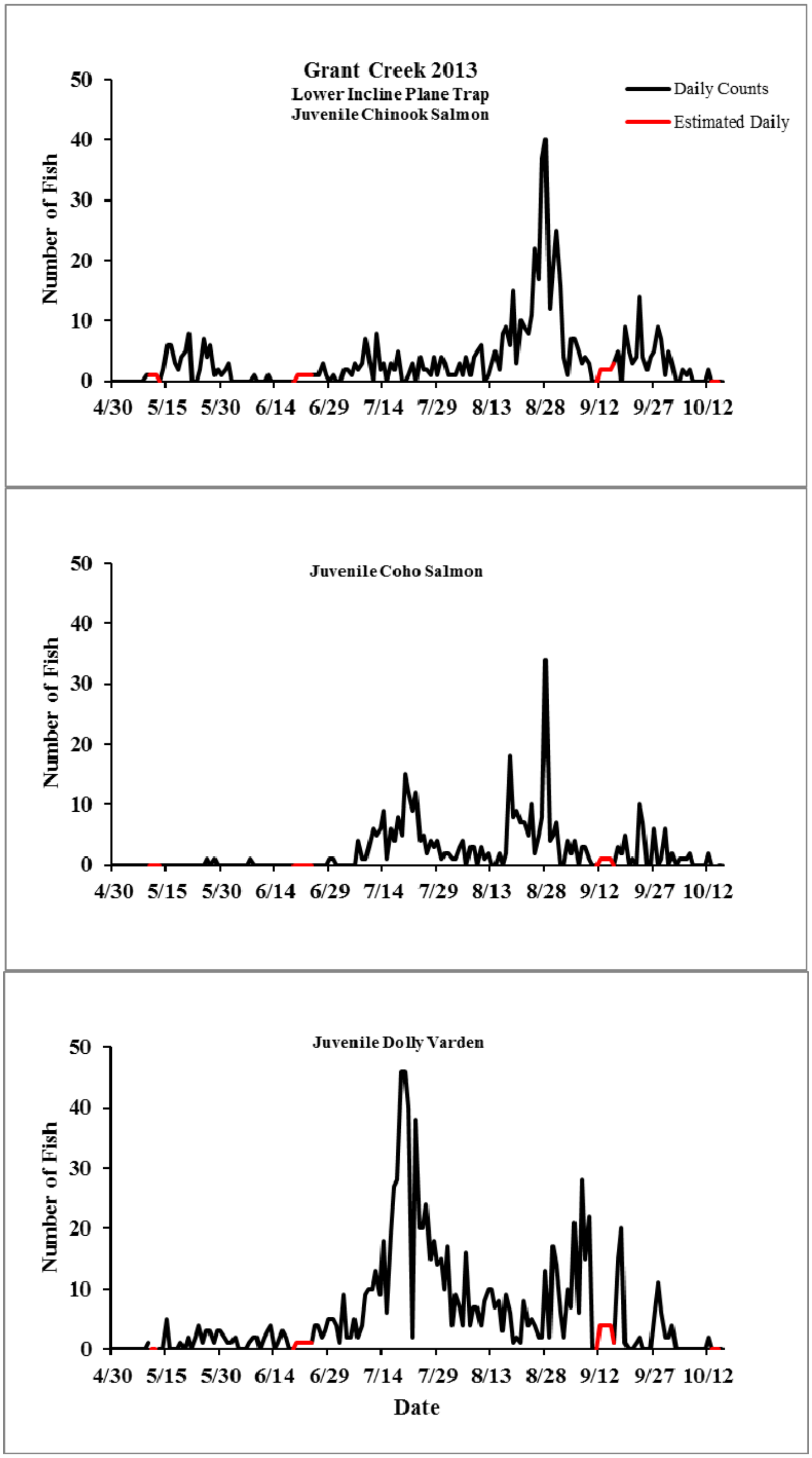


Figure E.4-38. Emigration timing for Chinook, coho, and Dolly Varden juveniles at the Lower Incline Plane Trap in Grant Creek, Alaska, 2013. Estimated or extrapolated values are highlighted red.

Trail Lake Narrows Fish and Aquatic Habitats

The Trail Lake Narrows was sampled in July to assess species diversity and relative abundance. Minnow trapping, beach seining and angling were employed to describe baseline conditions in an area of potential impact associated with the installation and use of an access road into the Project area (Figure E.4-39). Minnow traps were set in 13 locations with a total fishing effort of 1,133 hours capturing 381 fish (Table E.4-51).

Table E.4-51. Number of minnow traps, total effort, number of fish captured and CPUE in the Trail Lake Narrows in July 2013.

Lower Grant Creek Minnow Trapping					
Reach	**Number of Traps**	**Total Effort (days)**	**Total Effort (hrs.)**	**Number of Fish**	**CPUE (fish/hr)**
Trail Lake Narrow	52	47.2	1,133	381	0.34

Juvenile Chinook and three-spine sticklebacks were the most numerous fish captured in minnow traps followed by coho, Dolly Varden, sculpins sp., rainbow trout and sockeye (Table E.4-52). CPUE for Chinook and coho was lower in the Trail Lake Narrows than Reaches 1-4 of Grant Creek but greater than Reach 5 of Grant Creek. CPUE for Dolly Varden and rainbow trout in the Trail Lake Narrows was less than all reaches of Grant Creek. Juvenile Chinook captured in minnow traps in July varied in size from 45-121 mm FL indicating that both age-0 and age-1 fish were present. Coho varied in size from 45-97 mm FL. The size range for coho also suggests that age-0 and age-1 fish resided in the Trail Lake Narrows. Rainbow trout varied in size from 63-71 mm FL. Dolly Varden varied in size from 57-184 mm FL, which likely represents several age classes.

Table E.4-52. Number, proportion and CPUE of fish caught in the Trail Lake Narrows with minnow traps in July 2013.

Lower Grant Creek Minnow Trapping			
Species	**Number**	**Proportion**	**CPUE (fish/hr)**
Chinook	108	0.283	0.095
Dolly Varden	52	0.136	0.046
Coho	62	0.163	0.055
Rainbow Trout	4	0.010	0.004
Sockeye	1	0.003	0.001
Sculpin sp.	38	0.100	0.034
Three-spine Stickleback	116	0.304	0.102
Grand Total	**381**	**1.000**	**0.336**

REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 25 50 100 Feet

N

McMILLEN, LLC
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OFFICE: 208.342.4214 FAX: 208.342.4216

Developed For: Homer Electric Association, Inc. A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.4-39
Location of Minnow Trans and Angling Stations in the Trail Lake Narrows, 2013

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED M. Miller
ISSUED DATE 3/3/2015

DRAWING

SCALE: 1:900

Beach seining was employed at night in three locations where lower velocities and small substrates were conducive to this sampling method. Juvenile Chinook were the most abundant fish captured in beach seines followed by round whitefish and sculpins (Table E.4-53). Other species made up less than five percent of the catch and no coho were captured using beach seining.

Table E.4-53. Number and proportion of catch for fish seined in beach areas of the Trail Lake Narrows in July 2013.

Species	Abundance	Proportion
Chinook	100	0.58
Dolly Varden	2	0.01
Rainbow Trout	2	0.01
Sculpin sp.	27	0.16
Sockeye	4	0.02
Three-spine Stickleback	5	0.03
Round Whitefish	33	0.19
Total	**173**	**1.00**

Seven angling stations were used to capture fish within the Trail Lake Narrows area (Table E.4-54). There was a total of 13 adult trout/char that were hooked, with five of those fish being captured (effort=1 hr/station) for a CPUE of 0.7 fish/hr; for those fish, they were measured for length and weight before release.

Adult salmon, rainbow trout and Dolly Varden occur in the Trail Lakes Narrows area, which is also an upstream migration corridor for fish destined to spawn in Grant Creek and all other tributaries of upper Trail Lake. Likewise, this area is also a downstream migration corridor for salmonid production upstream. Dolly Varden and rainbow trout probably reside in the area taking advantage of juvenile salmon that migrate through or reside in this area. Juvenile Chinook were the most numerous fish captured with minnow traps and beach seines.

Spawning may also occur in this area; depressions (redds) were observed in suitable spawning gravels and sockeye carcasses were recovered in the area that had not been previously sampled. The redds could only be observed after water levels had resided in October.

Table E.4-54. Angling station and number and size and weight of rainbow trout and Dolly Varden observed in July 2013.

Station	Species	Length (mm FL)	Weight (g)
1	Rainbow Trout	343	424.2
	Rainbow Trout	299	241.8
	Dolly Varden	180	NA
	Dolly Varden	160	NA
	Salmonid	NA	NA
2	Dolly Varden	240	NA
	Rainbow Trout	301	294.0
	Salmonid	NA	NA
3	Salmonid	NA	NA
	Salmonid	NA	NA
4	Dolly Varden	268	191.0
5	No Fish	-	-
6	Rainbow Trout	381	523.8
	Rainbow Trout	220	NA
7	No Fish	-	-

4.6.1.2. Instream Flow

Information relating to aquatic resources has been collected during previous investigations into the potential development of hydroelectric generation on Grant Lake as well as during pre-licensing studies conducted by KHL in 2009 and early 2010.

Previous licensing efforts in the 1960s and 1980s for a proposed hydroelectric project at Grant Lake included studies of fish resources in Grant Lake and Grant Creek. Arctic Environmental Information and Data Center (AEIDC 1983) conducted fish sampling from 1981 to 1982 as part of a comprehensive environmental baseline study effort, and the USFWS (1961) conducted limited sampling from 1959 to 1960. An Instream Flow Study was completed in 1987 as part of a preliminary FERC License Application prepared by Kenai Hydro, Inc. (KHI; not related to the current Kenai Hydro, LLC; Envirosphere 1987, KHI 1987a, and KHI 1987b).

This effort included reports and written communications between KHI and state and federal agencies in 1986 and 1987 relative to a FERC LA for the proposed Grant Lake Hydroelectric Project (FERC No. 7633-002). Included were draft and final reports of a limited but complete Instream Flow Incremental Methodology (IFIM) investigation and negotiated minimum instream flows and ramping rates (Envirosphere 1987; KHI 1987a; and KHI 1987b).

The collaborative process for a study of "instream flow" effects in Grant Creek was initiated in 2009 (KHL 2010a). This effort also included preliminary habitat mapping of Grant Creek. The primary goal of the 2009 Instream Flow Study program was to establish a Technical Working Group (TWG) consisting of state and federal resource agency staff, KHL staff, and interested members of the local community. Once established, the TWG met three times during the 2009 study season to review the results of the 2009 aquatic baseline study efforts, discuss and agree upon an acceptable instream flow evaluation method, and request additional information to support that selection (KHL 2010a). A technical memorandum was drafted and shared with the Instream Flow TWG participants in 2009 detailing the results of the previous Instream Flow Study efforts (KHL 2009a).

The approach of this study involved three primary phases. During the first phase, the team spatially-synthesized existing aquatic habitat and fish use data generated during various field efforts throughout the 2009 and 2010 field seasons. This exercise was completed primarily to identify spatial data gaps. In the second phase, the team then ground-truthed habitat data in the field, collected additional habitat and fish use data in Reaches 1 through 5, and incorporated other suitable habitat and fish use data collected in 2010 (e.g., Instream Flow Study). Finally, the team analyzed the suite of habitats and fish use data to identify important factors affecting distribution of fish. The primary tasks associated with this approach were as follows:

- Preparation of an office-based aquatic habitat map (i.e., based on habitat observations assembled throughout the 2009 and 2010 field seasons).
- Field surveys to ground-truth the office-based mapping effort and fill spatial data gaps relative to aquatic habitat and fish use in Reaches 1 through 4. Actual collection of fish habitat use information was accomplished by the resident and rearing fish tasks discussed in the Fisheries Report and the instream flow task.
- Incorporated aquatic habitat fish use data that identified key rearing, spawning, and feeding habitats for salmon and resident fish and potential overwintering habitats.
- Analyzed and identified the factors that may influence fish use of the key habitats over those habitat units not occupied by fish in Grant Creek.

The office-based mapping exercise incorporated existing habitat data overlain by fish use data into a spatial format, using ArcMap© GIS software. The initial dataset included habitat units mapped during a microhabitat fish use reconnaissance study completed in June 2009[4]. The team plotted locations of salmon spawning activity recorded during 2009 foot surveys and high-use spawning areas identified by historical data (Ebasco 1984). The teams used the preliminary spatial fish habitat information to catalog and identify gaps in coverage.

The team conducted surveys to ground-truth the preliminary aquatic habitat delineation (i.e., generated through the office-based exercise), redraw mapping boundaries where appropriate, and confirm the location of habitat areas that are in need of additional study. The team delineated aquatic habitats at the mesohabitat level and subcategory scale, consistent with the approach developed for the approved 2009 habitat reconnaissance study.

The team identified key fish habitats in Grant Creek, based on observed fish use. This was accomplished by analyzing the microhabitat fish use data collected in support of the habitat mapping study, data collected in support of the Instream Flow Study, and data collected in 2009

[4]The 2009 fish microhabitat use reconnaissance study was initiated to gain insight into the types of habitats that fish occupy in Grant Creek. The team identified discrete microhabitat types and sampled for fish presence at 16 sites in Grant Creek.

during the reconnaissance study (KHL 2010a). These data were incorporated into the spatial dataset. Other fish use habitat datasets (e.g., foot surveys, telemetry surveys, electrofishing) were considered when developing key habitat designations. Surface areas of habitat types were calculated as needed using the capability of the Geographic Information System (GIS) software.

Mesohabitat types were identified and mapped in 2009/2010. The following definitions are provided for these habitat types (Overton et al. 1997, unless otherwise noted):

- Backwater: Pool formed by an eddy along a channel margin downstream from obstructions such as bars, rootwads, or boulders, or resulting from back-flooding upstream from an obstructional blockage. Also, a body of water, the stage of which is controlled by some feature of the channel downstream from the backwater, or in coves or covering low-lying areas and having access to the main body of water.
- Cover: Suspended material covering the land or water; measured as a percentage of the surface area when looking from above.
    - Fish: Anything that provides protection from predators or improves adverse conditions of stream flow or seasonal changes in metabolic costs. This may be overhead cover or submerged cover and it may be used for escape, feeding, hiding, or resting.
    - Overhead: Whitewater, surface turbulence, bank vegetation, tree branches, floating logs, or other debris touching or within 0.3 meters of the water surface.
    - Submerged: Large woody debris, other organic debris, ledges, or aquatic vegetation below the water surface.
- Fast water: Habitat types consist of turbulent (cascade, step run, high gradient riffle, and low gradient riffle) and non-turbulent (runs and glides).
- LWD: Large pieces of relatively stable woody material located within the bankfull channel and appearing to influence bankfull flows. These are categorized as singles, aggregates, or root wads.
    - Aggregate: Two or more clumped pieces, each of which qualifies as a single piece.
    - Rootwad: Root mass or boles attached to a log less than 3 meters in length.
- Pocket: Small bed depressions, often less than 30 percent of wetted width, formed around channel obstructions (boulders, logs, irregular bank, jutting peninsulas, and so forth) within fast water habitat types.
- Pool: A habitat type formed by either scour that has carved out a depression in the channel, or a location where the channel has been dammed. Surface velocities may be slow to fast, but subsurface velocities tend to be slow. Pools are characterized by a head crest (upstream break in slope) and a tail crest (downstream break in slope). Types of pools include the following:
    - Dammed: Pool formed by downstream damming action. Dam pools can be located in the main channel (or side channel) or backwaters.
    - Scour: Pool formed by scour action when flowing water impinges against and is diverted by a streambank or channel obstruction (rootwad, woody debris, boulder, bedrock, and so forth). Scour pools may be lateral scour, mid-scour, plunge, or underscour pools.

  - Lateral scour: A pool formed by the scouring action of the flow as it is directed laterally or obliquely to one side of the stream by a partial channel obstruction, such as a gravel bar or wing deflector, or by a shift in channel direction.
  - Mid-channel scour: A pool formed by the scouring action of the flow as it is directed toward the middle of the channel by a partial channel obstruction.
  - Plunge: A pool formed by scouring action from vertically falling water.
  - Underscour: A pool formed by scouring under an obstruction, such as a log. Sometimes called an upsurge pool.
- Riffle: Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.
- Side channel: A lateral channel with an axis of flow roughly parallel to the mainstem and which is fed by water from the mainstem; a braid of a river with flow appreciably lower than in the main channel.
- Slow water: Habitat types consist of dammed (main and backwater) and scour (lateral, mid-channel, plunge, and underscour).
- Stream margin: edge of the wetted perimeter.
- Undercut bank: A bank that has its base cut away at least 5 centimeters (cm) by the water or has been artificially made and overhangs directly above the water surface.

Grant Creek consists of six reaches; however, the focus of the mapping was on Reaches 1 – 5, located below the upstream migrational barrier (Figure E.4-14). GIS maps of aquatic habitats in Grant Creek are found in Figures E.4-40 and E.4-41. There are two series of maps: the first series (Figure E.4-40) shows mesohabitats found in Reaches 1 – 5 (pools, glides, etc.); the second series (Figure E.4-41) shows aquatic habitats (undercut banks, overhead cover, etc.) in the same reaches.

Table E.4-55 summarizes mesohabitats found in Grant Creek. Riffle habitats were predominant, accounting for 50 percent of all habitats. This was consistent throughout all reaches, with the exception of the secondary channel in Reach 3. Riffle habitats were followed by pools (19.3 percent) and cascades (15.3 percent). All of the cascades were found in the canyon (Reach 5).

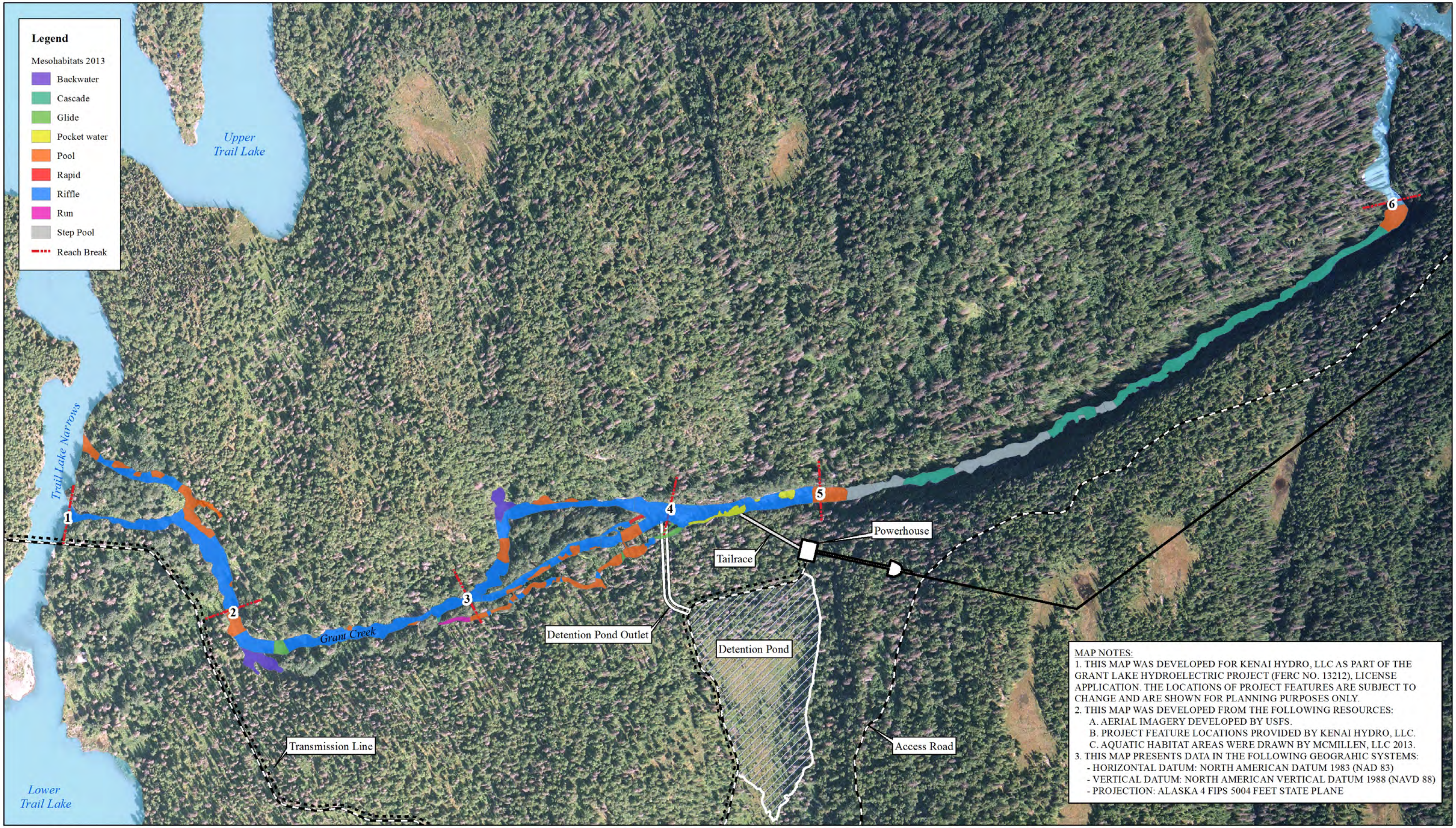
Table E.4-56 shows habitat types (stream margin, overhead vegetation, undercut banks, and LWD) found in Grant Creek. LWD was sparse in the mainstem of Grant Creek. High flows in Grant Creek move LWD downstream and eventually into the Trail Lakes. In the side channels and distributaries, where flows and velocities are much less than in the main channel, LWD is relatively abundant.

Table E.4-55. Mesohabitats found in Grant Creek.

Habitat Type	Total Area (Sq. Ft)	Reach 1 Distributary	Reach 1 Mainstem	Reach 2 Backwater Habitat	Reach 2 Mainstem	Reach 2 Secondary Channel	Reach 3 Backwater Habitat	Reach 3 Mainstem	Reach 3 Primary Side Channel	Reach 3 Secondary Channel	Reach 4 Mainstem	Reach 5 Mainstem
Backwater	8,534	0	0	4,837	0	0	3,697	0	0	0	0	0
Cascade	33,707	0	0	0	0	114	0	0	0	0	0	33,593
Glide	3,202	0	0	0	1,613	0	0	0	0	1,588	0	0
Pocket water	3,709	0	0	0	0	0	0	0	0	0	3,709	0
Pool	42,568	7,495	3,143	0	3,834	398	0	3,997	5,018	9,510	1,195	7,977
Rapid	511	0	0	0	0	0	0	0	511	0	0	0
Riffle	110,429	6,004	23,168	0	23,669	1,189	0	25,585	11,672	1,493	17,649	0
Run	576	0	0	0	0	0	0	0	0	576	0	0
Step Pool	16,858	0	0	0	0	0	0	0	0	0	0	16,858

Table E.4-56. Aquatic habitats found in Grant Creek.

Habitat Type	Total Area (Sq. Ft)	Reach 1 Distributary	Reach 1 Mainstem	Reach 2 Backwater Habitat	Reach 2 Mainstem	Reach 2 Secondary Channel	Reach 3 Backwater Habitat	Reach 3 Mainstem	Reach 3 Primary Side Channel	Reach 3 Secondary Channel	Reach 4 Mainstem	Reach 5 Mainstem
Margin	7,214	0	3,343	0	3,871	0	0	0	0	0	0	0
Overhead Vegetation	10,096	302	0	0	0	0	0	0	,2455	7,339	0	0
Undercut Bank	12,187	1,513	3,372	0	2,193	0	0	278	110	1,214	3,216	0
Large Woody Debris (LWD)	17,750	3,556	1,894	0	182	0	0	1,142	1,611	6,218	3,040	0



REV DATE BY DESCRIPTION

N

Drawing Scale:
0 150 300 600 Feet

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Figure E.4-40
Grant Creek Mesohabitats
Reaches 1 - 5

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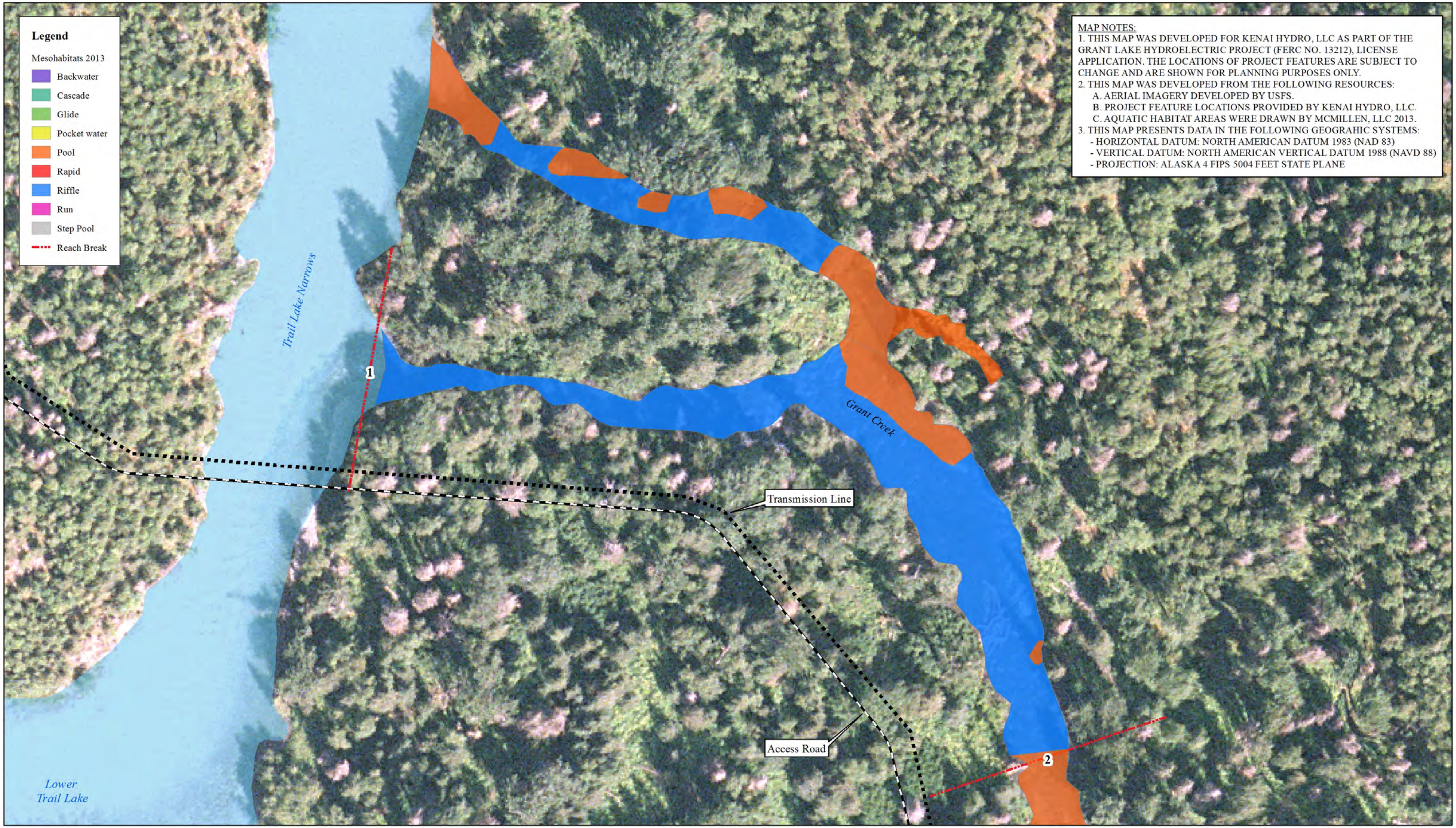
SCALE: 1:3,300

DRAWING
1 of 6



REV	DATE	BY	DESCRIPTION

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Figure E.4-40
Grant Creek Mesohabitats
Reach 1

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2 of 6
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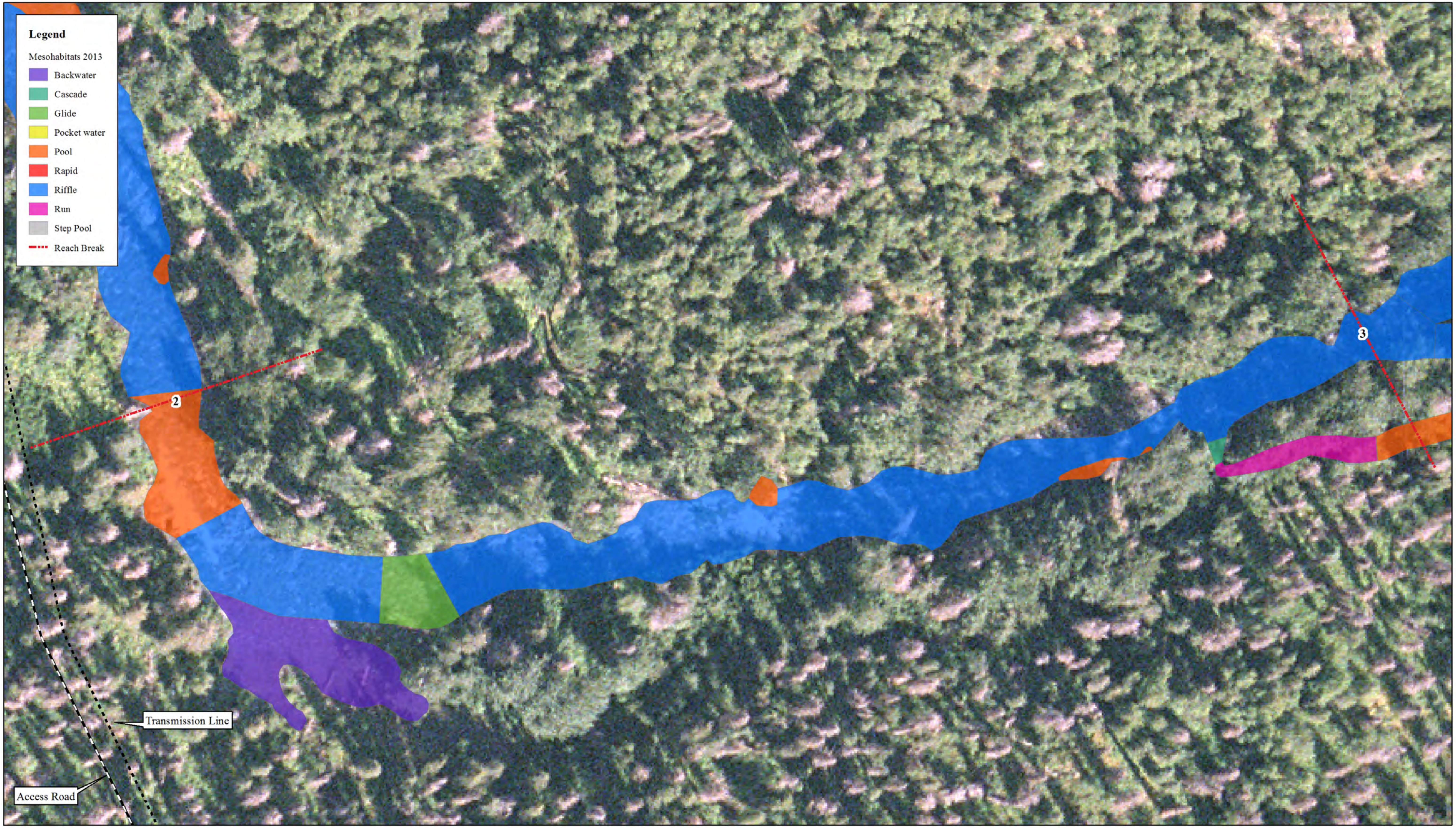

REV	DATE	BY	DESCRIPTION

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Figure 4.40
Grant Creek Mesohabitats
Reach 2

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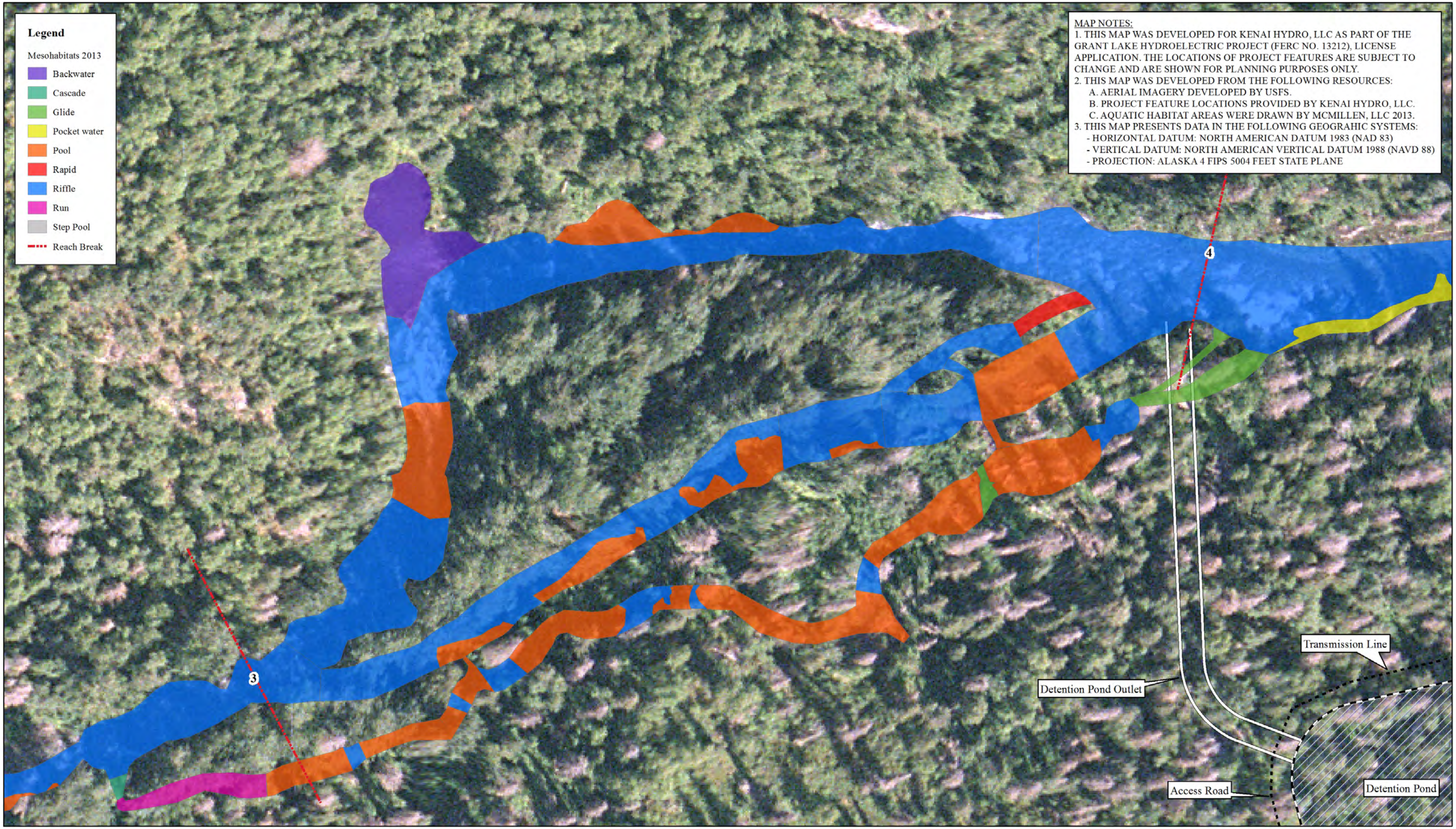
DRAWING
3 of 6

SCALE: 1:650



REV	DATE	BY	DESCRIPTION

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Drawing Scale: 0 20 40 80 120 Feet

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Figure E.4-40
Grant Creek Mesohabitats
Reach 3

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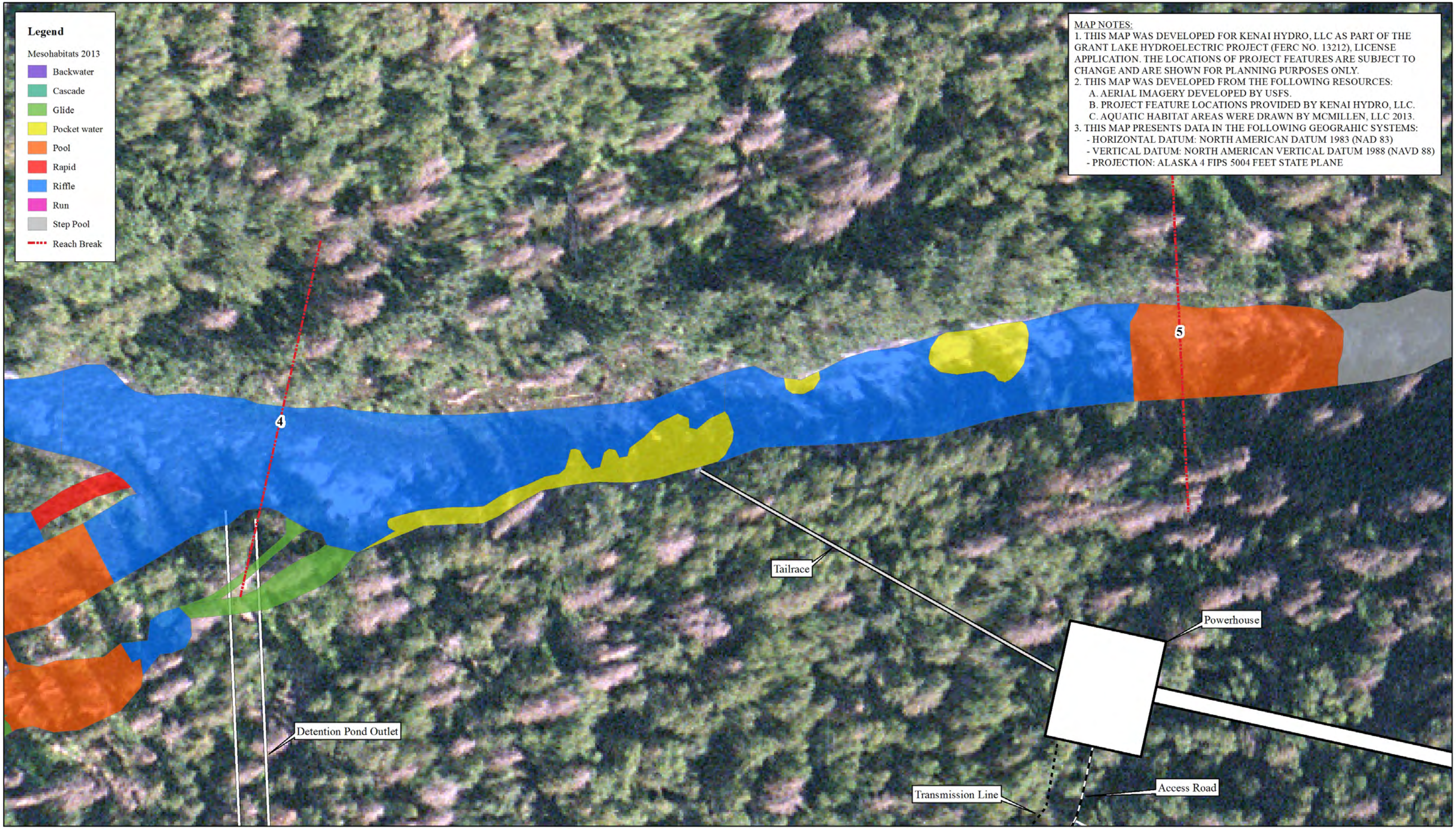
DRAWING: 4 of 6

SCALE: 1:700



REV	DATE	BY	DESCRIPTION

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Figure E.4-40
Grant Creek Mesohabitats
Reach 4

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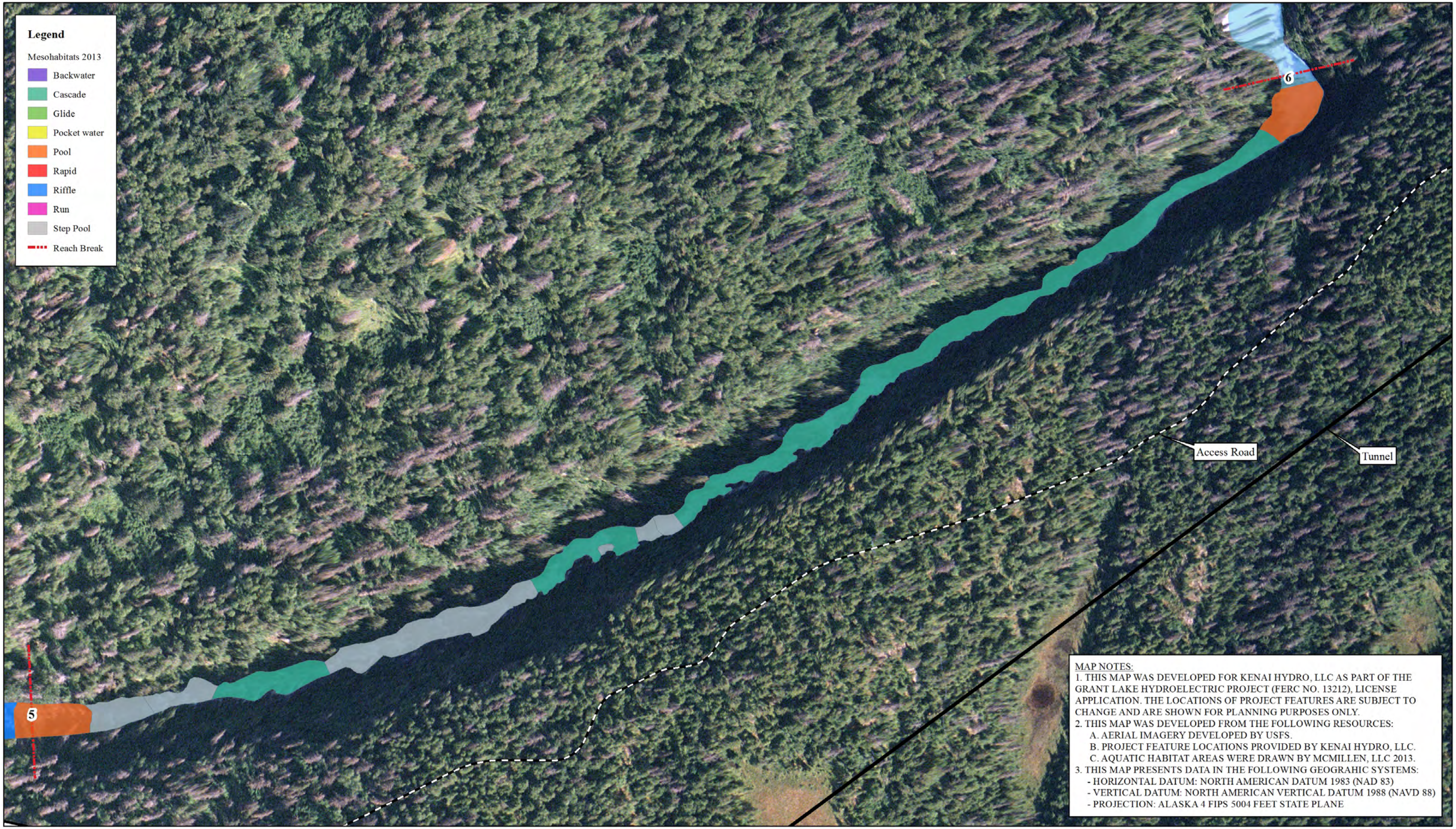
DRAWING
5 of 6

SCALE: 1:550



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATIONS OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
   C. AQUATIC HABITAT AREAS WERE DRAWN BY MCMILLEN, LLC 2013.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAPHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

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FigureE.4-40
Grant Creek Mesohabitats
Reach 5

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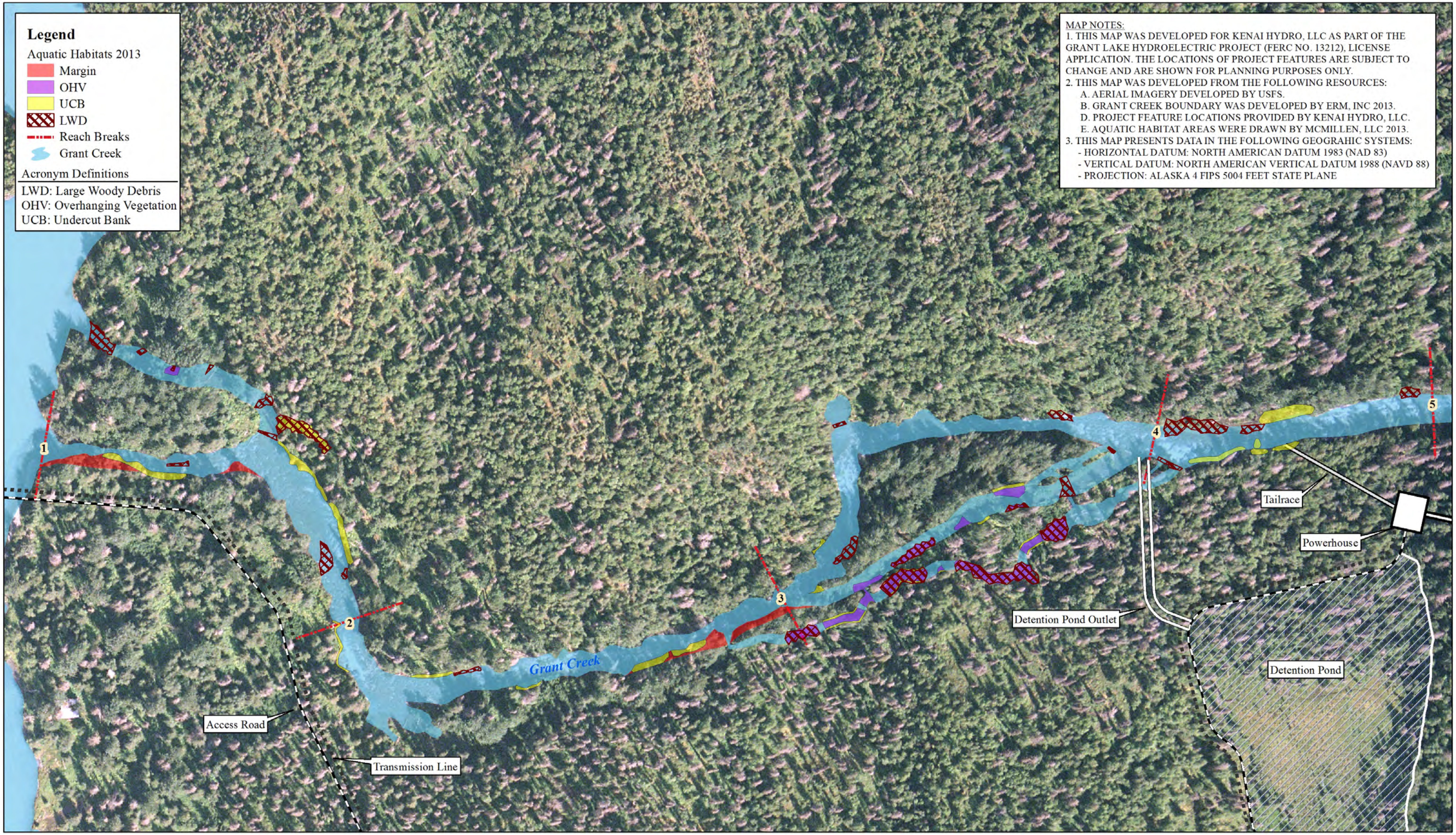
6 of 6

SCALE: 1:1,500



REV	DATE	BY	DESCRIPTION

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Drawing Scale: 0 75 150 300 Feet

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Figure E.4-41
Aquatic Habitats

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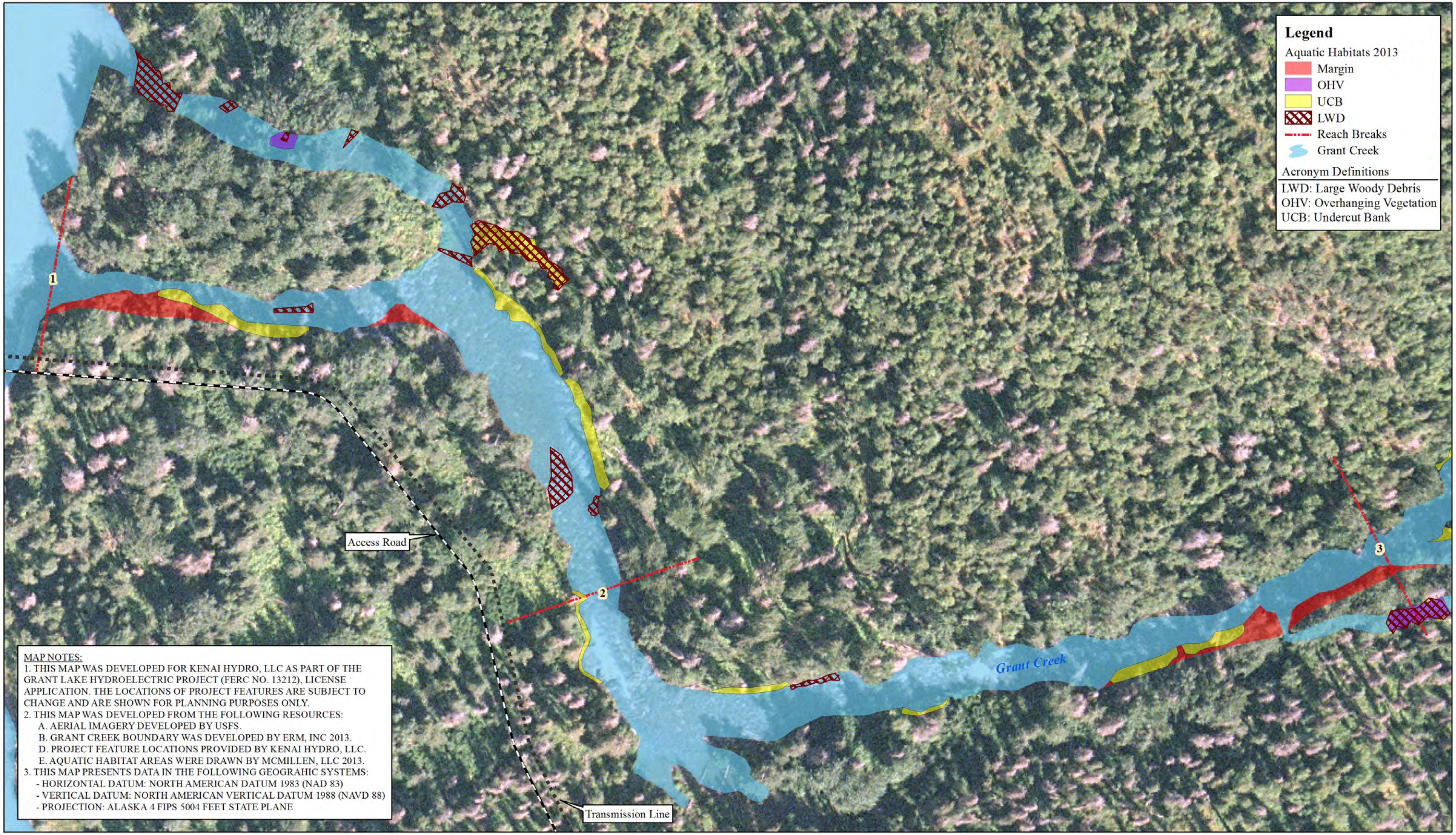
DRAWING 1 of 3

SCALE: 1:1,800



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), LICENSE APPLICATION. THE LOCATIONS OF PROJECT FEATURES ARE SUBJECT TO CHANGE AND ARE SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
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   B. GRANT CREEK BOUNDARY WAS DEVELOPED BY ERM, INC 2013.
   D. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
   E. AQUATIC HABITAT AREAS WERE DRAWN BY MCMILLEN, LLC 2013.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV. DATE BY DESCRIPTION

N

Drawing Scale:
0 25 50 100 150 Feet

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Figure E.4-41
Aquatic Habitats
Grant Creek: Reaches 1 & 2

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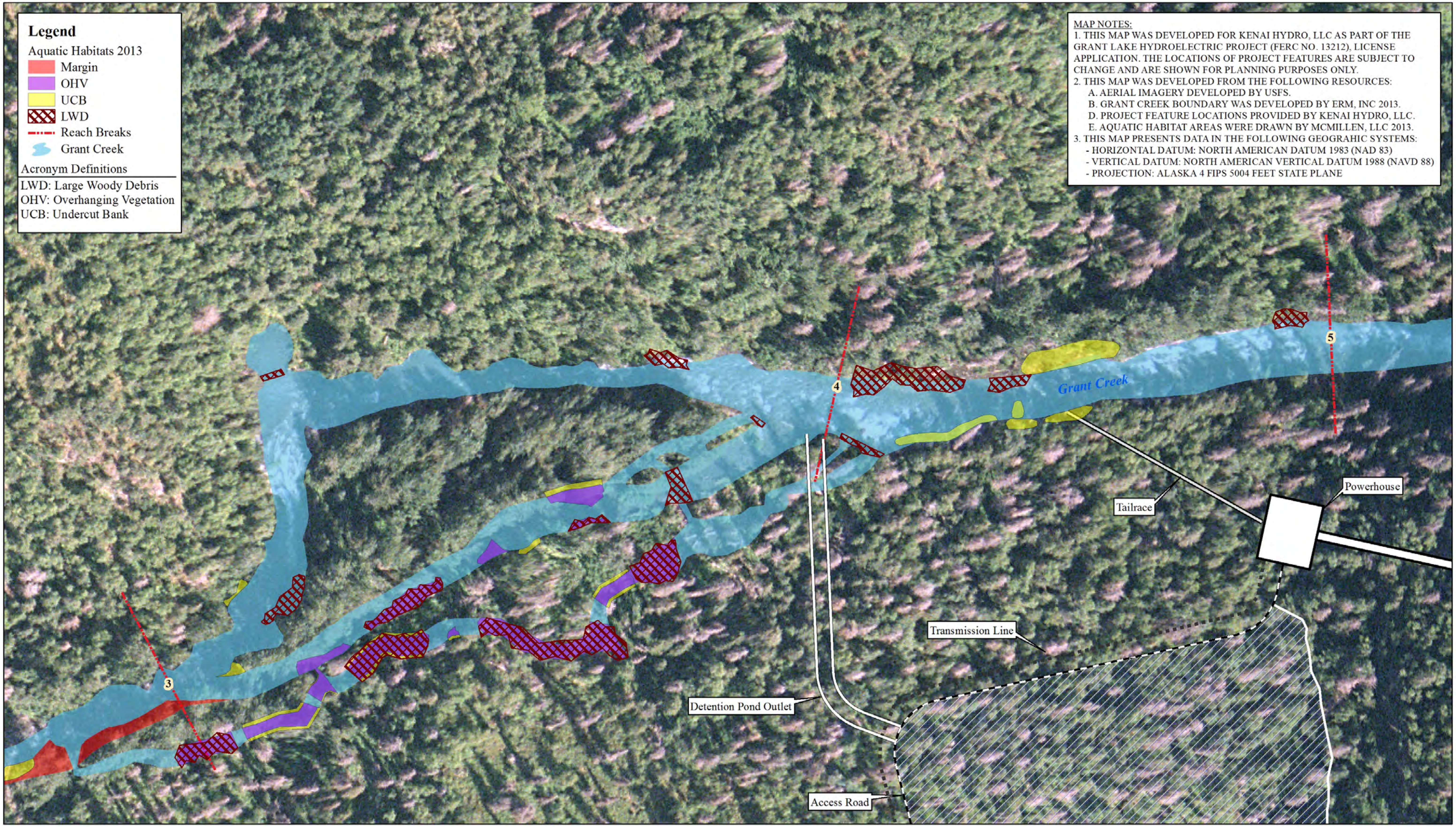
SCALE 1:1,000



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

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Figure E.4-41
Aquatic Habitats
Grant Creek: Reaches 3 & 4

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CHECKED: J. Blum
ISSUED DATE: 3/11/2015

DRAWING: 3 of 3

SCALE: 1:1,000

4.6.1.3. Benthic Macroinvertebrates and Periphyton

Aquatic macroinvertebrates and periphyton are vital elements of the food web that supports area fisheries. They represent the primary levels of productivity in the aquatic ecosystem and can be used as indicators of aquatic habitat condition (Barbour et al. 1999; Merritt and Cummins 1996). Acquiring information on the baseline characteristics of macroinvertebrate and periphyton populations provides tools for tracking aquatic habitat quality.

4.6.1.3.1 Macroinvertebrates

Initial macroinvertebrate studies in Grant Creek, were conducted in 1981 and 1982 using Surber samplers (Ebasco 1984). These methods were continued, with the addition of samples collected using the Alaska Stream Condition Index (ASCI) protocols, as a part of the licensing process in 2009 (KHL 2010a). After review of the 2009 macroinvertebrate study results, stakeholders decided to eliminate the ASCI methods from the 2013 study program as fewer taxa were collected using the ASCI method compared to the Surber sampler methods (KHL 2014e).

In 2009 and 2013, two sites were sampled within Grant Creek, GC100 and GC300 (Figure E.4-5). Taxonomic data was used to calculate several descriptive population metrics:

- Population density as numbers/m^2
- Taxa richness
  - Overall taxa richness
  - Ephemeroptera taxa richness
  - Trichoptera taxa richness
  - Plecoptera taxa richness
- Taxonomic composition as a percent of total number identified in sample
  - Percent Ephemeroptera
  - Percent Trichoptera
  - Percent Plecoptera
  - Percent Ephemeroptera/Plecoptera/Trichoptera (EPT)
  - Percent Chironomidae
  - Percent dominant taxon
- Population trophic characteristics
  - Percent filterers
  - Percent gatherers
  - Percent predators
  - Percent scrapers
  - Percent shredders
  - Filterer richness
  - Gatherer richness
  - Predator richness
  - Scraper richness
  - Shredder richness
- Hilsenhoff Biotic Index (HBI) scores
- ASCI habitat assessment scores

A combined total of 35 macroinvertebrate taxa were identified in samples collected at sites GC100 and GC300 in 2009 and 2013. They are listed in Table E.4-57.

The numbers of taxa and of individual organisms within each taxa were used to calculate a series of metrics that describe the macroinvertebrate populations at each site. Table E.4-58 lists metrics describing the macroinvertebrate populations with regard to the density (number of organisms per square meter) and the variety (richness) of the taxa assemblage.

With the exception of samples collected in 2009 at GC300, results appear fairly consistent between sites and years. This result was validated by studies conducted in the early 1980's that found no seasonal variation in macroinvertebrate abundance in Grant Creek (Ebasco 1984). At GC300 in 2009 density (2,204 organisms/m^2 compared to 19,282-12,034 organisms/m^2), taxa richness (15 taxa compared to 19-21 taxa), Ephemeroptera taxa richness (4 taxa compared to 6 taxa), and EPT taxa richness (10 taxa compared to 12 taxa) were lower than other samples.

Table E.4-59 lists percent composition metrics. Again results from samples collected at GC300 in 2009 vary noticeably from the other samples. The results reflect the fact that samples collected at GC300 in 2009 contained fewer Chironomidae (41 percent of organisms compared to 83-88 percent of organisms). Therefore, the percent of the macroinvertebrate population represented by EPT taxa was greater at GC300 in 2009 than at GC100 in 2009 or at GC100 and GC300 in 2013.

The data in Table E.4-60, functional feeding group metrics, also illustrates the overall similarity in the macroinvertebrate populations between sites and years, with the exception of GC300 in 2009. Chironomidae generally fall under the category of "gatherers" and the numbers are lower at GC300 in 2009 than in the other samples (56 percent gatherers compared to 88-91 percent gatherers). Conversely, the number of organisms within functional feeding groups comprised largely of EPT taxa are higher than other samples. For example, predators comprised 8 percent at GC300 in 2009 compared to 3-4 percent in other samples and scrapers comprised 17 percent compared to 1-3 percent.

Table E.4-57. List of macroinvertebrate taxa collected at Grant Creek sampling sites GC100 and GC300, 2009 and 2013.

Order	Family	Genus
Ephemeroptera	Ameletidae	Ameletus
	Baetidae	Unidentified
		Acentrella
		Baetis
	Ephemerellidae	Drunella
		Ephemerella
	Heptegeniidae	Cinygmula
		Epeorus
Plecoptera		Unidentified
	Chloroperlidae	Unidentified
		Haploperla
		Neaviperla
		Plumiperla
		Suwallia
		Triznaka
	Nemouridae	Zapada
	Perlodidae	Unidentified
		Isoperla
	Taeniopterygidae	Unidentified
Trichoptera	Apataniidae	Moselyana
	Brachycentridae	Brachycentrus
		Micrasema
	Glossosomatidae	Glossosoma
	Hydropsychidae	Arctopsyche
	Limnephilidae	Ecclisomyia
	Rhyacophilidae	Rhyacophila
Diptera		Unidentified
	Chironomidae	Unidentified
	Empididae	Chelifera
		Clinocera
	Simuliidae	Simullium
Bivalvia (Class)	Sphaeriidae	Unidentified
Gastropoda (class)	Gastopoda Unid.	Unidentified
	Lymnaeidae	Lymnaea
	Planorbidae	Unidentified
	Valvatidae	Unidentified
Crustacea (Phylum)	Ostracoda (Class)	Unidentified
Arachnoidea (Class)	Hydracarina (Sub-Order)	Unidentified
Oligochaeta (Class)	Unidentified	Unidentified
Nemotoda (Phylum)	Unidentified	Unidentified
Platyhelminthes (Phylum)	Turbellaria (Class)	Unidentified

Table E.4-58. Grant Creek macroinvertebrate population density and taxa richness metrics, 2009 and 2013. [1,2]

Sample Site	Date	Sample Type	Density (no. / m^2)	Taxa Richness	Ephemeroptera Taxa Richness	Plecoptera Taxa Richness	Trichoptera Taxa Richness	EPT Taxa Richness
GC100	08/06/09	Surber[1]	12034 (4697)	19 (0.8)	6 (0.75)	3 (0.80)	3 (0.40)	12 (0.5)
GC100	08/14/13	Surber	19282 (7877)	20 (1.5)	6 (0.00)	3 (0.49)	2 (1.02)	12 (0.8)
GC300	08/06/09	Surber	2204 (1764)	15 (3.1)	4 (1.36)	3 (1.33)	3 (1.60)	10 (3.4)
GC300	08/14/13	Surber	12835 (3275)	21 (2.3)	6 (0.49)	3 (1.02)	3 (0.89)	12 (1.7)
GC100	08/06/09	ASCI[2]	2740	10	4	2	1	7
GC300	08/06/09	ASCI	530	12	1	2	1	4

Notes:

1. Data reported are averages (followed by + or - standard deviation in parentheses) of five replicate Surber samples.
2. Data reported are totals for composited samples.

Table E.4-59. Grant Creek macroinvertebrate population composition by percent metrics, 2009 and 2013.[1]

Sample Site	Date	Sample Type	% Ephemeroptera	% Plecoptera	% Trichoptera	% EPT	% Chironomidae	% Dominant Taxa
GC100	08/06/09	Surber	3.9 (2.2)	2.6 (2.1)	1.3 (0.7)	7.7 (4.8)	84.7 (7.7)	84.7 (7.7)
GC100	08/14/13	Surber	2.6 (0.9)	1.4 (0.6)	0.4 (0.1)	4.4 (1.4)	88.5 (3.9)	88.5 (3.9)
GC300	08/06/09	Surber	18.0 (4.4)	8.9 (3.3)	4.6 (3.9)	31.5 (5.7)	41.0 (18.6)	48.4 (13.2)
GC300	08/14/13	Surber	6.4 (2.4)	1.8 (0.7)	0.5 (0.2)	8.7 (2.6)	83.3 (4.8)	82.3 (5.5)
GC100	08/06/09	ASCI	1.4	0.5	0.2	2.1	13.1	82.9
GC300	08/06/09	ASCI	1.3	1.6	0.7	3.6	7.5	77.8

Notes:

1. Averages, followed by + or - standard deviation in parentheses, are of five replicate Surber samples

Table E.4-60. Grant Creek macroinvertebrate functional feeding group metrics based on entire sample from each site, 2009 and 2013.

Sample Site	Date	Sample Type	% Filterers	% Gatherers	% Predators	% Scrapers	% Shredders	Filterer Richness	Gatherer Richness	Predator Richness	Scraper Richness	Shredder Richness
GC100	08/06/09	Surber	5	89	3	2	2	4	10	7	6	1
GC100	08/14/13	Surber	5	91	3	1	1	3	8	6	5	1
GC300	08/06/09	Surber	15	56	8	17	3	4	7	10	5	2
GC300	08/14/13	Surber	5	88	4	3	1	3	6	5	4	0
GC100	08/06/09	ASCI	83	14	2	1	0	1	3	4	3	1
GC300	08/06/09	ASCI	79	10	8	2	0	3	4	3	1	0

Biotic indices were developed to describe the quality of aquatic habitat based on the tolerance to disturbance of the organisms present. Each taxon is given a tolerance rating between 0 and 10, with 0 being the least tolerant. The HBI scores in Table E.4-61 continue the pattern of variance between data collected at GC300 in 2009 and the other samples. The HBI value for GC300 in 2009 was 4.71 compared to 5.60-5.81 for the other samples.

Table E.4-61. Grant Creek macroinvertebrate biotic indices and habitat assessments, 2009 and 2013.

Sample Site	Date	Sample Type	Hilsenhoff Biotic Index[1]	ASCI Habitat Assessment[2]
GC100	08/06/09	Surber	5.76	
GC100	08/14/13	Surber	5.81	
GC300	08/06/09	Surber	4.71	
GC300	08/14/13	Surber	5.60	
GC100	08/06/09	ASCI	7.5	200
GC300	08/06/09	ASCI	7.1	190

Notes:
1. Scale from 0-10, with 10 indicating greatest water body impairment.
2. Scale from 0-200, with 200 indicating most impaired macroinvertebrate habitat.

The metrics developed to describe macroinvertebrate populations in Grant Creek can also be used for comparison with other streams in the region. Comparison of Grant Creek macroinvertebrate metrics with the means of Cook Inlet streams reported by the USGS (Brabets et al. 1999) indicates that Grant Creek provides less optimal habitat for macroinvertebrates than other Cook Inlet streams (Table E.4-62). Grant Creek exhibits lower percent EPT, shredders, scrapers, and predators, and higher percent Diptera/Chironomidae and gatherers than the mean for other Cook Inlet streams.

Table E.4-62. Mean percent composition of the aquatic insect fauna in streams of the Cook Inlet Basin, Alaska [modified from Oswood and others (1995)] (excerpted from Brabets et al. 1999) and in Grant Creek, 2009 and 2013.

Fauna	Percent Composition Cook Inlet Watershed Streams	Percent Composition Grant Creek, 2009 and 2013 [1]
Taxonomic Structure		
Coleoptera	0.0	NA
Diptera	34.0	74.4 [2]
Ephemeroptera	41.3	7.7
Plecoptera	17.5	3.6
Trichoptera	7.2	1.7
Functional Group		
Shredders	11.6	1.8
Scrapers	11.2	5.8
Collector-filterers	6.6	7.5
Collector-gatherers	60.5	81.0
Predators	10.0	4.5

Notes:
1. Includes GC300 2009 which varies significantly from the other samples.
2. Chironomidae only.

Comparison of Grant Creek metrics with riffle/run, high gradient (> 2 percent) Kenai Peninsula Pacific Coastal Mountain Ecoregion stream metrics reported by ENRI (Major et al. 2000 and 2001), also indicates that Grant Creek habitat is more stressful for macroinvertebrate populations than other streams in the region. The cumulative ASCI scores from 2009 (KHL 2010a) calculated using several core metrics fall into the "poor" range: GC100 ASCI 2009 = 18 and GC300 ASCI 2009 = 18 (Tables E.4-63 and E.4-64).

Table E.4-63. Scoring thresholds for core metrics used to calculate ASCI scores (excerpted from Major et al. 2000), and Grant Creek: average of GC100 and GC300, 2009.

Stream Type	Metric	Index Score Metric Value				Grant Creek Values
		6	4	2	0	
RRM and RRH[1]	No. of Taxa	>16	12-16	7-11	<6	11
	No. of Ephemeroptera	>4	3-4	1-2	<1	3
	No. of Plecoptera	>4	3-4	1-2	<1	2
	No. of Trichoptera	>4	3-4	1-2	<1	1
	% EPT	>29	20-28	10-19	<10	1.4
	% Chironomidae	<39	39-59	60-79	>79	10.3
	% Dominant Taxon	<50	49-66	67-83	<83	80.4

Notes:
1. RRM and RRH – riffle run moderate gradient and riffle run high gradient.

Table E.4-64. ASCI scores based on core metrics (excerpted from Major et al. 2000), and score for Grant Creek: average of GC100 and GC300, 2009.

Ecoregion and Stream Type	Maximum	Score				Grant Creek Score
		Very Good	Good	Poor	Very Poor	
Pacific Coastal Mountains						
All Stream Types	42	>29	20-29	10-19	<10	18

Grant Creek macroinvertebrate populations reflect both the pristine water quality and challenging habitat conditions. Previous and current studies indicate that the benthic macroinvertebrate diversity is typical of cold, glacial fed streams (Ebasco 1984). These conditions result in macroinvertebrate populations comprised of taxa that have a low tolerance for water quality impairment but can also thrive where the growing season is short and streamflows variable. As a result, the most abundant taxa in Grant Creek were Chironomidae, followed by Ephemeroptera, Plecoptera, and clams.

4.6.1.3.2 Periphyton

Periphyton (single-celled algae) are primary producers in the foodweb of stream habitats. They form an algal coating on stream substrates such as boulders and large woody debris. One way to characterize the productivity of a stream is to evaluate the periphyton population. Periphyton studies were conducted in Grant Creek in the early 1980s and concentrated on the identification of diatom taxa (Ebasco 1984). In 2009 and 2013, periphyton investigations relied on the analysis of chlorophyll *a* concentrations to measure productivity of algal primary producers in the Grant Lake/Grant Creek system (KHL 2010a; KHL 2014e). Periphyton chlorophyll *a* analysis results were translated to concentration per area (μg/cm^2) reported as averages with standard deviations.

Average concentrations of chlorophyll *a* in Grant Creek samples from 2009 and 2013 varied between years and sites (Table E.4-65). Concentrations of chlorophyll *a* were greater at GC100 than GC300, although the spatial variability appeared to be less in 2013 than in 2009 (5.85 and 4.4 μg/cm^2 in 2013 compared to 34.79 and 12.70 μg/cm^2 in 2009). Both magnitude of the concentrations measured in 2009 and their variability were greater than in 2013.

Table E.4-65. Average[1] concentrations of chlorophyll *a* from periphyton collected in Grant Creek, 2009 and 2013.

Sample Site	Date	Chlorophyll *a* Concentration (μg/cm^2)
GC100	08/06/09	34.79 (23.76)
GC100	08/14/13	5.85 (4.92)
GC300	08/06/09	12.70 (9.94)
GC300	08/14/13	4.4 (2.84)

Notes:
1. Averages, followed by standard deviation in parentheses, are of 10 replicate samples.

4.6.2. Environmental Analysis

4.6.2.1. Fisheries

Conclusions contained within this section are based on analyses conducted by KHL, and utilize fishery, hydrology and instream flow data collected during the 2013 study period. Historical Grant Creek data as well as literature based data have been integrated where necessary. Analyses include the Salmonid Effective Spawning and Incubation Analysis, Draft Report and Grant Creek Habitat Time Series Analysis, Draft Report (Appendix 4 and 5, respectively, in Grant Creek Aquatic Habitat Mapping and Instream Flow Study Additional Information, Draft Report (KHL 2014h; Attachment E-2). In addition, the methods, results and discussion of a connectivity analysis of Reach 5 is presented in sections 4.2.6, 5.2.2, and 6.2.2 of the Grant Creek Aquatic Habitat Mapping and Instream Flow Study, Final Report, respectively (KHL 2014d).

4.6.2.1.1 Potential Impacts Associated with the Construction of the Grant Lake Project

Fishery related impacts associated with the construction phase of a hydroelectric plant would be relatively short-term; that is, during the actual construction phase of the Project and related facilities. For the proposed Grant Creek Project, that would include site-specific as well as stream-wide impacts. There will be five major work locations that are in relatively close proximity to Grant Creek (site-specific): near the Grant Lake outlet where an intake structure would be constructed; the return structure where Reach 5 flows will be supplemented near the upper portion of Reach 5; the powerhouse and related structures near the Reach 4/5 break; the access road near the left bank of Reach 1; and the bridge spanning the Trail Lake Narrows.

For each site-specific location, the primary impacts would be stream and stream-side disturbances, which could damage riparian zones and introduce sediments into Grant Creek. Occurrences on a small scale would likely result in short-lived and unnoticeable impacts to Grant Creek. However, on a greater scale, an increase in sediments could suffocate incubating fish eggs. Given the diversity of salmonids in Grant Creek, incubation occurs year-round (Table E.4-66).

Table E.4-66. Grant Lake salmonid species and life history stages.

Species	Life Stage	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
Chinook	Spawning																														X	X	X	X															
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coho	Spawning																																		X	X	X	X	X	X	X								
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sockeye	Spawning																													X	X	X	X	X	X	X	X												
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X																			
Dolly Varden	Spawning																															X	X	X	X	X	X	X	X	X	X	X	X						
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<60mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X													
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Adult																					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Rainbow	Spawning																			X	X	X	X	X	X																								
	Incubation/Emergence																			X	X	X	X	X	X	X	X	X	X	X	X	X	X																
	Fry (<50mm)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Adult																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								

Vegetative and riparian zone disturbances could have a more long-lived impact due to the length of time necessary for re-vegetation to occur. However, typical impacts associated with stream-side disturbances (i.e., erosion, increased water temperatures, loss of terrestrial insect production available to feeding juvenile fish, etc.) would be unlikely to affect Grant Creek to any major degree. Given the stream-side armoring of Grant Creek, erosion is unlikely, or would be relatively minor. Also, given the local climate and the short physical length of Grant Creek, increased temperatures associated with loss of riparian habitat would likely not occur. Finally, while not studied at Grant Creek, the loss of terrestrial insect production as a juvenile salmonid food source would be minimal given the relatively small footprint of project facilities.

Likely a greater risk to Grant Creek natural resources would be the introduction of pollutants associated with the construction of Project facilities. Fuels, explosives, and various construction related materials could be introduced into Grant Creek. Fish and other aquatic organisms are highly sensitive to petroleum based contaminants. Should a spill of significance occur, it could result in devastating impacts to Grant Creek biota. As such, stringent precautions and guidelines must be in place.

4.6.2.1.2 Potential Impacts Associated with the Operation of the Grant Lake Project

Mid- to long-term fisheries impacts that may be expected on Grant Creek will likely be associated with the operation rather than the construction of the Grant Creek Project, and will likely be the result of altered flows rather than physical alteration of the landscape.

Proposed operations will result in Grant Lake serving as a natural storage reservoir, with up to 13 feet of storage being drafted annually for the purpose of power generation. Water drafted from the lake will be transported along a tunnel extending from the lake to just east of the powerhouse, and will include a diversion structure that will allow water to be diverted into Grant Creek at the upstream end of Reach 5 for the purpose of regulating flows within that section of Grant Creek. A surge chamber and penstock will be located at the west end of the tunnel, which will flow into the powerhouse. The powerhouse will consist of two symmetrically-sized Francis turbines with a capacity of 385 cfs and an output of approximately 5 MW. Powerhouse outflow will be discharged into a detention pond for the purpose of "buffering" flows returning to Grant Creek; as such it will be possible to regulate sudden and drastic flow increases or decreases. The tailrace channel, the channel between the detention pond and Grant Creek, will discharge into Grant Creek near the Reach 4/5 break. A more detailed discussion regarding the proposed Project can be found in Section 2.1 of this Exhibit E.

<u>Reach 5 Flows, Connectivity, Spawning, Incubation and Juvenile Rearing</u>

The flow regime, as proposed, would generally decrease flows within Reach 5 year-round with a baseline flow of 5 cfs. During anadromous spawning, flows will be increased somewhat; during the Chinook spawning period (August 1 to September 7), flows will increase to 10 cfs. During the period of September 8 to October 31, flows will be maintained at 7 cfs for sockeye and coho spawning. For Dolly Varden char, which are fall spawners, flows will vary during the spawning period, and will range between 5 and 10 cfs during the August 15 to November 15 period. For rainbow trout, which spawn typically from mid-May to the end of June, flows will be 5 cfs and will be maintained at that level or higher until emergence in the fall.

Based on the 2013 Aquatic Habitat Mapping and Instream Flow Study (KHL 2014d) and subsequent analyses, flows of 10 cfs provide connectivity into Reach 5 for sockeye and coho, flows of 22 cfs provide connectivity for Chinook, and for resident species, connectivity is provided at 5 cfs (i.e., rainbow trout and Dolly Varden). Connectivity is based on the depth along key transects in an area of interest, and the method of analysis is commonly referred to as the Oregon Method (Thompson 1972). Within Reach 5, two transects (T510 and T520), represent areas of sensitivity. In order to provide connectivity to an upstream area, depths must meet two criteria: achieve a species specific depth spanning 25 percent of the overall transect width; and achieve a species specific depth spanning 10 percent continuous coverage of the overall transect width.

For Chinook, the required depth is 0.80 feet; for sockeye and coho, the depth is 0.60 feet; and for resident species (rainbow and Dolly Varden), the depth is 0.40 feet. Detailed discussions regarding the methods used in this analysis and results can be found in Section 4.6.2.2 of this Exhibit E.

No analyses were conducted specific to Reach 5 assessing spawning, incubation or juvenile rearing. The reasons being that for spawning, suitable spawning habitat was not associated with the two transects located within Reach 5 (T510 and T520). Therefore, it was not possible to conduct such an analysis. As for incubation and juvenile rearing, Reach 5 transects are included in the overall assessments of those life history components for Grant Creek. It should be noted however, that Reach 5 is a high gradient segment of Grant Creek (average of 6.4 percent; KHL 2014a) with minimal anadromous spawning. In 2013, no Chinook were observed spawning within Reach 5 and with only three sockeye and two coho redds documented. Collectively, the five redds observed in Reach 5 in 2013 only represented 1.3 percent of the total redds documented in all of Grant Creek (n = 388). Furthermore, it appears based on minnow trapping, snorkeling, and incline plane trap results, use of Reach 5 by juvenile salmonids is minimal (4.6.1.1.3). Finally, during spawning, flows in a typical water year will be at 10 cfs, and will later decrease to 5 cfs during incubation. Given that flows at a depth of 0.10 feet and greater are commonly used to model safe incubating conditions (KHL 2014h; Attachment E-2), adverse impacts to incubating embryo is unlikely with a 5 cfs decrease. Likewise, the overall loss of juvenile rearing habitat would be minimal.

Reaches 1 through 4 Spawning, Incubation, and Juvenile Rearing

At the request of the Instream Flow Subgroup (IFSG), which convened following the 2013 Grant Creek research period, KHL conducted a habitat time series analysis for all resident and anadromous salmonids within Grant Creek. Using RHABSIM, a series of Weighted Usable Area (WUA) curves were developed for all salmonid spawning and rearing life history stages. The analysis used daily WUA values, Grant Creek periodicity of salmonid life history within Grant Creek, and the synthesized 66-year flow record to calculate pre- and post-Project conditions; the results were then averaged to assess impacts to spawning. A detailed description of the analysis can be found in KHL (2014i).

For Chinook, the post-Project WUA available for spawning was 99.5 percent of the pre-Project WUA. For Chinook fry, the available post-Project rearing WUA was 96.9 percent of pre-Project conditions, and for Chinook juveniles, the post-Project WUA was 100.2 percent.

For coho, the post-Project WUA available for spawning, fry rearing, and juvenile rearing were 100.0, 99.0, and 99.2 percent of the pre-Project WUA condition.

For sockeye, the post-Project WUA available for spawning was 99.0 percent of the pre-Project conditions, and ranged between 98.0 and 100.1 percent. Since sockeye fry migrate out of natal streams shortly after emergence, no estimates of WUA are available for those life stages.

For Dolly Varden, the post-Project WUA available for spawning, fry rearing, juvenile rearing, and adult rearing were 100.3, 98.9, 102.9, and 96.5 percent of the pre-Project WUA condition. For rainbow trout, the post-Project WUA available for spawning, fry rearing, juvenile rearing, and adult rearing were 98.7, 101.4, 99.3, and 94.2 percent of the pre-Project WUA condition. Overall, for all species and life stages, the average post-Project WUA was 99.75 percent of the pre-Project WUA. Table E.4-67 summarizes the results of the Grant Creek habitat time series analysis.

Table E.4-67. Results of the Grant Creek habitat time series analysis (KHL 2014h; Attachment E-2), which depicts the post-Project WUA relative to the pre-Project conditions for anadromous and resident salmonids by life stage.

Species	Percent			
	Spawning	Fry Rearing	Juvenile Rearing	Adult Rearing
Chinook	99.5	96.9	100.2	---
Coho	100.0	99.0	99.2	---
Sockeye	99.0	---	---	---
Dolly Varden	100.3	98.9	102.9	96.5
Rainbow Trout	98.7	101.4	99.3	94.2

Trail Lake Narrows

Impacts associated with the operation of the Project are not anticipated within the Trail Lake Narrows. Generally, Grant Creek flows will increase somewhat during winter and early spring, and will decrease during periods of historically high flows. These alterations in flow are relatively minor relative to the amount of water passing through the Narrows from Upper Trail Lake. Therefore, Grant Creek flow alterations should have little if any impact on the Trail Lake Narrows downstream of the proposed bridge site.

A greater potential for impact comes from the construction, use and maintenance of an access bridge across the Trail Lake Narrows downstream of the Grant Creek confluence. During construction, there is the potential for shoreline disturbances which could result in sediment issues at the localized site. Furthermore, during construction, various pollutants could enter the Narrows and impact fish rearing downstream of that location. Finally, during the period of

August through November, a number of sockeye and coho spawners were observed at the location where the proposed bridge would span the Trail Lake Narrows. As such, construction activities could impact fish spawning at that location, and fish migrating past that location to reach upstream spawning locales.

Once completed, bridge maintenance (e.g., ice removal) could have an impact on fish utilizing the area downstream of the bridge location. More specifically, the application of chemical materials used to melt ice has the potential to enter the Narrows and impact incubating eggs. While a remote possibility, it is a concern that can be alleviated by using mechanical means to remove snow and ice on the access bridge.

Global Issues

In addition to the specific issues discussed above, the operation of the proposed Project could result in more general or global impacts to Grant Creek fisheries; more specifically, ramping rates of the powerhouse discharge, an alteration in Grant Creek water temperatures, and the loss of sediment transport within Grant Creek. For more details regarding the measures outlined below, see Section 4.6.3 of this Exhibit E.

Ramping Rates

The rate in which Project flows are ramped up, and especially decreased can result in stranding and mortality of juvenile salmonids. Stranding has the potential to isolate fish in areas of the river channel where predators or increased water temperatures can cause mortality. Typically, smaller juvenile fish are the most vulnerable to potential stranding due to their habitat preference and poor swimming ability. The incidence of stranding for juvenile fish is affected by river channel configuration, time of day, substrate type, and water temperature among other factors.

At this time, ramping rates have not been proposed by either the stakeholders or during the development of the initial operating guidelines. As such, guidelines will be developed in consultation with the stakeholders.

Temperature Variances

The depth of the intake structure within Grant Lake, and therefore the depth of where water is drawn for power generation could potentially have a large impact on Grant Creek biota, and in particular Grant Creek fishery resources. During periods of ice cover, Grant Lake water becomes increasingly warmer with depth, but is relatively stable and near the surface is similar to Grant Creek water temperatures. During ice free conditions, the opposite is true with warmer temperatures near the surface. The greatest differential between surface and bottom water temperatures occurs during the period of August to mid-September. Furthermore, during ice-free conditions, water at a depth of approximately 1.5 meters approximates temperatures within Grant Creek (KHL 2014b).

A change in water temperature as small as 2° C can affect the rate of egg development during the incubation period, and therefore, effect the time of hatching and emergence of fry (Scannell 1992). Accelerated development leading to early emergence can have several disadvantages such as decreased foraging ability or emergence before suitable prey species are available and increased susceptibility to predation (Scannell 1992).

As such, a variable-depth intake structure will be incorporated into the final design so that Grant Creek water temperatures can be regulated to conform to pre-Project conditions.

Sediment Transport

Transport of sediment within Grant Creek comes from two primary transport characteristics; suspended sediment and bedload sediment. The primary source of suspended sediment is the glacial headwaters of Grant Lake, but occurs at a relatively low level since most of the suspended sediment settles within Grant Lake. Also, of the suspended sediment that does enter Grant Creek, little settles within the creek due to the high gradient (KHL 2014a).

The primary source of bedload sediment within Grant Creek comes from Reaches 5 and 6, and is extremely limited (KHL 2014a). The bedload supply comes mainly from rock fall events within the canyon and in order for the bedload supply to mobilize, large hydrological events must occur. As such, a reduction in Reach 5 flows associated with the operation of the proposed Grant Creek Project will result in less gravel recruitment to lower reaches of Grant Creek.

A reduction in gravel recruitment to Grant Creek is likely to diminish the quantity and quality of spawning habitat in Grant Creek (KHL 2014a). As discussed in KHL (2014a), these impacts are likely to occur incrementally over time, and are typically measured in years and decades as the result of flow bypassed around the canyon reach.

To offset these impacts, a mitigation plan that likely includes gravel augmentation and maintenance flows through the canyon reach will be explored with stakeholders.

4.6.2.2. Aquatic Habitat and Instream Flow

As part of the Instream Flow Study, and at the request of the TWG, a sampling event was conducted June 23–25, 2009 on Grant Creek to characterize the types of aquatic habitats used by resident fish and rearing fish (KHL 2010a). Aquatic habitat was described at each sample site by recording macro-, meso-, and micro-habitat characteristics. During the June sampling event, snorkeling was the primary method used to document fish presence. Electrofishing was used primarily to confirm species identification and calibrate fish length estimates (KHL 2010a).

Collaboratively, the TWG and KHL decided to select an Instream Flow Study methodology based on the knowledge obtained from the summer 2009 aquatic resources and hydrology studies (KHL 2010a). Data and analyses from these studies were shared with the TWG in July and September. Based on the knowledge gained of Grant Creek's fish and hydrologic resources, KHL presented a proposed instream flow approach to the TWG on September 23, 2009 (KHL 2010a). Physical stream data required for instream flow modeling, per the proposed approach, were collected at 18 transects during low- and mid-flow conditions in 2010 (Figure E.4-42). Where applicable, these data were used in the 2013 Instream Flow Study (KHL 2014d).

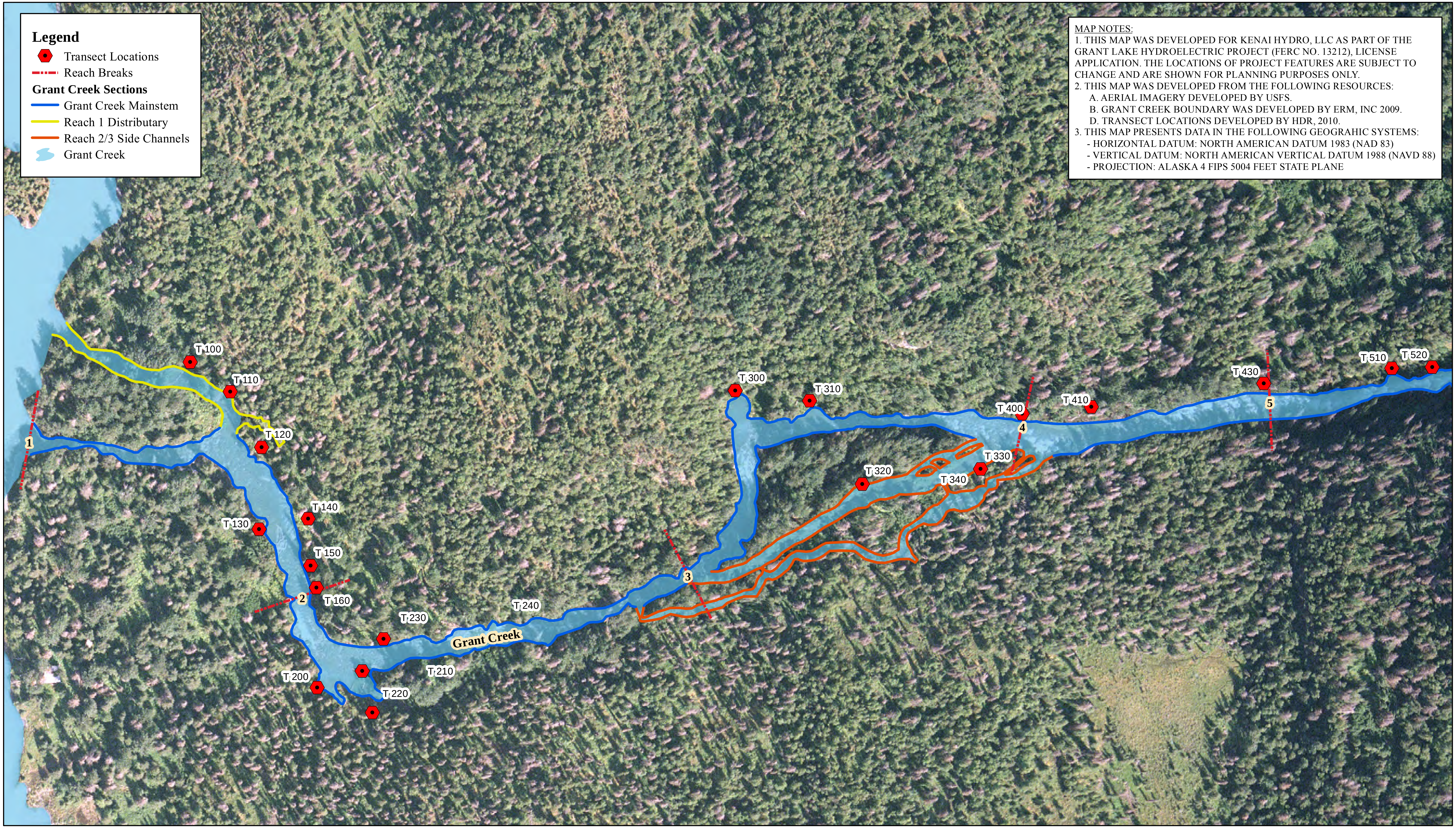
Together with existing information, the goals of the study efforts were to provide baseline information, and where applicable, information on alternative flow regimes, which would allow an assessment in the study report of potential Project impacts on aquatic resources. These impact assessments are used to identify potential PM&E measures.

The purposes of this study were to fully delineate and map the aquatic habitats available in Grant Creek, identify important spawning and rearing fish habitats for both resident and anadromous salmonids, and describe the distinguishing factors that may influence fish use of the key habitats over those habitat units not occupied by fish in Grant Creek.

The goals of this suite of studies were to provide supporting information on the potential resource impacts of the proposed Project that were identified during development of the PAD, public comment, and FERC scoping for the license application, as follows:

- Impact of Project operation on sediment transport (relative to the availability of spawning gravels) due to changes in flow in Grant Creek.
- Impact of Project operation (fluctuating lake levels in Grant Lake, changes in seasonal flow in Grant Creek, reduced flows between the dam and powerhouse on Grant Creek).

This work was completed in 2013 and presented in KHL (2014d). The results of these investigations are presented below.



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 95 190 380 Feet

McMILLEN, LLC

THE SONNA BUILDING 910 MAIN ST, SUITE 258 BOISE, ID 83702 OFFICE: 208.342.4214 FAX: 208.342.4216

Developed For:

Homer Electric Association, Inc.

A Touchstone Energy® Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

LICENSE APPLICATION

Figure E.4-42
Grant Creek Instream Flow Transect Locations

DESIGNED J. Woodbury

DRAWN J. Woodbury

CHECKED J. Blum

ISSUED DATE 11/13/2014

SCALE: 1:2,000

DRAWING

4.6.2.2.1 Habitat Mapping and Results

The specific goals of the aquatic habitat mapping were as follows:

- Prepare a geospatially referenced image of Grant Creek upon which aquatic habitat and fish use information can be superimposed.
- Develop a map of aquatic habitats that will provide a basis for describing the distribution of key habitat types.
- Identify important factors that influence fish use of key habitats for input to the instream flow analysis.
- Identify and map habitat with sufficient resolution so that GIS can be used to accurately calculate surface areas.

As shown in Figure E.4-41, Grant Creek below the powerhouse consists of a main channel, several side channels, two low-velocity lobes (T200 and T300), a backwater channel (T210 and T230), a high flow overflow channel (when flows are approximately 450 cfs), and a distributary in Reach 1.

The Reach 1 distributary has a barrier at its confluence with Grant Creek, consisting of rubble and large woody debris. This distributary does not get wetted until approximately 180 cfs (T100 and T110); when water is provided to this distributary, rearing and spawning habitat increase significantly. The side channels in Reaches 2 and 3 are wetted at all flows; however, the smaller side channels may be frozen over in winter at low flows and temperatures. These side channels provide a large proportion of the rearing habitat in Grant Creek. The two low-velocity lobes provide excellent rearing habitat; the side lobe in Reach 3 also provides good spawning habitat. The high flow overflow channel is wetted at flows of approximately 450 cfs and higher. These flows provide connectivity down to the Trail Lakes; when flows drop below 450 cfs, fish are stranded, connectivity vanishes and production is lost from the system.

4.6.2.2.2 Instream Flow

The Grant Creek Instream Flow Study approach to be applied to lower Grant Creek Reaches 1–4 was collaboratively developed based on input from the Instream Flow TWG. Public meetings of the TWG were held in April and September 2009, and a conference call was held in May 2009; input and suggestions were solicited during these meetings and also through e-mail and phone communications with the TWG and TWG members. Subsequently, KHL met with the stakeholders in December 2012 to update study plans and to prepare for the 2013 field season.

As agreed to during the previous 2010 investigations, the selected Instream Flow Study approach emphasized a detailed study of utilized habitat types and addressed the desire of the TWG to examine how important individual habitat units may be affected by changes in flow due to the operation of the Project. Rather than applying a typical habitat study that generalized mesohabitat units in a study reach, the agreed-upon approach used several techniques to tie physical microhabitat to flow and timing, and applied *in situ* knowledge of fish habitat use in Grant Creek as tools to determine potential effects of the Project.

The selected approach included the following:

- A series of single transect analyses, with each transect going through a known fish use area such as high-use spawning or rearing areas.
- Fish studies that helped identify microhabitat factors that affected fish use within each key habitat type.
- Monitoring temperature and flows at multiple locations in Grant Creek in conjunction with the Water Resources study program to establish baseline stream flow and temperature changes.

The 2013 Instream Flow Study built upon the investigations that began in 2009. Further detail of the methods used in the Instream Flow study can be found in KHL (2013b).

The instream flow methodology is based on the premise that stream-dwelling fish are more often found in a certain range of depths, velocities, substrates, and cover types, depending upon the species and life stage, and that the availability of these preferred habitat conditions varies with stream flow. Physical Habitat Simulation (PHABSIM) is designed to quantify potential physical habitat available for each target fish species and life stage of interest, at various levels of stream discharge, using a series of modeling programs initially developed by the USFWS. Major components of the methodology include 1) study site and transect selection; 2) transect weighting; 3) field collection of hydraulic data; 4) hydraulic simulation to determine the spatial distribution of combinations of depths and velocities with respect to substrate and cover under a variety of discharges; and (5) habitat simulation, using habitat suitability criteria (HSC) to generate an index of change in habitat relative to change in discharge. The product of the habitat simulation is expressed as WUA for a range of simulated stream discharges.

It is important to recognize that the product of an instream flow analysis is not a set value, but rather is a range of values to be used as a tool for discussing and determining a range of stream flows that will meet the needs of the affected resources. The Grant Creek Aquatic Habitat Mapping and Instream Flow Study Addendum Information, Draft Report (Attachment E-2), was the primary document utilized to summarize the analysis below. At the time of development, that document was consistent with the latest operational and infrastructural regime developments. Since, additional refinements have been made to infrastructure and operations, the most pertinent being a modification of generating units from a 1 MW and a 4 MW generating unit to two synonymous 2.5 MW units. No significant impacts (positive or negative) result from an habitat perspective with the exception of the months of March and April during which, additional flow down the Grant Creek channel will actually increase habitat values in the mainstem and side channels. Given that these refinements took place after development of the Grant Creek Aquatic Habitat Mapping and Instream Flow Study Addendum Information, Draft Report, the most current description and analysis in this regard is described in this section.

Specific Goals

The specific goals of the Instream Flow study were as follows:

- Assist impact analysis by modeling changes in key types of fish habitat relative to potential changes in stream flow.
- Provide a basis for planning Project instream flow mitigation measures.
- Provide a starting point for stream flow discussion.
- Provide supportable predictions of fish habitat availability in lower Grant Creek under various stream flow scenarios for key species and life history stages.
- Assess connectivity of the habitats present in Reach 5 (i.e., the canyon reach) to determine if reductions in stream flow in this reach potentially affect habitat connectivity.

Habitat Availability and Transect Selection

The habitat mapping, along with known fish utilization in Grant Creek, was used to select transects for Instream Flow modeling. The purpose of the habitat availability component of the Instream Flow Study was to measure available habitat at proposed mesohabitat sites as a function of discharge (Table E.4-68). Available habitat was correlated to results of the habitat utilization. This information was cross-referenced with historic hydrographs, recent hydrologic data, and potential flow scenarios in Grant Creek to determine discrete time periods when the habitat unit may be available for its designated use. Cross section geometry, substrate, cover, and hydraulic data were measured at each transect using techniques developed for PHABSIM.

Table E.4-68. Mesohabitat assessment sites (revised from KHL 2010c).

Transect	Channel Type	Fish Habitat Site	Notes	
100	Rearing Distributary	R1FH11	Linear transect, slow water	
110	Rearing Distributary	R1FH12	Linear transect, slow water, LWD	
120	Spawning Riffle		Spawning riffle	
130	Rearing Main	R1FH05	Main channel fast water, Side channel, small mid channel bar, vegetated, LWD upstream	
140	Rearing Main	R1FH05	Main channel fast water, Side channel, small mid channel bar, vegetated, LWD upstream	
150	Rearing Main	R1FH13	Woody debris, left bank (LB), fast water main channel	
160	Rearing Main	R1FH13	Woody debris, LB, fast water main channel	
200	Rearing Main	R1FH06	Backwater lobe	
210	Rearing Secondary	R2FH10	Small tertiary channel	
220	Rearing Main	R2FH10	Main channel, fast water, right bank (RB) undercut bank	
230	Rearing Main/ Secondary	R2FH10	Main channel, fast water, undercut bank on RB, surveyed across island to backwater pool	
300	Rearing Main		Backwater lobe	
310	Spawning Main	R2FH10	Backwater, low velocities, main channel, fast and deep	
320	Rearing Secondary	R3FH09	LWD, Secondary channel and spawning	
330	Rearing Secondary/Tertiary	R3FH09	LWD, Secondary channel, spawning and Tertiary channel	
400	Rearing Main	R3FH16	Small side channel, cobble/gravel bar - no vegetation, very deep undercut bank	
410	Rearing Main	R3FH16	Small side channel, cobble/gravel bar - no vegetation	
430	Spawning Main	R5FH15	Pool, deep fast, LWD upstream, shallow slow margin shelf	
Channel Type			**Count**	**Percent**
Rearing Distributary			2.0	11.1
Rearing Secondary/Tertiary			3.5	19.4
Spawning Main			3.0	16.7
Rearing Main			9.5	52.8
Total			18.0	

Calibration Flows

When possible, up to five sets of stage/discharge data were collected at each transect. These measurements were in addition to two sets of stage/discharge measurements taken in 2010. In some instances, distributary or side channel transects were either dry or still frozen, precluding some measurements. Additional WSE measurements were taken in these two areas at a Grant Creek flow of approximately 440 cfs. Due to channel changes at Transect 330, a new calibration measurement was also taken at this flow. WSEs at each transect were collected at a very high flow (approximately 700 cfs, as measured by an Acoustic Doppler Current Profiler [ADCP]). These flows and a WSE at each transect were used to generate the stage-discharge relationships.

The calibration flows are shown in Table E.4-69 for Grant Creek mainstem, side channels and distributary. Figures E.4-41 and E.4-42 show the locations of these transects, as well as the main channel, side channels, and Reach 1 distributary.

Table E.4-69. Calibration flows, Grant Creek (as measured in the mainstem).

Area	Measured Flows (cfs)					
	17	64	132	182	440	700
Main Channel	✓	✓	✓	✓		✓
Distributary	Dry/Frozen	Dry	Dry	✓	✓	✓
Reach 3 Side Channels	Frozen	✓	✓	✓	✓	✓

Flow Partitioning

As shown in Figure E.4-42, Grant Creek below the powerhouse consists of a main channel, several side channels, two low-velocity lobes (T200 and T300), a backwater channel (T210 and T230), a high flow overflow channel (when flows are approximately 450 cfs), and a distributary in Reach 1 that does not get wetted until approximately 190 cfs (T100 and T110). The Figure E.4-41 map series also shows these features. The side channels in Reaches 2 and 3 are wetted at all flows; however, the smaller side channels may be frozen over in winter at low flows and temperatures. All of these channels affect flow at some of the Grant Creek measured transects. KHL ran regression analyses in order to partition the flow appropriately for the PHABSIM model. Table E.4-70 summarizes the calculated partitioning of flow for each area of Grant Creek; Table E.4-71 presents the table of flows used for the PHABSIM analysis.

Table E.4-70. Calculations of flow in side channels, lobes, and tributaries, as related to the Grant Creek flow. [1]

Transect	% Flow	r^2	Comments
T100/110	0.99%	0.951	Dry at flows < 190 cfs
Overflow Channel	~ 1.70%	N/A	Activates at ~ 450 cfs; affects Reach 1 main channel transects
T200	*8.94%*	N/A	% of main channel at calibration measurement
T210/230 Side Channel (SC)	0.00%	N/A	Backwater with no velocity; WSE is dependent upon T200
T300	1.71%	N/A	% of main channel at calibration measurement
T310	GC-T330	N/A	All Reach 2/3 side channels flow represented by T330
T320	15.81%	0.990	
T330-M	15.06%	0.986	Main Channel of T330
T330-2nd	0.0844 T330-M	0.934	Secondary channel; percent of T330-M flow
T330-3rd	0.0219 T330-M	0.839	Tertiary channel; percent of T330-M flow

Notes:
1 Flow from Grant Creek stream gage unless otherwise noted.

Table E.4-71. Flow portioning in Grant Creek for PHABSIM study.

Reach 2/4[1]	T100/110	T200	T300	T310	T320	T330-MC	T330-2	T330-3	Reach 1[2]
10		0.89	0.17	8.33	1.58	1.51	0.13	0.03	10
20		1.79	0.34	16.67	3.16	3.01	0.25	0.07	20
30		2.68	0.51	25.00	4.74	4.52	0.38	0.10	30
40		3.57	0.68	33.33	6.33	6.03	0.51	0.13	40
50		4.47	0.85	41.67	7.91	7.53	0.64	0.16	50
60		5.36	1.02	50.00	9.49	9.04	0.76	0.20	60
70		6.26	1.19	58.33	11.07	10.54	0.89	0.23	70
80		7.15	1.36	66.67	12.65	12.05	1.02	0.26	80
90		8.04	1.53	75.00	14.23	13.56	1.15	0.30	90
100		8.94	1.71	83.33	15.81	15.06	1.27	0.33	100
110		9.83	1.88	91.67	17.40	16.57	1.40	0.36	110
120		10.72	2.05	100.00	18.98	18.08	1.53	0.40	120
130		11.62	2.22	108.33	20.56	19.58	1.65	0.43	130
140		12.51	2.39	116.67	22.14	21.09	1.78	0.46	140
150		13.40	2.56	125.00	23.72	22.60	1.91	0.49	150
160		14.30	2.73	133.33	25.30	24.10	2.04	0.53	160
170		15.19	2.90	141.67	26.88	25.61	2.16	0.56	170
180		16.08	3.07	150.00	28.46	27.12	2.29	0.59	180
190	1.89	16.98	3.24	158.33	30.05	28.62	2.42	0.63	190
200	1.99	17.87	3.41	166.67	31.63	30.13	2.54	0.66	200
225	2.24	20.11	3.84	187.50	35.58	33.89	2.86	0.74	225
250	2.49	22.34	4.26	208.33	39.53	37.66	3.18	0.82	250
275	2.74	24.57	4.69	229.17	43.49	41.43	3.50	0.91	275
300	2.99	26.81	5.12	250.00	47.44	45.19	3.82	0.99	300
325	3.23	29.04	5.54	270.83	51.39	48.96	4.14	1.07	325
350	3.48	31.28	5.97	291.67	55.35	52.72	4.45	1.15	350
375	3.73	33.51	6.40	312.50	59.30	56.49	4.77	1.24	375
400	3.98	35.74	6.82	333.34	63.25	60.26	5.09	1.32	400
450	4.48	40.21	7.67	375.00	71.16	67.79	5.73	1.48	449
500	4.98	44.68	8.53	416.67	79.07	75.32	6.36	1.65	497
550	5.47	49.15	9.38	458.34	86.98	82.85	7.00	1.81	545
600	5.97	53.61	10.23	500.00	94.88	90.38	7.63	1.98	592
650	6.47	58.08	11.09	541.67	102.79	97.92	8.27	2.14	640
700	6.97	62.55	11.94	583.34	110.70	105.45	8.91	2.31	688
750	7.46	67.02	12.79	625.00	118.60	112.98	9.54	2.47	736
800	7.96	71.49	13.64	666.67	126.51	120.51	10.18	2.64	784
850	8.46	75.95	14.50	708.34	134.42	128.05	10.82	2.80	831
900	8.96	80.42	15.35	750.00	142.32	135.58	11.45	2.97	879
950	9.46	84.89	16.20	791.67	150.23	143.11	12.09	3.13	927
1000	9.95	89.36	17.06	833.34	158.14	150.64	12.72	3.30	975

Notes:
1 Transects 220, 230 (Main Channel), 400, 410, and 430.
2 Transects 120, 130, 140, 150, and 160.

Output from the hydraulic models was then used to determine changes in the Grant Creek water depths, velocities, surface area, and fish habitat throughout a range of flows from 10 cfs to 1,000 cfs, depending on individual study site. The results of the model runs were then combined to produce WUA over the entire range of flows of interest.

Grant Lake Target Species and Periodicity

Table E.4-72 summarizes the salmonid species and life history stages that were modeled in the Grant Lake Instream Flow Study. Table E.4-73 shows the life history stages that were modeled at each transect. Rearing life history stages were modeled at each transect. Some transects, however, lacked either velocity or suitable substrate for spawning; these transects were excluded from the analysis.

Table E.4-74 presents Grant Lake salmonid periodicity. The periodicity for each of the species and life history stages were reviewed and approved by the IFSG during conference calls held between April and July 2014.

Table E.4-72. Salmonid species and life history stages to be modeled in the Grant Creek Instream Flow Study.

Species	Spawning	Fry Rearing	Juvenile Rearing	Adult Rearing
Sockeye Salmon	✓			
Coho Salmon	✓	✓	✓	
Chinook Salmon	✓	✓	✓	
Rainbow Trout	✓	✓	✓	✓
Dolly Varden Char	✓	✓	✓	✓

Table E.4-73. Life history stages modeled at each Grant Creek transect.

Transect	Life History Stage	
	Spawning	Rearing
100	✓	✓
110	✓	✓
120	✓	✓
130	✓	✓
140	✓	✓
150	✓	✓
160	✓	✓
200		✓
210[1/]		✓
220	✓	✓
230-MC	✓	✓
230-SC[1/]		✓
300	✓	✓
310	✓	✓
320	✓	✓
330-MC	✓	✓
330-SC		✓
330-TC	✓	✓
400	✓	✓
410	✓	✓
430	✓	✓

Notes:
1 Backwater

Table E.4-74. Grant Lake salmonid species and life history stages.

Species	Life Stage	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
Chinook	Spawning																														X	X	X	X															
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X																	
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coho	Spawning																																		X	X	X	X	X	X	X								
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sockeye	Spawning																													X	X	X	X	X	X	X	X												
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<50mm)																			X	X	X	X	X	X	X	X	X	X	X																			
Dolly Varden	Spawning																															X	X	X	X	X	X	X	X	X	X	X	X						
	Incubation/Emergence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Fry (<60mm)																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X													
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Adult																					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Rainbow	Spawning																			X	X	X	X	X	X																								
	Incubation/Emergence																			X	X	X	X	X	X	X	X	X	X	X	X	X	X																
	Fry (<50mm)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Adult																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								

Habitat Suitability Curves

The purpose of the habitat utilization component of the Instream Flow Study was to determine which meso- and microhabitat factors the fish in Grant Creek occupied to assess the impacts, if any, the Project would have on instream habitat. To maximize the knowledge of habitat selection factors for fish in Grant Creek, observations were made at the locations of transects and fish habitat sites.

In 2013, measurements of 99 spawning pairs of sockeye salmon were taken at flows ranging from 338 cfs – 469 cfs in the mainstem and 28 cfs – 74 cfs in the side channels. Measurements of 47 coho salmon spawning pairs were taken at flows ranging from 169 cfs – 285 cfs; however, all but four of the observed coho spawning occurred at flows ranging from 169 cfs – 179 cfs. For this reason, KHL extended the probability of use curves to reflect the upper end of optimum utilization (i.e., value of 1.0) in the Cooper Creek curves. Only three Chinook salmon pairs were observed spawning; these were discarded and literature-based curves were used.

Information relating to site-specific HSC was developed from these data and used in combination with HSC curves available in the existing literature and professional judgment to determine final HSC curves to be used in modeling. Development of final HSC curves was pursued as a collaborative effort with the Aquatics Resource Work Group (ARWG), which has been established to review aquatic data in 2014. HSC curves were combined with the transect measurements and mesohabitat characterizations to model changes in habitat as a function of discharge. Methods for normalizing values for HSC curves, using habitat utilization and habitat availability, are described in WDFW/WDOE (2013). HSC curves are found in KHL (2014d), Appendix 2. Habitat utilization data are covered extensively in KHL (2014d).

Transect Weighting

After collaboration, the IFSG recommended that instead of prioritizing species and transects based upon utilization, transects be weighted by the proportion of the habitat that each transect represented. In addition, the IFSG recommended that the HSC curves be processed through the Instream Flow model to produce WUAs for all species and life history stages.

KHL (2014i), Appendix 2, includes the Final Transect Weighting report. Table E.4-73 shows the species and life history stages that were modeled for Grant Creek. Table E.4-75 summarizes final transect and reach weighting.

Table E.4-75. Summary of transect and reach weighting.

Reach	Transect	Length (ft)
1 - Distributary	100	169
	110	227
	Total	***396***
1 - Main Channel	120	256
	130	167
	140	102
	150	118
	160	49
	Total	***692***
2 - Main Channel	200	51
	210	22
	220	405
	230-M[1/]	283
	230-BW[2/]	58
	Total	***820***
3 - Main Channel	300	90
	310	718
	Total	***808***
2/3 Side Channels	320	669
	330	810
	Total	***1,479***
4 - Main Channel	400	146
	410	297
	430	25
	Total	468
Total		
Distributary		396
Main Channel		2,788
Side Channel		1,479
Total		***4,663***

Hydrology

Proposed Engineering/Operations

Proposed operations of the Project are summarized in Table E.4-76. KHL proposes a bypass pipe to release required environmental flows when the lake is drawn down below the natural outlet level. The bypass would discharge into Grant Creek near the Reach 5-6 break.

In summary, minimum instream flows would be released into Reach 5 are as follows:

- 5 cfs release from January 1 – July 31, and November 1 – December 31
- 10 cfs release from August 1 through the first week in September
- 7 cfs from the second week of September through October 31

Table E.4-76 summarizes instream flow releases, pre- and with-Project power production flows, pre- and with-Project flows through the mainstem Grant Creek as well as the Reach 2/3 side channels, and salmonid species and life history stage periodicity.

Table E.4-76. Proposed Grant Creek engineering flows and salmonid species and life history periodicity.

	Stage	Species	January	February	March	April	May	June	July	August	September	October	November	December
Biology	Spawning	Chinook												
		Coho												
		Sockeye												
		D.Varden												
		Rainbow												
	Incubating	Chinook												
		Coho												
		Sockeye												
		D.Varden												
		Rainbow												
	Juveniles	Chinook												
		Coho												
		Sockeye												
		D.Varden												
		Rainbow												
	Fry	Chinook												
		Coho												
		Sockeye												
		D.Varden												
		Rainbow												
	Adult	D.Varden												
		Rainbow												
Hydrology	Composite Streamflow Record (CY 1948-2013)	Maximum Flow (cfs)	326	227	116	160	566	2140	1210	1383	1731	1295	851	570
		20% Exceedance	64	51	41	47	215	512	573	524	480	317	151	87
		Average Flow	52	43	33	36	146	409	503	444	367	233	123	73
		Median Flow	45	36	30	31	127	398	488	422	313	182	94	59
		80% Exceedance	32	25	21	22	62	290	419	346	215	115	67	42
		Minimum Flow	12	11	6	13	17	102	210	173	65	45	28	18
Operations	Typical Unit Operation	2.5 MW Unit (192.5 cfs)	Running	Running	Running	Running	Running	Running	Running	Running	Running	Running	Running	Running
		2.5 MW Unit (192.5 cfs)	Off	Off	Off	Off	Off	Running	Running	Running	Running	Off	Off	Off

		Jan				Feb				Mar				Apr				May				Jun			
Biological Parameters	Instream Flow Release (Reach 5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Pre-Project	55	51	51	52	47	45	41	39	36	34	32	31	30	31	35	45	69	101	152	227	318	382	431	483
	With-Project	102	98	98	99	94	91	88	85	83	80	79	77	77	78	81	92	115	147	151	226	197	260	309	360
	Approx. Reach 2/3 Natural Side	9.2	8.5	8.6	8.6	7.8	7.4	6.8	6.4	6	5.6	5.3	5.1	5	5.2	5.8	7.6	12	17	25	38	53	64	72	81
	Approx. Reach 2/3 Side Channel	22	21	21	21	21	20	19	18	10	10	10	10	10	10	10	10	11	16	26	37	33	43	52	60
Reservoir Rule Curve	Water Surface Elev.	698	680	698	697	696	696	696	695	695	694	694	693	693	692	692	691	691	690	690	690	691	692	693	694
	Drafting/Filling	Drafting																		Steady		Fill			

		Jul				Aug				Sep				Oct				Nov				Dec			
Biological Parameters	Instream Flow Release (Reach 5)	5	5	5	5	10	10	10	10	10	7	7	7	7	7	7	7	5	5	5	5	5	5	5	5
	Pre-Project	494	517	507	496	484	469	440	402	379	347	379	364	280	272	216	184	159	133	109	99	92	74	67	63
	With-Project	370	389	389	376	364	364	347	395	399	395	375	373	367	282	271	215	185	205	279	156	151	141	121	114
	Approx. Reach 2/3 Natural Side	82	86	84	83	81	78	73	67	63	58	63	61	47	45	36	31	26	22	18	16	15	12	11	10
	Approx. Reach 2/3 Side Channel	62	65	65	63	61	58	66	67	66	62	62	61	47	46	35	31	39	35	31	30	29	25	24	24
Reservoir Rule Curve	Water Surface Elev.	696	697	698	699	701	702	703	703	703	703	703	703	703	703	703	703	702	702	701	701	700	700	700	699
	Drafting/Filling	Fill						Steady										Drafting							

In general, flows during the November 1 – March 1 period will be higher with-Project than pre-Project. Flows will remain the same pre-Project and with-Project from March 1 – May 1 and late August through October 31, while flows will be reduced with-Project from May 1 until late August. For further detail, refer to Section 2.1.4 of this Exhibit E.

Long-term Grant Creek Flows

Measured flows at Grant Creek exist for three time periods: 1) The USGS (USGS gage 15246000 Grant Creek data – 1/1/1948 – 9/30/1958); 2) Ebasco data (1981 – 1983, intermittent); and KHL (4/3/2013 – 12/31/2013). The IFSG requested a long-term data record for the Project. Per that request, a composite, 66-year time series for Grant Creek for calendar year (CY) 1948 through CY 2013 was developed. The record was developed for pre-Project flows and with-Project flows and is a composite record of actual and synthesized data.

The record extension was based upon a correlation with overlapping Kenai River at Cooper Landing data (USGS 15258000) for the 1/1/1948 – 9/30/1958 period with the USGS data on Grant Creek. The hydrologic record was then extended from 10/1/1958 – 4/2/2013, excluding the Ebasco periods. That 66-year composite (measured and synthesized flows) record (pre-Project) was then revised to reflect the with-Project condition, producing two 66-year composite records for analysis. Further details can be found in Section 4.5 of this Exhibit E.

Figure E.4-43 compares average pre-Project, natural flows, to the with-Project flows.

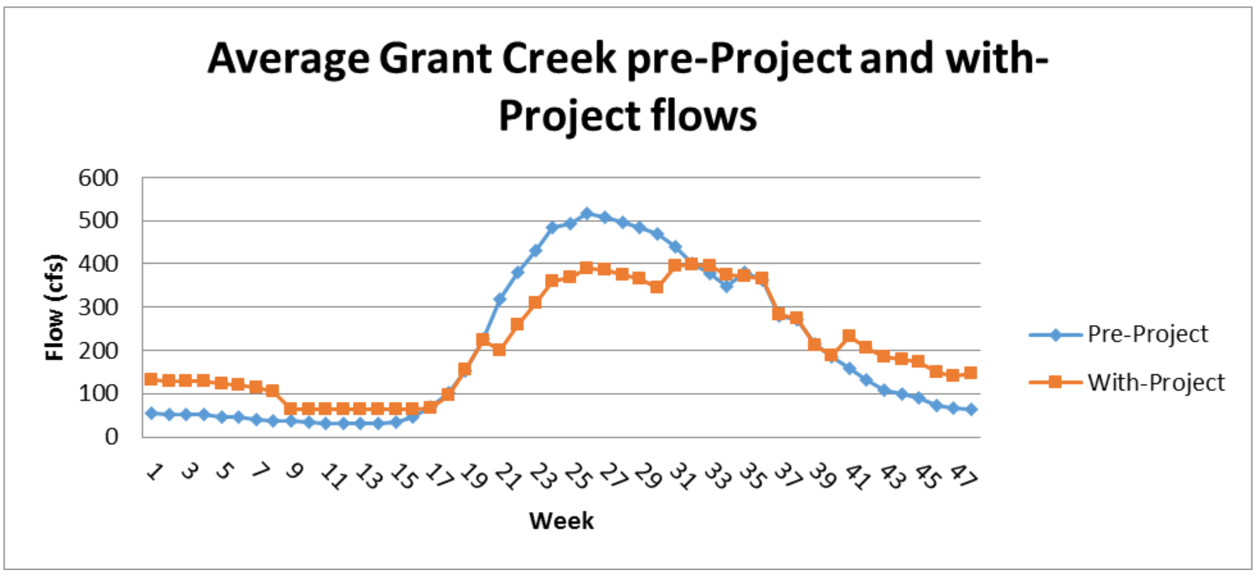


Figure E.4-43. Average Grant Creek pre-Project and with-Project flows.

Weighted Usable Area

Using the final transect weighting in Table E.4-75, and HSC curves (KHL 2014d, Appendix 2) for the species and life history stages shown in Table E.4-73, KHL produced WUA curves for

Grant Creek. Tables E.4-77 through E.4-79 and Figures E.4-44 through E.4-46 present WUA for Grant Creek salmonid spawning, fry, and juvenile/adult rearing, respectively.

Table E.4-77. Grant Creek spawning WUA.

Flow (cfs)	Chinook	Coho	Dolly Varden	Rainbow	Sockeye
10	1,068	5,568	18,631	14,839	5,238
20	6,599	9,209	27,940	23,150	8,323
30	12,856	12,213	32,314	27,879	10,782
40	17,810	14,677	36,115	31,648	12,930
50	21,367	16,867	39,113	34,761	14,825
60	24,260	18,649	41,288	37,342	16,632
70	26,813	20,247	43,146	39,482	18,001
80	29,371	21,867	44,807	41,434	19,090
90	31,474	23,114	46,150	43,147	20,074
100	33,798	24,291	46,641	44,529	20,917
110	36,017	25,399	46,605	45,565	21,690
120	37,711	26,241	46,197	46,302	22,432
130	39,104	27,015	45,651	46,884	23,046
140	40,431	27,649	45,110	47,342	23,556
150	41,662	28,071	44,505	47,692	24,041
160	42,863	28,316	43,850	47,765	24,489
170	43,998	28,505	43,217	47,726	24,876
180	45,084	28,647	42,739	47,703	25,244
190	46,151	28,794	42,561	47,668	25,482
200	46,974	28,861	42,306	47,466	25,584
225	48,741	29,158	42,011	47,180	26,137
250	49,687	29,635	42,450	46,882	26,601
275	50,337	30,151	42,759	46,908	26,985
300	51,161	30,591	42,739	46,909	27,420
325	51,863	31,095	43,001	47,169	27,805
350	52,248	31,584	43,342	47,577	28,147
375	52,471	31,905	43,417	47,716	28,560
400	52,715	32,329	43,300	47,709	29,021
450	52,861	33,469	42,684	47,613	29,815
500	53,165	34,506	41,583	47,525	30,523
550	54,165	35,033	40,231	47,346	31,094
600	55,510	35,105	38,968	46,818	31,504
650	56,596	34,953	37,471	45,930	31,663
700	57,242	34,576	35,683	44,740	31,720
750	57,401	34,030	34,027	43,370	31,537
800	57,174	33,323	32,467	41,998	31,152
850	56,583	32,508	30,975	40,471	30,640
900	56,024	31,561	29,541	38,767	30,056
950	55,423	30,558	28,140	37,026	29,419
1,000	54,640	29,598	26,718	35,417	28,802

Table E.4-78. Grant Creek fry rearing WUA.

Flow (cfs)	Chinook	Coho	Dolly Varden	Rainbow
10	93,680	77,590	102,219	62,468
20	96,290	73,052	109,681	63,732
30	102,978	76,830	116,702	69,555
40	110,212	82,216	119,827	75,214
50	114,072	84,107	118,341	78,294
60	114,860	83,429	115,523	78,864
70	113,859	81,717	112,962	77,912
80	112,035	79,704	111,138	76,708
90	110,487	78,216	109,706	75,548
100	108,806	77,131	108,300	74,715
110	107,783	77,094	107,869	74,103
120	107,160	77,356	108,238	73,267
130	107,259	78,093	108,932	72,726
140	108,223	79,427	110,204	73,077
150	109,775	80,844	111,670	73,786
160	111,216	82,011	113,087	74,767
170	113,469	83,793	114,815	76,272
180	115,219	85,228	116,995	77,321
190	123,962	93,392	126,896	83,981
200	125,591	94,651	128,222	85,224
225	131,369	98,462	132,156	89,319
250	135,690	101,765	137,008	92,170
275	140,535	105,427	140,688	95,269
300	145,442	108,532	142,503	98,864
325	148,318	109,888	143,360	101,208
350	149,991	110,652	143,398	102,628
375	150,896	110,881	142,625	103,429
400	151,012	110,259	141,628	103,383
450	150,234	108,527	140,925	102,382
500	149,890	107,125	140,120	100,892
550	148,960	105,678	138,794	99,267
600	148,041	104,950	138,512	97,744
650	148,545	104,949	138,419	97,269
700	148,820	104,784	138,264	96,500
750	149,488	105,003	137,825	95,852
800	150,103	104,820	136,502	94,953
850	150,158	104,680	134,977	93,836
900	149,692	103,251	132,513	92,547
950	148,320	101,160	130,552	90,330
1,000	146,560	98,592	128,412	87,935

Table E.4-79. Grant Creek juvenile and adult rearing WUA.

	Juvenile Rearing				Adult Rearing	
Flow (cfs)	**Chinook**	**Coho**	**Dolly Varden**	**Rainbow**	**Dolly Varden**	**Rainbow**
10	30,659	106,935	85,928	62,002	23,354	14,271
20	41,244	120,277	96,423	70,894	33,289	21,970
30	44,200	131,910	108,170	74,644	40,838	28,117
40	45,284	140,165	116,556	77,220	46,965	33,005
50	45,830	142,002	123,480	78,324	51,896	37,083
60	46,295	139,726	127,709	78,944	55,868	40,454
70	46,782	136,764	128,143	79,282	58,964	43,215
80	47,451	133,844	127,071	79,029	61,750	45,879
90	48,309	131,815	125,720	78,915	64,008	48,100
100	49,186	128,726	124,240	78,269	65,561	49,729
110	50,079	127,587	123,525	77,714	66,696	50,953
120	51,099	126,212	121,931	77,074	67,419	51,715
130	52,102	126,250	120,459	76,443	67,911	52,301
140	53,181	126,662	119,365	75,909	68,109	52,649
150	54,120	127,456	118,938	75,802	68,223	52,926
160	54,877	128,244	119,197	76,142	68,140	52,962
170	55,645	130,047	120,582	76,363	68,042	52,979
180	56,439	131,196	120,612	76,569	68,174	53,123
190	57,815	140,450	125,785	80,124	68,857	53,244
200	58,669	141,803	126,118	80,832	69,036	53,328
225	61,107	147,070	130,659	83,907	70,679	54,608
250	63,072	151,819	132,540	86,577	71,991	55,785
275	64,949	157,202	135,896	89,103	73,571	57,085
300	66,851	161,558	141,888	91,891	75,471	58,646
325	68,816	163,486	145,403	94,563	77,609	60,328
350	70,978	164,310	148,094	97,232	79,938	62,227
375	73,369	164,754	150,560	99,927	82,223	64,180
400	75,656	164,154	152,121	102,463	84,485	66,270
450	80,205	163,035	152,966	106,594	88,467	70,235
500	84,113	163,728	153,234	109,264	91,811	73,776
550	87,445	162,889	154,032	111,234	95,120	77,304
600	90,403	162,601	152,690	112,440	97,799	80,287
650	92,647	162,254	153,266	113,161	100,035	82,719
700	94,123	161,709	153,464	113,478	102,261	85,061
750	95,097	161,700	153,927	113,773	104,512	87,234
800	95,737	161,376	154,946	114,556	106,757	89,465
850	95,904	161,097	154,269	114,887	108,666	91,400
900	95,946	159,346	154,318	114,981	110,240	93,176
950	95,819	156,702	152,807	114,576	111,443	94,737
1,000	95,413	153,922	151,436	114,062	112,497	96,265

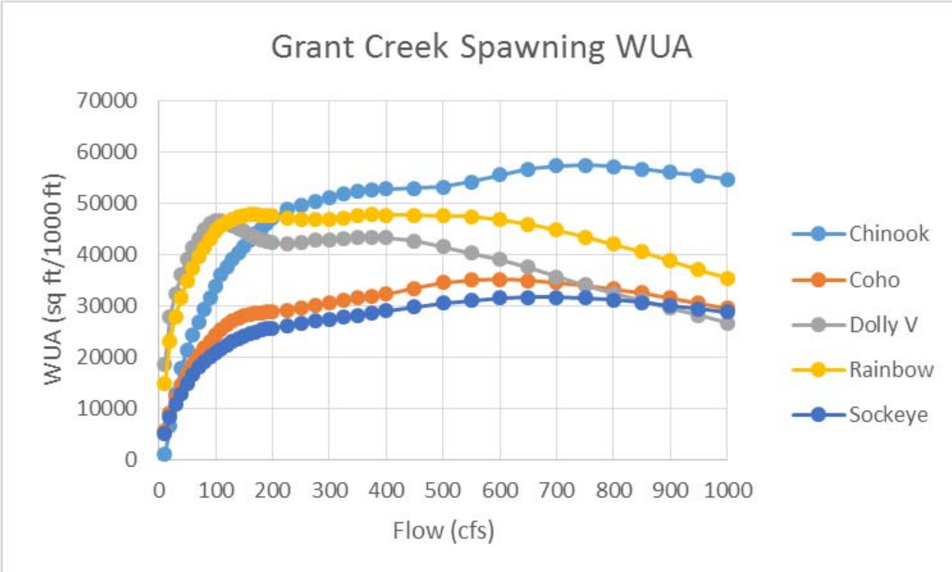


Figure E.4-44. Grant Creek spawning WUA.

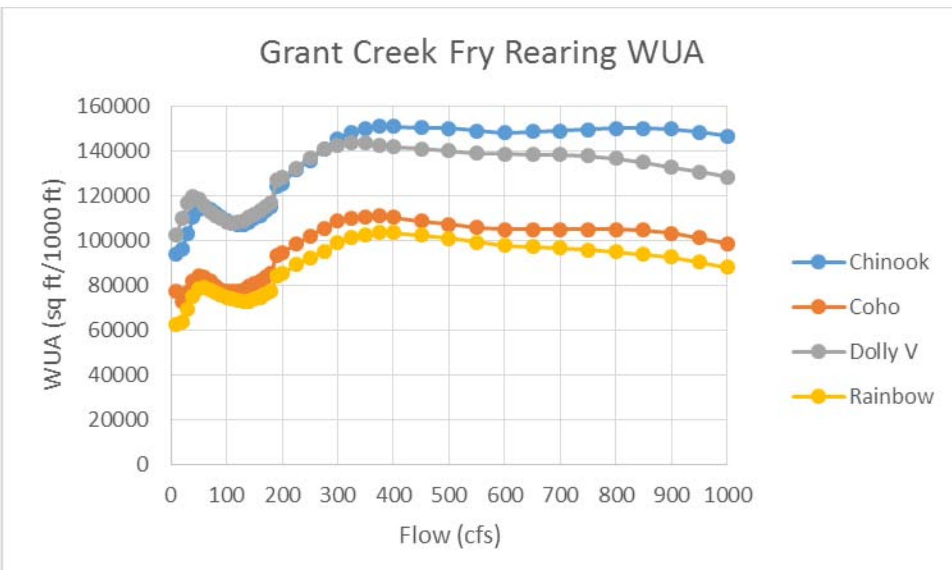


Figure E.4-45. Grant Creek fry rearing WUA.

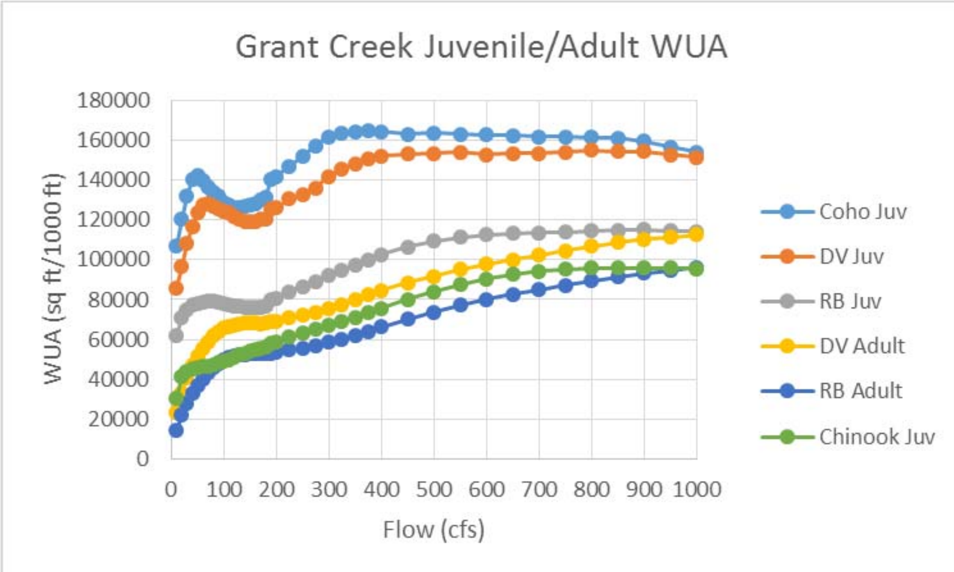


Figure E.4-46. Grant Creek juvenile and adult rearing WUA.

Effective Spawning Analysis

The IFSG expressed issues and concerns related to Grant Creek spawning flows and potential effects on incubating salmonid eggs at the proposed Project flows. KHL conducted an analysis to examine the percentage of incubating eggs that were protected (i.e., had 0.1 foot of water over the bed above the spawnable substrate) as flows were reduced.

The goals and objectives of the evaluation were as follows:

- Determine the amount and location of salmonid spawning habitat (as represented by transects selected during the Instream Flow Study) over a range of flows using current conditions (e.g., substrate and habitat as reflected in the Instream Flow Study). Flows for spawning reflect those examined for the Project, based on pre- and post-Project operation.
- Determine the effects of reductions in stream flow on incubating salmonid eggs, as determined by the models.

Information on methods and data sources are provided in KHL (2014i), Appendix 4. For this analysis, two different scenarios were modeled:

1. Results of spawning for all species at a flow of 450 cfs (per request of the ADF&G), with an analysis of substrates still covered by at least 0.1 foot of water as flows are decreased; and
2. Median monthly and weekly flows (pre-Project and post-Project) for those time periods that reflect each species' spawning and incubation periodicity.

Table E.4-80 shows transects used to model spawning habitat in Grant Creek. Table E.4-81 summarizes salmonid spawning periodicity and median monthly flows for Grant Creek. This table also provides the effective spawning analysis, as well as the approximate flows that will protect spawning habitat. The flows at which 98 percent, 90 percent, 80 percent, and 70 percent of the spawning WUA were recorded using linear interpolation, if required.

Table E.4-80. Transects used to model spawning habitat on Grant Creek.

			Spawning Substrate Available on Transect				
Reach	**Transect**	**Channel Type**	**Chinook**	**Coho**	**Sockeye**	**D Varden**	**Rainbow**
1 - Distributary	100	Rearing Distributary	✓	✓	✓	✓	✓
	110	Rearing Distributary		✓	✓	✓	✓
1 - Main Channel	120	Spawning Riffle	✓	✓	✓	✓	✓
	130	Rearing Main	✓	✓	✓	✓	✓
	140	Rearing Main	✓	✓	✓	✓	✓
	150	Rearing Main	✓	✓	✓	✓	✓
	160	Rearing Main	✓	✓	✓	✓	✓
2 - Main Channel	200	Rearing Main	✓			✓	✓
	220	Rearing Main	✓	✓	✓	✓	✓
	230	Rearing Main	✓	✓	✓	✓	✓
3 - Main Channel	300	Rearing Main	✓	✓	✓	✓	✓
	310	Spawning Main	✓	✓	✓	✓	✓
3 - Side Channel	320	Rearing Secondary	✓	✓	✓	✓	✓
	330	Rearing Secondary	✓	✓	✓	✓	✓
4 - Main Channel	400	Rearing Main	✓	✓	✓	✓	✓
	410	Rearing Main	✓	✓	✓	✓	✓
	430	Spawning Main	✓	✓	✓	✓	✓

Table E.4-81. Approximate flows at which certain percentages of spawning and incubation habitat are protected, given an initial spawning flow of 450 cfs or median pre-Project and post-Project spawning flows (all values in cfs).

								Median flow during incubation months (Pre- and Post-Project)											
Reach	**Species**	**Month**	**Spawning Flow**	**≥ 98%**	**≥ 90%**	**≥ 80%**	**≥ 70%**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Mainstem Reaches 1 - 4	**Chinook**		450	155	125	73	55												
		Aug - pre*	410	146	89	50	45	410	313	182	94	59	45	36	30	31	127	398	493
		Aug - post*	395	144	90	57	42	395	329	182	140	104	91	82	77	78	151	280	390
		Sep-pre*	320	116	40	28	22		313	182	94	59	45	36	30	31	127	398	493
		Sep-post*	348	137	70	43	32		329	182	140	104	91	82	77	78	151	280	390
	Coho		450	228	170	139	110												
		Sep-pre*	310	149	91	65	53		310	182	94	59	45	36	30	31	127	398	493
		Sep-post*	325	164	97	67	54		325	182	140	104	91	82	77	78	151	280	390
		Oct-pre	182	73	55	27	7			182	94	59	45	36	30	31	127	398	493
		Oct-post	182	73	55	27	7			182	140	104	91	82	77	78	151	280	390
	Sockeye		450	223	154	132	88												
		Aug - pre	422	202	143	112	73	422	313	182	94	59	45	36	30	31	127	398	493
		Aug - post	395	193	137	104	70	395	329	182	140	104	91	82	77	78	151	280	390
		Sep - pre	313	154	113	72	60		313	182	94	59	45	36	30	31	127	398	493
		Sep - post	329	163	89	64	51		329	182	140	104	91	82	77	78	151	280	390
	Dolly V		450	224	204	159	135												
		Aug - pre*	388	216	174	139	113	388	313	182	94	59	45	36	30	31	127	398	
		Aug - post*	395	217	177	141	114	395	329	182	140	104	91	82	77	78	151	280	
Mainstem Reaches 1 - 4	**Dolly V**	***Sep - pre***	313	198	146	119	85		313	182	94	59	45	36	30	31	127	398	
		Sep - post	329	88	85	85	62		329	182	140	104	91	82	77	78	151	280	
		Oct-pre	182	115	73	59	43			182	94	59	45	36	30	31	127	398	
		Oct-post	182	115	73	59	43			182	140	104	91	82	77	78	151	280	
		Nov-pre*	110	67	30	10	5				110	59	45	36	30	31	127	398	
		Nov-post*	157	151	121	83	45				157	104	91	82	77	78	151	280	
								May	**Jun**	**Jul**	**Aug**								
	Rain-bow		450	216	162	131	103												
		May - pre*	182	140	75	56	33	182	398	488	422								
		May - post*	181	139	71	45	13	181	280	390	395								
		Jun - pre	398						398	488	422								
		Jun - post	280	193	131	78	60		280	390	395								

Table E.4-81, continued…

Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Median flow during incubation months (Pre- and Post-Project) Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Reach 1								**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul***
Distributary	**Chinook**		4.48	1.79	-	-	-												
		Aug - pre*	4.08	1.79	-	-	-	4.08	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Aug - post*	3.93	1.79	-	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Sep-pre*	3.18	1.79	-	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep-post*	3.46	1.79	-	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
Reach 1	**Coho**		4.48	2.26	2.20	2.16	2.11												
Distributary		***Sep-pre****	3.08	1.79	-	-	-		3.08	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep-post*	3.23	1.79	-	-	-		3.23	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Oct-pre	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Oct-post	1.80	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
	Sockeye		4.48	2.23	2.18	2.13	2.07												
		Aug - pre	4.20	1.87	1.79	-	-	4.20	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Aug - post	3.93	1.79	-	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Sep - pre	3.12	1.79	-	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep - post	3.27	1.79	-	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
	Dolly V		4.48	2.26	2.19	2.13	2.07												
		Aug - pre*	3.86	1.97	1.79	-	-	3.86	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Aug - post*	3.93	1.97	1.79	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Sep - pre	3.12	1.90	1.79	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Sep - post	3.27	1.92	1.79	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Oct-pre	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Oct-post	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Nov-pre*	0.00	-	-	-	-				0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Nov-post*	0.00	-	-	-	-				0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
Reach 1								**May**	**Jun**	**Jul**	**Aug**								
Distributary	**Rain-bow**		4.48	2.33	2.20	2.14	2.09												
		May - pre*	1.80	1.79	-	-	-	1.81	3.96	4.86	4.20								
		May - post*	1.79	1.79	-	-	-	1.80	2.79	3.88	3.93								
		Jun - pre	3.94	1.98	1.79	-	-		3.96	4.86	4.20								
		Jun - post	2.77	1.90	1.79	-	-		2.79	3.88	3.93								
								Aug	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul***
Reach 3	**Chinook**		71.2	2.3	2.0	1.7	1.3												
Side Channels		***Aug - pre****	64.8	2.3	2.0	1.5	1.0	68.3	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2

Table E.4-81, continued…

Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
								Median flow during incubation months (Pre- and Post-Project)											
		Aug - post*	62.5	2.3	2.0	1.5	1.0	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
		Sep-pre*	50.6	2.3	1.9	1.5	1.0		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep-post*	55.0	2.3	1.9	1.5	1.0		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Coho		71.2	5.3	2.3	2.1	1.8												
		Sep-pre*	49.0	5.2	2.3	2.0	1.7		51.7	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep-post*	51.3	5.2	2.3	2.0	1.7		54.1	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
		Oct-pre	28.8	5.2	2.3	1.9	1.6			30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Oct-post	28.8	5.2	2.3	1.9	1.6			30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Sockeye		71.2	5.3	2.3	2.1	0.7												
		Aug - pre	66.7	5.3	2.3	2.1	1.9	70.3	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Aug - post	62.5	5.3	2.3	2.1	1.9	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
Reach 3 Side Channels	**Sockeye**	***Sep - pre***	49.5	5.2	2.3	2.0	1.8		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep - post	51.9	5.2	2.3	2.0	1.8		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Dolly V		71.2	5.3	2.3	2.1	2.0												
		Aug - pre*	61.4	5.2	2.3	2.0	1.8	64.7	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Aug - post*	62.5	5.2	2.3	2.1	1.8	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Sep - pre	49.5	1.4	0.8	-	-		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Sep - post	51.9	5.2	2.2	2.0	1.7		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Oct-pre	28.8	4.9	2.1	1.8	1.4			30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Oct-post	28.8	4.9	2.1	1.8	1.4			30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Nov-pre*	17.5	2.4	2.1	1.7	1.4				18.4	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Nov-post*	24.8	4.8	2.1	1.8	1.3				26.2	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
								May	**Jun**	**Jul**	**Aug**								
	Rainbow		71.2	5.1	2.3	2.0	1.8												
		May - pre*	28.8	3.9	2.1	1.8	1.4	30.3	66.4	81.3	70.3								
		May - post*	28.6	3.9	2.1	1.8	1.4	30.2	46.7	65.0	65.8								
		Jun - pre	63.0	5.1	2.2	1.9	1.7		66.4	81.3	70.3								
		Jun - post	44.3	5.0	2.2	1.9	1.6		46.7	65.0	65.8								
Grant Creek	**Chinook**		450	151	122	71	52												
All Reaches		***Aug - pre****	410	146	94	50	43	410	313	182	94	59	45	36	30	31	127	398	493
		Aug - post*	395	145	94	56	40	395	329	182	140	104	91	82	77	78	151	280	390
		Sep-pre*	320	108	36	27	19		313	182	94	59	45	36	30	31	127	398	493
		Sep-post*	348	137	69	41	30		329	182	140	104	91	82	77	78	151	280	390
	Coho		450	226	167	136	92												
		Sep-pre*	310	149	93	64	48		310	182	94	59	45	36	30	31	127	398	493

Table E.4-81, continued…

Reach	Species	Month	Spawning Flow	> 98%	> 90%	> 80%	> 70%	Median flow during incubation months (Pre- and Post-Project) Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
		Sep-post[*]	325	160	102	65	51		325	182	140	104	91	82	77	78	151	280	390
		Oct-pre	182	73	53	23	7			182	94	59	45	36	30	31	127	398	493
		Oct-post	182	73	53	23	7			182	140	104	91	82	77	78	151	280	390
	Sockeye		450	221	151	129	75												
		Aug - pre	422	201	142	110	70	422	313	182	94	59	45	36	30	31	127	398	493
		Aug - post	395	192	136	102	67	395	329	182	140	104	91	82	77	78	151	280	390
		Sep - pre	313	151	53	70	56		313	182	94	59	45	36	30	31	127	398	493
		Sep - post	329	163	92	63	46		329	182	140	104	91	82	77	78	151	280	390
	Dolly V		450	243	203	160	134												
		Aug - pre[*]	388	216	173	139	111	388	313	182	94	59	45	36	30	31	127	398	
		Aug - post[*]	395	217	174	140	112	395	329	182	140	104	91	82	77	78	151	280	
		Sep - pre	313	166	146	121	79		313	182	94	59	45	36	30	31	127	398	
		Sep - post	329	185	148	122	49		329	182	140	104	91	82	77	78	151	280	
Grant Creek		Oct-pre	182	118	72	57	36			182	94	59	45	36	30	31	127	398	
All Reaches		Oct-post	182	118	72	57	36			182	140	104	91	82	77	78	151	280	
		Nov-pre[*]	110	66	29	10	5				110	59	45	36	30	31	127	398	
		Nov-post[*]	157	150	120	80	44				157	104	91	82	77	78	151	280	
								May	Jun	Jul	Aug								
	Rainbow		450	216	163	129	155												
		May - pre[*]	182	140	73	53	29	182	398	488	422								
		May - post[*]	181	139	69	41	12	181	280	390	395								
		Jun - pre	398	209	149	122	74		398	488	422								
		Jun - post	280	190	129	73	56		280	390	395								

This analysis is based upon transects that were selected for habitat modeling as part of the Instream Flow Study conducted for the Project in 2013. Spawning habitat was, and continues to be, sparse in these reaches due to peak flows, relatively high gradient, and low gravel recruitment, resulting in predominantly cobble-boulder substrates.

In general, Grant Creek flows from January through mid-May and in the November through December period will be higher post-Project than they currently are pre-Project (Figure E.4-43). It is also important to note that under pre-Project flows, the Reach 1 Distributary dries up when flows in Grant Creek drop below approximately 180-190 cfs. If Project mitigation measures include altering the entrance to the Reach 1 Distributary, fish habitat, especially spawning and incubation habitat, will increase in this reach.

With these higher November through mid-May flows, incubating salmonid eggs will be afforded higher rates of protection with the Project in place than under the pre-Project regime. As a result, incubation will not be significantly affected, and may be enhanced over natural conditions.

Habitat Time Series

The IFSG requested KHL to conduct a habitat time series analysis for the salmonid life history stages present in Project. This effort required the use of a long-term hydrologic record to compare Grant Creek flows pre-Project to flows for the same time period, with-Project.

The goals and objectives of this analysis were as follows:

- Calculate habitat for the Grant Creek salmonid species and life history stages, as measured by WUA.
- Compare the amount of habitat for the Grant Creek salmonids pre-Project and with-Project for the period of record.

Methods are fully described in KHL (2014i). Data required to conduct the habitat time series analysis are listed below:

- Hydrologic Record. A long-term hydrologic record that extended from Calendar Year (CY) 1948 through CY 2013 was developed. The record was developed for pre-Project flows and with-Project flows and is a composite record of actual and synthesized data.
- Grant Creek final transect weighting for all transects.
- Final Grant Creek WUA, incorporating all species and life history stages for all transects.

Target species and life history stages were summarized in Table E.4-72; Grant Creek periodicity was provided in Table E.4-74. WUA was provided in Tables E.4-77 through E.4-79 and Figures E.4-44 through E.4-46. Hydrology, both pre-Project and with- Project, is summarized above. Daily flows from the expanded 66-year record were used tabulated for the species and life stages for the appropriate time periods, based on the Grant Creek periodicity. Further information can be found in KHL (2014i), Appendix 5.

Chinook Salmon

WUA for Chinook salmon spawning and rearing are shown in Figures E.4-47 to E.4-49. With-Project WUA ranged from 96.9 percent of pre-Project for Chinook fry rearing, to 100.2 percent for Chinook juvenile rearing. Chinook spawning with-Project WUA was 99.5 percent of the pre-Project WUA.

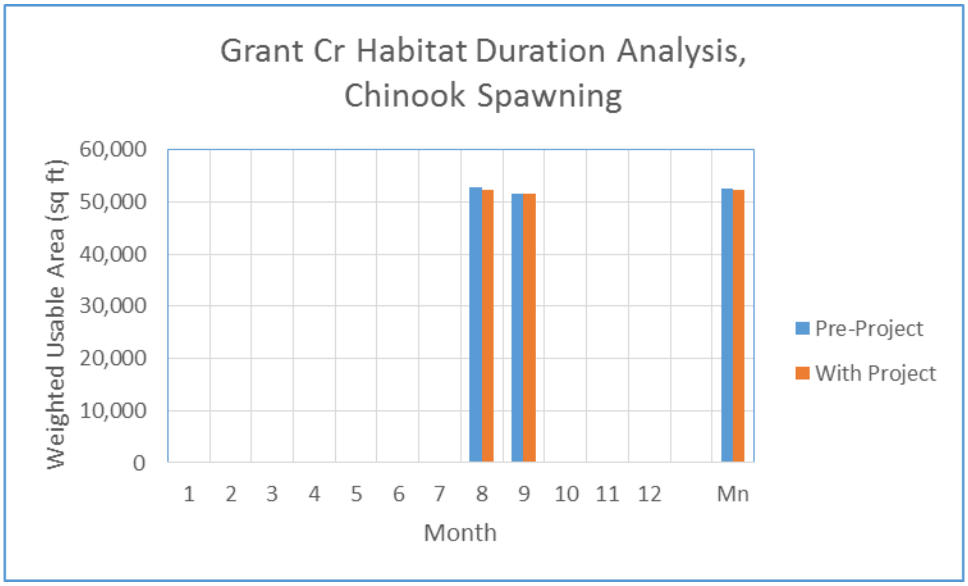


Figure E.4-47. Chinook spawning WUA.

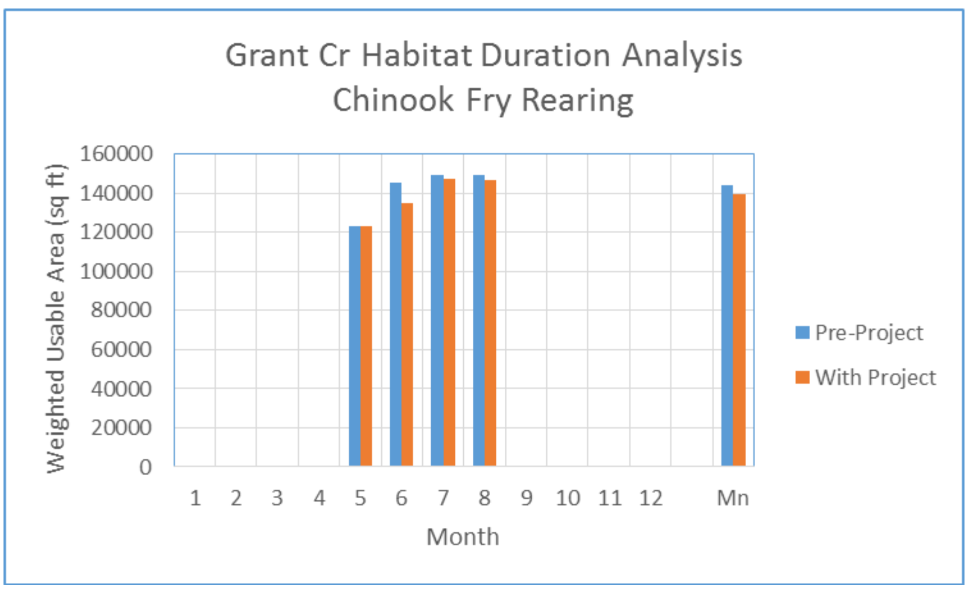


Figure E.4-48. Chinook fry rearing WUA.

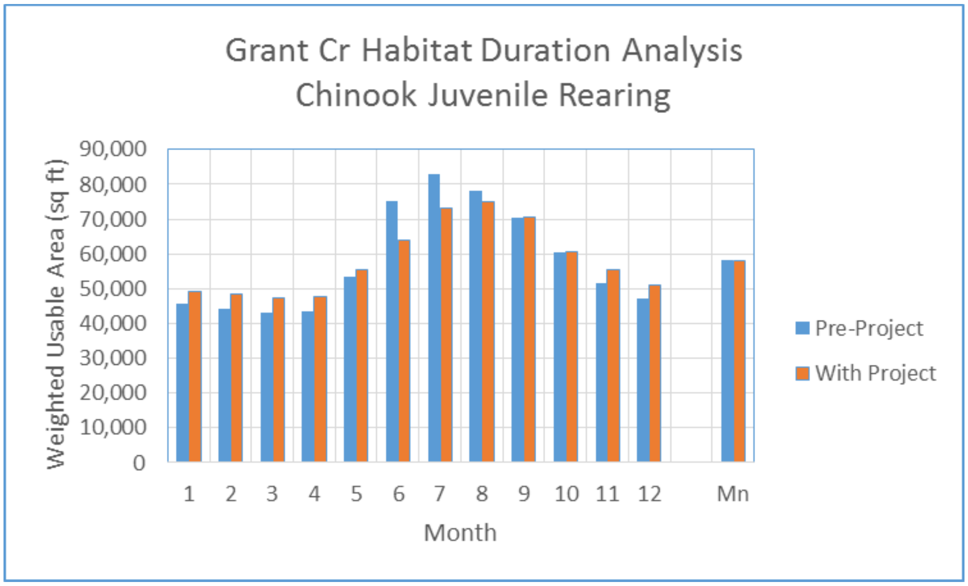


Figure E.4-49. Chinook juvenile rearing WUA.

Coho Salmon

WUA for coho salmon spawning and rearing are shown in Figures E.4-50 to E.4-52. With-Project WUA ranged from 99 percent of pre-Project for coho fry rearing, to slightly more than 100 percent for coho spawning. With-Project coho juvenile rearing WUA averaged 99.2 percent of pre-Project WUA; however, monthly with-Project WUA ranged from 93.9 percent to 103.8 percent of pre-Project WUA. With-Project WUA was generally higher than pre-Project WUA during the late fall – early spring months, when the Project would increase Grant Creek flows.

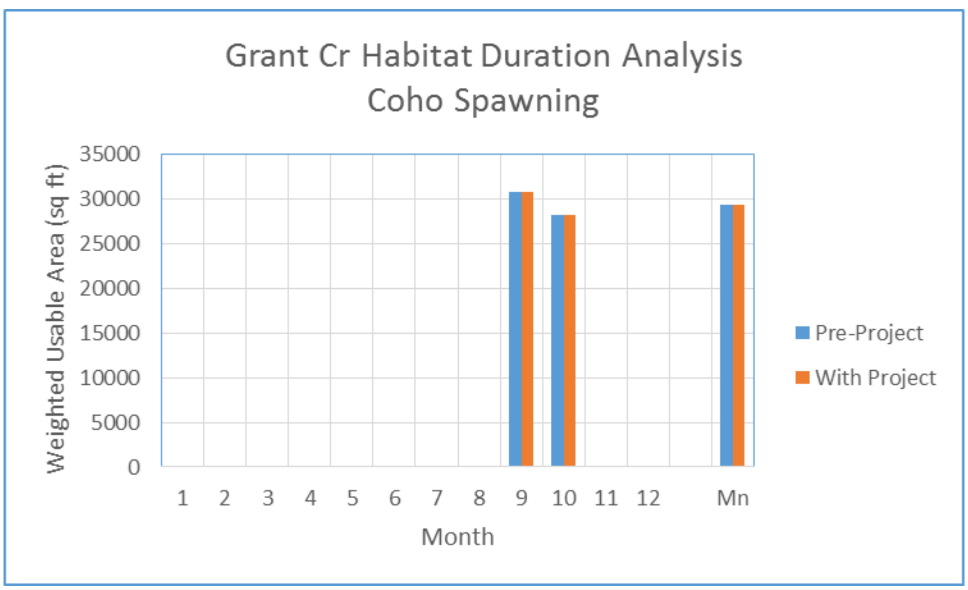


Figure E.4-50. Coho spawning WUA.

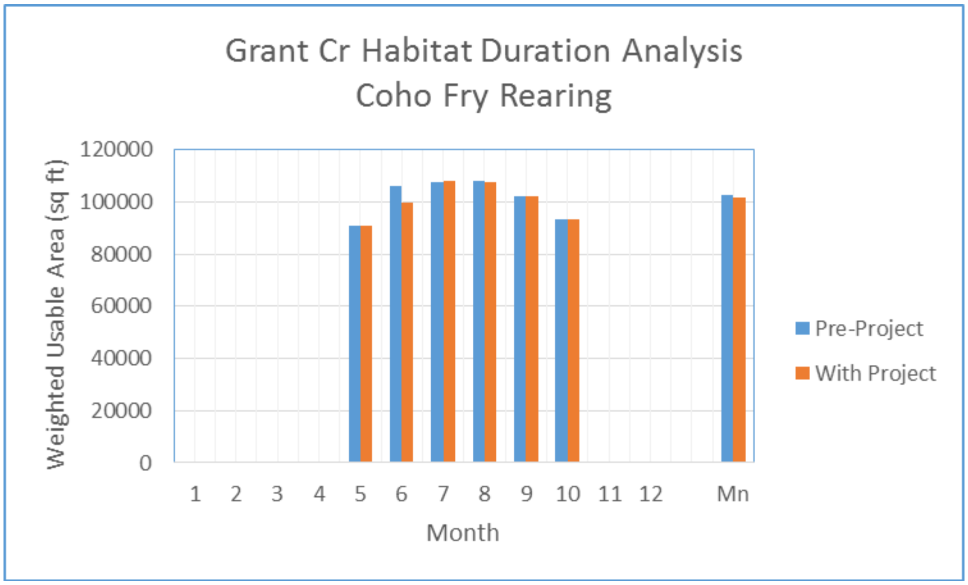


Figure E.4-51. Coho fry rearing WUA.

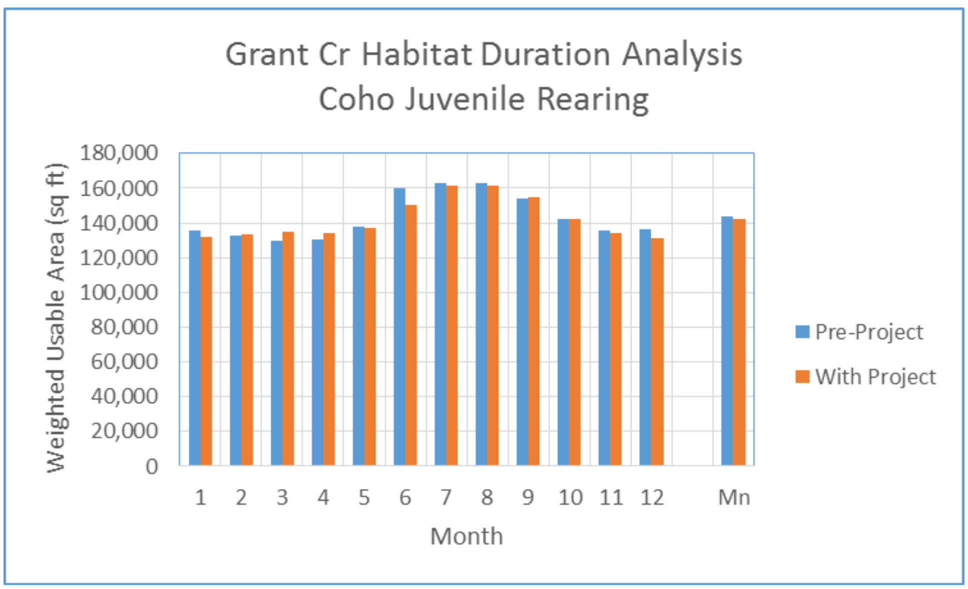


Figure E.4-52. Coho juvenile rearing WUA.

Sockeye Salmon

WUA for sockeye salmon spawning is shown in Figure 4.6-53. With-Project spawning WUA averaged 99 percent of pre-Project WUA, but ranged from 98.0 percent in August to 100.1 percent in September.

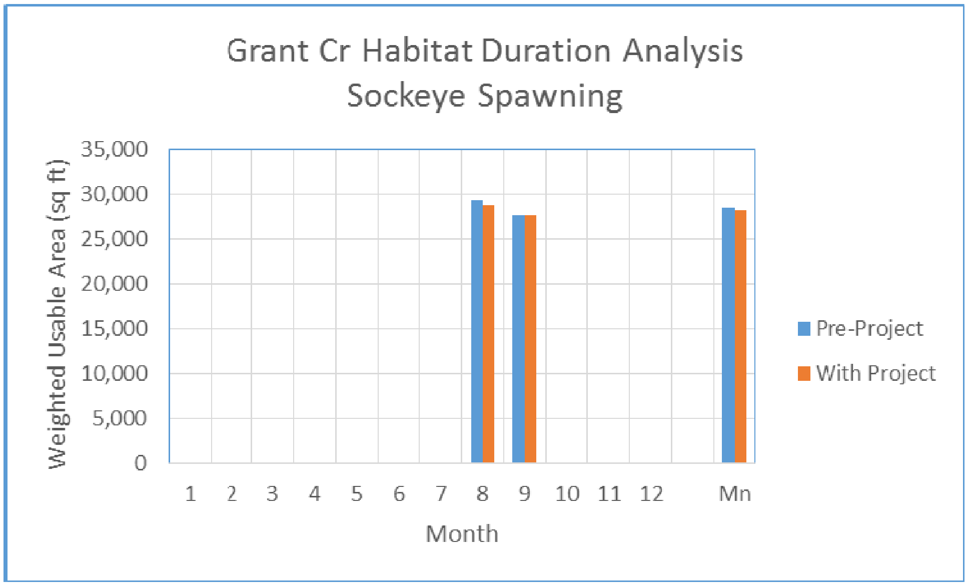


Figure E.4-53. Sockeye spawning WUA.

Dolly Varden

WUA for Dolly Varden spawning and rearing are shown in Figures E.4-54 to E.4-57. With-Project WUA ranged from 96.5 percent of pre-Project WUA for Dolly Varden adult rearing to 102.9 percent for Dolly Varden juvenile rearing. Dolly Varden fry rearing post-Project WUA averaged 98.9 percent of the pre-project WUA, ranging from 94.9 percent to 100.6 percent. With-Project spawning WUA was slightly greater than pre-Project WUA (100.3 percent).

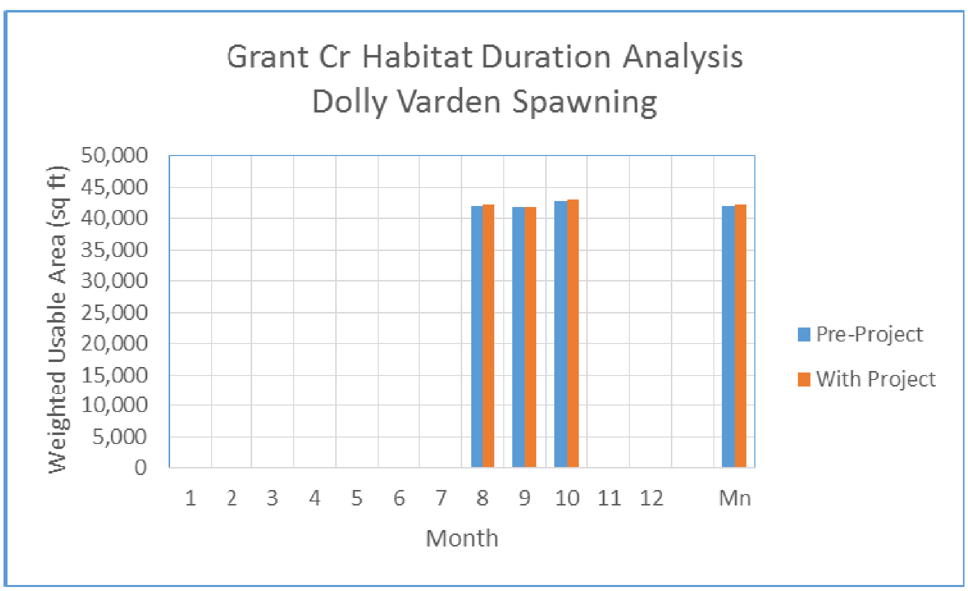


Figure E.4-54. Dolly Varden spawning WUA.

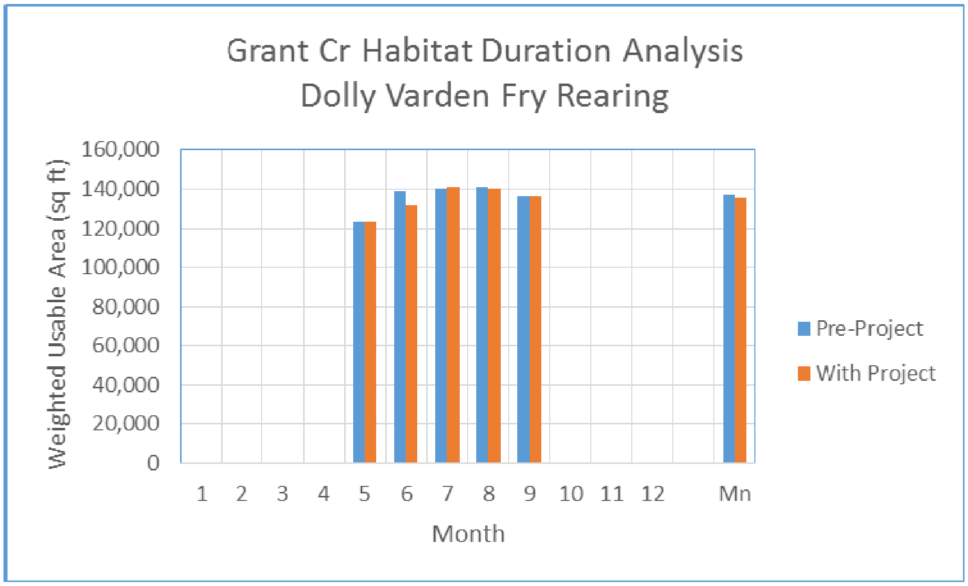


Figure E.4-55. Dolly Varden fry rearing WUA.

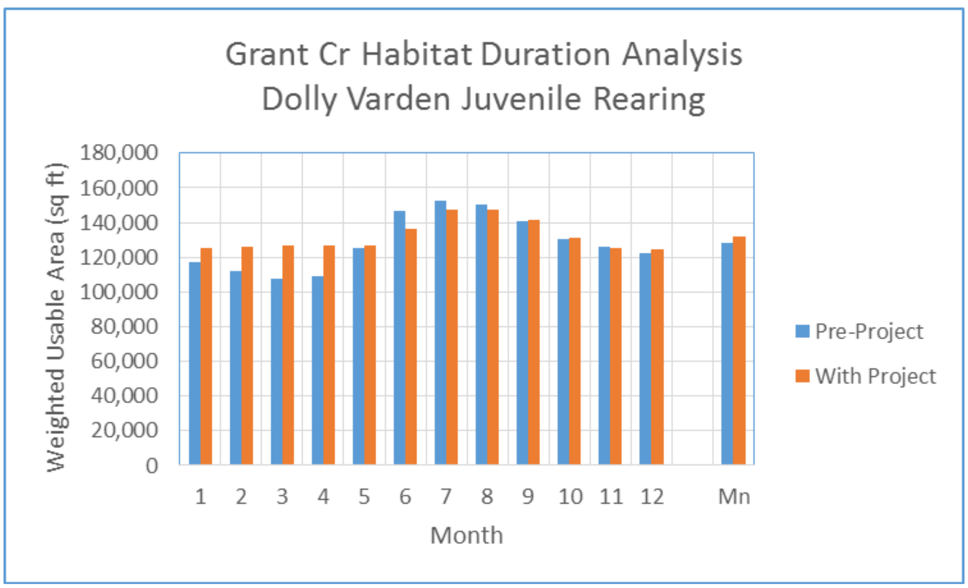


Figure E.4-56. Dolly Varden juvenile rearing WUA.

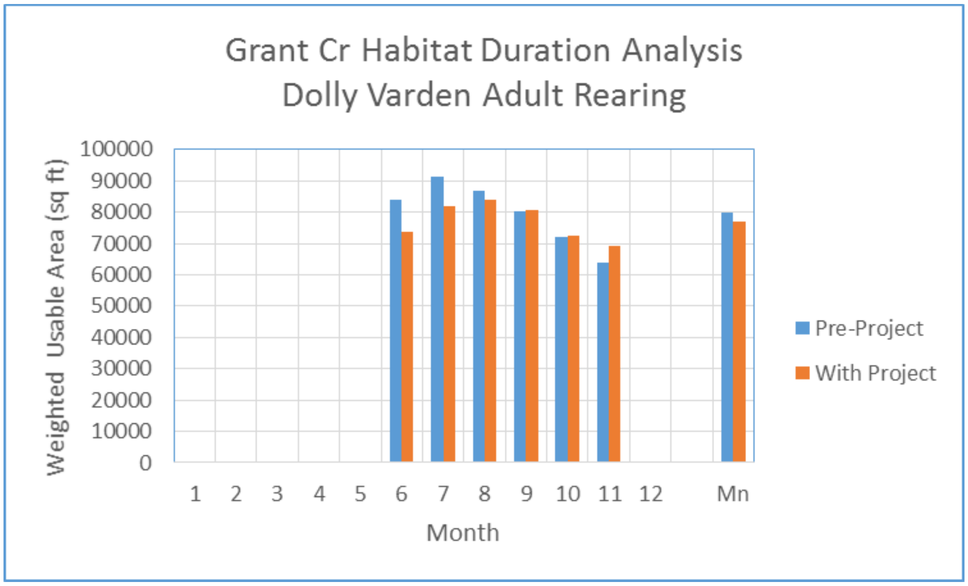


Figure E.4-57. Dolly Varden adult rearing WUA.

Rainbow Trout

WUA for rainbow trout spawning and rearing are shown in Figures E.4-58 to E.4-61. With-Project WUA ranged from 94.2 percent of pre-Project WUA for rainbow trout adult rearing to 101.4 percent for rainbow trout fry rearing. Rainbow trout juvenile rearing with-Project WUA averaged 99.3 percent, ranging from 88.9 percent – 106.8 percent of pre-Project WUA. Rainbow trout spawning with-Project WUA averaged 98.8 percent of pre-Project WUA, ranging from 98 percent to 100.1 percent.

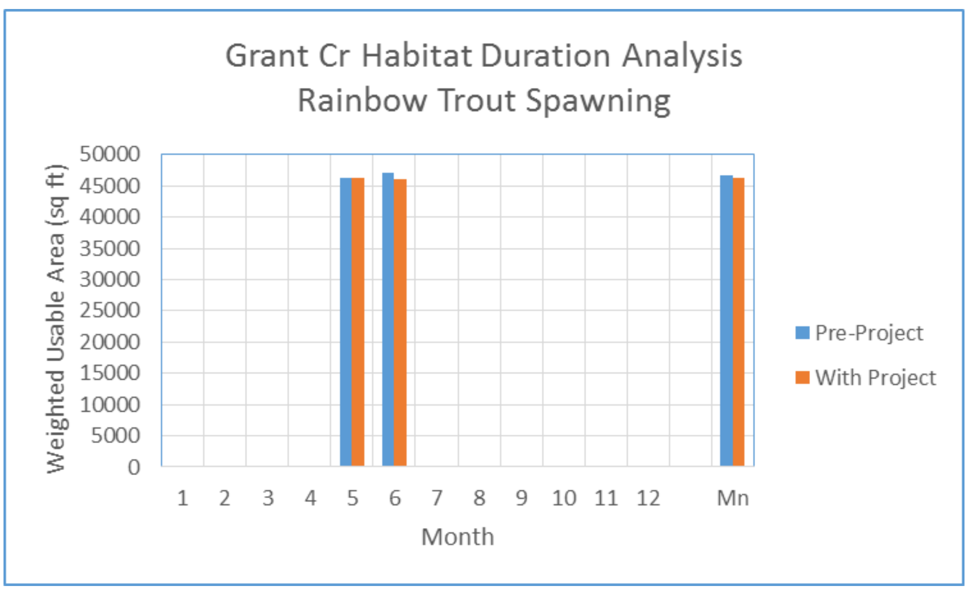


Figure E.4-58. Rainbow trout spawning WUA.

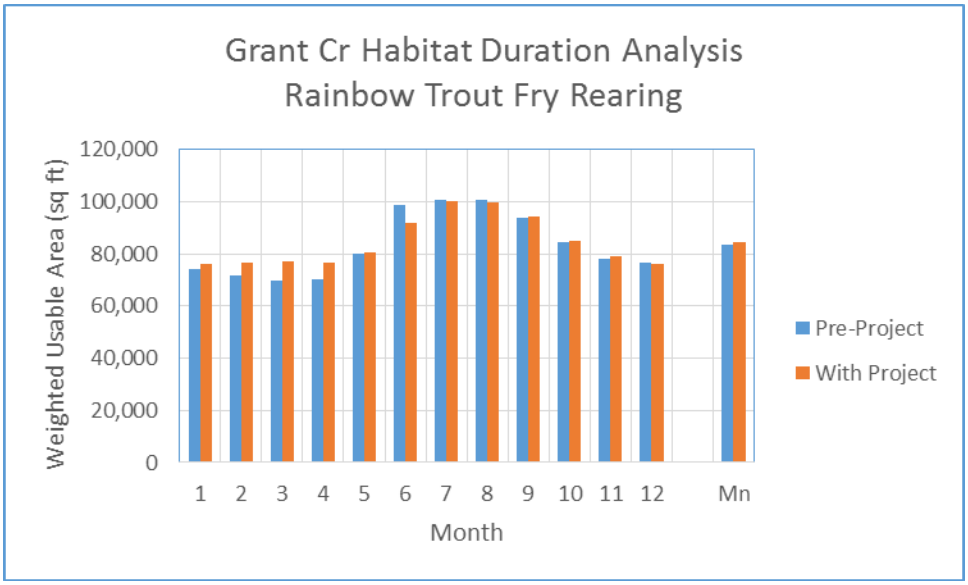


Figure E.4-59. Rainbow trout fry rearing WUA.

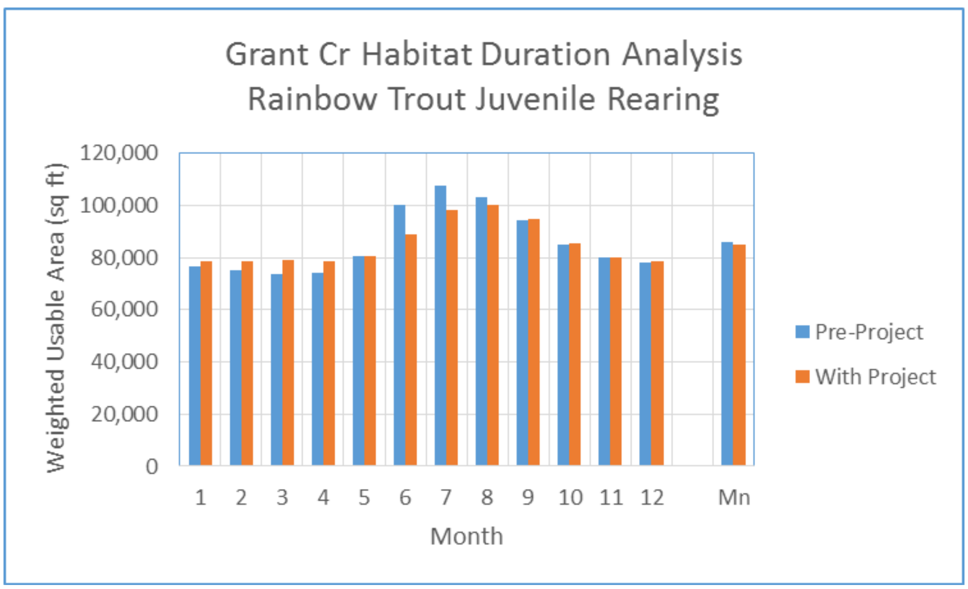


Figure E.4-60. Rainbow trout juvenile rearing WUA.

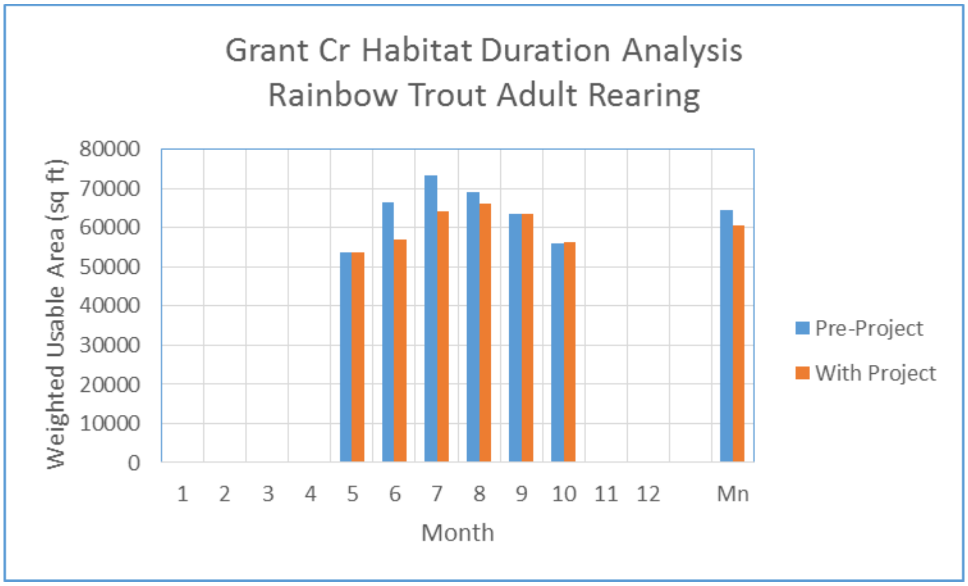


Figure E.4-61. Rainbow trout adult rearing WUA.

Summary

Pre-Project and with-Project WUA for all species and life history stages are shown in Figures E.4-62 to E.4-65 and are listed in Table E.4-82. Overall, with-Project WUA is nearly identical to pre-Project WUA (99.8 percent). With the exception of resident adult (i.e., Dolly Varden and rainbow trout) with-Project rearing WUA (96.7 percent of pre-Project WUA), with-Project WUA is within 0.1 percent or is greater than pre-Project WUA.

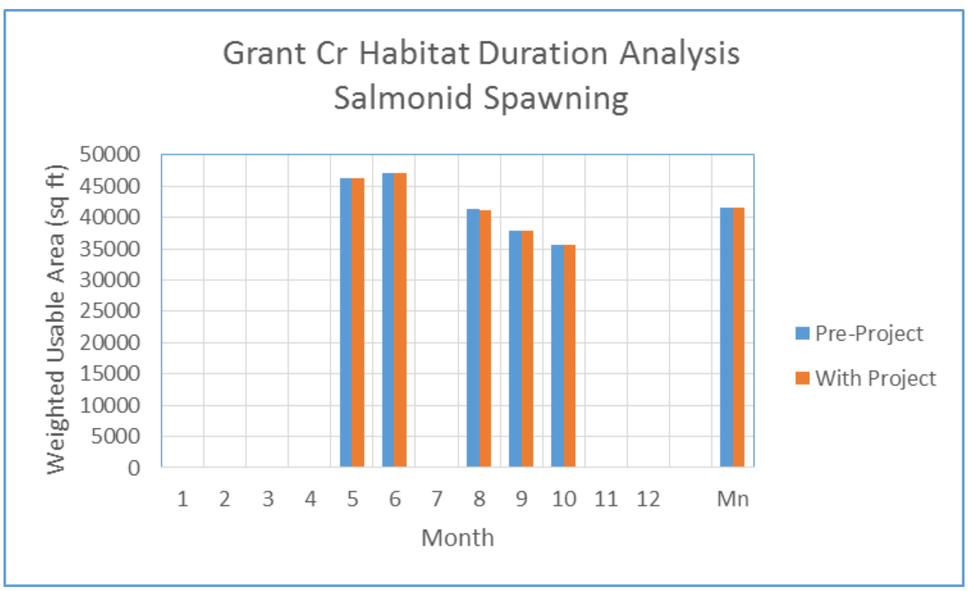


Figure E.4-62. Salmonid spawning WUA.

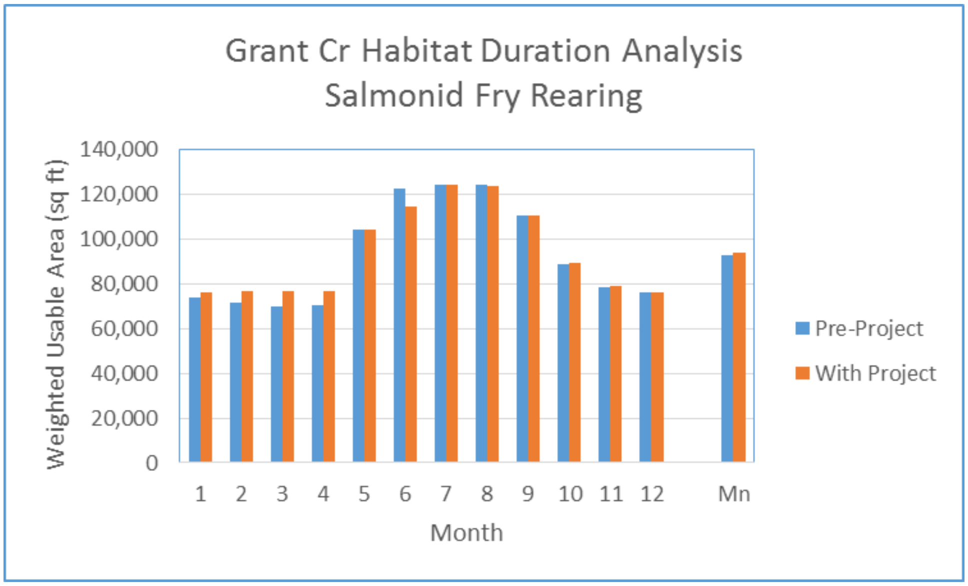


Figure E.4-63. Salmonid fry rearing WUA.

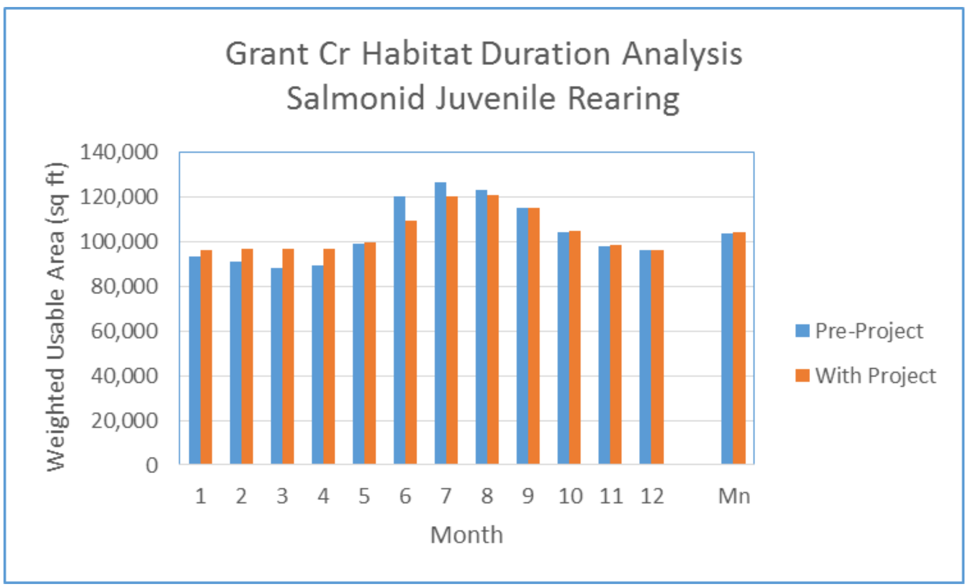


Figure E.4-64. Salmonid juvenile rearing WUA.

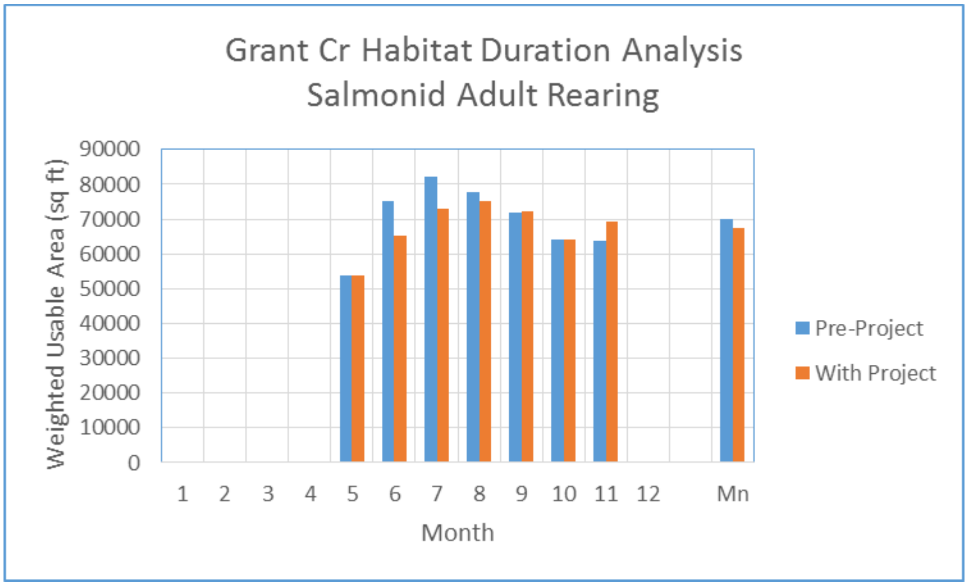


Figure E.4-65. Salmonid adult rearing WUA.

Table E.4-82. Grant Creek pre-Project and with-Project WUA for life history stages.

	Weighted Usable Area		
Life Stage	**Pre-Project**	**With Project**	**Percentage**
Spawning	41,635	41,607	99.93%
Fry Rearing	93,043	94,060	101.09%
Juvenile Rearing	103,890	104,437	100.53%
Adult Rearing	69,868	67,553	96.69%
Mean	***77,109***	***76,914***	***99.75%***

This analysis is based upon final transect weighting, final WUA for each species and life history stage, and the 66-year hydrologic record for pre-Project and with-Project flows.

Overall, with-Project WUA is nearly identical to pre-Project WUA, at 99.8 percent. The lowest with-Project WUA is for Dolly Varden and rainbow trout adult rearing. Adult rearing periodicity for these species extends from mid-May to the end of November. Project flows are reduced during the summer (June – August), which are the reason for lower adult rearing with-Project WUA during this period. If resident fish adult rearing WUA were removed from the analysis, overall with-Project WUA would be 100.6 percent of the pre-Project WUA.

This analysis does not take into consideration potential mitigation and enhancement measures for the Project. For example, currently the Reach 1 distributary does not become wetted until flows in Grant Creek reach approximately 180-190 cfs; even when wetted, this distributary receives less than 1 percent of the Grant Creek flow. If this distributary were to be reconfigured to allow more water into the distributary and at lower Grant Creek flows, WUA for spawning and rearing in this distributary would increase significantly. This proposed enhancement measure, along with documented additional and more consistent flows in the Reach 2/3 side channel complex, will likely increase habitat availability during operations to a level above the current natural condition.

Reach 5 Connectivity

One of the components of the Instream Flow study was to assess connectivity of the habitats present in Reach 5 (i.e., the canyon reach) to determine if reductions in stream flow in this reach potentially affect habitat connectivity.

During the 2013 field season, two transects (T510 and T520) that represented the areas sensitive to changes in flow and stage were selected and measured in Reach 5. Cross sections were surveyed at both transects. Head and tail pins on each bank as well as a benchmark were surveyed to establish relative elevations. A tape was stretched horizontally across the channel and attached to the head and tail pins. With an auto level and stadia rod, elevations of the streambed and banks were surveyed at regular intervals along the tape and WSEs were surveyed at locations where accurate measurements could be obtained. Water surface elevations were surveyed at flows ranging from 17 cfs – 706 cfs. Further details are provided in KHL (2014d).

Connectivity of the various pools and channels was measured and assessed using the Oregon Method (Thompson 1972). After 10 years of research on depth and velocity in streams in Oregon, Thompson concluded that the depth over "the shallow bars most critical of adult passage" was the feature that determined the likelihood of successful migration. Thompson recommends a minimum depth of 0.6 feet for large trout and 0.8 feet for Chinook salmon to achieve successful passage. The "Oregon Method", as it is now commonly called, concludes that the passage flow is adequate when the depth criterion is met on at least 25 percent of the transect width and on at least a 10 percent continuous portion. Transect data were collected to determine where connectivity meets these criteria and where it does not. Connectivity was assessed concurrently with the Instream Flow Study conducted downstream in Reaches 1–4, at the same range of flows. Table E.4-83 specifies the species and minimum depth criteria for passage.

Table E.4-83. Species evaluated for connectivity in Grant Creek.

Species Evaluated	Minimum Depth Criteria
Chinook Salmon	0.80 feet
Coho and Sockeye Salmon	0.60 feet
Dolly Varden Char and Rainbow Trout	0.40 feet

Table E.4-84 shows that for 25 percent of total width, the passage depth criterion for Chinook salmon, is met on individual transects from 6-29 cfs, with an average of 22 cfs. Discharges for continuous passage meet criterion at flows ranging from 5-21 cfs, with an average of 21 cfs. The discharges at which both passage criteria are met range from 6-29 cfs, with an average of 22 cfs.

The 25 percent of total width, the passage depth criterion for coho and sockeye salmon, is met on individual transects at flows ranging from 5-11 cfs, with an average of 10 cfs. Discharges for continuous passage meet criterion at flows ranging from 5 cfs – 10 cfs, with an average of 10 cfs. The discharges at which both passage criteria are met range from 5-11 cfs, with an average of 10 cfs.

For Dolly Varden and rainbow trout, the passage depth criterion for 25 percent of total width is met on individual transects at 5 cfs. Discharges for continuous passage meet criterion also at a flow of 5 cfs. The discharge at which both passage criteria are met is at a flow of 5 cfs.

In 2013, less than 2 percent of the adult salmonids were observed in Reach 5, none of which was a Chinook salmon. For all other adult salmonids, flows in Reach 5 are sufficient for all or a portion of their spawning period.

Table E.4-84. Discharge (cfs) for meeting salmonid passage criteria in Reach 5, Grant Creek.

Species	Passage Criteria	T510	T520	Average
Trout	Total (25%)	5	5	5
	Continuous (10%)	5	5	5
	Both Criteria	5	5	5
Coho	Total (25%)	11	5	5/10[1/]
	Continuous (10%)	10	5	5/10[1/]
	Both Criteria	11	5	5/10[1/]
Chinook	Total (25%)	29	6	22
	Continuous (10%)	21	5	21
	Both Criteria	29	6	22

Notes:
1. Criterion is met at 5 cfs, and then is below criterion until 10 cfs.

4.6.2.3. Benthic Macroinvertebrates and Periphyton

During Project construction, the potential of elevated turbidity levels may negatively affect macroinvertebrate species sensitive to sedimentation. In addition, the potential for elevated turbidity could decrease chlorophyll *a* concentrations due to decreased water clarity and photosynthetic activity. Since the scraper functional feeding group that relies on chlorophyll *a* as a food resource represent a low percentage of the total population, the effect is anticipated to be minimal and of short duration.

Due to the similarity in water quality between Grant Lake and Grant Creek, there would be very little impact on the water chemistry of Grant Creek due to Project operations. As summarized in Table E.4-13 (Section 4.5.1.3.2 of this Exhibit E), drawing water for Project use from relatively shallow depths ($\leq$ 1.5m) in Grant Lake would best duplicate the existing water temperature regime in Grant Creek and prevent changes to this critical habitat parameter. Finally, the change in flow regime due to Project operations is expected to have little effect on macroinvertebrate populations. With an elevated base flow, wetted perimeter and available habitat will be increased from pre-Project conditions on an annual basis. The reduction in peak flows is also expected to have a minimal effect on aquatic insects. The annual, summer high flow period represents a condition where nearly all stream habitats within Grant Creek experience high velocities. With reduced flows and velocities, habitat conditions may become more favorable and comparable to other high gradient stream systems in the Kenai Peninsula.

4.6.3. Proposed Environmental Measures

4.6.3.1. Fisheries

Global adherence to BMPs will be utilized in conjunction with all Project construction and operation related activities. With respect to fisheries resources, ensuring that short-term erosion and/or sediment load increases do not occur with construction activities. An ESCP, as described in Section 4.4.3 of this Exhibit E, will be implemented to minimize aquatic impacts as a result of sediment load increases.

Specific to fisheries resources, a Draft Biotic Monitoring Plan is under development by KHL and will be distributed for comment with the rest of the BE and management/monitoring plans between late April and mid-May. This plan will document monitoring efforts to be implemented during Project construction and the initial phases of operations. This plan is primarily fisheries-based and describes the measures to be employed to assess/confirm fish health and general condition during and immediately after Project construction and operation. During construction of the Project, focus will be placed on confirming that pre-existing priority sites for spawning, incubation and rearing are being maintained. Once operation has commenced, additional emphasis will be placed on documenting that Project operations are not having a net negative impact on Grant Creek and to some extent, confirming that the enhancement measures proposed in the plan are providing the additional habitat projected via modeling exercises. While refinement of the plan will occur per comments received after review and additional collaboration with stakeholders, the primary intent is to confirm no negative impact to documented fisheries populations in Grant Creek as a result of Project implementation.

During construction, all activities associated with BMPs and the monitoring and management plans will be managed by KHL's on-site ECM. Annually, all measures implemented, associated results, and collaboration with stakeholders will be documented in the Annual Compliance Report. The report will be provided to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.6.3.2. Instream Flow

As part of Project development, KHL has conducted studies and collaborated with stakeholders on acceptable instream flow amounts through the bypass reach (Reach 5). As a result of Project operations, water will be utilized for power generation effectively limiting flows in Reach 5 to some extent for the entirety of the year. During project construction, a pipe coming directly from the tunnel will distribute the agreed upon instream flow amount to the top end of Reach 5 immediately below the falls in Grant Creek. This water is being provided to maintain anadromous and resident passage in Reach 5. A 12-inch diameter pipeline will be installed using directional bore techniques from the new intake structure in the lake to the base of the falls. An overflow weir and control gate will be installed in the intake to allow controlled release of water from the lake to the base of the falls. The water will be pulled from the surface of the lake to maintain consistent temperature conditions at the base of the falls and within Reach 5 below. The amount of flow released will be controlled through the overflow weir in the intake where an accurate flow measurement can be accomplished.

KHL proposes instream flows of 5 cfs from January 1 – July 31, and November 1 – December 31. This period includes rainbow trout periodicity, and connectivity for trout is achieved at a flow of 5 cfs. From August 1 – September 7, KHL proposed a flow of 10 cfs in Reach 5. Chinook and sockeye salmon and Dolly Varden char spawn during this period. Connectivity is achieved for Dolly Varden at a flow of 5 cfs and then 10 cfs for sockeye salmon and 22 cfs for Chinook salmon. No Chinook, however, have been observed in Reach 5. From September 8 – October 31, KHL proposes a flow of 7 cfs. Sockeye and coho salmon and Dolly Varden char spawn during this period. Connectivity is achieved at a flow of 5 cfs for Dolly Varden, and 5 cfs, then 10 cfs for sockeye and coho salmon. It is important to note that during the study period, only 1.3 percent of adult salmon were observed in Reach 5. As proposed, the Project will provide additional flows to Reaches 1-4, including the side channels and distributary during the fall, winter, and early spring period, increasing the amount of fry, juvenile, and adult rearing habitat in Grant Creek below Reach 5 to a point that is anticipated to significantly increase the overall production potential for all fish species in Grant Creek. Confirmation of adherence to the instream flow requirements will be incorporated into the Annual Compliance Report. The report will be provided to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.6.3.3. Benthic Macroinvertebrates and Periphyton

Global adherence to BMPs will be utilized in conjunction with all Project construction and operation related activities. With respect to macroinvertebrates and periphyton, ensuring that short-term erosion and/or sediment load increases do not occur with construction activities. An ESCP, as described in Section 4.4.3 of this Exhibit E, will be implemented to minimize aquatic impacts as a result of sediment load increases.

During construction, all activities associated with BMPs and the monitoring and management plans will be managed by KHL's on-site ECM. Annually, all measures implemented, associated results and collaboration with stakeholders will be documented in the Annual Compliance Report. The report will be provided to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.6.4. Cumulative Effects Analysis

FERC's SD2 (FERC 2010b) identified potential cumulative effects related to construction and operation of the Project for fisheries resources. Given the lack of fisheries resources in Grant Lake, the focus of KHL's fisheries studies was on Grant Creek and the Trail Lakes Narrows area. Based on those comprehensive assessments, development of the proposed operational regime and a high level of collaboration with stakeholders, KHL believes that any cumulative effect associated with Project development will at a minimum, have no net impact on aquatic resources and more likely, produce positive effects.

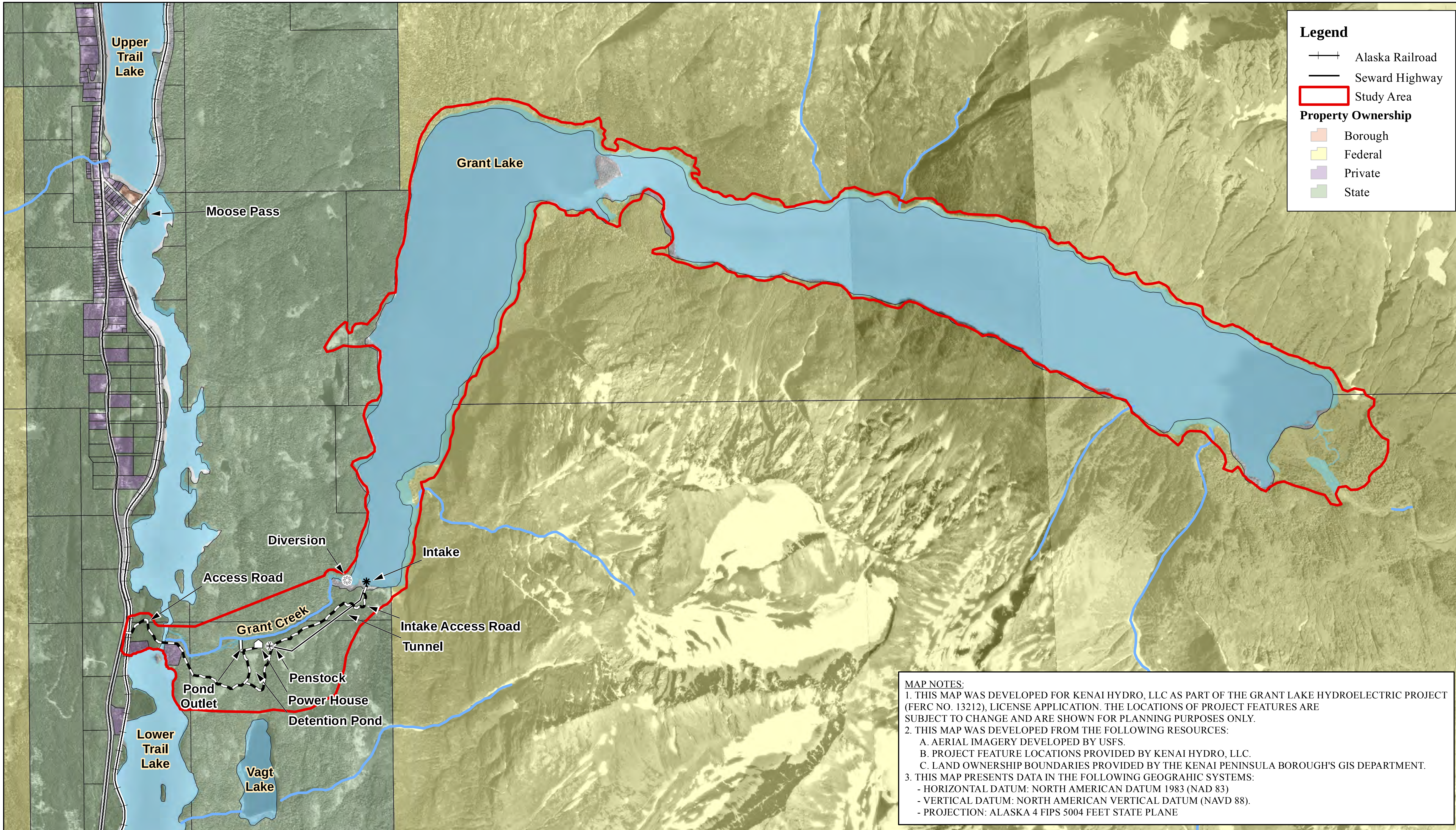
KHL is not intending to obscure the fact that flows will be significantly reduced in Reach 5. However, as previously documented, Reach 5 contains a minimal amount of the overall suitable aquatic habitat in Grant Creek. This combined with the measures that KHL will detail in the Draft Biotic Monitoring Plan and the associated data from which those measures are derived, provides substantive evidence that Grant Creek will contain a significantly higher amount of stable, quality aquatic habitat under the operational regime currently proposed by KHL. The result of this increased habitat would be higher production potential for aquatic species utilizing Grant Creek and as a result, have a direct benefit to the overall aquatic resource composition of the Kenai River drainage.

4.6.5. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources studies implemented by KHL, the aforementioned monitoring and management plans and the associated coordination with stakeholders, KHL has identified no aquatic-related unavoidable adverse impacts associated with construction and operation of the Project.

4.7. Terrestrial Resources

This section describes the terrestrial resources evaluated for the Project: 1) terrestrial vegetation, invasive plants, and sensitive plants; 2) wetlands and waters; and 3) wildlife. The Terrestrial Resources Study area extends from east of the Seward Highway and Alaska Railroad adjacent to Moose Pass, to just past the eastern shoreline of Grant Lake (Figure E.4-66). From south to north, the study area extends south along the highway to just south of Grant Creek and north to just beyond the north shoreline of Grant Lake. Terrestrial resources were evaluated with respect to each resource's potential nexus to the Project features, and includes the area determined to capture the spatial limits of potential direct and indirect impacts to the terrestrial resource disciplines evaluated. For the wildlife study, resources were evaluated within the entire Terrestrial Resources Study area. In contrast, all of the other terrestrial resource disciplines created a more focused assessment area within this collective Terrestrial Resources Study area (KHL 2014f).



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Drawing Scale:

0 0.25 0.5 1 Miles

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Developed For:

Homer Electric Association, Inc.

A Touchstone Energy® Cooperative

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Figure E.4-66
2013-14 Natural Resources Study Area

DESIGNED Jake Woodbury
DRAWN Jake Woodbury
CHECKED C. Warnock
ISSUED DATE 11/20/2014
SCALE: 1:27,000
DRAWING

4.7.1. Affected Environment

4.7.1.1. Terrestrial Vegetation, Invasive Plants and Sensitive Plants

4.7.1.1.1 Upland Terrestrial Vegetation

An upland vegetation type map of the general vegetation Project area was updated using aerial photograph imagery and ground truthing during the 2013 Terrestrial Resources Study (KHL 2014f; Figure E.4-67). Figures 3.3-2 through 3.3-6 in the Terrestrial Resources Study, Final Report (KHL 2014f) show more detailed information regarding the upland vegetation in the vegetation study area. Wetland vegetation types are discussed in detail in Section 4.7.1.2 of this Exhibit E. The vegetation study area contains a total of 5 upland vegetation types, including Coniferous Forest, Coniferous-Deciduous Forest, Alder Scrub, Grass-Forb Meadow, and Floodplain Forest and Scrub. The upland vegetation types, total acres, and percentages of the vegetation study area are presented in Table E.4-85. All of these upland vegetation types are widespread in the region. A short description of each upland vegetation type is provided below.

Table E.4-85. Upland vegetation types, acres, and percentages within the vegetation study area.

Vegetation Type	Acres[1]	Percent	Dominant Species
Coniferous Forest	173.7	30.5%	Lutz spruce, mountain hemlock, rusty menziesia, early blueberry, twinflower
Coniferous-Deciduous Forest	177.1	31.0%	Lutz Spruce, paper birch, poplar, quaking aspen, rusty menziesia
Alder Scrub	34.5	6.0%	Sitka alder, goatsbeard, willow species, devil’s club
Grass-Forb Meadow	2.2	0.4%	Bluejoint wheatgrass, goatsbeard, red raspberry, highbush cranberry
Floodplain Forest and Scrub	106.0	18.6%	Lutz spruce, poplar, paper birch, Sitka alder, willow, sedge species, river beauty, bluejoint reedgrass
Wetlands	77.1	13.5%	Refer to Section 4.7.1.2
Total	570.5	100.0%	

Notes:

1. Wetland acreages presented in Table E.4-85 differ from that in and Table E.4-86 because the value in Table E.4-85 is for the entire Terrestrial Resources Study area, whereas, that for Table E.4-86 is for the wetlands assessment area only.

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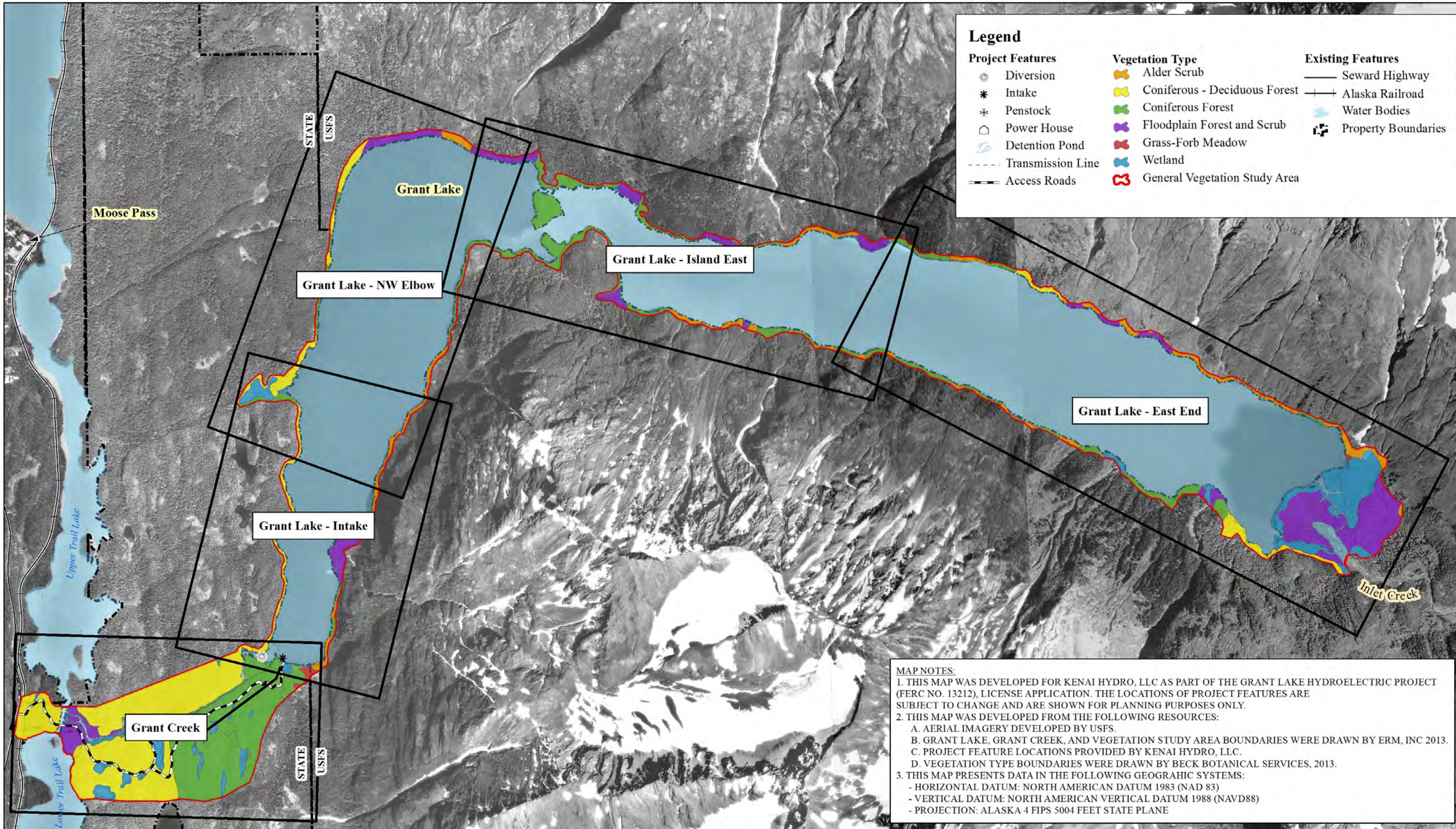

REV	DATE	BY	DESCRIPTION

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Drawing Scale:

0 0.2 0.4 0.8 Miles

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Figure E.4-67
Upland Vegetation Types

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED K. Beck
ISSUED DATE 2/26/2015

DRAWING

SCALE: 1:24,600

Coniferous Forest is a common vegetation type in the vegetation study area, occurring on 173.7 acres, and comprising 30.5 percent of the vegetated area. This vegetation type is represented by stands of Lutz spruce (*Picea x lutzii*), mountain hemlock (*Tsuga mertensiana*), and mixed Lutz spruce and mountain hemlock. Lutz spruce is a hybrid between Sitka spruce (*Picea sitchensis*) and white spruce (*Picea glauca*). Much of the forest in the vegetation study area is old growth. Evidence of past logging of some larger trees within the vegetation study area was observed during the Terrestrial Resources Study (KHL 2014f) in the vicinity of the Alaska Railroad and the Seward Highway. The understory layer is dense with tall shrub species, including rusty menziesia (*Menziesia ferruginea*), early blueberry (*Vaccinium ovalifolium*), and Alaska huckleberry (*Vaccinium alaskaense*). Common low-shrubs include: five-leaf bramble (*Rubus pedatus*), twinflower (*Linnaea borealis*), lingonberry (*Vaccinium vitis-idaea*), bunchberry (*Cornus canadensis*), crowberry (*Empetrum nigrum*), and Labrador tea (*Ledum groenlandicum*).

The Coniferous-Deciduous Forest is the most common vegetation type in the vegetation study area, occurring on 177.1 acres, and comprising 31.0 percent of the vegetated area. It is characterized by codominant stands of paper birch (*Betula papyrifera*) and Lutz spruce on typically well-drained, upland terrain. Mountain hemlock, poplar (*Populus balsamifera*), and quaking aspen (*Populus tremuloides*) may be present in the overstory canopy. Common understory shrubs include rusty menziesia, trailing black currant (*Ribes laxiflorum*), prickly rose (*Rosa acicularis*), Beauvard spiraea (*Spiraea stevenii*) and highbush cranberry (*Viburnum edule*).

The Alder Scrub vegetation type is represented by stands of often closed canopy Sitka alder (*Alnus viridis* ssp. *sinuata*) on the steep, avalanche-prone slopes around Grant Lake. It occurs on 34.5 acres and comprises 6.0 percent of the vegetated area. High snowfall and frequent avalanche activity determine the distribution of Alder Scrub and other plant communities on these slopes. These often dense stands of Sitka alder frequently have a sparse understory or an understory that is dominated by shorter shrubs, including goatsbeard (*Aruncus dioicus*), willow (*Salix* sp.) species, and devil's club (*Oplopanax horridum*). Coniferous tree seedlings and saplings were commonly observed in this vegetation type.

In the vegetation study area, the Grass-Forb Meadow vegetation type forms a mosaic with the Alder Scrub vegetation type and is mostly included as small, unmapped patches on the steep slopes above Grant Lake. Two larger Grass-Forb Meadows are mapped in the vegetation study area. The Grass-Forb Meadow vegetation type is the least common type in the vegetation study area, occurring on 2.2 acres, and comprising 0.4 percent of the vegetated area. The dominant plant species in this vegetation type is the tall, rhizomatous grass species bluejoint reedgrass (*Calamagrostis canadensis*), which often forms extensive swards. Forb associates are often diverse. Associated shrub species include goatsbeard, red raspberry (*Rubus idaeus*), and highbush cranberry.

The Floodplain Forest and Scrub vegetation type covers 106.0 acres of the vegetation study area, constituting 18.6 percent of the vegetated area. This vegetation type occurs on floodplain gravel bars that are successively colonized by herbaceous, shrub, and tree species. This type is often comprised of a mosaic of upland and wetland areas (described in Section 4.7.1.2 of this Exhibit E). The substrate of this vegetation type is typically well-drained sand, silt, gravel, and cobble. Upland portions within this type include: forests comprised of Lutz spruce, poplar, and sometimes paper birch; stands of large poplar, and stands of Sitka alder and willow species. In the earliest seral areas, herbaceous meadows are dominated by sedge species (*Carex* species), river beauty (*Chamerion latifolium*) bluegrass species (*Poa* species), bluejoint reedgrass, and horsetail species (*Equisetum* species).

Upland vegetation around Grant Lake is comprised of large stands of Coniferous Forest and Coniferous-Deciduous Forest on moderate slopes at the south east end, the elbow area, and the southwest shore. Steep, avalanche-prone slopes around the lake support extensive stands of the Alder Scrub vegetation type. Larger patches of the Grass-Forb Meadow vegetation type are located at the east and west ends of Grant Lake. Sizable stands of the Floodplain Forest and Scrub vegetation type are located on the wide floodplain associated with Inlet Creek and along outwash fans and floodplains associated with small drainages areas along the Grant Lake shore. Upland vegetation along Grant Creek and the Project feature corridor includes extensive stands of Coniferous Forest and Coniferous-Deciduous Forest. A large stand of the Floodplain Forest and Scrub vegetation type is present along lower Grant Creek, to where it enters the Trail Lake Narrows. In general, upland vegetation in the vegetation study area is influenced by natural successional patterns and periodic disturbance associated with natural processes like fires, spruce beetle outbreaks, flood events, and avalanches. Upland vegetation in most of the Grant Lake vegetation study area is currently largely unaffected by human activities.

4.7.1.1.2 Invasive Plants

Overall, very few populations of invasive plants were observed in the invasive plant study area during the Terrestrial Resources Study (KHL 2014f). Populations of the following four invasive plants were documented: annual bluegrass (*Poa annua*), Kentucky bluegrass (*Poa pratensis*), common dandelion (*Taraxacum officinale*), and white clover (*Trifolium repens*). Populations of each of these invasive species have previously been mapped in the vicinity of the invasive plant study area on State of Alaska lands (USFS 2013).

During the 2013 study, common dandelion and white clover were located along the Seward Highway ROW in the invasive plant study area. In addition, a small population of timothy (*Phleum pratense*) was observed in the invasive plant species study area along the Seward Highway in 2014. Common dandelion was located along the Alaska Railroad ROW. Annual bluegrass, Kentucky bluegrass and common dandelion were located on the Grant Lake Trail where it enters the invasive plant study area on the west end of the northshore of Grant Lake (USFS land). Ten scattered small- to medium-sized populations of common dandelion were scattered around Grant Lake in areas with exposed soil or gravel on State of Alaska and USFS lands. In the invasive plant study area, invasive plants were most likely to be located in areas where the substrate has been disturbed or where bare soil has been exposed. Except for the Grant Lake shoreline, invasive plants were not observed in areas that do not experience appreciable human disturbance. In addition to the five species of invasive weeds located in the invasive plant invasive plant study area, populations of common plantain (*Plantago major*) and alsike clover (*Trifolium hybridum*) have been documented previously within 0.25 mile of the invasive plant study area (USFS 2013).

4.7.1.1.3 Sensitive Plants

The USFS protects plant species designated as "sensitive" and species that are formally listed as threatened or endangered under the ESA. Aleutian shield fern (*Polystichum aleuticum*) is the only federally listed or proposed plant species within the range of the sensitive plant study area (USFWS 2013). Because no habitat for it is present within the Project vicinity, it was not expected to occur, and was not observed during fieldwork (KHL 2014f). A small population of the sensitive plant pale poppy (*Papaver alboroseum*) was located on USFS lands in the sensitive plant study area during the 2013 field surveys.

Pale poppy is distributed from the Kuril Islands to south central Alaska and is disjunct to north central British Columbia (Goldstein et al. 2009). Pale poppy requires open, well-drained habitat, and occasional disturbance either creates or maintains this habitat. One-time (as opposed to recurring) disturbances by humans can create habitat for the poppy. While some human disturbance may help maintain suitable open habitat, repeated disturbance may have affect the plant's ability to reproduce (Charnon 2007). In the sensitive plant study area, twenty pale poppy plants were observed growing on a semi-stabilized, sparsely vegetated, south-facing creek outwash area near the Grant Lake shore, on a cobble, sand, and gravel substrate. The nearest plants were 8 feet away from and between 1 and 3 feet (704-707 feet in elevation) higher than the natural maximum lake elevation of 703 feet.

The Grant Lake pale poppy population is located in the Floodplain Forest and Scrub vegetation type. Vegetation present at the site was an early successional community with shrubs, forbs, and graminoids. The population and habitat appear to be increasingly shaded due to natural vegetative succession. Dense Sitka alder and willow shrubs and seedlings dominate the site. Approximately half of the pale poppy plants in the population were growing under low Sitka alder branches. The more densely shaded pale poppy plants were smaller and had fewer capsules than plants that were in less shade. If natural vegetation succession in the vicinity of the Grant Lake pale poppy site continues without natural disturbance from an avalanche or flood event, it is likely that the already small population will decline in numbers and eventually disappear due to the species' requirement for open, well-drained habitat.

There is an historic cabin, a campsite and two campfire rings with evidence of recent use on the small gravel bar where the pale poppy population was located. During the 2013 Terrestrial Resources Study (KHL 2014f), there was no visible evidence of trampling of plants, although plants were as close as 5 feet away from one of the campfire rings. The only invasive plant species present in the vicinity of the pale poppy population was common dandelion (*Taraxacum officinale*).

4.7.1.2. Wetlands

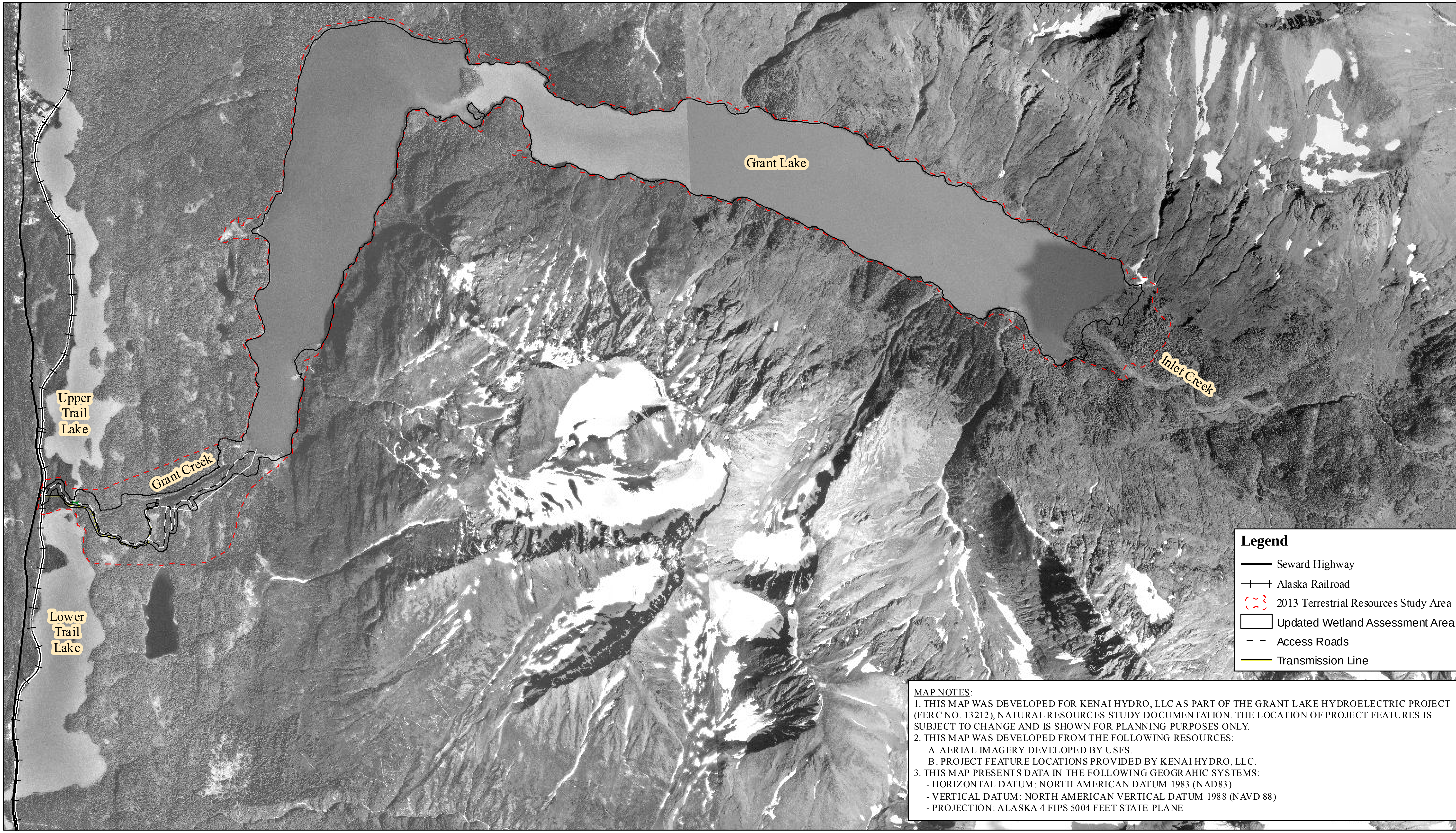
This section describes the waters of the U.S. (WOUS) within the Project area, which includes both wetlands and waters. Wetlands are defined for regulatory purposes under the CWA as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Waters (also referred to as "non-vegetated water") are defined as any non-vegetated area with a bed and bank, including intermittent, ephemeral, or perennial streams, rivers, or standing water (lakes and ponds). For the purpose of the DLA, all WOUS are referred to collectively as "wetlands" or "wetlands and waters."

The "waters" portion of this section overlaps with the two previous sections of this Exhibit E, Section 4.5, Water Quality and Quantity, and Section 4.6, Aquatic Resources (Instream Flow). Section 4.5 presents a detailed discussion of the hydrology, water chemistry, and temperature of Grant Creek and Grant Lake; and Section 4.6 presents a detailed discussion on the instream flow of Grant Creek, as related to fish habitat. This section is intended to provide a more general assessment of the waters with a focus on the regulatory needs for the CWA Section 404 permit application (KHL 2015b), which will be submitted to the USACE in early 2015.

Figure E.4-68 presents the wetlands and waters assessment area (referred to as the wetlands assessment area or WAA), within the broader Terrestrial Resources Study Area. The WAA is described in detail in the Terrestrial Resources Study, Final Report (KHL 2014f), and includes: 1) Grant Lake to approximately the 705-foot elevation contour along the lake shore[5]; 2) the area within a 100-foot buffer around Grant Creek; and 3) the area within 100 feet of all Project infrastructure features. The 2013 WAA reported in the Terrestrial Resources Report (KHL 2014f) was updated in December 2014 to reflect the addition of the surge chamber and access road, and switchbacks along the intake access road. Figure E.4-68 reflects the 2014 WAA. Note that areas outside of the WAA, but within the broader Terrestrial Resources Study area, were assessed using exclusively desktop methods for the purpose of informing the vegetation and wildlife components of the Terrestrial Resources Study; these areas were not ground-truthed in the field. Detailed discussion of wetlands and waters is limited to the findings within the WAA only.

Wetlands and waters were mapped using a combination of desktop and field techniques. Wetland determinations were performed according to the *1987 Corps of Engineers Wetland Delineation Manual* (USACE 1987) and the *Alaska Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region* (USACE 2007). Waters were mapped using global positioning system (GPS) points in the field, with subsequent editing in GIS using aerial photography and data collected for the Aquatic Habitat Mapping and Instream Flow Study (KHL 2014d) for Grant Creek side channel areas.

[5] 705 feet is the elevation of the gravity diversion structure that would have raised the pool level by a maximum height of approximately 2 feet (from 703 to 705 feet NAVD 88). The diversion structure is no longer a component of the Project proposal.



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION
	10/20/2013	JW	Internal Review

N

Drawing Scale: 0 0.25 0.5 1 Miles

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GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

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Figure E.4-68
2014 Updated Wetland Assessment Area

DESIGNED J. Woodbury
DRAWN M. Hjortsberg
CHECKED J. Blank
ISSUED DATE 12/23/2014

DRAWING

SCALE: 1:32,000

In addition, a functional assessment was also completed for the wetlands and waters using field data and the GIS-based wetlands and waters mapping. See the Terrestrial Resources Study, Final Report (KHL 2014f) for a detailed description of the functions assessed, assessment methods, and results of the functional assessment and categorization. Wetlands were assessed for eleven hydrologic, geomorphic, ecologic, and sociologic functions, as presented in the RGL 0901 guidance (USACE 2009). Waters were assessed separately from wetlands for 15 functions using an integration of USACE's *Functional Objectives for Stream Restoration* (Fischenich 2006), and U.S. EPA's *A Function-Based Framework for Stream Assessment and Restoration Projects* (Harman et al. 2012). Water assessment functions were related to system dynamics, hydrologic balance, sediment processes, biological support, and chemical processes and pathways. Results of the functional assessment were then converted into the functional Categories I, II, III, or IV as defined by RGL 09-01 (USACE 2009), with Category I being the highest functioning wetlands and Category IV being degraded and low functioning wetlands.

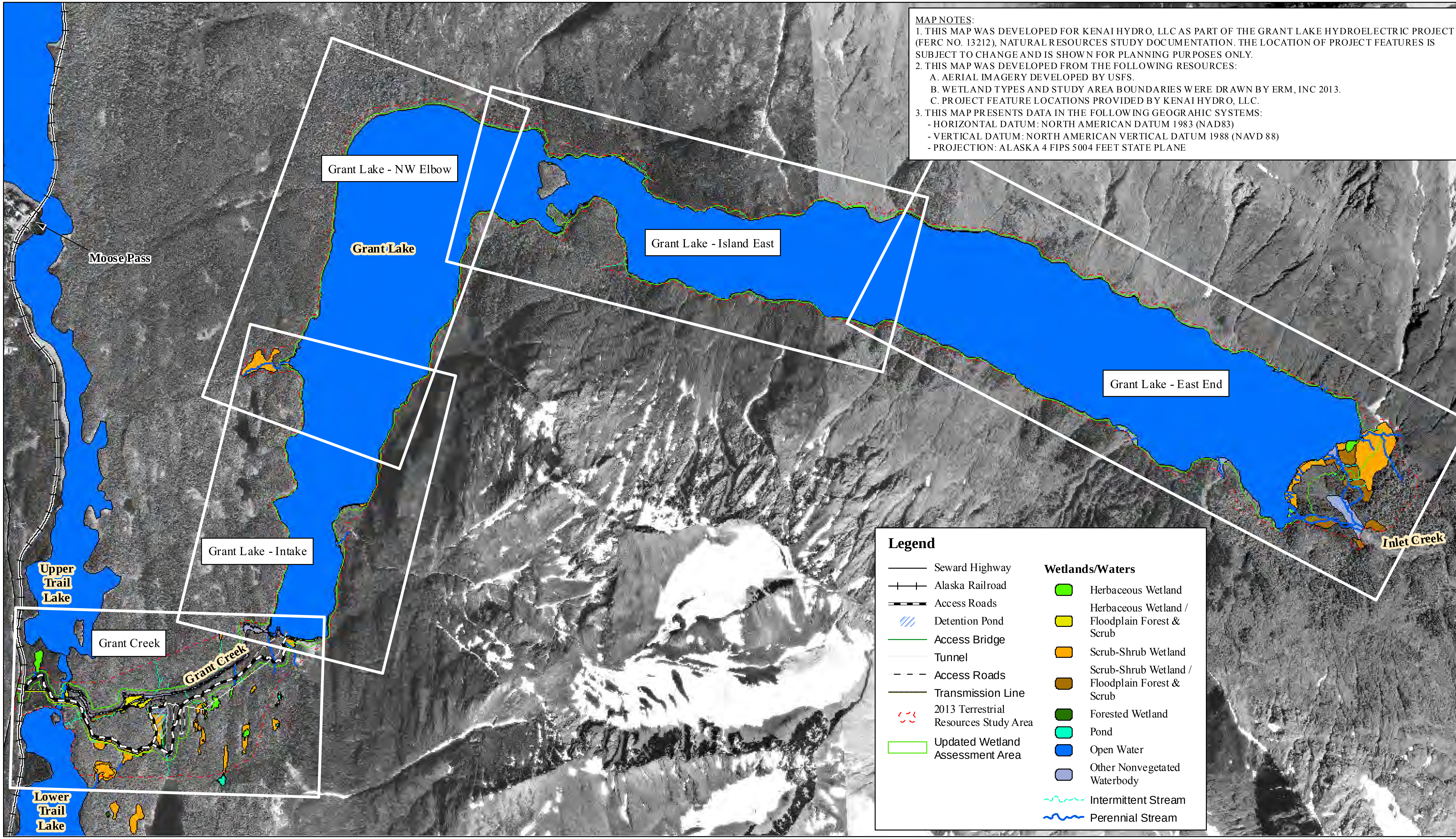
A summary of acreages by wetland or waters type is presented in Table E.4-86 and the wetlands and waters mapping is presented in Figures E.4-69 through E.4-74. A total of 38.5 acres of vegetated wetlands and 1,660 acres of waters were mapped within the WAA. Small streams that were too narrow to map as polygons (e.g., less than 15 feet wide) were mapped as lines and reported in linear feet. A total of 13,583 linear feet of small streams were mapped within the WAA (Table E.4-86). Twenty-three of the small stream segments were perennial (8,303 feet); 36 stream segments (5,279 feet) were intermittent with no water flowing in the channel during the 2013 assessment.

A detailed description of wetland and waters types is presented in Table E.4-87. Vegetated wetlands included herbaceous, scrub-shrub, forested wetlands associated with depressional, lacustrine, slope, and riparian areas. Depressional wetlands within the the WAA include those wetlands occurring within discrete topographic depressions primarily located on the south side of Grant Creek in the vicinity of the access road and transmission corridor. Lacustrine wetlands include persistent and non-persistent emergent wetlands, aquatic beds, and vegetated shoreline communities that are directly attached to or border Grant Lake (Figures E.4-71 through E.4-74). There were no vegetated lacustrine fringe wetlands associated with Upper Trail and Lower Trail lakes. Riverine wetlands are those wetlands that are adjacent to and hydrologically influenced by Inlet Creek, Grant Creek, and their tributaries, as well as drainages associated with Grant Lake.

Table E.4-86. Wetlands and waters – summary within wetlands assessment area.

	Revised 2014 Wetland Assessment Area	
Wetland Communities	**Acres**	**% Coverage**
Herbaceous Wetlands	5.68	15%
Herbaceous Wetland / Floodplain Forest & Scrub	3.11	8%
Scrub-Shrub Wetlands	20.92	54%
Scrub-Shrub Wetland / Floodplain Forest & Scrub	7.94	21%
Forested Wetlands	0.89	2%
Vegetated Wetland Subtotals	**38.5**	
Waters	**Acres**	**% Coverage**
Open Water - Grant Lake	1649.10	99%
Open Water - Trail Lake Narrows	1.02	0.06%
Open Water - Ponds	0.02	0.00%
Riverine- Grant Creek main and side channels	6.74	0.41%
Riverine- Outwash fans and areas of Inlet Creek channel	3.07	0.19%
Unvegetated Water Subtotals	**1660.0**	
WETLAND & WATER TOTALS	**1698.5**	
Non-Vegetated Waters[1]	Feet	
Small Streams (perennial)	8,303	61%
Small Streams (intermittent)	5,279	39%
FEET TOTAL	13,583	

Notes:
1. Streams that were mapped as lines rather than polygons due to width.



REV	DATE	BY	DESCRIPTION

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GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

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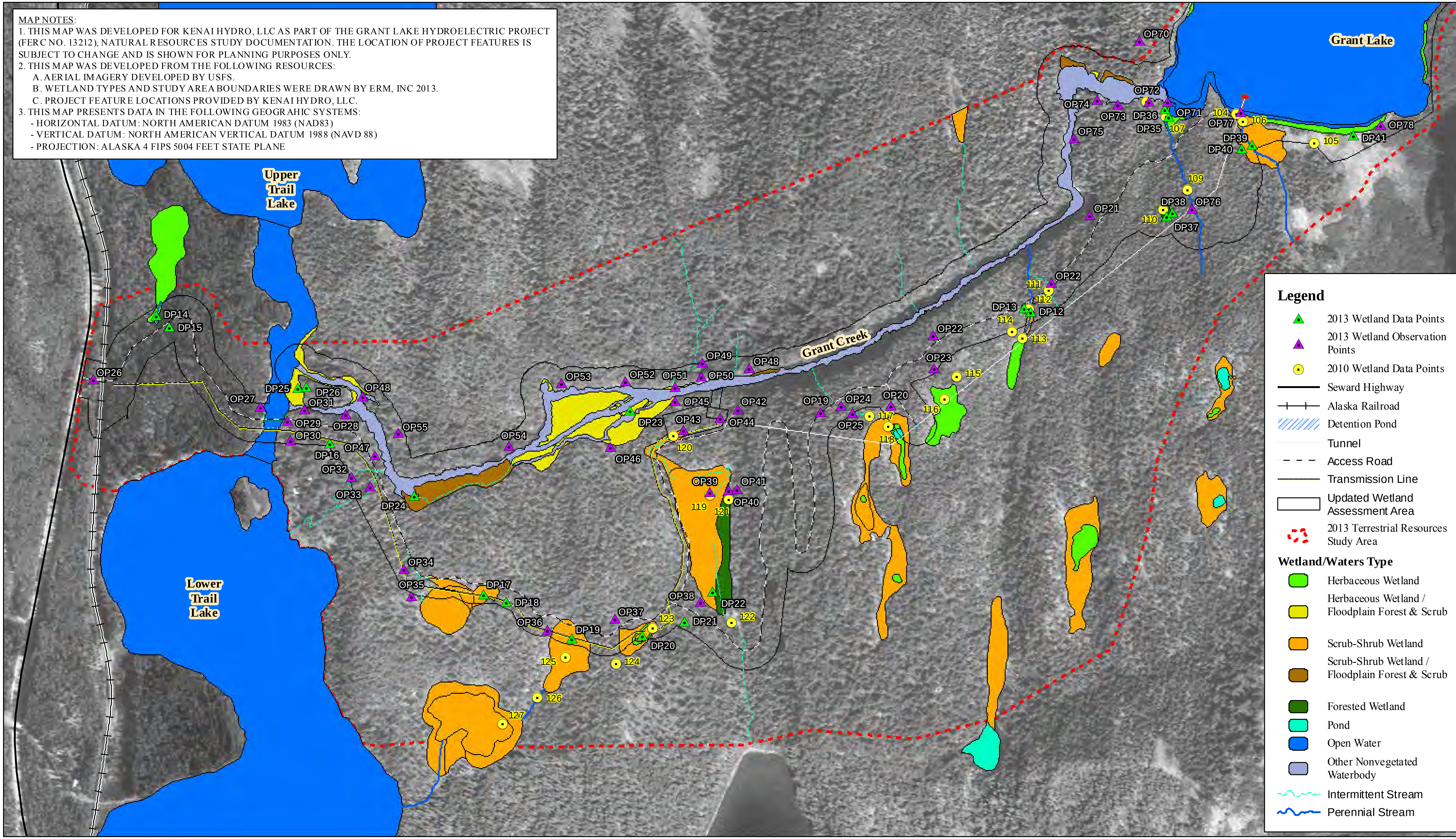
Figure E.4-69
2013 Wetland and Waters Types
Global Indicator Map

DESIGNED M. Hjortsberg
DRAWN M. Hjortsberg
CHECKED J. Blank
ISSUED DATE 12/23/2014

DRAWING 1 of 6

SCALE: 1:24,000



REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 275 550 1,100 Feet

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Figure E.4-70
2013 Wetland and Waters Types
Grant Creek

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ISSUED DATE 12/23/2014

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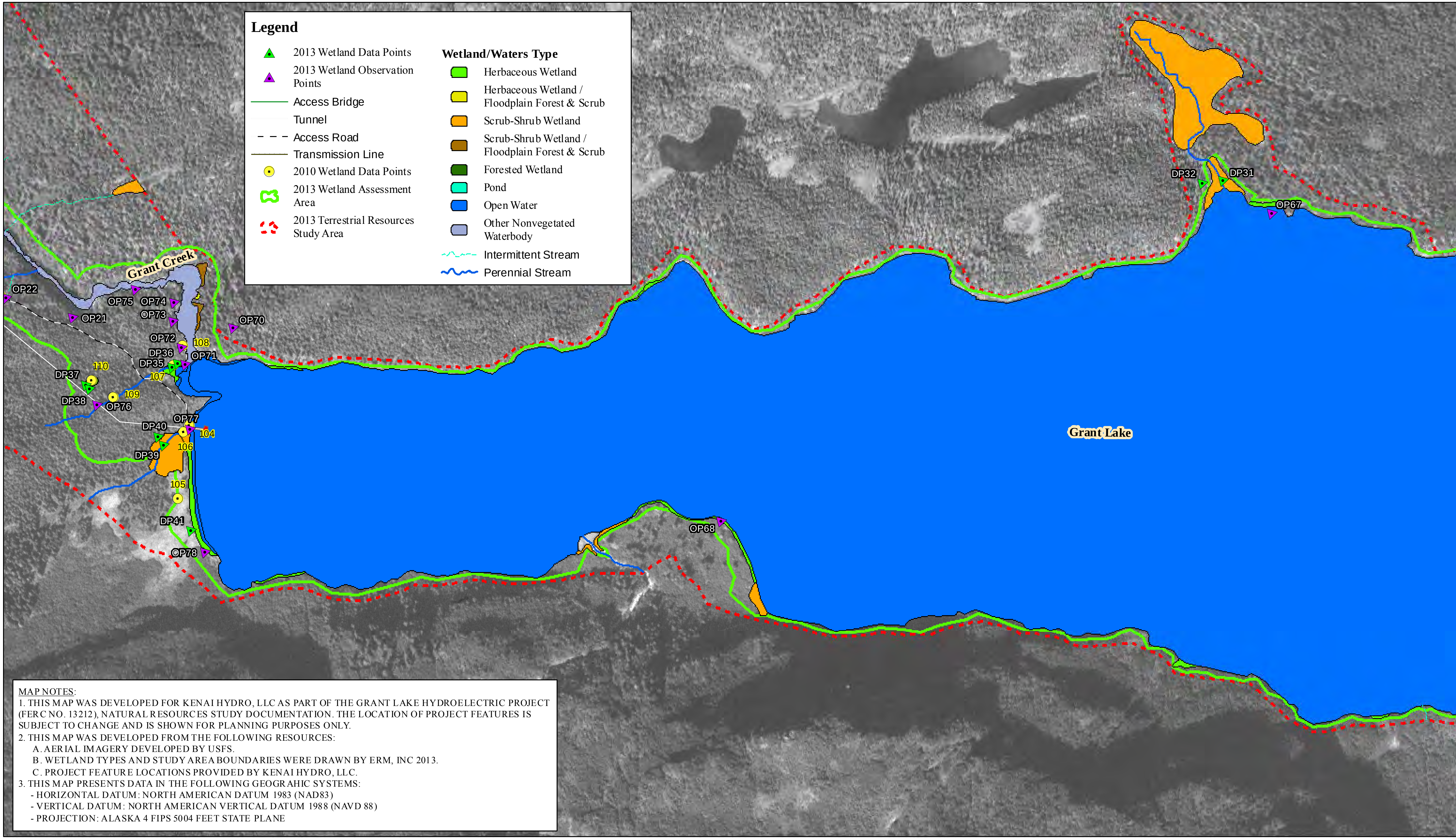
2 of 6

SCALE: 1:5,500



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. WETLAND TYPES AND STUDY AREA BOUNDARIES WERE DRAWN BY ERM, INC 2013.
   C. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

Drawing Scale: 0 275 550 1,100 Feet

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Figure E.4-71
2013 Wetland and Waters Types
Grant Lake - Intake

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ISSUED DATE 12/23/2014

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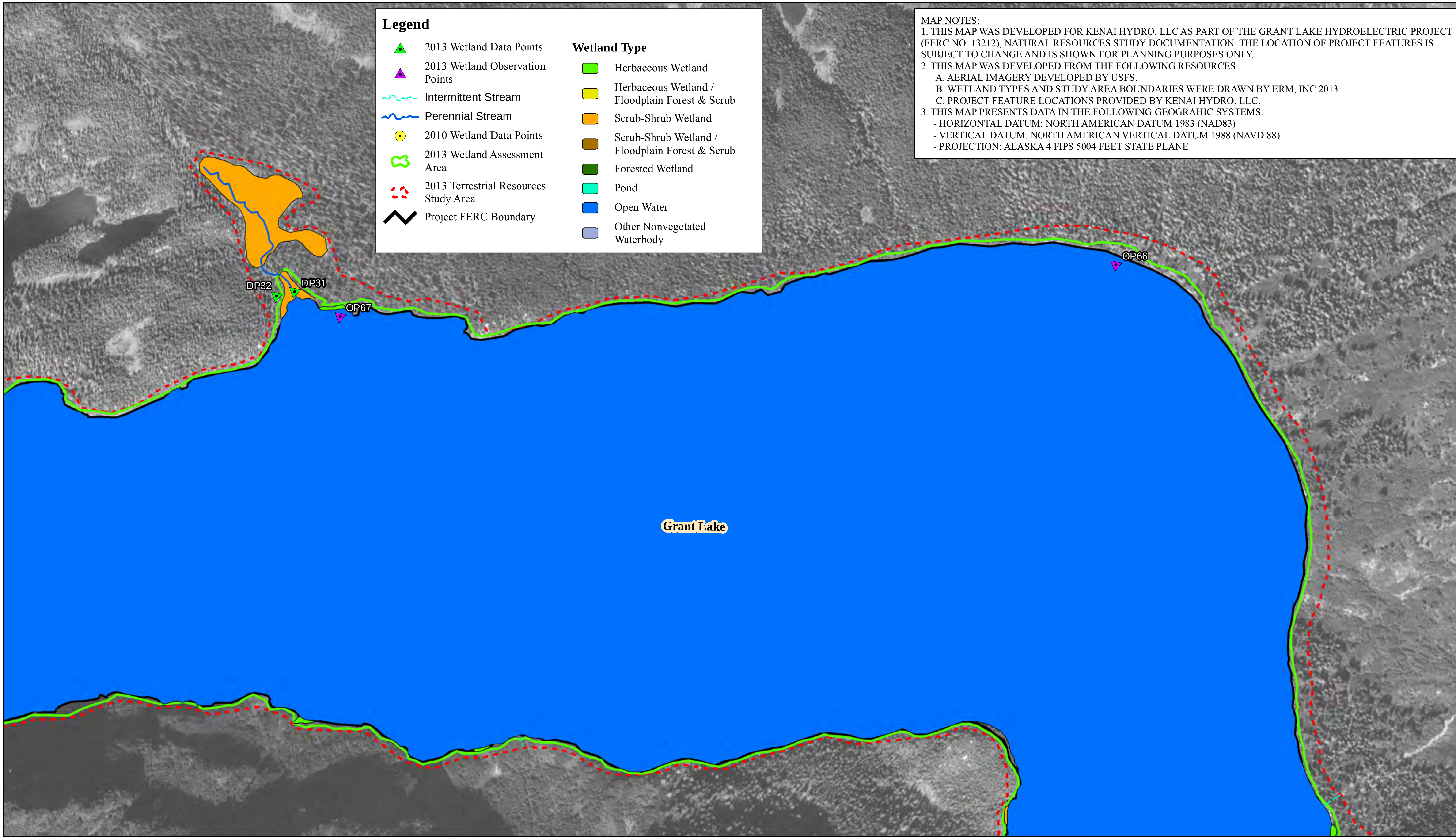
SCALE: 1:6,200



MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
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   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV	DATE	BY	DESCRIPTION

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Figure E.4-72
2013 Wetland and Waters Types
Grant Lake - NW Elbow

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SCALE: 1:7,000

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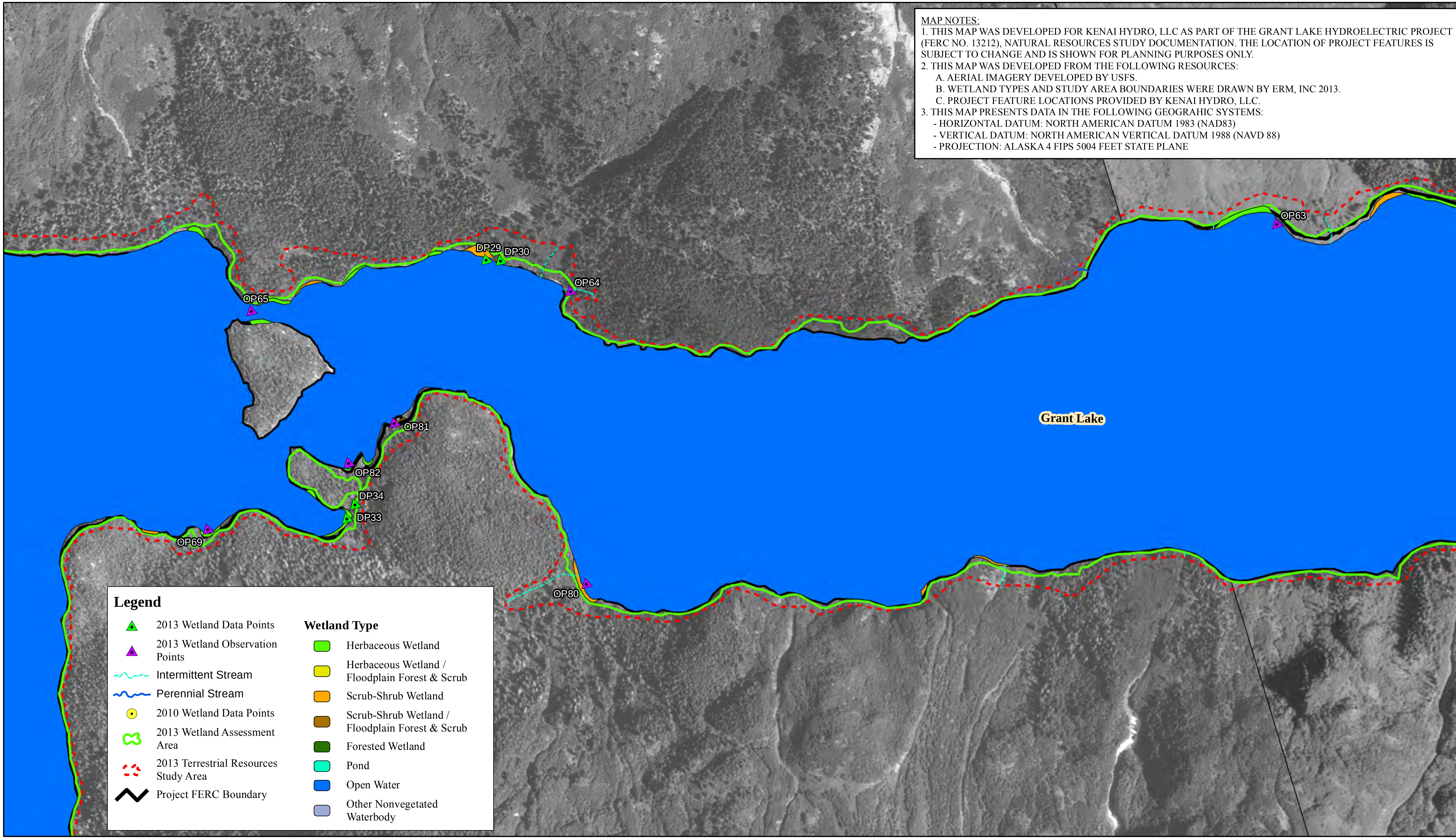
- HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD83)
- VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
- PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE



Legend

- 2013 Wetland Data Points
- 2013 Wetland Observation Points
- Intermittent Stream
- Perennial Stream
- 2010 Wetland Data Points
- 2013 Wetland Assessment Area
- 2013 Terrestrial Resources Study Area
- Project FERC Boundary

Wetland Type

- Herbaceous Wetland
- Herbaceous Wetland / Floodplain Forest & Scrub
- Scrub-Shrub Wetland
- Scrub-Shrub Wetland / Floodplain Forest & Scrub
- Forested Wetland
- Pond
- Open Water
- Other Nonvegetated Waterbody

REV	DATE	BY	DESCRIPTION

N

Drawing Scale:
0 275 550 1,100 Feet

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Figure E.4-73
2013 Wetland and Waters Types
Grant Lake - Island East

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CHECKED J. Blank
ISSUED DATE 11/11/2014

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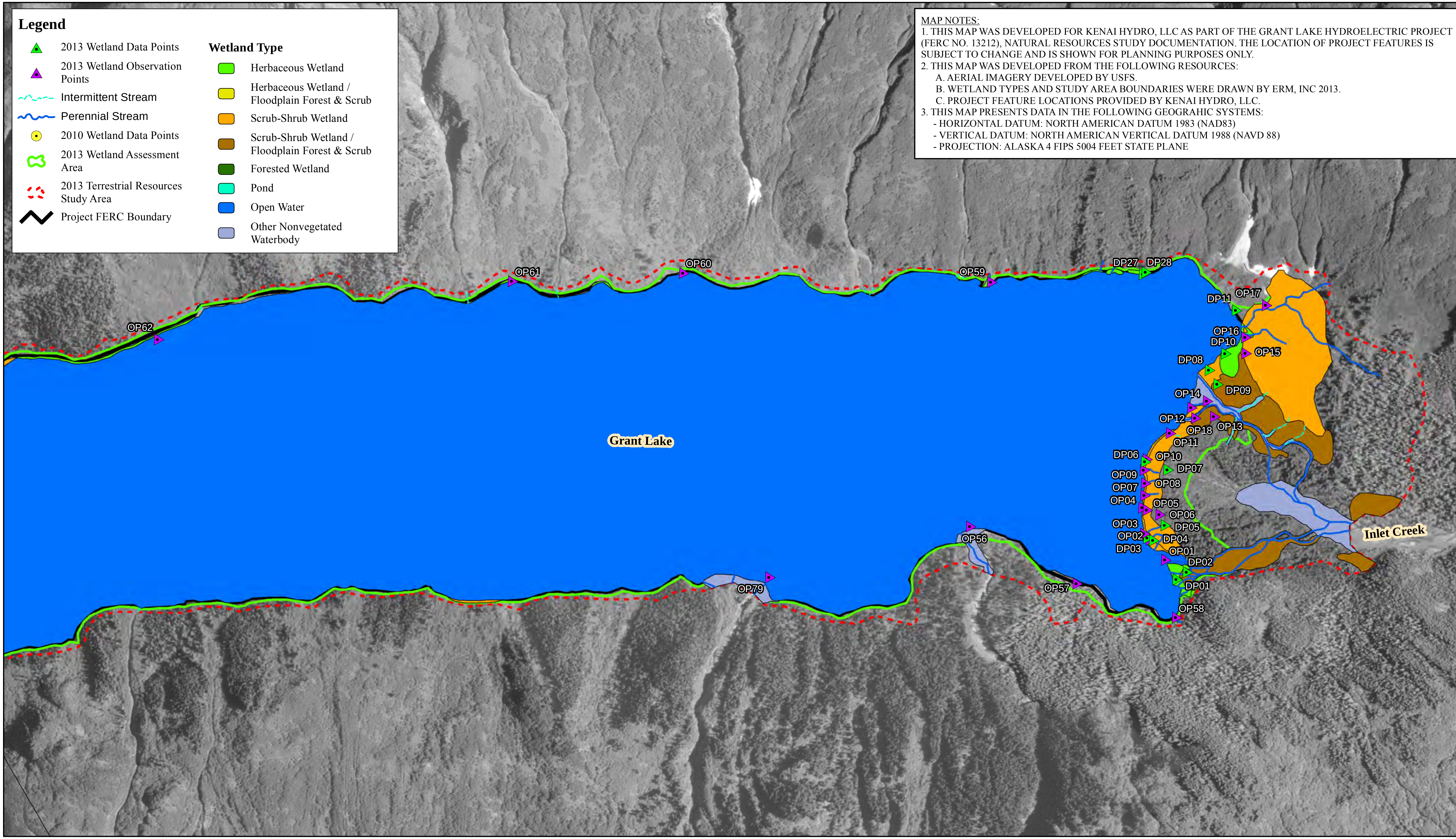
5 of 6

SCALE: 1:7,500



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 275 550 1,100 Feet

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Figure E.4-74
2013 Wetland and Waters Types
Grant Lake - East End

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DRAWING
6 of 6

SCALE: 1:9,900

Table E.4-87. Wetlands and waters within the 2014 wetlands assessment area (detailed).

Wetland Cover Type	Hydrogeomorphic Position	NWI Class/ Subclass[a]	NWI Hydro Modifier[b]	Revised 2014 Wetland Assessment Area (Acres)	Vegetation Description[c]
Herbaceous Wetland	Depressional	PEM1	B, E, F, H	0.13	Palustrine emergent wetlands with saturated hydrologic conditions occurring throughout or within portions of the WAA depressional features. Dominated by Drosera rotundifolia, Carex pauciflora, Rubus chamaemorus, Calamagrostis canadensis, Equisetum arvense. *Wetland Points: OP55, (HDR 113, 116, 118,123); similar to DP14 but fewer scrub shrub.*
		PEM1/SS1	E	0.08	Palustrine emergent and deciduous scrub-shrub mixed wetlands with saturated and seasonally flooded conditions occurring in a single depressional area within the transmission corridor west of Trail Lk. Dominated by Equisetum fluviatile, Comarum palustre, Sanguisorba canadensis, Calamagrostis canadensis, Salix barclayi, Betula glandulosa, Picea glauca. *Wetland Points: DP14*
	Lacustrine	PEM1	B, E, F, H	4.26	Palustrine emergent wetlands with hydrologic conditions ranging from saturated, seasonally flooded, semipermanently flooded, to permanently flooded typically occurring as a narrow fringe along portions of the Grant Lake shoreline. Dominated by Podagrostis aequivalvis, Poa palustris, Carex lenticularis, Carex utriculata, Calamagrostis canadensis, Equisetum arvense, Equisetum fluviatile, Carex aquatilis, Deschampsia caespitosa, Sanguisorba canadensis. *Wetland Points: DP10, DP27, DP33, OP59, OP61, OP62, OP65, OP67, OP82*
		PEM1/SS1	B, C, E	1.20	Palustrine emergent and deciduous scrub-shrub mixed wetlands with hydrologic conditions ranging from saturated to seasonally flooded occurring typically as a narrow fringe along portions of the Grant Lake and Trail Lake shoreline. Dominated by Chamerion latifolium, Calamagrostis canadensis, Comarum palustre, Equisetum arvense, Sanguisorba canadensis, Alnus viridis, Betula glandulosa, Populus balsamifera, Salix alaxensis, Salix barclayi, Salix sitchensis. *Wetland Points: DP01, DP35 (HDR107), OP60, OP68, OP69*
			Herbaceous Wetland Subtotal:	**5.68**	
Herbaceous Wetland / Floodplain Forest & Scrub	Riverine	PEM1	B, C, E	0.61	Palustrine emergent wetlands with hydrologic conditions ranging from saturated to seasonally flooded occurring as narrow fringe along stream channels or as part of a complex wetland-upland mosaic complex associated with Grant Creek side channels. Dominated by Calamagrostis canadensis, Carex sitchensis, Equisetum arvense, Sanguisorba canadensis. *Wetland Points: DP25, OP43, OP51, OP74*
		PEM1/SS1	C	2.50	Palustrine emergent and deciduous scrub-shrub mixed wetlands with seasonally flooded hydrologic conditions occurring in micro-topo lows within the complex riparian wetland-upland mosaic associated with the Grant Creek side channels. Dominated by Calamagrostis canadensis, Equisetum arvense, Athyrium felix-femina, Alnus viridis, Salix commutata. NOTE: Wetlands account for only 20% of the acreage associated with this mosaic community, the remaining 80% is upland. *Wetland Points: DP23.*
			Herbaceous Wetland / Floodplain Forest & Scrub Subtotal:	**3.11**	

Table E.4-87, continued…

Wetland Cover Type	Hydrogeomorphic Position	NWI Class/ Subclass[a]	NWI Hydro Modifier[b]	Revised 2014 Wetland Assessment Area (Acres)	Vegetation Description[c]
Scrub-Shrub Wetland	Depressional	PSS1	B, E	0.21	Palustrine deciduous scrub-shrub wetlands with saturated to seasonally flooded hydrologic conditions occurring throughout or within portions of the WAA depressional features Dominated by Ledum decumbens, Betula glandulosa, Vaccinium uliginosum. *Wetland Points: (HDR 129); similar to DP22*
		PSS1/3	B, E	0.31	Palustrine deciduous and broadleaved evergreen scrub-shrub wetlands with saturated conditions occurring throughout or within portions of the WAA depressional features. Typically dominated by Rubus chamaemorus, Cornus canadensis, Empetrum nigrum, Betula glandulosa, Andromeda polifolia, Ledum decumbens. *Wetland Points: None, similar vegetation to DP17*
		PSS1/EM1	B, E	2.95	Palustrine deciduous scrub-shrub and emergent mixed wetlands with saturated to seasonally flooded hydrologic conditions occurring throughout or within portions of the WAA depressional features, including the proposed detention pond area south of Grant Creek. Dominated by Picea glauca, Salix barclayi, Equisetum fluviatile, and Calamagrostis canadensis. *Wetland Points: DP22*
		PSS3/EM1	B	0.60	Palustrine broadleaved evergreen scrub-shrub and emergent mixed wetlands with saturated hydrologic conditions typically occurring within portions of the WAA depressional features. Dominated by Andromeda polifolia, Betula glandulosa, Empetrum nigrum, Carex pauciflora, Rubus chamaemorus, Equisetum arvense. *Wetland Points: DP17, DP20; (HDR 127)*
		PSS4	B	0.00	Palustrine needle leaved evergreen scrub-shrub wetland with saturated hydrologic conditions occurring in a single depressional feature south of the transmission corridor on the west side of Trail Lake. Outside of 2013 WAA, plant species not documented. *Wetland Points: None, located outside of 2013 WAA*
		PSS4/3/EM1	B	0.40	Palustrine needle leaved and broadleaved evergreen scrub-shrub and emergent mixed wetland with saturated hydrologic conditions occurring in a depressional feature within the transmission corridor. Dominated by Picea glauca, Rubus chamaemorus, Andromeda polifolia, Betula glandulosa, and Ledum decumbens. *Wetland Points: DP19 (HDR 125)*
	Lacustrine	PSS1	C, E	8.21	Palustrine deciduous scrub-shrub wetlands with saturated or seasonally flooded hydrologic conditions occurring as a narrow fringe along portions of the Grant Lake shoreline. Dominated by Salix alaxensis, Salix pulchra, Salix barclayi, Alnus viridis. *Wetland Points: OP12, OP15, OP80; (HDR106)*
		PSS1/EM1	B, C, E	7.24	Palustrine deciduous scrub-shrub and emergent mixed wetlands with saturated and seasonally flooded hydrologic conditions occurring typically as a narrow fringe along portions of the Grant Lake shoreline, or as larger wetlands at the Grant Lake inlet or outlet. Dominant plant species include Salix sitchensis, Salix alaxensis, Salix barclayi, Alnus viridis, Betula glandulosa, Carex hyemale, Carex canescens, Carex lenticularis, Equisetum arvense, Equisetum fluviatile, Calamagrostis canadensis, Chamerion latifolium, Sanguisorba canadensis. *Wetland Points: DP03, DP04, DP06, DP08, DP29, DP31, OP81*
	Riverine	PSS1	C	0.03	Palustrine deciduous scrub-shrub wetlands with seasonally flooded hydrologic conditions associated with small drainages within the the WAA. Dominated by Salix sitchensis, Salix alaxensis, Alnus viridis, Sanguisorba canadensis, Rubus chamaemorus, Calamagrostis canadensis, Cronus canadensis. *Wetland Points: OP58*
		PSS1/EM1	C, E	0.97	Palustrine deciduous scrub-shrub and emergent mixed wetlands with saturated to seasonally flooded hydrologic conditions associated with small drainages within the the WAA. Dominated by Salix pulchra, Salix barclayi, Alnus viridis, Tsuga mertensiana, Equisetum arvense, Equisetum fluviatile, Calamagrostis canadensis, Agrostis mertensii. *Wetland Points: DP12, DP39*
			Scrub-Shrub Wetland Subtotal:	**20.92**	

Table E.4-87, continued…

Wetland Cover Type	Hydrogeomorphic Position	NWI Class/ Subclass[a]	NWI Hydro Modifier[b]	Revised 2014 Wetland Assessment Area (Acres)	Vegetation Description[c]
Scrub-Shrub Wetland / Floodplain Forest and Scrub	Riverine	PSS1	A, B, C, E	5.67	Palustrine deciduous scrub-shrub wetlands with hydrologic conditions ranging from temporarily flooded, saturated, to seasonally flooded associated with the WAA active floodplain and outwash fan features. Dominated by Salix sitchensis, Salix alaxensis, Alnus viridis, Populus balsamifera, Calamagrostis canadensis, Equisetum hyemale. *Wetland Points: DP02, DP09*
		PSS1/EM1	C, E	2.22	Palustrine deciduous scrub-shrub and emergent mixed wetlands with saturated to seasonally flooded hydrologic conditions occurring in micro-topo lows within the complex riparian wetland-upland mosaic associated with the Grant Creek side channels. Dominated by Alnus viridis, Salix commutata, Calamagrostis canadensis. NOTE: Wetlands account for only 10% of the acreage associated with this mosaic community, the remaining 90% is upland. *Wetland Points: DP24, OP73, OP74*
		PSS1/FO1	C	0.04	Palustrine deciduous scrub-shrub and deciduous forested mixed wetlands with seasonally flooded hydrologic conditions associated riparian fringe along Grant Creek. Dominated by Salix sitchensis, Salix alaxensis, Alnus viridis, Betula papyrifera. *Wetland Points: Documented on field map only; similar to DP24 but with more mature deciduous trees*
Scrub-Shrub / Floodplain Forest & Scrub Wetland Subtotal:				**7.94**	
Forested Wetland	Slope	PFO4	B	0.81	Palustrine needle leaved evergreen forested wetland with saturated hydrologic conditions; within the the WAA this includes one wetland which is associated with the west-facing slope adjacent to the detention pond. Dominated by Picea glauca, Salix barclayi, Betula papyrifera, and Agrostis stolonifera. *Wetland Points: OP40 (HDR121)*
		PFO4/EM1	B	0.08	Palustrine needle leaved evergreen forested and emergent mixed wetland with saturated hydrologic conditions associated with a seasonal drainage on a north-facing slope. Dominated by Salix sitchensis, Salix alaxensis, Alnus viridis, Tsuga mertensiana, Rubus chamaemorus, Cornus canadensis. *Wetland Points: DP37, (HDR 110)*
Forested Wetland Subtotal:				**0.89**	
Open Water	Lacustrine	L1UB (Grant Lk.)	H	1648.20	Unvegetated deep water (greater than 6.6 ft deep) of Trail Lake and Grant Lake. *Wetland Points: None*
		L2UB (Grant Lk.)	H	0.82	Unvegetated shallow water (less than 6.6 ft deep) associated with the outlet of Grant Lake. *Wetland Points: None*
		L2US (Grant Lk.)	C	0.09	Unvegetated shallow water (less than 6.6 ft deep) associated with the outlet of Grant Lake. *Wetland Points: None*
		Total Grant Lk.		**1649.10**	
		L1UB (Trail Lk. Narrows)	H	1.02	Unvegetated deep water (greater than 6.6 ft deep) of Trail Lake Narrows. *Wetland Points: None*
Open Water Subtotal:				**1650.12**	

Table E.4-87, continued…

Wetland Cover Type	Hydrogeomorphic Position	NWI Class/ Subclass[a]	NWI Hydro Modifier[b]	Revised 2014 Wetland Assessment Area (Acres)	Vegetation Description[c]
Pond	Depressional	PUB	H	0.02	Shallow ponds (less than 20 acres in size) associated with depressional features within the the WAA. All were outside the original 2013 WAA. *Wetland Points: None, located outside original 2013 WAA*
			Pond Subtotal:	**0.02**	
Non-Vegetated Water	Riverine	R2UB (Grant Cr.)	H	6.74	Active channel and unvegetated portion of the Grant Creek main channel and side channels. *Wetland Points: OP28, OP45, OP48, OP51*
		R3UB (Outwash fans and Inlet Cr.)	C	3.07	Unvegetated channel beds and outwash fan located at the inlet of Grant Lake that are flooded during high flow and likely during high precipitation events, but dry during low flows. *Wetland Points: OP14, OP56, OP79*
		R3UB (Small streams, perennial)	H	8,303 ft	Unvegetated permanently flooded (flowing) active stream channels mapped as stream lines throughout the WAA. No acreages associated with these stream lines. *Wetland Points: DP12,(HDR112), DP14, DP31, DP39, OP01, OP02, OP03, OP07, OP08, OP09, OP16, OP18, OP56, OP58, OP59, OP68, OP76 (HDR109), OP79; (HDR126)*
		R4SB (Small streams, intermittent)	C	5,279 ft	Unvegetated intermittent seasonally flooded (not flowing during survey) stream channels mapped as stream lines throughout the WAA. No acreages associated with these stream lines. *Wetland Points: DP17, OP11, OP25, (HDR117) OP32, OP33, OP43, OP64, OP80; (HDR111)*
			Non-Vegetated Riverine Subtotal:	**9.82**	
			TOTALS	**1,698.51**	

Notes:
a/b. NWI and hydro modifier codes are from the Wetlands and Deepwater Habitats Classification table (Cowardin et al 1979)
c DP =wetland delineation point, ERM 2013 field; OP = observation point, ERM 2013 field; (HDR ##) = HDR data point, HDR 2010 field; Wetland types w/o specific data points were assessed as part of the ERM 2013 field study, the KHL 2010a field study conducted by HDR, or through a desktop analysis. Community associations were determined based on field knowledge of the wetland communities.

Waters within the the WAA include the non-vegetated portions of Grant Lake (deep and shallow lake margins) and Trail Lake Narrows, Grant Creek, Inlet Creek, Project area tributaries and drainages (collectively referred to as small streams), and ponds. All waters documented as part of the study had an ordinary high water mark, determined by a distinct vegetation line (e.g., a transition from unvegetated to vegetated, or from wetland to mesic or non-wetland vegetation), and/or geomorphic indicators (e.g., erosion line from wave action or stream flow). The riverine waters include the nonvegetated bed and bank of Inlet Creek channel, Grant Lake tributaries/drainages, Grant Creek tributaries/drainages, the Grant Creek channel, and numerous unvegetated floodplain and outwash fans that are likely inundated with surface water during spring break-up and flood events. Lacustrine waters, also referred to as ‘open water,’ include the non-vegetated portions of Grant Lake and Upper Trail and Lower Trail lakes (deep and shallow lake margins). Ponds (depressional waters) were also identified within the broader Terrestrial Resources Study Area, but not within the wetlands assessment area. Additional details on Grant Creek and Grant Lake can be found in this Exhibit E, Section 4.5, Water Quality and Quantity, and Section 4.6, Aquatic Resources (Instream Flow).

Most of the wetlands and waters within the WAA were functioning at their highest potential for each of the functions assessed for a given functional class. All wetlands and waters were categorized as Category II wetlands based on the USACE revised definitions published in May 2014 (USACE 2014).

4.7.1.3. Wildlife

This section describes the existing wildlife resources associated within the Project based on the 2013/2014 study effort (KHL 2014f; KHL 2015c [Attachment E-3]) and relevant data from previous Project studies. Wildlife resources were assessed within the entire Terrestrial Resources Study Area presented in Figure E.4-66. The 2013 Terrestrial Resources Study incorporates field work on wildlife resources associated with three distinct study efforts: 1) wildlife studies completed in the 1980s as part of a hydro licensing effort referred to as Ebasco (1984); 2) wildlife studies conducted in 2010, referred to as the 2010 wildlife studies (KHL 2011); and 3) the 2013/2014 wildlife studies. The Ebasco 1984 report and the 2010 wildlife studies as well as other readily available sources of information have been assimilated for a better understanding of Project area wildlife resources. Data sources used in the wildlife resources results section are referenced accordingly.

The Ebasco (1984) report served as the initial comprehensive assessment of wildlife resources within the Project area. The wildlife studies conducted in 2010, 2013, and 2014 build upon this study and serve to provide additional information for wildlife resources that required more research. The 1984 Ebasco wildlife investigation conducted for the Project included various literature reviews and field investigations on amphibians, birds (waterfowl, loons, grebes, gulls, terns, shorebirds, raptors, grouse and ptarmigan), and mammals (rodents, bats, hares, marmots, squirrels, beaver [*Castor canadensis*], porcupine [*Erethizon dorsatum*], wolf [*Canis lupus*], coyote [*Canis latrans*], red fox [*Vulpes vulpes*], black bear [*Ursus americanus*], brown bear [*Ursus arctos*], mink [*Neovison vison*], wolverine [*Gulo gulo*], lynx [*Lynx lynx*], moose [*Alces alces*], mountain goat [*Oreamnos americanus*], and Dall sheep [*Ovis dalli*]).

The 2010 wildlife studies collected information on breeding landbirds and shorebirds, Northern goshawks (*Accipiter gentilis)*, waterbirds, and little brown bats (*Myotis lucifugus*), as well as various incidental mammal observations that included moose, bear, and goats. In addition, USFS 2010 observations of bear and wolverine dens and raptor nests within the wildlife study area were provided to KHL and are referred to herein.

The 2013 and 2014 wildlife studies conducted by the Project encompassed Breeding Landbird and Shorebird studies, Northern Goshawk surveys, Winter Moose surveys, and Winter Waterbird surveys on Grant Lake. The Breeding Landbird and Shorebird studies and Northern Goshawk survey were conducted in the spring and summer of 2013 and 2014. The 2013/2014 Winter Moose and Winter Waterbird surveys were performed in December 2013 and March 2014.

The subsections that follow provide a summary of the primary components of the 2013/2014 wildlife studies: Raptor Nesting survey, Breeding Landbirds and Shorebirds, Waterbirds, and Terrestrial Mammals. The methods, results, and conclusions, as well as a summary of study variances from the 2013 Study Plan are provided for each study component. Detailed data analysis and results are described in the Terrestrial Resources Study, Final Report (KHL 2014f) and Terrestrial Resources Study, Report Addendum Terrestrial Resources Study, Report Addendum (KHL 2015c; Attachment E-3). Relevant data from the previous Project wildlife studies are also incorporated within the relevant section.

4.7.1.3.1 Raptors

There are 11 diurnal raptor species that potentially occur in the delineated Project area: osprey, Northern harrier, golden eagle, bald eagle, sharp-shinned hawk, Northern goshawk, red-tailed hawk, rough-legged hawk, American kestrel, merlin, and peregrine falcon. There are also six owl species that potentially occur in the delineated Project area: short-eared, great horned, great gray, Northern saw-whet, Northern hawk, and boreal. Occurrence includes migration and/or residence. All species listed are protected by the Migratory Bird Treaty Act (MBTA) 1972 (16 U.S.C. 1361 et seq.). The bald eagle is protected under the Bald and Golden Eagle Protection Act (BGEPA; 16 U.S.C. 668 et seq.) and is considered a species of special interest for the USFS (2008). Northern goshawks are also considered a species of special interest for the USFS (2008).

Based on vegetation classification, nesting habitat is available for all the listed diurnal raptors in the area. Seven raptors have been detected in the terrestrial study area (Table E.4-88). No owls were detected during any field studies.

Table E.4-88 provides a summary of the various raptors that have been detected during site-specific studies in the Grant Lake Project area. Based on vegetation classification, nesting habitat is available for all the listed diurnal raptors in the area. No owls were detected during any field studies; however, based on vegetation classification, suitable habitat exists throughout the Grant Lake area.

Table E.4-88. Raptors detected during site specific studies and year of study.

Raptor Species Detected in Project Area	Study Year
Bald Eagle	1984, 2010 and 2013
Northern Goshawk	2013
Sharp-shinned Hawk	1984
Osprey	2013
American Kestrel	1984
Golden Eagle	1984
Merlin	2013

USFS Sensitive Species and Species of Special Interest

Osprey: The osprey is a Region 10 sensitive species. Ospreys were not documented in the Grant Lake area during the Trail River Watershed landscape assessment (USFS 2008), but potential nesting and foraging habitat was observed in the Project area during the 2013 field efforts. An adult male Osprey was documented in 2013; however, its breeding status was unknown. Ospreys are very individualistic and type specific with regards to tolerance to human activities (Poole 1981).

Bald Eagle: Approximately 80 percent of all detected bald eagle nests on the Seward Ranger District are located in mature cottonwood trees with an average diameter of 31 inches and within 0.25 mile of an anadromous fish-bearing stream (USFS 2008). The breeding pair documented on Grant Creek in 2013 did not appear to be impacted by human activity and presence.

Northern Goshawks: This species is a year-round resident of the Chugach National Forest (USFS 1984). The majority of Northern goshawk nests discovered on the Seward Ranger District have been documented in old growth hemlock-spruce stands characterized by a closed canopy, large average diameter, gap regeneration, and an open understory (USFS 2008). A small stand of old growth hemlock and spruce at the east end of Grant Lake may provide additional nesting habitat (USFS 2008). The spruce bark beetle has affected approximately 95 percent of large conifer trees on the Kenai; a portion of these stands may yet provide nesting or foraging habitat, but the bark beetle is likely reducing the value of these stands for Northern goshawk nesting habitat as the canopy becomes more open (USFS 2008).

Breeding Landbirds and Shorebirds

Compilation of site specific data (Ebasco 1984, 2010 field work, and 2013 field work) and the documented species list from the Kenai Lake-Black Mountain Research Natural Area (RNA) (2007) (4 miles to the southwest of the Project area) provided sufficient information for an assessment of presence / no detection of breeding birds in the immediate surrounding area. Observed species in the Kenai Lake-Black Mountain RNA include all species detected during the site specific Grant Lake studies, except for the Northern harrier, ptarmigan (*Lagopus sp*.), green sandpiper (*Tringa ochropus*), Northern shrike (*Lanius excubitor*), and savannah sparrow (*Passerculus sandwichensis*) (USFS 2007).

Breeding bird presence in the Project area is contingent on many variables including habitat. Habitat includes vegetation as well as landform characteristics important to specific species. Bird species utilize forested and non-forested vegetation communities differently depending on nesting, cover, and foraging requirements. Landform characteristics important to species include elevation, slope, aspect, and rock ledges. Avifauna habitat types were developed by Kessel (1979) and utilized by Ebasco (1984). Ebasco (1984) correlated the avian breeding habitat types developed by Kessel (1979) to the general vegetation classifications developed for their study. All site-specific bird data has been incorporated into the Ebasco (1984) table format to include species detected during each site-specific study and their primary breeding habitats as described by Kessel (1979) (Table E.4-89).

Table E.4-89. Bird species and breeding habitats in the 2013 wildlife study area. [1]

Species Potentially Occurring in the Project Area		Observed or Reported During 2013 Field Season	Observed During 2010 Field Season	Observed During 1981-82 AEIDC Field Season [2]	Known Breeders	Inferred Breeders	Abundance [3]	Lacustrine Waters and Shorelines	Riverine Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Deciduous-Coniferous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
Red-throated Loon*	*Gavia stellata*						R	XX	X												
Pacific Loon	*Gavia pacifica*		X	X	X		U	XX	X												
Common Loon	*Gavia immer*	X		X	X		FC	XX	X												
Yellow-billed Loon*	*Gavia adamsii*						R														X
Horned Grebe	*Podiceps auritus*						U	XX	X												
Red-necked Grebe	*Podiceps grisegena*						R	XX	X												
Tundra Swan	*Cygnus columbianus*						R														X
Trumpeter Swan***	*Cygnus buccinator*	X					U	X			XX	X									
Greater White-fronted Goose*	*Anser albifrons*						U														X
Canada Goose	*Branta canadensis*	X					U	X			X	XX									
Mallard	*Anas platyrhynchos*		X	X		X	C	XX	X		X	X									
Gadwall	*Anas strepera*						R														X
Green-winged Teal	*Anas crecca*			X		X	U					XX									
American Widgeon	*Anas americana*			X	X		U	X			XX	X									
Northern Pintail	*Anas acuta*						FC	XX	X			X									
Northern Shoveler	*Anas clypeata*						C														X
Blue-wing Teal	*Anas discors*						R	X			XX	X									
Canvasback	*Aythya valisineria*						R														X
Greater Scaup	*Aythya marila*						R	XX													
Lesser Scaup	*Aythya affinis*			X			U	X			XX										
Harlequin Duck	*Histrionicus histrionicus*	X	X	X		X	R		XX								XX			XX	
Common Goldeneye	*Bucephala clangula*		X	X	X		FC	X	X											XX	
Barrows Goldeneye	*Bucephala islandica*	X	X	X			FC	X	X											XX	
Bufflehead	*Bucephala albeola*						U	X	X											XX	
Common Merganser	*Mergus merganser*	X	X	X			C	X	X											XX	
Red-breasted Merganser	*Mergus serrator*	X	X	X			FC	X	X		X	X									
Osprey***	*Pandion haliaetus*	X					R										XX	X	X		
Northern Harrier	*Circus cyaneus*						R				XX	X									
Golden Eagle	*Aquila chrysaetos*			X		X	C			XX									X		
Bald Eagle***	*Haliaeetus leucocephalus*	X	X	X			FC										XX	X	X		
Sharp-shinned Hawk	*Accipiter striatus*			X			C										X	XX	X		
Northern Goshawk***	*Accipiter gentilis*	X	X				U										X	X	XX		
Red-tailed Hawk	*Buteo jamaicensis*						U			X						X	X	X	X		
Rough-legged Hawk	*Buteo lagopus*						U			XX											
American Kestrel	*Falco sparverius*			X			R										X	X	XX		
Merlin	*Falco columbarius*	X					R			X							X	X	XX		
Peregrine Falcon	*Falco peregrinus*						R			XX											
Spruce Grouse	*Falcipennis*	X		X	X		FC											X	XX		

Table E.4-89, continued…

Species Potentially Occurring in the Project Area		Observed or Reported During 2013 Field Season	Observed During 2010 Field Season	Observed During 1981-82 AEIDC Field Season [2]	Known Breeders	Inferred Breeders	Abundance [3]	Lacustrine Waters and Shorelines	Riverine Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Deciduous-Coniferous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
	canadensis																				
Willow Ptarmigan	*Lagopus lagopus*			X		X	C							X	XX	X					
Rock Ptarmigan	*Lagopus muta*			X		X	C						XX	X							
White-tailed Ptarmigan	*Lagopus leucura*						U						XX	X							
Sandhill Crane	*Grus canadensis*	X					R				XX	X									
Black-bellied Plover	*Pluvialis squatarola*						U					X	XX								
Semipalmated Plover	*Charadrius semipalmatus*						U	XX	XX												
Greater Yellowlegs	*Tringa melanoleuca*	X		X		X	C				X	XX									
Lesser Yellowlegs*	*Tringa flavipes*			X		X	C					XX									
Wandering Tattler*	*Tringa incana*			X			U	X	XX												
Solitary Sandpiper*	*Tringa solitaria*		X			X	U				X	XX									
Spotted Sandpiper	*Actitis macularius*	X	X	X		X	FC	XX	XX			X	X								
Whimbrel	*Numenius phaeopus*						R				XX	X	X								
Western Sandpiper	*Calidris mauri*						U														X
Least Sandpiper	*Calidris minutilla*						U				XX	X									
Short-billed Dowitcher	*Limnodromus griseus*						U				XX	X								X	
Wilson's Snipe	*Gallinago delicata*	X	X	X		X	FC				X	XX									
Red-necked Phalarope	*Phalaropus lobatus*						U				XX	X									
Bonaparte's Gull	*Chroicocephalus philadelphia*						R	X												X	
Mew Gull	*Larus canus*	X		X			U			X	XX										
Herring Gull	*Larus argentatus*		X				R	X		XX	X										
Glaucous-winged Gull	*Larus glaucescens*	X					U			XX											
Arctic Tern	*Sterna paradisaea*			X			FC				XX	X									
Kittlitz's Murrelet*	*Brachyramphus brevirostris*						R			X											
Short-eared Owl	*Asio flammeus*						R				XX	X	X								
Great Horned Owl	*Bubo virginianus*						U			X							X	X	X		
Great Gray Owl	*Strix nebulosa*						U										X	XX	X		
Northern Saw-whet Owl	*Aegolius acadicus*						U										X	XX	X		
Northern Hawk Owl	*Surnia ulula*						U										X	X	XX		
Boreal Owl	*Aegolius funereus*						U											XX	X		
Rufous Hummingbird	*Selasphorus rufus*						U									X		XX			
Belted Kingfisher	*Megaceryle alcyon*	X	X	X		X	C			XX											
Northern Flicker	*Colaptes auratus*			X			U										XX	X	X		
Downy Woodpecker	*Picoides pubescens*						R										XX	X	X		
Hairy Woodpecker	*Picoides villosus*		X	X		X	U										XX	X	X		
American Three-toed Woodpecker	*Picoides dorsalis*		X	X		X	FC											XX	X		
Olive-sided Flycatcher*	*Contopus cooperi*		X				U											XX	X	X	
Western Wood-pewee	*Contopus sordidulus*		X				U											XX	X	X	
Alder Flycatcher	*Empidonax alnorum*	X	X			X	FC							X	XX	X				X	

Table E.4-89, continued…

Species Potentially Occurring in the Project Area		Observed or Reported During 2013 Field Season	Observed During 2010 Field Season	Observed During 1981-82 AEIDC Field Season [2]	Known Breeders	Inferred Breeders	Abundance [3]	Lacustrine Waters and Shorelines	Riverine Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Deciduous-Coniferous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
Willow Flycatcher	*Empidonax traillii*			X		X	FC							X	XX	X				X	
Say's phoebe	*Sayornis saya*						R													X	
Northern Shrike	*Lanius excubitor*			X			U							X	X	XX	X	X	X	X	
Steller's Jay	*Cyanocitta stelleri*		X			X	U											XX	X		
Gray Jay	*Perisoreus canadensis*		X	X		X	C										X	XX	X	X	
Black-billed Magpie	*Pica hudsonia*		X	X			C									XX	XX		X	X	
Northwestern Crow	*Corvus caurinus*						C														X
Common Raven	*Corvus corax*	X	X	X			C			X							X	X	X		
Tree Swallow	*Tachycineta bicolor*			X		X	A										X	X	X	X	
Violet-green Swallow	*Tachycineta thalassina*	X	X	X		X	A			X							X	X	X	X	
Bank Swallow	*Riparia riparia*			X		X	C			XX											
Cliff Swallow	*Petrochelidon pyrrhonota*						U			XX											
Barn Swallow	*Hirundo rustica*						R	X	X		X	X								XX	
Black-capped Chickadee	*Poecile atricapillus*	X	X	X	X		A									X	XX	X	X		
Chestnut-backed Chickadee	*Poecile rufescens*	X				X	FC										X	XX	X		
Boreal Chickadee	*Poecile hudsonicus*	X	X				FC									X	X	XX	X		
Red-breasted Nuthatch	*Sitta canadensis*						R										X	XX	X		
Brown Creeper	*Certhia americana*	X	X				U										X	XX	X		
Pacific Wren	*Troglodytes pacificus*	X					U										X	X	X		
American Dipper	*Cinclus mexicanus*	X	X	X	X		A		XX												
Golden-crowned Kinglet	*Regulus satrapa*		X				U											XX	X		
Ruby-crowned Kinglet	*Regulus calendula*	X	X	X		X	A											XX	X		
Gray-cheeked Thrush	*Catharus minimus*		X	X		X	R								XX	X				X	
Swainson's Thrush	*Catharus ustulatus*	X	X	X		X	FC									XX		XX	X	X	
Hermit Thrush	*Catharus guttatus*	X	X	X	X		C									X	X	XX	X	X	
Varied Thrush*	*Ixoreus naevius*	X	X	X		X	C									X		XX	X	X	
American Robin	*Turdus migratorius*	X	X	X		X	C									X	XX		X	X	
American Pipit	*Anthus rubescens*			X		X	C					X	XX								
Bohemian Waxwing	*Bombycilla garrulus*			X	X		U											XX	X	X	
Orange-crowned Warbler	*Oreothlypis celata*	X	X	X		X	C							X	XX		X				
Yellow-rumped Warbler	*Setophaga coronata*	X	X	X		X	A											XX	X		
Townsend's Warbler***	*Setophaga townsendi*	X	X	X	X		A									X		XX	X		
Blackpoll Warbler*	*Setophaga striata*						U											XX	X		
Yellow Warbler	*Setophaga petechia*	X	X	X		X	C							X	X	XX					
Wilson's Warbler	*Cardellina pusilla*	X	X	X	X		A							X	XX	X					
Northern Waterthrush	*Parkesia noveboracensis*	X	X				FC	X	X		XX	X									
American Tree Sparrow	*Spizella arborea*		X	X			FC								X	X				XX	
Fox Sparrow	*Passerella iliaca*	X	X	X			U								XX	X				X	

Table E.4-89, continued…

Species Potentially Occurring in the Project Area		**Observed or Reported During 2013 Field Season**	**Observed During 2010 Field Season**	**Observed During 1981-82 AEIDC Field Season [2]**	**Known Breeders**	**Inferred Breeders**	**Abundance [3]**	**Lacustrine Waters and Shorelines**	**Riverine Waters and Shorelines**	**Cliffs, Cutbanks, and Block Fields**	**Wet Meadow**	**Dwarf Shrub Meadow**	**Dwarf Shrub Mat**	**Low Shrub Thicket**	**Medium Shrub Thicket**	**Tall Shrub Thicket**	**Deciduous Forest**	**Coniferous Forest**	**Mixed Deciduous-Coniferous Forest**	**Scattered Woodland and Dwarf Forest**	**Migratory Only**
Savannah Sparrow	*Passerculus sandwichensis*			X		X	C					XX	X	X	X						
Lincoln's Sparrow	*Melospiza lincolnii*		X	X			U					X		XX	X						
Song Sparrow	*Melospiza melodia*			X			U				XX	X									
White-crowned Sparrow	*Zonotrichia leucophrys*		X	X		X	C							XX	X	X				X	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	X	X	X		X	A						X	XX	X	X					
Dark-eyed Junco	*Junco hyemalis*	X	X	X		X	FC												XX	X	
Lapland Longspur	*Calcarius lapponicus*						U					X	XX								
Snow Bunting	*Plectrophenax nivalis*						U														X
Gray-crowned Rosy Finch	*Leucosticte tephrocotis*			X			FC						XX								
White-winged Crossbill	*Loxia leucoptera*	X					U											XX	X		
Pine Grosbeak	*Pinicola enucleator*	X	X	X		X	C											XX	X		
Pine Siskin	*Spinus pinus*	X	X				U											XX	X		
Hoary Redpoll	*Acanthis hornemanni*						U						XX	X	X						
Common Redpoll	*Acanthis flammea*		X				C						XX	X	X	X		X		X	
Redpoll Species	*Acanthis sp.*	X					C						XX	X	X	X		X		X	

Notes:
A – Abundant; C – Common; FC - Fairly common; U – Uncommon; R - Rare
XX – Primary breeding habitat; X - Secondary breeding habitat
(I) - Habitat types follow Kessel 1979
(2) - As reported in Ebasco 1984
(3) - Abundance categories follow USFS unpublished. Applies to study area only
* - Alaska Audubon's Red-listed Species (2010)
*** - USFS Sensitive Species or Species of Special Interest (USFS 2008)

Sources:
Ebasco 1984; Kessel 1979; Ehrlich et al. 1988; Gabrielson and Lincoln 1959; USFS unpublished; Tarres 1980; Bellrose 1980 and Kortright 1967.

The Project area previously described by the USFS cover class was updated in 2013. All reclassified vegetation is defined and discussed in the Terrestrial Vegetation, Invasive Plants and Sensitive Plants Section (4.7.1.1) and Wetlands and Waters Section (4.7.1.2) of this Exhibit E. Table E.4-90 provides the 2013 vegetation types, the number of points that fell into each class, and the bird species detected in each class. Although not located within the 2013 study area, the birch category was retained from the USFS (2007) cover classification. Species distribution was extrapolated to the non-sampled identical vegetation classes in the Project area based on the vegetation information collected from the 33 sample points in 2010 and 2013.

Table E.4-90. Qualitative assessment of avian species presence in sampled 2013 wildlife study area vegetation classification.

2013 Vegetation Types	Grass-Forb Meadow	Coniferous Forest	Birch (Original USFS Classification)	Coniferous Deciduous Forest	Scrub Shrub Wetland	Herbaceous Wetland / Floodplain Forest & Scrub
Number of points in Vegetation Class	**1**	**16**	**1**	**12**	**2**	**1**
Species Detected						
Alder Flycatcher	X					
American Dipper		X		X	X	
American Robin		X		X		
American Tree Sparrow	X					
Bald Eagle				X		
Barrow’s Goldeneye		X			X	
Black-billed Magpie				X		
Black-capped Chickadee		X				
Boreal Chickadee		X		X		
Brown Creeper		X		X		
Chestnut-backed Chickadee				X	X	
Common Loon		X				
Dark-eyed Junco		X	X	X	X	
Fox Sparrow	X	X			X	
Glaucous-winged Gull				X		
Golden-crowned Kinglet		X				
Golden-crowned Sparrow		X				
Gray Jay				X		
Greater Yellowlegs					X	
Hairy Woodpecker		X				
Hermit Thrush	X	X	X	X	X	
Lincoln's Sparrow				X		
Merganser Species		X				
Merlin				X		

Table E.4-90, continued…

2013 Vegetation Types	Grass-Forb Meadow	Coniferous Forest	Birch (Original USFS Classification)	Coniferous Deciduous Forest	Scrub Shrub Wetland	Herbaceous Wetland / Floodplain Forest & Scrub
Number of points in Vegetation Class	**1**	**16**	**1**	**12**	**2**	**1**
Species Detected						
Mew Gull				X		
Northern Waterthrush				X		
Orange-crowned Warbler	X	X	X	X	X	
Pacific Wren		X				
Pine Grosbeak			X	X		
Pine Siskin		X		X	X	
Red-breasted Merganser		X			X	
Redpoll Species		X		X	X	
Ruby-crowned Kinglet		X	X	X	X	X
Sandhill Crane				X		
Swainson's Thrush		X	X	X	X	
Townsend's Warbler		X		X	X	
Varied Thrush	X	X	X	X	X	X
White-winged Crossbill		X		X	X	
Wilson's Snipe				X		
Wilson's Warbler	X	X		X	X	
Yellow Warbler	X	X		X	X	
Yellow-rumped Warbler		X	X	X	X	
Additional Species that may be Present in 2013 Vegetation Class						
Alder Flycatcher		X	X	X	X	X
American Dipper			X		X	X
American Pipit		X			X	
American Robin			X		X	X
American Three-toed Woodpecker		X		X	X	
American Tree Sparrow		X	X	X	X	X
Arctic Tern		X			X	
Black-billed Magpie		X	X		X	X
Black-capped Chickadee			X	X	X	X
Bohemian Waxwing		X		X	X	
Boreal Chickadee			X		X	X
Brown Creeper			X		X	
Chestnut-backed Chickadee		X	X			
Common Raven		X	X	X	X	

Table E.4-90, continued…

2013 Vegetation Types	Grass-Forb Meadow	Coniferous Forest	Birch (Original USFS Classification)	Coniferous Deciduous Forest	Scrub Shrub Wetland	Herbaceous Wetland / Floodplain Forest & Scrub
Number of points in Vegetation Class	**1**	**16**	**1**	**12**	**2**	**1**
Species Detected						
Common Redpoll			X	X	X	X
Fox Sparrow			X	X		X
Golden-crowned Kinglet				X	X	
Golden-crowned Sparrow			X	X	X	X
Gray-cheeked Thrush		X	X	X	X	X
Gray Jay		X	X		X	
Greater Yellowlegs		X				
Hairy Woodpecker			X	X	X	
Hermit Thrush						X
Herring Gull		X	X	X	X	X
Lesser Yellowlegs		X			X	
Lincoln's Sparrow		X			X	X
Mew Gull		X			X	
Northern Flicker		X	X	X	X	
Northern Shrike		X	X	X	X	X
Northern Waterthrush		X	X		X	X
Olive-sided Flycatcher		X		X	X	
Orange-crowned Warbler						X
Pacific Wren			X	X	X	
Pine Grosbeak		X			X	
Redpoll Species			X			X
Rock Ptarmigan					X	X
Sandhill Crane		X			X	
Savannah Sparrow		X		X	X	X
Solitary Sandpiper		X			X	
Song Sparrow		X			X	
Spotted Sandpiper		X	X	X	X	X
Spruce Grouse		X		X	X	
Steller's Jay		X		X	X	
Swainson's Thrush						X
Townsend's Warbler			X			X
Tree Swallow		X	X	X	X	
Violet-green Swallow		X	X	X	X	
Wandering Tattler		X	X	X	X	X
Western Wood-pewee		X		X	X	

Table E.4-90, continued…

2013 Vegetation Types	Grass-Forb Meadow	Coniferous Forest	Birch (Original USFS Classification)	Coniferous Deciduous Forest	Scrub Shrub Wetland	Herbaceous Wetland / Floodplain Forest & Scrub
Number of points in Vegetation Class	**1**	**16**	**1**	**12**	**2**	**1**
Species Detected						
White-crowned Sparrow		X	X	X	X	X
White-winged Crossbill					X	
Willow Flycatcher		X	X	X	X	X
Willow Ptarmigan			X	X	X	X
Wilson's Snipe		X		X		
Wilson's Warbler			X			X
Yellow Warbler			X		X	X
Yellow-rumped Warbler		X				

Vegetation classes not sampled include: Alder Scrub, Forested Wetland, and Herbaceous Wetland. Table E.4-91 qualitatively evaluates the species most likely found in these habitats based on Kessel (1979) and the descriptions for these habitats provided in the Terrestrial Vegetation, Invasive Plants and Sensitive Plants Section (4.7.1.1) and Wetlands and Waters Section (4.7.1.2) of this Exhibit E.

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Table E.4-91. Qualitative assessment of avian species presence in non-sampled Project area vegetation classification.

Species that may be Present in 2013 Vegetation Types	Alder Scrub	Forested Wetland	Herbaceous Wetland
Alder Flycatcher	X	X	X
American Dipper		X	
American Pipit	X	X	
American Robin		X	
American Three-toed Woodpecker	X	X	
American Tree Sparrow		X	X
Arctic Tern	X	X	
Black-billed Magpie	X	X	
Black-capped Chickadee		X	
Bohemian Waxwing	X	X	
Boreal Chickadee		X	
Brown Creeper		X	
Chestnut-backed Chickadee		X	
Common Raven	X	X	
Common Redpoll		X	
Dark-eyed Junco	X	X	
Fox Sparrow		X	
Golden-crowned Kinglet	X		
Golden-crowned Sparrow		X	
Gray Jay	X	X	
Gray-cheeked Thrush		X	X
Greater Yellowlegs		X	
Hairy Woodpecker	X	X	
Hermit Thrush		X	X
Herring Gull		X	
Lesser Yellowlegs	X	X	
Lincoln's Sparrow		X	X
Mew Gull		X	
Northern Flicker	X	X	X
Northern Shrike	X	X	
Northern Waterthrush		X	
Olive-sided Flycatcher	X		
Orange-crowned Warbler		X	
Pacific Wren		X	
Pine Grosbeak		X	
Pine Siskin	X	X	

Table E.4-91, continued…

Species that may be Present in 2013 Vegetation Types	Alder Scrub	Forested Wetland	Herbaceous Wetland
Redpoll Species		X	
Ruby-crowned Kinglet		X	X
Sandhill Crane	X	X	
Savannah Sparrow		X	X
Solitary Sandpiper		X	X
Song Sparrow	X	X	X
Spotted Sandpiper		X	
Spruce Grouse		X	
Steller's Jay	X	X	
Swainson's Thrush	X	X	
Townsend's Warbler		X	
Tree Swallow	X	X	
Varied Thrush		X	
Violet-green Swallow	X	X	X
Wandering Tattler		X	
Western Wood-pewee	X	X	
White-crowned Sparrow		X	
White-winged Crossbill	X	X	
Willow Flycatcher	X		
Willow Ptarmigan		X	X
Wilson's Snipe	X		
Wilson's Warbler	X		
Yellow Warbler		X	
Yellow-rumped Warbler			

USFS Sensitive Species and Species of Special Interest

Marbled Murrelet (Brachyramphus marmoratus): This medium sized seabird inhabits inland freshwater lakes and nests in inland areas of old-growth conifer forest or on the ground (Carter and Sealy 1986; Marshall 1988). Marbled murrelets have not been observed in the Grant Lake area. Murrelets are known to select mature or old growth conifers for nesting, and this habitat is found within the area in mature hemlock and spruce-hemlock forests.

Townsend's Warbler: This species is found throughout forested locations on the Kenai and Seward Ranger District (USFS 2008). They are associated with older, mature spruce and hemlock forests and are not found as often in young coniferous or hardwood forests. Seward Ranger District Breeding Bird surveys indicate that Townsend's warblers are found in higher numbers in older spruce and hemlock forests, and that they have declined in numbers between 1994 and 2000 (Prosser 2002). Townsend's warblers were detected during the 1984, 2010, and

2013 Grant Lake surveys and their habitat occurs throughout forested sections of this area, in mature hemlock and spruce-hemlock forests.

Audubon's Red-Listed Species

The Alaska WatchList is Audubon Alaska's science-based, early warning system to identify bird species at risk. It is a tool to focus attention and resources on vulnerable and declining bird populations across the state. Species and subspecies on the WatchList face some combination of population decline, small population size, or limited geographic range. The Red List has the highest level of concern: species are vulnerable and currently declining or depressed from a prior decline. The species listed below are identified on the Alaska WatchList.

Varied Thrush: This species is found in spruce forests, deciduous (balsam poplar and dense alder stands), and mixed forests (Kessel 1989; Kessel 1998; George 2000). Shrub understory appears important to breeding; shady, mossy forests, deciduous shrub, dense alder thickets, and isolated cottonwood patches are all apparently preferred habitat (Kessel 1998). Varied thrushes were detected in the 1984, 2010, and 2013 Grant Lake surveys and their habitat occurs throughout forested sections of this area.

Lesser Yellowlegs: This species breeds in muskegs and freshwater marshes in open boreal forests and forest / tundra transition habitats. Nesting habitat is typically a combination of shallow wetlands, trees, shrubs, and open water. The species will forage in boreal forest wetlands (Tibbitts and Moskoff 1999). Lesser yellowlegs were only detected in the 1984 surveys and their habitat occurs throughout sections of this area.

Wandering Tattler: Mostly restricted to the alpine zone, this species usually breeds along rocky or scrubby vegetated edges of mountain streams and lakes; frequents rapidly flowing streams and tundra habitats, wet meadows, moraine deposits, scree slopes, and braided rivers, but is sometimes also found in forest clearings away from water. These birds often nest on the ground in a rocky or gravelly site (Weeden 1965; Johnsgard 1981; Weeden 1959). Nests have also been observed in dwarf shrub tundra near streams or lakes (Spindler et al. 1980; Gill et al. 2002). Wandering tattlers were detected in the 1984 surveys; however, their habitat does not likely occur in the Project area.

Solitary Sandpiper: This species nests in wooded wetlands in muskeg bogs, spruce forests, and deciduous riparian woodlands (Moskoff 1995) and, occasionally, riparian tall shrub thickets (Spindler and Kessel 1980; McCaffery and Harwood 2004). More specifically, on the Kenai Peninsula, this sandpiper is closely associated with wet forest gaps 10 to 20 meters (~11 to 22 yards) wide (Collins et al. 1999). Solitary sandpipers were only detected during the 2010 surveys and their habitat likely occurs in the Project area.

Kittlitz's Murrelet: This is a ground nesting species with nests constructed on barren scree slopes, a short distance below a peak or ridge (Day et al. 1983; Day 1995; Piatt et al. 1999). Breeding generally occurs in high elevation alpine areas, with little or no vegetative cover. When present, vegetation is primarily comprised of lichens and mosses (Day et al. 1983). Kittlitz's murrelets have not been observed in the Grant Lake area and their habitat does not likely occur in the Project area.

Olive-sided Flycatcher: The species shows a preference for forest edges, including harvested areas and open canopied forested habitats where forests are naturally open or semi-open. This species, although considered an indicator for coniferous forests, is also found in mixed deciduous / coniferous forests. Further, this species is associated with openings and water (e.g., bogs, wetlands) and dead standing trees, and is closely associated with recently burned areas (Wright 1997). Olive-sided flycatchers were detected during the 2010 surveys and their habitat likely occurs in the Project area.

Blackpoll warbler: This species is found predominantly along rivers, streams, or bogs in mixed or coniferous forests and tall shrub thickets (especially *Salix alaxensis* and *Alnus incana*) with mixed spruce-paper birch overstory ([*Betula papyrifera*] Gabrielson and Lincoln 1959; Kessel 1989; McCaffery 1996; Kessel 1998; Cotter and Andres 2000). These species will also inhabit riparian areas and ecotones between treeline alpine tundra (Kessel 1998; Kessel and Gibson 1978). Blackpoll warblers have not been observed in the Grant Lake area; however, their habitat does occur in the Project area.

4.7.1.3.2 Waterbirds

The 2010 data identified the presence of eight species of waterfowl on Grant Lake (Table E.4-92).

Table E.4-92. Waterfowl species detected during 2010 studies.

Species	Scientific name
Barrow's Goldeneye	*Bucephala islandica*
Common Goldeneye	*Bucephala clangula*
Common Loon	*Gavia immer*
Pacific Loon	*Gavia pacifica*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Harlequin Duck	*Histrionicus histrionicus.*
Mallard	*Anas platyrhynchos*

The 1984 study reported two additional species of waterfowl, American widgeon and green-winged teal. Barrow's and common goldeneye species as well as red-breasted mergansers were also observed with broods during the 2010 study. All three species are considered diving ducks and feed primarily on aquatic invertebrates (goldeneyes) and crustaceans and fish (merganser). The 1984 study documented the availability of the following aquatic food resources for diving ducks: Diptera, Plecoptera, Tricoptera, Bivalvia, Gastropoda and Gammaridae. Prey concentrations and availability appear to sustain reproduction and brood rearing on Grant Lake. Both goldeneye species are cavity nesters. Presence and availability of nest sites are a natural limiting factor. Females will often return to the same nest if reproduction is successful in previous years. The red-breasted merganser is a ground nester, and habitat for nest selection may not be as limited for this waterbird species in the Grant Lake area. There is suitable habitat available for ground-nesting ducks including the for-mentioned puddle ducks in certain areas of Grant Lake.

Winter Use of Grant Lake Area

Trumpeter swans were detected on March 3, 2013, on the east side of Lower Trail Lake (K. Graham (USKH) personal communication April 23, 2013). It is purported that these birds over winter in this area. Apparently the location remains ice-free due to the high pressure of water flow through the Trail Lake narrows.

The 2013 – 2014 survey data support the suggestion that Grant Lake and narrows area between the Trail Lakes provide overwintering habitat to waterbirds. Prey concentrations and availability may provide wintering opportunities on Grant Lake and the Trail Lakes; however, the extent of the prey availability is unknown.

Trumpeter swans feed primarily on submerged vegetation. Grant Lake and the narrows may or may not provide foraging habitat for this species, but their presence in these area indicate that the swans are benefiting from the open water habitat in some way.

USFS Sensitive Species and Species of Special Interest

Trumpeter Swan: This is a USFS sensitive species that prefers large ponds, lakes, and marshes; constructing massive nest mounds in areas of reeds, sedges, or similar emergent vegetation, primarily on stationary fresh waterbodies (Mitchell 1994). Swans are considered shy waterfowl easily disturbed during nesting; however, once cygnets are mobile, adults become very protective. Trumpeter swans were observed north of the Project area during USFS surveys (2008); however, no nests or cygnets were observed during these USFS (2008) surveys. Trumpeters were also sighted during spring 2013 below the Trail Lake narrows; however, they were not re-sighted during summer field work. Suitable habitat likely occurs in the wildlife study area.

Audubon's Red-Listed Species

Red-throated Loon: This species will typically select marshy islands for nest sites or on dry shores. They will nest on small oligotrophic lakes in diverse habitats, such as forests or tundra up to 1,070 meters (~3,510 feet) in elevation. The availability of freshwater fish limits this species' distribution (Soper 1946; Palmer 1962; Davis 1972; Bundy 1976; Bergman and Derksen 1977; Cramp and Simmons 1977; Merrie 1978; Derksen et al. 1981; Furness 1983; Reimchen and Douglas 1984; Johnsgard 1987; Douglas and Reimchen 1988; Eberl and Picman 1993; Barr et al. 2000). Red-throated loons have not been observed in the Grant Lake area, but their nesting habitat does occur in the Project area.

Yellow-billed Loon and Greater White-fronted Goose: Both species are considered non-breeders in this area and warrant no further discussion as their primary breeding habitats also do not occur in the Project area.

4.7.1.3.3 Terrestrial Mammals

Bear

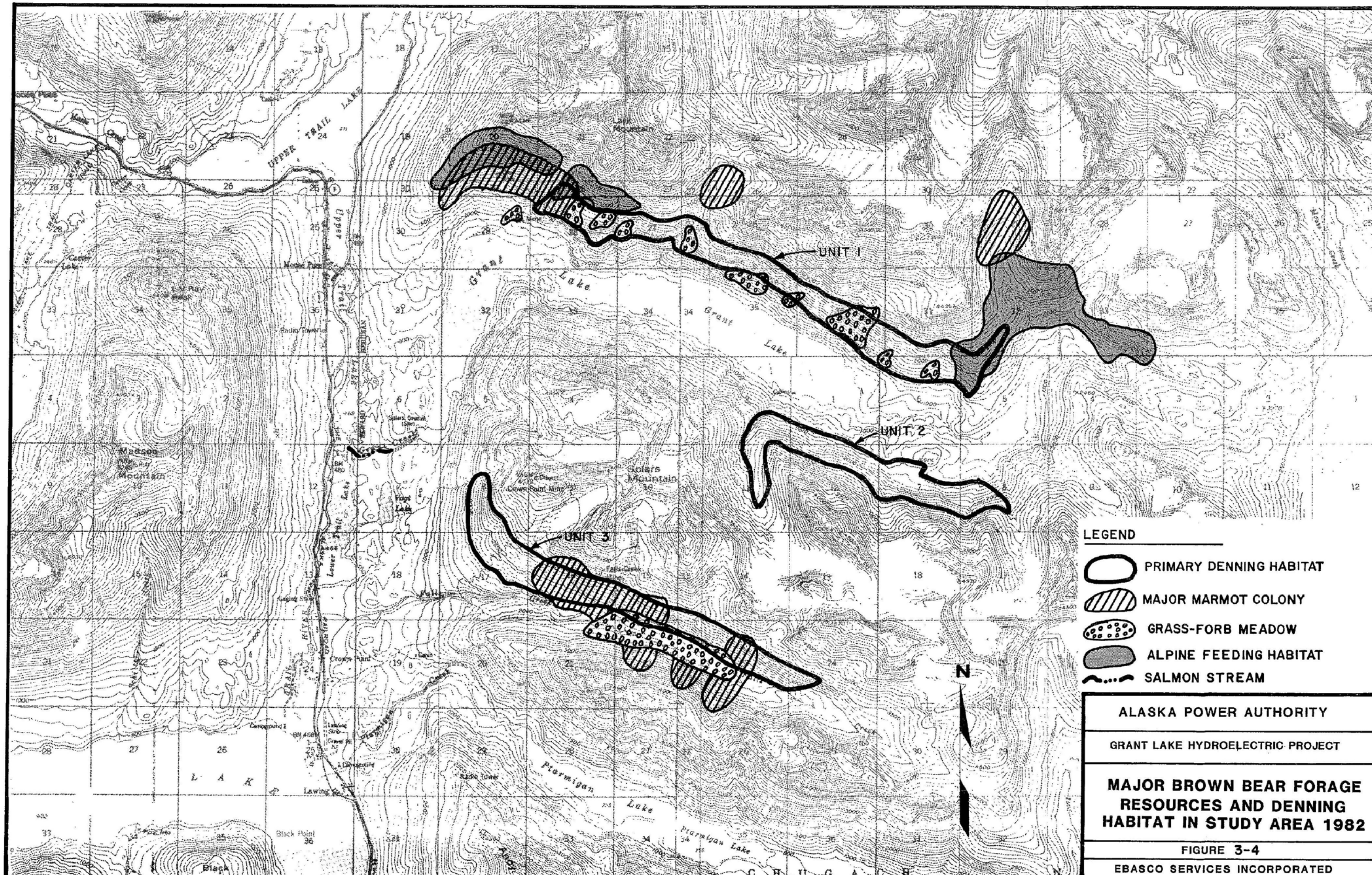
Ebasco (1984) surveyed for the presence of black bears in their defined study area and reported detecting nine bears during three field surveys. They did not discover activity in the upper Grant Lake valley.

Important black bear habitat in the Project area includes the lower alpine zone near the shrubline, which is important in July and August for the young, succulent forbs and sedges it produces. During August and September, salmon present in Grant Creek are sought by black bears. Because salmon are unavailable in great numbers, bears intermittently forage in the subalpine zone and on lowland berries at this time. Elderberries, blueberries, rosehips, salmon berries and low and highbush cranberries are probably utilized heavily.

Likely denning habitat for those black bears residing locally year-round in the Grant Lake area includes the bench between Grant Lake and Upper Trail and Lower Trail lakes.

On the Kenai Peninsula, the primary limiting factor for brown bear is spring and summer feeding habitat. Spring and summer habitat includes south-facing hillsides and avalanche chutes, big game winter ranges, and salmon streams that provide the high quality foods that bears need to develop fat reserves before denning and to replenish fat stores depleted after denning. Carrion, berries, and fish sources in the watershed provide a diversity of food sources for bears (USFS 2008). Ebasco (1984) delineated denning habitat for brown bear based on sightings of individual bears and their sign at the time of den emergence, and on the basis of certain geomorphic and vegetation characteristics. Three units of potential denning habitat were delineated in this manner (Figure E.4-75).

The USFS (2008) also delineated high value brown bear denning habitat in the more general Trail River Landscape Assessment (2008) (Figure E.4-76). The model predicted the probability of denning across the landscape. Potential denning habitat is abundant and well distributed on steep slopes. The identified habitat is most likely to be used by females with cubs after den emergence, which is also important for foraging (USFS 2008).



3-84

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Figure E.4-75
Major Brown Bear Forage and Denning Habitat (Ebasco 1984)

DESIGNED J. Woodbury
DRAWN M. Hjortsberg
CHECKED A. Ajmi
ISSUED DATE 11/11/2014
DRAWING

80 - 100% Probable Denning Habitat and Brown Bear Core Prescription in the Trial River Landscape Assessment Area

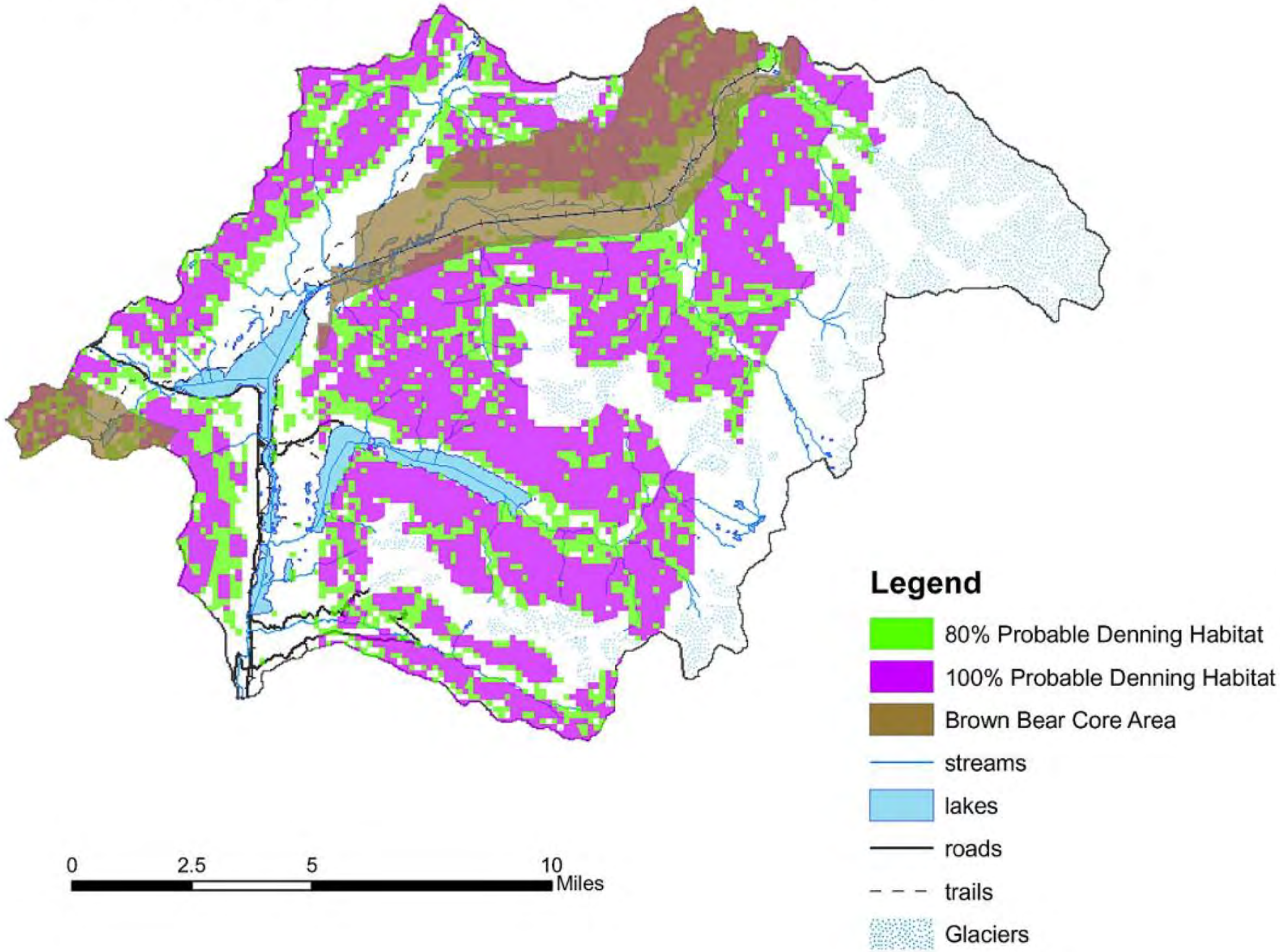

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Figure E.4-76
Major Brown Bear Forage and Denning Habitat (USFS 2008).

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Mountain Goat

The 2010 wildlife study field efforts reported sighting six mountain goats during Waterbird surveys. Ebasco (1984) delineated goat habitat based on assessment of ADF&G information (see Figure E.4-77).

The principal area of goat use in the Grant Lake basin is the north side of the lake. These south-facing slopes are utilized in fall, winter, spring, and into early summer. Occupied areas reach from alpine benches downslope into stringers of mountain hemlock. This plant was present in 70 percent of all fecal samples collected from alpine winter ranges at Grant Lake (Hansen and Archer 1981). The primary area of interchange between Grant Lake and other subpopulations is into the Moose Creek drainage to the northeast and across the glacier to the east to the Kings River-Kings Bay area.

Based on Chugach National Forest GIS data, mountain goat winter range primarily occurs on south-facing alpine slopes within the Trail River Watershed (USFS 2008). Predictive modeling delineated mountain goat winter habitat well outside the 2013 wildlife study area (see Figure E.4-78).

Dall Sheep

The Grant Lake area is purportedly considered the outer boundary of sheep range on the Kenai Peninsula covering the entire Grant Lake drainage in several small bands. During the Ebasco (1984) field studies, sheep were only noted on the northern half of the Grant Lake drainage, which may be the most favored range (see Figure E.4-79). Dall sheep habitat does not likely occur in the Project area.

Bat

The little brown Myotis is the only bat found in Interior and South Central Alaska, and has only been documented in forested regions of Alaska (Parker 1996; Parker et al. 1997). This species favors old-growth forests and riparian habitats (Parker et al. 1996), and will roost in buildings, trees, under rocks and wood, and caves (MacDonald and Cook 1996). Currently, there is not enough information for this species in Alaska to assess the presence or absence of habitat in the Project area.

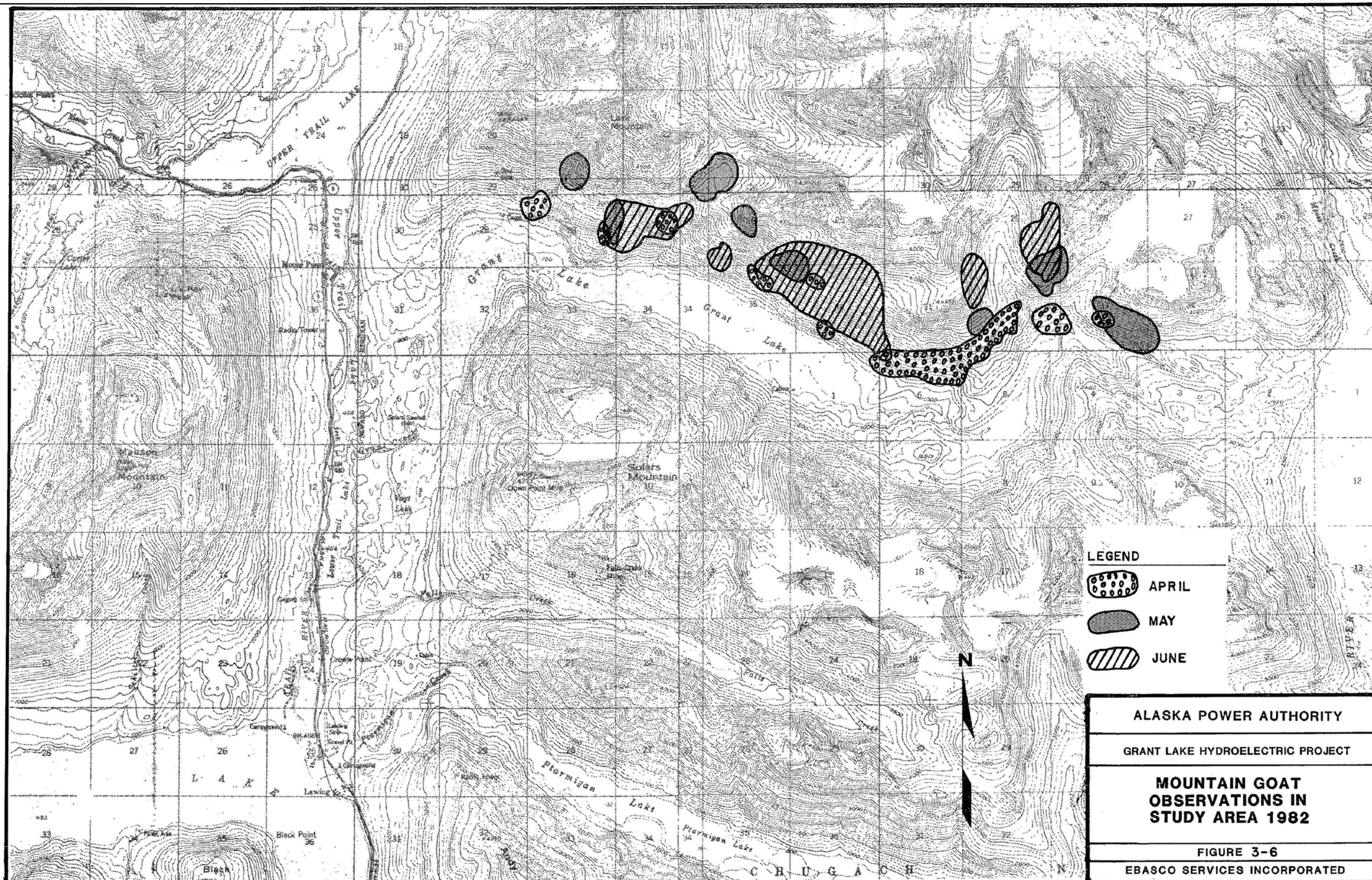
Moose

This species is primarily associated with early to mid-succession habitat and riparian areas and are dependent on early seral vegetation types including young hardwoods (willow, birch, aspen, and, to a smaller extent, cottonwoods). Ebasco (1984) delineated moose habitat based on assessment of ADF&G information (see Figure E.4-80).

Primary limiting factors for moose in Alaska and the Kenai Peninsula are the availability of winter range, predation, collision mortality from vehicles and trains (Lottsfeldt-Frost 2000), and distance between feeding and hiding / thermal cover (Renecker and Schwartz 1998).

Chugach National Forest GIS data indicated that high-quality habitat is primarily in riparian areas along the river valleys, but is distributed throughout the Trail River Watershed on all but the highest elevations (USFS 2008). The ADF&G considers the overall habitat on the Seward Ranger District to be of low quality and capable of supporting only 2 to 5 moose per square mile. Predictive modeling of moose winter range is displayed in Figure E.4-78 (USFS 2008).

Primary limiting factors for moose in Alaska and the Kenai Peninsula are the availability of winter range, predation, collision mortality from vehicles and trains (Lottsfeldt-Frost 2000), and distance between feeding and hiding, / thermal cover (Renecker and Schwartz 1998). Chugach National Forest GIS data indicated that high-quality habitat is primarily in riparian areas along the river valleys, and is distributed throughout the Trail River watershed on all but the highest elevations (USFS 2008). ADF&G designate the moose density in Game Mangement Unit 7 as “chronically low” and that the severe winters coupled with deep snow conditions most likely contribute to high mortality rates in this area (McDonough 2010). USFS (2008) predictive modeling of moose winter range is displayed in Figure 5.3-6 of the Terrestrial Resources Study, Final Report (KHL 2014f). Results from the 2013 - 2014 Winter Moose surveys appear to support ADF&G’s assessment of low moose numbers in the Project area during the winter. There were no moose or tracks observed within the USFS (2008) predicted wintering habitat during the 2013–-2014 aerial surveys.



3-92

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Figure E.4-77
Mountain Goat Observations in Study Area (Ebasco 1984)

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ISSUED DATE 11/11/2014
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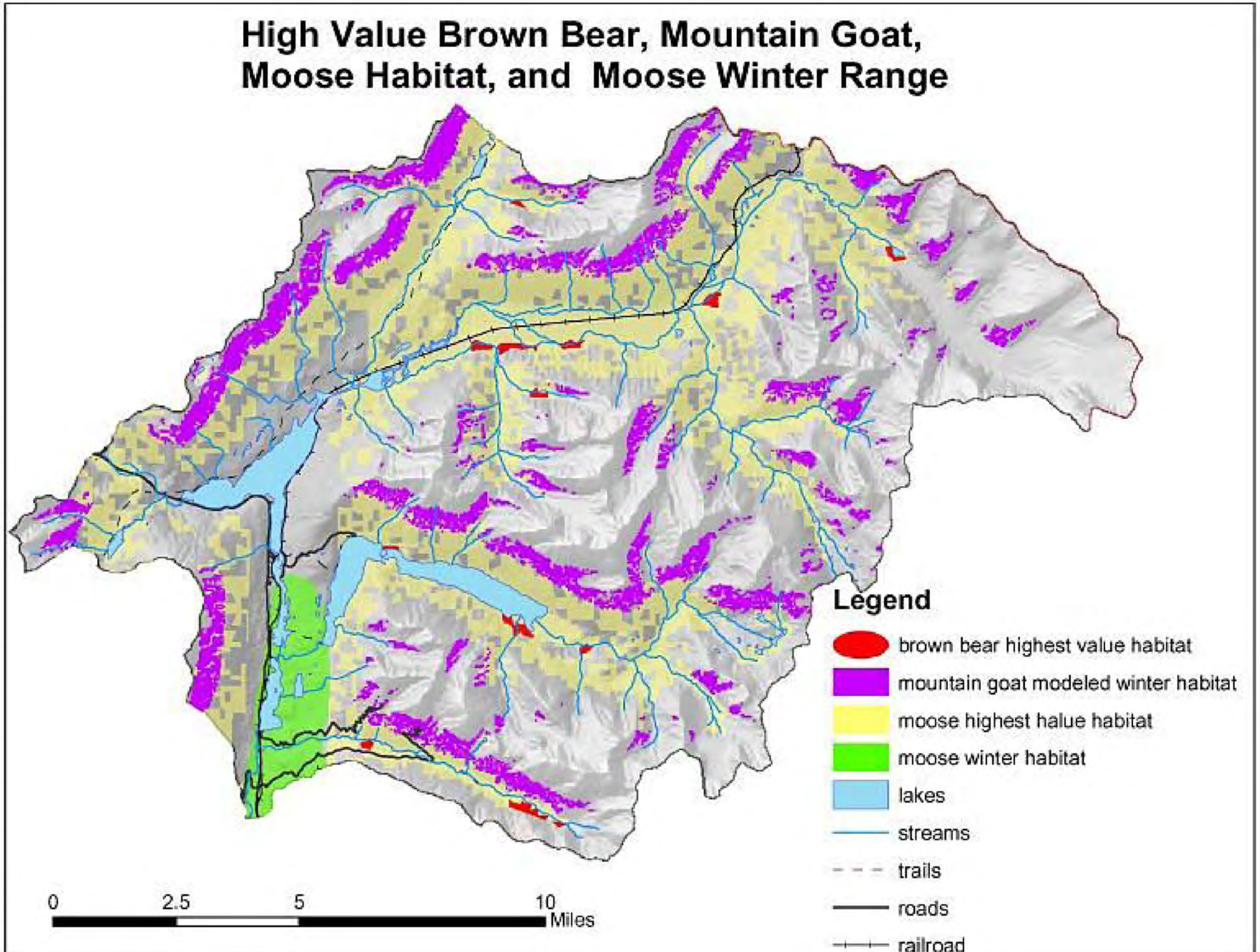

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Figure E.4-78 High Value Brown Bear, Mountain Goat, Moose Habitat, and Moose Winter Range (USFS 2008)

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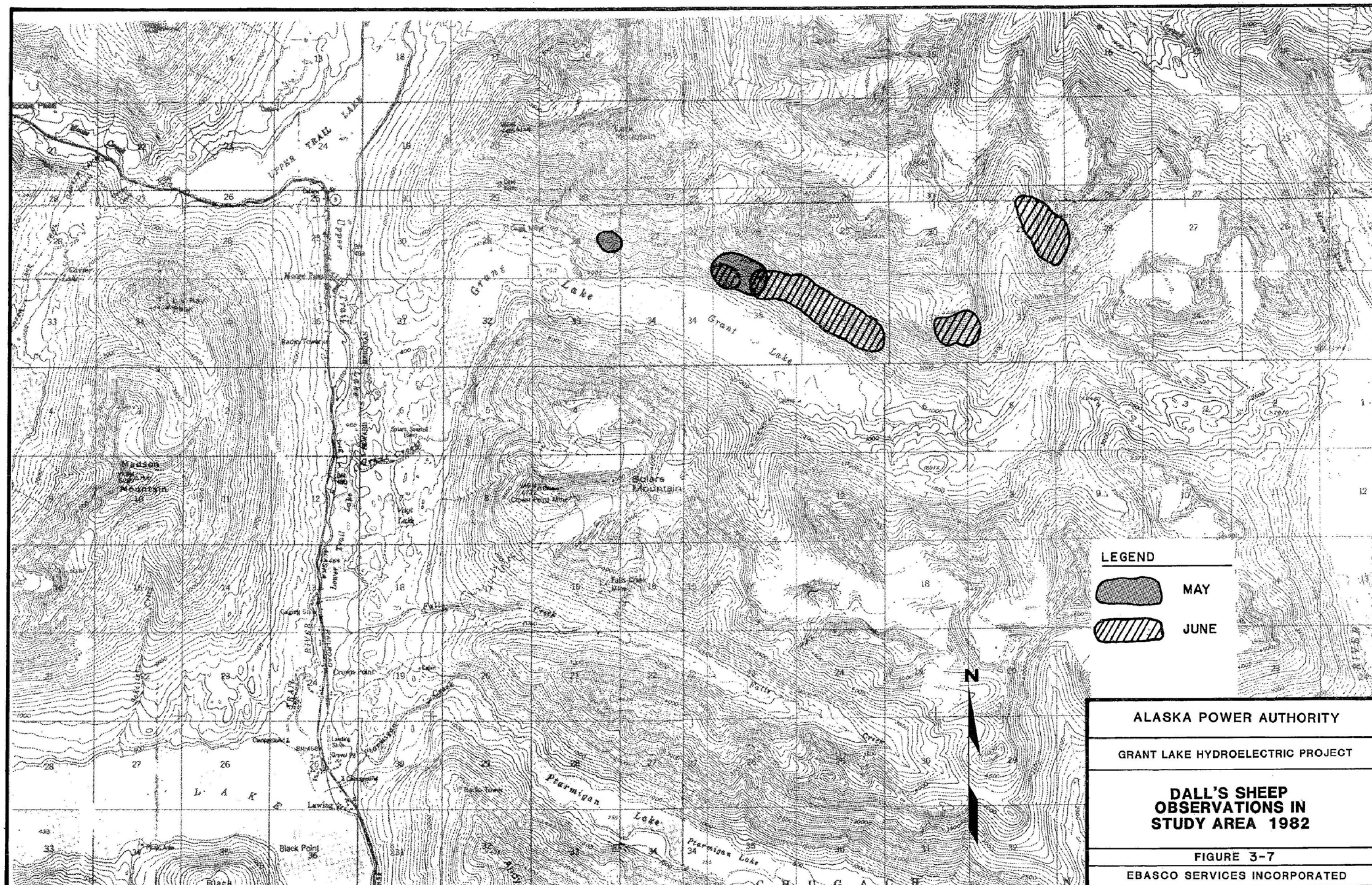

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Figure E.4-79
Dall Sheep Observations on Study Area (Ebasco 1984)

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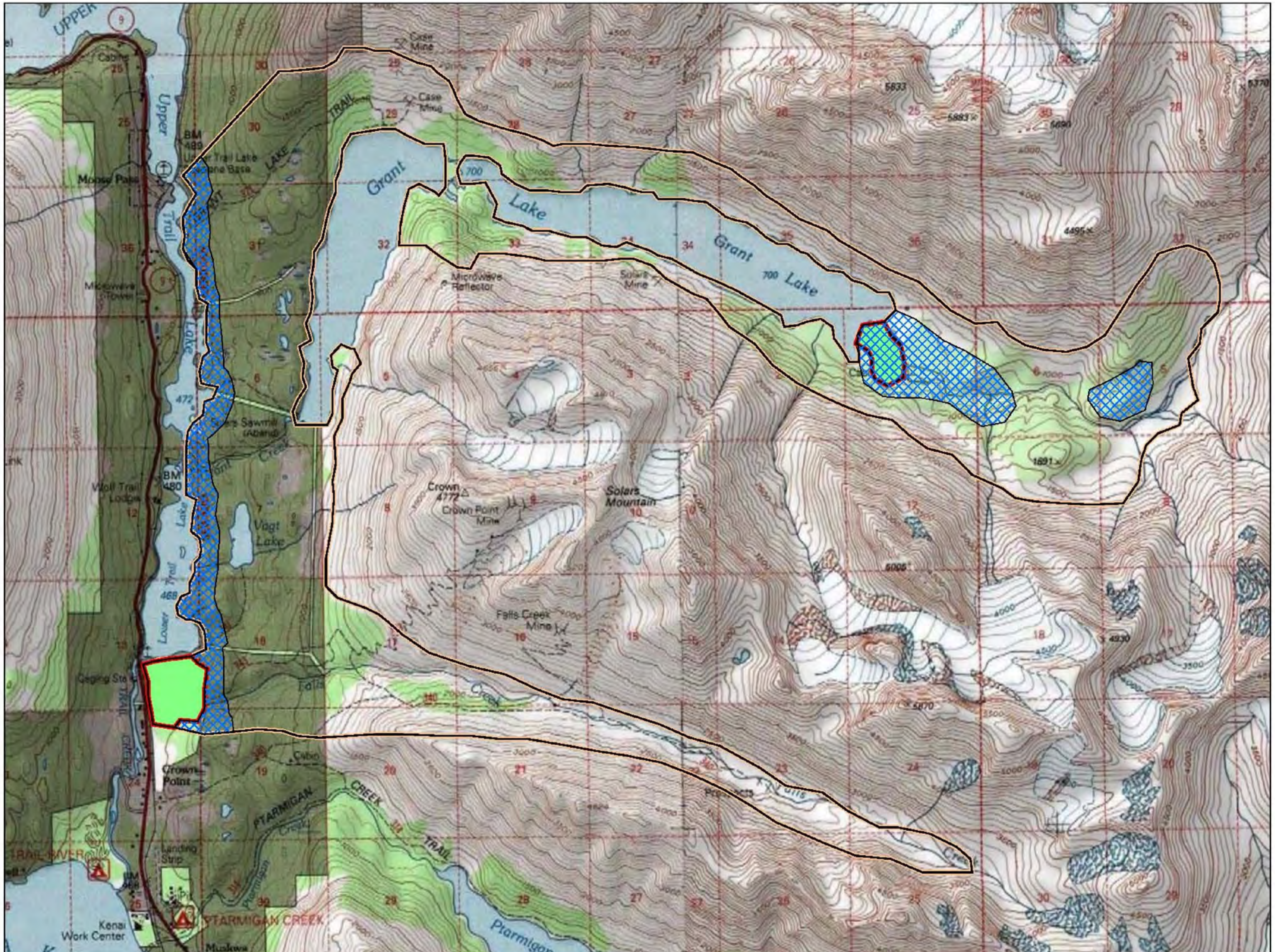

Moose Range, 1982

Moose Range
- Summer Range
- Summer and Secondary Winter Range
- Summer and Primary Winter Range

NORTH

Feet
0 2,625 5,250

Map Projection: NAD 83 Alaska State Plane Zone 4 Feet
Data Sources:
Author: HDR Alaska, Inc.
Date:

This map represents a conceptual level of utility, detail, and accuracy. The information displayed here is for planning purposes only. Base information shown constitutes data from various federal, state, public, and private sources. These maps are for review purposes only.

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Figure E.4-80
Moose Range on Study Area
(Ebasco 1984)

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4.7.2. Environmental Analysis

4.7.2.1. Terrestrial Vegetation, Invasive Plants and Sensitive Plants

4.7.2.1.1 Upland Terrestrial Vegetation

The Terrestrial Resources Study, Final Report (KHL 2014f) lists potential direct and indirect Project-related impacts to upland vegetation. Direct impacts to upland vegetation are impacts caused by the direct footprint of Project facilities; and include vegetation clearing, soil disturbance, altered natural grade, fill material placement, damage by machinery, and Grant Lake seasonal water level drawdown and fluctuations. Indirect impacts are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Potential indirect impacts to upland vegetation include: invasive plant infestation, soil erosion, poor native vegetation reestablishment, change of light or moisture levels, shift to earlier successional vegetation stage, and the effects of the Grant Lake drawdown and fluctuations. Direct impacts to upland vegetation by the construction of Project infrastructure would include the permanent removal of vegetation in some areas, and periodic alteration and clearing of vegetation in other areas. Direct impacts would also include soil disturbance, altered natural grade, fill material placement, and damage by machinery. Indirect effects of Project construction and maintenance to upland vegetation may include: invasive plant infestation, soil erosion, and poor native vegetation reestablishment.

This environmental analysis only considers the impacts to upland vegetation. Impacts to wetland vegetation are discussed in detail in Section 4.7.2.2 of this Exhibit E. For this analysis, Project components are grouped by type and locality within the proposed Project boundary [6] (Figure E.4-81). Amounts of Project-related upland permanent vegetation loss and vegetation alteration and clearing are evaluated.

The proposed Project would permanently remove approximately 0.92 acres of upland vegetation in the footprints of Project components including, the powerhouse, work area, penstock, detention pond, tailrace and their buffers (Table E.4-93). Alteration and clearing of upland vegetation would occur to areas surrounding these Project components during construction and then periodically re-cleared for regular maintenance. This would total 2.2 acres. Clearing and maintenance would impact vegetation by causing a shift to an earlier successional vegetation stage and creating local changes in light and moisture levels. Total direct impacts of Project components (including the powerhouse, parking area, penstock, detention pond, tailrace, and their buffers) to upland vegetation would total 3.12 acres. Upland vegetation types being directly impacted would be the Coniferous-Deciduous Forest (2.91 acres) and the Coniferous Forest (0.21 acres) vegetation types.

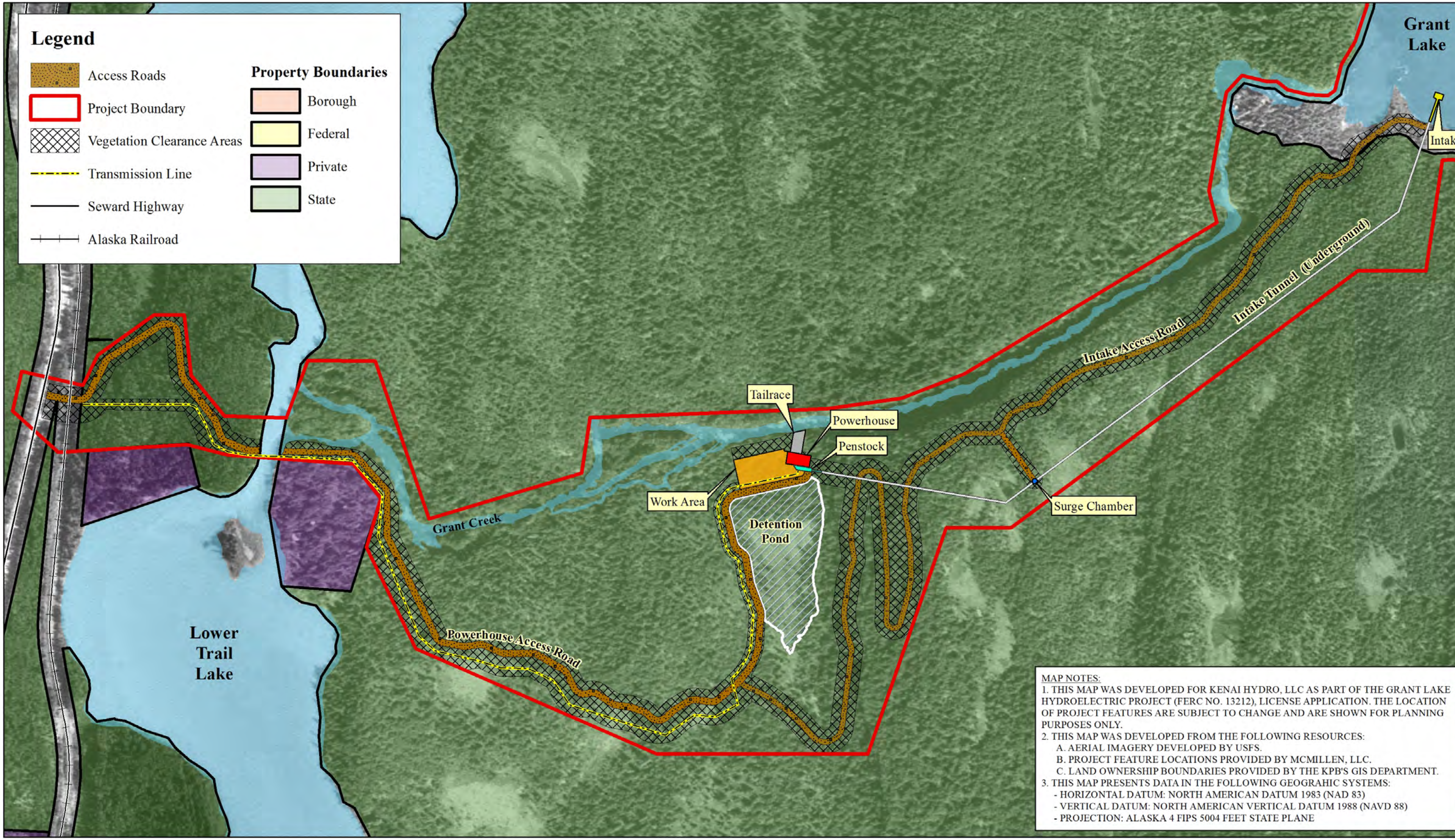
The powerhouse access road and transmission line corridor would parallel each other and would be approximately 1- mile long. The road would have a 24-foot wide top, a 3-foot wide shoulder

[6] The affected environment (Section 4.7.1.1.1) describes upland vegetation within the vegetation study area, which is an area slightly larger than the proposed Project boundary. The environmental analysis, however, focuses on upland vegetation within the Project boundary to give an accurate representation of the potential Project impacts.

on each side, a 35-foot wide cleared ROW on the north side and an 85-foot wide cleared ROW on the south side. The transmission line would be located in the ROW on the south side of the road. The entire corridor would be 150 feet wide. Construction of the powerhouse access road and transmission line corridor would permanently remove 3.32 acres of upland vegetation. Upland vegetation in the powerhouse access road ROW would be cleared during construction, and periodically re-cleared for regular maintenance on a total of approximately 8.69 acres. Clearing and maintenance would impact vegetation by causing a shift to an earlier successional vegetation stage, creating changes in light and moisture levels, and causing potential invasive plant introduction and spread. Direct impacts to upland vegetation by the powerhouse access road and transmission line corridor would total 12.01 acres. Upland vegetation types being directly impacted would be the Coniferous-Deciduous Forest (10.37 acres) and the Floodplain Forest and Scrub (1.64 acres) vegetation types.

The intake access road would be approximately 1 mile long with a 16-foot wide top, a 3-foot wide shoulder on each side, and a 39-foot wide cleared ROW on each side of the road. The entire corridor would be 100 feet wide. The impacts of components adjacent to the intake access road, including the surge chamber, surge chamber access road, and bypass clearing are included with the intake access road. Construction of the intake access road and adjacent Project components would permanently remove 3.44 acres of upland vegetation. Upland vegetation in the intake access road ROW and around adjacent Project components would be cleared during construction, and periodically re-cleared for regular maintenance on a total of approximately 10.22 acres. Clearing and maintenance would impact vegetation by causing a shift to an earlier successional vegetation stage, creating changes in light and moisture levels, and causing potential invasive plant introduction and spread. Direct impacts to upland vegetation by the intake access road and adjacent Project components would total 13.66 acres. Upland vegetation types being directly impacted would be the Coniferous Forest (11.26 acres) and the Coniferous-Deciduous Forest (2.4 acres) vegetation types.

Permanent upland vegetation loss as a result of construction and operation of the Project would occur on 7.68 acres (26.7 percent), while vegetation alteration and clearing would occur to 21.11 acres (73.3 percent) of upland vegetation. Total direct impacts of Project components to upland vegetation would be 28.79 acres, or 22.9 percent of a total of 125.69 acres of upland vegetation within the Project boundary (Table E.4-94).



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Drawing Scale:
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Figure E.4-81
General Project Features, Facilities, Adjacent Cleared Areas, and Right of Ways

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DRAWN Jake Woodbury
CHECKED K. Beck
ISSUED DATE 2/18/2015
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SCALE: 1:4,700

Table E.4-93. Acres of upland vegetation types affected by the Project.

Project Feature	Powerhouse / Tailrace / Work Area / Penstock / Detention Pond / Buffers	Powerhouse Access Road / Transmission Line Corridor / ROW	Intake Access Road / Surge Chamber and Access Road / Bypass Clearing / ROWs	Totals
Upland Vegetation Types - Permanent Vegetation Loss (acres)				
Coniferous Forest			2.82	2.82
Coniferous-Deciduous Forest	0.92	2.79	0.62	4.33
Floodplain Forest and Scrub		0.53		0.53
Total (acres)	**0.92**	**3.32**	**3.44**	**7.68 (26.7%)**
Upland Vegetation Types - Vegetation Alteration (acres)				
Coniferous Forest	0.21		8.44	8.65
Coniferous-Deciduous Forest	1.99	7.58	1.78	11.35
Floodplain Forest and Scrub		1.11		1.11
Total (acres)	**2.2**	**8.69**	**10.22**	**21.11 (73.3%)**
Grand Total (acres)	**3.12**	**12.01**	**13.66**	**28.79 (100%)**

Table E.4-94. Total area and percentages of upland vegetation types affected by the Project.

Upland Vegetation Type	Total Acres Affected by the Project	Number Acres in Project Area [1]	Total Area of Each Vegetation Type Affected by the Project (%)
Coniferous Forest	11.47	59.89	19.2
Coniferous-Deciduous Forest	15.68	52.71	29.7
Alder Scrub	0	4.36	0
Grass-Forb Meadow	0	0.13	0
Floodplain Forest and Scrub	1.64	8.6	19.1
Total Acres	**28.79**	**125.69**	**22.9**

Notes:

1. Total upland vegetation acreage presented in Table E.4-94 (125.69) differs from that in Table E.4-85 (493.4) because the value in Table E.4-94 is for the area within the Project boundary, whereas, that for Table E.4-85 is for the larger vegetation study area.

Percentages of direct Project impacts to upland vegetation types in the Project area are: Coniferous Forest (19.2 percent), Coniferous-Deciduous Forest (29.7 percent), and Floodplain Forest and Scrub (19.1 percent). There are no direct impacts to the Alder Scrub and Grass-Forb Meadow vegetation types in the Project area. The Project footprint occurs in upland vegetation types which are common throughout the region. The Draft VMP, to be distributed for comment between late April and mid-May, will include guidelines for a vegetation maintenance schedule and invasive plant prevention and control measures for the access roads, transmission line corridor, and Project components.

The seasonal water level drawdown and fluctuations of the Grant Lake could have potential direct effects on upland vegetation around Grant Lake. The proposed operational scenario will have a 13-foot seasonal drawdown which will occur entirely below the natural maximum water elevation and the zone of upland vegetation. The upper 692 feet of this drawdown occurs under natural conditions. Grant Lake will have a normal maximum lake elevation of 703 feet NAVD 88 and a minimum lake elevation of 690 feet NAVD 88. The Project will be drafted in fall and winter and refilled in spring and summer. Because the lake will not fill above the natural maximum elevation of 703 feet NAVD 88, the Project is not expected to have direct impacts on upland vegetation around the Grant Lake.

BMP for construction, revegetation and invasive weed control will be included in the Draft VMP for the Projectto be distributed for comment between late April and mid-May. Implementation of measures in the plan will help minimize direct and indirect impacts to upland vegetation and also help minimize invasive plant introduction and spread.

4.7.2.1.2 Invasive Plants

Invasive plants are those that are not considered native to Alaska, as listed by the Alaska Exotic Plant Information Clearinghouse (AKEPIC 2014). The Chugach National Forest Revised Land and Resource Management Plan cites as a goal to “prevent introduction and spread of exotic plants and reduce areas of current infestation” (USFS 2005). Invasive plant species displace and degrade native vegetation and wildlife habitat. Invasive species have many characteristics that allow them to outcompete native vegetation. They grow rapidly, mature early, produce copious amounts of seed and are often able to reproduce both sexually and asexually. Most invasive plants are sun-loving, though some tolerate some degree of shade. Even light disturbance can create conditions conducive for invasive plant establishment.

An indirect impact of the Grant Lake drawdown during the growing season is the creation of relatively large expanses of bare, unshaded ground that may support invasive plant species. Under the proposed operation scenario, lake levels could be up to 13 feet below natural lake levels at the start of the growing season, and returning to natural levels by mid-August. The potential for invasive plant colonization in these exposed areas depends on duration and timing of substrate exposure. Some invasive species may be able to tolerate some amount of inundation, while other species may be able to produce seed during a relatively short time period when they are not inundated. Invasive species may have the potential to spread rapidly around the Grant Lake drawdown zone and subsequently into adjacent upland areas. Where Project-disturbed areas intersect areas with natural disturbance such as streams, lakeshores, and newly exposed avalanche chutes, invasive plant establishment may spread beyond Project components.

An indirect impact of ground disturbance from construction and regular maintenance activities along access roads, the transmission line corridor and around Project facilities is the creation of suitable substrate for invasive plant establishment. In addition to natural dispersion methods (air, flowing water and animal dispersion), vehicles and tools used for construction and maintenance activities may serve as a means by which invasive plant propagules can reach disturbed areas in the Project area.

An indirect impact of potential increased recreational use of the Project area may be the transport of invasive plants into and around the Project area. Hiking, hunting, boat use and camping along access roads, the transmission line corridor and on the Grant Lake may readily bring invasive plants from outside the Project area to substrates where they can become established. In addition, ground substrate disturbance resulting from recreational activities like hiking, may create suitable substrate for invasive plant establishment.

The Draft VMP, to be distributed for comment between late April and mid-May, will include provisions to guide noxious weed prevention and control, the revegetation of disturbed areas, and vegetation monitoring and contingency measures. Implementation of the plan will help protect native vegetation communities and habitat.

4.7.2.1.3 Sensitive Plants

During the 2013 Terrestrial Resources Study, a small population of pale poppy (*Papaver alboroseum*), a USFS-designated sensitive plant, was located on the shore of the USFS owned portion of Grant Lake. No proposed Project features are located on USFS land on Grant Lake; thus the poppy population will not be directly affected by the construction or maintenance of Project facilities. Because the plants are located between elevation 704 and 707 feet NAVD 88, the Grant Lake seasonal water level drawdown (between elevation 690 and 703 feet NAVD 88) and fluctuations will not inundate and are not expected to have indirect impacts on pale poppy plants. While the Grant Lake water elevation drop to 690 feet NAVD 88 during the early part of the growing season may have an overall drying effect of the pale poppy substrate, pale poppy should not be negatively affected as it is an upland species which is able to grow on very dry habitats.

An indirect impact of Grant Lake seasonal water elevation drawdown is that invasive plant species may spread into the drawdown zone between 690 and 703 feet NAVD 88, and subsequently onto adjacent upland areas, including the pale poppy habitat. Currently the only invasive plant species present in the vicinity of the pale poppy population is common dandelion. There may be some horned dandelion (*Taraxacum ceratophorum*), a similar looking native species, growing with the common dandelion, so an effort should be made to distinguish the two species if control efforts were implemented. Horned dandelion was observed elsewhere on the Grant Lake shore.

A historic cabin, a campsite and two campfire rings with evidence of recent use are located in close proximity to the pale poppy population. There was no visible evidence of trampling of plants when the population was surveyed in 2013, although plants were located as close as 5 feet away from one of the campfire rings. An indirect impact of potential increased recreational use of Grant Lake may be an increased potential for trampling and possibly scorching of pale poppy plants. In addition, increased recreational access and use of Grant Lake may spread invasive species into pale poppy habitat.

The Draft VMP, to be distributed for comment between late April and mid-May, will describe measures to assess whether the Project is having negative impacts on the pale poppy population on USFS land and establishes a framework for adaptive management to modify Project infrastructure and/or operations for sensitive plant management. It will also detail measures to help minimize the establishment and spread of invasive plants in the Project area generally, as well as in the vicinity of the pale poppy population. A Draft BE for USFS listed sensitive plants in the Grant Lake Project area is under development and will be distributed for comment between late April and mid-May.

4.7.2.2. Wetlands

For the purpose of assessing impacts to wetlands and waters, direct and indirect impacts (used here synonymously with "effects") are defined per the definitions of "effects" described on page 49 of FERC's guidelines, *Preparing Environmental Documents, Guidelines for Applicants, Contractors, and Staff* (FERC 2008). Direct impacts to wetlands and waters include impacts caused by the direct footprint of Project facilities, including fill placed in wetlands or waters, or clearing of wetland vegetation adjacent to facilities. Indirect impacts to wetlands and waters are less straightforward, resulting from complex interactions between the natural environment, the direct impacts, and the resulting indirect impacts themselves. Recognizing this complexity, for the purpose of this assessment indirect impacts include any impacts to wetlands or waters resulting from changes in the natural hydrology, geomorphology, ecology, or water quality of wetlands and/or waters, as a result of direct impacts. These include impacts resulting from changes in the level of Grant Lake, changes to flow timing and magnitude in Grant Creek, and changes in hydrology within wetlands and/or waters due to the placement of Project facilities. Indirect impacts also include impacts resulting from changes to water quality (e.g., water chemistry, suspended sediment levels, temperature), or geomorphology (e.g., bank erosion or changes in channel bedload) caused by any direct impacts to wetlands or waters. Lastly, indirect impacts also include impacts resulting from ecological changes, such as changes in vegetation or the biotic community of a wetland or water, or weed infestation. For the purpose of this report, indirect impact is synonymous with "secondary" impact as defined by the USACE, and direct impact has the same meaning for both FERC and USACE.

Note that a loss or reduction in wetland or waters function could result from either direct or indirect impacts. As an example, a loss or reduction of the wildlife habitat function for a wetland could be caused by either fill in the wetland (direct impact), or by changes in hydrology that cause the wetland to transition from a scrub-shrub wetland to an herbaceous wetland (indirect impact).

This section describes the Project-related direct and indirect impacts to wetlands and waters by hydrogeomorphic type (depressional, lacustrine, or riverine), with separate sections for direct versus indirect impacts. Acres of impacts to wetlands and waters are presented in Table E.4-95. This table includes only quantified impacts; qualitative impacts (weed infestation, sedimentation, temporary turbidity, and potential changes in function) were not quantified. Table E.4-96 presents a general qualitative discussion of direct and indirect impacts, of short term or permanent duration. Figures E.4-82 through E.4-84 present the direct and indirect impacts to wetlands and waters within the Project corridor. Indirect impacts along Grant Lake are presented in text only, not in figures.

The Terrestrial Resources Study, Final Report (KHL 2014f) also describes the various direct and indirect interdisciplinary linkages between wetlands and waters with other study disciplines evaluated for this Project. A full discussion of fill-related impacts to WOUS will also be included in the 404 permit application.

The "waters" portion of this section overlaps with the Section 4.5, Water Quality and Quantity, and Section 4.6, Aquatic Resources (Instream Flow) of this Exhibit E. Section 4.5 presents a detailed discussion of the impacts to hydrology, water chemistry, and temperature of Grant Creek and Grant Lake; and Section 4.6 presents a detailed discussion on the instream flow of Grant Creek. This section, 4.7.2.2, Wetlands and Waters, is intended to provide a more general assessment of impacts to waters with a focus on the regulatory needs for the CWA Section 404 permit application, which will be submitted in early 2015. See Sections 4.5 and 4.6 for detailed discussion of direct and indirect impacts to Grant Creek and Grant Lake.

Table E.4-95. Estimated direct and indirect impacts to wetlands and waters.

<table>
<tr><th></th><th></th><th></th><th colspan="2">Permanent Impacts</th><th colspan="2">Temporary Impacts</th><th rowspan="2">Total</th></tr>
<tr><th></th><th>Impact Type</th><th>Wetlands/ Waters Affected</th><th>Wetlands (Acres)</th><th>Waters (Acres)</th><th>Wetlands (Acres)</th><th>Waters (Acres)</th></tr>
<tr><td rowspan="3">Direct Impacts</td><td>Fill</td><td>Various wetlands/waters</td><td>0.42</td><td>0.07</td><td>/</td><td>/</td><td>0.49</td></tr>
<tr><td>Vegetation clearing</td><td>Various wetlands</td><td>1.49</td><td>/</td><td>/</td><td>/</td><td>1.49</td></tr>
<tr><td>Inundation</td><td>Detention pond wetland</td><td>/</td><td>/</td><td>2.75</td><td>/</td><td>2.75</td></tr>
<tr><td colspan="3" align="right">Subtotal Direct Impacts</td><td>1.91</td><td>0.07</td><td>2.75</td><td>0.00</td><td></td></tr>
<tr><td colspan="3" align="right">Total Direct Impacts</td><td colspan="2">1.98</td><td colspan="2">2.75</td><td>4.73</td></tr>
<tr><td rowspan="3">Indirect Impacts (Hydrology)[1]</td><td>Reduced peak flows</td><td>Grant Cr and fringe wetlands below powerhouse</td><td>4.19</td><td>3.58</td><td>/</td><td>/</td><td>7.77</td></tr>
<tr><td>Reduced mean and peak flows</td><td>Grant Cr wetlands/ waters in bypass reach</td><td>0.36</td><td>3.17</td><td>/</td><td>/</td><td></td></tr>
<tr><td>Water lowering</td><td>Grant Lk and fringe wetlands</td><td>13.64</td><td>1649.11</td><td>/</td><td>/</td><td>1662.75</td></tr>
<tr><td colspan="3" align="right">Subtotal Indirect Impacts</td><td>18.18</td><td>1655.86</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td colspan="3" align="right">Total Indirect Impacts</td><td colspan="2">1674.04</td><td colspan="2">0.00</td><td>1674.04</td></tr>
</table>

Notes:
Only hydrology-driven indirect impacts are calculated here due to their potential to change a wetland from wetland to non-wetland, or a wetland to water. Other indirect impacts (weeds, sediment, and erosion) are not presented.

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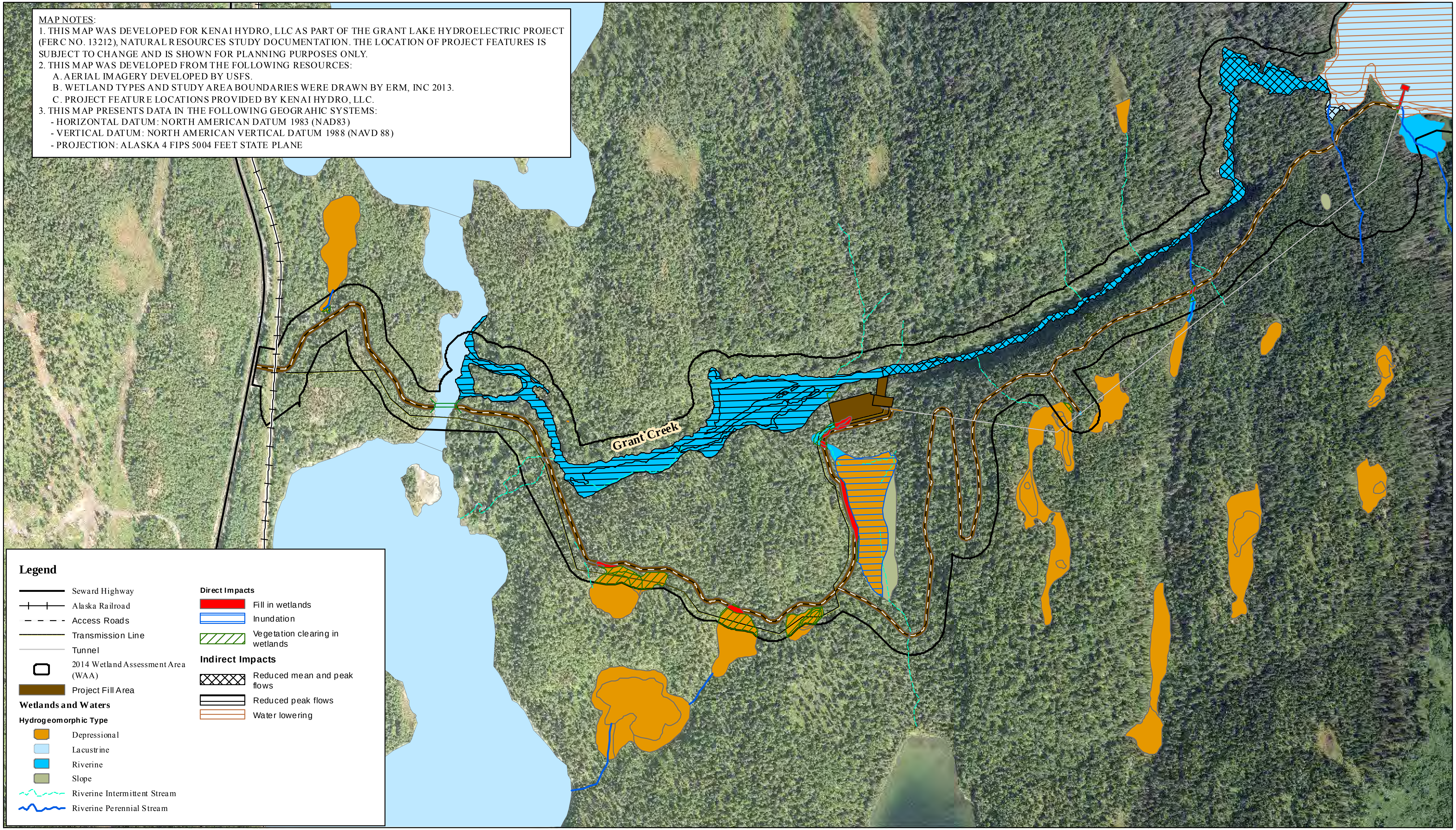
MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. WETLAND TYPES AND STUDY AREA BOUNDARIES WERE DRAWN BY ERM, INC 2013.
   C. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 250 500 1,000 Feet

McMILLEN, LLC

1401 SHORELINE DRIVE
BOISE, ID 83702

OFFICE: 208.342.4214
FAX: 208.342.4216

Developed For:

Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.4-82
Impacts to Wetlands/Waters- Overview

DESIGNED L. Shoutis
DRAWN L. Shoutis
CHECKED L. Shoutis
ISSUED DATE 12/23/2014
SCALE: 1:5,500

MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
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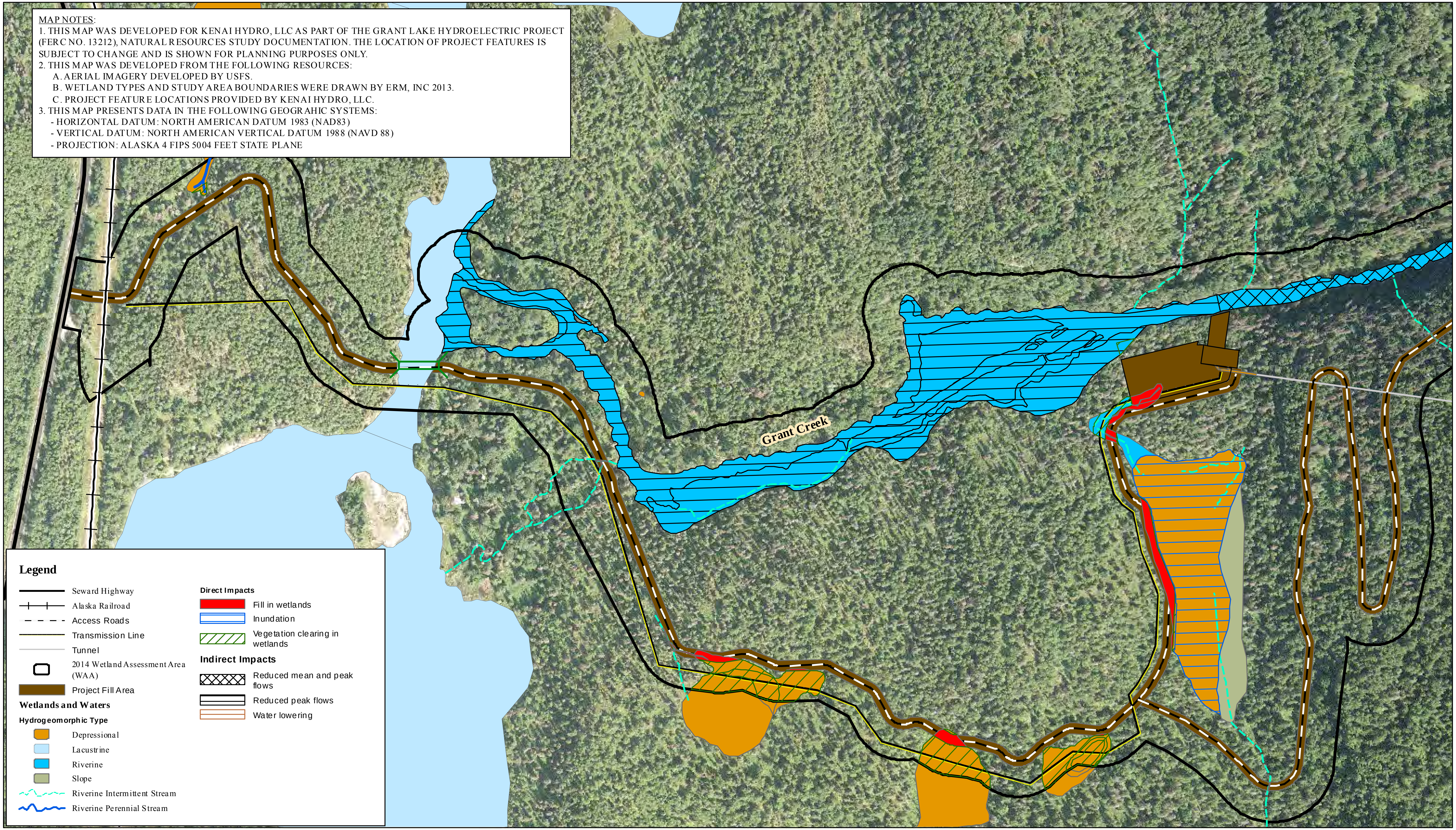
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE



Legend

- Seward Highway
- Alaska Railroad
- Access Roads
- Transmission Line
- Tunnel
- 2014 Wetland Assessment Area (WAA)
- Project Fill Area

Wetlands and Waters

Hydrogeomorphic Type
- Depressional
- Lacustrine
- Riverine
- Slope
- Riverine Intermittent Stream
- Riverine Perennial Stream

Direct Impacts
- Fill in wetlands
- Inundation
- Vegetation clearing in wetlands

Indirect Impacts
- Reduced mean and peak flows
- Reduced peak flows
- Water lowering

REV	DATE	BY	DESCRIPTION

N

Drawing Scale: 0 — 250 — 500 — 1,000 Feet

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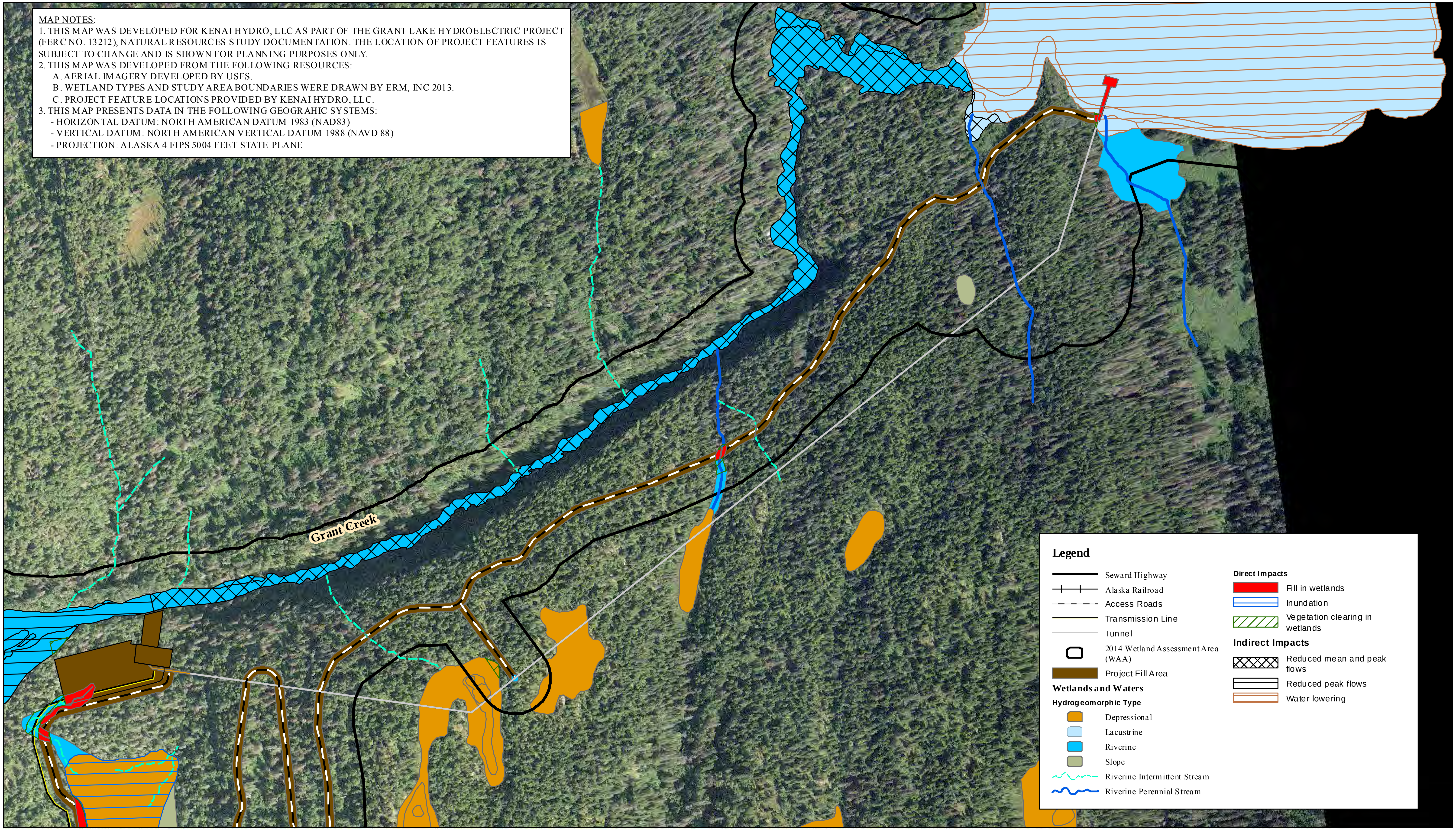
GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.4-83
Impacts to Wetlands/Waters- West

DESIGNED L. Shoutis
DRAWN L. Shoutis
CHECKED L. Shoutis
ISSUED DATE 12/23/2014
SCALE: 1:5,500



REV	DATE	BY	DESCRIPTION

N

Drawing Scale: 0 250 500 1,000 Feet

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Developed For:
Homer Electric Association, Inc.
A Touchstone Energy® Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO.13212

LICENSE APPLICATION

Figure E.4-84
Impacts to Wetlands/Waters- Overview

DESIGNED L. Shoutis
DRAWN L. Shoutis
CHECKED L. Shoutis
ISSUED DATE 12/23/2014

SCALE: 1:5,500

Table E.4-96. Potential impacts to wetlands and waters by Project infrastructure type.

Project Component	Potential Qualitative Short Term Impacts[1,2]		Potential Qualitative Long Term/Permanent Impacts[1]	
	Direct	Indirect	Direct	Indirect
GRANT CREEK DIVERSION				
Natural Outlet Option	Shoreline/bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term redacted capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills due to structure; reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; effects of new min lake level elevation on wetland vegetation; change in lakeshore erosion/deposition; effect of new Grant Creek in-stream flow regime on Grant Creek and hydrologically connected riparian wetlands; change in capacity to perform certain wetland functions (i.e., shoreline stabilization, wildlife habitat)
WATER CONVEYANCE				
Intake Structure	Shoreline/bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills due to structure; altered bank, shoreline and lakebed; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Weed infestation; effects of new max lake level drop on wetland vegetation (i.e., wetland to upland conversion); down cutting in creeks may drain wetlands and add suspended sediments to water column; change in lakeshore erosion/deposition; effect of new in-stream flow regime on hydrologically connected riparian wetlands; change in capacity to perform certain wetland functions (i.e. shoreline stabilization, wildlife habitat)
Tunnel	At surficial entrance and exit of tunnel: vegetation clearing/grubbing; soil disturbance; shoreline/bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	At surficial entrance and exit of tunnel: weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills due to structure; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	At surficial entrance and exit of tunnel: weed infestation; soil erosion, sediment input to water column; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)
Penstock	Vegetation clearing/grubbing; soil disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Fills due to structure; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Weed infestation; soil erosion; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)
Tailrace	Vegetation clearing/grubbing; soil disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Wetland excavation and fills; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Drainage of adjacent wetlands; weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)
Tailrace Detention Pond	Vegetation clearing/grubbing; soil disturbance; bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills due to structures associated with detention pond and conveyance pipeline; inundation of wetland areas; sedimentation; loss of certain wetland functions and gain of others (i.e., loss of wildlife habitat functions tied to existing vegetation, and gain of open water habitat resulting from inundation)	Possible expansion of wetland fringe around water edge; weed infestation; soil erosion; sedimentation/burial of existing wetland vegetation; sediment input to water column (if pipeline conveys sediment laden water); poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)
POWERHOUSE				
Powerhouse Structure	Vegetation clearing/grubbing; soil disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Fills due to structure; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Weed infestation; soil erosion; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)

Table E.4-96, continued…

Project Component	Potential Qualitative Short Term Impacts[1,2]		Potential Qualitative Long Term/Permanent Impacts[1]	
	Direct	**Indirect**	**Direct**	**Indirect**
TRANSMISSION LINE/SWITCHYARD				
Above Ground	Vegetation clearing/grubbing; soil disturbance; bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills where poles are installed in wetlands or surface water bodies; loss of certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Weed infestation; soil erosion; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat). Change in wetland vegetation community if ROW is maintained clear of woody vegetation.
ACCESS ROADS				
Access Roads	Vegetation clearing/grubbing; soil disturbance; bank disturbance; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; short-term reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat); temporary surface water turbidity	Fills due to structure; permanently reduced capacity to perform certain wetland functions (i.e., water quality, wildlife habitat, stormwater attenuation)	Weed infestation; soil erosion; sediment input to water column; poor native vegetation re-establishment; change in capacity to perform certain wetland functions (i.e., water quality, wildlife habitat)

Notes:

1. The potential impacts discussed in this table are qualitative based primarily on the terrestrial studies and the limited amount of engineering design work conducted prior to this report being developed. This table and the associated impacts will be refined as engineered designs are finalized for the Project.
2. Short term impacts would occur primarily during construction; Project would be constructed over a 30-36 month time period.

4.7.2.2.1 Direct Impacts

Direct impacts to wetlands and waters will occur only within the Project corridor between Grant Lake and the Trail Lake Narrows, as summarized in in Table E.4-95. Figures E.4-82 through E.4-84 present the direct impacts to wetlands and waters.

Direct Impacts to Wetlands

As presented in Table E.4-95, the following types of permanent direct impacts to wetlands were identified: 1) permanent fill placed in wetlands; 2) permanent clearing of forested and shrub vegetation that will occur for the life of the Project; and 3) short term, low frequency inundation of the detention pond wetland. Short term or temporary direct impacts were limited to vegetation disturbance during construction that will be rehabilitated after construction is complete. There are no direct impacts to slope wetlands.

Depressional Wetlands. Direct impacts to depressional wetlands will result from 1) permanent fill placed for construction of the powerhouse access road, 2) permanent vegetation clearing buffers along the powerhouse access road, and 3) temporary inundation of the detention pond wetland. Inundation of the detention pond wetland will occur with very low frequency and is not expected to alter the wetland vegetation type. While the water conveyance tunnel would pass under several depressional wetlands, it will not disturb the surface and would therefore not result in any direct impacts to depressional wetlands.

Lacustrine Wetlands. Grant Lake lacustrine wetlands located at the Grant Lake outlet will be directly impacted by construction of the low level intake structure, and surficial entrance to the tunnel. No vegetation clearing will occur within lacustrine wetlands. There were no lacustrine fringe wetlands associated with Trail Lake within the assessment area.

Riverine Wetlands. Direct impacts to riverine wetlands will result from 1) fill placed in the riparian stringer wetlands associated with small intermittent streams, and 2) permanent vegetation clearing buffers associated with the powerhouse access road, and the powerhouse. The tailrace channel, extending from the powerhouse to Grant Creek will have a concrete fish barrier structure located on the creek bank, but above the maximum water surface elevation. As such, the fish barrier and tailrace will not be placed within a wetland or water. There are no direct impacts associated with Project construction, operation, or maintenance for riverine wetlands associated with Inlet Creek, or the tributaries/drainages that terminate at Grant Lake. The water conveyance tunnel would pass under several seasonal drainages; however, it is assumed the underground tunnel would be constructed in a manner that would not alter stream hydrology and, therefore, would not result in any impacts to those drainages or their associated wetlands.

Direct Impacts to Waters

Direct impacts to waters are summarized in Table E.4-95. Permanent direct impacts to waters were limited to fill placed in waters. There were no short term direct impacts to waters.

Lacustrine Waters. Direct impacts to Grant Lake and the Upper Trail and Lower Trail lakes will result from the construction of the low level intake structure at the outlet of Grant Lake.

Construction of the access roads or transmission line will not require fill to be placed in Grant Lake or the Trail Lake Narrows. The clear span bridge across the Trail Lake Narrows will be constructed such that it will not place any fill into the Narrows.

Riverine Waters. Direct impacts to riverine waters will result from fill placed during construction into small perennial and intermittent streams along the intake access road, the powerhouse access road, and at the powerhouse parking area. The water conveyance tunnel would pass under several seasonal drainages; however, it is assumed the underground tunnel would be constructed in a manner that would not alter stream hydrology and, therefore, would not result in any impacts to those drainages or their associated wetlands.

Indirect Impacts to Wetlands

Permanent and temporary indirect impacts to wetlands and waters are quantified in Table E.4-95 and discussed by Project feature Table E.4-96. Figures E.4-82 through E.4-84 present the indirect impacts to wetlands and waters within the Project corridor. Indirect impacts to Grant Lake fringe wetlands are presented in text only, not in the figures.

Depressional Wetlands. Depressional wetlands within the assessment area experience little to no hydrologic influence from Grant Lake or Grant Creek. Therefore, there are no anticipated indirect impacts to depressional wetlands associated with changes to lake level elevations and fluctuations, nor are there any anticipated impacts to depressional wetlands associated with the proposed changes to Grant Creek Project flows. While the water conveyance tunnel would pass under several depressional wetlands, it is assumed the underground tunnel would be constructed in a manner that would not alter wetland hydrology and, therefore, would not result in any indirect impacts to depressional wetlands.

Lacustrine Wetlands. In addition to Grant Lake itself, lacustrine fringe wetlands adjacent to Grant Lake could be indirectly impacted by proposed changes to timing and duration of the surface water elevation in the lake. A low level intake structure would be constructed on the south side of the natural outlet to release any required environmental flows when the lake is drawn down below the natural outlet level. This will result in a new minimum lake elevation of approximately 690 feet NAVD 88. The maximum lake elevation will be 703 feet NAVD 88, which is estimated to be at or just slightly below the natural maximum lake elevation based on modeling of the lake surface elevation using Grant Creek flows (exact natural lake surface elevation is unknown).

The lacustrine fringe wetlands along Grant Lake are adapted to the current natural pool elevation during the growing season, within the normal natural lake level variation. These wetlands were categorized as lacustrine wetlands because in addition to being located adjacent to a lake, the lake provides a primary hydrologic source at least for a portion of the growing season. For many of the lacustrine fringe wetlands along the lake, the primary hydrologic source likely shifts between lacustrine, riverine (for wetlands located at the base of small tributaries or at alluvial fans), or even precipitation, depending on the conditions in a given year, and the location of the wetland. As such, the working assumption for the potential indirect impact to these lacustrine wetlands is that the lake provides a primary hydrologic source for at least a portion of the growing season. The proposal to lower the lake elevation during the growing season for prolonged periods of time (e.g., weeks to months), will likely cause lacustrine wetlands, particularly herbaceous wetlands, to dry out and convert to non-wetlands. Lacustrine wetlands that also have a perennial or seasonal water source from a small tributary to Grant Lake will be less affected by the drop in lake elevation.

In addition to hydrologic changes, the increase in exposed area around the lake shore during the growing season could also cause shoreline erosion, and allow for infestation of invasive weed species, which could spread weeds into the wetlands along the lake shore. The Project botanical surveys identified dandelions as the only invasive species currently along Grant Lake, but other invasive species could potentially recruit into the exposed areas.

The magnitude of indirect impacts to lacustrine fringe wetlands along Grant Lake will depend on the proposed deviation from the natural magnitude, duration, and timing of the minimum lake elevation. Figure E.4-85 illustrates the seasonal proposed reservoir water levels in Grant Lake, and the estimated natural lake levels during the growing season (modeled by the Project engineering team using Grant Creek flow volumes). The lake will be drawn down during fall and winter, and allowed to refill to natural levels in spring and summer. Under natural conditions, Grant Lake levels are estimated to be at their maximum (estimated 703 feet NAVD 88) during June through September, corresponding to the growing season. Under the proposed operational scenario depicted in Figure E.4-85, lake levels could be up to 13 feet below natural high levels in the start of the growing season, returning to natural levels by mid-August. It is important to note that the natural lake level fluctuation is variable and currently, lake elevations may fluctuate up to 11 feet and typically sees 6-8 foot variation over the course of a year within the same band that operations would be utilizing.

Given that the natural outlet will not be modified, maximum lake elevations will not be altered from the natural regime, and hence there will be no potential for increased inundation of lacustrine fringe wetlands under the current proposed operational scenario.

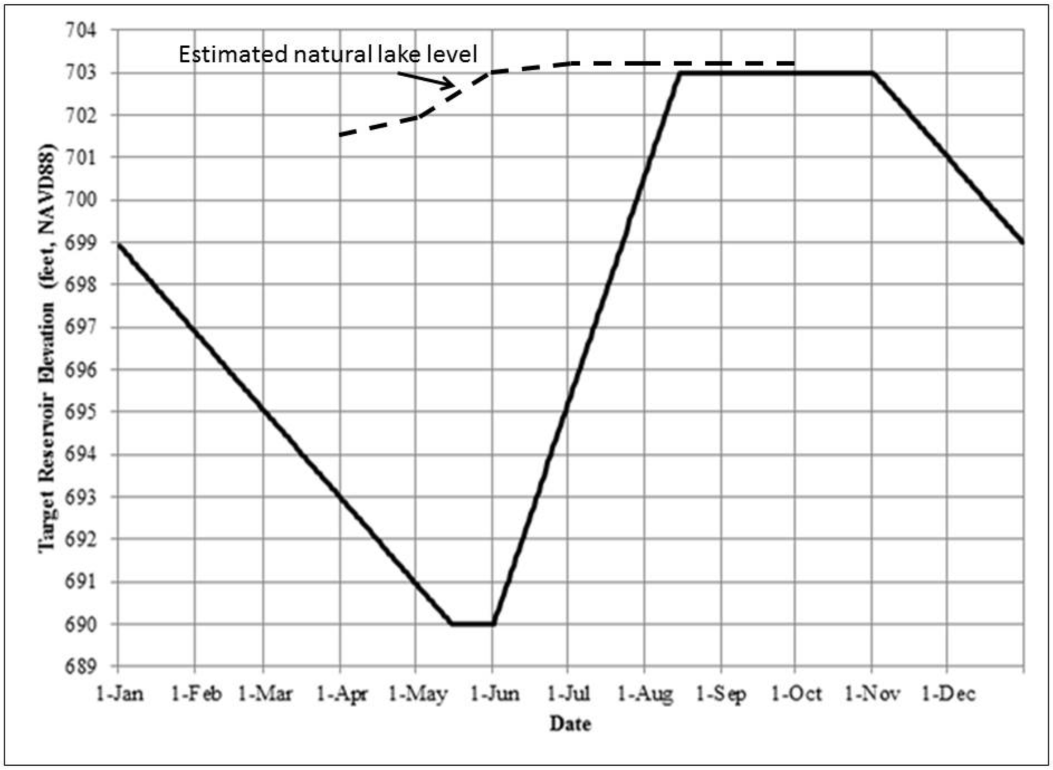

Figure E.4-85. Proposed Grant Lake seasonal lake levels (solid line). Estimated natural lake levels during the growing season shown as dashed line (approximately at or slightly above 703 feet NAVD 88).

Riverine Wetlands. Any increase in turbidity in small tributary drainages to Grant Creek during construction of the access roads would be short term or temporary. Riverine wetlands located along Grant Creek (main and side channels) may be potentially impacted as a result of changes in instream flow in Grant Creek. These potential impacts are described for the upper and lower portions of Grant Creek separately below, where instream flow will decrease and increase, respectively.

In the upper portion of Grant Creek, also referred to as the canyon reach or bypass reach, between the Grant Lake outlet and the powerhouse tailrace (Reach 4/5 break), instream flows will be reduced. A limited amount of water would continue to flow down Grant Creek's canyon reach to provide a consistent baseflow throughout the year. This drop in flow would most likely cause the four small wetland fringe communities mapped within the canyon reach to be drained and convert to uplands.

From the powerhouse tailrace downstream to the Grant Creek outlet, peak flows will be reduced; however, the new instream flow pattern is expected to maintain side channels (Reach 3) wetted spring through fall. Wetlands located along the lower portion of Grant Creek are predominantly associated with complex wetland/upland floodplain mosaics that are supported by flood and baseflow hydrology. The anticipated instream flow changes to lower Grant Creek could affect associated riverine wetlands in a variety of ways. Wetland areas located in the distal fringes of the existing Grant Creek floodplain that are supported by current natural peak flows may be negatively affected by reduced peak flow hydrology (although it is unknown what proportion of the wetland hydrology is supported by groundwater baseflows vs. surface water contributions).

Riverine wetlands associated with Grant Lake drainages are all located at the Grant Lake inlet, and of these, only a single riverine wetland is directly abutting Grant Lake. For this single riverine wetland, the timing and duration of the new minimum lake levels could cause erosion or depositional changes to stream channels within the wetland. Changes to channel bed and form could, in turn, affect the hydrology of the adjacent wetland. Due to their lack of adjacency to Grant Lake, none of the other riverine wetlands at the Grant Lake inlet are expected to be indirectly impacted by the Project.

Indirect Impacts to Waters

Permanent and temporary indirect impacts to waters are presented in Tables E.4-95 and E.4-96. Permanent indirect impacts to waters are associated with hydrologic changes resulting from altered hydrology in Grant Creek and Grant Lake as a result of Project operations, and potential soil erosion and sedimentation in areas of hydrologic alteration. Short term or temporary indirect impacts include short term increases in turbidity during construction.

Lacustrine Waters. Project operations will indirectly impact Grant Lake by changing its area, with the change dependent on the lake level fluctuation during different times of year. Lake fluctuations are not expected to change significantly for Upper Trail and Lower Trail lakes as a result of the Project; therefore, there are no anticipated gains or losses to the open water component of the Trail Lake system.

Riverine Waters. All intermittent and perennial small drainage crossings along the access road will be culverted, therefore no indirect impacts due to hydrologic changes are expected for these intermittent and perennial small streams. Any increase in turbidity in small drainages along the access roads during construction would be short term or temporary. The Project will indirectly impact the hydrology of Grant Creek (main and side channels) as a result of changes in instream flow, and will potentially impact other small tributary drainages to Grant Lake as a result of changes in lake level fluctuation.

In the upper portion of Grant Creek, (canyon reach) between the Grant Lake outlet and the powerhouse tailrace (Reach 4/5 break), instream flows will be reduced. A limited amount of water would continue to flow down Grant Creek's canyon reach to provide a consistent baseflow throughout the year. This drop in flow would expose more channel bed and bank, and reduce sediment transport. From the powerhouse tailrace downstream to the Grant Creek outlet, peak flows will be reduced, however the new instream flow pattern is expected to maintain side channels (Reach 3) wetted spring through fall. The changes in instream flow resulting from the Project are not expected to impact the water chemistry or temperature of Grant Creek, in part due to the proposed depth of the intake structure, which will be sited to best match the water temperature of Grant Creek.

Grant Lake drainages. Inlet Creek and other small streams that enter Grant Lake have the potential to be affected by the new lake level elevations. The proposed operational scenario will drop the lake elevation down 13 feet below natural maximum elevations. The new minimum lake levels could cause erosion or depositional changes to stream channels and their associated floodplains and outwash fans at the Grant Lake interface. Depending on the timing, duration and frequency, reduced lake level elevation could cause the Inlet Creek and lake drainage channels to downcut or become incised. Fortunately, the majority of the Grant Lake shoreline is well-armored with angular rocks which would likely minimize the potential for channels to become incised.

4.7.2.3. Wildlife

The potential impacts associated with Project construction and operational activities are qualitatively evaluated for direct and indirect impacts in the subsections to follow. Wildlife presence in the Project area is contingent on many variables including habitat. Habitat is comprised of resources (water, food, and shelter) and environmental requirements (temperature, predators, and competitors) that determine the presence, survival, and reproduction of a species. Wildlife exhibits a propensity to occupy those habitats that provide the resources to fulfill the requirements necessary for the continuance of that species. This section utilizes the factor of vegetation (food and cover) to qualitatively assess species presence and use of the 2013 wildlife study area.

Vegetation characteristics utilized for this qualitative assessment of impacts to wildlife have been obtained from various sources, including the site-specific Ebasco (1984) report, the USFS (2007) cover-type ArcGIS layer, and the 2013/2014 field efforts. The level of vegetation classification varies for each source; therefore, an amalgamation of all these resources was necessary to discern habitat specific to the components of the wildlife study. General vegetation characteristics (cover type), as defined or mapped by each source, were compared. More specific habitat characteristics (understory species) were then delineated by correlating all available sources. A qualitative assessment of species presence and use of the 2013 wildlife study area is presented in the following section components. Each section includes a qualitative evaluation of Project impacts.

Direct impacts may be short-term or long-term, depending on how the biological resources are altered or lost during the course of the Project implementation and operation. Examples of direct impacts from project-related construction include removal of vegetation and the loss or interruption of wildlife foraging or nesting areas. The evaluation of direct impacts assumes that biological resources required for wildlife survival would be lost. Indirect impacts occur when project-related activities affect biological resources in a manner other than a direct loss of the resource. For example, indirect impacts from a construction project might last only during construction or for the long-term operation of the facility. Noise, lighting, siltation, substantial reduction in water quality, and increased human activity within or directly adjacent to sensitive habitat areas are examples of potential indirect impacts to wildlife.

4.7.2.3.1 Potential Impacts to Raptors

Removal or loss of vegetation affects raptors in several ways that include loss of old growth trees for nesting platforms (bald eagles, osprey, and red-tailed hawks) and perches. Project-related tree removal may have direct or indirect impacts. Unintentional (resulting from other deliberate construction activities) removal includes tree species influenced by changes in creek levels, causing tree mortality and eventual structure loss. Tree platforms utilized for large raptor nests and perches are lost naturally every year. Raptors often construct multiple nests in a season (osprey) or build new structures every year. The loss of the tree or the nest from the previous season is not a detriment to successful breeding, and is not predicted to impact the overall raptor population on the Kenai Peninsula. The direct removal of any nest structure utilized by bald eagles, regardless of activity state, without a permit is prohibited.

Removal of vegetation will also directly impact forest nesting and foraging raptor species including Northern goshawks and sharp-shinned hawks. Impacts include loss of nesting and foraging habitat. Both species are considered shy and may be sensitive to disturbance. Activities related to forest removal and anthropogenic access may cause these two species to move to other less disturbed areas (indirect impact); however, the movement of these accipiters is not predicted to impact the overall population of the Kenai Peninsula. The USFWS (2005) has published recommendations for time periods to avoid vegetation clearing. These recommendations are provided to help avoid vegetation removal during the breeding season.

Mortality (direct impact) to forest raptors may increase with the placement of power lines along the access route. Birds, especially resident species, unaccustomed to these lines may be impacted by flying into the line or through electrocution. Collision and nesting deterrent methods will be considered during the Project design phase to avoid or minimize impacts.

Disturbance associated with construction and operational phases of the Project may impact raptor presence and distributions in the area (indirect impact); however, the movement of these species is not predicted to impact the overall population of the Kenai Peninsula.

4.7.2.3.2 Potential Impacts to Breeding Birds and Shorebirds

Removal or loss of vegetation affects breeding birds and shorebirds in several ways that include loss of old growth trees for nesting, foraging, and cover habitat. Project-related tree and vegetation removal may have direct or an indirect impacts. Unintentional removal (indirect impact) includes understory changes to plant species influenced by intentional tree removal (direct impact); causing mortality and eventual structure loss or alteration. Breeding birds and shorebirds often construct a new nest every season and habitat is often lost to natural events like flooding and fire. The loss of nesting habitat from the previous season is not a detriment to successful breeding and is not predicted to impact the overall breeding birds and shorebirds population on the Kenai Peninsula. The direct removal of any active nest structure is prohibited. The USFWS (2005) has published recommendations for time periods to avoid vegetation clearing. These recommendations are provided to help avoid vegetation removal during the breeding season.

Removal or loss of vegetation will impact songbirds by decreasing the availability of habitat for cover from predators and for foraging. Loss of cover may increase predation on both breeding adults as well as nests (direct impact). Activities related to forest removal and anthropogenic access may also cause shy or sensitive species to move to other less acoustically disturbed areas (indirect impact); however, these movements are not predicted to impact the overall songbird population of the Kenai Peninsula. The USFWS (2005) has published recommendations for time periods to avoid vegetation clearing. These recommendations are provided to help avoid vegetation removal and disturbance during the breeding season.

Mortality (direct impact) to breeding birds and shorebirds may increase with the placement of power lines along the access route. Birds, especially resident species, unaccustomed to these lines may be impacted by flying into the line or through electrocution. Collision deterrent methods will be considered during the Project design phase to avoid or minimize impacts.

4.7.2.3.3 Potential Impacts to Waterbirds

Removal or loss of vegetation may have direct or indirect impacts to waterfowl like goldeneyes by loss of old growth trees for nesting habitat. Unintentional (resulting from other deliberate construction activities) removal includes tree species influenced by changes in creek levels, causing tree mortality and eventual structure loss. Nest and trees are lost naturally every year to natural events that include flooding and fire. Cavity-nesting ducks make efficient use of hard to find tree-cavity nest sites, and are capable of identifying new cavities as trees age. The loss of the tree from the previous season can be a limiting factor in successful breeding, but this is not predicted to impact the overall waterbird population on the Kenai. The direct removal of any active nest structure is prohibited; the USFWS (2005) has published recommendations for time periods to avoid vegetation clearing. These recommendations are provided to help avoid vegetation removal during the breeding season.

Changes in lake and creek levels may indirectly impact waterfowl and waterbirds like American dippers by decreasing or altering prey availability. Lake elevation changes will also directly impact shorebirds by limiting available nesting and foraging habitat. Spotted sandpipers are known breeders along the shoreline of Grant Lake (2010 field data) and will place nests along the perimeter of lakes and rivers. Typical breeding habitat includes the edge of an open or semi-open area adjacent to water, with low ground cover, such as shrub-dotted or lightly treed meadows or grassland. This species prefers shores with rocks, wood, or debris (NatureServe 2007). Changes in the predator-prey dynamics and nesting surface availability may be temporary or permanent depending on the species and extent of lake elevation change.

Construction and operational activities indirectly impact shy or sensitive species, causing individuals to move to other less acoustically disturbed areas; however, these movements are not predicted to impact the overall waterfowl population of the Kenai Peninsula.

Mortality (direct impact) to waterfowl may increase with the placement of power lines along the access route. Waterfowl unaccustomed to these lines may be impacted by flying into the line or through electrocution. Collision deterrent methods will be considered during the Project design phase to avoid or minimize impacts.

Changes in lake and creek outflow levels during the winter may indirectly impact waterfowl and waterbirds like trumpeter swans and diving ducks by decreasing or altering open water habitat at the mouth of Grant Creek and the outflow at the narrows. Decreased open water availability may lead to decreased resting and foraging habitat during the winter season.

Waterfowl that overwinter in the region and spend time on waterbodies in this area of the Kenai Peninsula are currently subject to the natural freeze up / thaw processes during the winter. The possible project-related alterations to open water habitat are not predicted to impact the overall waterfowl population of the Kenai Peninsula.

4.7.2.3.4 Potential Impacts to Terrestrial Mammals

Removal or loss of vegetation may impact mammals (moose, bear, mountain goats, lynx, and other small mammals) by decreasing the availability of forest cover from predators and foraging. Project-related tree and vegetation removal may have direct or an indirect impacts. Unintentional removal (indirect impact) includes understory changes to plant species influenced by intentional tree removal (direct impact); causing mortality and eventual structure loss or alteration. Loss of cover may increase predation on both breeding adults as well as young (direct impact). Activities related to forest removal and anthropogenic access may also cause more shy or sensitive species to move to other less acoustically disturbed areas (indirect impact); however, these movements are not predicted to impact the overall mammal population of the Kenai Peninsula. Black bear are very adaptable to human disturbance. This is not necessarily the case with brown bear, as impacts of roads and trails resulting from new development in the watershed may reduce the quality of available habitat and increase the number of negative bear-human encounters. On the Kenai Peninsula, habitat modification and human activities have resulted in an increase in the number of brown bears killed in defense of life or property (Suring and Del Frate 2002). During the summer, bears concentrate along salmon streams in areas that are heavily used by people; several encounters have occurred at salmon streams resulting in injury to humans and injury or death to brown bears (USFS 2008).

Changes in lake levels during the winter may indirectly impact moose by altering travel routes across Grant Lake. Altered lake levels may impact ice thickness necessary for transit. Moose density in this region of the Kenai Peninsula has been documented as low (McDonough 2010). The possible Project-related habitat alterations are not predicted to impact the overall moose population of the Kenai Peninsula.

4.7.3. Proposed Environmental Measures

4.7.3.1. Terrestrial Vegetation, Invasive Plants and Sensitive Plants

Global adherence to BMPs will be utilized in conjunction with all Project construction and operation related activities. With respect to vegetation, no sensitive plant species were documented near any of the planned infrastructural areas. As such, no impact to sensitive species is expected. Additionally, the ECM will coordinate with construction leads to ensure all BMPs related to avoiding invasive plant species introduction are being followed.

All of the aforementioned and general BMPs along with more site-specific measures will be documented in the Draft VMP, which is currently under development by KHL and will be distributed for comment with the the BE and th rest of the management/monitoring plans between late April and mid-May. The Draft VMP will synthesize efforts to manage any sensitive species identified in the Project area with prevention measures for either any expansion of current invasive species or introduction of new invasive plants as a result of Project construction or operation. This plan describes measures to assess whether the Project is having negative impacts on the pale poppy sensitive plant population on USFS land on Grant Lake. It will also create a framework for adaptive management to modify Project infrastructure and/or operations to avoid or minimize additional impacts to sensitive plants. Additionally, the Draft VMP will describe measures to avoid and/or minimize impacts resulting from invasive plant species during Project construction and operations. The plan is being developed using guidelines from the Chugach National Forest Invasive Plant Management Plan (USFS 2005) and the Guide to Noxious Weed Prevention Practices (USFS 2001).

Specific to sensitive plant species, an isolated pale poppy population was discovered on the shoreline of Grant Lake during natural resource studies in 2013 (see Sections 4.7.1.1 and 4.7.2.1). Per the proposed operational scenario defined in Exhibit B of this DLA, it is not anticipated that Project operations will have a negative impact on the identified pale poppy population. Never the less, the Draft VMP will have a section that specifically addresses the methods to be utilized for monitoring the population during the construction and the initial phases of Project operation. All measures associated with vegetation monitoring during both construction and operations will be documented yearly in the Annual Compliance Report. The report will be supplied to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

In addition to Draft VMP inclusion, a Draft BE is being prepared for the aforementioned pale poppy population on Grant Lake and will be distributed for comment between late April and mid-May. As previously mentioned, it is not anticipated that Project operations will have a negative impact on the population. However, commensurate with requirements, a comprehensive BE is being prepared for the USFS that describes the proposed action along with KHL's botanical experts professional opinion (based on site-specific evaluation), of the impacts to the pale poppy (if any) associated with Project construction and operation.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.7.3.2. Wetlands

All global BMPs associated with wetland maintenance and retention will be employed during Project operations and construction. KHL's ECM will be on-site and coordinating with construction crews daily to ensure that the BMPs are being adhered to.

Per requirements, KHL has collaborated with the USACE and currently has a 404 permit application pending with the agency. As part of that 404 permitting process, KHL has determined that approximately 0.49 acres of wetlands/waters will be lost due to Project construction and subsequent operations. As such, and given the lack of a "mitigation bank" in the Kenai Peninsula area, KHL is proposing to utilize the USACE approved mitigation approach of in-lieu fee of mitigation (ILF).

ILF programs typically provide two options for wetland/waters mitigation: 1) rehabilitation or enhancement of degraded wetlands/waters; or 2) preservation of wetlands/waters. In Alaska, the option of using the ILF rehabilitation or enhancement is limited to select areas (e.g. Municipality of Anchorage and the Mat-Su Borough), and is not available in the Project watershed service area. Therefore, KHL has proposed to use of ILF through preservation of off-site wetlands/waters as the mechanism of compensatory mitigation. The Conservation Fund (TCF) is the only USACE-approved ILF provider for the service area.

Table E.4-97 presents the total impacted acres, proposed exchange ratio, and required credits for the impacts to wetlands and waters. Per the most up to date USACE ratios for compensatory mitigation (USACE 2014), the ratio for mitigation using preservation for category II wetlands is 2:1. Therefore to mitigate for the loss of 0.49 acres of wetlands/waters, the Project would require 0.98, or approximately 1 mitigation credit. This is further divided into impacted acres and credits required by hydrogeomorphic (HGM) type, which TCF uses to determine the specific type of wetland or water that will be preserved for the ILF mitigation. This assessment and proposal is further documented in the 404 application.

Table E.4-97. Proposed Project mitigation ratios and ILF preservation credit requirements in acres.

HGM	Total Impacted Acres	Proposed Exchange Ratio	Credits Required
Depressional	0.28	2:1	0.55
Riverine or lacustrine	0.21	2:1	0.43
Total	**0.49**		**0.98**

Notes:
1. HGM groupings are used by the ILF provider to determihe costs per credit.
2. Ration for category II wetlands/waters using ILG preservation, per USACE 2014 rations. All Project wetlands/waters are considered Category II.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.7.3.3. Wildlife

The primary impact identified associated with wildlife known to utilize the Project area is associated with the potential for impacts to migratory avian species and bald eagles to be disturbed and “harassed” as a result of construction and/or operation activities. As such, a Draft Avian Protection Plan (APP) is being developed and will be distributed for comment between late April and mid-May. The Draft APP will describe the methods and infrastructure that will be implemented to minimize impacts to avian species both during the short-term construction period and subsequent operations. The USFWS (2007) has published recommendations to avoid disturbance to occupied bald eagle nests during development activities. The USFWS (2007) recommend the following:

- Keep a distance between the activity and the nest (distance buffers),
- Maintain preferably forested (or natural) areas between the activity and around nest trees (landscape buffers), and
- Avoid certain activities during the breeding season.

The buffer areas serve to minimize visual and auditory impacts associated with human activities near nest sites. Ideally, buffers would be large enough to protect existing nest trees and provide for alternative or replacement nest trees. The size and shape of effective buffers vary depending on the topography and other ecological characteristics surrounding the nest site. The height of the nest above the ground may also ameliorate effects of human activities; eagles at higher nests may be less prone to disturbance.

The primary protection measures proposed by KHL that will be described in the APP include:

<u>Migratory birds</u>

- Plan of construction and operation timeline
- Risk assessment of activity and timeline
- Measures taken based on Project actions
    - Monitoring associated with vegetation removal
    - Monitoring associated with power line and infrastructure placement
- Documenting and reporting

<u>Bald eagles</u>

- Plan of construction and operation timeline
- Risk assessment of activity and timeline
    - Aerial nest surveys
- Measures taken based on Project actions
    - Nest mitigation and monitoring
        - Buffer boundaries
        - Nest monitoring
- Documenting and reporting

The on-site ECM will be responsible for ensuring that all methods outlined in the APP are being implemented during construction. All efforts associated with the APP will be documented in the Annual Compliance Report. The report will be supplied to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.7.4. Cumulative Effects Analysis

Consistent with FERC's SD2 (FERC 2010b), no cumulative negative effects were identified associated with terrestrial resources. Impacts documented in the Project area are anticipated to be minimal for vegetation, wetlands and wildlife. The aforementioned monitoring and management plans along with implemented BMPs during construction are anticipated to address potential impacts and minimize them to the extent possible.

Only one sensitive plant species was documented in the Project area and due to its location, it is not anticipated that it will be impacted by Project construction or subsequent operations. This combined with the rigid set of methods that will be explicit in both the BMPs and VMP, indicates that there will be limited impact to the vegetation in the Project area.

Generally speaking wetlands in the Project are relatively limited and not associated with planned Project infrastructure sites. It is anticipated that the proposed operational regime and associated flow regime for Grant Creek will facilitate continued persistence and potential promotion of wetlands in the Project.

It should be noted that KHL intends to solicit public input with respect to the allowance of public access to the Project area via the newly constructed access road. If the public consensus is to allow public access, the potential does exist for additional hunting pressure in the area which could, over time, reduce populations of certain game species. Further discussion related to public access can be found in Section 4.8 of this Exhibit E.

4.7.5. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources studies implemented by KHL, the aforementioned monitoring and management plans and the associated coordination with stakeholders, KHL has identified no terrestrially-related unavoidable adverse impacts associated with construction and operation of the Project.

4.8. Recreation and Land Use Resources

4.8.1. Affected Environment

4.8.1.1. Recreation

This section describes the Recreation, Visual and Land Use attributes that were identified and evaluated during the licensing process. The Project is located near Moose Pass, Alaska, a small community located on the Kenai Peninsula of Alaska. The Project area is heavily dominated by mountains, low density populations, and diverse ecosystems. The overall landscape character is natural, with diverse topography, large lakes, fast moving rivers, alpine tundra, and taiga forest. It is home to long-standing trail systems to the west and ancient ice-fields to the east. Figure E.4-86 displays the Project’s general geographic location.

In late 2012 and early 2013 a comprehensive Recreation and Visual Resources, Final Study Plan was prepared for the Project (KHL 2013d) which focused on seasonal use characteristics (Recreation Use) and visual and audio components of the existing environment (Visual Resources) in and around the Project area.

The recreation use component resulted in a synthesis of recreational data collected in 2010 and additional work conducted during the 2013 field season. The primary objective of the recreation use component was to assess recreation use within the study area to evaluate potential Project impacts on recreational resources. Tasks included the identification of data sources, a literature review, a preliminary assessment of levels and type of recreational use, and identification of potential agency personnel and others with whom to consult by phone or in person. Foot and boat surveys (summer and winter) provided direct information on the condition of trails and boat access points, and provided information about current use. Trail and boat access points in the Project vicinity that may be affected by water level fluctuation were photographed to illustrate potential change. Track lines and waypoints along study area trails were recorded by GPS (subsequently entered into the Project GIS database) and illustrative views were photographed.

The primary objective of the visual resource component of the study was to analyze Project effects on visual resources. Key viewpoints for evaluation were determined by the updated Project design; by recreation site visits; by examining available GIS scenic, elevation, contour, and other pertinent layers; and through input from land management agencies and stakeholders. This work was coordinated with interviews conducted as part of the recreation analysis and was accomplished in part during the meetings held at the time of FERC scoping for the Project in June 2010. Photos taken from these key viewpoints served as the basis for the existing and simulated scenery conditions for the assessment of changes that may be posed by the Project. Evaluation of change to the existing character included an examination of proposed Project components and operations with respect to the ability of the landscape to accept change. This evaluation was based on the "seen areas" and "distance zones" as determined by computer analysis, the "scenic integrity," and the magnitude of change to existing "scenic attractiveness." Within this was an analysis of vegetation, soils, colors, texture, and other landscape attributes; an analysis of these components to accept change; a description of the potential effect of the change; and a description of the effect on stakeholders. This information was weighed against the objectives that were delineated within the USFS, ADNR, and Kenai Peinsula Borough (KPB) land management plans (USFS 2002; ADNR 2001; and KPB 2005) to the extent such objectives exist. Analysis included an evaluation of potential protection and mitigation options.

General boundaries for the 2013 Recreation and Visual Resources Study (KHL 2014g) were approximately five radial miles around the Project area. These boundaries extend from Moose Pass, to the top of the ridgelines around Grant Lake itself, south around Lower Trail Lake, north along the highway corridor, and back to Moose Pass (Figure E.4-86). The Project area was defined by mountain ridges which provide a distinct separation of the Project area from other adjacent uses.

The Project location is subject to a large volume of people passing through the area, many of whom are tourists and most of whom are traveling for scenic enjoyment. The Seward Highway, connecting Anchorage to Seward, is used by travelers either driving to Anchorage for supplies or to Seward for recreation. This highway is one of the most used highways in the state, and holds the honor of being a Scenic Byway. Its value as being a scenic resource is well established.

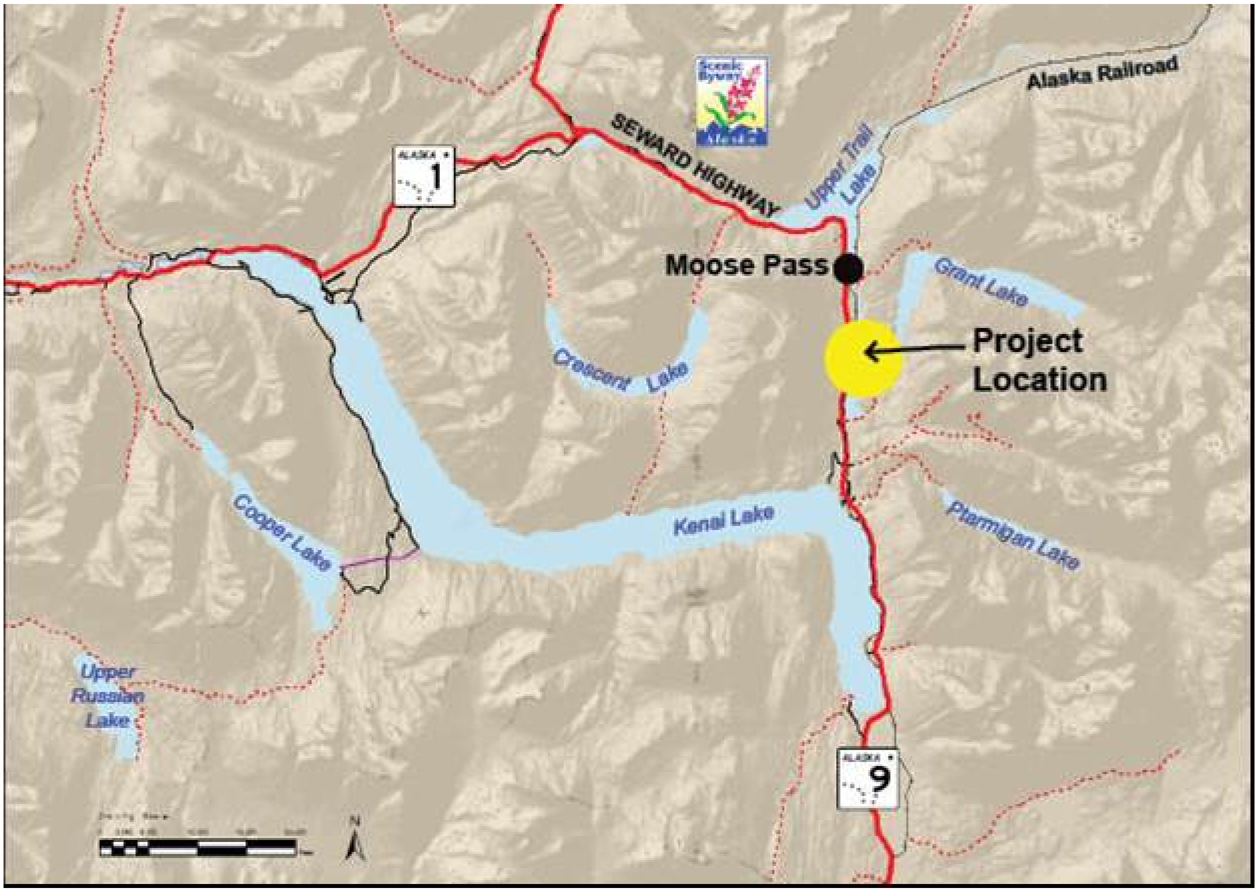

Figure E.4-86. Project location.

4.8.1.1.1 Recreation Facilities

Trails

There are three trails of some consequence located in the Project vicinity (Figure E.4-87). The Vagt Lake Trail begins at a pulloff from the Seward Highway at approximate Milepost 25 of the highway and connects to the southern end of Vagt Lake, located east of Lower Trail Lake. At that location, it joins the INHT, which continues approximately 1/2-mile along the western shore of Vagt Lake before it ends, awaiting continuation of construction.

The "Saddle Trail" begins at the eastern shore of Upper Kenai Lake and connects to Grant Lake. The trail has access at the shoreline by boat/canoe in the summer and snowmachine or skiing in the winter. It daylights at Grant Lake approximately 1-mile north of the Grant Creek outlet from Grant Lake. The trail is approximately one-mile long with a grade that varies between five and fifteen percent. It is not maintained and has a tread of varying quality approximately 2 to 5 feet wide.

The "Case Mine Trail" is located another mile north of the Saddle Trail and also has access from Upper Trail Lake. In the winter, access is available by ski or snowmachine. In the summer, most access is via an Alaska Railroad bridge across Upper Trail Lake, at a relatively narrow point immediately west of Moose Pass, the access point being near a Moose Pass town park/ball field. This trail is less used and the tread is not as wide as the Saddle Trail. It connects to the northern shore of Grant Lake, at the north-south/east-west bend in the lake. The termination is at a location of some mine relics documented in Section 4.10 of this Exhibit E, which includes an evaluation of historic resources.

Other Recreation Facilities

There are limited "constructed" recreation facilities within the Project area beyond the trails discussed above and a community ballfield in Moose Pass (Figure E.4-87). Almost all recreation use is either trail or water based. While uses are described in the following section, beyond the trails described above, water features that are used for recreation purposes include Upper Trail Lake, Lower Trail Lake, Vagt Lake, and Grant Lake. There are commercial docks within the community of Moose Pass that are used for vendor-related flightseeing. There is also a boat launch area that consists of shallow-sloped gravel beach. A gently sloping shoreline allows boat access to Lower Trail at the Vagt Lake Trailhead (milepost 25 of the Seward Highway) with parking limited to approximately one dozen vehicles. Trailer parking is possible though space and turning radius is limited.

Rest room facilities are limited in the area for recreation users. A camera that has been posted at the Vagt Lake Trailhead has shown that the pulloff at that location is often used as an "unofficial" place for relief and approximately 300 motorists along the Seward Highway paused at the Vagt Lake Trailhead for "break" purposes of one type or another during the period March 31 to September 30, 2014.

Recreation Uses

There are a number of recreation uses of existing facilities. These uses are all related to the trails and water features discussed in the previous section, or to the abundance of scenery within the region. These uses/activities include:

- Hiking/Walking
- Camping
- Fishing
- Boating
- Hunting
- Snowmachining
- Snowshoeing
- Cross Country Skiing
- Ice fishing
- Aerial Sight-Seeing
- Driving for Pleasure

Existing Observed Winter Use

During a winter review of use in the Project area, snowmachine users were observed unloading and parking at the Vagt Lake Trailhead and traveling northeast across Lower Trail Lake (Figure

E.4-88) to a partially flagged route through the trees up to Vagt Lake. An alternative start point was in Moose Pass, near an existing boat ramp. Other snowmachine users were observed traveling north-south along the western shores of both Trail Lakes and beyond across Upper Trail Lake toward Johnson Pass. Users did not ride through the Narrows as the water was open and flowing quite strongly through the area. This appears to be a normal phenomenon, keeping a portion of Lower Trail Lake open during the winter months. Open water was also observed at the Alaska Railroad trestle, located between Moose Pass and the rail line. Users traveled on the railroad tracks for passage around these open water areas. The Alaska Railroad Corporation signs the tracks and considers this use as trespassing.

While no use of Grant Lake was witnessed, project personnel did view tracks showing some limited use of Grant Lake by skiers and snowmachines. However, there was no evidence of trails leading to Grant Lake from trails along the Trail Lakes shoreline. Terrain challenges and the lack of a well-defined trail link easily used by snowmobilers may limit the interest in snowmachining at the lake. However, it is expected that the Saddle Trail and the mine access road both of which are north of Grant Creek may provide access to Grant Lake for snowmachining.

Baseline noise in the area measured consistently at 40 decibels (dB). Conditions during measurement included a gentle wind and background road noise from the highway. At the time snowmachine users passed by along the lake creating decibel readings that spiked to 75-80 dB.

Along the Vagt Lake Trail, local residents were observed hiking and snowshoeing as recreation. Cross country ski tracks were also found leading from the Vagt Lake Trailhead to Vagt Lake (Figures E.4-89 and E.4-90). Though it is difficult to identify the number of users, it appeared that snow had fallen within 48 hours and numerous tracks were observed. No further winter use was observed at the time of the survey.

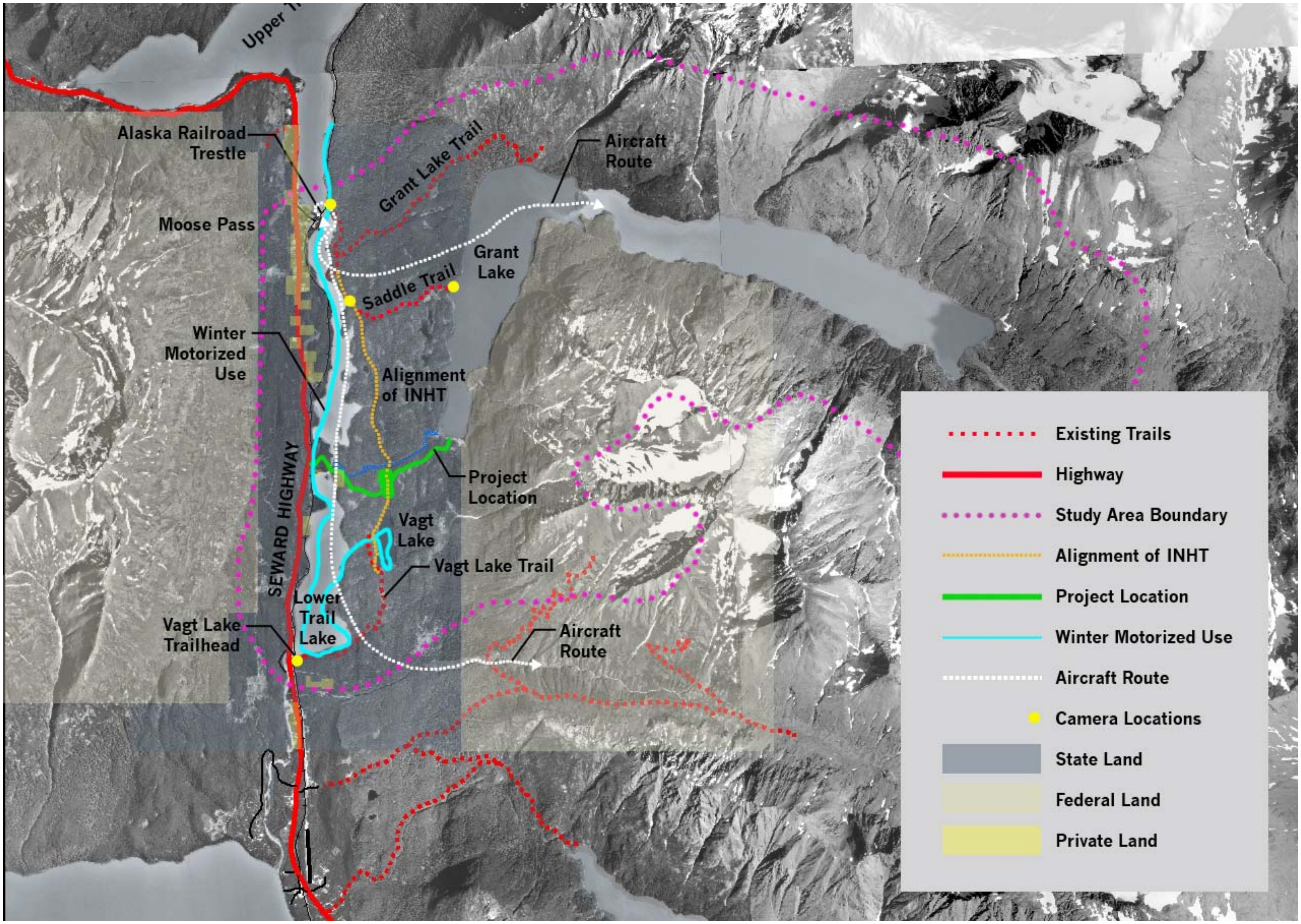

Figure E.4-87. Project vicinity recreation resources.

Figure E.4-88. Trail Lake.

Figure E.4-89. Vagt Lake trailhead.

Figure E.4-90. INHT along western side of Vagt Lake.

Existing Observed Summer Use

Summer uses included hiking on Vagt Lake Trail, camping at Vagt Lake, fishing in Upper Trail Lake, Lower Trail Lake, and Vagt Lake, some motorized all-terrain vehicle (ATV) activity on Grant Lake Trail, and small aircraft takeoffs and landings at Trail Lake. Additionally, the team providing fishery research for the Project noted approximately 12 anglers on Grant Creek, over the entire summer and fall data gathering period.

Recreational Uses 2014

At the December 12, 2012 natural resources study plan meeting and March 20, 2014 natural resources study report meeting, stakeholders requested that more quantitative information be collected to determine recreation use patterns in the vicinity of Moose Pass, Alaska. KHL investigated various methods for gathering the requested information and determined that cameras unobtrusively located at key locations would be the best means to achieve the requested information. Based on that and review of reference material as to how to collect the information, from March 31 to September 23, 2014, trail users were quantified and categorized according to primary activity from data collected by four motion sensor cameras near Moose Pass, Alaska (see locations Figure E.4-87). There were over 1,600 users, the majority of them were hikers and the majority of users used the Vagt Lake Trail (1,151). Over 300 people used the trails for only short periods of time and were put in the “Break” category. Many of those users appeared to be on bathroom breaks. Fishing was another high user activity with over 200 people visiting the area to fish during the time frame. Motorized activity was fairly low with only 11 users frequenting the trails with ATVs or dirt bikes.

Figures E.4-91 and E.4-92 and Table E.4-98 show the number of trail users by location and recreation activity.

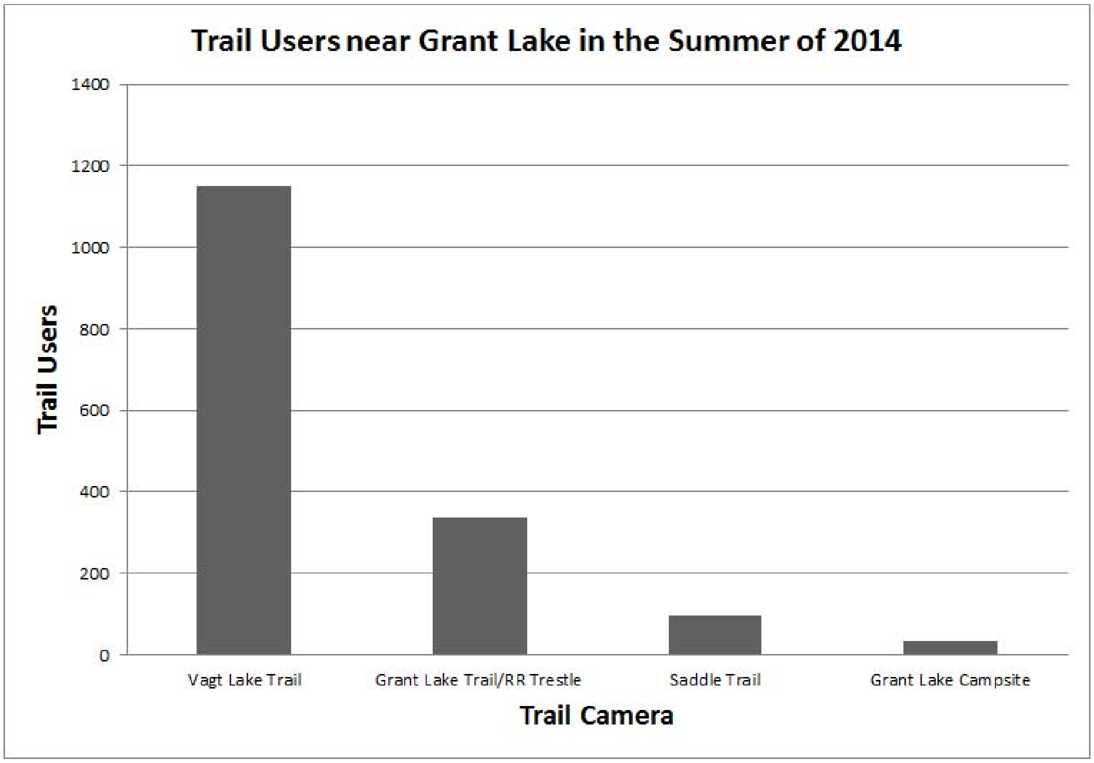

Figure E.4-91. Total trail users, 2014.

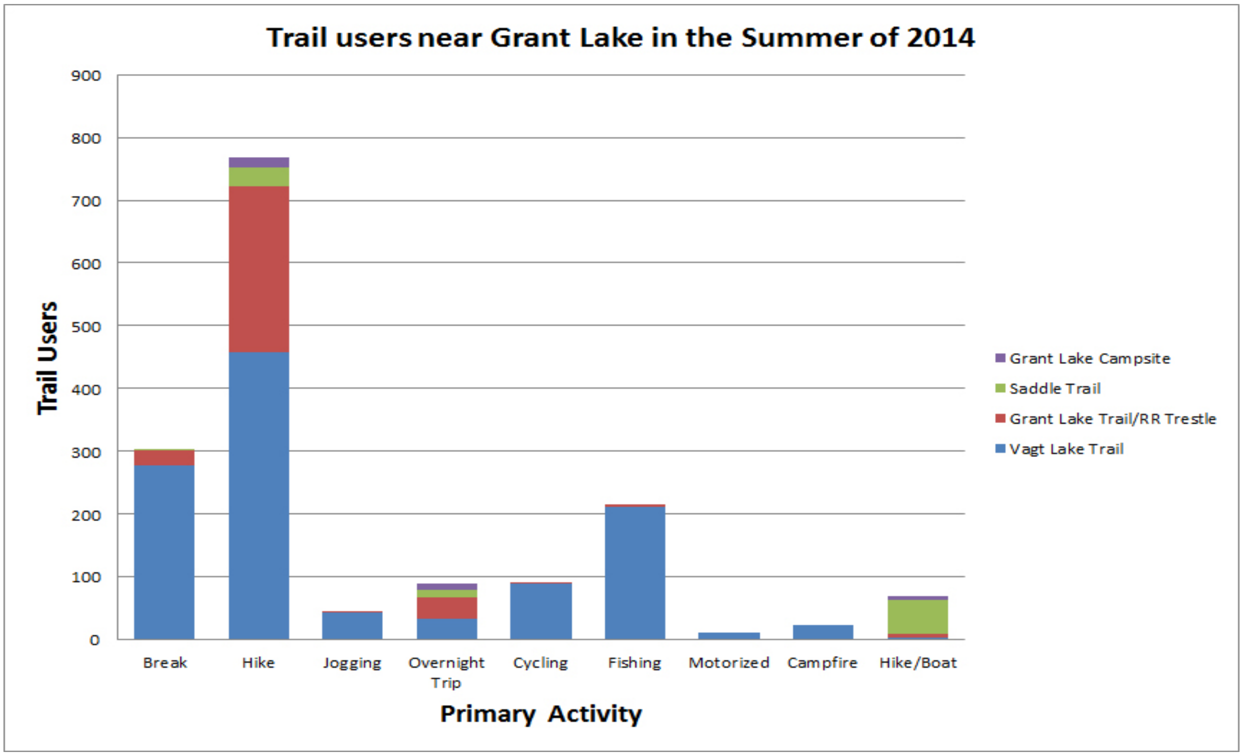

Figure E.4-92. Trail users by type, 2014.

Table E.4-98. Numbers of trail users by type and location.

Trail	Break	Hike	Jogging	Overnight	Cycling	Fishing	Motorized	Campfire	Hike / Boat	Total
Vagt Lake	278	458	44	33	89	212	11	23	3	1151
Railroad Trestle	23	265	2	34	2	4	0	0	7	337
Saddle Trail	2	29	0	12	0	0	0	0	53	96
Grant Lake	0	16	0	10	0	0	0	0	6	32
Totals	303	768	46	89	91	216	11	23	69	1616

Boaters from Vagt Lake trailhead were also observed floating down Trail River to Kenai Lake. Trail River provides neither the river experience nor the length of river to be a viable commercial float experience though some floating of the river does take place as a recreation activity. Evidence of ATV use from Trail Lake to Grant Lake is shown in Figures E.4-93 and E.4-94. As evidenced from camera recordings, use is light but is sufficient enough to leave clear indications of use.

Figure E.4-93. Grant Lake trail.

Figure E.4-94. Grant Lake Trail through meadow.

At the time of the on-ground site investigation in 2013, noise levels ranged from 40-50 dB. No nearby motorized use was occurring during the inspection. Noise was generated from highway traffic, and though the Seward Highway had increased usage in comparison to the winter survey, noise levels did not exceed 50 dB.

Driving for pleasure, as with tourism-related bus traffic, is a key recreation activity along the Seward Highway corridor. Alaska Department of Transportation & Public Facilities (ADOT&PF) reports a range of average annualized daily traffic count ranging between 1,568 vehicles per day in 2012 to 1,614 vehicles per day in 2010 (ADOT&PF 2011). In 2012, this traffic had a highest “maximum average daily traffic count” of 3,802 vehicles in July and a low maximum average daily traffic count of 611 in January. Most of these drivers and passengers are expected to be traveling partly to enjoy scenery, regardless of the primary reason for the trip.

Sight-Seeing Flights (Aircraft)

Small aircraft provide sight-seeing flights several times a day in the summer months. The typical routes are from Moose Pass, over Grant Lake to Prince William Sound for viewing mountainous terrain and glaciers with a return to Moose Pass by flying over Falls Creek. Aircraft are typically float planes that leave from Trail Lake (Figure E.4-95). These same aircraft are utilized for hunting and fishing purposes in the area. Discussions with float plane operators suggest that Grant Lake is not used as a fishing destination but is a drop-off location for hunting of mountain goats, caribou, bear, and moose.

Figure E.4-95. Floatplane tie up, Trail Lake.

Hunting

Under the ADF&G, Grant Lake is within Game Management Unit 7 (Figure E.4-96), which covers the eastern portion of the Kenai Peninsula. The area is open for black bear, brown bear, caribou, Dall sheep, moose, mountain goat, wolf, and wolverine. These hunts are permitted through the ADF&G, with regulations pertaining to residents and non-residents alike, and vary according to season.

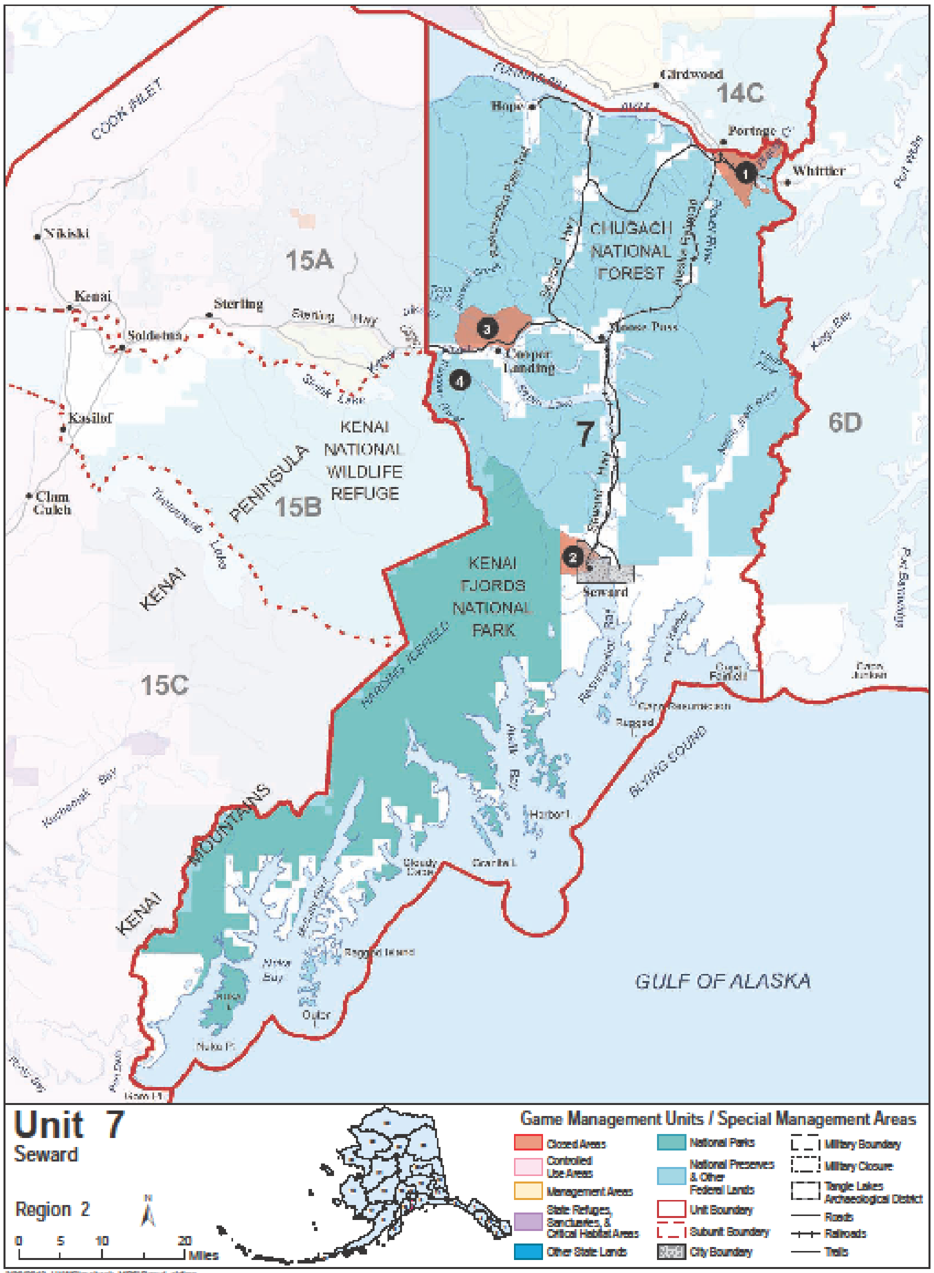

Figure E.4-96. Game management Unit 7.

Table E.4-99 reflects the harvested quantities of the game species as recorded by ADF&G in 2012. Also, Table E.4-99 encompasses a much broader area than the Project area. The amount of backcountry area and the terrain that is represented by the Project area relative to full game management unit would suggest that the area is hunted for all or most of the game species indicated.

Table E.4-99. Harvest within Game Management Unit 7 (ADF&G 2013).

Species	Hunt Number	Hunters	Harvest
Black Bear	General Season	6,129	1,469
Brown/Grizzly Bear	RB300	389	25
Caribou	DC001	89	24
Dall Sheep	General Season	2,001	599
Moose	General Season	19,202	3,758
Mountain Goat	DG339	2	0

Fishing

Vagt Lake is an ADF&G stocked lake, making it an enticing destination for recreationists and the summer camera recordings indicated a total visitation of 212 fishermen at the Vagt Lake Trailhead. The lake is a 2-mile walk from the Vagt Lake trailhead, allowing it to be a convenient and enjoyable walk through the woods around Lower Trail Lake. Preliminary sampling has noted that Grant Lake is not actively used for fishing as the only species known and/or documented to be in the lake are sculpin and stickleback.

Grant Creek is fished for rainbow trout and Dolly Varden but is closed to the taking of salmon. During the seven month period of fish sampling conducted by fisheries biologists for the Project in 2013, approximately 12 fishermen were observed on Grant Creek. It is not known how many visits occurred by fishermen in 2014 of the numbers recorded as “fishing” or “hike/boat” in the summer survey, recognizing that most fishermen would probably have boated to Grant Creek to fish since hiking to the creek is not currently easily accomplished. Boating to the creek is easiest from the northern side of the creek since swift water complicates access from the south side. It is possible to raft or pack raft across the creek however to gain access to either side. Power motors would also provide access.

4.8.1.2. Land Use

Most of the Project area is located on Kenai Peninsula Borough and State of Alaska lands with a minimal amount of private land being present. There is no municipal government with management responsibilities though the Kenai Peninsula Borough does have land use management responsibility and planning powers. Most land use issues affecting the Project area are addressed through the Kenai River Comprehensive Management Plan, which is administered as part of the Kenai River Special Management Area (KRSMA), with headquarters at the Donald E. Gilman River Center.

The Donald E. Gilman River Center is a multi-agency permitting, information, and education center dedicated to the protection of the Kenai River and natural resources of the Kenai Peninsula. Agencies include Alaska State Parks, the Kenai Peninsula Borough, and the Alaska Department of Fish and Game.

Lands east of the western shore of Grant Lake lies within Chugach National Forest. The USFS manages the forest via the Revised Land and Resource Management Plan for Chugach National Forest (USFS 2002). That plan is currently being updated.

Following is a description of the relevant management plans.

4.8.1.2.1 Kenai River Comprehensive Management Plan

The Kenai River Comprehensive Management Plan (ADNR 1997) proposes that a number of state parcels adjoining Trail Lakes and Trail River be incorporated into the KRSMA and proposes that these actions be accommodated within the Kenai Area Plan. It also proposes a 200-foot vegetated buffer be provided along the shore of the lakes and river. These proposals are provided to protect fish populations and resources of the Kenai River.

4.8.1.2.2 Kenai Area Plan

From the Kenai Area Plan (ADNR 2001), public recreation and tourism presents goals of keeping public areas open and available for use. This management plan supports recreation and tourism activities such as backcountry skiing, hiking, snowmaching, and sightseeing. Specifically from this plan, the INHT trail and trail corridor is to have a conveyance of a 1,000-foot-wide easement to include a visual and sound buffer between the recreation corridor and adjacent uses. No permanent structures or equipment are to be placed within the trail corridor. In keeping with this management plan, the Project has provided an alternate route for the INHT easement, keeping the 1,000-foot-wide corridor away from any permanent structures and adjacent uses.

The Kenai Area plan has designated Grant Lake within region 2B, with the Grant Lake Project area affected by Units 380G, 380F, and 381. Figure E.4-97 illustrates where these units are located with respect to Grant Lake. Green cross-hatched areas shown on the graphic are proposed as “Proposed Addition to Kenai River SMA”. Red cross-hatched areas are shown as “Borough/City Selected”. These particular areas have been identified for their Public Recreation and Tourism uses and protection of existing habitat. They are recognized as being strongly oriented toward recreation, particularly with respect to the trails and surrounding lakes.

Figure E.4-97. Kenai Area Plan, enlargement of Grant Lake designation.

4.8.1.2.3 Chugach National Forest Revised Land and Resource Management Plan

The USFS manages lands east of the western shore of Grant Lake. Also, the agency has construction and management responsibilities for the INHT within the Project area. The USFS lands are managed in accordance with the Revised Land and Resource Management Plan for Chugach National Forest (USFS 2002). The plan is currently being updated. Until revisions are final, the 2002 plan remains "current". This management plan provides guidance for all resource management activities on national forest land within the Chugach National Forest.

The area in and around Grant Lake is managed as part of the Kenai Mountains Roadless Area, encompassing 319,600 acres. It is managed to meet goals for improved and developed recreation opportunities while maintaining landscape character and providing for timber management.

Grant Lake is designated within the 2002 Revised Land and Resource Management Plan with a prescription for "Fish, Wildlife, and Recreation Management". Areas north and east of the lake are managed as "Backcountry". "Fish, Wildlife, and Recreation Management" provides a "desired future condition" of "ecological processes, moderately affected by human activity, dominate…Evidence of resource management may be present." "Backcountry" areas present a desired future condition of "ecological processes, largely unaffected by human activity, provide excellent opportunities for solitude, tranquility, isolation, quiet, challenge, and a degree of risk when traveling backcountry" (USFS 2002).

The Grant Lake/Ptarmigan unit of the USFS Land and Resource Management Plan is designated for motorized use. However, the isolation of Grant Lake and the Project area from the road system and the difficulty in gaining access to much of the Project area has limited motorized use.

4.8.1.3. Iditarod National Historic Trail (INHT)

The INHT is proposed within a dedicated easement inside of the Project area. In the effort to reconnect the Seward-Girdwood portion, an easement of 1,000 foot width was issued by the ADNR in August of 2004. This is more specifically described in November of 2004 in the Final Finding and Decision, ADL 228890, Grant of Public Easement, INHT, Seward to Girdwood (ADNR 2004). According to this document, the INHT will connect at milepost 25, or the outlet for Lower Trail Lake and this trailhead will be upgraded with a parking lot to hold up to 50 vehicles. The trail continues north using the Vagt Lake Trail to the northeast tip of Upper Trail Lake where the trail crosses back onto federal land. There is some light use of the trail to Vagt Lake and there have been trail improvements from the south, to Vagt Lake, to accommodate this use. However, north of Vagt Lake the trail is merely flagged and use appears to vary from occasional to non-existent. To date, no firm plans have been conveyed to KHL with respect to plans to actually construct the trail through the Project area. At present, blue flagging marking the proposed route is all that delineates the trails route through not only the Project area but lands on both sides of the currently proposed Project boundary. As an additional note, when constructed, the proposed INHT route will truly be commerative in nature and does not reflect the actual route of the historic trail through the Project area. The actual historical route has been documented to be much closer to the current railroad and Seward Highway area.

4.8.2. Environmental Analysis

4.8.2.1. Recreation

4.8.2.1.1 Winter Use

Other than the proposed access roadway associated with the Project, Project components in general would have very little effect upon existing winter use. None of the components other than the road would interject development where there is concentrated or even sparse winter use.

Currently, other than seasonal closures, management plans allow winter motorized use of the Grant Creek and Grant Lake drainages. However, physical features and the lack of road access provide only limited use of Grant Lake for recreation. The road access to the powerhouse and to the intake structure would change the winter use patterns.

With provision of road access to Grant Creek, it is expected that winter use will increase as a result of the safe passage around/over Trail Lakes and the development of a roadway to Grant Lake. If public access is deemed preferable and allowed (see Section 4.8.3.1 of this Exhibit E for further details), it will be much easier for snowmachine users, skiers, and hikers to navigate over or around Upper and Lower Trail lakes without the current risk posed by open water on the

Trail Lake complex, particularly at narrow locations on the lakes and the connection between the two lakes.

Dependent upon access provisions that are provided by the Project for public use, including parking, it is possible that Grant Lake would provide snowmaching and ready access for those wanting to snowmobile on the lake and off into the headlands above the lake. Also, the roadway would provide ready access for those wishing to backcountry ski in the area.

While this presents opportunities for motorized and non-motorized winter recreation, it also expands the presence of humans and compromises the setting for those seeking quiet and solitude. It may also lead to some conflict between skiers and snowmachiners should snowmachine use expand greatly. Ice fishing is not expected to expand beyond the existing use level since there are not game fish of consequence in Grant Lake for ice fishing.

While recreational opportunities will increase, the provision of access to the public is an issue that will have to be negotiated between KHL and the USFS.

4.8.2.1.2 Summer Use

As with winter use, the summer use levels are expected to increase. If the establishment of a fifty car parking lot at the Vagt Lake Trailhead as proposed by the Grant of Public Easement for the INHT does occur, that alone will trigger an expanded use by user groups. Additionally, the bridge across the narrows, if provided, will provide quick and easy access for summer recreation around the Grant Lake area; something that is limited at present. Also, it may assist in lessening trespass that occurs on the Alaska Railroad crossing of Lower Trail Lake. Access is an issue that will require coordination with management agencies as this ability to expand recreation use has the same effect as with winter use; greater recreation opportunity but greater presence of humans in an area that currently receives little use.

4.8.2.1.3 Sight-Seeing Flights (Aircraft)

It is not expected that sight-seeing flights will be affected by the Project. Although there will be temporary construction activity and changes to the landscape as a result of the Project infrastructure, sight-seeing users will still enjoy the lakes, rivers, mountains, and ice-fields that surround Moose Pass.

4.8.2.1.4 Hunting and Fishing

Impacts to hunting as a result of the Project include a possible increase in hunting pressure as a result of the proposed access road that would more easily facilitate access to Grant Lake. Currently, most individuals are understood to gain access to hunted areas via float plane. A roadway that would allow hunters to either unload a boat at Grant Lake, or to easily hike up the road with a pack raft, would increase the numbers of hunters that would hunt around Grant Lake and the surrounding backcountry.

There would also likely be an increase in fishing activity on Grant Creek. Currently, Grant Creek receives limited fishing activity due both to limited access and the lack of an open salmon fishery. The availability of a roadway that facilitates creek access would open the opportunity for trout and Dolly Varden fishing along the creek. While the fishery is assumed to be limited in the future to non-anadromous species, the availability of a creek on the road system would enable those fishermen who simply fish for the recreational experience and thus fishing pressure on the creek would likely increase.

4.8.2.1.5 Noise

Noise sources would include vehicles that are traveling the access roadway to the powerhouse and to the intake structure. However, the facility is proposed to operate remotely with access on a monthly basis during normal operational periods. For those limited visits, sound levels at 50 feet from the source of pickup trucks and automobiles would range in the neighborhood of 70-80 dB (Reed 2010). Thus recreation users of the roadway or the INHT would be subjected to short periods of noise above that of the ambient noise of 40 dB in the winter and 40-50 dB in the summer for those limited portions of trail that cross or are adjacent to the roadway.

The provision of a roadway may induce snowmachine traffic to the roadway and may also induce an increase in use of Grant Lake and the surrounding areas. Snowmachines generate sound levels as high as 83 dBA at 50 feet from the source (Reed 2010) and the sound can be detrimental to the experience of non-motorized users in an area. While this is a moderate to major impact to that use, the use of Grant Lake by non-motorized users tends to be small to absent in the winter in particular, thus the overall impact to existing conditions would be relatively small.

4.8.2.1.6 Construction

Construction impacts would be temporary and would affect trail use and fishing along Grant Creek. The presence of construction equipment and construction noise would provide a short-term but major impact to the environment desired by those recreating along the creek. Construction is planned to take place only in the summer months, thus noise and lighting impacts during the winter months, would be limited. Noise impacts would be expected to some degree in the summer though the construction site is generally removed from residences and visitor destinations, depending on the individual part of the infrastructure that is being constructed.

4.8.2.1.7 Recreational Opportunities

The proposed Project provides an opportunity for increased recreation access to the area. The access road could provide Grant Lake access that is currently difficult and unavailable to many recreationists. Having the access could increase boating opportunities and access to backcountry that provides spectacular views and wildlife viewing. The Project could also allow increased access to hunters, allowing quicker access to background peak areas. The Project could provide parking to facilitate use of both hiking to Grant Lake on the Project access roadway, and to the INHT.

While the opportunity for increased recreation activity is provided, this has a negative aspect of possibly increasing the evidence of humans within this area of forest and on Grant Lake. Wilderness areas are managed for their pristine conditions and their lack of the evidence of human disturbance. If an increase in recreational opportunities is undesirable, a gate could be installed on the access road at any point to limit access to authorized personnel only. Close coordination with agencies will be needed to determine how access will be managed to meet agency goals.

4.8.2.2. Land Use

All changes in land use that would be attributed to the Project are either directly related to Project facilities with the exception of changes that would be induced by the access roadway. There is one private parcel that will adjoin or be in close proximity to the access road at such time that the road is proposed for construction. The owner of that parcel could possibly benefit from the presence of the roadway and it could possibly encourage the use of the property for commercial tourism opportunities. Contrary to that, the owner could possibly find that the roadway encourages unwanted intrusion and compromises his intended use of the site as a "remote parcel".

Project facilities are located beyond the 200-foot buffer proposed by KRSMA. Because the lands are retained in State ownership for purposes of habitat protection, there is no prescribed 200-foot buffer in the Kenai Area Plan. Still, the roadway and Project facilities would be located on State of Alaska land that is proposed for habitat protection and recreation uses. Proposed facilities could enhance the ability to meet recreation goals with the provision of increased access to trail and backcountry resources, though there would be some limited compromise of habitat protection goals in order to provide for the road and transmission line.

This may not fully meet management intent of Chugach National Forest for lands that are designated and managed as "backcountry". These areas are available for non-motorized recreation; however, the provision of road access to Grant Lake may induce increased use of the backcountry for snowmachining. While the numbers of non-motorized users is small, this may not be in conformance with the management intention of the USFS.

4.8.2.3. INHT

Currently, there is a conflict between the Project and the INHT with the powerhouse and ancillary facilities being located within the easement. While the current access road alignment limits crossings of the trail to one 90-degree crossing, under the current Project proposal, the INHT would essentially be located within or with direct views to the clearing limits expected for the powerhouse and its ancillary facilities including the detention pond, the outfall of the pond, the termination of the underground penstock, and clearing associated with parking and the access road. For the safety of the public, it is expected that the Project may require security measures to prevent vandalism or damage and the structures and fencing may not be in keeping with the setting appropriate for the INHT.

One alternative under consideration is for the INHT to be re-routed to the west, but still retain a 500-foot setback from the privately owned parcels located near the Trail Lake shoreline. This re-routed section would provide the desired buffer for the trail while giving users a more enjoyable view of the lakes. It also bypasses some marshy areas and exposes users to more distinctive landforms, water characteristics, and areas of outstanding scenic quality.

Figure E.4-98 illustrates where such a route might be located, with threads that illustrate where potential alternate locations for segments might be located.

In the interest of determining whether the proposed alternative could pose harm to historic or archaeological resources, KHL performed a field survey of the proposed route. The field survey of the proposed, re-routed corridor for the INHT through the Project area occurred September 17-19, 2014. This work also included a section of the intake access road that was not surveyed in 2013. The only cultural materials found during the survey were a small cluster of culturally modified trees (CMT). The CMTs were not given an Alaska Heritage Resources Survey (AHRS) number and are not considered eligible for the NRHP. This information is included in the Cultural Resources Study, Final Report (KHL 2015a) for the Project and has been made available to those stakeholders permitted to review the documentation per Section 106 requirements.

KHL has been in ongoing consultation with the requisite stakeholders related to this issue. Initial discussions began in 2009 with direct talks beginning with KHL and the USFS and the ADNR, including those in the SHPO. In these early discussions KHL discussed the process for evaluation of project impacts and licensing requirements.

In 2010, HDR Alaska, representing KHL, exchanged multiple emails with the USFS and ADNR discussing the easement for the INHT with discussion of proposed road alignments. Emails were exchanged that provided emails of the agencies' proposed location for the INHT. Most contacts with agencies occurred in April and May in 2010 with numerous discussions regarding potential impacts to cultural resources, including discussion of the INHT. In May of 2010, KHL sent SHPO a letter to initiate the Section 106 consultation. As a result of early discussions, KHL laid out a possible alternative to the INHT that would avoid proposed Project components.

At an interagency meeting in December 2012, representatives of ADNR and USFS provided input including discussing the INHT status and requirements. At this meeting, KHL also illustrated a revised alignment for road access to the proposed hydro site which would avoid aligning the road in terrain that was also proposed for the INHT, limiting exposure of Project components to trail users and limiting crossing of the access road by the INHT to one crossing.

In 2013, KHL again turned focus to a proposed alternate to the proposed USFS alignment to the INHT. To that end, KHL evaluated and proposed an alternate that would provide an enhanced user experience, with views to area peaks and Upper and Lower Trail lakes.

KHL contacted individual agencies in early July and throughout August 2013 to address the INHT relocation, including ADNR (both the KRSMA representatives and the SHPO) and the USFS. Also, KHL continued to request and receive guidance as to the approval process and roles of the agencies.

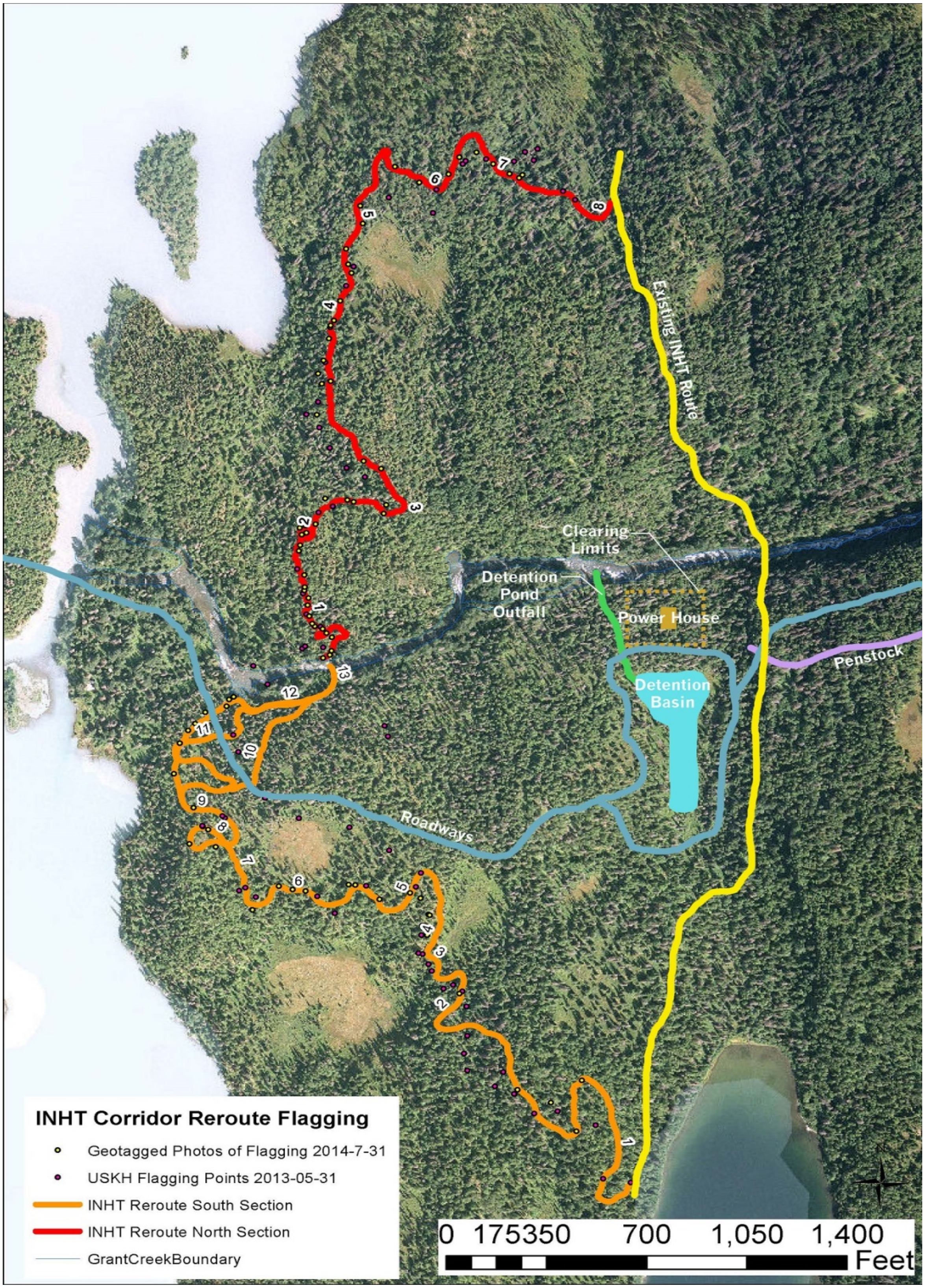

Figure E.4-98. INHT corridor re-route flagging.

KHL set up a meeting in November 2013 with the multiple stakeholder agencies and met at USFS Glacier District offices to outline the process that would be required for resolution of a possible INHT relocation. The meeting defined the agencies that would be involved and a general outline as to how a process would need to proceed. KHL followed up in November and December with meeting minutes and emails to further clarify the meeting results. The November meeting was approximately one month prior to an interagency meeting of Project status in which again the INHT was reviewed and discussed.

An on-site walk of the proposed re-routed trail was set up for July 15, 2014. That meeting was attended by four members of the USFS, two members of the SHPO, and a member of the Kenai Peninsula Borough. At that meeting the members agreed that it would be appropriate for KHL to provide a “Letter of Intent” to begin a process of review of the proposed re-route alternative and that a Memorandum of Understanding or Agreement would be in order to agree to the terms under which an evaluation of the alternative would take place. Meeting minutes and agency response indicated agreement with that approach.

Following the meeting, KHL coordinated with the USFS in order to understand what the “Trail Management Objectives” were for the trail. Upon collecting those objectives, KHL returned to the proposed alignment alternative site and established more specific flagging of the route. Subsequent to that, KHL coordinated with the USFS to let them know that more specific flagging had been established.

As a culmination of the consultation efforts to date, KHL developed a Letter of Intent and a Memorandum of Agreement (MOA) in August 2014 to begin the evaluation process. The documents were sent to the USFS, SHPO, ADNR, and the Kenai Peninsula Borough. Though no agency took exception to the Letter of Intent, SHPO indicated that it was not appropriate for them to enter a MOA because there had been no demonstration that there were any Project effects related to the INHT alternate routing that would suggest that their agency would have any purview. Also, the USFS indicated that, “At this time an MOA is not the appropriate tool in facilitating the decision to move forward with the Project proposal and potential trail realignment. The appropriate tool is the NEPA process as it will address, and hopefully answer questions associated with the proposed re-route.”

Coordination continues on the proposed re-route.

4.8.3. Proposed Environmental Measures

4.8.3.1. Recreation

The Project has the potential to provide the opportunity of enhanced recreation opportunities through the provision of an access road with pull-outs, restrooms, and off-loading facilities to serve both summer and winter recreation opportunities. The Grant Lake area provides excellent backcountry access possibilities for hikers, skiers, and snowmachiners. However, access has been limited by the amount of time that is necessary to negotiate terrain-challenging hiking/skiing trails and twisting trails that limit snowmachining. The access road could provide the opportunity for pull-offs at any number of locations.

A pull-off at the lower reaches would provide fishing access without requiring a boat to negotiate Upper or Lower Trail Lake. This would be a positive recreation opportunity though it would increase fishing pressure on the creek. Signs would need to be posted to clearly denote that salmon fishing is restricted due to the possibility of increased salmon retention by unknowing fishermen.

A pull-off at a midpoint of the road, below the powerhouse (depending on a selected INHT location) could provide access and a trailhead to the INHT, discussed below. This trailhead could provide parking for use by the public.

A pull-off at the upper reaches of the roadway, or at the road terminus at Grant Lake could provide access by snowmobile, ski, or snowshoe. Such a roadway pull-off would also provide opportunities for hunters and backcountry hikers/skiers to gain access quickly to upper elevations of Chugach National Forest. This pull-off could provide an off-loading ramp for snowmachines.

It is extremely important to note that all of this potential benefit associated with additional access is dependent on public input and preference. KHL has every intention of polling the local community and soliciting their comments with respect to the allowance of access via the Project corridor. This polling and commenting period began with the Public Meeting held in Moose Pass on November 6, 2014 and will continue with the formal commenting period associated with DLA review. If the majority of the commenting public would prefer access to the Grant Creek drainage be prohibited, the aforementioned enhancements (pull-outs, off-loading facilities, etc.) will not be constructed and the access route will be used by KHL staff only to maintain and operate the Project.

If however, the local public would prefer access be allowed via the Project related corridor, further discussion with respect to specifics of the access infrastructure would be discussed with stakeholders and the public prior to implementation. It should be noted that all possibilities of access require coordination with ADNR, ADF&G, and the USFS to address how such access opportunities would affect land management and resource plans and opportunities. Once public preference is fully understood, the Annual Compliance Report will document associated recreational efforts and plans for subsequent implementation on an annual basis.

At this point, it is KHL's assumption that collaboration with stakeholders and the public related to public access will occur during and subsequent to the DLA review process. As such, a Draft PSAP will be developed to document the currently planned methods for providing and monitoring public use and safety on Project lands once preference is determined. The Draft PSAP will then be included with the FLA for FERC review. This plan is intended to monitor the use of the access road to the powerhouse and intake structure for motorized and non-motorized use. Once a decision is made with respect to public access, a camera may be installed at the new trailhead (if so agreed by stakeholders) and monitored to determine the extent of public use and the type of use that has been generated by the improvements. Stakeholder interests are intended to have access to data gathered by the monitoring provisions in order to provide appropriate management for the area.

Depending on preference related to access, the PSAP will be developed accordingly to comprehensively document management and maintenance measures to be implemented. As previously mentioned, it is KHL's current intent to make decisions related to the allowance of public access prior to FLA filing with FERC.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.8.3.2. Land Use

All lands that are directly affected by the proposed Project are retained in public ownership. As a result, land management plans that are in place provide specific land use related to protection of land and water resources and for public recreation purposes. Additionally, there is not a need for buffers or other retained easements at Grant Lake or Grant Creek as all land is in public ownership and fully provides for public access.

Use of ADNR land will remain in its current state and there should not be a need for specific changes to the management policies and plans currently in place. However, depending on public preference with respect to access, there may be an increase in human presence in the area and specific management of pull-offs, trails, and other amenities such as kiosks and parking, will require coordination between KHL and responsible agencies. This management and coordination will be outlined in the PSAP.

USFS lands may be affected by the roadway to the Project intake on Grant Lake. The USFS is currently updating the existing Revised Land and Resource Management Plan for Chugach National Forest (USFS 2002) and consideration may be appropriate to address how the Grant Lake area is managed with respect to intended Wilderness properties and specifically "road management policies" with respect to the management of the access road. KHL will work with the USFS, other agencies and the pulic to accommodate these management and maintenance requirements and will incorporate them into their collaboratively developed PSAP.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.8.3.3. INHT

The proposed re-route of the currently unconstructed INHT provides an opportunity to provide an enhanced user experience with views of Upper and Lower Trail lakes, and surrounding peaks including Crown Peak. It also provides a diversity of terrain that is not available with the current alignment of the INHT. KHL has indicated to stakeholders that it is willing to bear the costs of any expenses related to trail construction that would exceed that necessary for the existing alignment as proposed by the agencies. KHL has also indicated a willingness to address re-platting of the easement as necessary to provide the trail alignment and necessary 1.000-foot wide easement.

After extensive coordination and an on-site meeting during which stakeholders walked portions of the trail, KHL developed a Letter of Intent and a MOA in August of 2014 to begin the evaluation process. The documents were sent to the USFS, SHPO, ADNR, and the Kenai Peninsula Borough. Though no agency took exception to the Letter of Intent, SHPO indicated that it was not appropriate for them to enter a MOA because there had been no demonstration that there were any Project effects related to the INHT alternate routing that would suggest that their agency would have any purview. Additionally, the USFS indicated that, "At this time an MOA is not the appropriate tool in facilitating the decision to move forward with the project proposal and potential trail realignment. The appropriate tool is the NEPA process as it will address, and hopefully answer questions associated with the proposed re-route."

Sections 4.8.1.3 and 4.8.2.3 of this Exhibit E and the associated consultation record (Attachment E-1), document the extensive level of coordination KHL has gone through with stakeholders related to the INHT re-route. Per USFS preference, any stakeholder decision related to approval of a re-route will be made once the public review process associated with the FLA filing occurs and a FERC license is issued. At that time, KHL and the stakeholders will reconvene and finalize a collaborative agreement with respect to the appropriate re-route. All phases of the re-route process will be documented consistent with the respective Annual Compliance Report. Documentation will include but not be limited to stakeholder consultation record, agreements reached and associated signed documents, maps and figures documenting the approved re-route and a schedule for implementation of the agreed upon process. Per Section 2.1.5 of this Exhibit E, once an agreement is collaboratively reached with stakeholders, an INHT Re-routing Plan (INHTRP) will be drafted by KHL that will outline:

- Process for modifying easements
- Acquisition of permits (if needed)
- Costs associated with re-route and responsible party

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.8.4. Cumulative Effects Analysis

FERC's SD2 (FERC 2010b) identified potential cumulative effects related to construction and operation of the Project for recreation based activities. Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, KHL does see the potential for additional recreational access and opportunity associated with the proposed Project access road. Additional access via the Project access road has the potential to increase the number of people utilizing the back country for activities such as hunting, hiking, snowmachining, sightseeing, etc. With additional use comes the potential for additional impact to the natural environment. That said, additional recreational use opportunity, especially in pristine locations, is viewed by many as a positive attribute. While this additional access and opportunity for recreating in the backcountry may be viewed as negative by some and positive by others, KHL fully intends to allow public and stakeholder input and preference to define whether additional access is allowed via Project related -orridors.

As more comprehensively described in Section 4.8.3.1 of this Exhibit E, if the majority of the commenting public (along with requisite stakeholders) would prefer access to the Grant Creek drainage be prohibited, the access route will only be used by KHL staff to maintain and operate the Project. If however, the local public would prefer access be allowed via the Project-related corridor, further discussion with respect to specifics of the access infrastructure would be discussed with stakeholders and the public prior to implementation and all plans for implementation and maintenance will be documented in the PSAP to be filed with the FLA. Refinement of the plan and subsequent implementation of the selected access option will be documented on a yearly basis in the Annual Compliance Report. The report will be provided to stakeholders for review and comment prior to KHL finalizing and filing with FERC.

4.8.5. Unavoidable Adverse Impacts

Regardless of the selected option associated with access via the Project developed access road, KHL recognizes the potential for the public to legally or illegally (as the case may be), use the access road for various reasons. KHL intends to strictly implement the measures outlined in the PSAP to ensure the access road is only utilized for approved purposes. As such and based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, KHL has identified no recreation or land use related unavoidable adverse impacts associated with construction and operation of the Project.

4.9. Aesthetic Resources

4.9.1. Affected Environment

4.9.1.1. Viewers

There are three major types of viewer groups or constituents in the Project area. The groups were identified based on the existing land uses and travel routes. Table E.4-100 identifies the viewer groups and their expectations and values for the viewshed of the Project. These viewers are described in terms of their "concern levels". "Concern levels are a measure of public importance placed on landscapes viewed from travelways and use areas"(USFS 1995). There are three concern levels, with high (1) denoting those viewers who would have high interest in the surrounding landscape.

Table E.4-100. Viewer group and expected values for the viewshed.

Viewer Group	Expected Values
Residents	Generally have a desire for protection of visual quality, including views from roadways, waterways, and individual residences. Generally cautious concerning changes to visual environment.
Recreationists/ Tourists	Includes both road and rail traffic. Generally have high appreciation for visual quality of an area and desire for undisturbed areas. Also share a desire for views from roadways and waterways.
Aircraft	High variability in visual values and the acceptance of changes to existing visual conditions. Many are sight-seers with high degree of sensitivity to visual quality.

There are variations in the number of residents, recreationists, tourists, and viewers from aircraft throughout the year. Summer months are typically characterized by a significant increase in viewers, particularly as a result of tour travel, as well as fishing and hunting activities. This visitor population drops drastically after these seasons have passed into the winter months. Both numbers of on the ground viewers and the air traveler populations are much lower during winter and early spring. Float planes, which are docked on Upper Trail Lake during the summer months, are removed from the lake in the winter. There is little small aircraft traffic in the winter compared to numbers of float plane takeoffs and landings that occur from May through September. These visitors typically have a high level of appreciation for scenic values and scenic integrity. In fact, it is these values that bring them to visit this area.

The population of Moose Pass is generally stable through the entirety of the year. The State of Alaska Department of Labor and Work Force Development (2013) reports 219 residents in Moose Pass in April 2010, 240 residents in July 2011, and 231 in July 2012. This would seem to indicate relative stability given that April is more indicative of winter conditions than summer conditions in Moose Pass. The residents of Moose Pass can be characterized as treasuring their "small town" culture and the environment in which they are located. They have a high value for the setting in which the town is located and have a high level of value for scenic integrity.

Seward, located approximately 25 miles south of Moose Pass, experienced approximately 355,000 visitors in the summer of 2011 (McDowell 2011). Virtually all of these visitors pass through Moose Pass by either road or rail. Rail passenger service is only available in the summer. A majority of the road traffic passes through the community in the summer months as well. In 2012, this traffic had a highest "maximum average daily traffic count" of 3,802 vehicles in July and a low maximum average daily traffic count of 611 in January (ADOT&PF 2013).

There are a number of recreationists who travel on the eastern side of the valley via trails or on Trail Lakes in the winter. Most trail use is limited in the Vagt Lake area, to the south of the Project components. Winter use within the Project area is generally confined to the Vagt Lake area or is located on the Trail Lake frozen surface and includes snowmachiners, snowshoers and skiers. There are a small number of fishermen who travel along the Grant Creek bank but the number is quite limited as salmon fishing is restricted on the creek. There is evidence that some residents/recreationists hike along Grant Creek though the size of the trails indicate that this use is very limited. These recreationists typically have a high level of appreciation for the conduct of their recreation activities and value the undisturbed setting.

Hikers typically gain access to Grant Lake via the Grant Lake trail which is located north of the Project and provides access to a mine site located at the northern corner of the lake. There are also known to be some recreationists who fly small boats or pack in rafts for traveling along the shoreline of Grant Lake. Some of these include hunters trying to gain access to remote areas to the north and west of Grant Lake. Both hikers and hunters value the setting of their recreation pursuit and prefer an undisturbed landscape.

4.9.1.2. Visual Character

4.9.1.2.1 Landscape Visibility

Landscape visibility addresses the relative importance and sensitivity of what is seen and perceived in the landscape. It consists of three elements:

- Travel ways and use areas
- Concern levels
- Distance zones

Landscape visibility is also a function of several other considerations, including:

- Context of viewers
- Duration of view
- Degree of discernible detail
- Seasonal variations
- Number of viewers.

The first area of analysis involves determining whether the Project area can be seen from travel ways and use areas. Travel ways represent linear concentrations of public viewing. Use areas are specific locations that receive concentrated public viewing. For this Project, primary travel ways and use areas include the road system running north-south along the western shores of Trail Lakes. Secondary travel ways include the small aircraft sight-seeing routes from Upper Trail Lake west to Prince William Sound and back.

As discussed in Section 4.8 of this Exhibit E, viewer concern for their surroundings is an important part of the analysis of the importance of visual quality impacts. As described, almost all viewers have a high sensitivity to either the presence of undisturbed landscapes, or sensitivity to changes of the landscape as viewed from their homes. Thus the concern level of almost all viewers of the landscape is considered to be high, being a concern level of “1”.

4.9.1.2.2 Distance Zones, Viewer Exposure, and Seasonal Variations

Distance zones define the viewing distances of the viewer. The zones are noted as foreground, middleground, and background. The viewing distances are based on the amount of details that the observer can perceive. Distance zones help determine what portions of the landscape are more critical to the visual character and what areas are more sensitive to change. For example, travelers on the highway are more aware of changes to the foreground of the landscape than the background, given the same level of change of the landscape. Table E.4-101 further describes distance zones.

Table E.4-101. Distance zones (USFS 1995).

Distance Zones	Distance	Description	Distance Zones	Distance
Foreground (fg)	0 – 0.5 miles	Distinguish vegetative detail and full use of senses	Foreground (fg)	0 – 0.5 miles
Middleground (mg)	0.5 – 4 miles	Distinguish large boulders, small openings in the forest	Middleground (mg)	0.5 – 4 miles
Background (bg)	4 miles to horizon	Distinguish groves of trees, large openings in the forest.	Background (bg)	4 miles to horizon

This Project area is dominated by Foreground and Middleground distance zones. Almost all views are from the valley floor and the natural topography obscures views of most background areas east or west of primary view areas. Views are available to background peaks to the north and south, but only to the tops of peaks to the east, east of Grant Lake.

Viewer exposure is a function of the type of view seen; the distance, perspective, and duration of the view. The term exposure may also refer to the number of people exposed to a particular view. It is expressed by the numbers, distance, duration, and speed of view for each of the Viewer Groups. Table E.4-102 outlines viewer groups and the associated exposure periods based on observations of their use patterns and use periods.

Table E.4-102. Viewer groups and exposure period.

Viewer Group	Exposure Period
Residents	Continual
Recreationists/ Tourists	Varies-generally minutes, hours for fishermen on Grant Lake and hunters in Grant Lake basin
Aircraft	Varies-generally seconds or minutes

Seasonal variations are characterized by leaf loss within the Project area between summer and winter conditions. Summer foliage tends to obscure views with restriction of views beyond a distance of as much as several hundred feet for undisturbed areas. Also, the presence of foliage tends to provide screening of some views from the Seward Highway across Trail Lake. These views are extended to greater distances, across the lake, during winter months.

Winter months provide greater contrast of manmade disturbances since disturbed lands provide planes or lines that are visible since a lack of vegetation provides a strong contrasting line or plane within the landscape. This depends on whether vegetation between the viewer and disturbance obscures or modifies the view.

4.9.1.2.3 Scenic Attractiveness

There are three values used to describe the scenic attractiveness of an area. These classes are developed to determine the relative scenic value of landscapes. They measure the scenic importance of a landscape based on human perceptions of intrinsic beauty of landform, water characteristics, vegetation pattern, and cultural land use. Table E.4-103 characterizes scenic attractiveness classifications.

Table E.4-103. Attractiveness classes and description (USFS 1995).

Class	Title	Description
A	Distinctive	Areas where landform, vegetative patterns, water characteristic and cultural features combine to provide unusual, unique, or outstanding scenic quality. These landscapes have strong positive attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.
B	Typical	Areas where landform, vegetative patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality. These landscapes have generally positive, yet common, attributes of variety, unity, vividness, mystery, intactness, order harmony, uniqueness, pattern, and balance. Normally they would form the basic matrix within the landscape unit.
C	Indistinctive	Areas where landform, vegetative patterns, water characteristics, and cultural land use have low scenic quality. Often water and rockform of any consequence are missing in class C landscapes. These landscapes have weak or missing attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.

4.9.1.2.4 Scenic Classes

Scenic classes indicate the relative importance, or value, of discrete landscape areas having similar characteristics of scenic attractiveness and landscape visibility. Scenic classes are determined using the matrix in Table E.4-104.

Table E.4-104. Scenic class matrix (USFS 1995).

Scenic Attractiveness	Distance Zone and Concern Levels		
	Fg1	**Mg1**	**Bg1**
A	1	1	1
B	1	2	2
C	1	2	3

4.9.1.3. Landscape Units

To provide a framework for more specific analysis of the visual environment, three landscape units have been identified based on the interaction of existing land use patterns, topography, and distance from the Project. Each unit is defined with respect to its scenic attractiveness and scenic integrity and identification of these units is an important key to analyzing the visual effects of the

Project. The respective units and associated matrix are documented in Figure E.4-99 and Table E.4-105, respectively.

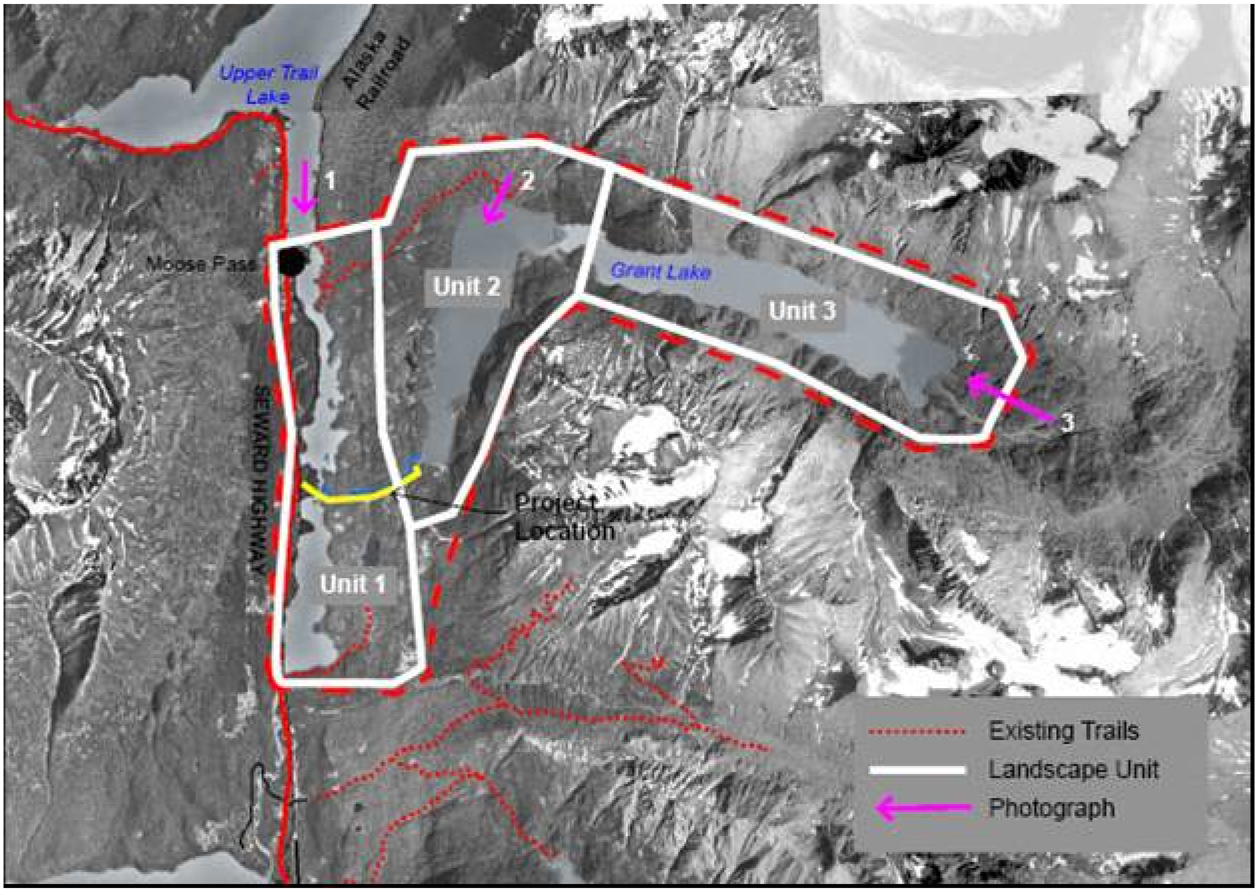

Figure E.4-99. Unit keys.

Table E.4-105. Unit key matrix.

Unit	Title	Description	Elevation
1	Trail Lakes Valley	Corridor of Trail Lakes valley from Moose Pass to Lower Trail Lake bridge	Lake elevation to ~300 feet above
2	Grant Lake West	Western half of Grant Lake	Lake elevation to ~300 feet above
3	Grant Lake East	Eastern half of Grant Lake	Lake elevation to ~300 feet above

4.9.1.3.1 Unit 1: Trail Lakes Valley

The Trail Lakes Unit includes almost all travel ways and viewers, except some of those traveling by aircraft. It also includes recreationists using trails or fishing the shoreline of Grant Creek.

Further it would include those traveling on the frozen surface of Trail Lake in the winter. Residents, recreationists, and aircraft have varying degrees of visibility for this unit, as their exposure is fluctuating from a few seconds to continual. Their concern level and exposure periods provide a high level of sensitivity to changes in the viewshed.

The area is characterized in Figure E.4-100, with a long view to the south down Upper to Lower Trail Lakes, with Kenai Lake far in the background. Travel patterns of viewers are shown in Figure E.4-101. Viewers are primarily residents of Moose Pass and travelers on the Alaska Railroad or Seward Highway. Viewers are afforded foreground views, and the area has a highly distinctive scenic attractiveness, or Class A as defined in Table E.4-104. Most views are foreground due to the enclosed nature of the Trail Lake basin. Background views are occasionally available with breaks in vegetation for those traveling on the Seward Highway or the Alaska Railroad, or living in Moose Pass. Shoreline vegetation tends to be deciduous, mixing with conifers with increasing elevation, turning to a primarily coniferous forest up to the u-shaped valley crest. Views are provided to alpine settings in the background. The landscape is typified by forest, dominant water features of high complexity and high level of order, and low density development in Moose Pass that tends to be of small scale and complementary to the landscape. The landforms, vegetative patterns, and water characteristics are intrinsically unique, with the majority of the existing landscape well preserved.

Figure E.4-100. Looking south across Trail Lakes toward Kenai Lake-view from aircraft.

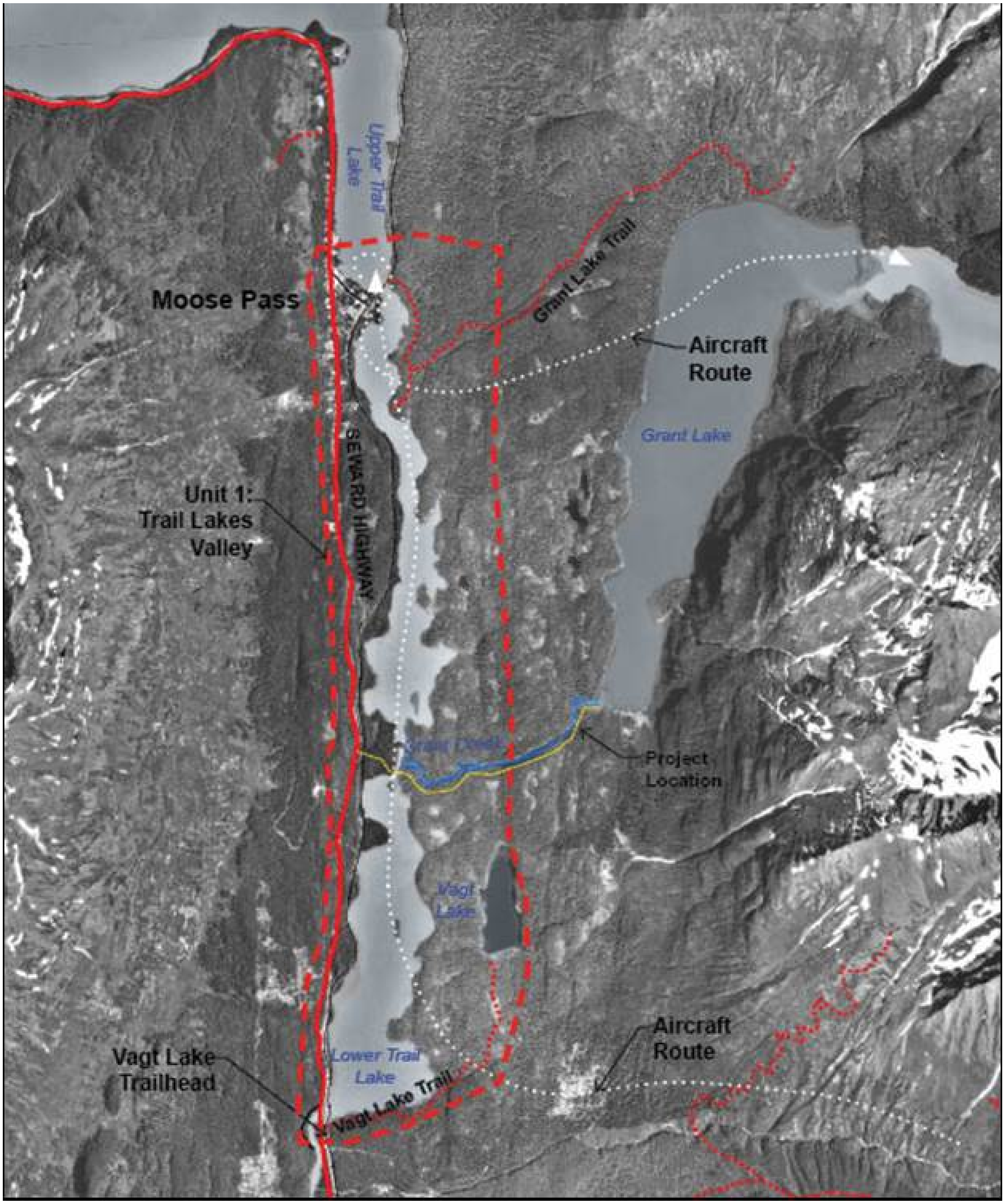

Figure E.4-101. Unit 1: Trail Lakes Valley.

4.9.1.3.2 Unit 2: Grant Lake West

The Grant Lake West landscape unit is highly distinctive (Class A as defined in Table E.4-104), and virtually fully intact with little to no evidence of human presence, as shown in Figure E.4-102. This view is from the north, looking south towards the project features, specifically the outfall of the lake. Figure E.4-103 illustrates travel patterns for those who visit this unit. The area has few viewers, no residents within the unit, and recreationists/tourists restricted to either those using the limited amount of trail access or those viewing the area by aircraft. The viewer exposure period ranges from hours for those traveling by trail or seconds/minutes for those traveling by aircraft.

This unit is characterized by Grant Lake and the surrounding mountains. The limited number of viewers located within the area would have foreground views. However, for most viewers, who are located in Moose Pass or on the road/rail corridor, the area is unseen. Vegetation remains an evergreen and deciduous forest around the lake and dissipates into alpine tundra with elevation. Large openings provide a mix of perennial herbaceous plants, with numerous Alaskan wildflowers.

Figure E.4-102. Looking south across Grant Lake from Grant Lake Trail.

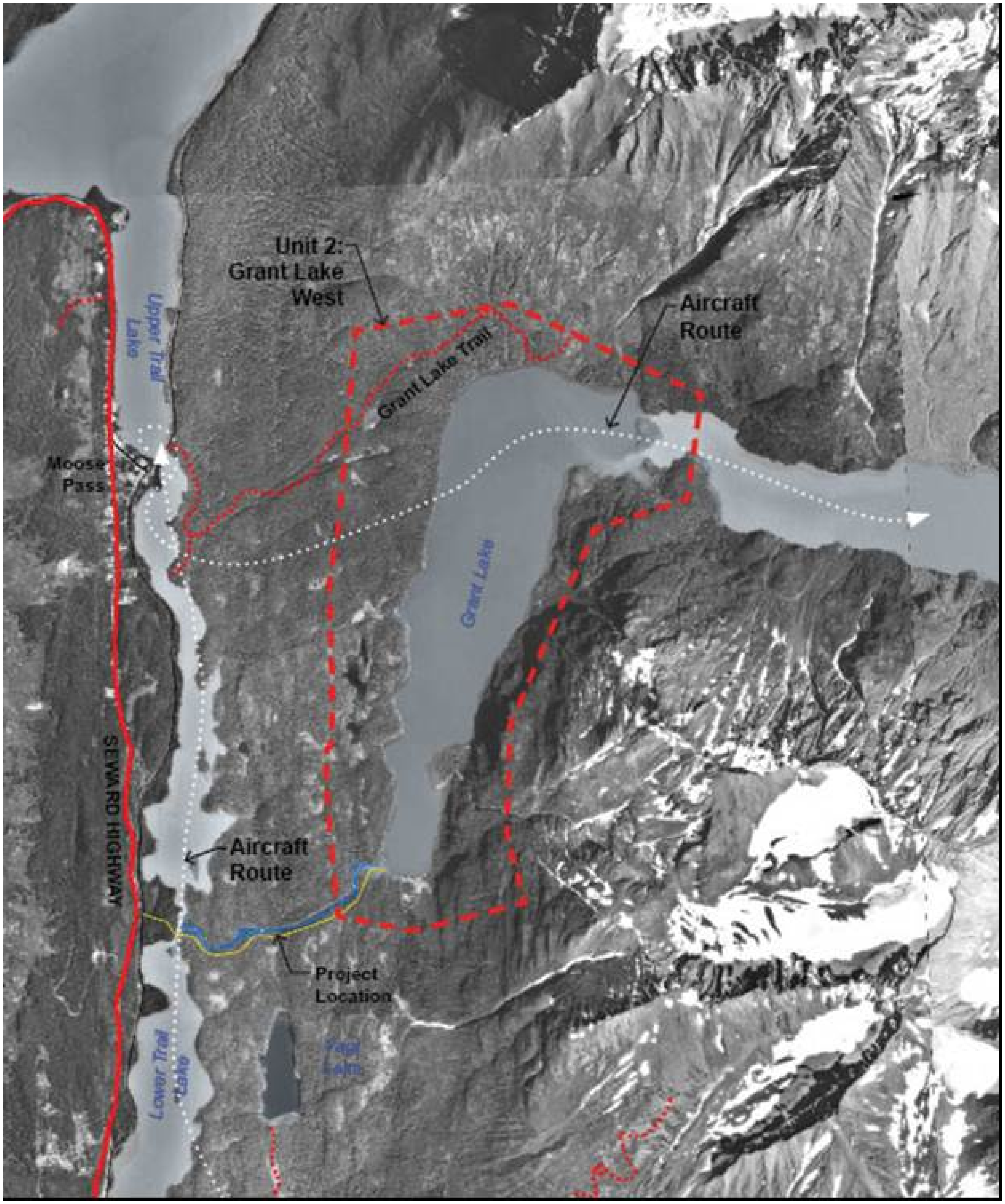

Figure E.4-103. Unit 2: Grant Lake West.

4.9.1.3.3 Unit 3: Grant Lake East

Naturally obscured by the sharp easterly turn of Grant Lake, this eastern portion of Grant Lake is a u-shaped valley that feeds to the previously discussed unit, separated by a thin neck of water. The valley is entirely undisturbed as in evidence in Figure E.4-104. The distance from this unit to the Project is approximately 3-6 miles with no direct line of sight to Project components.

Viewer exposure is restricted to aircraft and the occasional recreationist and/or hunter who may access the area by trail and possibly travel by packraft (Figure E.4-105). Aircraft views are typically from relatively high elevations and duration of the view changes dramatically dependent upon altitude and weather. These groups may include hunters as well.

Figure E.4-104. Looking west across Grant Lake, view from aircraft.

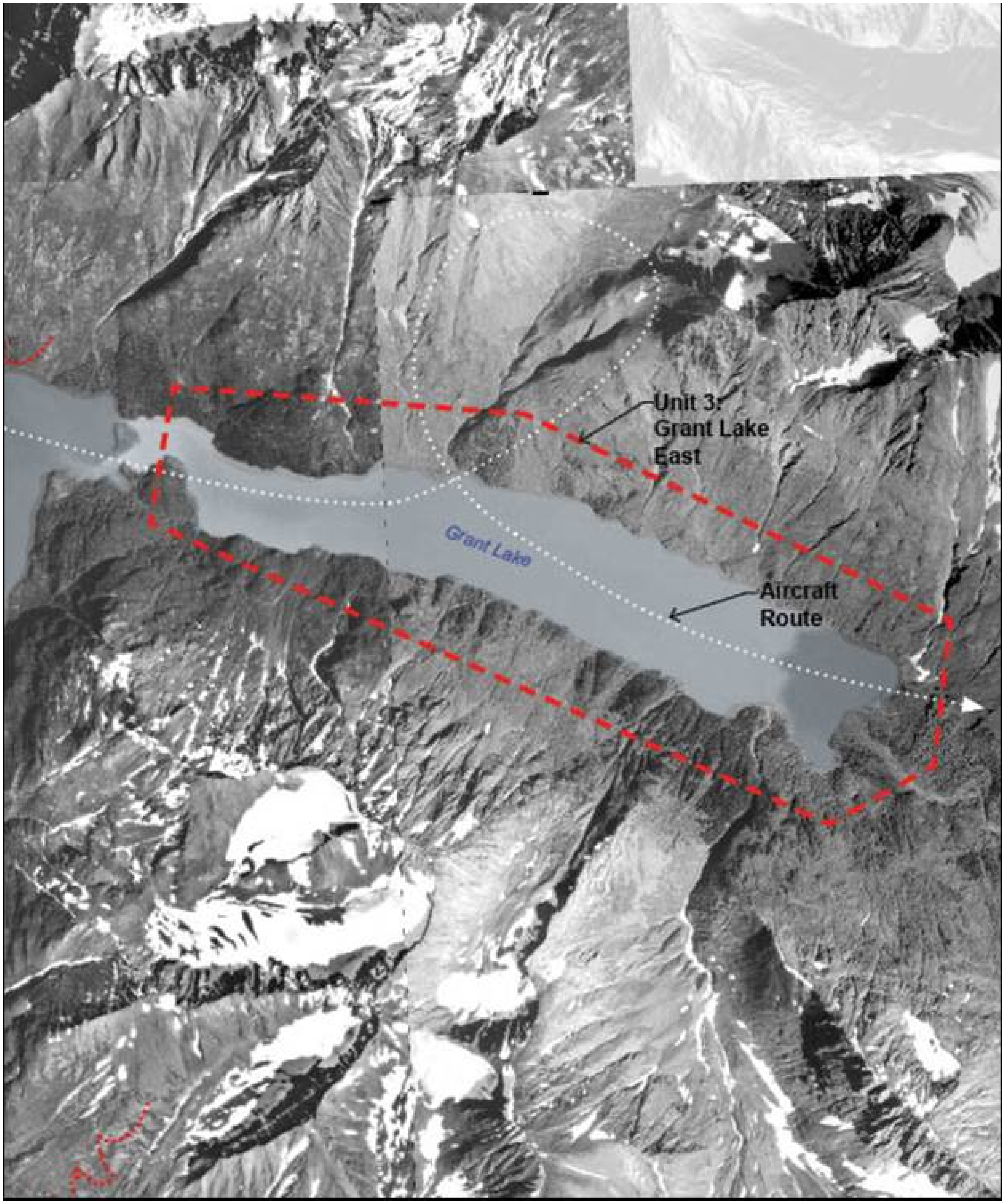

Figure E.4-105. Unit 3: Grant Lake East.

The scenic attractiveness of the viewshed is distinctive, or Class A as shown in Table E.4-104. Peaks provide a serrated skyline with a complex mix of snow, valleys, and well-patterned vegetation. The area is a pristine wilderness with unique landforms and water features. Vegetation is sparse, with forest surrounding the lake and covering the valley floor, with alpine tundra at upper elevations.

4.9.1.4. Summary of Existing Conditions

The Grant Lake Project area is a highly distinctive, well-seen, and valued area of the Kenai Peninsula. Of particular note is that much of the landscape is undisturbed and much is little used and is unseen by most people. Following is a summary of key observations.

Landscape Character. The landscape of the Project area is characterized by complex mountains with serrated ridgelines and a highly ordered landscape. Water features are striking with turquoise waters and clear streams that provide marked contrast with the colors and patterns of the forest. Vegetation is typical of the area, primarily of a mixed deciduous/coniferous forest that leads to high altitude alpine vegetation that is highly patterned and colorful, contrasting with geological features and scree slopes. The community of Moose Pass is also distinctive, and is small scale, in keeping with the landscape. The area is highly memorable.

Scenic Attractiveness. The landscape remains a Class A, or distinctive landscape (as previously defined in Table E.4-104) throughout the Project area. The foreground, middleground, and background each are unique and attractive to viewers.

Scenic Integrity. The majority of the Project area is intact and undisturbed, allowing for a high level of scenic integrity. Currently, the only evidence of human presence is associated with the road and rail corridor, including the community of Moose Pass. While these elements provide evidence of human presence, the roadway, the railway, and the community of Moose Pass are within scale and context of the setting.

Viewer Groups. Residents, recreationists/tourists, and aircraft are the primary viewers of the Project area. Most views are constrained to the Seward Highway, the Alaska Railroad, and residents of Moose Pass, and those who travel by snowmachine, skis, snowshoes, or on foot.

Landscape Visibility. The Project area is viewed by the viewer groups from all distance zones; however, the natural topography of the area limits distance zones to the foreground for most viewers.

Concern Levels. Concern levels are high, as the area is used and viewed by a wide range of viewers, all of whom value the area for its high visual quality and intactness.

Scenic Class. The scenic class and the scenic attractiveness of the area remain at the highest level of 1, due to the unique landforms, vegetative patterns, and outstanding topography, and thee concern level of the viewers.

4.9.2. Environmental Analysis

4.9.2.1. Landscape Unit Analysis

4.9.2.1.1 Unit 1—Trail Lakes Valley

Project components within this unit include the access roadway, the powerhouse, possibly transmission lines, ancillary support structures including parking, fencing, rock-lined channel, and the auxiliary detention pond.

The roadway entrance and a short portion of its length would be visible from the Seward Highway and the Alaska Railroad. Other Project components would be visible to those who fish Grant Creek and to the limited number of hikers who may on occasion follow the creek. The natural topography of the unit does offer enough variation to allow some features to blend more, or to be masked by the undulating landforms and density of the vegetation. This provides screening of proposed Project components, which will be hidden or concealed within the landscape for almost all viewers.

4.9.2.1.2 Unit 2—Grant Lake West

Project components that would be located within the area would include the Project's intake structure and the access roadway, located at the southerly most portion of the lake, near the Grant Lake outfall. These components would generally be unseen by those along the lake shore. The intake structure would be seen by boaters who currently gain access via packraft or plane. It would be seen in the middleground for those who hike around the lake and can view the opening of the lake to Grant Creek. Aircraft would be able to see the structures as well though the exposure time would be limited.

4.9.2.1.3 Unit 3—Grant Lake East

Unit 3 does not contain any Project components. However, proposed lake level changes may create a visual variation that may be noticeable by those gaining access to the area. Seasonal flows currently provide for some variations in lake levels thus an exposed shoreline does occur during the year. The lower level attributed to KHL would persist for more periods of time though the character would be similar to that of historic patterns, perhaps slightly pronounced.

4.9.2.2. Key View Analysis

The unit by unit analysis provides an understanding of the landscape character of units of landscape with generally common features. However, it is appropriate to consider "key views" that existing viewers commonly have of areas that may be affected by the project. For the purposes of showing potential Project impacts, key views were selected and developed to create visual simulations of the conditions that might result from project development. The following key views were selected as having the most valuable potential in showing Project components and visual impacts. The location of these key views is indicated in Figure E.4-106.

- Key View 1: view of the Trail Lakes narrows access road crossing area from the Seward Highway
- Key View 2: view of the intake structure and lake shoreline
- Key View 3: view of proposed facilities from the Seward Highway or Alaska Railroad (winter)
- Key View 4: view of the access road or powerhouse from the ROW for the proposed INHT.

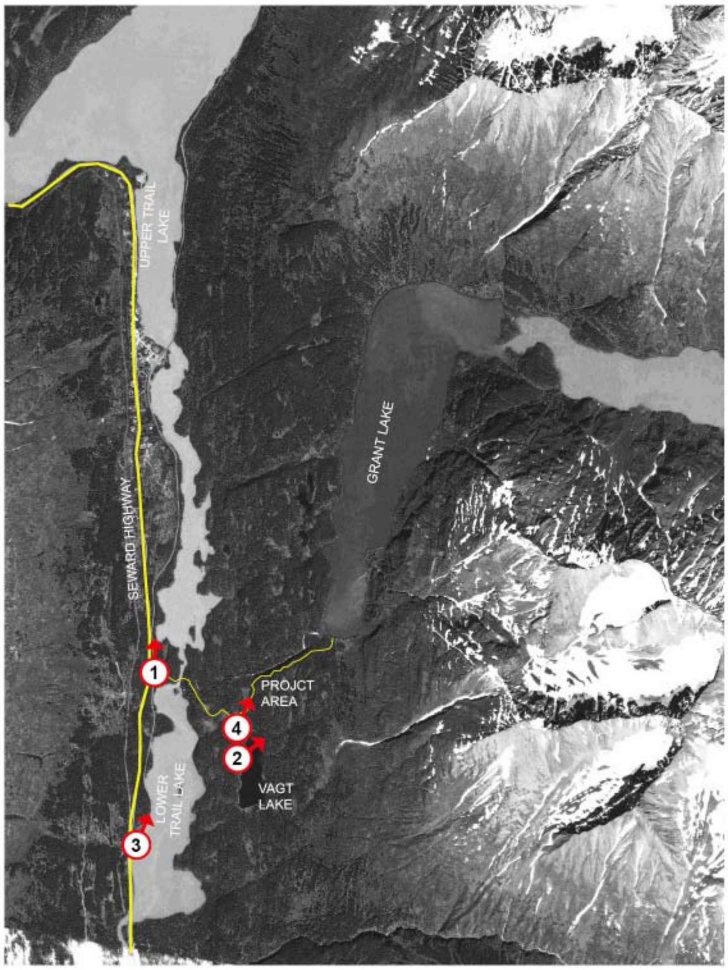

Figure E.4-106. Location of key views.

4.9.2.2.1 Key View 1: Access Road from Seward Highway

Key view #1 is the view of the Project access road from the Seward Highway. The new access road leaves the Seward Highway at approximately MP 26.9, crosses the Alaska Railroad tracks, then continues east to the proposed bridge.

The highway corridor between Lower Trail Lake and Upper Trail Lake tends to be viewed as a “closed forest” as the existing vegetation blocks the majority of viewing points along the road. Moreover, the narrowness of the road leads the viewer’s eye forward until the vegetation recedes at both Lower Trail Lake and Moose Pass itself.

This access road may become more visible with the winter months and loss of foliation; however, the scale of the roadway would be similar to that of a driveway which is a common feature along the highway. There is an existing driveway to private land approximately 100 yards south of the proposed new roadway. It is expected the existing roadway would be closed and the old entrance maintained as a turnoff. One issue that could increase the visual presence of the road would be an agency decision that would open the KHL Project access to wide public use. If public access is desirable by agencies and agreed-to by KHL, the roadway could have an increased presence and be marked by road signs and possibly the width of the roadway increased to offer vehicle turn lanes. Figures E.4-107 and E.4-108 display the current view and the likely view with the Project component (access road) in place, respectively, with the assumption that the roadway will be non-public.

Figure E.4-107. Key View 1: Before.

Figure E.4-108. Key View 1: After.

4.9.2.2.2 Key View 2: View of Intake Structure and Lake Shoreline

This key view simulation shows the small intake structure located at the southern shores of Grant Lake, the diversion dam to the west, the remaining stream and stream bed once diverted, and the small access road to the intake structure. Also with in this view is the powerhouse itself, the detention pond, and the outlet diversion. Each Project component is linked by a small gravel road, with the upper access road not maintained in the winter. The current Project design has the level of the lake rising up to two feet above natural conditions, but as the edges of the lake are quite steep, the effect will be less noticeable as the change does not widen but simply raises the level of the lake in this area. Over time there may be a recognizable ring of vegetation as flooded vegetation at the shoreline edge dies out and becomes evident. However, there are currently natural seasonal fluctuations of the lake level that provide an exposed shoreline at low water levels thus the new condition will be an small expansion of an existing condition that occurs on the lake. While this will be discernible on the ground and may be noticeable, it will be less so, if evident at all from the air. Figures E.4-109 and E.4-110 display the current view and the likely view with the Project components (lake infrastructure) in place, respectively.

Figure E.4-109. Key View 2: Before.

Figure E.4-110. Key View 2: After.

4.9.2.2.3 Key View 3: View of Facilities from Seward Highway

As the highway corridor is quite narrow, and the vegetation impedes most views, the only open areas whereby a viewer from the Seward Highway would have a vantage point of the Project would be near Lower Trail Lake. The bridge crossing, powerhouse, and primary access road will not be visible to most viewers from the Seward Highway. The upper access road connecting the powerhouse to the intake structure may be more visible, as it climbs in elevation, however most vegetation is evergreen thus it is not expected that the roadway will be visible to most Seward Highway viewers in the summer or winter. Figures E.4-111 and E.4-112 display the current view and the likely view with the access road being slightly visible climbing the hillside in the right-center of the photo, in the distance. The change would be negligible, particularly considering that viewers at this location are traveling at a speed of approximately 50 miles per hour. Drivers are focused on views down the road while passengers are focused on more visible landscape of the lake and Crown Point Peak, more to the east, 45-90 degrees to the location that the access road would be.

Figure E.4-111. Key View 3: Before.

Figure E.4-112. Key View 3: After.

4.9.2.2.4 Key View 4: Access Road or Powerhouse from the Right-of-Way for the Proposed INHT

The INHT trail will intersect with the powerhouse access road, intersecting south of Grant Creek and east of Lower Trail Lake. This intersection would be a marked intersection that would provide views to an opening in the forest allowing more visibility and exposure to the Project. This intersection could serve as a trailhead in the future dependent on the desire of managing agencies. Figure E.4-113 displays the current view and the likely view with the Project component (access road) in place respectively. In the simulation, the access road is illustrated at a crossing of the INHT and assumes a gravel surface for both the trail and the road at this crossing location. A sign would provide direction for hikers and other users.

Figure E.4-113. Key View 4: Before and after.

4.9.2.3. Project Effects

4.9.2.3.1 Project Components

Intake Structure. The intake structure would include a gravity diversion structure and intake tower that would be approximately 15 feet above the lake surface. The structure would be hidden for most viewers excepting the small number of those traveling along the shoreline by boat, or by those traveling above the lake by aircraft. The structures would be minor elements in the landscape. The concrete tower would contrast with the lake surface providing a striking light color against the turquoise waters of the lake. However, the size of the structure relative to the lake, as seen from the air provides a minor change to the landscape.

Shoreline Alteration. The change in lake level could provide evidence of vegetation die back as the vegetation adapts to changing lake levels. This vegetation as it dies, or the remaining shoreline as the lake level changes, would provide an expanded shoreline around the lake. While this could occur, there are currently natural seasonal fluctuations at the shoreline edge and during drought conditions the shoreline currently is visible as an exposed edge, thus the possible shoreline expansion would be an increase to the visibility of the shoreline rock edge, not a new condition. This will be visible to those traveling by foot but less conspicuous to those traveling over the area by plane. This would be a minor change to the shoreline landscape.

Access Roadway. The access roadway would be visible from the Seward Highway, from the Alaska Railroad tracks, and for those traveling by boat, raft, snowmachine, snowshoe, or skis on Trail Lake. It would also be visible from the air. It would generally be unseen by residents of Moose Pass. From the Seward Highway it would read as a side road or driveway intersecting the highway, a common element along the roadway. The road would also be seen by those who would use the INHT at the time that construction takes place. At this point in time, the INHT is a dedicated easement but not constructed. For those affected, the bridge crossing of the Trail Lake narrows would be similar in scale and scope to that of the Alaska Railroad crossing that currently exists. The roadway would continue into the forest and only several hundred feet would be visible for users along Trail Lake. Thus the roadway would be a moderate change to the landscape though generally unseen by most viewers.

Auxiliary Detention Basin. The detention basin would generally be unseen except from the air. It would be seen from the INHT as mapped, though not constructed at this time. The basin would generally be confined within an existing depression in the landscape. Thus, the form of the feature would approximate that of the existing landscape. However, the fluctuating water levels will change the nature of the vegetation as the vegetation adapts to growing conditions. There would also be minor site structures that would be associated with the detention basin, pipes, and infrastructure. These structures and the changes to the landscape would be moderate changes to the landscape but would be largely unseen, depending on whether the INHT easement is relocated or not.

Powerhouse/Ancillary Features. The powerhouse would be a visible, man-made structure in a natural setting as would other components such as parking and associated channels and site structures. They would not replicate the area's landscape in form though the Project components could be colored or painted to be complementary to the landscape. The components would be unseen by most viewers excepting those hiking, skiing, snowshoeing, or fishing along Grant Creek. It would also be evident to those hiking along the INHT, should it be constructed as currently planned.

Powerlines. The construction of powerlines above ground could possibly present an impact to visual resources, dependent on their location. While other Project facilities would be screened by existing vegetation or replicate existing visual features in the Project area, the powerlines would contrast with the setting and visual resources.

Construction. Construction activities would have little impact to visual resources excepting during the temporary construction activities associated with the roadway and bridging of Trail Lake. The presence of construction equipment could be a minor to moderate impact to visual resources during the construction period depending on how construction equipment was staged. However, the location of almost all Project components is unseen from key viewpoints and most viewers. The construction would generate noise that would be heard by recreationists as pilings were driven, should pile or sheet driving be required. Further, lights may be needed for construction that would be evident in mornings and evenings during winter construction, should winter construction take place.

Operations and Maintenance. Routine operations and maintenance will typically take place monthly during normal operations. There will be dust generated on the gravel road and noise generated by vehicles traveling on the roadway, but this activity is expected to be limited in period and of little detriment to visual quality. During the winter months there would be lights from the vehicles monthly but again, this would be of little consequence to visual quality. The powerhouse itself would have security lighting that would be on through darkness on winter nights. This lighting is expected to be very localized, only at the powerhouse. The lighting is assumed to have cutoffs to ensure that there is little fugitive light. Given the density of the forest at the powerhouse site, there should be little indication of lighting, if any, that would compromise the dark skies visible from key viewpoints or from any locations near Moose Pass.

4.9.3. Proposed Environmental Measures

Project components will be developed to provide some separation of Project facilities from Grant Creek and will be designed to provide colors and textures that are complementary to the landscape. Construction will be staged such that equipment is kept on site, outside of views. In addition, KHL proposes to do most work during the summer months, thus the possibility of light intrusion should be minimal to non-existent.

With respect to the INHT, the proposed alternative route (see Section 4.8 of this Exhibit E) could be situated as to provide a net benefit to the trail user experience. The currently proposed trail route is located such that views are limited and the trail provides a generally homogenous vegetation and terrain experience from the northward shore of Vagt Lake. An alternative alignment could reduce the presence of Project components relative to the trail location as planned and could provide enhanced views to Trail Lake and background peaks. KHL plans on continuing its collaboration with stakeholders with respect to this issue. A series of meetings and site visits were held in 2013 and 2014 (see Table E.3-2 for major stakeholder engagements and the consultation record for a complete history [Attachment E-1]). KHL has developed a proposed re-route that has been reviewed by the stakeholders. Per USFS preference, any stakeholder decision related to approval of a re-route will be made once the public review process associated with License Application submittal occurs and a FERC license is issued. At that time, KHL and the stakeholders will reconvene and finalize a collaborative agreement with respect to the appropriate re-route. All phases of the re-route process will be documented consistent with the respective Annual Compliance Report. Documentation will include but not be limited to stakeholder consultation record, agreements reached and associated signed documents, maps and figures documenting the approved re-route and a schedule for implementation of the agreed upon process.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.9.4. Cumulative Effects Analysis

Consistent with FERC's SD2 (FERC 2010b), no negative cumulative effects were identified associated with aesthetic resources. Given that the local area is heavily forested, visual anomalies associated with Project construction and operation would be minimal to non-existent from the local community of Moose Pass (see Figure E.4-112). Any Project impacts would be localized and unseen by most viewers. Those local visual impacts will be further mitigated by standard BMPs associated with appropriate staging of equipment and supplies.

A potentially positive impact exists from an aesthetics perspective related to the proposed INHT. If an agreement can be reached with respect to a re-route of the unconstructed trail through the Project area, the proposed alternative route (see Section 4.8 of this Exhibit E) could be situated as to provide a net benefit to the trail user experience. The currently proposed trail route is located such that views are limited and the trail provides a generally homogenous vegetation and terrain experience from the northward shore of Vagt Lake. An alternative alignment could reduce the presence of Project components relative to the trail location as planned and could provide enhanced views to Trail Lake and background peaks. KHL plans on continuing its collaboration with stakeholders with respect to this issue.

4.9.5. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, KHL has identified no aesthetically-related unavoidable adverse impacts associated with construction and operation of the Project.

4.10. Cultural Resources

4.10.1. Affected Environment

In accordance with 36 CFR 800, cultural resources inventory and evaluation has taken place within an Area of Potential Effects (APE) established for the Project. The APE for archaeological and historical resources includes lands that could be affected (directly or indirectly) by operation of the Project, or by ground-disturbing activities required by or permitted under the FERC license. The APE consists of lands within the FERC-licensed Project boundary, as well as areas where potential Project-related activities might affect cultural resources.

The APE is composed of an area 100 feet beyond the perimeter of all Project features, such as the location that would be impacted by powerhouse construction, areas along Grant Creek that may experience increased use, and corridors for road access and transmission line alignments. The proposed APE also includes an area around Grant Lake extending from the current waterline to 30 feet above the proposed maximum lake elevation, or up to 733 feet NAVD 88. Possible archaeological resources that could currently be under water, but may be exposed in the future due to drawdown or decreased lake level will be addressed in a HPMP. The APE was expanded in 2014 to include a proposed re-alignment corridor for the planned INHT.

The APE considered for traditional cultural properties (TCP) was larger than the APE for archaeological and historical sites. As such, it included the general Project area surrounding Grant Lake and Grant Creek, Upper and Lower Trail lakes, and the Seward Highway corridor around Moose Pass.

4.10.1.1. Historical and Archaeological Resources in the Proposed Project Area

At least ten cultural resources studies have been completed within one mile of the Project area. Most of the recent studies were conducted in association with the Iditarod Trail Project's planned construction of a commemorative trail. The area between the Trail Lakes and Grant Lake, and a portion of the northern shore of Grant Lake were surveyed in the early 2000s as part of this effort. Areas along the northern shore of Grant Lake were surveyed for a habitat improvement project and prescribed burns in 1996 and 2004 (Alden 1996a; 1996b; 1996c; Vinson 1997; Schick 2005). Katherine Arndt (1982) surveyed portions of the Project Area in the early 1980s for an early design of the Grant Lake Hydroelectric Project. Her efforts, however, focused on the then proposed Project footprint between the mouth of Grant Lake and the two Trail Lakes. Prior to the work described herein, the entire lakeshore had not yet been previously surveyed.

Nine AHRS sites are located within the Project area (Table E.4-106). Of these, only two—SEW-00768 and SEW-00823—had not previously been evaluated for eligibility to the NRHP.

The INHT is a gold rush era network of trails that connected Seward with Nome. The primary route of the trail on the Kenai Peninsula, which includes the Seward Moose Pass Trail (SEW-00148), follows the Alaska Railroad alignment (Schick 2009). A comprehensive management plan for the INHT system was completed and signed by the Secretary of the Interior in 1986 (BLM 1986).

Table E.4-106. AHRS sites located within the Project area.

AHRS No.	Site Name	Description	Eligibility
SEW-00029	Alaska Railroad	One of three railroads built by the U.S. Government	Nomination Closed
SEW-00148	Seward-Moose Pass Trail	Part of the Iditarod National Historic Trail	National Historic Trail
SEW-00285	Solars Sawmill	Collection of wooden structures, operated between 1920-1941	Determined Not Eligible
SEW-00659	Case Mine (Grant Lake Placer Mine)	Cabin, bunkhouse, and 4 associated structures, 1900-1940s	Determined Eligible
SEW-00768	Grant Lake Cabin	Frame cabin, dating to historic prospecting, mining, hunting, or trapping	No Determination of Eligibility
SEW-00823	North Grant Lake Cabin (Case Mine Dynamite Shack)	Log cabin/dynamite storage for area mines	No Determination of Eligibility
SEW-01144	Dock Site at Grant Lake	Scatter of cut timbers, logs, cans, and other debris	Determined Not Eligible
SEW-01454	Grant Lake Road to Case Mine	Access trail to the Case Mine	Determined Eligible
SEW-01455	Grant Lake Trail	Trail that connects Upper Trail Dock Site with the Grant Lake Dock Site	Determined Eligible

4.10.1.2. Cultural Resource Study Methods

The inventory and assessment of archaeological and historical resources, as described below, were guided by the Cultural Resources, Final Study Plan (KHL 2013e). This plan was developed as a result of consultation with the SHPO and other consulting parties. Consultation began in 2009 and has included three Cultural Resources Work Group (CRWG) meetings.

All aspects of the cultural resources study have been conducted according to Section 106 of the NHPA (36 CFR Part 800), the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716), the Secretary of the Interior's Professional Qualifications Standards (48 FR 22716), and the ACHP's general guidelines for identification and testing procedures as set forth in Treatment of Archaeological Properties, A Handbook.

Probability areas for historic and archaeological resources were established before field survey. KHL developed a model utilizing criteria identified by the USFS to delimit sensitivity areas. These criteria—outlined in Appendix E of the Second Amended Programmatic Agreement Among the USDA Forest Service, Alaska Region, the Advisory Council on Historic Preservation, and the Alaska State Historic Preservation Officer Regarding Heritage Resource Management on National Forest in the State of Alaska – include proximity to trails, mines, and water bodies; degree of slope; and vegetation type. The USFS's sensitivity model includes other parameters as well, but these did not apply to the Project APE. The goal of the probability model for the Project was streamline the field survey by identifying areas that have a higher potential to contain archaeological and historical materials. Much of the APE was deemed by the model to have high potential due to proximity to water bodies, trails, and mines.

The cultural resources study fieldwork was completed in three sessions over a total of twenty days. The first session, between June 3 and 6, 2013, covered the APE from the Seward Highway to the mouth of Grant Lake and both banks of Grant Creek. The second part of the survey, including the Grant Lake portion of the APE, occurred between June 10 and 22, 2013. Portions of the lakeshore APE were not surveyed due to unsafe conditions or relatively recent landslides that would have erased any historic or archaeological materials. The third session occurred between September 17 and 19, 2014. This portion of the survey covered a proposed re-alignment corridor for the INHT and a section of the intake access road that was not surveyed in 2013.

The identification of TCPs has relied on consultation with any of the aforementioned tribal organizations that have expressed interest in the protection and preservation of locations with traditional cultural significance. A TCP is a property that is eligible for the NRHP "because of its association with cultural practices or beliefs of a living community" (Parker and King 1990). TCPs are historic properties (as defined by the NHPA) and as such are subject to the same Section 106 process as other archeological and historical sites. A TCP is a tangible property that meets one or more of the four basic criteria set forth in the NRHP regulations (36 CFR Part 60). To date, no potential TCPs have been identified in the general Project area. However, KHL will continue to consult with tribal groups with close traditional ties to Project area and will evaluate any TCPs identified in the future.

4.10.1.3. Cultural Resources Study Results

The field investigators recorded everything found during the survey, including modern debris, recent campsites, and numerous canoes cached around Grant Lake. Much of this material is described in the Cultural Resources Study, Final Report (KHL 2015a), as it is all part of the pattern of human use of the Project area. Fourteen newly identified locations were assigned AHRS numbers and evaluated for NRHP eligibility.

Six properties in the APE are eligible for the NRHP. These include one historic district and five individually eligible properties (Table E.4-107). The Case Mine District (SEW-00659), the Seward-Moose Pass Trail (SEW-00148), Grant Lake Trail (SEW-01455), Grant Lake Road to Case Mine (SEW-01454) had already been determined eligible for the NRHP prior to the 2013 survey. Also, although the original nomination for the Alaska Railroad (SEW-00029) has never been finalized, the railroad is considered eligible for the NRHP for the purposes of this analysis. Solars Sawmill (SEW-00285) was determined not eligible for the NRHP in 1985, probably because all the buildings had collapsed and the site no longer had any architectural integrity. However, Solars Sawmill retains considerable information potential and is eligible for the NRHP under Criterion D.

Table E.4-107. Summary of cultural resources and their eligibility status.

Property Name	AHRS Number	Status/Eligibility to NRHP
Alaska Railroad	SEW-00029	Eligible for the NRHP under Criterion A
Seward-Moose Pass Trail	SEW-00148	Eligible for the NRHP
Commemorative Iditarod Trail	N/A	Not eligible for the NRHP
Trail	SEW-01515	Not eligible for the NRHP
Trail	SEW-01516	Not eligible for the NRHP
Four Depressions	SEW-01517	Not eligible for the NRHP
Wire Cables	SEW-01518	Not eligible for the NRHP
Prospect Pit	SEW-01519	Not eligible for the NRHP
Cable Crossing on Grant Creek	SEW-01520	Not eligible for the NRHP
Sawmill-Upper Trail Lake Trail	SEW-01521	Significant, unknown integrity
Solars Sawmill	SEW-00285	Eligible to the NRHP under Criterion D
Grant Lake Trail	SEW-01455	Determined eligible for the NRHP under Criterion A
Dock Site at Grant Lake	SEW-01144	Determined not eligible
Case Mine	SEW-00659	Determined eligible for the NRHP under Criteria A and D
Grant Lake Road to Case Mine	SEW-01454	Determined eligible for the NRHP under Criterion A
Case Mine Prospect Pits	SEW-01522	Contributing property to Case Mine District
North Grant Lake Cabin	SEW-00823	Contributing property to Case Mine District
SEW-01523	SEW-01523	Not eligible for the NRHP
SEW-01524	SEW-01524	Not eligible for the NRHP
SEW-01525	SEW-01525	Not eligible for the NRHP
SEW-01526	SEW-01526	Not eligible for the NRHP
Grant Lake Prospect	SEW-00822	Not eligible for the NRHP
Grant Lake Cabin	SEW-00768	Not eligible for the NRHP
Scatter of Historic Artifacts	SEW-01527	Not eligible for the NRHP
Pulley and Cable	SEW-01528	Not eligible for the NRHP

The Case Mine, as defined in 2002, included four spatially discrete areas and a trail that connected them. CRC's analysis suggests that the Case Mine District should be expanded to include the already eligible Grant Lake Road to Case Mine and the newly evaluated North Grant Lake Cabin (SEW-00823). Additional recommended revisions include expanding the boundaries of the mine camp and the tractor shed area (Table E.4-108).

Table E.4-108. Case Mine District contributing and non-contributing elements.

Element Name	AHRS Number	Non-/Contributing /Individually Eligible
Millsite	N/A	Contributing Element
Mine Workings	N/A	Contributing Element
Camp Area	N/A	Contributing Element
Sawmill area	N/A	Contributing Element
Workshop	N/A	Contributing Element
Bunkhouse	N/A	Contributing Element
Burro Shed	N/A	Contributing Element
Meathouse	N/A	Contributing Element
Tarp Outhouse	N/A	Contributing Element
Case Mine Cabin	N/A	Contributing Element
Outhouse	N/A	Contributing Element
Workshop Dump	N/A	Contributing Element
Cabin Dump	N/A	Non-contributing Element
General Material Scatter	N/A	Non-contributing Element
Can Dump	N/A	Contributing Element
East Dump	N/A	Contributing Element
Lakeside Trail (Tractor Shed) Area	N/A	Contributing Element
Lakeside Trail	N/A	Contributing Element
Fire Ring	N/A	Non-contributing Element
Metal Cable	N/A	Contributing Element
Canoe and Modified Bicycle	N/A	Non-contributing Element
Sullivan Air Compressor	N/A	Contributing Element
Portable Toilet	N/A	Non-contributing Element
Tractor Shed and Cletrac Tractor	N/A	Contributing Element
Modern Mining Materials and Mining Claim Post	N/A	Non-contributing Element
Grant Lake Road to Case Mine	SEW-01454	Contributing Element/ Individually Eligible
Case Mine Prospect Pits	SEW-01522	Contributing Element
North Grant Lake Cabin	SEW-00823	Contributing Element

4.10.2. Environmental Analysis

4.10.2.1. Estimated Project Effect

Potential Project effects on historic properties within the APE could result from construction of Project infrastructure and increased visitor use of the area (Table E.4-109). The proposed access road crosses both the Alaska Railroad (SEW-00029) and Seward-Moose Pass Trail (SEW-00148). The proposed Alaska Railroad crossing could add another at-grade crossing along a relatively short section of the track, although another option would be to utilize an already existing crossing to the south. However, neither possibility would significantly alter the characteristics that make the railroad eligible to the NRHP. Therefore, the Project will not adversely affect the Alaska Railroad. As the Seward-Moose Pass Trail reportedly underlies the Alaska Railroad and/or the Seward Highway in this vicinity, it also will not adversely affected by the access road. Neither the Alaska Railroad nor the Seward-Moose Pass Trail will be affected if the area sees increased use in this area. Both historic properties already see high volume traffic, which has not diminished their eligibility to the NRHP.

A bridge over the Trail Lake narrows and the access road, whether officially open to the public or not, will likely be utilized by hikers, campers, and hunters. Increased use of the area could result in the creation of more user-developed trails, removal of artifacts for souvenirs, vandalism, and utilization of historic structures for shelters or as sources of firewood.

The Project access road would intersect the current easement of the commemorative INHT to the west of the detention pond. In total, the Project would impinge on approximately 1,000 feet of the proposed commemorative trail. Neither Section 106 of the NHPA nor the Alaska Historic Preservation Act (AS 45.31) would preclude realigning the trail easement. Any new route for the commemorative trail would likely have the same effects on historic properties in the Project area as the current easement. The USFS has already determined that the trail will affect the Grant Lake Road to Case Mine (SEW-01454) and the Grant Lake Trail (SEW-01455), but determined in 2009 that the effect to the road and the trail will not be adverse (Schick 2009).

National Historic and Scenic Trails are designated by act of Congress, although these designations, unto themselves, have no direct relationship to or implication on NRHP eligibility. A designated National Historic Trail may be eligible for listing in the NRHP, although this is not always the case. Application of the NRHP criteria of significance is extremely problematic when there is no physical “trail” to preserve, manage, or evaluate. Only if a designated National Historic Trail includes some physical manifestation of its existence, can it be evaluated for eligibility using standard evaluation tools, methodology, and standards. One potential re-alignment corridor for the commemorative trail through the APE was surveyed by CRC in 2014 and no new historic properties were identified.

Drawdown of the lake could affect Solars Sawmill (SEW-00285) by increasing the rate of erosion along the water’s edge at the site. Lower lake levels will expose two rock jetties and possibly other historic features that are currently underwater. Also, the sawmill, which is eligible for the NRHP for its data potential, contains artifacts and building remains that could be adversely affected by increased visitation and/or use as a modern campsite.

The Grant Lake Trail (SEW-01455) and Grant Lake Road to Case Mine (SEW-01454) are not near any of the Project’s infrastructure and should not be adversely affected by the proposed development.

The Case Mine District (SEW-00659) is not near any Project infrastructure. However, three areas of the district—the Case Mine camp area, the Lakeside Trail area, and the North Grant Lake Cabin (SEW-00823)—are easily accessed by trail or boat. Modern materials present within the Case Mine area indicate that the area is already heavily utilized by visitors. Increased use could adversely affect the historic materials in district, as it contains numerous historic objects that could easily be removed by recreationists and deteriorating structures that could easily be scavenged for firewood.

Table E.4-109. Summary of the estimated effect of the project for historic properties.

Property Name	AHRS Number	Evaluation of Effect
Alaska Railroad	SEW-00029	No Adverse Effect
Seward-Moose Pass Trail	SEW-00148	No Effect
Sawmill-Upper Trail Lake Trail	SEW-01521	No Adverse Effect
Solars Sawmill	SEW-00285	Adverse Effect
Grant Lake Trail	SEW-01455	No Adverse Effect
Case Mine	SEW-00659	Adverse Effect
Case Mine Camp	N/A	Adverse Effect
Lakeside Trail	N/A	No Effect
Lakeside Trail Area	N/A	Adverse Effect
Millsite	N/A	No Effect
Mine Workings	N/A	No Effect
Grant Lake Road to Case Mine	SEW-01454	No Adverse Effect
Case Mine Prospect Pits	SEW-01522	No Effect
North Grant Lake Cabin	SEW-00823	Adverse Effect

4.10.2.2. Proposed Environmental Measures

A Draft HPMP is under development by KHL based on the recommendations of SHPO and USFS for the avoidance or mitigation of any impacts on historic or archaeological sites and resources. The plan will be distributed for comment with the BE and the rest of the management/monitoring plans between late April and mid-May. The HPMP will describe the known historic resources in the Project area that may be affected by the construction, operation, and maintenance of this Project. The Draft HPMP will outline steps to minimize impacts to known cultural resources and describe management measures of cultural resources that will be affected by this Project. The Draft HPMP will also outline steps to take if new resources are discovered within the Area of Potential Effects (APE). The Draft HPMP is being developed in accordance with the Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects prepared by FERC in May 2002 (FERC 2002) as jointly issued by FERC and the ACHP. The HPMP will become a part of the license and is intended as an integrated component of KHL’s overall management of the Project.

This Draft HPMP will be reviewed and revised in consultation with the following entities:

- USFS
- SHPO
- Kenai Peninsula Borough
- Cook Inlet Region, Inc. (CIRI)
- Kenaitze Indian Tribe

- Salamatof Native Association
- Ninilchik Traditional Council
- Kenai Natives Association
- Native Village of Eklutna
- Quekcak Native Tribe
- A CRWG established during this licensing process that has included—at different times—various representatives of the organizations listed above

The formal inventory and evaluation of cultural resources within the APE was done to determine the nature and significance of historic properties that might be affected by Project construction, operation, and maintenance. Types of Project-related impacts considered included shoreline erosion, public use of Project-area recreational facilities, recreation use of undeveloped areas, and operation and maintenance activities. Cultural resource considerations will be taken into account in conjunction with planning of any potential ground-disturbing activities, and factored into the schedule and budget for all such activities. The highest priority will be on avoidance of impacts.

KHL has initiated a collaborative process with all requisite stakeholders in relation to a re-route of the INHT. This effort will continue concurrent with other licensing efforts. Details related to decisions will be made available as they develop. For further information on the INHT, process steps to date, and plans for resolutions, see Section 4.8.3.3 of this Exhibit E.

A full summary of all measures, as well as the associated implementation timeframes, being proposed by KHL for the original license will be provided with the FLA.

4.10.3. Cumulative Effects Analysis

Consistent with FERC's SD2 (FERC 2010b), no cumulative effects were identified associated with Cultural Resources. Per Section 4.9.3, a Draft HPMP is being developed for the avoidance or mitigation of any impacts on historic or archaeological sites and resources.

The operational regime outlined in Exhibit B of this DLA will ensure that no historically or archaeologically relevant sites are inundated as a result of Project operations. KHL has the intention of utilizing public and stakeholder input to determine whether the primary access road associated with the Project can be utilized by the general public. If the local public and stakeholder preference is to allow access, KHL will collaborate with the CRWG to determine logical locations for signs to document important structures, artifacts, etc. and highlight their historical importance to avoid any impact to specific sites.

4.10.4. Unavoidable Adverse Impacts

Based on the comprehensive set of natural resources and engineering analyses conducted and reviewed as part of this licensing process, KHL has identified no culturally-related unavoidable adverse impacts associated with construction and operation of the Project.

4.11. Socioeconomics

4.11.1. Affected Environment

The Project is located within the boundaries of the KPB. The nearest community is the unincorporated town of Moose Pass – population approximately 206 – about 1.5 miles to the southeast of Grant Lake. The nearest major town is Seward, population approximately 2,830, located approximately 25 miles south of Moose Pass (2010 U.S. Census Data).

4.11.1.1. Land Use and Real Estate

The Project area lies entirely within the KPB. Land use patterns in the Project area are rural. Most of the lands in the Project area are public, either state or federal. However there are several areas of private ownership along the Seward Highway. Borough land management policies are described in the Kenai Peninsula Borough Comprehensive Plan and the Kenai Peninsula Borough Coastal Zone Management Plan (KPB 2005 and 2008). Table E.4-110 and Figure E.4-114 show land ownership in the KPB. Land use is predominantly characterized as vacant and is shown in Figure E.4-115.

Table E.4-110. Kenai Peninsula Borough land ownership information (KPB 2005).

Kenai Peninsula Borough Land Ownership		
	Square Miles	**Percent of Total**
University of Alaska	25.9	0.1%
Cities	26.9	0.1%
Mental Health Trust	27.7	0.1%
KPB	107.3	0.4%
Private	401.7	1.6%
Native	1,593.6	6.4%
State	3,426.6	13.9%
Federal	10,610.9	42.9%
Total Upland	16,220.6	65.5%

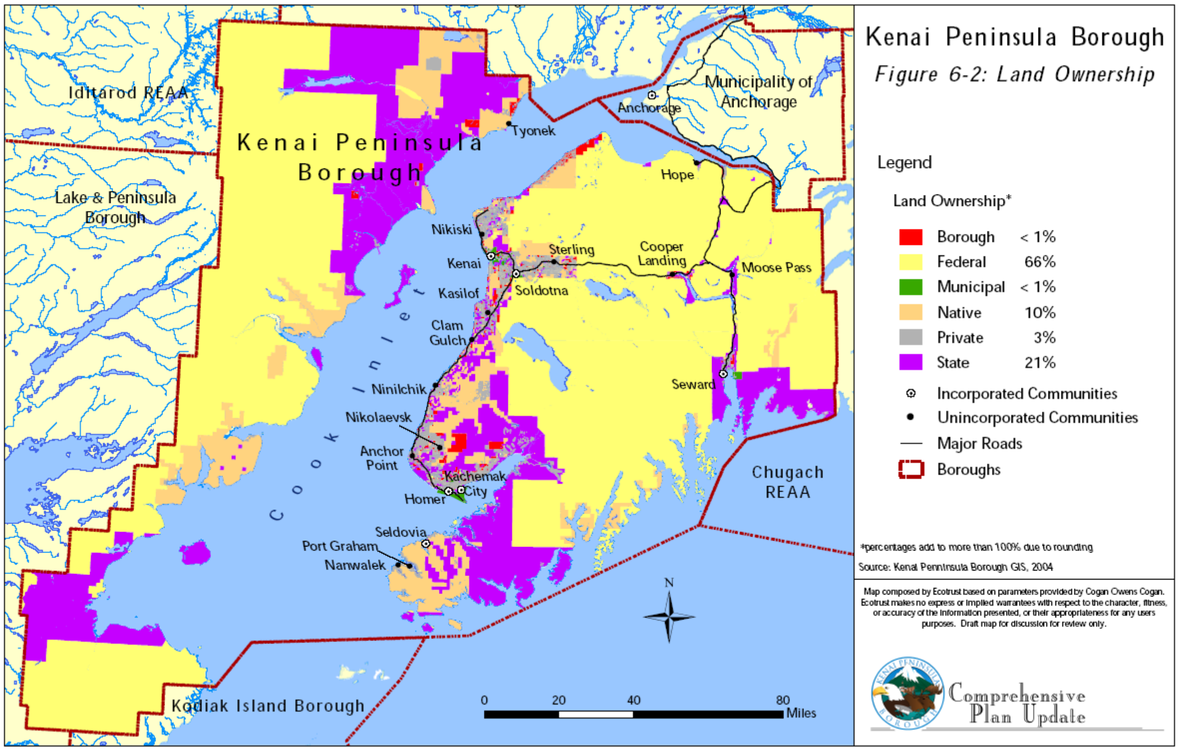

Figure E.4-114. General Kenai Peninsula land ownership delineation (KPB 2005).

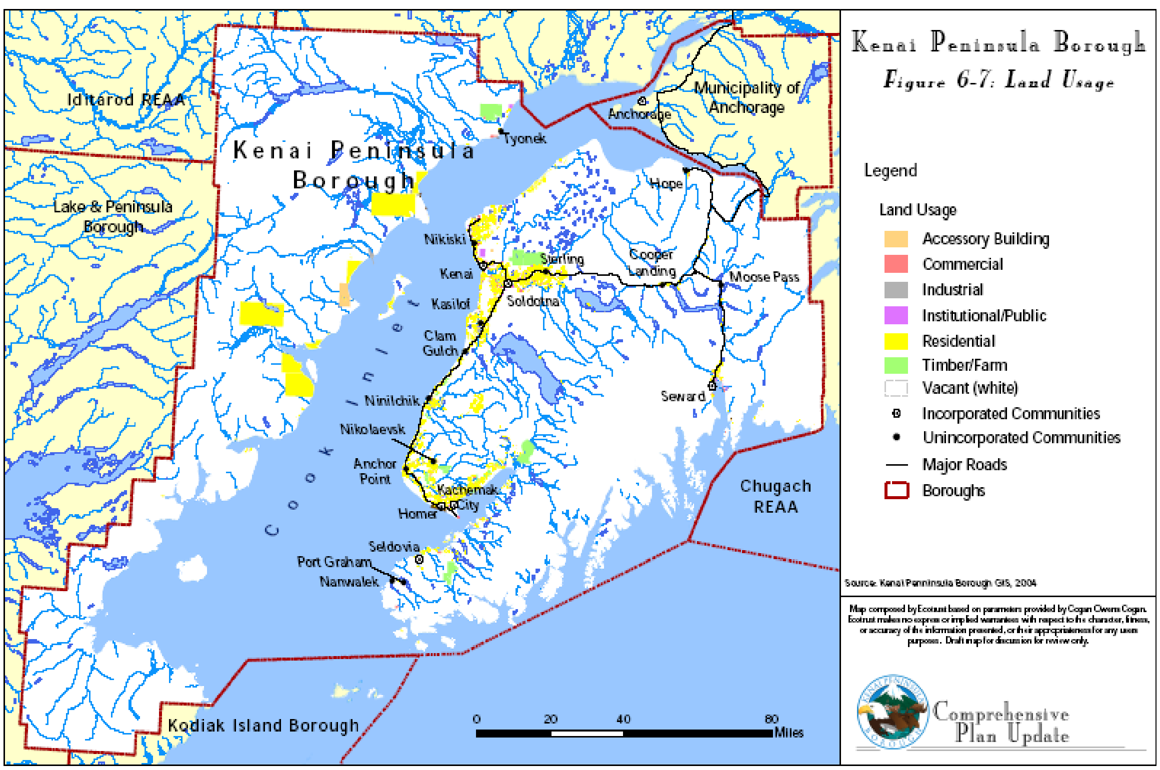

Figure E.4-115. Land use in the Kenai Peninsula Borough (KPB 2005).

4.11.1.2. Demographics

Population density in the Project vicinity is relatively low. The Project area is approximately 100 miles from Anchorage, Alaska's largest city. The population of the area is centered near the Seward highway.

The population characteristics of the Project area are similar to those of the Kenai Peninsula Borough, as a whole. Population growth was greatest during the 1970s and early 1980s. The most recent U.S. Census data for incorporated cities in the Borough are shown in Table E.4-111, and current growth rates are estimated at less than 1percent (KPB 2008), with negative population growth in several towns near the Project area.

Table E.4-111. Population growth in the Kenai Peninsula Borough (KPB 2010).

	Number and Annual Rate of Change in Population, Kenai Peninsula Borough and Incorporated Cities in the Borough: 2006-2010			
	2006	**2010**	**Total Change**	**Annual Rate of Change**
Kenai Peninsula Borough	51,350	55,400	4050	810
Homer	5,454	5,003	-451	-90.2
Kachemak City	458	472	14	2.8
Kenai	6,864	7,100	236	47.2
Seldovia (city)	375	255	-120	-24.0
Seward	2,627	2,963	336	67.2
Soldotna	3,807	4,163	356	71.2

The racial composition of the borough is predominantly white, except for the small native villages (2013 U.S. Census Data).

In general, adjusted incomes in the KPB decreased during the last few of decades (KPB 2005). Table E.4-112 summarizes occupations and income in the KPB.

Table E.4-112. Income and occupations in Kenai Peninsula Borough (2013 U.S. Census Data).

Income and Poverty Levels: **Note:** Current socio-economic measures could differ significantly. Kenai Peninsula Borough located in the Kenai Peninsula Census Area.	
Per Capita Income:	$30,789
Median Household Income:	$59,421
Persons in Poverty:	5,200
Percent Below Poverty:	9.1 percent
Total Potential Work Force (Age 16+):	44,129
Total Employment:	27,984
Employment by Occupation:	
Management, Professional & Related:	7,528
Service:	4,951
Sales & Office:	5,666
Construction, Natural Resources & Maintenance:	4,355
Production, Transportation & Material Moving:	2,855

Notes:
1 Current socio-economic measures could differ significantly. The Kenai Peninsula Borough is located in the Kenai Peninsula Census Area.

The KPB Comprehensive Plan (KPB 2005) points out the following issues regarding borough demographics:

- Aging population – the average age and percent of population in higher age groups has increased and is predicted to continue to do so.
- Declines in school age children – there are budget and service issues surrounding declining enrollment.
- Declining incomes – decreases in real income may signal increased demand on social and other services at the same time that there is less money to support taxes and fees.

4.11.1.2.1 Industry and Employment

Employment in the KPB is concentrated in several industries and summarized in Table E.4-113. Moose Pass and Seward employment is consistent with Borough employment information.

Table E.4-113. Employment in the Kenai Peninsula Borough (2013 U.S. Census Data). [1]

Total Potential Work Force (Age 16+):	44,129
Total Employment:	25,355
Percent Unemployed (civilian):	8.9%
Adults Not in Labor Force (Not Seeking Work):	16,145
Percent of All 16+ Not Working (Unemployed + Not Seeking):	45.5%
Private Wage & Salary Workers:	17,741
Self-Employed Workers (in own not incorporated business):	2,738
Government Workers (City, Borough, State, Federal):	4,785

Notes:
1 Current socio-economic measures could differ significantly. The Kenai Peninsula Borough is located in the Kenai Peninsula Census Area.

4.11.1.2.2 Public Sector

Kenai Peninsula Borough is incorporated as a second class borough and as such levees taxes and fees, which fund borough government and services. The KPB operates the schools and the landfill, but most other services such as sewer, water, fire, and law enforcement are managed locally by each city. There are 43 schools in the Kenai Peninsula School District with a total of 9,077 students and employing 751 teachers (ADCRA 2014).

4.11.1.2.3 Electricity

A majority of the electricity supplied to the Kenai Peninsula is provided by HEA. However, Chugach Electric supplies electricity to the Project area. The proposed Project will supply HEA customers.

4.11.2. Environmental Analysis

The overall socioeconomic impact to the area both during construction and the long-term operation of the Project will be minimal. KHL will place priority on employing local construction personnel if available. Given the small population local to the Project area, it is anticipated that additional assistance will be required and KHL will utilize additional qualified construction staff as required to ensure that a high quality Project is constructed with emphasis placed on efficiency and long term operation. Regardless of origination, it is anticipated that the local communities (Moose Pass, Seward, etc.) could absorb the lodging requirements of the construction staff, even at its most substantial. Additionally, it is not anticipated that there will be any impact to the areas governmental facilities and services.

As with most multi-season construction efforts, on-site manpower needs and associated payroll will fluctuate and coincide with the periods most conducive to development of discrete infrastructural components. Table E.4-114 provides KHL's monthly estimates for "manpower" and associated payroll costs. These estimates are based upon certain assumptions with respect to receipt of a FERC license and may fluctuate based upon timing, specific requirements set forth in the license, etc.

Table E.4-114. KHL monthly manpower estimates and associated payroll expenditures for construction of the Grant Lake Project.

	2017			2018		
	Monthly Manpower Totals	**Percent of Manpower by Month**	**Monthly Manpower Costs**	**Monthly Manpower Totals**	**Percent of Manpower by Month**	**Monthly Manpower Costs**
Jan	[redacted]	[redacted]	[redacted]	15	2.45	$311,714
Feb	[redacted]	[redacted]	[redacted]	15	2.45	$311,714
Mar	[redacted]	[redacted]	[redacted]	15	2.45	$311,714
Apr	[redacted]	[redacted]	[redacted]	20	3.27	$415,619
May	15	2.45	$311,714	22	3.59	$457,181
Jun	30	4.90	$623,428	50	8.17	$1,039,047
Jul	45	7.35	$935,142	52	8.50	$1,080,609
Aug	60	9.80	$1,246,856	52	8.50	$1,080,609
Sep	54	8.82	$1,122,170	33	5.39	$685,771
Oct	40	6.54	$831,237	15	2.45	$311,714
Nov	42	6.86	$872,799	15	2.45	$311,714
Dec	20	3.27	$415,619	2	0.33	$41,562

Once operational, KHL will operate the Project remotely. While potential exists for a consistent local resident near the Project to conduct regular checks related to maintenance, safety and adequate operation, the more likely scenario is that the Project will be operated from the HEA dispatch center in Nikiski and personnel devoted to the Project would travel to the local Project area on an as needed basis.

Very few private parcels containing residences or businesses exist near the proposed Project area. At this time, KHL has no intention of purchasing and/or displacing any residences or businesses as a result of Project construction or operation. With respect to the more global fiscal impact to the local area, KHL expects minimal to no adverse impact. Important variables such as public safety and school operating costs would be unaffected by construction activities and subsequent operation. There is some limited potential for additional Seward Highway road maintenance as a result of increased construction traffic transiting locally to and from the Project area although during the construction season, most equipment will be stored on site which will limit the amount of additional highway use. This combined with the recent local highway maintenance activities would suggest that any impact to the highway local to the Project would be minimal at worst. KHL currently has no control over local public power (electricity) costs as Chugach Electric Association (CEA) currently provides power to the local area. However, electric reliability would most likely increase in the communities of Moose Pass and Seward as a result of the proximal / distributed generation of the project. Additionally, the potential exists for hydro power swap agreements between HEA and CEA or the City of Seward (Grant Lake Power for Bradley Lake Power) to avoid transmission wheeling tariffs that would reduce power costs for both entities.

4.11.3. Proposed Environmental Measures

There are no environmental measures associated with Socioeconomics proposed by KHL.

4.11.4. Cumulative Effects Analysis

Consistent with FERC's SD2 (FERC 2010b), no cumulative effects were identified associated with the Socioeconomic componenet of the Project or surrounding area.

4.11.5. Unavoidable Adverse Impacts

KHL has identified no socioeconomic-related unavoidable adverse impacts associated with construction and operation of the Project.

4.12. Developmental Analysis

The following subsections provide estimated costs associated with proposed PM&E measures and the economic costs and developmental benefits of KHL's Proposed Action. The Project's net economic benefit under a given alternative is the difference between the cost of producing power and the value of that power. Consistent with FERC's approach to economic analysis, the power benefit of the Project is estimated based on the cost of obtaining an equivalent amount of energy and capacity using the most likely alternative generating resource in the region. The analysis is based on current (i.e., 2015) electric power cost conditions and does not consider future escalation of fuel prices in estimating the value of the Project's benefits. For a more sophisticated estimate of Project benefits that accounts for escalating fuel prices in the Cook Inlet area of Alaska, see the predicted net present value benefit of the Project as discussed in Section 6.2 of Exhibit D.

4.12.1. Power and Economic Benefits of the Project

Total average energy output from the Project is projected to be 18,600 MWh (see Exhibit B, Section 3.3 of this DLA). Purchasing an equivalent quantity of energy from natural gas generation and the equivalent quantity of spinning reserve (see Exhibit D, Section 6.1 of this DLA), will cost KHL approximately $2,309,359 (see Exhibit D, Section 6 of this DLA), based upon the 2015 blended cost of thermally generated power, resulting in an average power benefit of $124.16/MWh. The annualized costs for the construction, operation, and maintenance of the Project totals $2,168,421 in 2015 dollars (see Exhibit D, Section 5 of this DLA), resulting in an average cost of $116.58/MWh.

A summary of parameters and assumptions used for the economic analysis of the Project are provided in Table E.4-115. Greater detail regarding the values included in the table can be found in Exhibits B and D of this DLA.

Table E.4-115. Summary of parameters and assumptions used for the economic analysis of the Grant Lake Project.

Parameter	Value
Costs	
Period of analysis (years)	50 years
Estimated cost of capital	3 percent [1]
Property taxes (2015)	0 percent [2]
Federal tax rate (2015)	0 percent [3]
State tax rate (2015)	0 percent [3]
Local tax rate (2015)	0 percent [3]
Total annual costs for construction (2015)	$53,223,728 [4]
Operations and maintenance ($/year) (2015)	$112,000 [5]
Power value	
Average annual generation	18,600 MWh [6]
Approximate alternative power value	$2,269,200 [7]
Annual value of contingency spinning reserve (low estimate) (2015)	$40,159 [8]

Notes:
1 From Exhibit D, Section 5.1.
2 From Exhibit D, Section 4.
3 From Exhibit D, Section 5.2.
4 From Exhibit D, Sections 4.
5 From Exhibit D, Section 5.4.
6 From Exhibit B, Section 3.3.
7 Based on a power price of $122/MWh (from Exhibit D, Section 6.2).
8 From Exhibit D, Section 6.1.

4.12.2. Costs of Environmental Measures

KHL's Proposed Action will include a variety of PM&E measures that would increase operating costs. Annualized costs of KHL's proposed PM&E measures, by resource area are being developed concurrent with efforts to develop the Draft BE and management/monitoiring plans which will explicitly detail all proposed PM&Es to be implemented in association with construction and operation of the Project. KHL intends to refine those plans and the associated proposed measures per comments received from stakeholders. Once the comment period is complete, KHL will revise the DLA, BE and management/monitoring plans and synthesize all documents into a comprehensive package prior to filing in which, the BE and management/monitoring plans are appended to the FLA. Concurrent with this exercise and with the intent of developing a comprehensive and complete FLA for FERC review, a breakdown of costs for each resource area will be developed and incorporated into Exhibit D.

4.12.3. Comparison of Alternatives

Annualized costs, benefits, and net benefits of the Proposed Action and No Action alternatives are presented in Table E.4-116. Because under the No Action alternative, the Project would not be constructed, no power would be generated, and therefore, the net annual benefit is $0 ($0/MWh). Under the Proposed Action, annual net benefit would be $140,938 ($7.58/MWh).

Table E.4-116. Summary of cost, power benefits, and net benefits of the Grant Lake Project. (All costs in 2015 dollars).

Parameter	No Action	Proposed Action
Approximate power plant capability	0 MW	5 MW [1]
Annual generation	0 MWh	18,600 MWh [2]
Annual power values	$0	$2,309,359 [3]
Annual cost	$0	$2,168,421 [4]
Net annual benefit	$0	$140,938

Notes:
1 From Exhibit B, Section 2.2.2.
2 From Exhibit B, Section 3.3.
3 Based on a power price of $122/MWh and the annual value (low estimate) of contingency spinning reserve (from Exhibit D, Section 6).
4 The annual cost of the Proposed Action includes annualized cost to construct ($2,056,421), and the annual operations and maintain costs ($112,000)(from Exhibit B, Section 5). The proposed PM&E costs will be included with the FLA.

4.13. Consistency with Comprehensive Plans

Section 10(a)(2) of the FPA requires FERC to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, and conserving waterways affected by the project. The comprehensive plans discussed in the section below were reviewed to Project consistency.

4.13.1. Bureau of Land Management. South central Alaska water resources study: Anticipating water and related land resource needs. October 1981.

Consistency exsits to the extent that this document is regionally descriptive and inclusive of the proposed Project area.

4.13.2. Alaska Department of Natural Resources. Fish Creek management plan. August 1984.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.3. Alaska Department of Fish and Game. Palmer Hay Flats State Game Refuge. December 2002.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.4. Alaska Department of Fish and Game. Susitna Flats State Game Refuge. March 1988.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.5. Alaska Department of Fish and Game. Catalog of waters important for spawning, rearing, or migration of anadromous fishes. June 2014.

Consistency exsits to the extent that this document is regionally descriptive, inclusive of the proposed Project area and specific to Grant Creek.

4.13.6. Department of Fish and Game. Anchor River/Fritz Creek Habitat Area. June 1989.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.7. Alaska Department of Fish and Game. Mendenhall Wetlands State Game Refuge. March 1990.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.8. Alaska Department of Fish and Game. Anchorage Coastal Wildlife Refuge. February 1991.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.9. Alaska Department of Fish and Game. Minto Flats State Game Refuge. March 1992.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.10. Alaska Department of Fish and Game. Kachemak Bay/Fox River Flats Critical Habitat Areas. December 1993.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.11. Alaska Department of Fish and Game. Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area. July 1994.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.12. Alaska Department of Fish and Game. Tugidak Island Critical Habitat Area. June 1995.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.13. Alaska Department of Fish and Game. McNeil River State Game Refuge and State Game Sanctuary, draft. November 1995.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.14. Alaska Department of Fish and Game. Kenai River comprehensive management plan. December 1997.

Consistency exsits to the extent that this document is regionally descriptive, inclusive of the proposed Project area and specific to Grant Creek.

4.13.15. Alaska Department of Fish and Game. Atlas to the catalog of waters important for spawning, rearing, or migration of anadromous fishes. 2014.

Consistency exsits to the extent that this mapping program is regionally descriptive, inclusive of the proposed Project area and specific to Grant Creek.

4.13.16. Alaska Department of Fish and Game. Yakataga State Game Refuge June 1999.

No relevant consistencies exist between this plan and the Grant Lake Project.

4.13.17. Alaska Department of Fish and Game. Kenai Peninsula brown bear conservation strategy. June 2000.

Consistency exsits to the extent that this document is regionally descriptive and inclusive of the proposed Project area.

4.13.18. Department of Agriculture, U.S. Forest Service. Chugach National Forest revised land and resource management plan. May 2002.

Consistency exsits to the extent that this document is regionally descriptive, inclusive of the proposed Project area and specific to Grant Lake.

4.13.19. Alaska Department of Natural Resources. Alaska's Outdoor Legacy: Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2009-2014. July 2009.

While globally descriptive of recreational uses, opportunities, and potential for the entire state of Alaska, some documentation of the Kenai Penninsula as a whole and specific recreational categories prevelant to the Project area are discussed resulting in some level of consistency.

4.13.20. U.S. Fish and Wildlife Service. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. December 1989.

While globall descriptive of the nation as a whole, the primary goal of the document is to define mechanisms for allowing recreational fishing opptortunities to persist and potentially expand.

Given this and the fact that recreational fishing (for certain species) is permitted in the Project area, some level of consistency exists.

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Attachment E-1. Licensing Consultation Record

This attachment contains a summary table of the Grant Lake Hydroelectric Project licensing consultation record and the full corresponding documentation.

Because of the potentially sensitive nature of information regarding archeological and historic sites, records related to the topic of cultural resources containing such information (as identified in the summary table) are not being distributed to the general public. This information is being filed separately as Volume 2 with a Privileged designation. It may be obtained by request to Kenai Hydro, Inc. or FERC, subject to confidentiality provisions.

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
7/1/2009	Paul McLarnon (HDR) and Karen O'Leary (USFS) exchanged emails regarding Kenai Hydro's special use permit for studies.	USFWS 2	009-07-01USFSSpecialUsePermit.pdf
7/8/2009	Jenna Borovansky (LVA) and Mark Luttrell (RBCA) exchanged emails regarding public availability of the PAD.	Resurrection Bay Conservation Alliance	2009-08-07LuttrellPADavailability.pdf
8/6/2009	Kenai Hydro, LLC filed a Pre-Application Document (PAD) with FERC.	All Licensing Contacts	2009-08-06PAD.pdf
8/27/2009	Jenna Borovansky (LVA) provided Mark Luttrell (RBCA) with requested PAD background information via email.	Resurrection Bay Conservation Alliance	2009-08-27LuttrellRBCA.pdf
9/1/2009	Jenna Borovansky (LVA) emailed agencies a reminder that comments on Kenai Hydro's request to use the Traditional Licensing Process were due.	ADFG; ADNR; USFWS; USFS; USACE; NOAA; NPS	2009-09-01TLPcommentReminder.pdf
9/14/2009	Steve Gilbert (KHL) filed with FERC a request for use of the Traditional Licensing Process (TLP).	FERC 20	09-09-14TLPrequest.pdf
9/15/2009	Jennifer Hill (FERC) sent Steve Gilbert (KHL) a letter authorizing KHL to initiate Section 106 consultation.	FERC 2	009-09-15Section106Designation.pdf
9/15/2009	Ann Miles (FERC) issued Steve Gilbert (KHL) a letter approving the use of the TLP.	FERC 20	09-09-15TLPapproval.pdf
9/22/2009	Kenai Hydro, LLC held an aquatic resources technical work group meeting with agencies and interested stakeholders, and conducted a site visit to Grant Creek to receive input on the fisheries and instream flow studies.	ADFG; ADNR; USFWS; USFS; NOAA; Citizen	2009-09-22_TWG_Final_Mtg_Summary.pdf
9/23/2009	Jason Werner emailed Brad Zubeck (KHL) information regarding his private property located on Grant Creek.	Property owners	2009-09-23Werner.pdf
9/30/2009	Steve Gilbert (KHL) filed with FERC the second preliminary permit progress report.	FERC 2	009-09-30ProgressReport2nd.pdf
10/7/2009	Jim Ferguson (ADFG) emailed Jenna Borovansky (LVA) regarding his availability for upcoming public meetings.	ADFG 20	09-10-07FergusonADFG.pdf
10/7/2009	Burce Jaffa emailed Jenna Borovansky (LVA) regarding his availability for upcoming public meetings.	Citizen 20	09-10-07Jaffa.pdf
10/7/2009	Lynnda Kahn (UWFWS) emailed Jenna Borovansky (LVA) regarding her availability for upcoming public meetings.	USFWS 20	09-10-07KahnUSFWS.pdf
10/7/2009	Karen O'Leary emailed Jenna Borovansky (LVA) regarding her availability for upcoming public meetings.	USFS 20	09-10-07OlearyUSFS.pdf
10/7/2009	Sue Walker (NOAA-NMFS) emailed Jenna Borovansky (LVA) regarding her availability for upcoming public meetings.	NOAA 2	009-10-07WalkerNMFS.pdf
10/7/2009	Jason Werner emailed Jenna Borovansky (LVA) regarding his availability for upcoming public meetings.	Property owners	2009-10-07WernerLandowner.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
10/7/2009	Jenna Borovansky (LVA) emailed all licensing contacts proposed dates for a Joint Meeting and FERC Scoping meeting.	All Licensing Contacts	2009-10-07JointMtgDatesProposal.pdf
10/7/2009	Jenna Borovansky (LVA) emailed the Hydropower Reform Coalition regarding updated contact information.	Hydropower Reform Coalition	2009-10-07HRCcontact.pdf
10/11/2009	Gary Fandrei (CIAA) emailed Jenna Borovansky (LVA) regarding his availability for upcoming public meetings.	Cook Inlet Aquaculture Association	2009-10-11Fandrei.pdf
10/12/2009	Bob Baldwin (FOCL) emailed comments to Jenna Borovansky (LVA) regarding scheduling of scoping meetings.	FOCL 20	09-10-12BaldwinFOCL.pdf
10/12/2009	Valerie Connor (Alaska Center for the Environment) emailed Jenna Borovansky (LVA) recommendations for upcoming public meeting locations and participation.	Alaska Center for the Enivornment	2009-10-12ConnorACE.pdf
10/12/2009	Mark Luttrell (RBCA) emailed Jenna Borovansky (LVA) recommendations for upcoming public meeting locations and participation.	Resurrection Bay Conservation Alliance	2009-10-12LuttrellRBCA.pdf
10/12/2009	Joshua O. Milligan (USFS) emailed Jenna Borovansky (LVA) regarding his availability for upcoming public meetings.	USFS 20	09-10-12MilliganUSFS.pdf
10/13/2009	Katherine McCafferty (USACE) emailed Jenna Borovansky (LVA) regarding her availability for upcoming public meetings.	USACE 2	009-10-13McCaffertyACOE.pdf
10/21/2009	Karen Kromrey (USFS) emailed Jenna Borovansky (LVA) regarding her availability for upcoming public meetings.	USFS 2009-10-21Krom	reyUSFS.pdf
10/22/2009	Bruce Jaffaa emailed Jenna Borovansky (LVA) regarding a recommendation from the Moose Pass Advisory Planing Commission to hold a public meeting regarding the Grant Lake Project in Moose Pass.	Moose Pass Advisory Planning Commission	2009-10-22JaffaMPAPC.pdf
10/23/2009	Jenna Borovansky (LVA) emailed all licensing contacts notification of a November 12, 2009 Joint Meeting.	All Licensing Contacts	2009-10-23JointMtgAnnouncement.pdf
10/23/2009	Brad Zubeck (KHL) emailed Moose Pass parties in response to requests regarding the location of public meetings regarding the Grant Lake Project.	All Licensing Contacts; Moose Pass representatives	2009-10-23PublicMtgLocation.pdf
10/27/2009	Steve Gilbert (KHL) filed with FERC notice of the November 12, 2009 Public Meeting.	FERC 20	09-10-27PublicMtgNotice.pdf
10/31/2009	Jan Odhner emailed Jenna Borovansky (LVA) regarding the location of the Grant Lake Project.	Citizen 20	09-10-31Odhner.pdf
11/6/2009	Lynnda Kahn (USFWS) emailed Siera Brownlee (HDR) regarding wildlife studies and eagle nest locations in the Grant Lake Project area.	USFWS Pr	iv_2009-11-06KahnUSFWS.pdf
11/10/2009	Jenna Borovansky (LVA) notified Aquatic Resources Technical Work Group members that a meeting summary for the September 22-23, 2009 meeting was available on the Kenai Hydro website and provided an agenda for the November 12, 2009 Joint Meeting.	ADFG; ADNR; FERC; USFWS; USFS; USACE; NOAA; NPS; Citizen	2009-11-10FinalTWGmtgSummary.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
11/12/2009	KHL held a public meeting regarding the Grant Lake Project licensing process on November 12, 2009.	All Licensing Contacts	2009-11-12PublicMtg.pdf
11/13/2009	Brad Zubeck (KHL) and Karen O'Leary (USFS) exchanged emails regarding Forest Service representation at the November 12, 2009 Joint Meeting.	USFS 20	09-11-13OlearyUSFS.pdf
11/19/2009	Brad Zubeck (KHL) emailed Mike Cooney the participant list for the November 12, 2009 Joint Meeting	Citizen 20	09-11-19Cooney.pdf
11/24/2009	Jeff Estes (City of Seward) emailed Brad Zubeck (KHL) information regarding the transmission line proposal for the Grant Lake Project.	City of Seward	2009-11-24EstesCityofSeward.pdf
12/4/2009	Kenai Hydro, LLC filed a transcript of the November 12, 2009 Joint Meeting and proof of public notice.	FERC 20	09-12-04JointMtgTranscript.pdf
12/7/2009	Jenna Borovansky (LVA) and Mark Luttrell (RBCA) exchanged emails regarding access to the November 12, 2009 Joint Meeting transcript and attendance sheet.	Resurrection Bay Conservation Alliance	2009-12-07LuttrellRBCA.pdf
12/17/2009	Brad Zubeck (KHL) filed a letter with FERC regarding incorrect contact information contained in the Friends of Cooper Lake's December 9, 2009 comment letter.	FERC 2	009-12-17FERCkBose.pdf
12/21/2009	Mike Cooney wrote to Kenai Hydro regarding CIRI's participation in Kenai Hydro, LLC and the timing of FERC scoping meetings.	Citizen 20	09-12-21Cooney.pdf
12/31/2009	Kenai Hydro, LLC filed affadavits of publication for the Joint Meeting and notice of a public meeting to be held in January 2010 in Moose Pass, Alaska.	FERC 2	009-12-31Project13211-13212mtgnotice.pdf
12/31/2009	Jenna Borovansky (LVA) notified all relicensing contacts that a public meeting regarding the Grant Lake Project will be held in Moose Pass, Alaska on January 13, 2010.	All Licensing Contacts	2009-12-31MoosePassMtgNotice.pdf
1/1/2010	William Coulson emailed Brad Zubeck (KHL) comments on the Grant Lake Project.	Citizen 20	10-01-01Coulson.pdf
1/8/2010	Brita Mjos emailed Brad Zubeck (KHL) comments on the Grant Lake Project.	Citizen 20	10-01-08Mjos.pdf
1/11/2010	Brad Zubeck (KHL) gave a powerpoint presentation to the ADF&G Advisory Committee and answered questions regarding the Grant Lake Project.	ADFG 2	010-01-11ADFGAdvisoryCommitteeMtg.pdf
1/11/2010	Valerie Connor provided Kenai Hydro, LLC with comments on the PAD.	Alaska Center for the Environment	2010-01-11ConnorACE.pdf
1/11/2010	Robert Baldwin (Friends of Cooper Landing) provided Kenai Hydro, LLC comments on the Grant Lake PAD.	FOCL 20	10-01-11FOCL.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
1/11/2010	Mark Luttrell (RBCA) submitted comments on the Grant Lake PAD to Kenai Hydro, LLC.	Resurrection Bay Conservation Alliance	2010-01-11RBCA.pdf
1/12/2010	Mike Cooney and Brad Zubeck (KHL) exchanged emails regarding information for the January 13, 2010 public meeting in Moose Pass.	Citizen 20	10-01-12Cooney.pdf
1/13/2010	Bruce Jaffa emailed Brad Zubeck (KHL) follow-up to the January 13, 2010 public meeting.	Citizen 20	10-01-13Jaffa.pdf
1/14/2010	Irene Lindquist emailed Brad Zubeck (KHL) information regarding trails in the Grant Lake Project area.	Citizen 2	010-01-14Lindquist.pdf
1/14/2010 Bru	ce Jaffa emailed Brad Zubeck (KHL) information regarding a cabin located on Grant Lake and local use of the area.	Citizen 20	10-01-14Jaffa.pdf
2/8/2010	Kenai Hydro, LLC filed a summary of the January 13, 2010 public meeting in Moose Pass.	FERC 2	010-02-08GrantLake_FallsCreek_comments.pdf
3/1/2010	Kenai Hydro, LLC filed updated contact information with FERC.	FERC	2010-03-01_updated_applicant_contact_info_KHL.pdf
3/2/2010	Kenai Hydro, LLC filed its 2009 environmental study report with FERC.	FERC	2010_03_02_P13211_13212KHLstudyreportfiling.pdf
3/4/2010	Jenna Borovansky (LVA) notified all licensing contacts that the 2009 environmental baseline study report was available on the Kenai Hydro website.	All Licensing Contacts	2010-03-04Notice2009StudyReport.pdf
3/4/2010	Jenna Borovansky (LVA) emailed the Aquatics Technical Work Group that the 2009 environmental baseline study report was posted on the Kenai Hydro website.	ADFG; ADNR; FOCL; FERC; USFWS; USFS; USACE; NOAA; NPS; Kenaitze Indian Tribe	2010-03-04TWGstudyReportNotice.pdf
3/5/2010	Bruce Jaffa and Jenna Borovansky (LVA) exchanged emails regarding availability of information from the Moose Pass public meeting.	Citizen 20	10-03-05Jaffa.pdf
3/15/2010	Brad Zubeck (KHL) exchanged emails with Thomas Harkreader regarding the mine near Grant Lake.	Citizen 20	10-03-15Harkreader.pdf
3/31/2010	Steve Gilbert (KHL) filed with FERC the third preliminary permit progress report.	FERC 20	10-03-31ProgressReport3rd.pdf
4/16/2010	Sirena Brownlee (HDR) discussed by phone the timing of bear den surveys in the Grant Lake area with Jeff Selinger (ADFG).	ADFG 20	10-04-16SelingerADFG.pdf
4/16/2010	Sirena Brownlee (HDR) emailed Jeff Selinger (ADFG) to confirm the timing of bear den surveys in the Grant Lake area.	ADFG 20	10-04-16SelingerADFG2.pdf

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4/20/2010	Brad Zubeck (KHL), Mike Salzetti (KHL), Jenna Borovansky (LVA), Joe Adamson (FERC), Jennifer Hill (FERC), and Kim Nyguen (FERC) met by conference call to discuss the initiation of the 2010 study season and early scoping.	FERC 20	10-04-20FERC.pdf
4/20/2010	Lesli Schick (ADNR) emailed John Wolfe (HDR) maps with the Iditarod Trail location in the Trail Lake/Grant Lake area.	ADNR 20	10-04-30SchickANDR.pdf
4/23/2010	Jenna Borovansky (LVA) emailed agency and tribal representatives regarding their availability for early June meetings.	ADFG; FERC; USFWS; USFS; USACE; NOAA; NPS; Kenai Peninsula Borough; EPA; Qutekcak Native Tribe; Kenaitze Tribe	2010-04-23AgencyStudyNotice.pdf
4/23/2010	Jenna Borovansky (LVA) emailed licensing contacts that the 2010 study season will proceed and that draft study plans will be provided for review.	All Licensing Contacts	2010-04-23StudyProgramNotice.pdf
5/3/2010	Jenna Borovansky (LVA) emailed Kim Nguyen and Mark Ivy (FERC) a list of agency representatives' availability for the first week in June for a scoping meeting.	FERC 20	10-05-03NguyenIvyFERC.pdf
5/3/2010	Kenai Hydro, LLC filed a revised project description and PAD study issues with FERC.	FERC 2	010-05-03RevisedProjectDescription.pdf
5/4/2010	Jenna Borovansky (LVA) emailed all licensing contacts notification that draft study plans for the Aquatic and Water Resources were posted on the Kenai Hydro website and that a review Project description was filed with FERC on May 3, 2010.	All Licensing Contacts	2010-05-04AquaticsWaterStudyPlanNotice.pdf
5/4/2010	Brad Zubeck (KHL) had a phone conversation with Mark Ivy (FERC) regarding scoping meeting logistics, and future Project permitting needs.	FERC 2	010-05-04IvyFERC.pdf
5/4/2010	John Wolfe (HDR) exchanged emails with Jamie Schmidt (USFS) regarding the USFS easements on ANDR land for the Iditarod trail and information on proposed road alignments to follow-up on a phone conversation regarding the Iditarod Trail location relative to proposed road access to the Grant Lake Project.	USFS 2010-05-04Sc	hmidtUSFS.pdf
5/5/2010	Mary Ann Benoit (USFS-Seward Ranger District) called Sirena Brownlee (HDR) to provide information on bear den surveys and raptor surveys to be conducted in the Project area.	USFS 20	10-05-05BenoitUSFS.pdf
5/11/2010	Thomas Harkreader emailed Jenna Borovansky (LVA) information regarding ongoing mining activities in the Grant Lake area.	Citizen 20	10-05-11Harkreader.pdf
5/11/2010	Jenna Borovansky (LVA) emailed all licensing contacts notification of the FERC scoping meetings and that draft study plans for the Recreation and Visual, Terrestrial, and Cultural Resources were posted on the Kenai Hydro website.	All Licensing Contacts	2010-05-11RecreationTerrestrialCulturalStudyPlanNotice.pdf

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5/17/2010	David Pearson emailed Kenai Hydro comments on the Recreation and Visual Resources draft study plan.	Citizen 2	010-05-17PearsonRecreationComments.pdf
5/18/2010	Brad Zubeck (KHL) exchanged emails with Valerie Connor (ACE) regarding questions on the schedule for the Grant Lake Project.	USACE 2	010-05-18ConnorACE.pdf
5/18/2010	Jack Dean emailed Jenna Borovansky (LVA) regarding assistance with access to the study plans.	Citizen 20	10-05-18Dean.pdf
5/20/2010	Jenna Borovansky (LVA) emailed Instream Flow TWG members notice of a June 22, 2010 meeting to discuss the instream flow study.	ADFG; ADNR; FERC; USFWS; USFS; Kenai River Sportsfishing; CIAA	2010-05-20TWGmtgNotice.pdf
5/21/2010	Brad Zubeck (KHL) exchanged emails with Doug Palmer (USFWS), Jason Mouw (ADFG), Karen O'Leary (USFS) and other agency representatives regarding a request for an extended comment deadline on the draft study plans.	ADFG; NMFS; FOCL; FERC; USFWS; USFS; USACE; ADNR	2010-05-21AgencyStudyPlanCommentDeadline.pdf
5/21/2010	Jenna Borovansky (LVA) emailed all licensing contacts notice of a study plan discussion session and reminder of upcoming FERC scoping meetings.	All Licensing Contacts	2010-05-21StudyPlanMeetingNotice.pdf
5/23/2010	Kate Glaser and Jenna Borovansky (LVA) exchanged emails regarding the FERC environmental site visit.	Citizen 20	10-05-23Glaser.pdf
5/24/2010	Jeff Estes (City of Seward) emailed Kenai Hydro, LLC comments on the proposed road alignment.	City of Seward	2010-05-24EstesSeward.pdf
5/25/2010	Mary Ann Benoit (USFS) emailed Sirena Brownlee (HDR) regarding the Terrestrial Resources draft study plan and frequency of bird surveys in the Project area.	USFS 20	10-05-25BenoitUSFS.pdf
5/25/2010	Jenna Borovansky (LVA) emailed details regarding the FERC environmental site review on June 2, 2010.	ADFG; FERC; USFS; USACE; NOAA; Citizen; ADNR	2010-05-25SiteVisitDetails.pdf
5/26/2010	Jenna Borovansky (LVA) emailed agency representatives regarding an extension of the draft study plan comment deadline.	ADFG; FERC; USFWS; USFS; USACE; EPA; ADNR	2010-05-26AgencyStudyPlanCommentExtension.pdf
5/26/2010	James Hasbrouck (ADFG) emailed James Brady (HDR) information on fish stocking in Vagt Lake.	ADFG 20	10-05-26HasbrouckADFG.pdf
5/26/2010	Brad Zubeck (KHL) exchanged emails with Eric Rothwell (NOAA) regarding arranging a time for Eric to accompany field crews in the Project area.	NOAA 2	010-05-26RothwellNOAA.pdf
5/26/2010	Brad Zubeck (KHL) sent a letter to Judith Bittner (SHPO) and consulting parties to initiate Section 106 consultation and propose a meeting to review the proposed Cultural Resources APE.	See Summary of Contact	2010-05-26Section106ConsultInitiation.pdf

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5/26/2010	Jenna Borovansky (LVA) exchanged emails with Mark Ivy (FERC) to clarify the study plan comment schedule.	FERC 2	010-05-26IvyFERC.pdf
5/29/2010	Jenna Borovansky (LVA) and Thomas Harkreader exchanged emails regarding the mine near Grant Lake.	Citizen 20	10-05-29Harkreader.pdf
6/8/2010	Jenna Borovansky (LVA) emailed Mark Luttrell (RBCA) information regarding the cultural resources study.	Resurrection Bay Conservation Alliance	2010-06-08LuttrellRBCA.pdf
7/30/2010	Jennifer Hill (FERC) issued a letter to Brad Zubeck (KHL) requesting that KHL meet with USFS within 120 days to discuss the Grant Lake Project proposed location and configuration.	FERC 2	010-07-30FERCjHill.pdf
8/10/2010	Jenna Borovansky and Steve Padula (LVA) held a conference call with the USFS regarding land management objectives.	USFS 2	010-08-10GrantLakeUSFSConfCallSummary.pdf
8/31/2010	Kenai Hydro, LLC filed a revised project description with FERC.	FERC	2010-08-13RevisedProjectDescription.pdf
9/30/2010	Mike Salzetti (KHL) filed with FERC the fourth preliminary permit progress report.	FERC 20	10-09-30ProgressReport4th.pdf
10/12/2010	Mike Salzetti (KHL) filed with FERC notes from the August 10, 2010 meeting with the USFS.	USFS 20	10-10-12USFSmtgNotes.pdf
3/21/2011	Tim Welch (FERC) issued a letter to Brad Zubeck (KHL) requesting a status of the preliminary permit for Falls Creek.	FERC 2	011-03-21FallsCrPPstatusRequest.pdf
3/31/2011	Mike Salzetti (KHL) filed with FERC the fifth preliminary permit progress report.	FERC 20	11-03-31ProgressReport5th.pdf
9/30/2011	Mike Salzetti (KHL) filed with FERC the sixth preliminary permit progress report.	FERC 20	11-09-30ProgressReport6th.pdf
9/30/2011	Mike Salzetti (KHL) filed with FERC an application for a second preliminary permit for the Grant Lake Project.	FERC 2	011-09-30PP2ndAppl.pdf
12/29/2011	Ken Hogan (FERC) issued a letter to Mike Salzetti (KHL) notifying KHL of acceptance of the application for a second preliminary permit.	FERC 2	011-12-29PP2ndApplAccept.pdf
8/28/2012	Mike Salzetti (KHL) filed with FERC the first preliminary permit progress report.	FERC 20	12-08-28ProgressReport1st.pdf
10/31/2012	Cory Warnock (LVA) emailed licensing participants with a meeting proposal to gauge appropriate dates for re-initiation of stakeholders into the licensing process.	All Licensing Contacts	2012-10-31ProcessReinitiation.pdf
10/31/2012	Cory Warnock (LVA) exchanged emails with Monte Miller (ADFG) regarding the potential location and timing of the Natural Resources Studies Meeting.	ADFG 20	12-10-31ADFGmMiller.pdf

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10/31/2012	Cory Warnock (LVA) exchanged emails with Cassie Thomas (NPS) regarding potential locations for the Natural Resources Studies Meeting.	NPS 20	12-10-31NPScThomas.pdf
11/1/2012	Cory Warnock (LVA) exchanged emails with Michael Walton (ADNR) regarding potential locations for the Natural Resources Studies Meeting.	ADNR 2	012-11-01ADNRmWalton.pdf
11/1/2012	Cory Warnock (LVA) exhanged emails with Robin Swinford (ADNR) regarding potential dates for the Natural Resources Studies Meeting.	ADNR 20	12-11-01ADNRrSwinford.pdf
11/1/2012	Cory Warnock (LVA) exchanged emails with Sue Walker (NOAA Fisheries) regarding potential locations for the Natural Resources Studies Meeting.	NOAA 2	012-11-01NOAAsWalker.pdf
11/5/2012	Lynnda Kahn (USFWS) emailed Cory Warnock (LVA) regarding her unavailability to participate in a Natural Resources Studies Meeting between December 6 through January 7.	USFWS 20	12-11-05USFWSlKahn.pdf
11/9/2012	Cory Warnock (LVA) notified licensing participants by email that a meeting to discuss the 2013 study program would be held on December 12, 2012 in Anchorage, Alaska.	All Licensing Contacts	2012-11-09StudiesMtgNotice.pdf
11/9/2012	Cory Warnock (LVA) exchanged emails with Monte Miller (ADFG) regarding logistics and attendees associated with the December 12, 2012 Natural Resources Studies Meeting.	ADFG 20	12-11-09ADFGmMiller.pdf
11/9/2012	Amal Ajmi (Oasis ERM) emailed Mary Ann Benoit (USFS) regarding a proposed schedule for the wildlife studies.	USFS 20	12-11-09USFSmBenoit.pdf
11/9/2012	Cory Warnock (LVA) emailed Ginny Litchfield (ADFG) regarding addition of name to contact list for the Grant Lake Project licensing process.	ADFG 20	12-11-09ADFGgLitchfield.pdf
11/9/2012	Cory Warnock (LVA) exchanged emails with Brent Goodrum (ADNR) regarding adding relevant ADNR staff to contact list for the Grant Lake Project licensing process.	ADNR 20	12-11-09ADNRbGoodrum.pdf
11/13/2012	Amal Ajmi (Oasis ERM) exchanged emails with Mary Ann Benoit (USFS) regarding the potential existence of ALMS survey plots.	USFS 20	12-11-13USFSmBenoit.pdf
11/14/2012	Cory Warnock (LVA) emailed Valerie Conner (Alaska Center for Environment), Mike Cooney (Friends of Cooper Landing), Ricky Gease (KRSFA), and Jan Konigsberg (HRC) regarding the December 12, 2012 Natural Resources Studies Meeting.	Kenai River Sportsfishing; Friends of Cooper Landing; Alaska Center for Environment; Hydro Reform Coalition	2012-11-14StudiesMtgNotice2.pdf
11/14/2012	Cory Warnock (LVA) emailed Ken Hogan (FERC) requesting a call to discuss the re-initiation of the licensing process for the Grant Lake Project.	FERC 20	12-11-14FERCkHogan.pdf
11/14/2012	Cory Warnock (LVA) and Ken Hogan (FERC) discussed by phone the re-initiation of the licensing process for the Grant Lake Project.	FERC 20	12-11-14FERCkHogan2.pdf

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11/16/2012	Cory Warnock (LVA) emailed Doug Ott (AEA) regarding adding him to the contact list for the Grant Lake Project licensing process.	AEA 20	12-11-16AEAdOtt.pdf
11/19/2012	Cory Warnock (LVA) exchanged emails with Lynnda Kahn (USFWS) regarding general approach for scheduling of future stakeholder meetings.	USFWS 20	12-11-19USFWSlKahn.pdf
11/26/2012	Cory Warnock (LVA) emailed licensing participants the agenda for the December 12, 2012 Natural Resources Studies Meeting.	All Licensing Contacts	2012-11-26StudiesMtgAgenda.pdf
11/27/2012	Cory Warnock (LVA) exchanged emails with Kevin Laves (USFS) regarding who the main USFS contact is for the Grant Lake Project.	USFS 20	12-11-27USFSkLaves4.pdf
11/27/2012	Dwayne Adams (USKH) and Cliff Larson (ADNR) discussed by phone potential permit requirements for the visual and recreational survey work planned for 2013.	ADNR 2	012-11-27ADNRcLarson.pdf
11/27/2012	Amal Ajmi (Oasis ERM) and Kevin Laves (USFS) discussed by phone special use permit needs and USFS staff involved on the Grant Lake Project.	USFS 20	12-11-27USFSkLaves2.pdf
11/27/2012	Amal Ajmi (Oasis ERM) exchanged emails with Kevin Laves (USFS) regarding permit needs for the Grant Lake Project wildlife studies.	USFS 20	12-11-27USFSkLaves3.pdf
11/27/2012	Amal Ajmi (Oasis ERM) exchanged emails with Kevin Laves (USFS) regarding the USFS representatives for the Grant Lake Project.	USFS 20	12-11-27USFSkLaves.pdf
11/28/2012	Amal Ajmi (Oasis ERM) exchanged emails with Thomas McDonough (ADFG) regarding permit needs for the Grant Lake Project wildlife studies.	ADFG 2	012-11-28ADFGtMcDonough.pdf
11/29/2012	Cory Warnock (LVA) exchanged emails with Kevin Laves (USFS) regarding the identification of the main USFS representative for the Grant Lake Project.	USFS 20	12-11-29USFSkLaves.pdf
11/29/2012	Cory Warnock (LVA) and Robert Stovall (USFS) discussed by phone the agenda for the December 12, 2012 Natural Resources Studies Meeting and the general plan for the 2013 study season.	USFS 20	12-11-29USFSrStovall.pdf
11/30/2012	Cory Warnock (LVA) exchanged emails with Katherine McCafferty (ACOE) regarding who the main ACOE representative is for the Grant Lake Project.	USACE 20	12-11-30ACOEkMccafferty.pdf
12/3/2012	Cory Warnock (LVA) emailed licensing participants requesting a response regarding participation in the December 12, 2012 Natural Resources Studies Meeting.	All Licensing Contacts	2012-12-03StudiesMtgAttendeeRequest.pdf
12/3/2012	Cory Warnock (LVA) exchanged emails with Pamela Russell (ADNR) regarding the identification of the main ADNR representative for the Grant Lake Project.	ADNR 2	012-12-03ADNRpRussell.pdf

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12/3/2012	Kevin Laves (USFS) emailed Cory Warnock (LVA) that he will not be attending the December 12, 2012 Natural Resources Studies Meeting.	USFS 20	12-12-03USFSkLaves.pdf
12/3/2012	Cory Warnock (LVA) exchanged emails with Sue Walker (NOAA Fisheries) regarding general approach for scheduling of future stakeholder meetings.	NOAA 2	012-12-03NOAAsWalker.pdf
12/3/2012	Amal Ajmi (Oasis ERM) exchanged emails with Clifford Larson (ADNR) regarding permit needs for the Grant Lake Project wildlife studies.	ADNR 2	012-12-03ADNRcLarson.pdf
12/4/2012	Krissy Plett (ADNR) emailed Cory Warnock (LVA) regarding the addition of ADNR staff to the contact list for the Grant Lake Project.	ADNR 20	12-12-04ADNRkPlett.pdf
12/7/2012	Cory Warnock (LVA) exchanged emails with Barbara Stanley (USFS) regarding her participation at the December 12, 2012 Natural Resources Studies Meeting and the availability of meeting materials on the Kenai Hydro website.	USFS 2	012-12-07USFSbStanley.pdf
12/12/2012	HEA held a meeting on December 12, 2012 to discuss the Grant Lake Project Natural Resources Study Plans.	All Licensing Contacts	2012-12-12StudiesMtg.pdf
12/13/2012	Cory Warnock (LVA) emailed Ken Hogan (FERC) thanking him for participating in the December 12, 2012 Natural Resources Studies Meeting.	FERC 20	12-12-13FERCkHogan.pdf
12/13/2012	Cory Warnock (LVA) emailed Eric Rothwell (NOAA Fisheries) contact information for Paul Pittman (Element Solutions), the lead on the geomorphology tasks associated with the Water Resources Study Plan.	NOAA 2	012-12-13NOAAeRothwell.pdf
12/17/2012	Cory Warnock (LVA) exchanged emails with Eric Rothwell (NOAA Fisheries) regarding comments on the the geomorphology tasks associated with the Water Resources Study Plan and the anticipated deadline for comments on the meeting summary and study plans.	NOAA 2	012-12-17NOAAeRothwell.pdf
12/28/2012	Paul Pittman (Element Solutions) emailed Eric Rothwell (NOAA Fisheries) regarding questions related to the the geomorphology tasks associated with the Water Resources Study Plan.	NOAA 2	012-12-28NOAAeRothwell.pdf
1/3/2013	John Blum (McMillen) emailed Eric Rothwell (NOAA Fisheries) a copy of the K. Thompson paper regarding determining instream flows for fish (1972).	NOAA 2	013-01-03NOAAeRothwell.pdf
1/3/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding scheduling a call to discuss the existing USFS' Special Use Permit for the Grant Lake Project.	USFS 2	013-01-03USFSkVanMassenhove.pdf
1/7/2013	Cory Warnock (McMillen) and Eric Rothwell (NOAA Fisheries) discussed by phone the geomorphology tasks associated with the Water Resources Study Plan.	NOAA 2	013-01-07NOAAeRothwell.pdf

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1/7/2013	Cory Warnock (LVA) emailed licensing participants the draft summary from the December 12, 2012 Natural Resources Studies Meeting and indicated a deadline of February 1, 2013 to provide comments on the draft summary, study plans, and permit table.	All Licensing Contacts	2013-01-07StudiesMtgDraftSummary.pdf
1/7/2013	Cory Warnock (McMillen) exchanged emails with Deidre StLouis (USFS) confirming a call for January 9, 2013 to discuss the existing USFS' Special Use Permit for the Grant Lake Project.	USFS 20	13-01-07USFSdStLouis.pdf
1/9/2013	Cory Warnock (McMillen), Deidre StLouis (USFS) and Katherine VanMassenhove (USFS) discussed by phone the use of an existing Special Use Permit for Grant Lake Project 2013 study season.	USFS 2	013-01-09USFSdStLouisKVanMassenhove.pdf
1/11/2013	Cory Warnock (McMillen) emailed Scott Ayers (ADFG) requesting a time to discuss the multi-agency permitting process as it relates to the Grant Lake Project.	ADFG 20	13-01-11ADFGsAyers.pdf
1/11/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding the current ADFG contact for permitting.	ADFG 20	13-01-11ADFGmMiller.pdf
1/14/2013	Amal Ajmi (ERM) emailed Jeff Selinger (ADFG) with an introduction to the planned 2013 Grant Lake terrestrial studies work.	ADFG 20	13-01-14ADFGjSelinger.pdf
1/16/2013	Dwayne Adams (USKH) and Robert Stovall (USFS) discussed by phone the permit needs for the Grant Lake Project recreation studies.	USFS 20	13-01-16USFSrStovall.pdf
1/18/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) following up to the January 9, 2013 phone call re: the use of the existing Special Use Permit for the Grant Lake Project 2013 study season.	USFS 2	013-01-18USFSkVanMassenhove.pdf
1/22/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) with the permit needs table and a study methodologies summary related to the discussion about the use of the existing USFS' Special Use Permit for the Grant Lake Project.	ADFG 2	013-01-22USFSkVanMassenhove.pdf
1/23/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the use of the existing USFS' Special Use Permit for the Grant Lake Project 2013 study program.	USFS 2	013-01-23USFSkVanMassenhove.pdf
1/25/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the use of the existing USFS' Special Use Permit for the Grant Lake Project 2013 study program.	USFS 2	013-01-25USFSkVanMassenhove.pdf
1/25/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) with modifications to list of primary activities planned on USFS lands (related to the ongoing discussion about the use of existing USFS' SUP for the 2013 study program).	USFS 2	013-01-25USFSkVanMassenhove2.pdf

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1/28/2013	Cory Warnock (McMillen) exchanged emails with Lynnda Kahn (USFWS) regarding McMillen's offer for follow up call to discuss December 12 meeting, and USFWS' target date to submit its study plan comments.	USFWS 20	13-01-28USFSlKahn.pdf
1/29/2013	Amal Ajmi (ERM) emailed Jeff Selinger (ADFG) regarding logistics of conducting aerial surveys of moose.	ADFG 20	13-01-29ADFGjSelinger.pdf
2/1/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the Special Use Permit amendment to allow access by helicopter and snow machine.	USFS 2	013-02-01USFSkVanMassenhove.pdf
2/4/2013	Cory Warnock (McMillen) exchanged emails with Cassie Thomas (NPS) regarding the NPS comments on the December 12, 2012 meeting note and the Recreation/Visual Resources Study Plan.	NPS 20	13-02-04NPScThomas.pdf
2/6/2013	Mike Salzetti (HEA) emailed Katherine VanMassenhove (USFS) the Special Use Permit amendment to allow access by helicopter and snow machine signed by HEA.	USFS 2	013-02-06USFSkVanMassenhove.pdf
2/10/2013	Cory Warnock (McMillen) emailed Katherine VanMassenhove (USFS) regarding the fully executed Special Use Permit amendment to allow access by helicopter and snow machine (signed amendment attached).	USFS 2	013-02-10USFSkVanMassenhove.pdf
2/11/2013	Cory Warnock (LVA) emailed Pamela Russell (ADNR) a map of the data collection locations with respect to the Multi-Agency Permit Application for the Grant Lake 2013 studies program.	ADNR 2	013-02-11ADNRpRussell.pdf
2/11/2013	Eric Rothwell (NOAA Fisheries) emailed Cory Warnock (McMillen) comments on the Aquatics Resources and Water Resources final study plans.	NOAA 2	013-02-11NOAAeRothwell.pdf
2/12/2013	Mike Salzetti (HEA) emailed Patti Berkhahn (ADFG) responses to follow up questions related to the Multi-Agency Permit Application.	ADFG 20	13-02-12ADFGpBerkhahn.pdf
2/12/2013	Patti Berkhahn (ADFG) emailed Mike Salzetti (HEA) the Fish Habitat Permit.	ADFG 20	13-02-12ADFGpBerkhahn2.pdf
2/13/2013	Scott Ayers (ADFG) emailed Cory Warnock (McMillen) regarding the need for HEA to apply for a Fish Resources Permit for the Grant Lake 2013 study program (permit application attached).	ADFG 20	13-02-13ADFGsAyers.pdf
2/13/2013	Mike Yarborough (CRC Consultants) emailed Cultural Resources Work Group (CRWG) members regarding scheduling a meeting to discuss the Area of Potential Effect (APE).	CRWG 2	013-02-13CRWGmtgDateRequest.pdf
2/13/2013	Frank Winchell (FERC) emailed Mike Yarborough (CRC Consultants) regarding his availability for a call to discuss the APE.	FERC 20	13-02-13FERCfWinchell.pdf

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2/13/2013	Shina Duvall (SHPO) emailed Mike Yarborough (CRC Consultants) regarding her availability for a call to discuss the APE.	SHPO 20	13-02-13SHPOsDuvall.pdf
2/20/2013	Mike Salzetti (HEA) emailed Scott Ayers (ADFG) the completed Fish Resources Permit application.	ADFG 20	13-02-20ADFGsAyers.pdf
2/21/2013	Cory Warnock (McMillen) emailed Scott Ayers (ADFG) the link to the Multi-Agency Permit Application.	ADFG 20	13-02-21ADFGsAyers.pdf
2/21/2013	Cory Warnock (McMillen) exchaged emails with Scott Ayers (ADFG) regarding the receipt of and approximate timeframe for processing the Fish Resources Permit application.	ADFG 20	13-02-21ADFGsAyers2.pdf
2/22/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller and Shawn Johnson (ADFG) regarding the potential for ADFG to assist with fish DNA sampling.	ADFG 20	13-02-22ADFGmMiller.pdf
2/26/2013	Mike Salzetti (HEA) emailed Claire Leclair (ADNR) requesting a status on the processing of the Multi-Agency Permit Application.	ADNR 20	13-02-26ADNRcLeclair.pdf
2/26/2013	Mike Yarborough (CRC Consultants) emailed CRWG members a second time regarding scheduling a meeting to discuss the APE.	CRWG 2	013-02-26CRWGmtgDateRequest.pdf
2/26/2013	Frank Winchell (FERC) emailed Mike Yarborough (CRC Consultants) regarding his availability for a call to discuss the APE.	FERC 20	13-02-26FERCfWinchell.pdf
2/27/2013	Levia Shoutis (ERM) exchanged emails with Rob Develice (USFS) regarding vegetation cover type maps.	USFS 20	13-02-27USFSrDevelice.pdf
2/27/2013	Katy Beck (Beck Botanical) and Betty Charnon (USFS) discussed via phone sensitive plants and invasive weeds in the vicinity of the proposed Grant Creek Project.	USFS 2	013-02-27USFSbCharnon.pdf
2/27/2013	Ed DeCleva (USFS) emailed Mike Yarborough (CRC Consultants) regarding his availability for a call to discuss the APE.	USFS 20	13-02-27USFSeDeCleva.pdf
2/27/2013	Mike Salzetti (HEA) filed with FERC the second preliminary permit progress report.	FERC 2	013-02-27ProgressReport2nd.pdf
3/4/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the status on the processing of the Multi-Agency Permit Application.	ADNR 20	13-03-04ADNRcLeclair.pdf
3/5/2013	Cory Warnock (McMillen) and Claire Leclair (ADNR) discussed via phone clarifying questions ADNR had regarding the Multi-Agency Permit Application.	ADNR 20	13-03-05ADNRcLeclair.pdf
3/7/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding the contact information for the ADFG representative to discuss the potential for ADFG assisting with fish DNA sampling.	ADFG 20	13-03-07ADFGmMiller.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
3/7/2013	Cory Warnock (McMillen) and Bill Templin (ADFG) discussed via phone HEA using ADFG genetic sampling supplies and the potential for ADFG's lab to conduct genetic analysis of anadromous fish samples.	ADFG 20	13-03-07ADFGbTemplin.pdf
3/7/2013	Ed DeCleva (USFS) emailed Mike Yarborough (CRC Consultants) checking in on the status of scheduling a call to discuss the APE.	USFS 20	13-03-07USFSeDeCleva.pdf
3/8/2013	Cory Warnock (McMillen) emailed Bill Templin (ADFG) the Aquatic Resources Study Plan with regard to an ongoing discussion about ADFG assisting HEA with fish DNA sampling.	ADFG 20	13-03-08ADFGbTemplin.pdf
3/8/2013	Mike Yarborough (CRC Consultants) emailed Ed DecLeva (USFS) with a status on the scheduling of a call to discuss the APE.	USFS 20	13-03-08USFSeDeCleva.pdf
3/11/2013	Cory Warnock (McMillen) exchanged emails with Kathy VanMassenhove (USFS) regarding clarifying questions about coverage of digging as part of the 2013 Grant Lake study efforts under the Special Use Permit amendment.	USFS 2	013-03-11USFSkVanMassenhove.pdf
3/12/2013	Cory Warnock (McMillen) and Scott Ayers (ADFG) exchanged emails regarding ADFG follow up questions regarding the Fish Resources Permit application.	ADFG 20	13-03-12ADFGsAyers.pdf
3/13/2013	Cory Warnock (McMillen) and Andy Barclay (ADFG) exchanged emails regarding scheduling a call to discuss fish DNA sampling.	ADFG 20	13-03-13ADFGaBarclay.pdf
3/13/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) regarding responses to ADFG follow up questions related to the Fish Resources Permit application.	ADFG 20	13-03-13ADFGsAyers.pdf
3/13/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the status on the processing of the Multi-Agency Permit Application, specifically as it relates to ground-disturbing activity.	ADNR 20	13-03-18ADNRcLeclair.pdf
3/14/2013	Cory Warnock (McMillen) and Andy Barclay (ADFG) discussed via phone fish DNA sampling.	ADFG 20	13-03-14ADFGaBarclay.pdf
3/18/2013	Scott Ayers (ADFG) emailed Mike Salzetti (HEA) about issuance of the Fish Resource Permit for the Grant Lake studies program.	ADFG 20	13-03-18ADFGsAyers.pdf
3/19/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) regarding HEA questions related to the Fish Resource Permit.	ADFG 20	13-03-19ADFGsAyers.pdf
3/19/2013	Cory Warnock (McMillen) and Ken Hogan (FERC) discussed via phone the status of the licensing process and filing of the final study plans.	FERC 20	13-03-19FERCkHogan.pdf
3/20/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) regarding a request to amend the Fish Resource Permit.	ADFG 20	13-03-20ADFGsAyers.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
3/20/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding confirmation that the pending ADNR permit is not needed to conduct the fish survey work by foot along Grant Creek.	ADNR 20	13-03-20ADNRcLeclair.pdf
3/20/2013	Cory Warnock (LVA) emailed licensing participants the December 12, 2012 Natural Resources Studies Meeting summary, the Final Study Plans comment/response table, and notification of the availability of revised Final Study Plans on the Project website.	All Licensing Contacts	2013-03-20FinalStudyPlans.pdf
3/20/2013	Cory Warnock (McMillen) exchanged emails with Eric Volk (ADFG) regarding scheduling a call to discuss scale sampling.	ADFG 20	13-03-20ADFGeVolk.pdf
3/21/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the potential need to amend the existing Special Use Permit for ground disturbing activities related to the 2013 Grant Lake study program.	USFS 2	013-03-21USFSkVanMassenhove.pdf
3/25/2013	Cory Warnock (McMillen) emailed Andy Barclay (ADFG) regarding scheduling a call to discuss fish DNA sampling.	ADFG 20	13-03-25ADFGaBarclay.pdf
3/25/2013	Mike Salzetti (HEA) filed with FERC the Final Study Plans, comment/response tables related to comments on the Final Study Plans as discussed at the December 12, 2012 Natural Resources Studies Meeting, and the December 12 meeting summary.	FERC 20	13-03-25FinalStudyPlans.pdf
3/25/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding scheduling a call to discuss the need to amend the existing Special Use Permit for ground disturbing activities related to the 2013 Grant Lake study program.	USFS 2	013-03-25USFSkVanMassenhove.pdf
3/26/2013	Scott Ayers (ADFG) emailed Cory Warnock (McMillen) an amendment to the Fish Resource Permit.	ADFG 20	13-03-26ADFGsAyers.pdf
3/27/2013	Cory Warnock (McMillen) exchanged emails with Eric Volk (ADFG) regarding scheduling a call to discuss scale sampling.	ADFG 20	13-03-27ADFGeVolk.pdf
3/27/2013	Mike Salzetti (HEA), Cory Warnock (McMillen), Andy Barclay (ADFG), and Bill Templin (ADFG) discussed via phone ADFG assisting HEA with fish DNA sampling.	ADFG 20	13-03-27ADFGaBarclay.pdf
3/28/2013	Cory Warnock (McMillen) and Mark Willette (ADFG) discussed via phone the potential for Mr. Willette's group to provide scale cards and subsequent analysis of Chinook scales.	ADFG 2	013-03-28ADFGmWillette.pdf
3/28/2013	Cory Warnock (McMillen) and Tim McKinley (ADFG) discussed via phone the potential for scale reabsorption to be an issue with Chinook in the upper Kenai Watershed.	ADFG 20	13-03-28ADFGtMcKinley.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
3/28/2013	Cory Warnock (McMillen) called various ADFG staff to inform them of the start of the Grant Lake Study Program, per requirements of HEA's Fish Habitat Permit and Fish Resource Permit.	ADFG 2	013-03-28ADFGstudyNotifications.pdf
3/29/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the status of the pending ADNR Special Park Use permit.	ADNR 20	13-03-29ADNRcLeclair.pdf
3/29/2013	Mike Salzetti (HEA), Cory Warnock (McMillen), and Katherine VanMassenhove (USFS) discussed via phone the pending amendment to the existing Special Use Permit to allow for wetlands core sampling.	USFS 2	013-03-29USFSkVanMassenhove.pdf
4/1/2013	Cory Warnock (McMillen) emailed Pam Russell (ADNR) regarding whether there are any permits needed by the State to allow for wetlands core sampling.	ADNR 2	013-04-01ADNRpRussell.pdf
4/1/2013	Mike Salzetti (HEA) and Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding fees associated with the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-04-01USFSkVanMassenhove.pdf
4/1/2013	Cory Warnock (McMillen) emailed Clair Leclair (ADNR) requested information regarding the planned wetlands core sampling.	ADNR 20	13-04-01ADNRcLeclair.pdf
4/2/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the status of the pending ADNR Special Park Use permit.	ADNR 20	13-04-02ADNRcLeclair.pdf
4/2/2013	Sarah Meitl (CRC Consultants) emailed Dara Glass (CIRI), Sherry Nelson (USFS), Shina DuVall (SHPO), and Frank Winchell (FERC) an agenda for the April 3, 2013 call to discuss the APE.	FERC; USFS; SHPO; Cook Inlet Region	2013-04-02APEdiscussionAgenda.pdf
4/2/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the stipulation in the issued ADNR Special Park Use permit regarding vegetation clearing.	ADNR 20	13-04-02ADNRcLeclair2.pdf
4/3/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding the stipulation in the issued ADNR Special Park Use permit associated with hauling out human waste.	ADNR 20	13-04-02ADNRcLeclair3.pdf
4/3/2013	HEA held a CRWG conference call to discuss the Area of Potential Effect (APE).	CRWG 20	13-04-03CRWGmtg.pdf
4/4/2013	Cory Warnock (McMillen) exchanged emails with Jack Blackwell and Claire Leclair (ADNR) regarding scheduling of a site visit at the Grant Creek man camp.	ADNR 20	13-04-04ADNRjBlackwell.pdf
4/4/2013	Cory Warnock (McMillen) emailed Claire Leclair (ADNR) the signed stream gauge Special Park Use Permit.	ADNR 20	13-04-04ADNRcLeclair.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
4/5/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) regarding an error with the permit number identified in the ground disturbing Special Park Use permit.	ADNR 20	13-04-05ADNRcLeclair.pdf
4/5/2013	Claire Leclair (ADNR) emailed Cory Warnock (McMillen) links to information related to regarding management of human waste in remote camps.	ADNR 20	13-04-05ADNRcLeclair2.pdf
4/5/2013	Cory Warnock (McMillen) exchanged emails with Katherine McCafferty (USACE) regarding scheduling a call to discuss the planned wetlands core sampling.	USACE 20	13-04-05USACEkMcCafferty.pdf
4/15/2013	Cory Warnock (McMillen) exchanged emails with Candice Snow (ADNR) regarding schedule a call to discuss the potential need for a ANDR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-04-15ADNRcSnow.pdf
4/16/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-04-16USFSkVanMassenhove.pdf
4/16/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) requesting clarification regarding the proposed technique for marking fish relative to the provisions of the Fish Resource Permit.	ADFG 20	13-04-16ADFGsAyers.pdf
4/16/2013	Candice Snow (ADNR) emailed Charles Sauvageau (McMillen) the application for ANDR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-04-16ADNRcSnow.pdf
4/16/2013	Cory Warnock, Charles Sauvageau (McMillen), and Candice Snow (ADNR) discussed by phone the need for an ANDR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-04-16ADNRcSnow2.pdf
4/16/2013	Cory Warnock (McMillen), Levia Shoutis and Jeanette Blank (ERM), and Katherine McCafferty (USACE) discussed by phone the planned wetlands core sampling.	USACE 20	13-04-16USACEkMcCafferty.pdf
4/17/2013	Cory Warnock (McMillen) exchanged emails with Candice Snow (ADNR) regarding completion of application for ANDR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-04-17ADNRcSnow.pdf
4/17/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) regarding scheduling a call to discuss potential techniques for marking fish relative to the provisions of the Fish Resource Permit.	ADFG 20	13-04-17ADFGsAyers.pdf
4/17/2013	Sarah Meitl (CRC Consultants) exchanged emails with Sherry Nelson and Katherine VanMassenhove (USFS) regarding requested information related to the cultural resources survey provided by CRC Consultants to the USFS.	USFS 2	013-04-17USFSsNelson.pdf

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4/17/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) confirming a call for April 18 to discuss potential techniques for marking fish relative to the provisions of the Fish Resource Permit.	ADFG 20	13-04-17ADFGsAyers2.pdf
4/18/2013	Cory Warnock (McMillen) emailed Candice Snow (ADNR) the completed and signed application for an ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-04-18ADNRcSnow.pdf
4/18/2013	Cory Warnock (McMillen), John Stevenson and Mark Miller (BioAnalysts), and Scott Ayers (ADFG) discussed by phone potential techniques for marking fish relative to the provisions of the Fish Resource Permit.	ADFG 20	13-04-18ADFGsAyers.pdf
4/19/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) with follow up questions to the April 18 call to discuss potential techniques for marking fish relative to the provisions of the Fish Resource Permit.	ADFG 20	13-04-19ADFGsAyers.pdf
4/19/2013	Cory Warnock (McMillen) exchanged emails with Jack Blackwell (ADNR) following up to ADNR's April 15 site visit to the Grant Creek man camp and agreement to amend the ground disturbing permit.	ADNR 20	13-04-19ADNRjBlackwell.pdf
4/19/2013	Mike Salzetti (HEA) mailed a letter to Judith Bittner (SHPO) regarding the proposed APE.	SHPO 2	013-04-19SHPOjBittner.pdf
4/22/2013	Mike Salzetti (HEA) filed with FERC the April 3 CRWG conference call meeting summary.	FERC 20	13-04-22CRWGmtgNotes.pdf
4/23/2013	Cory Warnock (McMillen) discussed with Scott Ayers (ADFG) by phone the potential use of staining baths versus VIE tags.	ADFG 20	13-04-23ADFGsAyers.pdf
4/24/2013	Claire Leclair emailed Cory Warnock (McMillen) a revised ground disturbing Special Park Use permit with the correct permit number.	ADNR 20	13-04-24ADNRcLeclair.pdf
4/24/2013	Cory Warnock (McMillen) emailed with Sherry Nelson (USFS) requesting a status update on the proposed approach for the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-04-24USFSsNelson.pdf
4/25/2013	Scott Ayers (ADFG) emailed Mike Salzetti (HEA) an amendment to the Fish Resource Permit.	ADFG 20	13-04-25ADFGsAyers.pdf
4/25/2013	Cory Warnock (McMillen) and Sherry Nelson (USFS) discussed by phone the USFS' preferred approach for the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-04-25USFSsNelson.pdf
4/29/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) requesting a status on issuance of the amendment to the ground disturbing Special Park Use permit.	ADNR 20	13-04-29ADNRcLeclair.pdf
4/29/2013	Scott Ayers (ADFG) emailed Mike Salzetti (HEA) a revised amendment to the Fish Resource Permit.	ADFG 20	13-04-29ADFGsAyers.pdf

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4/29/2013	Cory Warnock (McMillen) exchanged emails with Shina Duvall (SHPO) confirming receipt of HEA's April 19 regarding the proposed APE.	SHPO 20	13-04-29SHPOsDuvall.pdf
4/30/2013	Claire Leclair (ADNR) emailed Cory Warnock (McMillen) the amendment to the ground disturbing Special Park Use permit.	ADNR 20	13-04-30ADNRcLeclair.pdf
5/3/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) clarifying the proposed approach for the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-05-03USFSkVanMassenhove.pdf
5/7/2013	Cory Warnock (McMillen) exchanged emails with Candice Snow (ADNR) regarding the status of the application for an ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-05-07ADNRcSnow.pdf
5/7/2013	Cory Warnock (McMillen) emailed Shina Duvall (SHPO) a letter from HEA confirming the proposed approach for the amendment to the existing Special Use Permit for ground disturbing activities.	SHPO 20	13-05-07SHPOsDuvall.pdf
5/8/2013	Judith Bittner (SHPO) mailed a letter to Mike Salzetti (HEA) confirming the proposed APE and the proposed approach for the amendment to the existing Special Use Permit for ground disturbing activities.	SHPO 2	013-05-08SHPOjBittner.pdf
5/10/2013	Jeanette Blank (ERM) emailed Katherine McCafferty (USACE) a memo summarizing the proposed wetlands functional assessment methodology.	USACE 20	13-05-10USACEkMcCafferty.pdf
5/13/2013	Cory Warnock (McMillen) exchanged emails with Claire Leclair (ADNR) confirming that provisions of the ground disturbing Special Park Use permit allow for the cutting/removal of dead/downed logs for purposes of accessing the stream.	ADNR 20	13-05-13ADNRcLeclair.pdf
5/14/2013	Cory Warnock (McMillen) exchanged emails with Candice Snow (ADNR) regarding the status of the application for an ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-05-14ADNRcSnow.pdf
5/21/2013	Cory Warnock (McMillen) exchanged emails with Ed DeCleva, Sherry Nelson, and Katherine VanMassenhove (USFS) confirming that the SHPO has all relevant information to issue the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 20	13-05-21USFSeDecleva.pdf
5/23/2013	Jeanette Blank (ERM) emailed Katherine McCafferty (USACE) a second time a memo summarizing the proposed wetlands functional assessment methodology.	USACE 20	13-05-23USACEkMcCafferty.pdf
5/23/2013	Emily Hutchison (HEA) emailed Candice Snow (ADNR) certificate of insurance for the ADNR permit related to the installation of thermistors in Grant Lake.	USFS 2	013-05-23ADNRcSnow.pdf

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5/24/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the status for processing the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-05-24USFSkVanMassenhove.pdf
5/28/2013	Sherry Nelson (USFS) emailed HEA, McMillen, and other USFS staff confirming that the SHPO has all relevant information to issue the amendment to the existing Special Use Permit for ground disturbing activities.	USFS 2	013-05-28USFSsNelson.pdf
5/30/2013	Katherine VanMassenhove (USFS) emailed Cory Warnock (McMillen) the fully executed amendment to the existing Special Use Permit, specific to the cultural resources study.	USFS 2	013-05-30USFSkVanMassenhove.pdf
6/5/2013	Mike Salzetti (HEA) emailed Candice Snow (ADNR) the bond for the ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-06-05ADNRcSnow.pdf
6/11/2013	Monet Miller (ADFG) emailed Cory Warnock (McMillen) comments to the final study plans for the water, aquatics, and terrestrial resources.	ADFG 20	13-06-11ADFGmMiller.pdf
6/12/2013	Cory Warnock (McMillen) exchanged emails with Candice Snow (ADNR) regarding the status of the issuance of an ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-06-12ADNRcSnow.pdf
6/12/2013	Candice Snow (ADNR) emailed Mike Salzetti (HEA) the fully executed ADNR permit related to the installation of thermistors in Grant Lake.	ADNR 2	013-06-12ADNRcSnow2.pdf
6/13/2013	Cory Warnock (McMillen) and Ken Hogan (FERC) discussed by phone a number of items pertaining to the Project.	FERC 20	13-06-13FERCkHogan.pdf
6/14/2013	Cory Warnock (McMillen) exchanged emails with Tom Harkreader (White Rock Mining) regarding the current status of the Falls Creek Project at FERC.	White Rock Mining	2013-06-14FallsCrInquiry.pdf
6/14/2013	Cory Warnock (McMillen) forwarded to Tom Harkreader (White Rock Mining) an email from FERC staff related to Section 24 reserved authority for the Falls Creek Project.	White Rock Mining	2013-06-14FallsCrInquiry2.pdf
6/17/2013	Mike Salzetti (HEA) exchanged emails with Paul Torgerson (Grant Lake Mining) regarding the current status of the Grant Lake Project licensing process.	Grant Lake Mining	2013-06-17GrLkMiningPtorgerson.pdf
6/21/2013	Cory Warnock (McMillen) exchanged emails with Scott Ayers (ADFG) requesting an amendment to the Fish Resource Permit to allow for continued tagging of rainbow through the month of July.	ADFG 20	13-06-21ADFGsAyers.pdf
6/21/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the status for processing the amendment to the existing Special Use Permit for ground disturbing activities, specifically for the cultural resources work.	USFS 2	013-06-21USFSkVanMassenhove.pdf

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6/24/2013	Scott Ayers (ADFG) emailed Mike Salzetti (HEA) a signed amendment to the Fish Resource Permit (4).	ADFG 20	13-06-24ADFGsAyers.pdf
6/26/2013	Katy Beck (Beck Botanicals) emailed Betty Charnon (USFS) requesting completion of the pre-field sensitive plant review form.	USFS 2	013-06-26USFSbCharnon.pdf
6/27/2013	Andrew Scott (McMillen) exchanged emails with Brock Tabor (ADEC) regarding relevant water quality standards.	ADEC 20	13-06-27ADECbTabor.pdf
6/27/2013	Andrew Scott (McMillen) and Brock Tabor (ADEC) discussed via phone relevant water quality standards.	ADEC 20	13-06-27ADECbTabor2.pdf
6/27/2013	Nancy Norvell (Alaska Natural Heritage Program) emailed Katy Beck (Beck Botanicals) GIS data regarding sensitive plant locations in the Grant Lake Project area.	Alaska Natural Heritage Program	2013-06-27AKNHPnNorvell.pdf
6/27/2013	Katy Beck (Beck Botanicals) exchanged emails with Betty Charnon (USFS) regarding sensitive and invasive plant species in the Grant Lake Project area.	USFS 2	013-06-27USFSbCharnon.pdf
6/27/2013	Linda Kelly (USFS) emailed Katy Beck (Beck Botanicals) a draft map of invasive plant species occurrences in the Grant Lake Project area.	USFS 20	13-06-27USFSlKelly.pdf
6/27/2013	Katy Beck (Beck Botanicals) exchanged emails with Matt Carlson (Alaska Natural Heritage Program) regarding the GIS data for sensitive plant locations in the Grant Lake Project area.	Alaska Natural Heritage Program	2013-06-27AKNHPmCarlson.pdf
7/8/2013	Katherine VanMassenhove (USFS) emailed Mike Salzetti (HEA) a fully executed amendment to the existing Special Use Permit for ground disturbing activities, specifically for the cultural resources work.	USFS 2	013-07-08USFSkVanMassenhove.pdf
7/11/2013	Nancy Norvell (Alaska Natural Heritage Program) emailed Katy Beck (Beck Botanicals) a map of sensitive plant locations in the Grant Lake Project area. NOTE: Map is designated privileged.	Alaska Natural Heritage Program	2013-07-11AKNHPnNorvell.pdf
7/22/2013	Dwayne Adams (USKH) met with Lesli Schick (ADNR) to discuss the approach for the INHT relocation from its currently planned location and easement.	ADNR 20	13-07-22ADNRlSchick.pdf
7/26/2013	Dwayne Adams (USKH) and Katherine Van Massenhove (USFS) discussed via phone who the USFS staff person(s) is responsible for the INHT.	USFS 2	013-07-26USFSkVanMassenhove.pdf
7/30/2013	Cory Warnock (McMillen) exchanged emails with Ken Gates (USFWS) regarding update on current fish capture numbers related to the Grant Lake Project aquatics studies.	USFWS 20	13-07-30USFWSkGates.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
8/5/2013	Cory Warnock (McMillen) exchanged emails with Ken Gates (USFWS) regarding update on current fish capture numbers related to the Grant Lake Project aquatics studies.	USFWS 20	13-08-05USFWSkGates.pdf
8/7/2013	Dwayne Adams (USKH) met with Alice Rein (USFS) to discuss who the USFS staff person(s) is responsible for the INHT.	USFS 20	13-08-07USFSaRein.pdf
8/8/2013	Cory Warnock (McMillen) exchanged emails with William Ashton (ADEC) regarding the requirements for a QAPP related to water quality studies.	ADEC 20	13-08-08ADECwAshton.pdf
8/8/2013	Cory Warnock (McMillen) emailed licensing participants notice regarding a September 5 agency site visit.	All Licensing Contacts	2013-08-08SiteVisitNotice.pdf
8/8/2013	Cory Warnock (McMillen) emailed Ken Gates (USFWS) preliminary data collected from the weir.	USFWS 20	13-08-08USFWSkGates.pdf
8/8/2013	Cory Warnock (McMillen) exchanged emails with Lynnda Kahn (USFWS) regarding who is the primary fisheries USFWS representative.	USFWS 20	13-08-08USFWSlKahn.pdf
8/8/2013	Cory Warnock (McMillen) exchanged emails with Jeff Anderson (USFWS) regarding is unavailability to attend the September 5, 2013 project site visit.	USFWS 20	13-08-08USFWSjAnderson.pdf
8/13/2013	Ken Gates (USFWS) emailed Cory Warnock (McMillen) regarding the preliminary data collected from the weir.	USFWS 20	13-08-13USFWSkGates.pdf
8/15/2013	Cory Warnock (McMillen) emailed licensing participants additional information regarding the September 5 agency site visit.	All Licensing Contacts	2013-08-15SiteVisitNotice2.pdf
8/20/2013	Cory Warnock (McMillen) emailed Lesli Schick and Pam Russell (ADNR) regarding INHT discussions relative to the September 5 project site visit.	ADNR 20	13-08-20ADNRlSchickPrussell.pdf
8/23/2013	Mike Salzetti (HEA) filed with FERC a response letter to ADFG's informal study plan comments.	FERC 2	013-08-23StPlCommentResponses.pdf
8/23/2013	Amal Ajmi (ERM) emailed Jeff Selinger (ADFG) regarding planning for upcoming moose surveys.	ADFG 20	13-08-23ADFGjSelinger.pdf
8/26/2013	Cory Warnock (McMillen) emailed Monte Miller (ADFG) a letter (dated August 20) with HEA responses to ADFG study plan comments.	ADFG 20	13-08-26ADFGmMiller.pdf
8/27/2013	Cory Warnock (McMillen) emailed site visit participants with logistical details regarding the September 5 visit.	All Licensing Contacts	2013-08-27SiteVisitDetails.pdf
8/27/2013	Cory Warnock (McMillen) emailed licensing participants a letter with HEA responses to ADFG study plan comments.	All Licensing Contacts	2013-08-27StPlCommentResponses2.pdf
8/27/2013	Cory Warnock (McMillen) emailed licensing participants the third Project progress report as filed with FERC.	All Licensing Contacts	2013-08-27ProgressReport.pdf
8/28/2013	Amal Ajmi (ERM) and Jeff Selinger (ADFG) discussed by phone planning for upcoming moose surveys.	ADFG 20	13-08-28ADFGjSelinger.pdf

Date	**Summary of Contact**	**Agency/Organization Consulted**	**Documentation filename (pdf)**
8/30/2013	Cory Warnock (McMillen) emailed site visit participants final logistical details regarding the September 5 visit.	All Licensing Contacts	2013-08-30SiteVisitDetails2.pdf
9/5/2013	HEA conducted a site visit of the Grant Lake Project. Al	l Licensing Contacts	2013-09-05SiteVisit.pdf
9/5/2013	Dwayne Adams (USKH) and John Eavis (USFS) discussed via phone a November INHT meeting. (Dwayne left voicemails for Eavis to discuss same further on 9/23, 9/26, and 10/21.)	USFS 20	13-09-05USFSjEavis.pdf
9/9/2013	Patti Berkhahn (ADFG) emailed Mike Salzetti (HEA) and John Stevenson (BioAnalysts) regarding the fuel containment structure currently located near the weir.	ADFG 20	13-09-09ADFGpBerkhahn.pdf
9/9/2013	Cory Warnock (McMillen) emailed licensing participants regarding the tentative plan for upcoming natural resources study report distribution and organization of work groups that will meet to discuss the study results.	All Licensing Contacts	2013-09-09WGmtgOrg.pdf
9/9/2013	Cassie Thomas (NPS) emailed Cory Warnock (McMillen) regarding work group designation.	NPS 20	13-09-09NPScThomas.pdf
9/9/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding work group designations and issues related to the fuel containment structure currently located near the weir as discussed at the September 5 project site visit.	ADFG 20	13-09-09ADFGmMiller.pdf
9/9/2013	Brenda Trefon (Kenaitze Indian Tribe) emailed Cory Warnock (McMillen) regarding work group designations.	Kenaitze Indian Tribe	2013-09-09KenaitzeBtrefon.pdf
9/10/2013	Eric Rothwell (NOAA Fisheries) emailed Cory Warnock (McMillen) regarding work group designations.	NOAA 2	013-09-10NOAAeRothwell.pdf
9/10/2013	David Griffin (ADNR) emailed Cory Warnock (McMillen) regarding work group designations.	ADNR 2	013-09-10ADNRdGriffin.pdf
9/10/2013	Cory Warnock (McMillen) exchanged emails with Pam Russell (ADNR) regarding work group designations and issues related to the fuel containment structure currently located near the weir as discussed at the September 5 project site visit.	ADNR 2	013-09-10ADNRpRussell.pdf
9/10/2013	Patti Berkhahn (ADFG) emailed Cory Warnock (McMillen) regarding work group designations.	ADFG 20	13-09-10ADFGpBerkhahn.pdf
9/11/2013	Cory Warnock (McMillen) exchanged emails with Paul Torgerson (Grant Lake Mining) about timing of distribution of study reports.	Grant Lake Mining	2013-09-11GrLkMiningPtorgerson.pdf
9/13/2013	Jan Konigsberg (HRC) emailed Cory Warnock (McMillen) regarding work group designations.	HRC 20	13-09-13HRCjKonigsberg.pdf
9/13/2013	Katy Beck (Beck Botanicals) exchanged emails with Betty Charnon (USFS) regarding guidance related to preparing a botany resource report.	USFS 2	013-09-13USFSbCharnon.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
9/14/2013	Mike Cooney emailed Cory Warnock (McMillen) regarding work group designations.	Citizen 2	013-09-14mCooney.pdf
9/14/2013	Robert Baldwin (Kenai River Watershed Foundation) emailed Cory Warnock (McMillen) regarding work group designations.	Kenai River Watershed Foundation	2013-09-14KenaiWatershedRbaldwin.pdf
9/16/2013	Katy Beck (Beck Botanicals) exchanged emails with Rob Develice and Betty Charnon (USFS) regarding information and guidelines related to invasive plant species in Alaska.	USFS 20	13-09-16USFSrDevelice.pdf
9/17/2013	Mike Salzetti (HEA) emailed Doug Ott (AEA) regarding communications with Grant Lake Mining.	AEA 20	13-09-17AEAdOtt.pdf
9/17/2013	Cory Warnock (McMillen) emailed licensing participants that the fuel containment issue raised at the September 5 project site visit has been resolved.	All Licensing Contacts	2013-09-17FuelContainment.pdf
9/17/2013	Paul Torgerson (Grant Lake Mining) emailed Cory Warnock (McMillen) regarding work group designations.	Grant Lake Mining	2013-09-17GrLkMiningPtorgerson.pdf
9/18/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding communications with Paul Torgerson (Grant Lake Mining).	ADFG 20	13-09-18ADFGmMiller.pdf
9/19/2013	Cory Warnock (McMillen) emailed Paul Torgerson (Grant Lake Mining) regarding his request to participate in work group meetings and a general status update of the Grant Lake Project licensing process.	Grant Lake Mining	2013-09-19GrLkMiningPtorgerson.pdf
9/23/2013	Cory Warnock (McMillen) emailed licensing participants who did not respond with the first inquiry regarding the work group he/she would like to participate in.	All Licensing Contacts	2013-09-23WGrequests.pdf
9/23/2013	Kathleen Mushovic (BLM) emailed Cory Warnock (McMillen) regarding work group designations.	BLM 20	13-09-23BLMkMushovic.pdf
9/23/2013	Cory Warnock (McMillen) exchanged emails with Doug Ott (AEA) regarding work group designations.	AEA 20	13-09-23AEAdOtt.pdf
9/23/2013	Dwayne Adams (USKH) exchanged emails with John Eavis (USFS) regarding scheduling of a INHT meeting.	USFS 20	13-09-23USFSjEavis.pdf
9/25/2013	Katie McCafferty (USACE) emailed Cory Warnock (McMillen) regarding work group designations.	USACE 20	13-09-25USACEkMcCafferty.pdf
9/25/2013	Joe Klein (ADFG) emailed Cory Warnock (McMillen) regarding work group designations.	ADFG 2	013-09-25ADFGjKlein.pdf
9/27/2013	Cory Warnock (McMillen) emailed Pam Russell (ADNR) and Patti Berkhahn (ADFG) with a photo of the fuel containment structure.	ADFG; ADNR	2013-09-27ADNRpRussellADFGpBerkhahn.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
9/30/2013	Scott Ayers (ADFG) emailed Cory Warnock Amendment 5 to the Fish Resource Permit.	ADFG 20	13-09-30ADFGsAyers.pdf
10/7/2013	Cory Warnock (McMillen) emailed Patti Berkhahn and Ginny Litchfield (ADFG) regarding possible need for permit amendment in order to utilize box trap.	ADFG 20	13-10-07ADFGpBerkhahn.pdf
10/7/2013	Cory Warnock (McMillen) and Patti Berkhahn (ADFG) exchanged emails regarding written authorization to permit use of box trap.	ADFG 20	13-10-07ADFGpBerkhahn2.pdf
10/21/2013	Dwayne Adams (USKH) emailed John Eavis (USFS) regarding scheduling of a INHT meeting.	USFS 20	13-10-21USFSjEavis.pdf
10/23/2013	Cory Warnock (McMillen) exchanged emails with Eric Rothwell (NOAA Fisheries) regarding general Grant Lake Hydroelectric Project information and potential agency meeting dates for discussing study reports.	NOAA 2	013-10-23NOAAeRothwell.pdf
10/23/2013	Dwayne Adams (USKH) exchanged emails with John Eavis (USFS) regarding scheduling of a INHT meeting.	USFS 20	13-10-23USFSjEavis.pdf
10/24/2013	Dwayne Adams (USKH) and Pam Russell (ADNR) discussed via phone a November INHT meeting. (Dwayne left voicemails for Russell to discuss same on 8/12 and 8/27.)	ADNR 2	013-10-24ADNRpRussell.pdf
10/28/2013	Dwayne Adams (USKH) emailed interested licensing participants notice of a November 13, 2013 INHT meeting.	ADFG; ADNR; USFS; Kenai Peninsula Borough	2013-10-28INHTmtgNotice.pdf
11/1/2013	Amal Ajmi (ERM) exchanged emails with Katherine VanMassenhove (USFS) regarding winter moose surveys and relevant permits.	USFS 2	013-11-01USFSkVanMassenhove.pdf
11/6/2013	Dwayne Adams (USKH) emailed interested licensing participants materials for the November 13, 2013 INHT meeting. NOTE: Map is designated privileged.	ADFG; ADNR; USFS; Kenai Peninsula Borough	2013-11-06INHTmtgMaterials.pdf
11/7/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding winter moose surveys and reissuance of the existing special use permit.	USFS 2	013-11-07USFSkVanMassenhove.pdf
11/11/2013	Cory Warnock (McMillen) emailed Andy Barclay (ADFG) inquiring about assisting with genetic sampling of anadromous species.	ADFG 20	13-11-11ADFGaBarclay.pdf
11/12/2013	Cory Warnock (McMillen) emailed Ken Gates (USFWS) preliminary weir data collected during the 2013 field season.	USFWS 20	13-11-12USFWSkGates.pdf
11/13/2013	Dwayne Adams (USKH) exchanged emails with Lesli Schick (ADNR) regarding next steps for laying out the INHT route.	ADNR 20	13-11-13ADNRlSchick.pdf

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11/13/2013	HEA held a meeting to discuss the re-route of the INHT. NOTE: Presentation is designated privileged.	All Licensing Contacts	2013-11-13INHTmtg.pdf
11/15/2013	John Blum (McMillen) emailed Eric Rothwell (NOAA Fisheries), Jeff Anderson (USFWS) and Monte Miller (ADFG) regarding the status of the Grant Creek instream flow (IFIM) study and the Washington Department of Fish and Widlife's IFIM study guidelines.	ADFG; USFWS; NOAA	2013-11-15HSI curves.pdf
11/18/2013	Cory Warnock (McMillen) emailed Shina Duvall and Lesli Schick (ADNR) follow up to the November 13, 2013 meeting regarding the proposed INHT route.	ADNR 20	13-11-18ADNRlSchickSduvall.pdf
11/19/2013	Cory Warnock (McMillen) exchanged emails with Eric Rothwell (NOAA Fisheries) and Monte Miller (ADFG) regarding habitat suitability (HSI) curves.	ADFG; NOAA	2013-11-19HSIcurves.pdf
11/19/2013	Monte Miller (ADFG) emailed Eric Rothwell (NOAA Fisheries), Jeff Anderson (USFWS), Joe Klein (ADFG), and Cory Warnock and John Blum (McMillen) the Cooper Lake Project instream flow study report (attachment not included).	ADFG; USFWS; NOAA	2013-11-19ADFGmMiller.pdf
11/20/2013	Cory Warnock (McMillen) exchanged emails with Eric Rothwell (NOAA Fisheries) regarding scheduling a call to discuss HSI curves.	NOAA 2	013-11-20NOAAeRothwell.pdf
11/20/2013	Cory Warnock (McMillen) exchanged emails with Shina Duvall and Lesli Schick (ADNR) regarding scheduling a call to discuss cultural resources and the proposed INHT route.	ADNR 20	13-11-20ADNRsDuvallLschick.pdf
11/22/2013	HEA held a conference call to discuss the INHT reroute and the associated cultural/historical impacts.	ADNR 2	013-11-22INHTsection106Call.pdf
11/25/2013	Cory Warnock (McMillen) exchanged emails with Jeff Anderson (USFWS) regarding a proposed date for a call to discuss HSI curves.	USFWS 20	13-11-25HSIcurves.pdf
11/25/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding a proposed date for a call to discuss HSI curves.	ADFG 20	13-11-25HSCIcurves2.pdf
11/27/2013	HEA held a conference call to discuss HSI curves.	ADFG; USFWS; NOAA	2013-11-27HSIcurveCall.pdf
12/2/2013	Cory Warnock (McMillen) and Mark Luttrell (Artifact Illustration) exchanged emails regarding the overall status of the Grant Lake licensing process and the activities related to cultural resources.	Artifact Illustration	2013-12-02ArtifactIllustrationMluttrell.pdf
12/2/2013	Cory Warnock (McMillen) exchanged emails with Harold Shepherd (Center for Water Advocacy) regarding work group designations.	Center for Water Advocacy	2013-12-02CWAhShepherd.pdf
12/2/2013	Cory Warnock (McMillen) exchanged emails with Mark Willette (ADFG) regarding the Chinook scale sample aging effort.	ADFG 2	013-12-02ADFGmWillette.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
12/5/2013	John Blum (McMillen) emailed Eric Rothwell (NOAA Fisheries), Jeff Anderson (USFWS) and Monte Miller (ADFG) follow up to the November 27 conference call regarding HSI curves.	ADFG; USFWS; NOAA	2013-12-05HSIcurves.pdf
12/9/2013	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding proposed HSI curves.	ADFG 20	13-12-09ADFGmMiller.pdf
12/9/2013	Cory Warnock (McMillen) exchanged emails with Adam Reimer (ADFG) regarding preliminary counts of Chinook salmon that passed the weir in Grant Creek in 2013.	ADFG 20	13-12-09ADFGaReimer.pdf
12/9/2013	Scott Ayers (ADFG) emailed John Stevenson (BioAnalysts) the data submission form related to ADFG's Fish Resources permit.	ADFG 20	13-12-09ADFGsAyers.pdf
12/10/2013	Cory Warnock (McMillen) emailed interested stakeholders draft notes for the November 13, 2013 INHT meeting.	ADFG; ADNR; USFS; Kenai Peninsula Borough	2013-12-10INHTmtgDraftNotes.pdf
12/11/2013	Shina Duvall (ADNR) emailed Cory Warnock (McMillen) that she had no comments on the November 13, 2013 INHT meeting draft notes.	ADNR 20	13-12-11ADNRsDuvall.pdf
12/12/2013	Cory Warnock (McMillen) exchanged emails with Katherine VanMassenhove (USFS) regarding the status of renewal of the special use permit.	USFS 2	013-12-12USFSkVanMassenhove.pdf
12/12/2013	Monte Miller (ADFG) emailed John Blum (McMillen) a report regarding HSI curves for Fall Creek Project.	ADFG 20	13-12-12ADFGmMiller.pdf
12/13/2013	Robert Stovall (USFS) emailed Cory Warnock (McMillen) that he had no comments on the November 13, 2013 INHT meeting draft notes.	USFS 20	13-12-13USFSrStovall.pdf
12/16/2013	Monte Miller (ADFG) emailed John Blum (McMillen) a study plan regarding an instream flow study for Falls Creek Project.	ADFG 20	13-12-16ADFGmMiller.pdf
12/18/2013	Lesli Schick (ADNR) emailed Cory Warnock (McMillen) comments on the draft notes for the November 13, 2013 INHT meeting.	ADNR 20	13-12-18ADNRlSchick.pdf
12/18/2013	John Blum (McMillen) emailed Eric Rothwell (NOAA Fisheries), Jeff Anderson (USFWS) and Monte Miller, Joe Klein and Jason Mouw (ADFG) proposed HSI curves.	ADFG; USFWS; NOAA	2013-12-18HSIcurvesRev.pdf
12/19/2013	Monte Miller (ADFG) emailed Cory Warnock (McMillen) regarding the status of ADFG's review of proposed HSI curves.	ADFG 20	13-12-19ADFGmMiller.pdf
12/31/2013	John Stevenson (BioAnalysts) emailed Scott Ayers (ADFG) the 2013 fish collection data form as required by the Grant Lake fish resource permit.	ADFG 20	13-12-31ADFGsAyers.pdf
1/2/2014	Cory Warnock (McMillen) exchanged emails with Harold Shepherd (Center for Water Advocacy) regarding the Grant Lake licensing process timeline.	Center for Water Advocacy	2014-01-02CWAhShepherd.pdf

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1/3/2014	John Stevenson (BioAnalysts) exchanged emails with Scott Ayers (ADFG) regarding the 2013 fish collection data form provided by HEA as required by the Grant Lake fish resource permit.	ADFG 20	14-01-03ADFGsAyers.pdf
1/6/2014	John Stevenson (BioAnalysts) exchanged emails with Adam Reimer (ADFG) regarding 2013 Grant Creek Chinook passage estimates.	ADFG 20	14-01-06ADFGaReimer.pdf
1/8/2014	Cory Warnock (McMillen) exchanged emails with Paul Torgerson (Grant Lake Mining) regarding water tests on Grant Lake.	Grant Lake Mining	2014-01-08WGrLkMiningPtorgerson.pdf
1/9/2014	Cory Warnock (McMillen) emailed Ken Hogan (FERC) the email from Grant Lake Mining regarding water testing.	FERC 20	14-01-09FERCkHogan2.pdf
1/9/2014	Cory Warnock (McMillen) and Ken Hogan (FERC) discussed via phone 1) Grant Lake licensing process status; 2) collaborative approach to the INHT re-route; and 3) inquiries of Grant Lake Mining.	FERC 20	14-01-09FERCkHogan.pdf
1/10/2014	Mike Salzetti (HEA) filed with FERC the November 13, 2013 INHT meeting summary. NOTE: Presentation is designated privileged.	FERC 20	14-01-10INHTmtgNotes.pdf
1/13/2014	Cory Warnock (McMillen) exchanged emails with Robert Stovall (USFS) regarding the status of submittal of draft study reports and upcoming work group meetings.	USFS 20	14-01-13USFSrStovall.pdf
1/21/2014	Cory Warnock (McMillen) emailed licensing participants with proposed dates for study report meetings.	All Licensing Contacts	2014-01-21StudyReportMtgDates.pdf
1/27/2014	Cory Warnock (McMillen) exchanged emails with Eric Rothwell (NOAA Fisheries) regarding potential March study report meeting dates.	NOAA 2	014-01-27NOAAeRothwell.pdf
1/27/2014	Mark Luttrell (Artifact Illustration) emailed Cory Warnock (McMillen) requesting the privileged INHT meeting presentation from the November 13, 2013 INHT meeting notes.	Artifact Illustration	2014-01-27ArtifactIllustrationMluttrell.pdf
1/27/2014	Cory Warnock (McMillen) emailed licensing participants with final dates for study report meetings (March 18-21).	All Licensing Contacts	2014-01-27StudyReportMtgFinalDates.pdf
1/31/2014	Monte Miller (ADFG) emailed Cory Warnock (McMillen) contact information for Barbara Stanley's (USFS) replacements.	ADFG 20	14-01-31ADFGmMiller.pdf
2/3/2014	Katherine VanMassenhove (USFS) emailed Cory Warnock (McMillen) about being Barbara Stanley's (USFS) replacement.	USFS 2	014-02-03USFSkVanMassenhove.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
2/11/2014	Cory Warnock (McMillen) emailed the NRWG regarding availability of the water quality/hydrology and recreation/visual resources draft study reports on the McMillen ftp site.	NRWG (NOAA Fisheries, NPS, USACE, ADFG, ADNR, AEA, Center for Water Advocacy, Friends of Cooper Landing, Kenaitze Indian Tribe)	2014-02-11StudyReports.pdf
2/18/2014	Mike Yarborough (CRC) emailed the CRWG that the study report meeting would be held on March 21, 2014 and regarding the availability of the cultural resources study draft report.	CRWG (USFS, ADNR, SHPO, Cook Inlet Region, Artifact Illustration, AK Fed of Natives, Native Village of Eklutna, Kenai Native Association, Ninilchik Village Tribe, Chenega Corp, Quetekack Native Tribe, Kenaitze Indian Tribe)	2014-02-18CRWGmtgDate.pdf
2/20/2014	Frank Winchell (FERC) emailed Mike Yarborough (CRC) regarding participation in the March 21 CRWG meeting.	FERC 20	14-02-20CRWGmtgDate.log
2/20/2014	Dara Glass (CIRI) and Mark Luttrell (Artifact Illustration) emailed Mike Yarborough (CRC) regarding attendance at the March 21 CRWG meeting and request for a CD of the cultural resources study draft report.	Cook Inlet Region; Artifact Illustration	2014-02-20CIRIandArtifactIllustration.pdf
2/26/2014	Mike Salzetti (HEA) filed with FERC the fourth preliminary permit progress report.	FERC 20	14-02-26ProgressReport4th.pdf
2/26/2014	Helen Sagner (USFS) emailed Mike Salzetti (HEA) the 2014 Special Use Permit for review and signature.	USFS 2	014-02-26USFShSagner.pdf
2/26/2014	Mike Salzetti (HEA) exchanged voicemails with Monte Miller (ADFG) regarding the recently filed 4th progress report.	ADFG 20	14-02-26ADFGmMiller.pdf
2/27/2014	Eric Rothwell (NOAA Fisheries) exchanged emails with Cassie Thomas (NPS) regarding the potential conflict between meetings scheduled for HEA's Grant Lake Project and AEA's Susitna-Watana Project.	NOAA; NPS	2014-02-27StReportMtgDates.pdf
2/27/2014	Cory Warnock (McMillen) emailed the NRWG regarding availability of the geomorphology and terrestrial resources draft study reports on the McMillen ftp site.	NRWG (NOAA Fisheries, NPS, USACE, ADFG, ADNR, AEA, Center for Water Advocacy, Friends of Cooper Landing, Kenaitze Indian Tribe)	2014-02-27StudyReports.pdf
2/27/2014	Cory Warnock (McMillen) emailed the ARWG regarding availability of the macroinvertebrate/periphyton study report on the McMillen ftp site.	ARWG (NOAA Fisheries, USFWS, USACE, ADFG, ADNR, AEA, Friends of Cooper Landing)	2014-02-27StudyReports2.pdf

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2/28/2014	Cory Warnock (McMillen) and Robert Stovall (USFS) exchanged emails regarding USFS' participation in the March 18-21 study report meetings and their review of draft study reports.	USFS 20	14-02-28USFSrStovall.pdf
2/28/2014	Mike Yarborough (CRC) and Dara Glass (CIRI) exchanged emails regarding CIRI availability to attend the March 21 CRWG meeting.	Cook Inlet Region	2014-02-28CIRIdGlass.pdf
3/4/2014	Emily Andersen (McMillen) exchanged emails with Robert Stovall (USFS) regarding the specifics of the March 18-21 study report meetings.	USFS 20	14-03-04USFSrStovall.pdf
3/4/2014	Cory Warnock (McMillen) exchanged emails with Jason Mouw (ADFG) regarding difficulties with ADFG being able to access McMillen's ftp site.	ADFG 20	14-03-04ADFGjMouw.pdf
3/4/2014	Cory Warnock (McMillen) exchanged emails with Jason Mouw (ADFG) regarding trying to post study reports to the ADFG ftp site.	ADFG 20	14-03-04ADFGjMouw2.pdf
3/4/2014	Cory Warnock (McMillen) emailed the NRWG with the March 18, 2014 meeting agenda.	NRWG (NOAA Fisheries, NPS, USACE, ADFG, ADNR, AEA, Center for Water Advocacy, Friends of Cooper Landing, Kenaitze Indian Tribe)	2014-03-04StudyReportMtgAgenda.pdf
3/4/2014	Cory Warnock (McMillen) emailed the ARWG with the March 19 and 20, 2014 meeting agendas.	ARWG (NOAA Fisheries, USFWS, USACE, ADFG, ADNR, AEA, Friends of Cooper Landing)	2014-03-04StudyReportMtgAgenda2.pdf
3/4/2014	Cory Warnock (McMillen) emailed Jason Mouw the geomorphology, macroinvertebrate, recreation/visual resources, and water quality/hydrology draft study reports.	ADFG 20	14-03-04ADFGjMouw3.pdf
3/5/2014	Robert Stovall (USFS) emailed his staff and copied Cory Warnock (McMillen) with the March 18 meeting agenda.	USFS 20	14-03-05USFSrStovall.pdf
3/5/2014	Cory Warnock (McMillen) emailed the ARWG regarding availability of the fisheries assessment study report on the McMillen ftp site.	ARWG (NOAA Fisheries, USFWS, USACE, ADFG, ADNR, AEA, Friends of Cooper Landing)	2014-03-05StudyReport.pdf
3/5/2014	Cory Warnock (McMillen) emailed the ARWG regarding availability of the instream flow study report on the McMillen ftp site.	ARWG (NOAA Fisheries, USFWS, USACE, ADFG, ADNR, AEA, Friends of Cooper Landing)	2014-03-05StudyReport2.pdf
3/5/2014	Cory Warnock (McMillen) emailed Ken Hogan (FERC) the agendas for the March 18-20 study report meetings and suggested a follow up call to de-brief on the meetings.	FERC 20	14-03-05FERCkHogan.pdf
3/7/2014	Cory Warnock (McMillen) exchanged emails with Ken Hogan (FERC) regarding scheduling a follow up call to de-brief on the March 18-21 study report meetings.	FERC 20	14-03-07FERCkHogan.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
3/7/2014	Cory Warnock (McMillen) exchanged emails with Jason Mouw (ADFG) regarding getting ADFG the fisheries assessment and instream flow draft study reports.	ADFG 20	14-03-07ADFGjMouw.pdf
3/10/2014	Amal Ajmi (ERM) exchanged emails with Mary Ann Benoit USFS) regarding plans for the spring moose survey.	USFS 20	14-03-10USFSmBenoit.pdf
3/10/2014	Mike Salzetti (HEA) exchanged emails with Helen Sagner (USFS) regarding the execution of the special use permit renewal.	USFS 2	014-03-10USFShSagner.pdf
3/12/2014	Mike Yarborough (CRC) exchanged emails with Mark Luttrell (Artifact Illustration) regarding the March 21 CRWG meeting.	Artifact Illustration	2014-03-12ArtifactIllustrationMluttrell.pdf
3/13/2014	Mike Yarborough (CRC) emailed the CRWG the agenda for the March 21 CRWG meeting.	ADNR; FERC; USFS; Cook Inlet Region; SHPO; Artifact Illustration	2014-03-13CRWGmtgAgenda.pdf
3/18/2014	HEA held a meetings on March 18, 19 and 20, 2014 to discuss the Grant Lake Project Natural Resources, Draft Study Reports. [See 8/15/14 FERC filing entry for meeting materials.]	All Licensing Contacts	2014-03-18thru20-14SHmtgFinalNotes.pdf
3/19/2014	Audrey Alstrom (AEA) emailed Cory Warnock (McMillen) regarding not being able to attend the March 18-20 study report meetings.	AEA 20	14-03-19AEAaAlstrom.pdf
3/24/2014	Cory Warnock (McMillen) emailed the IFSG a Go-To meeting invite for the March 27, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-03-24IFSGcallInvite.pdf
3/24/2014	Cory Warnock (McMillen) exchanged emails with Monte Miller (ADFG) regarding the start time of the March 27, 2014 IFSG conference call.	ADFG 20	14-03-24ADFGmMiller.pdf
3/24/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG regarding the availability of the March 18-20 meeting presentations on the Project website, comment deadline for draft study reports, and planning for the next work group meetings.	ARWG and NRWG	2014-03-24StudyReportMtgFollowup.pdf
3/24/2014	Mike Salzetti (HEA) emailed Helen Sagner (USFS) regarding the status of the signing of the renewed special use permit.	USFS 2	014-03-24USFShSagner.pdf
3/25/2014	Cory Warnock (McMillen) exchanged emails with Hal Shepherd (Center for Water Advocacy) regarding access to draft study reports.	Center for Water Advocacy	2014-03-25CWAhShepherd.pdf
3/25/2014	Helen Sagner (USFS) emailed Mike Salzetti (HEA) the fully executed special use permit renewal.	USFS 2	014-03-25USFShSagner.pdf
3/25/2014	Mark Miller (BioAnalysts) emailed Mark Willette (ADFG) requesting confirmation regarding the 0.x data of the scale age analysis.	ADFG 2	014-03-25ADFGmWillette.pdf
3/25/2014	Mark Miller (BioAnalysts) and Jeff Anderson (USFWS) had a follow up discussion via phone to the March 19, 2014 ARWG meeting.	USFWS 20	14-03-25USFWSjAnderson.pdf

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3/25/2014	Mark Miller (BioAnalysts) exchanged emails with Jeff Anderson (USFWS) regarding additional relevant information pertaining to rainbow trout and Dolly Varden.	USFWS 2	014-03-25USFWSjAnderson2.pdf
3/25/2014	Mike Yarborough (CRC) emailed Frank Winchell (FERC) the March 21, 2014 CRWG meeting presentation. NOTE: Presentation is designated privileged.	FERC 20	14-03-25FERCfWinchell.pdf
3/26/2014	John Blum (McMillen) exchanged emails with Jason Mouw (ADFG) with the range of flows upon which measurements were taken for the HSI work in Grant Creek.	ADFG 20	14-03-26ADFGjMouw.pdf
3/26/2014	John Blum (McMillen) emailed the IFSG an agenda for the March 27, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-03-26IFSGcallAgenda.pdf
3/27/2014	Levia Shoutis (ERM) emailed Katie McCafferty (USACE) with a proposed approach to the Grant Lake waters functional assessment, including a guidelines document.	USACE 20	14-03-27USACEkMcCafferty.pdf
3/27/2014	Katie McCafferty (USACE) emailed Cory Warnock (McMillen) comments on the terrestrial resources study draft report.	USACE 20	14-03-27USACEkMcCafferty2.pdf
3/27/2014	HEA held an IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-03-27IFSGcall.pdf
3/28/2014	John Blum (McMillen) emailed the IFSG draft notes from the March 27, 2014 IFSG conference call for review.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-03-28IFSGcallDraftNotes.pdf
3/28/2014	John Blum (McMillen) emailed the IFSG an updated periodicity chart for review and comment.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-03-28Periodicity.pdf
3/31/2014	Levia Shoutis (ERM) and Katie McCafferty (USACE) discussed via phone ERM's proposed approach to the waters functional assessment.	USACE 20	14-03-31USACEkMcCafferty.pdf
4/2/2014	Cory Warnock (McMillen) exchanged emails with Ken Hogan (FERC) regarding follow up to their call about the March 18-21 study report meetings and the licensing process moving forward.	FERC 20	14-04-02FERCkHogan.pdf
4/3/2014	Jason Mouw (ADFG) emailed John Blum (McMillen) regarding the updated periodicity chart.	ADFG 20	14-04-03ADFGjMouw.pdf
4/3/2014	Jason Mouw (ADFG) emailed the IFSG a paper regarding fish incubation and groundwater.	ADFG 20	14-04-03ADFGjMouw2.pdf
4/3/2014	John Blum (McMillen) emailed the IFSG the final notes from the March 27, 2014 conference call and proposed dates for the next IFSG call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-03IFSGcallFinalNotes.pdf
4/4/2014	Jeff Anderson (USFWS) emailed John Blum (McMillen) regarding being unavailable for any of the proposed dates for the next IFSG conference call.	USFWS 20	14-04-04USFWSjAnderson.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
4/9/2014	John Blum (McMillen) emailed the IFSG notice of the April 18, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-09IFSGcallNotice.pdf
4/9/2014	Cory Warnock (McMillen) emailed the IFSG a Go-To meeting invite for the April 18, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-09IFSGcallInvite.pdf
4/9/2014	Cory Warnock (McMillen) emailed Sue Walker (NOAA Fisheries) regarding her replacing Eric Rothwell (NOAA Fisheries) on the Grant Lake Project.	NOAA 2	014-04-09NOAAsWalker.pdf
4/10/2014	Cory Warnock (McMillen) emailed Robert Stovall and John Eavis (USFS), Cassie Thomas (NPS), Lesli Schick (ADNR), and Dara Glass (CIRI) regarding the additional recreational study work planned for spring/summer 2014.	ADNR; USFS; NPS; Cook Inlet Region	2014-04-10TrailCams.pdf
4/15/2014	Cory Warnock (McMillen) and Dwayne Adams (USKH) exchanged emails with Cassie Thomas (NPS), John Eavis (USFS), and Pam Russell (ADNR) regarding feedback on the proposed trail camera work.	ADNR; USFS; NPS	2014-04-15TrailCamInput.pdf
4/15/2014	Dwayne Adams (USKH) and Pam Russell (ADNR) discussed via phone the permitting needs related to the proposed 2014 trail camera work.	ADNR 2	014-04-15ADNRpRussell.pdf
4/16/2014	Cory Warnock (McMillen) emailed Robert Stovall and John Eavis (USFS), Cassie Thomas (NPS), Pam Russell and Lesli Schick (ADNR), and Dara Glass (CIRI) with a response to agency feedback on the proposed trail camera work.	ADNR; USFS; NPS; Cook Inlet Region	2014-04-16TrailCamResponse.pdf
4/16/2014	Mike Salzetti (HEA) emailed Paul Torgerson (Grant Lake Mining) a response letter to inquiries made by Mr. Torgerson about the Grant Lake Project.	Grant Lake Mining	2014-04-16GrantLkMiningPtorgerson.pdf
4/16/2014	Mike Salzetti (HEA) filed with FERC a response letter to Paul Torgerson (Grant Lake Mining).	FERC 2	014-04-16GrantLkMiningPtorgerson2.pdf
4/16/2014	Frank Winchell (FERC) emailed Mike Yarborough (CRC) to let him know comments on the Cultural Resources, draft report are in the mail on a CD.	FERC 20	14-04-16FERCfWinchell.pdf
4/17/2014	John Blum (McMillen) emailed the IFSG the agenda and materials for the April 18, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-17IFSGcallAgendaMaterials.pdf
4/17/2014	Dwayne Adams (USKH) emailed Pam Russell (ADNR) a completed permit application for the proposed trail camera work.	ADNR 2	014-04-17ADNRpRussell.pdf
4/18/2014	Cory Warnock (McMillen) emailed Dara Glass (CIRI) the link to the Grant Lake Project website.	Cook Inlet Region	2014-04-18CIRIdGlass.pdf
4/18/2014	HEA held an IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-18IFSGcall.pdf

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4/24/2014	Dwayne Adams (USKH) emailed interested licensing participants regarding a proposed INHT site visit proposed for May 21, 2014.	ADNR; USFS; SHPO	2014-04-24INHTsiteVisitDate.pdf
4/24/2014	Dwayne Adams (USKH) emailed Marcus Mueller (Kenai Peninsula Borough) regarding participation in the May 21, 2014 INHT site visit.	Kenai Peninsula Borough	2014-04-24KenaiBoroughMmueller.pdf
4/25/2014	John Blum (McMillen) emailed the IFSG draft notes from the April 18, 2014 IFSG conference call for review, spawning and rearing utilization, and proposed dates for the next IFSG call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-04-25IFSGcallDraftNotes.pdf
4/25/2014	Jeff Anderson (USFWS) emailed John Blum (McMillen) that he is unavailable for a IFSG meeting the week of May 19, 2014.	USFWS 20	14-04-25USFWSjAnderson.pdf
4/29/2014	Dwayne Adams (USKH) emailed interested licensing participants regarding alternate dates for a INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-04-29INHTsiteVisitDate.pdf
4/29/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG draft notes for the March 18-20 study report meetings.	ARWG and NRWG	2014-04-29StudyReportMtgDraftNotes.pdf
4/29/2014	Mike Yarborough (CRC) emailed the CRWG draft notes for the March 21, 2014 CRWG meeting and proposed dates for the next CRWG meeting. NOTE: The meeting notes are designated privileged.	ADNR; FERC; USFS; Cook Inlet Region; SHPO; Artifact Illustration	2014-04-29CRWGmtgDraftNotes.pdf
4/30/2014	Jeff Anderson (USFWS) emailed Cory Warnock (McMillen) comments on the March 19, 2014 ARWG meeting draft notes.	USFWS 20	14-04-30USFWSjAnderson.pdf
4/30/2014	Monte Miller (ADFG) emailed Cory Warnock (McMillen) comments of the draft natural resources study reports.	ADFG 20	14-04-30ADFGmMiller.pdf
4/30/2014	Cory Warnock (McMillen) and Kathie McCafferty (USACE) exchanged emails regarding dates for a future Project Operations Workshop.	USACE 20	14-04-30USACEkMcCafferty.pdf
5/1/2014	Frank Winchell (FERC) emailed Mike Yarborough (CRC) regarding his availability to attend the proposed July 2014 CRWG meeting.	FERC 20	14-05-01FERCfWinchell.pdf
5/1/2014	John Blum (McMillen) emailed the IFSG following up regarding proposed May 22, 2014 date for next IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-01IFSGcallDate.pdf
5/1/2014	Shina Duvall (SHPO) emailed Cory Warnock (McMillen) comments on the cultural resources study draft report.	SHPO 20	14-05-01SHPOsDuvall.pdf
5/1/2014	Robert Stovall (USFS) emailed Cory Warnock (McMillen) a status update on USFS' draft study report comments.	USFS 20	14-05-01USFSrStovall.pdf
5/2/2014	Jason Mouw (ADFG) emailed John Blum (McMillen) confirmation of his and Monte Miller's availability for a May 22, 2014 IFSG call.	ADFG 20	14-05-02ADFGjMouw.pdf
5/3/2014	Cory Warnock (McMillen) emailed the IFSG an Go-To Meeting invite for the May 22, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-03IFSGcallInvite.pdf

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5/5/2014	Jeff Anderson (USFWS) emailed John Blum (McMillen) that he is unavailable for the May 22, 2014 IFSG meeting.	USFWS 20	14-05-05USFWSjAnderson.pdf
5/7/2014	Dwayne Adams (USKH) emailed interested licensing participants regarding alternate dates for a INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-05-07INHTsiteVisitDates.pdf
5/12/2014	John Blum (McMillen) emailed the IFSG the final meeting notes to the April 18, 2014 IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-12IFSGcallFinalNotes.pdf
5/13/2014	John Stevenson (BioAnalysts) and Scott Ayers (ADFG) discussed via phone the deadline for the fish resources permit reporting requirement.	ADFG 20	14-05-13ADFGsAyers.pdf
5/14/2014	Paul Torgerson (Grant Lake Mining) emailed Mike Salzetti (HEA) inquiring as to when water test results from the 2013 study season would be available.	Grant Lake Mining	2014-05-14GrantLkMiningPtorgerson.pdf
5/14/2014	Dwayne Adams (USKH) emailed interested licensing participants regarding alternate dates for a INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-05-14INHTsiteVisitDates.pdf
5/14/2014	Dwayne Adams (Earthscape) emailed interested licensing participants notification of the July 15, 2014 INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-05-14INHTsiteVisitNotice.pdf
5/15/2014	Dwayne Adams (Earthscape) and Katherine VanMassenhove (USFS) exchanged emails regarding Katherine's participation in the July 15, 2014 INHT site visit.	USFS 2	014-05-15USFSkVanMassenhove.pdf
5/19/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG notification of the July 7-8, 2014 Operations Workshop and Public Meeting.	ARWG and NRWG	2014-05-19JulyWorkshopDates.pdf
5/19/2014	Cory Warnock (McMillen) emailed Nicole Lantz (SHPO) a completed AHRS corporate user agreement application.	SHPO 20	14-05-19SHPOnLantz.pdf
5/19/2014	Cory Warnock (McMillen) left a voicemail for Robert Stovall (USFS) regarding the status of finalization of the study reports.	USFS 20	14-05-19USFSrStovall.pdf
5/20/2014	Cory Warnock (McMillen) emailed Nicole Lantz (SHPO) a completed AHRS corporate user agreement application and waiver for himself and Emily Andersen (McMillen).	SHPO 20	14-05-20SHPOnLantz.pdf
5/21/2014	John Blum (McMillen) emailed the IFSG an agenda for the May 22, 2014 call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-21IFSGmtgAgenda.pdf
5/21/2014	Cory Warnock (McMillen) and Nicole Lantz (SHPO) exchanged emails regarding the approval of McMillen's AHRS data access.	SHPO 20	14-05-21SHPOnLantz.pdf
5/22/2014	Cory Warnock (McMillen) and Dara Glass (CIRI) exchanged emails about Dara's unavailability to attend the May 22, 2014 IFSG call.	Cook Inlet Region	2014-05-22CIRIdGlass.pdf
5/22/2014	Cory Warnock (McMillen) emailed the IFSG a Go To Meeting invite for the June 12, 2014 IFSG call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-22IFSGmtgInvite.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
5/22/2014	HEA held a IFSG conference call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-22IFSGcall.pdf
5/23/2014	John Blum (McMillen) emailed the IFSG updated information regarding spawning and rearing locations.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-23SpawnRearLocations.pdf
5/27/2014	Dwayne Adams (Earthscape) emailed interested licensing participants notification of the July 15, 2014 INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-05-27INHTmtgDate.pdf
5/28/2014	John Blum (McMillen) emailed the IFSG draft notes for the May 22, 2014 call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-05-28IFSGDraftCallNotes.pdf
5/28/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG the location of the July 7-8 Operations Workshop and Public Meeting.	ARWG and NRWG	2014-05-28OperationsWorkshopLocation.pdf
5/29/2014	Levia Shoutis (ERM) and Katie McCafferty (USACE) exchanged emails regarding direct and indirect impacts to wetlands.	USACE 20	14-05-29USACEkMcCafferty.pdf
6/2/2014	Jason Mouw (ADFG) emailed John Blum (McMillen) comments on the draft notes from the May 22, 2014 call.	ADFG 20	14-06-02ADFGjMouw.pdf
6/10/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG an engineering/operations technical memo (1) in preparation for the July 7 Operations Workshop.	ARWG and NRWG	2014-06-10EngTechMemo.pdf
6/10/2014	John Blum (McMillen) and Monte Miller (ADFG) exchanged email regarding the requested input on the spawning transects and transect weighting information.	ADFG 20	14-06-10ADFGmMiller.pdf
6/10/2014	John Blum (McMillen) emailed the IFSG final notes for the May 22, 2014 call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-06-10IFSGFinalCallNotes.pdf
6/11/2014	Cory Warnock (McMillen) and Hal Shepherd (CWA) exchanged emailed regarding details related to the July 8, 2014 Public Meeting.	Clean Water Advocacy	2014-06-11CWAhShepherd.pdf
6/13/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG an engineering/operations technical memo (2) in preparation for the July 7 Operations Workshop.	ARWG and NRWG	2014-06-13EngTechMemo2.pdf
6/13/2014	John Blum (McMillen) and Monte Miller (ADFG) exchanged emails regarding the requested input on the spawning transects and transect weighting information.	ADFG 20	14-06-13ADFGmMiller.pdf
6/13/2014	John Blum (McMillen) emailed the IFSG revised final notes for the May 22, 2014 call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-06-13IFSGrevFinalCallNotes.pdf
6/16/2014	John Blum (McMillen) and IFSG members exchanged emailed regarding dates for a June call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-06-16IFSGcallAvailability.pdf
6/16/2014	Cory Warnock (McMillen) emailed the IFSG a Go To Meeting invite for the June 23, 2014 IFSG call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-06-16IFSGcallInvite.pdf

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6/16/2014	Robert Stovall (USFS) emailed Cory Warnock (McMillen) comments on the draft study reports.	USFS 20	14-06-16USFSrStovall.pdf
6/16/2014	Cory Warnock (McMillen) emailed Robert Stovall (USFS) regarding the USFS draft study report comments.	USFS 20	14-06-16USFSrStovall2.pdf
6/17/2014	John Blum (McMillen) and Jason Mouw (ADFG) exchanged emails regarding the requested input on the spawning transects and transect weighting information.	ADFG 20	14-06-17ADFGjMouw.pdf
6/20/2014	John Blum (McMillen) emailed the IFSG about rescheduling the June 23, 2014 call.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-06-20IFSGrescheduleCall.pdf
6/20/2014	Cory Warnock (McMillen) and Dara Glass (CIRI) exchanged emails about scheduling a meeting between HEA and CIRI.	Cook Inlet Region	2014-06-20CIRIdGlass.pdf
6/23/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG regarding postponement of the July 8, 2014 Public Meeting to later in the year.	ARWG and NRWG	2014-06-23PublicMtgDelay.pdf
6/23/2014	Cory Warnock (McMillen) and Brendan Culverwell (SNL Financial) exchanged emails regarding the status of the licensing process.	SNL Financial	2014-06-23SNLfinancialBculverwell.pdf
6/27/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG an engineering/operations technical memo (3) in preparation for the July 7 Operations Workshop.	ARWG and NRWG	2014-06-27EngTechMemo3.pdf
7/2/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG an agenda for the July 7, 2014 Operations Workshop.	ARWG and NRWG	2014-07-02OpsWorkshopAgenda.pdf
7/3/2014	Cory Warnock (McMillen) and Jeff Anderson (USFWS) exchanged emails regarding meeting materials for the July 7, 2014 Operations Workshop.	USFWS 20	14-07-03USFWSjAnderson.pdf
7/7/2014	HEA held a workshop on July 7, 2014 to discuss proposed engineering and operations of the Grant Lake Project. [See 8/15/14 FERC filing entry for meeting materials.]	All Licensing Contacts	2014-07-07OpsWorkshop.pdf
7/8/2014	Cory Warnock (McMillen) and Dara Glass (CIRI) exchanged emails about scheduling a meeting between HEA and CIRI for the end of August.	Cook Inlet Region	2014-07-08CIRIdGlass.pdf
7/9/2014	Dwayne Adams (Earthscape) emailed interested licensing participants a reminder about the July 15, 2014 INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-07-09INHTsiteVisitReminder.pdf
7/9/2014	David Griffin (ADNR) emailed Dwayne Adams (Earthscape) that he will not be able to attend the July 15, 2014 INHT site visit.	ADNR 2	014-07-09ADNRdGriffin.pdf
7/11/2014	Dwayne Adams (Earthscape) emailed interested licensing participants requesting confirmation of planned attendance to the July 15, 2014 INHT site visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-07-11INHTsiteVisitAttendance.pdf

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7/11/2014	Lesli Schick (ADNR) emailed Dwayne Adams (Earthscape) that she will be unable to attend the July 15, 2014 INHT site visit.	ADNR 20	14-07-11ADNRlSchick.pdf
7/15/2014	Claire Leclair (ADNR) emailed Dwayne Adams (Earthscape) that no one at ADNR will be able to attend the July 15, 2014 INHT site visit.	ADNR 20	14-07-15ADNRcLeclair.pdf
7/15/2014	HEA conducted a site visit on July 15, 2014 to discuss possible alternatives to a current alignment of the INHT.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-07-15INHTsiteVisit.pdf
7/17/2014	John Blum (McMillen) emailed Joe Klein, Monte Miller, and Jason Mouw (ADFG) a draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-07-17ADFGhabQuantTransectWeight.pdf
7/17/2014	John Stevenson (BioAnalysts) emailed Joe Klein and Monte Miller (ADFG) maps discussed on the July 17, 2014 call regarding the draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 20	14-07-17ADFGtransectMaps.pdf
7/17/2014	Monte Miller (ADFG) emailed John Blum (McMillen) comments on the draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 20	14-07-17ADFGmMiller.pdf
7/17/2014	John Blum (McMillen), John Stevenson (BioAnalysts), and Joe Klein and Monte Miller (ADFG) discussed via phone the draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 20	14-07-17ADFGjKleinMmiller.pdf
7/18/2014	Cory Warnock (McMillen) and Betsy McCracken (USFWS) exchanged emails regarding logistics for transmitting study reports to USFWS.	USFWS 2	014-07-18USFWSbMcCracken.pdf
7/25/2014	John Blum (McMillen) emailed Joe Klein, Monte Miller, and Jason Mouw (ADFG) a revised draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-07-25ADFGhabQuantTransectWeight.pdf
7/29/2014	Dwayne Adams (Earthscape) emailed interested licensing participants draft notes from the July 15, 2014 INHT Site Visit.	ADNR; USFS; Kenai Peninsula Borough; SHPO	2014-07-29INHTsiteVisitDraftNotes.pdf
7/29/2014	Dwayne Adams (Earthscape) left voicemails for John Eavis, Robert Stovall, and Alison Rein (USFS) requesting relevant Trail Management Objectives for the INHT.	USFS 20	14-07-29USFStmoRequest.pdf
7/30/2014	John Eavis (USFS) emailed Dwayne Adams (Earthscape) the draft Trail Management Objectives (TMO) for the relevant section of the INHT.	USFS 20	14-07-30USFSjEavis.pdf
8/1/2014	John Blum (McMillen) emailed Joe Klein, Monte Miller, and Jason Mouw (ADFG) a second revised draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-08-01ADFGhabQuantTransectWeight.pdf
8/1/2014	Dwayne Adams (Earthscape) and Robert Stovall (USFS) discussed via phone the TMOs for the relevant portion of the INHT and USFS comments on the draft notes for the July 15, 2014 INHT site visit.	USFS 20	14-08-01USFSrStovall.pdf

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8/1/2014	Dwayne Adams (Earthscape) and Shina Duvall (SHPO) exchanged emails regarding the draft notes for the July 15, 2014 INHT site visit.	SHPO 20	14-08-01SHPOsDuvall.pdf
8/1/2014	John Blum (McMillen) and Joe Klein (ADFG) exchanged emails regarding comments on the second revised draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-08-01ADFGjKlein.pdf
8/4/2014	John Blum (McMillen) emailed Joe Klein, Monte Miller, and Jason Mouw (ADFG) a third revised draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-08-04ADFGhabQuantTransectWeight.pdf
8/4/2014	John Blum (McMillen) and Joe Klein (ADFG) exchanged emails regarding ADFG approval of the third revised draft Habitat Quantification and Transect Weighting Methodology report.	ADFG 2	014-08-04ADFGjKlein.pdf
8/5/2014	John Blum (McMillen) emailed the IFSG the final Habitat Quantification and Transect Weighting Methodology report.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-08-05IFSGhabQuantTransectWeight.pdf
8/15/2014	Mike Salzetti (HEA) filed with FERC the final notes and materials from the March 18-20, 2014 Stakeholder Meetings and July 7, 2014 Operations Workshop, responses to stakeholder draft study report comments, and final study reports.	FERC 2	014-08-13MarchJulyMtgNotesFinalReports.pdf
8/18/2014	Cory Warnock (McMillen) and Scott Ayers (ADFG) exchanged emails regarding the Fisheries Assessment, Final Report. [See 8/15/14 FERC filing entry for the attached report.]	ADFG 20	14-08-18ADFGsAyers.pdf
8/19/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG that the final notes from the March 18-20 and July 7 meetings, responses to stakeholder draft study report comments, and final study reports, are posted on the Kenai Hydro website.	ARWG and NRWG	2014-08-19MarchJulyMtgNotesFinalReports.pdf
8/20/2014	Cory Warnock (McMillen) and Scott Ayers (ADFG) exchanged emails regarding the Fisheries Assessment, Final Report.	ADFG 20	14-08-20ADFGsAyers.pdf
8/20/2014	Mike Salzetti (HEA) emailed Jan Konigsberg (HRC) a status update on the progress made during the Grant Lake Project licensing process to date.	Hydro Reform Coalition	2014-08-20HRCjKonigsberg.pdf
8/22/2014	Dwayne Adams (Earthscape) emailed Gary Williams (KPB) an Initial Letter of Intent regarding the possible easement relocation for the INHT corridor and revised notes from the July 15, 2014 INHT site visit.	Kenai Peninsula Borough	2014-08-22KPBgWilliams.pdf
8/22/2014	Dwayne Adams (Earthscape) emailed Judy Bittner (SHPO) an Initial Letter of Intent regarding the possible easement relocation for the INHT corridor and revised notes from the July 15, 2014 INHT site visit.	SHPO 2	014-08-22SHPOjBittner.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
8/22/2014	Dwayne Adams (Earthscape) emailed Jack Blackwell (ADNR) an Initial Letter of Intent regarding the possible easement relocation for the INHT corridor and revised notes from the July 15, 2014 INHT site visit.	ADNR 20	14-08-22ADNRjBlackwell.pdf
8/22/2014	Dwayne Adams (Earthscape) emailed Clark Cox (ADNR) an Initial Letter of Intent regarding the possible easement relocation for the INHT corridor and revised notes from the July 15, 2014 INHT site visit.	ADNR 20	14-08-22ADNRcCox.pdf
8/22/2014	Dwayne Adams (Earthscape) emailed Terri Maceron (USFS) an Initial Letter of Intent regarding the possible easement relocation for the INHT corridor and revised notes from the July 15, 2014 INHT site visit.	USFS 2014-08-22USFStMaceron.pdf	
8/25/2014	Dwayne Adams (Earthscape) and Marcus Mueller (KPB) exchanged emails regarding the management authority related to the Kenai Area Plan.	Kenai Peninsula Borough	2014-08-25KPBmMueller.pdf
8/25/2014	Dwayne Adams (Earthscape) and Shina Duvall (SHPO) discussed via phone the purposes of a Memorandum of Agreement (MOA) versus an Memorandum of Understanding (MOU).	SHPO 20	14-08-25SHPOsDuvall.pdf
8/27/2014	Dwayne Adams (Earthscape) and John Eavis (USFS) exchanged emails regarding the status of flagging the alternate INHT route.	USFS 20	14-08-27USFSjEavis.pdf
8/27/2014	Mike Salzetti (HEA) filed with FERC the fifth preliminary permit progress report.	FERC 20	14-08-27ProgressReport5th.pdf
8/27/2014	Dwayne Adams (Earthscape) and Shina Duvall (SHPO) exchanged emails regarding the difference between a Memorandum of Agreement (MOA) and Memorandum of Understanding (MOU).	SHPO 20	14-08-27SHPOsDuvall.pdf
8/29/2014	Cory Warnock (McMillen) and Scott Ayers (ADFG) exchanged emails regarding ADFG's input on the Fisheries Assessment, Final Report with respect to the Fish Resources permit.	ADFG 20	14-08-29ADFGsAyers.pdf
8/29/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG the 5th preliminary permit progress report.	ARWG and NRWG	2014-08-29ProgressReport5th.pdf
8/29/2014	David Griffin (ADNR) emailed Cory Warnock (McMillen) requesting that Ryan Thomas, a new ADNR staff person assigned to permitting, be added to the project distribution list.	ADNR 2	014-08-29ADNRdGriffin.pdf
8/29/2014	Robert Stovall (USFS) emailed Dwayne Adams (Earthscape), Mike Salzetti (HEA), and Cory Warnock (McMillen) regarding providing comments on the proposed MOA related to the INHT re-alignment.	USFS 20	14-08-29USFSrStovall.pdf
9/4/2014	John Stevenson (BioAnalysts) emailed Jay Johnson (ADFG) requesting details regarding an AWC submittal.	ADFG 2	014-09-04ADFGjJohnson.pdf
9/4/2014	John Stevenson (BioAnalysts) and Scott Ayers (ADFG) exchanged emails regarding AWC submittal.	ADFG 20	14-09-04ADFGsAyers.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
9/5/2014	John Stevenson (BioAnalysts) and Scott Ayers (ADFG) exchanged emails regarding AWC submittal and completion of the fish resource permit requirements.	ADFG 20	14-09-05ADFGsAyers.pdf
9/5/2014	John Stevenson (BioAnalysts) emailed Jay Johnson (ADFG) requisite materials for an AWC nomination.	ADFG 2	014-09-05ADFGjJohnson.pdf
9/5/2014	John Stevenson (BioAnalysts) and Jay Johnson (ADFG) exchange emails regarding the transmittal of materials for an AWC nomination.	ADFG 2	014-09-05ADFGjJohnson2.pdf
9/5/2014	John Stevenson (BioAnalysts) emailed Scott Ayers (ADFG) that AWC nomination materials had been submitted.	ADFG 20	14-09-05ADFGsAyers2.pdf
9/19/2014	Robert Stovall (USFS) emailed Dwayne Adams (Earthscape), Mike Salzetti (HEA), and Cory Warnock (McMillen) a response letter on the Letter of Intent and MOA related to the INHT re-alignment.	USFS 20	14-09-19USFSrStovall.pdf
9/22/2014	Cory Warnock (McMillen) and Robert Stovall (USFS) discussed via phone the USFS' response letter to the Letter of Intent and MOA related to the INHT re-alignment.	USFS 20	14-09-22USFSrStovall.pdf
10/13/2014	Cory Warnock (McMillen) emailed Lesli Schick (ADNR) to request a phone conference to discuss the INHT re-alignment process moving forward.	ADNR 20	14-10-13ADNRlSchick.pdf
10/13/2014	Dwayne Adams (Earthscape) and Karen Morrissey (ARRC) exchanged emails regarding ARRC policy on public use of ARRC trestle in Moose Pass.	Alaska Railroad Corporation	2014-10-13ARRCkMorrissey.pdf
10/16/2014	Cory Warnock (McMillen) emailed an appointment notification to Lesli Schick (ADNR) for a phone conference on October 20 to discuss the INHT re-alignment process going forward.	ADNR 20	14-10-16ADNRlSchick.pdf
10/17/2014	Dara Glass (CIRI) emailed Ethan Shutt (CIRI), Mike Salzetti (KHL), and Cory Warnock (McMillen) an appointment notification for a meeting on November 5, 2014 to discuss the status of the Grant Lake Project licensing process.	Cook Inlet Region	2014-10-17CIRIdGlass.pdf
10/17/2014	Cory Warnock (McMillen) and Dara Glass (CIRI) exchanged emails confirming a meeting on November 5, 2014 to discuss the status of the Grant Lake Project licensing process.	Cook Inlet Region	2014-10-17CIRIdGlass2.pdf
10/20/2014	Cory Warnock (McMillen) emailed the ARWG and NRWG a notice for the November 6, 2014 Public Meeting.	ARWG and NRWG	2014-10-20PublicMtgNotice.pdf
10/20/2014	Mike Salzetti (HEA) and Sean Skaling (AEA) exchanged emails regarding AEA's potential participation in the November 6 AEA meeting.	AEA 20	14-10-20AEAsSkaling.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
10/20/2014	Cory Warnock (McMillen) emailed interested parties in the INHT with an update to the re-alignment process.	ADNR; USFS; SHPO	2014-10-20INHTprocess.pdf
10/20/2014	Cory Warnock (McMillen), Dwayne Adams (Earthscape), Mike Yarborough (CRC), and Lesli Schick (ADNR) discussed via phone a modified process for the INHT re-alignment.	ADNR 20	14-10-20ADNRlSchick.pdf
10/21/2014	Robert Stovall (USFS) emailed Mike Salzetti (HEA) and Cory Warnock (McMillen) regarding USFS' participation in the November 6 Public Meeting.	USFS 20	14-10-21USFSrStovall.pdf
10/27/2014	John Blum (McMillen) emailed the IFSG the draft Aquatics Habitat Mapping and Instream Flow Study, report addendum.	IFSG (NOAA Fisheries, USFWS, ADFG, Cook Inlet Region)	2014-10-27IFIMaddendumReport.pdf
10/29/2014	Mike Salzetti (KHL) and Bruce Jaffa (Jaffa Construction) exchanged emails regarding adding Jaffa to the stakeholder distribution list.	Jaffa Construction	2014-10-29JaffaConstrBJaffa.pdf
10/31/2014	Levia Shoutis (ERM) and Katy McCafferty (USACE) exchanged emails regarding the 404 application review process and the differences between a preliminary JD and an approved JD.	USACE 20	14-10-31USACEkMcCafferty.pdf
10/31/2014	Cory Warnock (McMillen) emailed Jeff Hetrick the public service announcement for the November 6 Public Meeting.	Citizen 20	14-10-31jHetrick.pdf
11/1/2014	Mike Yarborough (CRC) was copied on an email from Mark Luttrell (Artifact Illustration) regarding the November 6 Public meeting.	Artifact Illustration	2014-11-01ArtifactIllustrationMluttrell.pdf
11/3/2014	Matt McMillan (Stantec) and Pam Russell (ADNR) exchanged emails regarding a permit for use of three trail cameras around Grant Lake.	ADNR 2	014-11-03ADNRpRussell.pdf
11/5/2014	Mike Salzetti (HEA) and Cory Warnock (McMillen Jacobs) met with Ethan Shutt and Dara Glass (CIRI) to provide an update on the Grant Lake Hydroelectric Project progress.	Cook Inlet Region	2014-11-05CIRImtg.pdf
11/6/2014	HEA held a Public Meeting in Moose Pass, AK. [See 12/15/14 FERC filing entry for meeting materials.]	All Licensing Contacts	2014-11-06PublicMtg.pdf
11/8/2014	Dan Hertrich (AEA) emailed Mike Salzetti (HEA) and Cory Warnock and Mort McMillen (McMillen) thanking them for the Grant Lake Project description and sharing general approval for the project.	AEA 20	14-11-08AEAdHertrich.pdf
11/10/2014	Levia Shoutis (ERM) and Katie McCafferty (USACE) exchanged emails regarding the organization and content of the Section 404 permit application.	USACE 20	14-11-10USACEkMcCafferty.pdf
11/11/2014	Cory Warnock (McMillen) and David Griffin (ADNR) exchanged emails regarding the ADNR proposal for an MOU between KHL and ADNR regarding post-licensing activities.	ADNR 2	014-11-11ADNRdGriffin.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
11/11/2014	Cory Warnock (McMillen) and Mark Luttrell (Artifact Illustration) exchanged emails regarding Mark's request for a current Grant Lake Project description.	Artifact Illustration	2014-11-11ArtifactIllustrationMluttrell.pdf
11/15/2014	Cory Warnock (McMillen) and Jeff Hetrick exchanged emails regarding questions by Jeff following the November 6 Public Meeting.	Citizen 20	14-11-15jHetrick.pdf
11/24/2014	Cory Warnock (McMillen) emailed the November 6, 2014 Public Meeting participants the draft notes from the meeting.	Public mtg participants	2014-11-24PublicMtgDraftNotes.pdf
11/24/2014	Joe Gallagher (HEA) emailed JJ Kaiser the November 6 Public Meeting draft notes.	Citizen 2	014-11-24jjKaiser.pdf
11/24/2014	Cory Warnock (McMillen) and Mark Luttrell (Artifact Illustration) exchanged emails regarding Mark's request for a current Grant Lake Project description.	Artifact Illustration	2014-11-24ArtifactIllustrationMluttrell.pdf
12/5/2014	Levia Shoutis (ERM) and Katie McCafferty (USACE) discussed via phone the content and organization of the Section 404 permit application.	USACE 20	14-12-05USACEkMcCafferty.pdf
12/11/2014	Mike Salzetti (HEA) gave a presentation to the Kenai River Special Management Area (KRSMA) Board.	ADNR 20	14-12-11KRSMAboardMtg.pdf
12/12/2014	Levia Shoutis (ERM) and Katie McCafferty (USACE) discussed via phone various aspects of the wetlands-related discussion in the forthcoming Draft License Application and content of the Section 404 permit application.	USACE 20	14-12-12USACEkMcCafferty.pdf
12/15/2014	Mike Salzetti (HEA) filed with FERC the final notes and materials from the November 6, 2014 Public Meeting.	All Licensing Contacts	2014-12-15PublicMtgFinalNotes.pdf
12/15/2014	Cory Warnock (McMillen) emailed ARWG and NRWG members the final notes from the November 6, 2014 Public Meeting. [See 12/15/14 FERC filing entry for minutes and materials.]	ARWG and NRWG	2014-12-15PublicMtgFinalNotes2.pdf
12/15/2014	Cory Warnock (McMillen) emailed public meeting participants the final notes from the November 6, 2014 Public Meeting. [See 12/15/14 FERC filing entry for minutes and materials.]	Public mtg participants	2014-12-15PublicMtgFinalNotes3.pdf
12/17/2014	Cory Warnock (McMillen) and Katharine Glaser exchanged emails regarding timing of DLA commenting.	Citizen 2	014-12-17kGlaser.pdf
12/29/2014	Dwayne Adams (Earthscape) and John Eavis (USFS) exchanged emails regarding potential costs for the new segment of the INHT.	USFS 20	14-12-29USFSjEavis.pdf
1/5/2015	Levia Shoutis (ERM) and Katie McCafferty (USACE) exchanged emails regarding the need for an approved jurisdictional determination form with the application request for a preliminary determination.	USACE 20	15-01-05USACEkMcKafferty.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
1/8/2015	Levia Shoutis (ERM) and Katie McCafferty (USACE) exchanged emails regarding the schedule for submittal of a Section 404 application.	USACE 20	15-01-08USACEkMcCafferty.pdf
1/8/2015	Mike Salzetti (HEA) gave a presentation to the Kenai Peninsula Economic Outlook Forum.	Kenai Peninsula Economic Outlook Forum	2015-01-08KenaiPenOutlookForumPres.pdf
1/9/2015	Jason Mouw (ADF&G) emailed John Blum (McMillen Jacobs) requesting additional information regarding the Aquatic Habitat Mapping and Instream Flow Study, Addendum Report.	ADFG 20	15-01-09ADFGjMouw.pdf
1/9/2015	John Mohorcich (KPB) emailed Joe Gallagher (HEA) regarding issuance of a preliminary decision by ADNR for the conveyance of lands to the Kenai Peninsula Borough.	Kenai Peninsula Borough	2015-01-09KPBjMohorcich.pdf
1/13/2015	John Blum (McMillen) and Jason Mouw (ADF&G) discussed via phone ADF&G's request for additional information related to the Aquatic Habitat and Instream Flow Study, Addendum Report.	ADFG 20	15-01-13ADFGjMouw.pdf
1/20/2015	Emily Andersen and Cory Warnock (McMillen Jacobs) and Ken Hogan (FERC) exchanged emails regarding scheduling a call for January 27 to discuss the status of the Grant Lake Project licensing process.	FERC 20	15-01-20FERCkHogan.pdf
1/22/2015	Emily Andersen and Cory Warnock (McMillen Jacobs) and Ken Hogan (FERC) exchanged emails regarding preliminary permit extensions.	FERC 20	15-01-22FERCkHogan.pdf
1/27/2015	Mike Salzetti (HEA) filed with FERC an preliminary permit extension request.	FERC 2	015-01-27FERCextensionRequestLtr.pdf
1/27/2015	John Blum (McMillen Jacobs) and Jason Mouw (ADF&G) exchanged emails regarding McMillen's expanded WUA information.	ADFG 20	15-01-27ADFGjMouw.pdf
1/28/2015	Jason Mouw (ADF&G) emailed John Blum (McMillen Jacobs) with a question about the Grant Creek hydrologic dataset.	ADFG 20	15-01-28ADFGjMouw.pdf
2/1/2015	Mike Salzetti (HEA) emailed Karen Kromrey (USFS) about the current mining plan in the area of the proposed Grant Lake Hydroelectric Project.	USFS 20	15-02-01USFSkKromrey.pdf
2/2/2015	Cory Warnock (McMillen Jacobs) emailed Irene Lindquist (USFS) with a status update on Draft License Application development and the target submittal date.	USFS 2	015-02-02USFSiLindquist.pdf
2/2/2015	Mike Salzetti (HEA) and Mary Hermon (ADNR) exchanged emails regarding HEA's comment regarding the Preliminary Decision of Land Conveyance.	ADNR 20	15-02-02ADNRmHermon.pdf
2/6/2015	Mike Yarborough (CRC) emailed current CRWG members that a findings letter and Cultural Resources Study Final Report was mailed on CD.	CRWG: USFS, ADNR, SHPO, CIRI, Artifact Illustrations	2015-02-06CRfinalReport.pdf

Date	Summary of Contact	Agency/Organization Consulted	Documentation filename (pdf)
2/6/2015	Mike Yarborough (CRC) mailed current CRWG members a findings letter and Cultural Resources Study Final Report on CD. Note: The letter and report are designated Privileged.	CRWG: USFS, ADNR, SHPO, CIRI, Artifact Illustrations	2015-02-06CRfinalReport2.pdf
2/9/2015	John Blum (McMillen Jacobs) emailed Jason Mouw (ADF&G) clarifying information regarding the Grant Creek hydrologic record.	ADFG 20	15-02-09ADFGjMouw2.pdf
2/9/2015	John Blum (McMillen Jacobs) and Jason Mouw (ADF&G) discussed via phone ADF&G's questions regarding the Grant Creek hydrologic record.	ADFG 20	15-02-09ADFGjMouw.pdf
2/18/2015	Barb Whiton (McMillen Jacobs) emailed select licensing contacts requesting mailing information for the forthcoming Draft License Application.	All Licensing Contacts	2015-02-18DLAmailingInfo.pdf
2/24/2015	Mike Salzetti (HEA) filed with FERC the findings letter and Cultural Resources Study, Final Report. Note: The letter and report are designated Privileged.	FERC 20	15-02-24CRfinalReport.pdf
2/26/2015	Mike Salzetti (HEA) contributed to a letter from Sara Fisher-Goad (AEA) to Representative Gara responding to a letter from his office dated February 13 regarding concerns with the Grant Lake Project.	Representative Gara	2015-02-26RepGara.pdf
2/27/2015	FERC issued an order denying extension of term for preliminary permit.	FERC	2015-02-27ExtensionDenial.pdf
3/2/2015	Mike Salzetti (HEA) and David Griffin (ADNR) exchanged emails regarding ADNR's inquiry about the potential for development of an MOU between ADNR and HEA related to the Grant Lake Project.	ADNR 2	015-03-02ADNRdGriffin.pdf

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Attachment E-2. Aquatic Habitat Mapping and Instream Flow Study, Addendum

Grant Lake Hydroelectric Project (FERC No. 13212)

Aquatic Resources – Grant Creek Aquatic Habitat Mapping and Instream Flow Study Additional Information

Draft Report

Prepared for
Kenai Hydro LLC

Prepared by

MCMILLEN
DESIGN with Vision. BUILD with Integrity.

October 2014

TABLE OF CONTENTS

Appendices

List of Tables

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Aquatic Resources – Grant Creek Aquatic Habitat Mapping and Instream Flow Study Additional Information
Draft Report
Grant Lake Hydroelectric Project (FERC No. 13212)

1 INTRODUCTION

As part of the ongoing licensing of the Grant Lake Hydroelectric Project (Project; FERC No. 13212), Kenai Hydro LLC (KHL) met with the natural resource agencies and other stakeholders on March 19 – 20, 2014, in Anchorage, Alaska. During this meeting, the natural resource agencies and KHL identified areas where further data analysis would be required prior to making or evaluating a proposed instream flow and operating regime for the Project.

An Instream Flow Work Group (Work Group) was formed, consisting of staff from the National Oceanographic and Atmospheric Administration (NOAA), Alaska Department of Fish and Game (ADFG), the U.S. Fish and Wildlife Service (USFWS), Cook Inlet Region, Inc. (CIRI), BioAnalysts, and McMillen, LLC (McMillen).

A series of conference calls were held with the Work Group from March 17 – July 17, 2014, to discuss data analysis needs for providing the information requested. Outstanding issues included the following:

- Sockeye salmon fry emergence timing in Grant Creek
- Locations of salmonid spawning and rearing in Grant Creek
- Priority species and transect weighting
- Final Weighted Usable Area (WUA) for Grant Creek
- Effective spawning and incubation analysis
- Grant Creek habitat time series

This document is intended to provide supplemental information to the June 2014 Instream Flow Study report. The following sections describe the analysis conducted to address those issues raised by the Work Group. Where separate reports were generated, they are included as appendices.

2 ADDITIONAL ANALYSIS CONDUCTED FOR THE GRANT CREEK INSTREAM FLOW STUDY

2.1. Sockeye Salmon Fry Emergence Timing In Grant Creek

The Work Group requested that sockeye salmon fry emergence be added to the periodicity chart. There was uncertainty regarding the emergence timing, and it was suggested that Daily Temperature Units (DTUs) be researched in order to determine sockeye salmon fry emergence timing. Table 2.1-1 summarizes DTUs from the literature or communication with those involved in sockeye salmon aquaculture on the Kenai Peninsula.

Table 2.1-1. Review of daily temperature units (ºC) for sockeye salmon fry hatching and emergence.

Source:	Location	Hatch	Emergence	Emergence Timing
T. Prochazka (CIAA)	AK	600-650	950-1,000	early March - early May
Taylor & Heard, ADFG	AK	650	1100[1/]	
Pieper et al. (1982)	Unknown	666	1,000	
Hendry et al. (1998)	WA	615	950	

[1/] Fry fully developed.

The Work Group decided that the use of 950 – 1,000 DTUs was appropriate for sockeye salmon fry emergence. Using actual 2013 Grant Creek sockeye salmon run timing and water temperature data, emergence would have occurred from early through late May. Given yearly variances in run timing and water temperatures, the Work Group thought the majority of sockeye fry emergence would occur during May; however, emergence timing for all sockeye salmon fry could occur as early as March and as late as July.

2.2. Locations of Salmonid Spawning and Rearing in Grant Creek

The Work Group requested that KHL superimpose salmonid spawning and rearing locations onto a map of Grant Creek that included the Instream Flow transects. These data would be used, in part, to inform the decision on priority species and transects to be used to develop final WUA curves for those species and life history stages found and prioritized in Grant Creek.

Appendix 1 includes the maps for salmonid spawning and rearing in Grant Creek, including their vicinity to Instream Flow transects. Catch per unit effort (CPUE) is provided for rearing salmonids; transects were ranked from highest CPUE to lowest in order to evaluate whether certain transects were more heavily used and should be weighted accordingly.

2.3. Priority Species and Transect Weighting

After collaboration, the Work Group recommended that instead of prioritizing species and transects based upon utilization, transects be weighted by the proportion of the habitat that each transect represented. In addition, the Work Group recommended that the Habitat Suitability Criteria (HSC) curves be processed through the Instream Flow model to produce WUAs for all species and life history stages.

Appendix 2 includes the Final Transect Weighting report. Table 2.3-1 shows the species and life history stages that were modeled for Grant Creek. Table 2.3-2 summarizes final transect and reach weighting.

Table 2.3-1. Target species and life history stages modeled in the Grant Creek Instream Flow Study.

Species	Spawning	Fry Rearing	Juvenile Rearing	Adult Rearing
Sockeye Salmon	✓			
Coho Salmon	✓	✓	✓	
Chinook Salmon	✓	✓	✓	
Rainbow Trout	✓	✓	✓	✓
Dolly Varden Char	✓	✓	✓	✓

Table 2.3-2. Summary of reach and transect weighting (ft).

Reach	Transect	Length (ft)
1 - Distributary	100	169
	110	227
	Total	***396***
1 - Main Channel	120	256
	130	167
	140	102
	150	118
	160	49
	Total	***692***
2 - Main Channel	200	51
	210	22
	220	405
	230-M[1/]	283
	230-BW[2/]	58
	Total	***820***
3 - Main Channel	300	90
	310	718
	Total	***808***
2/3 Side Channels	320	669
	330	810
	Total	***1,479***
4 - Main Channel	400	146
	410	297
	430	25
	Total	468
Total		
Distributary		396
Main Channel		2,788
Side Channel		1,479
Total		***4,663***

[1/] Main Channel; [2/] Backwater

2.4. Final Weighted Usable Area for Grant Creek

Using the final transect weighting, and HSC curves for the species and life history stages shown in Table 2.3-1, KHL produced WUA curves for Grant Creek. Appendix 3 presents WUA for Grant Creek salmonid spawning, fry, and juvenile/adult rearing, respectively.

2.5. Effective Spawning and Incubation Analysis for Grant Creek

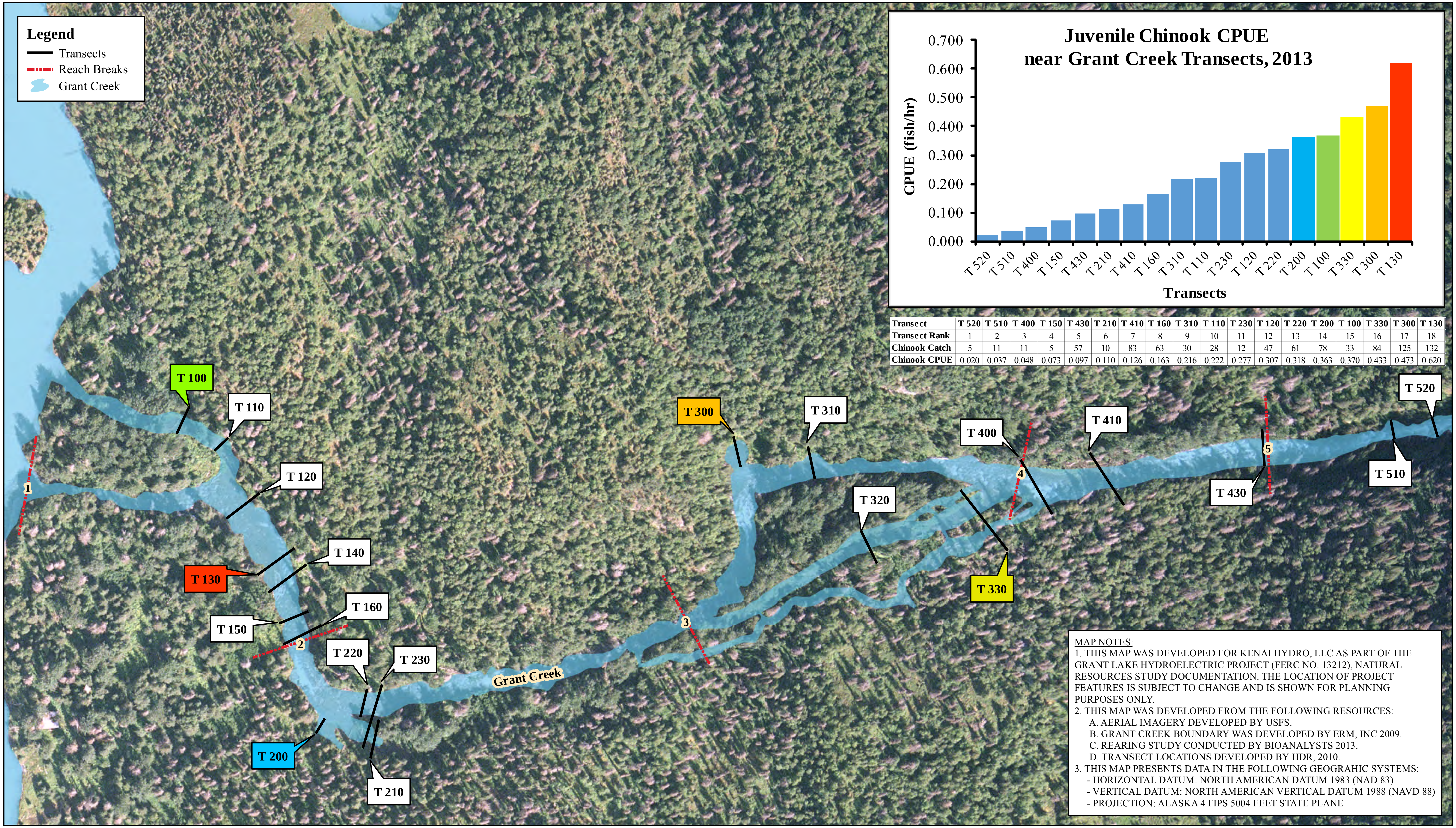
This report was produced to address issues and concerns regarding spawning flows and potential effects of Project flows on incubating salmonid eggs. KHL analyzed spawning flows of 450 cubic feet per second (cfs), as well as the median flows for the time periods when Grant Creek salmonids were spawning. The effective spawning analysis report is included as Appendix 4.

2.6. Grant Creek Habitat Time Series

This report was produced to address a request from the Work Group to conduct a habitat time series analysis for the salmonid life history stages present in Grant Creek for the Project. This report used 66 years of daily flows, both pre-Project and with-Project. The Grant Creek habitat time series report is included as Appendix 5.

Appendix 1: Grant Creek Salmonid Spawning and Rearing Locations

This appendix contains the following figures:



Transect	T 520	T 510	T 400	T 150	T 430	T 210	T 410	T 160	T 310	T 110	T 230	T 120	T 220	T 200	T 100	T 330	T 300	T 130
Transect Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Chinook Catch	5	11	11	5	57	10	83	63	30	28	12	47	61	78	33	84	125	132
Chinook CPUE	0.020	0.037	0.048	0.073	0.097	0.110	0.126	0.163	0.216	0.222	0.277	0.307	0.318	0.363	0.370	0.433	0.473	0.620

MAP NOTES:

1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. GRANT CREEK BOUNDARY WAS DEVELOPED BY ERM, INC 2009.
   C. REARING STUDY CONDUCTED BY BIOANALYSTS 2013.
   D. TRANSECT LOCATIONS DEVELOPED BY HDR, 2010.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV | DATE | BY | DESCRIPTION

N

Drawing Scale:
0 95 190 380 Feet

MCMILLEN, LLC

Developed For:
Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

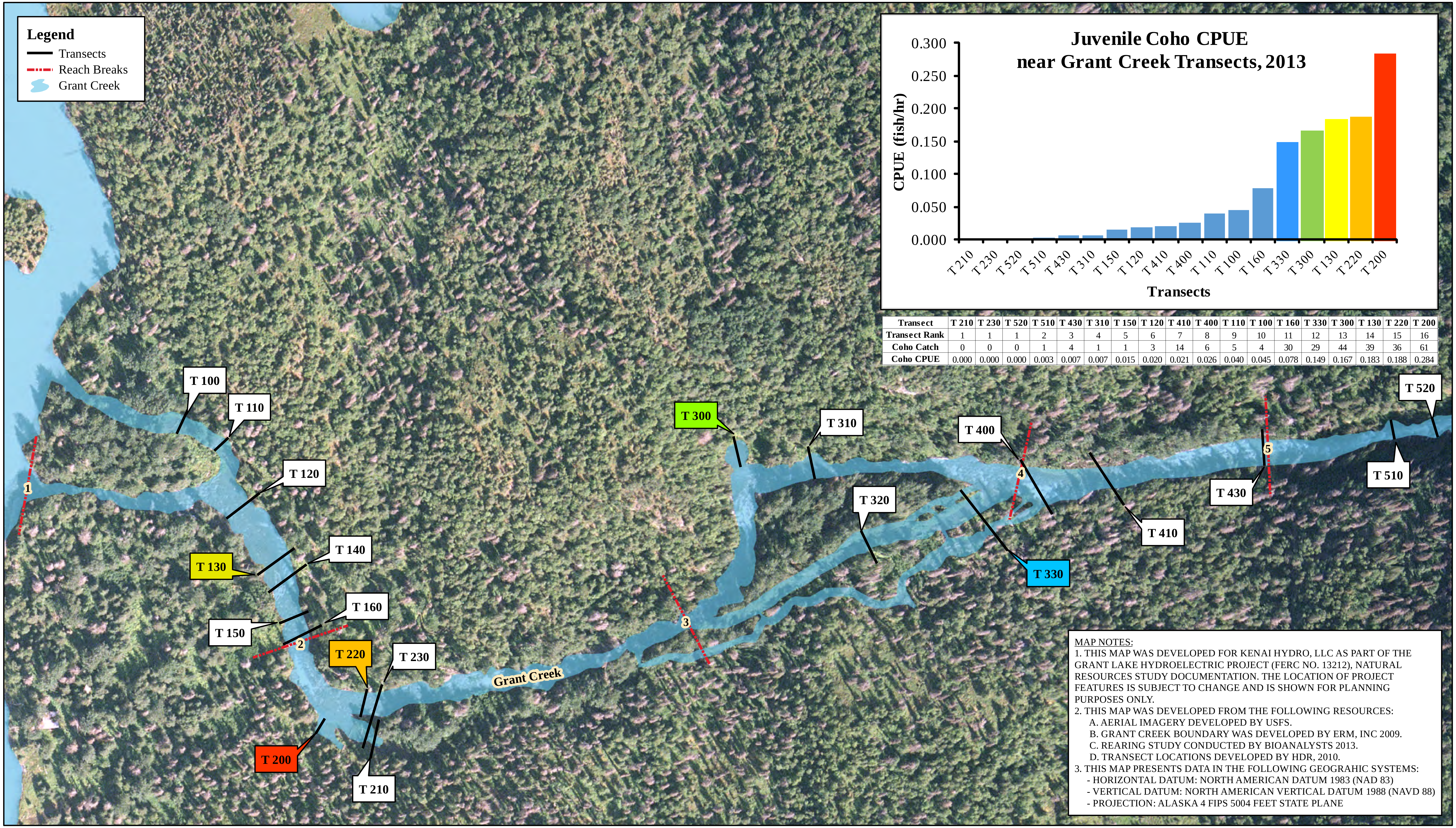
GRANT LAKE NATURAL RESOURCES STUDY

Chinook Salmon
Rearing Habitat By Transect

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Blum
ISSUED DATE 7/18/2014

DRAWING

SCALE: 1:2,000



Transect	T 210	T 230	T 520	T 510	T 430	T 310	T 150	T 120	T 410	T 400	T 110	T 100	T 160	T 330	T 300	T 130	T 220	T 200
Transect Rank	1	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Coho Catch	0	0	0	1	4	1	1	3	14	6	5	4	30	29	44	39	36	61
Coho CPUE	0.000	0.000	0.000	0.003	0.007	0.007	0.015	0.020	0.021	0.026	0.040	0.045	0.078	0.149	0.167	0.183	0.188	0.284

MAP NOTES:

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   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV DATE BY DESCRIPTION

N

Drawing Scale:
0 95 190 380 Feet

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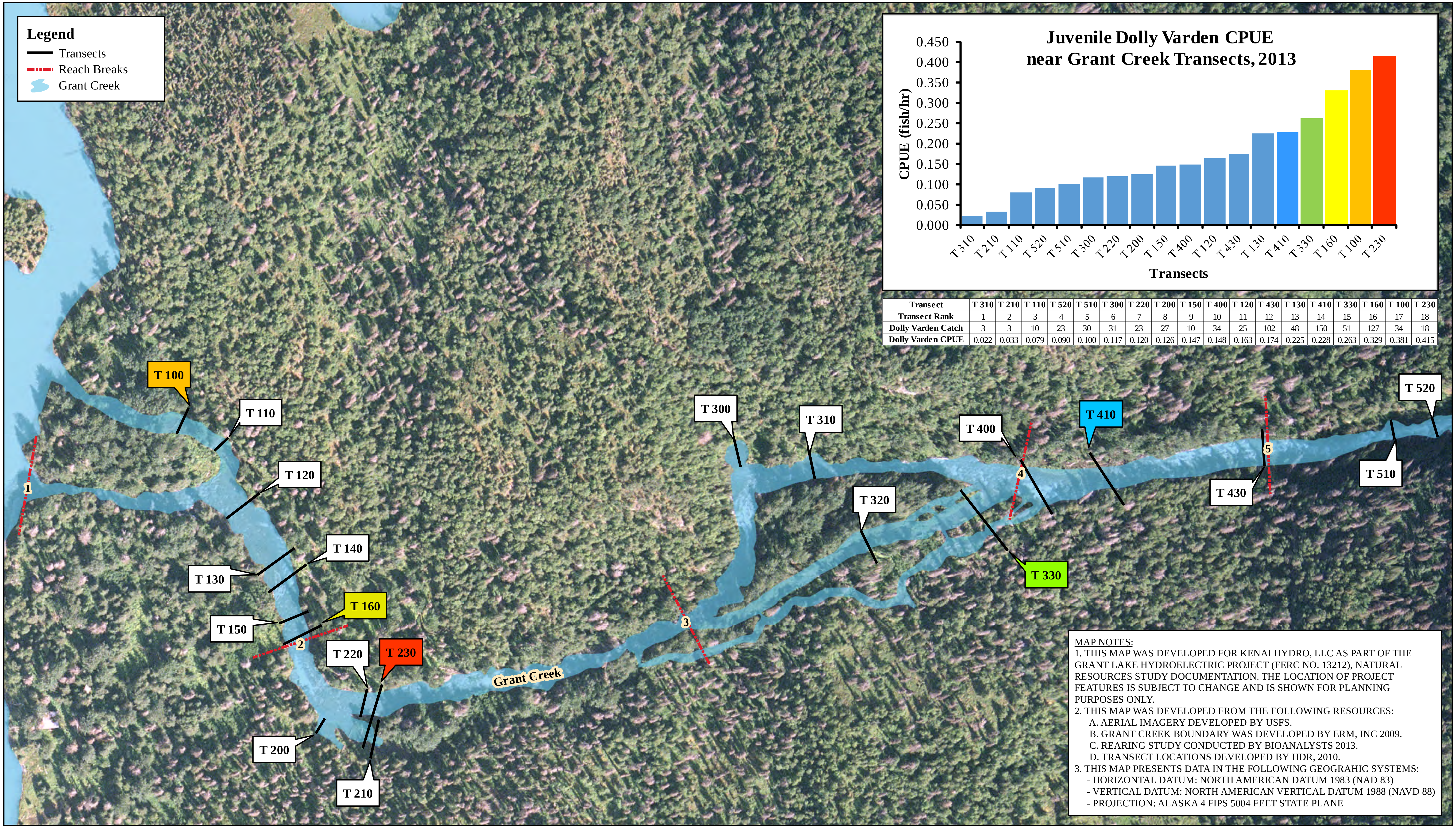
Developed For:
Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

GRANT LAKE NATURAL RESOURCES STUDY

Coho Salmon
Rearing Habitat By Transect

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Blum
ISSUED DATE 7/18/2014
DRAWING
SCALE: 1:2,000



Transect	T 310	T 210	T 110	T 520	T 510	T 300	T 220	T 200	T 150	T 400	T 120	T 430	T 130	T 410	T 330	T 160	T 100	T 230
Transect Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Dolly Varden Catch	3	3	10	23	30	31	23	27	10	34	25	102	48	150	51	127	34	18
Dolly Varden CPUE	0.022	0.033	0.079	0.090	0.100	0.117	0.120	0.126	0.147	0.148	0.163	0.174	0.225	0.228	0.263	0.329	0.381	0.415

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2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
   A. AERIAL IMAGERY DEVELOPED BY USFS.
   B. GRANT CREEK BOUNDARY WAS DEVELOPED BY ERM, INC 2009.
   C. REARING STUDY CONDUCTED BY BIOANALYSTS 2013.
   D. TRANSECT LOCATIONS DEVELOPED BY HDR, 2010.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAHIC SYSTEMS:
   - HORIZONTAL DATUM: NORTH AMERICAN DATUM 1983 (NAD 83)
   - VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)
   - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

REV DATE BY DESCRIPTION

N

Drawing Scale:
0 95 190 380 Feet

MCMILLEN, LLC
THE SONNA BUILDING 910 MAIN ST., SUITE 258 BOISE, ID 83702
OFFICE: 208.342.4214 FAX: 208.342.4216

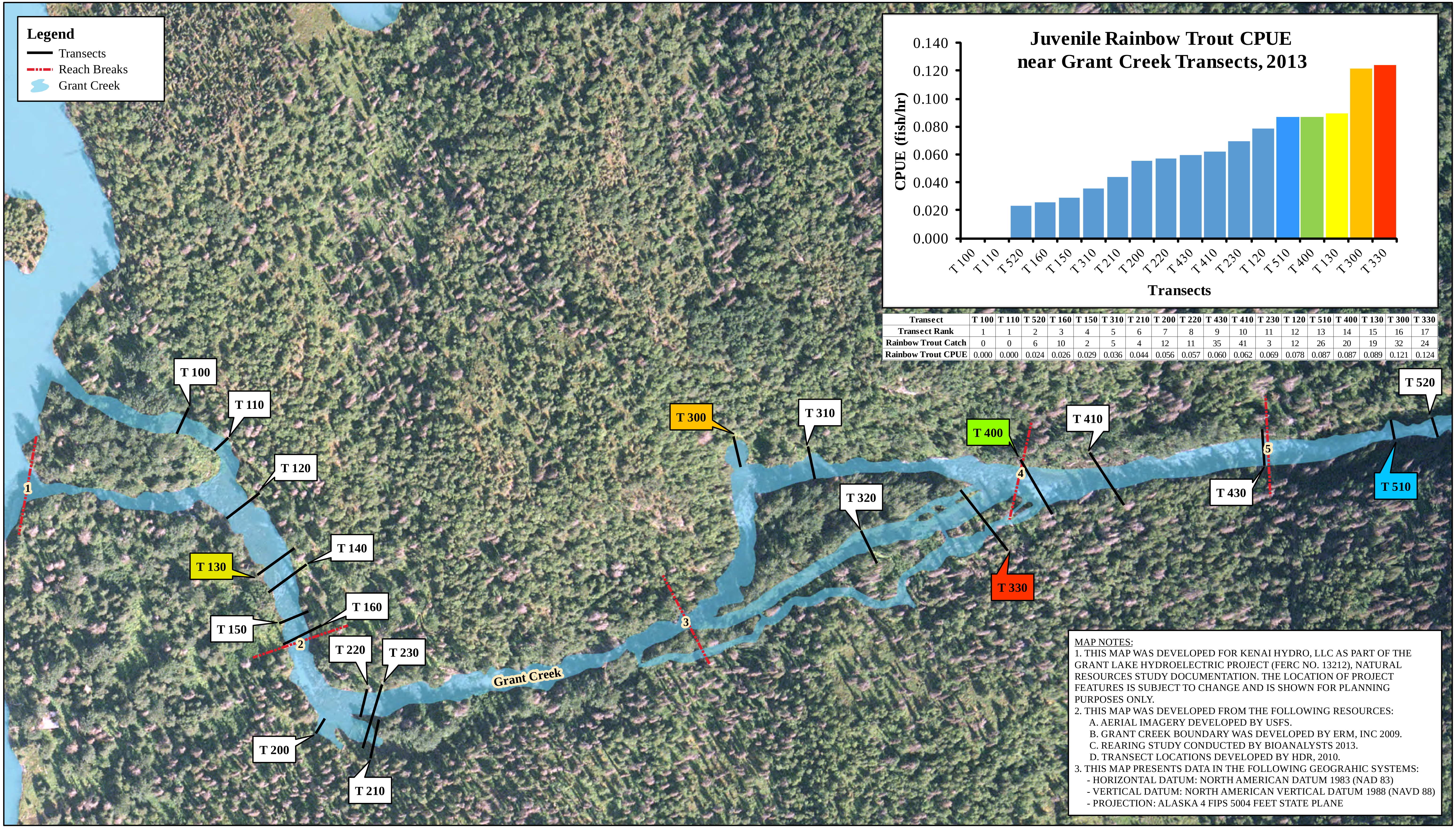
Developed For:
Homer Electric Association, Inc.
A Touchstone Energy Cooperative

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

GRANT LAKE NATURAL RESOURCES STUDY

Juvenile Dolly Varden Rearing Habitat By Transect

DESIGNED J. Woodbury
DRAWN J. Woodbury
CHECKED J. Blum
ISSUED DATE 7/18/2014
DRAWING
SCALE: 1:2,000



Transect	T 100	T 110	T 520	T 160	T 150	T 310	T 210	T 200	T 220	T 430	T 410	T 230	T 120	T 510	T 400	T 130	T 300	T 330
Transect Rank	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Rainbow Trout Catch	0	0	6	10	2	5	4	12	11	35	41	3	12	26	20	19	32	24
Rainbow Trout CPUE	0.000	0.000	0.024	0.026	0.029	0.036	0.044	0.056	0.057	0.060	0.062	0.069	0.078	0.087	0.087	0.089	0.121	0.124

MAP NOTES:
1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
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REV DATE BY DESCRIPTION

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Drawing Scale:
0 95 190 380
Feet

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GRANT LAKE NATURAL RESOURCES STUDY

Rainbow Trout
Rearing Habitat By Transect

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DRAWN J. Woodbury
CHECKED J. Blum
ISSUED DATE 7/18/2014
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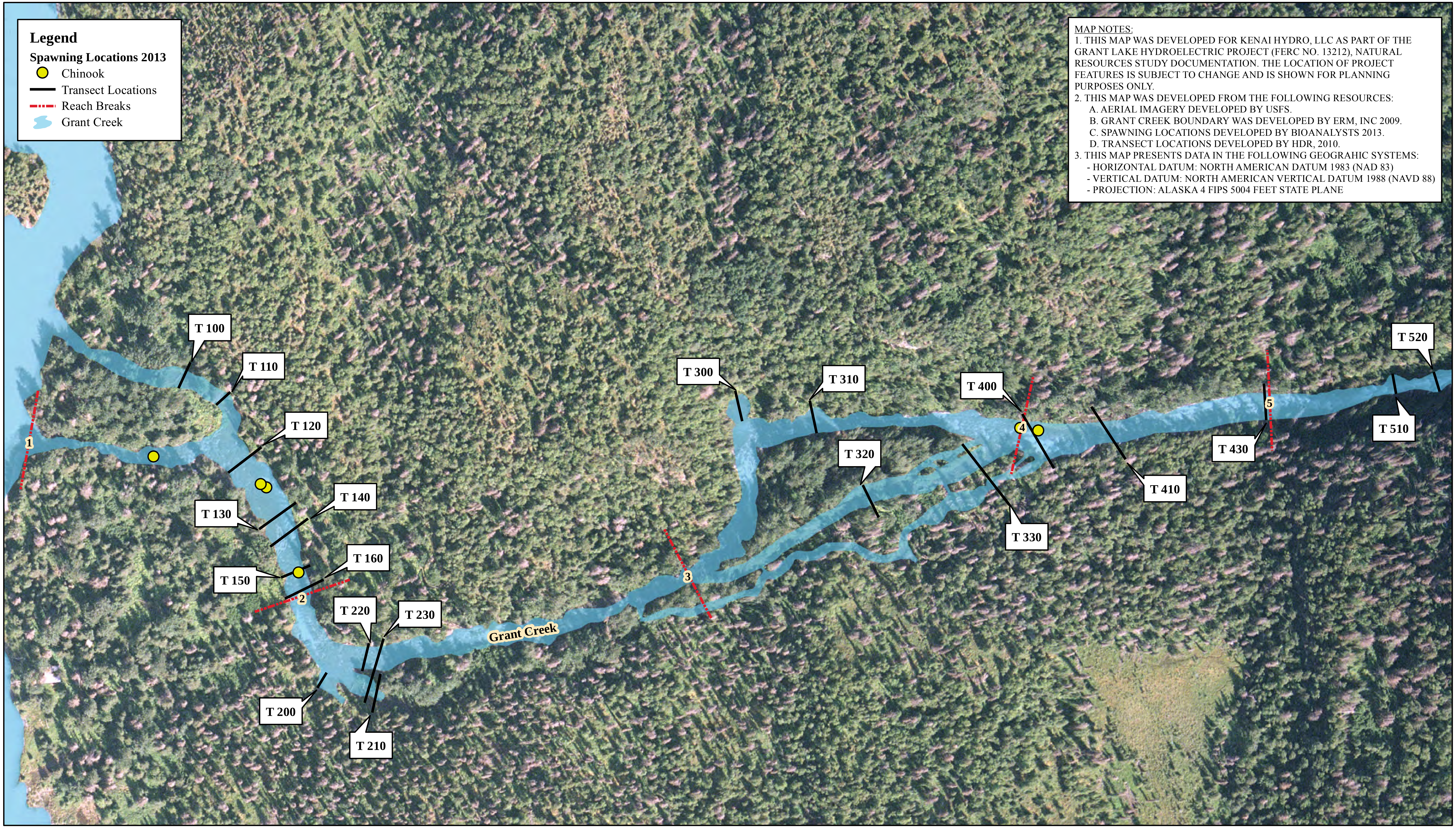

REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 95 190 380 Feet

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GRANT LAKE NATURAL RESOURCES STUDY

Transect Locations & Chinook Spawning Locations

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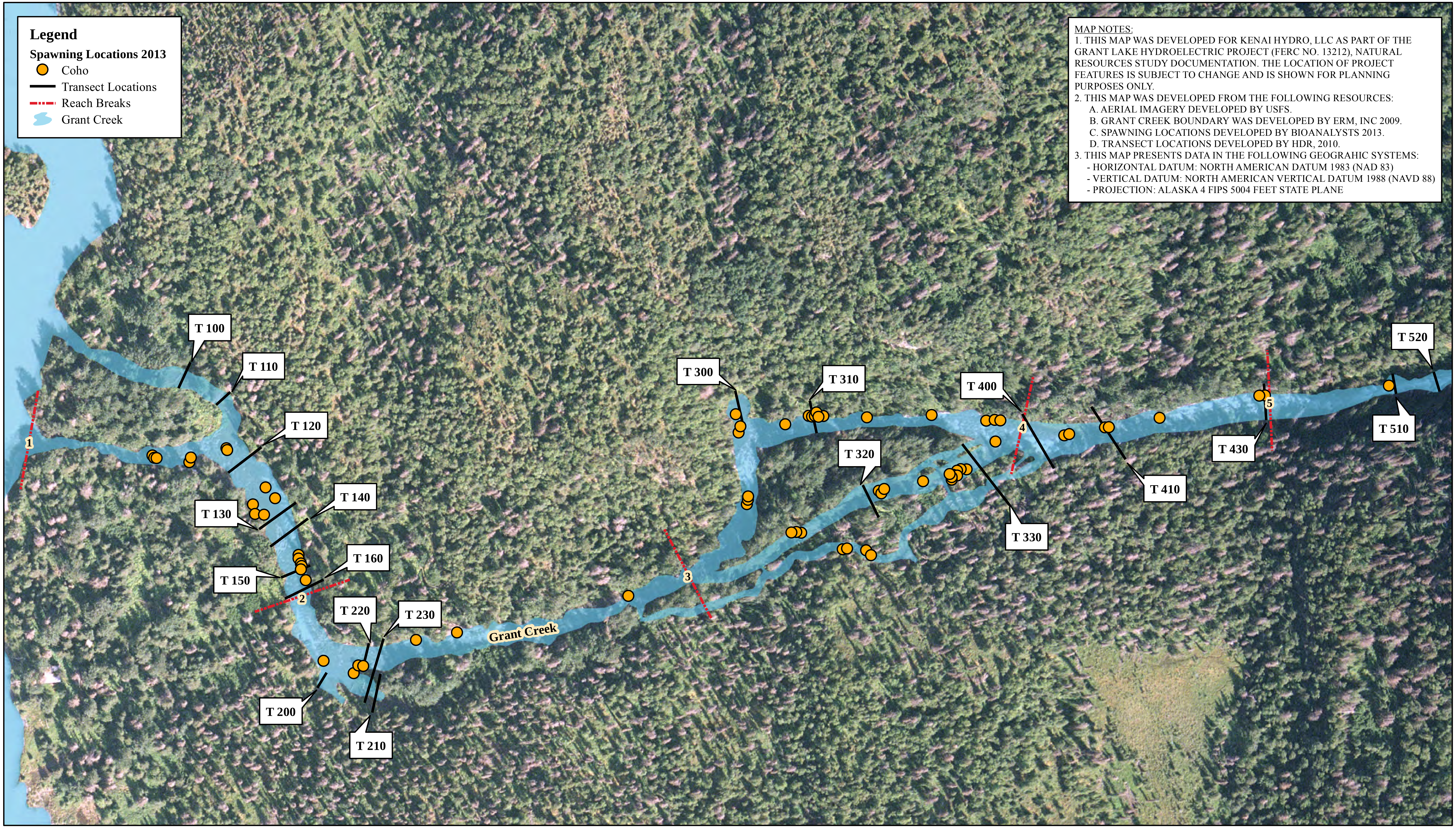

REV	DATE	BY	DESCRIPTION

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Drawing Scale:
0 95 190 380 Feet

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GRANT LAKE NATURAL RESOURCES STUDY

Transect Locations &
Coho Spawning Locations

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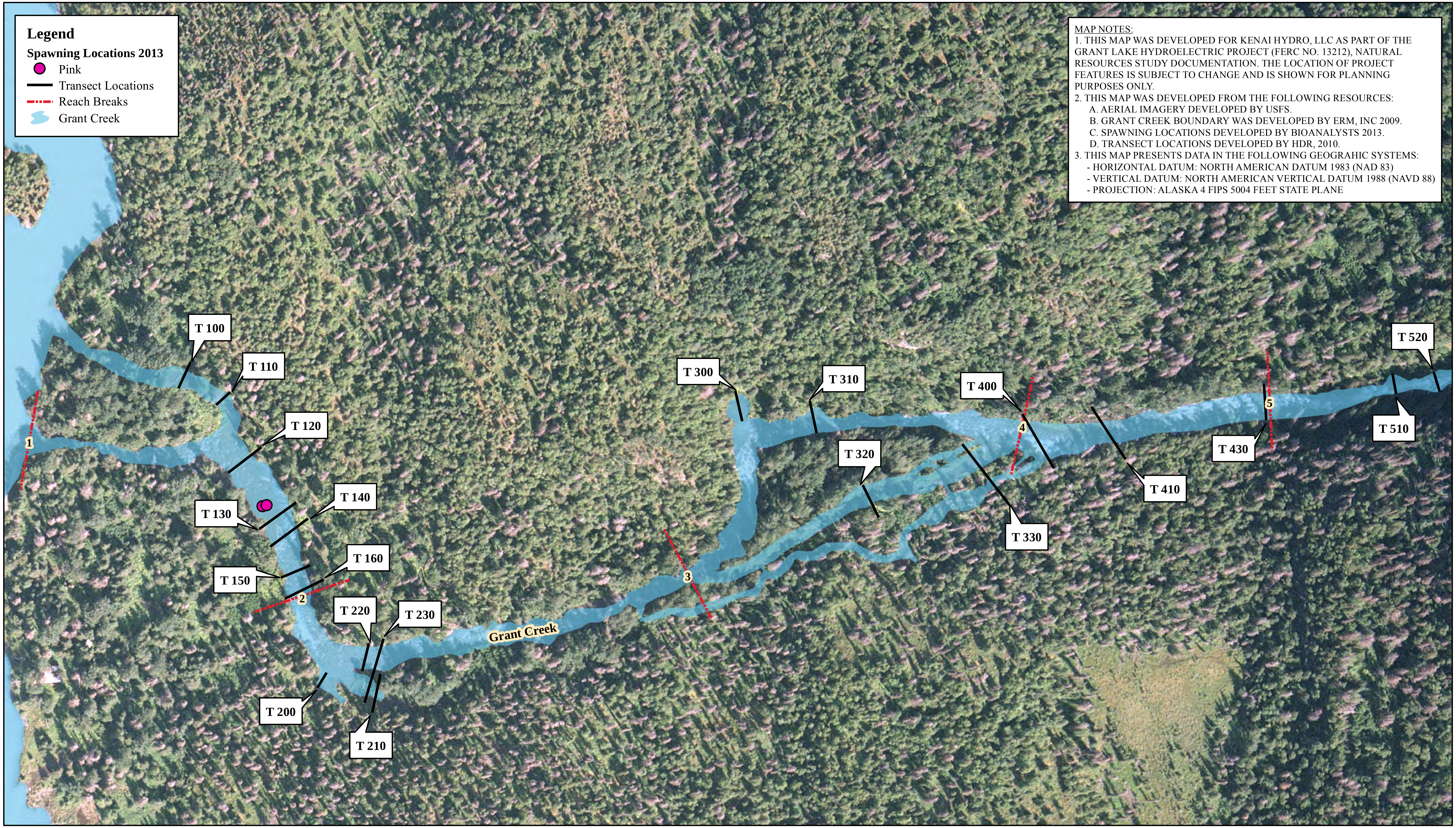

REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 95 190 380 Feet

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GRANT LAKE NATURAL RESOURCES STUDY

Transect Locations &
Pink Salmon Spawning Locations

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CHECKED J. Blum
ISSUED DATE 7/18/2014

DRAWING

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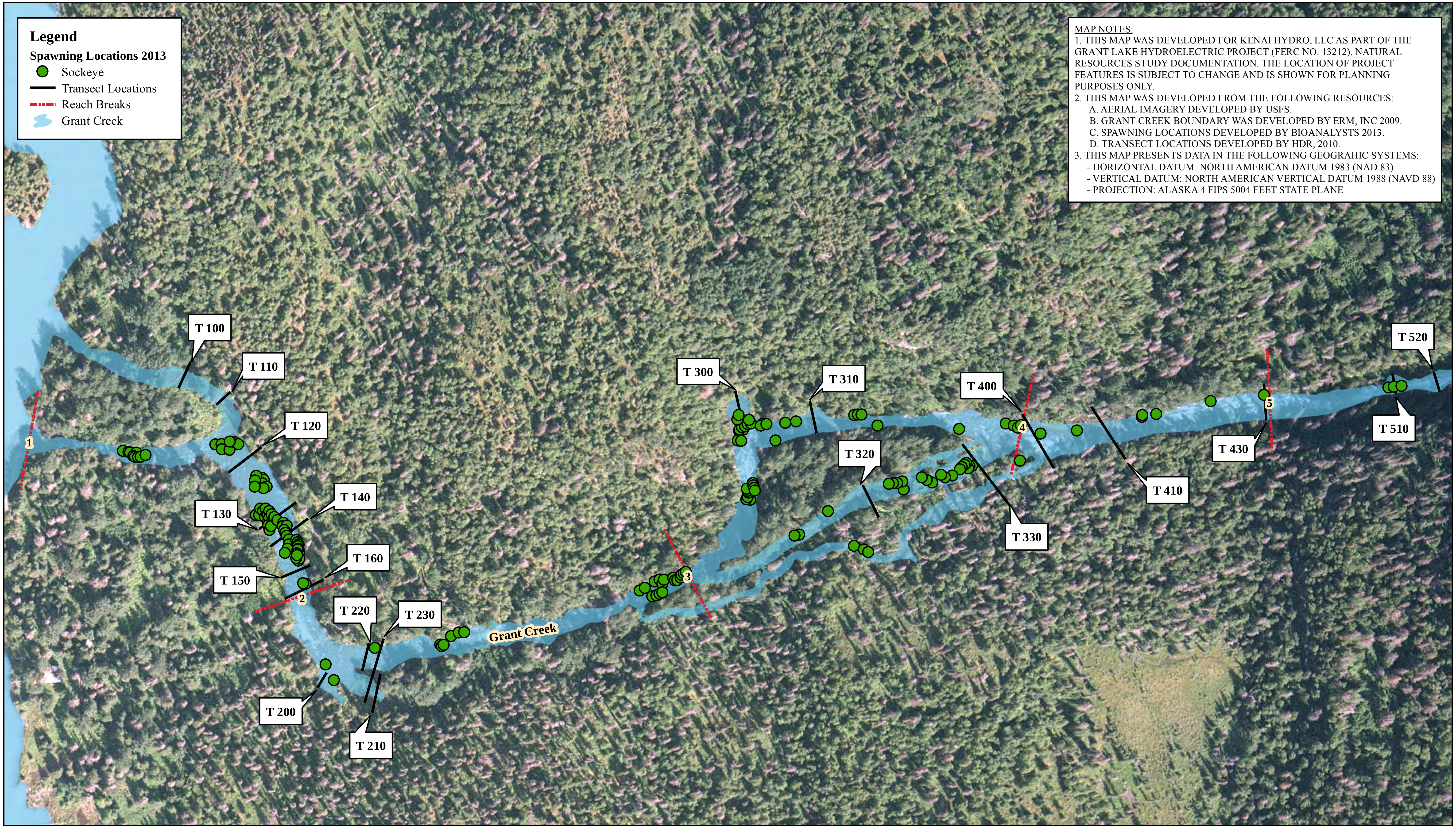

REV	DATE	BY	DESCRIPTION

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Drawing Scale:
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GRANT LAKE NATURAL RESOURCES STUDY

Transect Locations &
Sockeye Spawning Locations

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Appendix 2: Habitat Quantification/Transect Weighting Methodology

Grant Lake Hydroelectric Project (FERC No. 13212)

Habitat Quantification / Transect Weighting Methodology

Final Report

Prepared for
Kenai Hydro LLC

Prepared by

McMILLEN
DESIGN with Vision. BUILD with Integrity.

August 2014

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1 INTRODUCTION

As part of the Instream Flow assessment of habitat within Grant Creek, it is necessary to identify habitat types within reaches of Grant Creek, to quantify those habitats, and to weight them in proportion to their availability within lower Grant Creek. These analyses are then used to weight those transects that were selected and modeled within Reaches 1 through 4. As such, we have undertaken a process to identify and quantify habitat within the various reaches of Grant Creek. Our assessment has been tailored to provide metrics consistent with the work conducted by Flory (1999) on Falls Creek, AK; a summary of these results was provided by Alaska Department of Fish and Game. This document is a brief summary of the methodology used in our analysis.

2 MAP LAYOUT

A scaled map of Grant Creek, which depicted meso-habitats, was overlaid with reach breaks and transect locations. An 8.5 x 11 inch map of each reach was prepared, and the area (ft^2) associated within a given transect was added to each map; the upstream and downstream boundaries associated with each transect were based on one of two criteria:

1. In the event another transect was relatively close to the transect of interest, the boundary was located an equidistance from each transect, or
2. If the nearest transect was more than one meso-habitat away, then the boundary was located at the edge of the meso-habitat associated with that transect or some obvious geophysical feature within Grant Creek (Figure 3-1).

All non-transect sections of Grant Creek were also categorized, and numbered sequentially starting within the Reach 1 Distributary and working upstream (e.g., S1, S2, etc.).

3 MEASUREMENT OF HABITAT

With the prepared maps, it was then possible to measure the length (in millimeters) of each habitat type within a given reach. Each habitat type was associated with either a specific transect (e.g., T300, T310, etc.) or a non-transect area (e.g., S8, S9, etc.). In the event a single habitat type fell within a specific area, such as S8 (Figure 3-1), measurement of that habitat was relatively straightforward and was simply confined by the boundaries located at the Reach 2/3 break (downstream) and the boundary with S9 (upstream). In the event more than one habitat type existed within a specific area, it was then necessary to subjectively proportion the length of each habitat type for that site. A good example of this scenario is most of the Primary Secondary Channel of Reach 3 (Figure 3-1), where multiple meso-habitats occurred in all segments with the exception of S13, which consisted only of riffle habitat.

With each habitat type measured by reach, each transect and non-transect segment of Grant Creek quantified, and with additional information from the GIS database (i.e., reach length and overall area of each habitat type, in ft^2), it was then possible to calculate area of habitat associated with each segment within Grant Creek, and linear feet of habitat by segment. It was also possible to compile those data and generate results consistent with work by Flory (1999) on Falls Creek, AK. Figure 3-2 and Table 3-1 show an example of the first level of analysis, where transect and non-transect segments of Reach 1 are summarized to provide the proportion of habitat within the reach, and the overall area of habitat associated within those segments. Appendix 1 shows Grant Creek reaches and calculations of habitat areas within each reach.

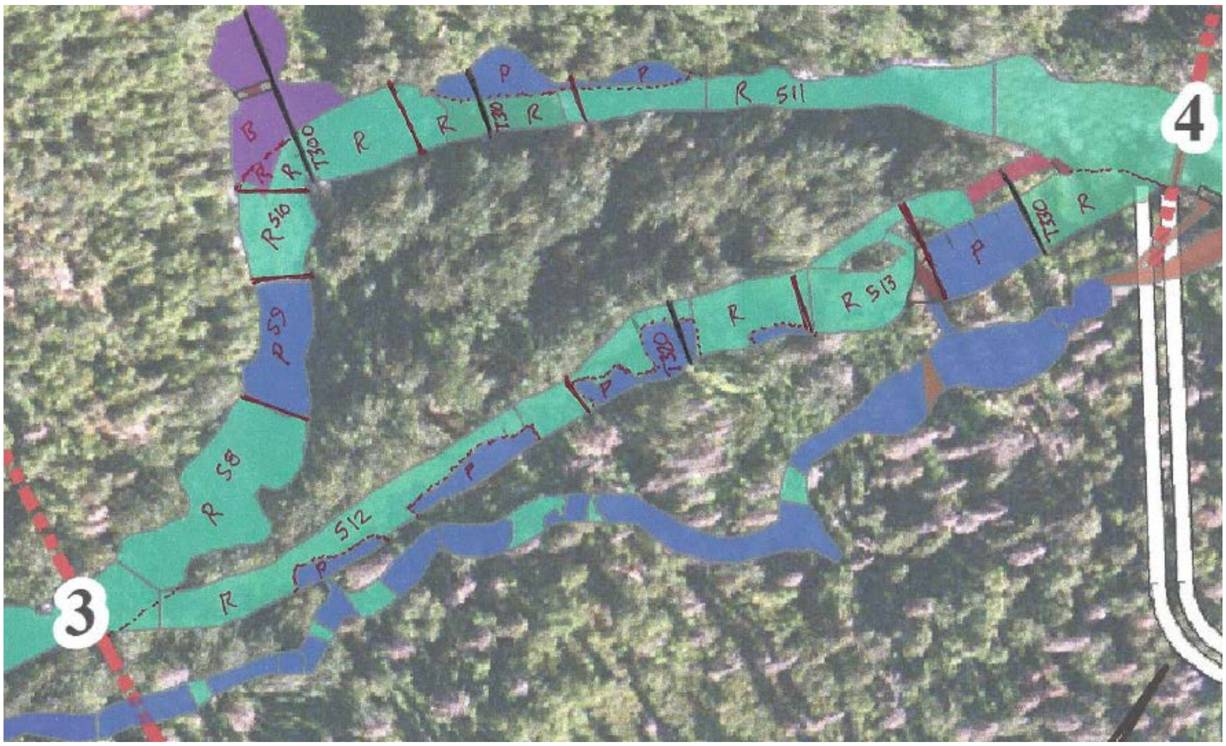


Figure 3-1. A map of Reach 3 that identifies transects, transect breaks, and habitat types that were used to assess habitat weighting.

Once habitat frequencies were established for each transect, available habitats (by type) were then scaled in proportion to their availability within that reach. The results were then summed and each transect was weighted in accordance with its area and assigned a length (in ft).

For example, in the Reach 1 Distributary, there are 7,495 ft^2 of pool habitat, and 6,004 ft^2 of riffle habitat, for a total of 13,499 ft^2 (Table 3-3). Of the habitat associated with Transects 100 and 110, T100 had 20.6% of the pool habitat and 70% of the riffle habitat; T110 had 79.4% of the pool habitat and 30% of the riffle habitat. For reach weighting, therefore, T100 had 20.6% of the 7,495 ft^2 of pool habitat (1,543 ft^2) and 70% of the 6,004 ft^2 of riffle habitat for a total of 5,746 ft^2 in the Reach 1 Distributary. That constituted 42.6% of the habitat within this reach. Given a length of 396 ft, T100 was weighted 169 ft (42.6% X 396). Each transect in each reach was weighted using this same method. The only deviation was in the Reach 2/3 side channels, where habitat was aggregated in both channels and weighted accordingly.

Table 3-2 shows the lengths of each reach. There are 396 linear ft of habitat in the Distributary in Reach 1, 2,788 linear ft of habitat in mainstem Reaches 1 – 4, and 1,479 linear ft in the Reach 2/3 side channels. Tables 3-3 – 3-8 show calculation details for each reach in lower Grant Creek. Table 3-9 summarizes weighting for all transects.

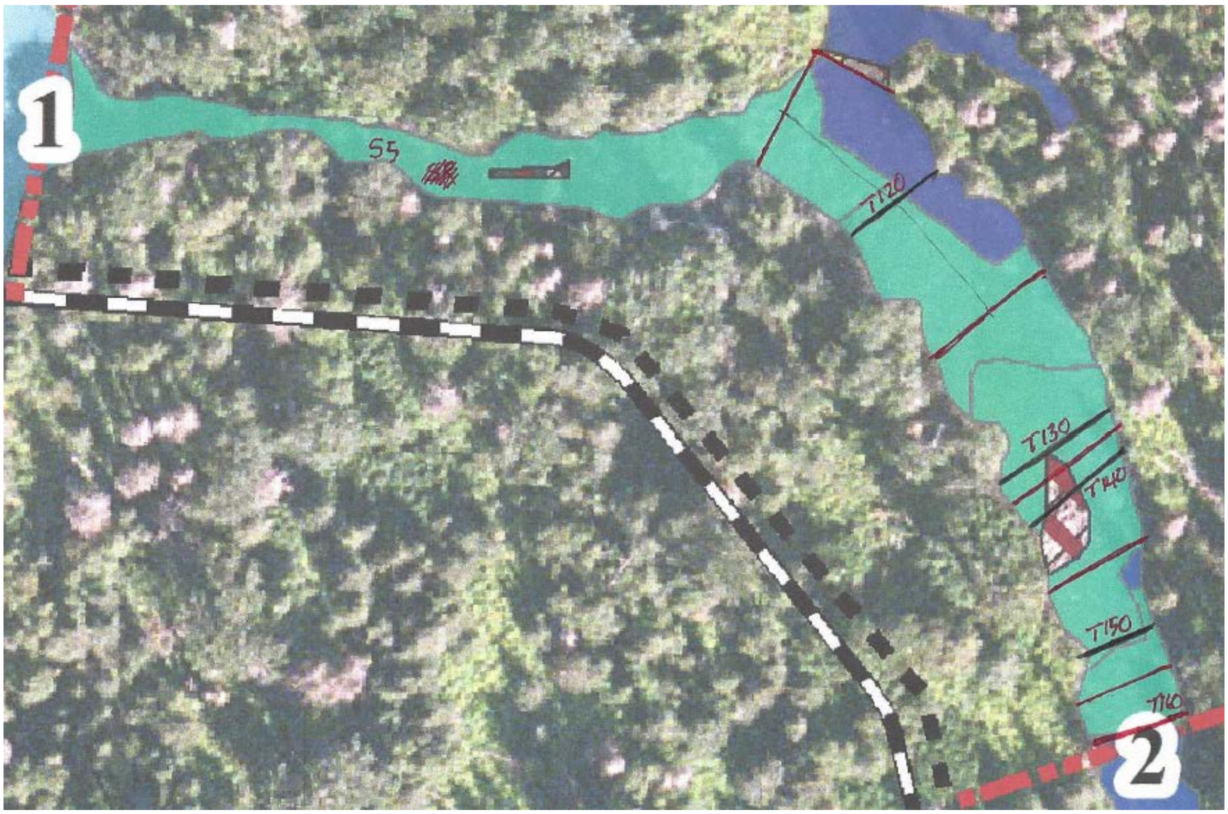


Figure 3-2. A map of Reach 1 that identifies transects, transect breaks, and habitat types that were used to assess habitat weighting.

Table 3-1. A summary of the proportion and area (ft^2) of habitat by type for transect and non-transect areas of Grant Creek, AK.

Reach	Transect/ Segment	Habitat	Reach Length (ft)	% of Habitat Within Reach	Habitat Area (ft^2)	Trans/Seg Area (ft^2)
Reach 1 Distributary	S1	Pool	396	33.3%	7,495	2,498
	S2	Riffle	396	21.3%	6,004	1,276
	S3	Pool	396	16.7%	7,495	1,249
	S3	Riffle	396	16.3%	6,004	976
	S4	Pool	396	6.4%	7,495	480
	S4	Riffle	396	25.0%	6,004	1,501
	T100	Riffle	396	26.3%	6,004	1,576
	T100	Pool	396	9.0%	7,495	673
	T110	Riffle	396	11.3%	6,004	675
	T110	Pool	396	34.6%	7,495	2,594
	Total	***Pool***			7,495	
		Riffle			6,004	
Reach 1 Mainstem	S5	Riffle	692	53.5%	23,168	12,394
	T120	Riffle	692	13.6%	23,168	3,146
	T120	Pool	692	94.4%	3,143	2,968
	T130	Riffle	692	12.8%	23,168	2,956
	T140	Riffle	692	7.8%	23,168	1,811
	T150	Riffle	692	8.6%	23,168	2,002
	T150	Pool	692	5.6%	3,143	175
	T160	Riffle	692	3.7%	23,168	858
	Total	***Pool***			3,143	
		Riffle			23,168	

Reach	Transect/ Segment	Habitat	Reach Length (ft)	% of Habitat Within Reach	Habitat Area (ft^2)	Trans/Seg Area (ft^2)
Reach 2 Mainstem	S6	Pool	820	86.4%	3,834	3,311
	T200	Backwater	820	38.9%	4,837	1,881
	T220	Riffle	820	16.8%	23,669	3,968
	T220	Glide	820	30.0%	1,613	484
	T230	Glide	820	70.0%	1,613	1,129
	T230	Backwater	820	44.4%	4,837	2,150
	T230	Riffle	820	10.8%	23,669	2,551
	T210	Backwater	820	16.7%	4,837	806
	S7	Riffle	820	72.5%	23,669	17,149
	S7	Pool	820	13.6%	3,834	523
	Total	***Backwater***			4,837	
		Riffle			23,669	
		Glide			1,613	
		Pool			3,834	
Reach 3 Mainstem	S8	Riffle	808	22.9%	25,585	5,866
	S9	Pool	808	66.7%	3,997	2,665
	S10	Riffle	808	22.4%	25,585	5,741
	T300	Backwater	808	100.0%	3,697	3,697
	T310	Riffle	808	5.9%	25,585	1,498
	T310	Pool	808	27.3%	3,997	1,090
	S11	Riffle	808	48.8%	25,585	12,480
	S11	Pool	808	6.1%	3,997	242
	Total	***Riffle***			25,585	
		Pool			3,997	
		Backwater			3,697	

Reach	Transect/ Segment	Habitat	Reach Length (ft)	% of Habitat Within Reach	Habitat Area (ft^2)	Trans/Seg Area (ft^2)
Reach 3 Primary Side Channel	S12	Riffle	606	48.8%	11,672	5,698
	S12	Pool	606	41.5%	5,018	2,083
	T320	Riffle	606	18.9%	11,672	2,206
	T320	Pool	606	24.5%	5,018	1,231
	S13	Riffle	606	18.9%	11,672	2,206
	T330	Pool	606	34.0%	5,018	1,704
	T330	Riffle	606	13.4%	11,672	1,562
	T330	Rapid	606	100.0%	511	511
Reach 3 Secondary Side Channel	S14	Cascade	873	100.0%	114	114
	S15	Run	873	100.0%	576	576
	S16	Pool	873	11.0%	9,908	1,094
	S17	Riffle	873	9.5%	2,683	256
	S18	Pool	873	13.0%	9,908	1,287
	S19	Riffle	873	7.1%	2,683	192
	S20	Pool	873	3.2%	9,908	322
	S21	Riffle	873	14.3%	2,683	383
	S22	Pool	873	16.2%	9,908	1,608
	S23	Riffle	873	21.4%	2,683	575
	S24	Pool	873	1.9%	9,908	193
	S25	Riffle	873	4.8%	2,683	128
	S26	Pool	873	24.0%	9,908	2,380
	S27	Riffle	873	14.3%	2,683	383
	S28	Pool	873	16.2%	9,908	1,608
	S29	Glide	873	10.7%	1,588	170
	S30	Pool	873	14.3%	9,908	1,415
	T330	Riffle	873	28.6%	2,683	767
	S31	Glide	873	89.3%	1,588	1,418

Reach	Transect/ Segment	Habitat	Reach Length (ft)	% of Habitat Within Reach	Habitat Area (ft^2)	Trans/Seg Area (ft^2)
	Total Side Channel	***Riffle***			14,355	
		Pool			14,926	
		Glide			1,588	
		Rapid			511	
		Cascade			114	
Reach 4 Mainstem	T400	Riffle	468	11.7%	17,649	2,061
	T410	Riffle	468	17.5%	17,649	3,092
	T410	Pocket Water	468	8.6%	3,709	318
	S32	Riffle	468	70.8%	17,649	12,496
	S32	Pocket Water	468	91.4%	3,709	3,391
	T430	Pool	468	100.0%	1,195	1,195
	Total	***Riffle***			17,649	
		Pocket Water			3,709	
		Pool			1,195	

Table 3-2. Lower Grant Creek reach lengths.

Reach	Length (ft)
R 1 Distributary	396
R 1 Mainstem	692
R 2	820
R 3 Mainstem	808
R 3 Side Channel	606
R 2/3 Side Channel	873
R 4	468
Total	
Distributary	396
Main Channel	2,788
Side Channel	1,479
Total	**4,663**

Table 3-3. Reach 1 Distributary area and transect weighting.

Total Length (ft)	**396**								
	Pool		**Riffle**		**Total**			**Reach Weights**	
Trans	**Area**	**% age**	**Area**	**% age**	**Pool**	**Riffle**	**Total**	**% age**	**Length**
T100	673	20.6%	1,576	70.0%	1,543	4,203	5,746	42.6%	169
T110	2,594	79.4%	675	30.0%	5,952	1,801	7,753	57.4%	227
Total	***3,267***		***2,252***		***7,495***	***6,004***	***13,499***		***396***

Table 3-4. Reach 1 main channel area and transect weighting.

Total Length (ft)	**692**								
	Pool		**Riffle**		**Total**			**Reach Weights**	
Trans	**Area**	**% age**	**Area**	**% age**	**Pool**	**Riffle**	**Total**	**% age**	**Length**
T120	2,968	94.4%	3,146	29.2%	2,968	6,766	9,734	37.0%	256
T130	0	0.0%	2,956	27.4%	0	6,356	6,356	24.2%	167
T140	0	0.0%	1,811	16.8%	0	3,896	3,896	14.8%	102
T150	175	5.6%	2,002	18.6%	175	4,306	4,480	17.0%	118
T160	0	0.0%	858	8.0%	0	1,845	1,845	7.0%	49
Total	***3,143***		***10,774***		***3,143***	***23,168***	***26,311***		***692***

Table 3-5. Reach 2 area and transect weighting.

Total Length (ft) = 820															
	Pool		Backwater		Glide		Riffle		Total					Reach Weights	
Trans	Area	% age	Area	% age	Area	% age	Area	% age	Pool	BackW	Glide	Riffle	Total	% age	Length
T200	0	0.0%	1,881	38.9%	0	0.0%	0	0.0%	0	1,881	0	0	1,881	6.2%	51
T210	0	0.0%	806	16.7%	0	0.0%	0	0.0%	0	806	0	0	806	2.7%	22
T220	0	0.0%	0	0.0%	484	30.0%	3,968	60.9%	0	0	484	14,407	14,891	49.4%	405
T230-M	0	0.0%	0	0.0%	1,129	70.0%	2,551	39.1%	0	0	1,129	9,262	10,391	34.5%	283
T230-BW	0	0.0%	2,149.8	44.4%	0	0.0%	0	0.0%	0	2,150	0	0	2,150	7.1%	58
Total	***0***		***4,837***		***1,613***		***6,520***		***0***	***4,837***	***1,613***	***23,669***	***30,119***		***819***

Table 3-6. Reach 3 main channel area and transect weighting.

Total Length (ft) = 808												
	Pool		Backwater		Riffle		Total				Reach Weights	
Trans	Area	% age	Area	% age	Area	% age	Pool	Backwater	Riffle	Total	% age	Length
T300	0	0.0%	3,697	100.0%	0	0.0%	0	3,697	0	3,697	11.1%	90
T310	1,090	100.0%	0	0.0%	1,498	100.0%	3,997	0	25,585	29,582	88.9%	718
Total	***1,090***		***3,697***		***1,498***		***3,997***	***3,697***	***25,585***	***33,279***		***808***

Table 3-7. Reach 2/3 side channels area and transect weighting.

Total Length (ft) = 1,479												
	Pool		Riffle		Rapids		Total				Reach Weights	
Trans	Area	% age	Area	% age	Area	% age	Pool	Riffle	Rapids	Total	% age	Length
T320	1,231	41.9%	2,206	48.6%	0	0.0%	2,104	5,677	0	7,782	45.2%	669
T330	1,704	58.1%	2,329	51.4%	511	100.0%	2,914	5,995	511	9,419	54.8%	810
Total	***2,935***		***4,535***		***511***		***5,018***	***11,672***	***511***	***17,201***		***1,479***

Table 3-8. Reach 4 area and transect weighting.

Total Length (ft) =	468											
	Pool		Pocket Water		Riffle		Total				Reach Weights	
Trans	Area	% age	Area	% age	Area	% age	Pool	PocketW	Riffle	Total	% age	Length
T400	0	0.0%	0	0.0%	2,061	40.0%	0	0	7,060	7,060	31.3%	146
T410	0	0.0%	318	100.0%	3,092	60.0%	0	3,709	10,589	14,298	63.4%	297
T430	1,195	100.0%	0	0.0%	0	0.0%	1,195	0	0	1,195	5.3%	25
Total	***1,195***		***318***		***5,153***		***1,195***	***3,709***	***17,649***	***22,553***		***468***

Table 3-9. Summary of reach and transect weighting (ft).

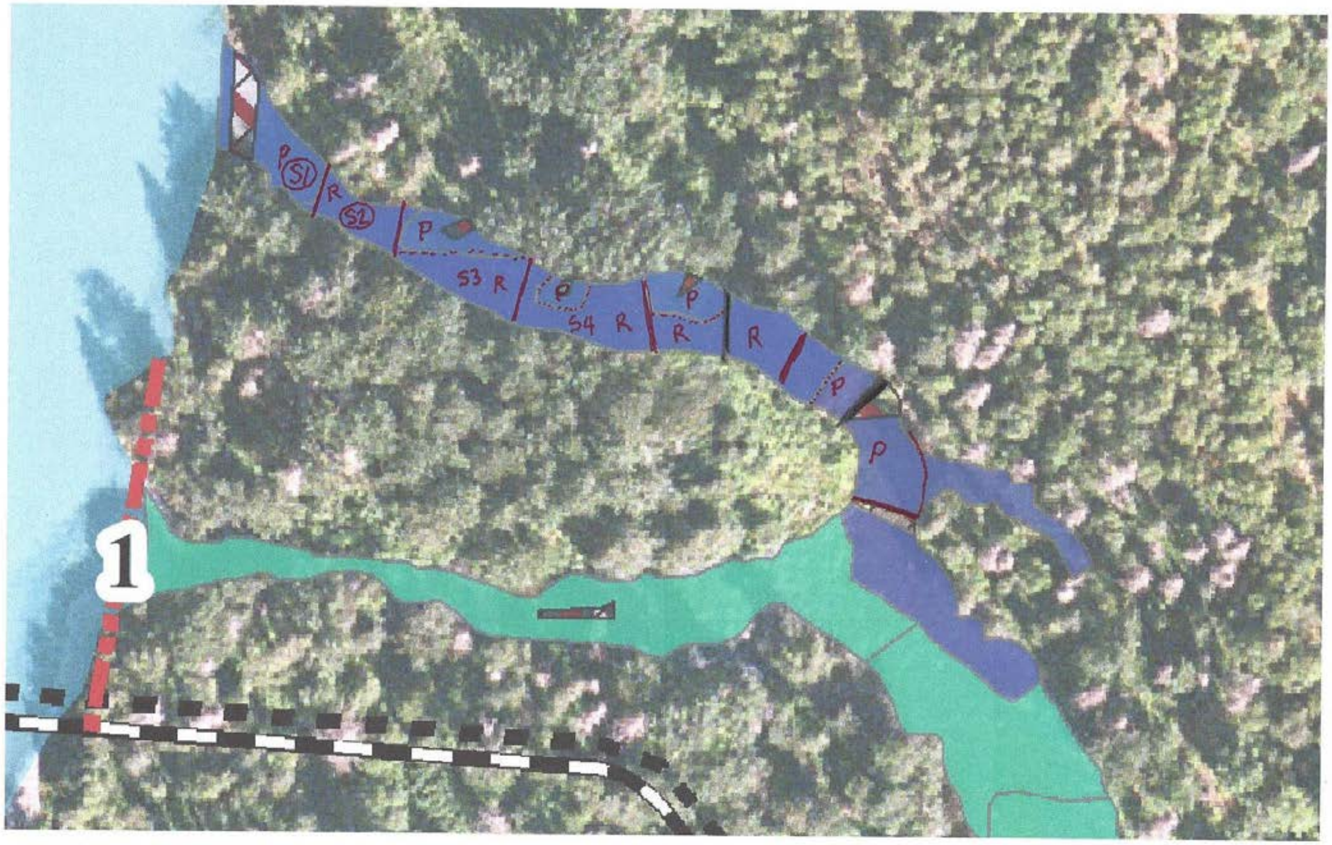
Reach	Transect	Length (ft)
1 - Distributary	100	169
	110	227
	Total	***396***
1 - Main Channel	120	256
	130	167
	140	102
	150	118
	160	49
	Total	***692***
2 - Main Channel	200	51
	210	22
	220	405
	230-M[1/]	283
	230-BW[2/]	58
	Total	***820***
3 - Main Channel	300	90
	310	718
	Total	***808***
2/3 Side Channels	320	669
	330	810
	Total	***1,479***
4 - Main Channel	400	146
	410	297
	430	25
	Total	468
Total		
Distributary		396
Main Channel		2,788
Side Channel		1,479
Total		***4,663***

4 LITERATURE CITED

Flory, E. A. 1999. Fish and fish habitats of the Falls Creek area. Prepared by Icy Strait Environmental Services, Gustavus, AK. Prepared for Gustavus Electric Company, Gustavus, AK. 46 pp.

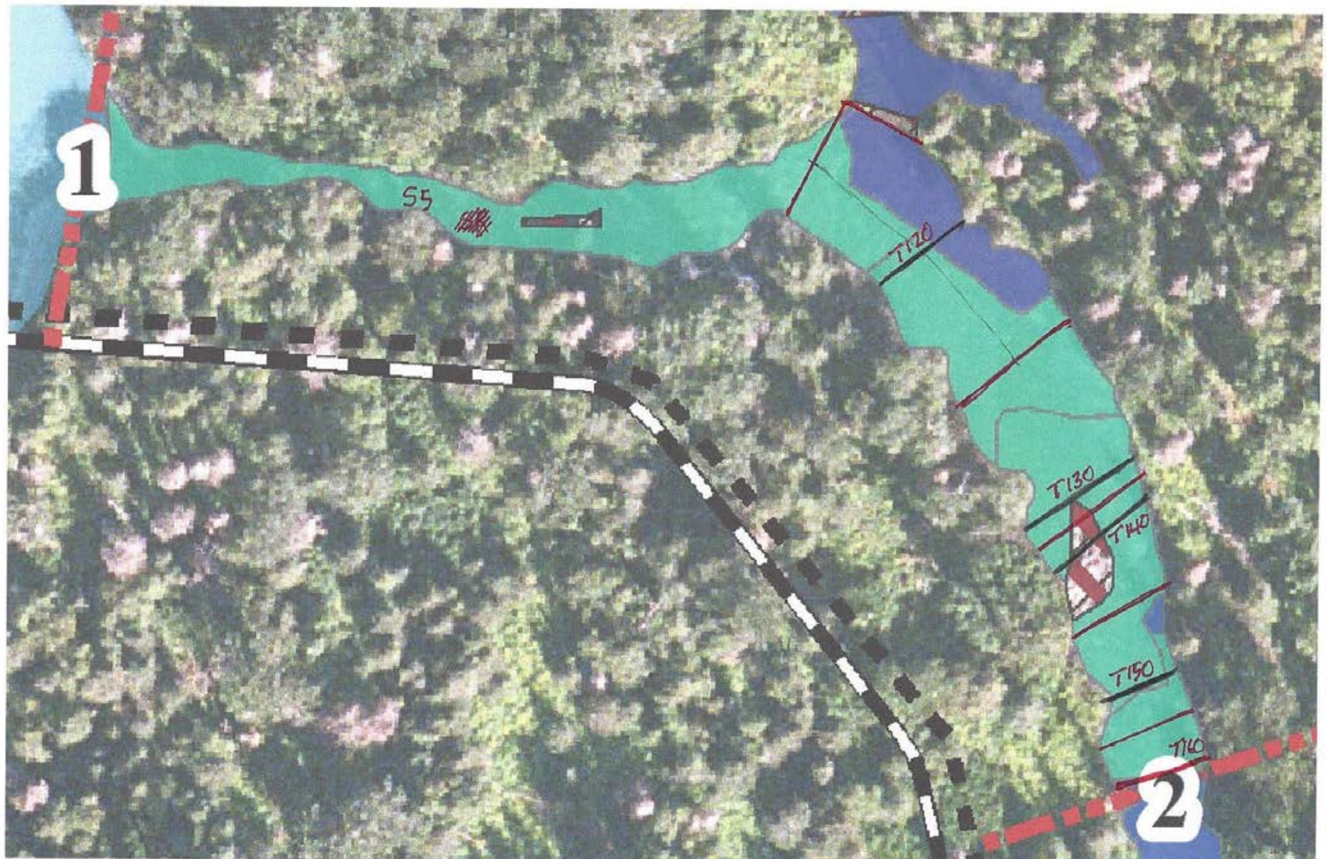
Appendix 1: Calculation of Reach Habitat Types and Transect Weighting, Grant Creek Instream Flow Study

R1- Distributary



S1	Pool	26		T100	Riffle	21	} 28
S2	Riffle	17		"	Pool	7	
S3	Pool	13	} 26	T110	Riffle	9	} 38
S3	Riffle	13		"	Pool	27	
S4	Pool	5	} 25				
S4	Riffle	20					

R1

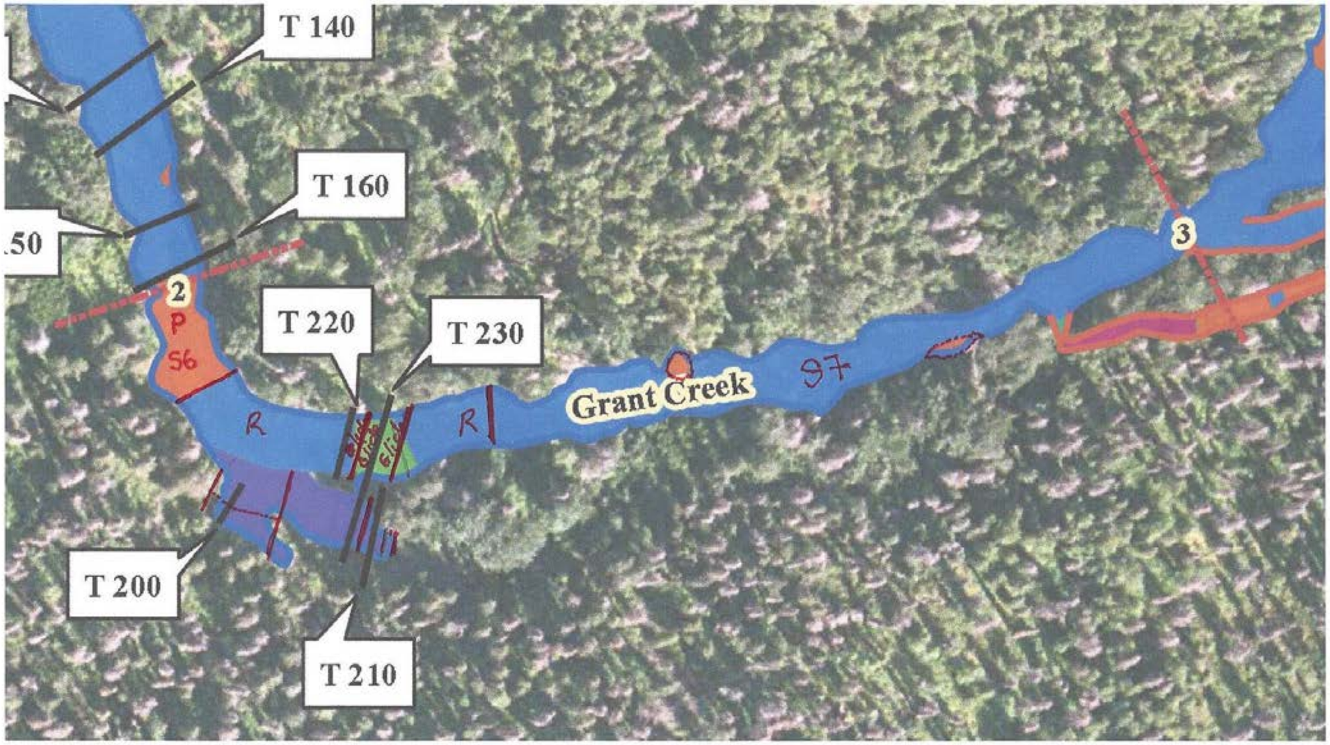


S5 Riffle 130
T120 Riffle 33 } 50
T120 Pool 17
T130 Riffle 31
T140 Riffle 19

T150 Riffle 21 } 22
T150 Pool 1
T160 Riffle 9

Pool = 18
Riffle = 243

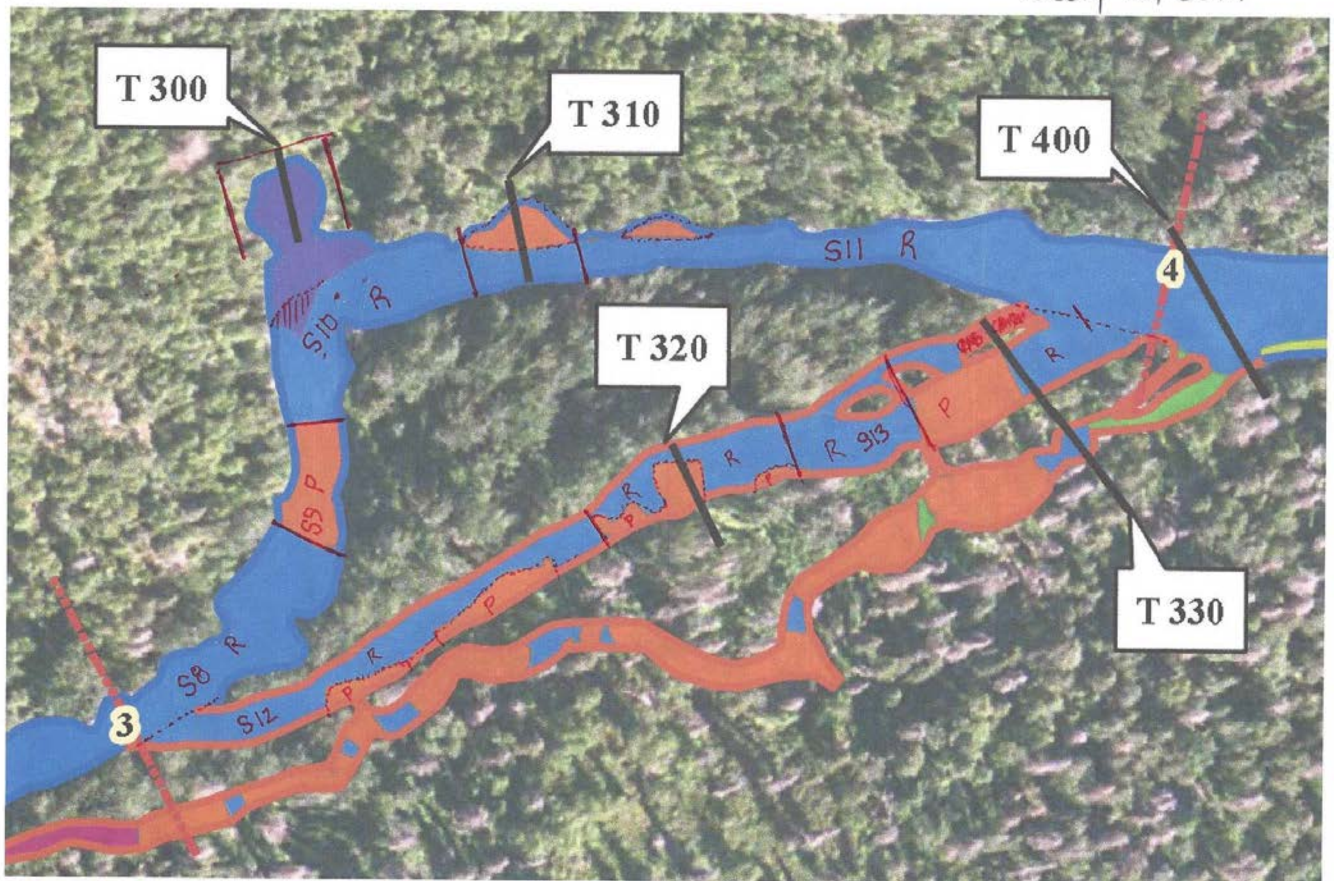
Reach 2 July 18, 2014



S6 Pool 19
T200 BackH2O 14
T220 Riffle 28 } 31
Glide 3
T230 Glide 7
T230 BackH2O 16
T230 Riffle 18

T210 BackH2O 6
S7 Riffle 121 } 124
S7 Pool 3

Reach 3 July 18, 2014



Mainstem

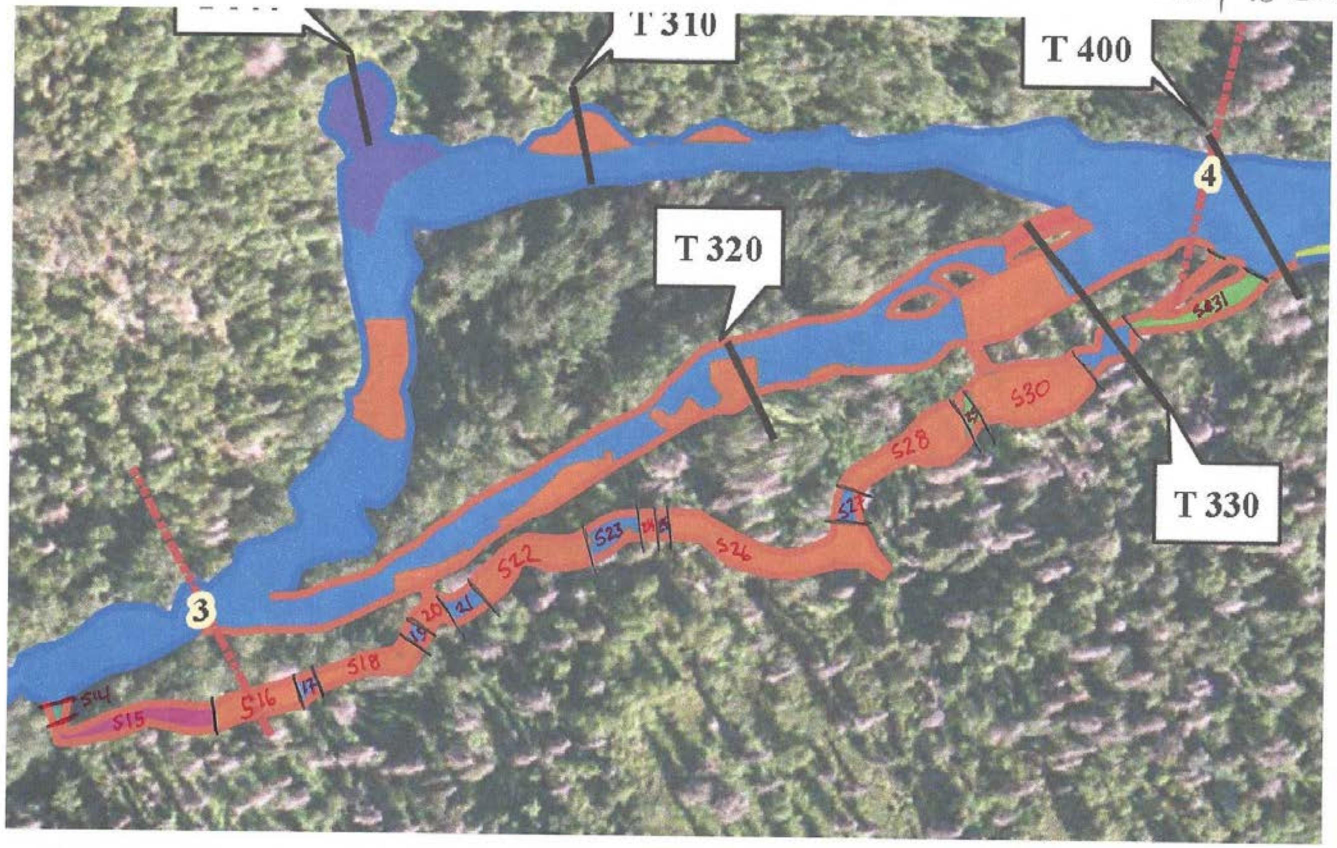
S8	Riffle	47	T310	Riffle	12	} 21
S9	Pool	22	T310	Pool	9	
S10	Riffle	46	S11	Riffle	100	} 102
T300	Back H_2O	20	S11	Pool	2	

Secondary

S12	Riffle	62	} 84	S13	Riffle	24	
S12	Pool	22		T330	Pool	18	} 35
T320	Riffle	24	} 37	T330	Riffle	17	
T320	Pool	13		T330	Rapid	---	

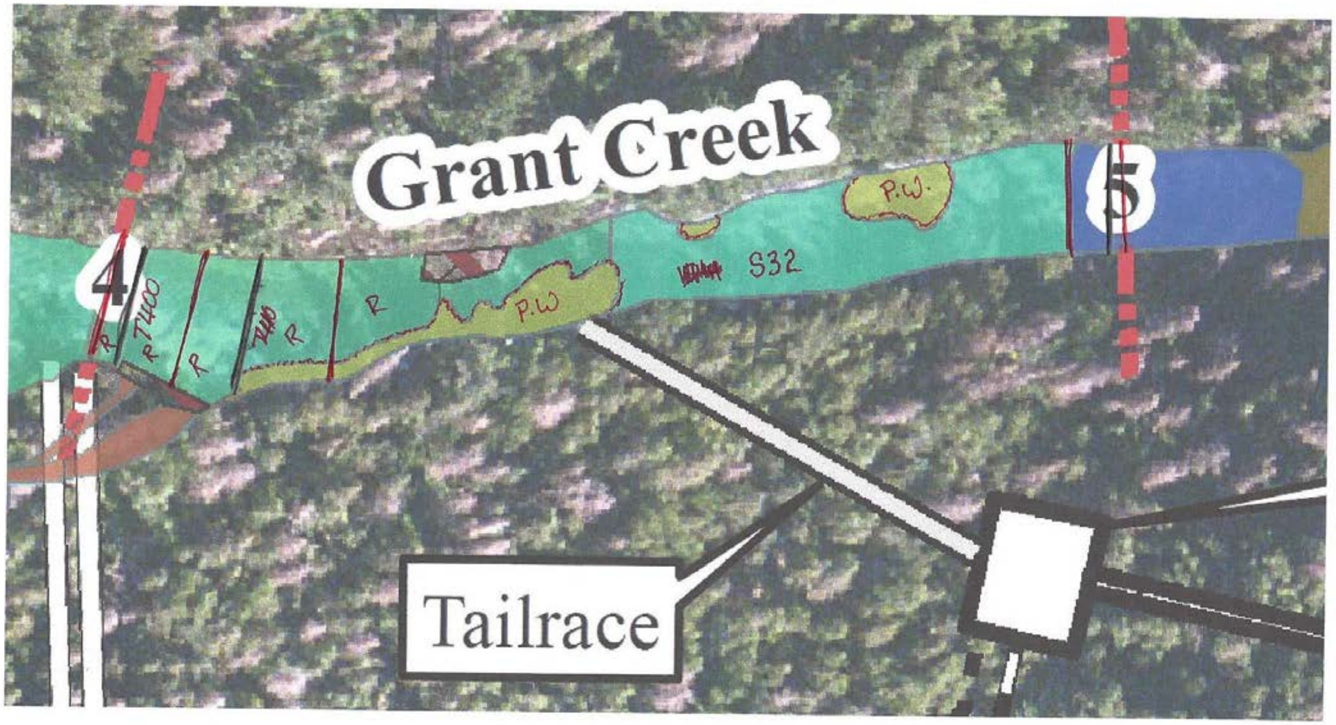
Reach 3 Secondary Side Channel

July 18 2014



S14	Cascade	3	S20	Pool	5	S26	Pool	37	S31	Glide	25
S15	Run	31	S21	Riffle	6	S27	Riffle	6			
S16	Pool	17	S22	Pool	25	S28	Pool	25			
S17	Riffle	4	S23	Riffle	9	S29	Glide	3			
S18	Pool	20	S24	Pool	3	S30	Pool	22			
S19	Riffle	3	S25	Riffle	2	T330	Riffle	12			

R4



T400	Riffle	16	
T410	Riffle	24	27
T410	Pocket H_2O	3	
S32	Riffle	97	129
S32	Pocket H_2O	32	
T430	Pool	11	

Appendix 3: Final Grant Creek WUA

This appendix contains the following tables and figures:

Table A.3-1. Grant Creek spawning WUA.

Flow (cfs)	Chinook	Coho	Dolly Varden	Rainbow	Sockeye
10	1,068	5,568	18,631	14,839	5,238
20	6,599	9,209	27,940	23,150	8,323
30	12,856	12,213	32,314	27,879	10,782
40	17,810	14,677	36,115	31,648	12,930
50	21,367	16,867	39,113	34,761	14,825
60	24,260	18,649	41,288	37,342	16,632
70	26,813	20,247	43,146	39,482	18,001
80	29,371	21,867	44,807	41,434	19,090
90	31,474	23,114	46,150	43,147	20,074
100	33,798	24,291	46,641	44,529	20,917
110	36,017	25,399	46,605	45,565	21,690
120	37,711	26,241	46,197	46,302	22,432
130	39,104	27,015	45,651	46,884	23,046
140	40,431	27,649	45,110	47,342	23,556
150	41,662	28,071	44,505	47,692	24,041
160	42,863	28,316	43,850	47,765	24,489
170	43,998	28,505	43,217	47,726	24,876
180	45,084	28,647	42,739	47,703	25,244
190	46,151	28,794	42,561	47,668	25,482
200	46,974	28,861	42,306	47,466	25,584
225	48,741	29,158	42,011	47,180	26,137
250	49,687	29,635	42,450	46,882	26,601
275	50,337	30,151	42,759	46,908	26,985
300	51,161	30,591	42,739	46,909	27,420
325	51,863	31,095	43,001	47,169	27,805
350	52,248	31,584	43,342	47,577	28,147
375	52,471	31,905	43,417	47,716	28,560
400	52,715	32,329	43,300	47,709	29,021
450	52,861	33,469	42,684	47,613	29,815
500	53,165	34,506	41,583	47,525	30,523
550	54,165	35,033	40,231	47,346	31,094
600	55,510	35,105	38,968	46,818	31,504
650	56,596	34,953	37,471	45,930	31,663
700	57,242	34,576	35,683	44,740	31,720
750	57,401	34,030	34,027	43,370	31,537
800	57,174	33,323	32,467	41,998	31,152
850	56,583	32,508	30,975	40,471	30,640
900	56,024	31,561	29,541	38,767	30,056
950	55,423	30,558	28,140	37,026	29,419
1,000	54,640	29,598	26,718	35,417	28,802

Table A.3-2. Grant Creek fry rearing WUA.

Flow (cfs)	Chinook	Coho	Dolly Varden	Rainbow
10	93,680	77,590	102,219	62,468
20	96,290	73,052	109,681	63,732
30	102,978	76,830	116,702	69,555
40	110,212	82,216	119,827	75,214
50	114,072	84,107	118,341	78,294
60	114,860	83,429	115,523	78,864
70	113,859	81,717	112,962	77,912
80	112,035	79,704	111,138	76,708
90	110,487	78,216	109,706	75,548
100	108,806	77,131	108,300	74,715
110	107,783	77,094	107,869	74,103
120	107,160	77,356	108,238	73,267
130	107,259	78,093	108,932	72,726
140	108,223	79,427	110,204	73,077
150	109,775	80,844	111,670	73,786
160	111,216	82,011	113,087	74,767
170	113,469	83,793	114,815	76,272
180	115,219	85,228	116,995	77,321
190	123,962	93,392	126,896	83,981
200	125,591	94,651	128,222	85,224
225	131,369	98,462	132,156	89,319
250	135,690	101,765	137,008	92,170
275	140,535	105,427	140,688	95,269
300	145,442	108,532	142,503	98,864
325	148,318	109,888	143,360	101,208
350	149,991	110,652	143,398	102,628
375	150,896	110,881	142,625	103,429
400	151,012	110,259	141,628	103,383
450	150,234	108,527	140,925	102,382
500	149,890	107,125	140,120	100,892
550	148,960	105,678	138,794	99,267
600	148,041	104,950	138,512	97,744
650	148,545	104,949	138,419	97,269
700	148,820	104,784	138,264	96,500
750	149,488	105,003	137,825	95,852
800	150,103	104,820	136,502	94,953
850	150,158	104,680	134,977	93,836
900	149,692	103,251	132,513	92,547
950	148,320	101,160	130,552	90,330
1,000	146,560	98,592	128,412	87,935

Table A.3-3. Grant Creek juvenile and adult rearing WUA.

	Juvenile Rearing				Adult Rearing	
Flow (cfs)	Chinook	Coho	Dolly Varden	Rainbow	Dolly Varden	Rainbow
10	30,659	106,935	85,928	62,002	23,354	14,271
20	41,244	120,277	96,423	70,894	33,289	21,970
30	44,200	131,910	108,170	74,644	40,838	28,117
40	45,284	140,165	116,556	77,220	46,965	33,005
50	45,830	142,002	123,480	78,324	51,896	37,083
60	46,295	139,726	127,709	78,944	55,868	40,454
70	46,782	136,764	128,143	79,282	58,964	43,215
80	47,451	133,844	127,071	79,029	61,750	45,879
90	48,309	131,815	125,720	78,915	64,008	48,100
100	49,186	128,726	124,240	78,269	65,561	49,729
110	50,079	127,587	123,525	77,714	66,696	50,953
120	51,099	126,212	121,931	77,074	67,419	51,715
130	52,102	126,250	120,459	76,443	67,911	52,301
140	53,181	126,662	119,365	75,909	68,109	52,649
150	54,120	127,456	118,938	75,802	68,223	52,926
160	54,877	128,244	119,197	76,142	68,140	52,962
170	55,645	130,047	120,582	76,363	68,042	52,979
180	56,439	131,196	120,612	76,569	68,174	53,123
190	57,815	140,450	125,785	80,124	68,857	53,244
200	58,669	141,803	126,118	80,832	69,036	53,328
225	61,107	147,070	130,659	83,907	70,679	54,608
250	63,072	151,819	132,540	86,577	71,991	55,785
275	64,949	157,202	135,896	89,103	73,571	57,085
300	66,851	161,558	141,888	91,891	75,471	58,646
325	68,816	163,486	145,403	94,563	77,609	60,328
350	70,978	164,310	148,094	97,232	79,938	62,227
375	73,369	164,754	150,560	99,927	82,223	64,180
400	75,656	164,154	152,121	102,463	84,485	66,270
450	80,205	163,035	152,966	106,594	88,467	70,235
500	84,113	163,728	153,234	109,264	91,811	73,776
550	87,445	162,889	154,032	111,234	95,120	77,304
600	90,403	162,601	152,690	112,440	97,799	80,287
650	92,647	162,254	153,266	113,161	100,035	82,719
700	94,123	161,709	153,464	113,478	102,261	85,061
750	95,097	161,700	153,927	113,773	104,512	87,234
800	95,737	161,376	154,946	114,556	106,757	89,465
850	95,904	161,097	154,269	114,887	108,666	91,400
900	95,946	159,346	154,318	114,981	110,240	93,176
950	95,819	156,702	152,807	114,576	111,443	94,737
1,000	95,413	153,922	151,436	114,062	112,497	96,265

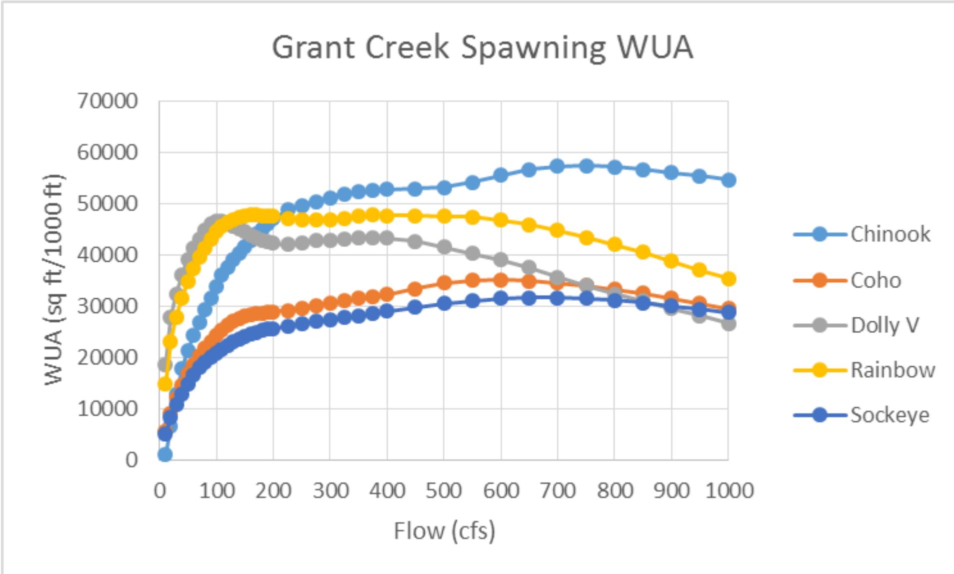


Figure A.3-1. Grant Creek spawning WUA.

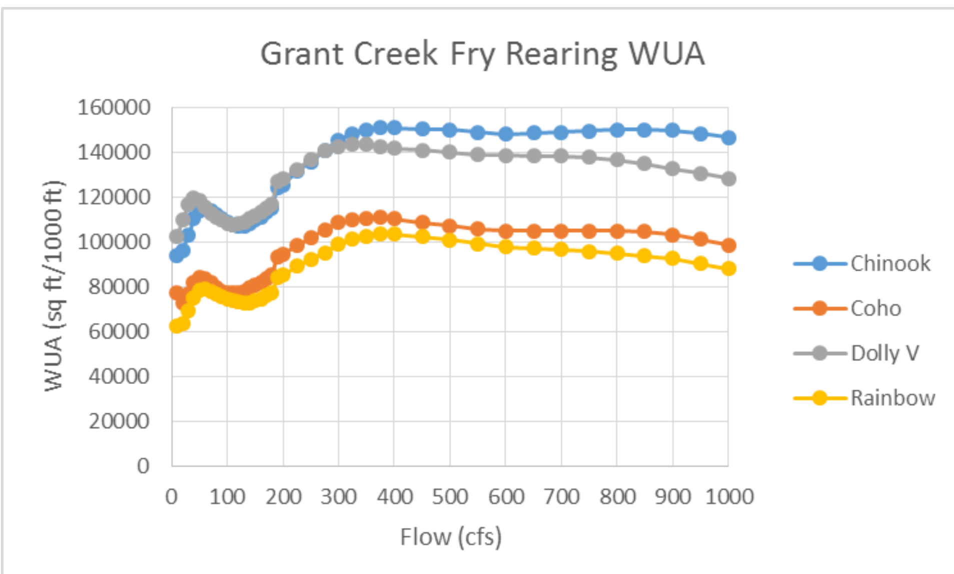


Figure A.3-2. Grant Creek fry rearing WUA.

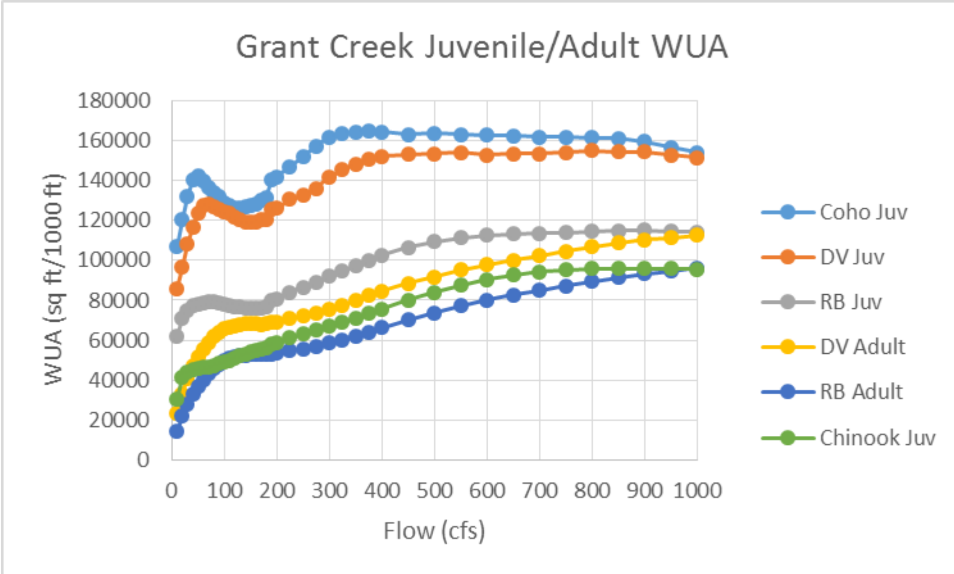


Figure A.3-3. Grant Creek juvenile and adult rearing WUA.

Appendix 4: Salmonid Effective Spawning and Incubation Analysis

Grant Lake Hydroelectric Project (FERC No. 13212)

Salmonid Effective Spawning and Incubation Analysis

Draft Report

Prepared for
Kenai Hydro LLC

Prepared by

MCMILLEN
DESIGN with Vision. BUILD with Integrity.

October 2014

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Salmonid Spawning and Incubation Analysis
Draft Report
Grant Lake Hydroelectric Project (FERC No. 13212)

1 INTRODUCTION

This report is intended to address issues and concerns regarding spawning flows and potential effects on incubating salmonid eggs at the proposed Grant Lake Hydroelectric Project (Project) flows.

The goals and objectives of the evaluation were as follows:

- Determine the amount and location of salmonid spawning habitat (as represented by transects selected during the Instream Flow Study) over a range of flows using current conditions (e.g., substrate and habitat as reflected in the Instream Flow Study). Flows for spawning reflect those examined for the Project, based on pre- and post-Project operation.
- Determine the effects of reductions in stream flow on incubating salmonid eggs, as determined by the models.

2 METHODS

McMillen, LLC (McMillen) ran the previously calibrated Instream Flow models used for the Instream Flow Study. The following data, including data sources, were used to run the models on the Project streams:

- McMillen selected all calibrated transects that had spawning habitat in the affected stream reaches. These included (Instream Flow Report, KHL 2014):
  - Reach 1 Distributary (2 transects)
  - Reach 1 Main Channel (5 transects)
  - Reach 2 Mainstem (3 transects) *[Note: 2 side channel transects in Reach 2 had no flow; as a result, they were not modeled for spawning]*
  - Reach 3 Mainstem (2 transects)
  - Reach 3 Side Channel (2 transects)
  - Reach 4 Mainstem (3 transects)
- Chinook, coho, and sockeye salmon, rainbow trout and Dolly Varden char spawning Habitat Suitability Criteria (HSC) Curves (Appendix 2 of the Instream Flow Report, KHL 2014)
- Bed elevation at each transect (Appendix 6 of the Instream Flow Report)
- Stage at given flows (from the HYDSIM sub module of RHABSIM; Appendix 6 of the Instream Flow Report, KHL 2014)

- Existing Chinook, coho, and sockeye salmon spawning substrate as reflected in the hydraulic models along the transects at flows ranging from 50 to 450 cubic feet per second (cfs) (Appendix 1 to this report)

McMillen used RHABSIM (Riverine Habitat Simulation System) by Thomas R. Payne and Associates (now with Normandeau Associates, Arcata, CA) to produce weighted usable area (WUA) curves for the spawning species listed above. One of the options available in the program is the ability to evaluate WUA on a cell-by-cell basis along each transect at a variety of flows.

WUA for an individual cell is calculated as:

S (depth) * S (velocity) * S (substrate) * the area the cell represents,

where S = the suitability index for depth, velocity, and substrate, respectively. A value of 1.0 for each suitability index is optimum, while a value of 0.0 indicates no value for that particular variable. For this analysis, two different scenarios were modeled:

1. Results of spawning for all species at a flow of 450 cfs (per request of the Alaska Department of Fish and Game [ADFG]), with an analysis of substrates still covered by at least 0.1 foot of water as flows are decreased; and
2. Median monthly and weekly flows (pre-Project and post-Project) for those time periods that reflect each species' spawning and incubation periodicity.

2.1 Value of Spawning Habitat

Any spawning habitat, regardless of the combined suitability value (e.g., S (depth) * S (velocity) * S (substrate)), was analyzed, provided the combined value > 0. Substrate HSC values (ranging from 0.0 – 1.0) were graphed and are found in Appendix 1.

2.2 Criteria for Protection of Incubating Eggs

The criterion used in this analysis was that the depth of water over a particular cell that was included as spawning/incubation habitat had to be at least 0.1 foot or greater (1.2 inches). This type of analysis has been used extensively by McMillen staff on Washington State hydroelectric projects as well as in the Box Canyon and Lower Wahleach Hydroelectric projects in British Columbia. The process to determine the WUA value included the following:

- The water surface elevation for the transect was calculated (from sub-module HYDSIM of RHABSIM) for each modeled flow;
- For each modeled flow, the depth of the water over that cell was calculated by subtracting the bed elevation of the cell from the calculated water surface elevation;
- If the depth of water over the cell was ≥ 0.1 foot, the WUA for that cell was used and added to the total WUA;
- If the depth of water over the cell was < 0.1 foot, a value of 0.0 was used, and

- Flows were modeled down from the spawning flows in 25-cfs and 5-cfs increments to 5 cfs as related to the Grant Creek stream gage *[Note: flows were scaled in the Reach 1 Distributary and Reach 3 side channels to correspond to the appropriate flow at the gage]*.

The level of protection afforded incubating eggs was then calculated as the percentage of spawning habitat still covered with at least 0.1 foot of water at a given incubation flow. The following ranges were used to evaluate level of protection.

Protection (%) of incubating eggs	Range
>98%	98% – 100%
≥90%	90% – 97.9%
≥80%	80% – 89.9%
≥70%	70% – 79.9%

2.3 Spawning Flows Modeled

McMillen used 450 cfs as the modeled flow for spawning activity for all species. Grant Creek salmonid periodicity, for all species and life history stages, including spawning, is provided in Table 3.1-1. In addition, McMillen analyzed monthly median flows, both pre-Project and post-Project for the months that the salmonid species spawned. During those periods when spawning did not occur during the entire month, median flows were calculated for the appropriate time periods only.

2.4 Incubation Flows

Grant Creek salmonid incubation timing was taken from Table 3.1-1. Median monthly and weekly flow aggregates were calculated from the 66-year synthesized pre-Project and post-Project hydrology. Percent protection of incubating eggs was then calculated for each species and flow increment for each transect.

2.5 Transect Location of Spawning Salmonids

Appendix 1 indicates the location of spawning Chinook, coho and sockeye salmon on the Instream Flow transects.

3 RESULTS

3.1 Target Species

Target species and periodicity are provided in Table 3.1-1.

3.2 Transects and Study Sites

Spawning gravels are relatively scarce on those transects within the Project area. Table 3.2-1 includes transects and study reaches that had spawnable gravel in the Project reaches. Seventeen transects were selected for modeling, based upon their likelihood to provide spawning habitat.

3.3 HSC Curves

The HSC curves used for the development of these analyses are provided as Appendix 2 of the Instream Flow Report (KHL 2014).

3.4 Spawning Periodicity Flows for Project Reaches

Table 3.4-1 summarizes salmonid spawning periodicity and median monthly flows for Grant Creek. In addition to analyzing a spawning flow of 450 cfs, median flows (both pre-Project and post-Project) were used to evaluate spawning and egg incubation protection. Table 3.4-1 summarizes median flows in the main channel of Grant Creek, as well as in the Reach 1 Distributary, Reaches 2/3 Side Channels, and the mainstem of Reach 3.

Appendix 1 depicts the bed elevation, salmon spawning substrate suitability values, and water surface elevations for flows ranging from 50 to 450 cfs. This appendix also includes the locations of known Chinook, coho, and sockeye salmon spawning on these transects. No rainbow trout or Dolly Varden char were observed spawning in Grant Creek.

Table 3.4-2 presents the effective spawning analysis, as well as the approximate flows that will protect spawning habitat. The flows at which 98%, 90%, 80%, and 70% of the spawning WUA were recorded using linear interpolation, if required.

Table 3.1-1. Life history and periodicity for Grant Creek salmonids.

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
Coho	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
Sockeye	Spawning												
	Incubation/Emergence												
Dolly Varden	Spawning												
	Incubation/Emergence												
	Fry (<60mm)												
	Juvenile												
	Adult												
Rainbow	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
	Adult												

Table 3.2-1. Transects used to model spawning habitat on Grant Creek.

Reach	Transect	Channel Type	Spawning Substrate Available on Transect				
			Chinook	Coho	Sockeye	D Varden	Rainbow
1 - Distributary	100	Rearing Distributary	✓	✓	✓	✓	✓
	110	Rearing Distributary		✓	✓	✓	✓
1 - Main Channel	120	Spawning Riffle	✓	✓	✓	✓	✓
	130	Rearing Main	✓	✓	✓	✓	✓
	140	Rearing Main	✓	✓	✓	✓	✓
	150	Rearing Main	✓	✓	✓	✓	✓
	160	Rearing Main	✓	✓	✓	✓	✓
2 - Main Channel	200	Rearing Main	✓			✓	✓
	220	Rearing Main	✓	✓	✓	✓	✓
	230	Rearing Main	✓	✓	✓	✓	✓
3 - Main Channel	300	Rearing Main	✓	✓	✓	✓	✓
	310	Spawning Main	✓	✓	✓	✓	✓
3 - Side Channel	320	Rearing Secondary	✓	✓	✓	✓	✓
	330	Rearing Secondary	✓	✓	✓	✓	✓
4 - Main Channel	400	Rearing Main	✓	✓	✓	✓	✓
	410	Rearing Main	✓	✓	✓	✓	✓
	430	Spawning Main	✓	✓	✓	✓	✓

Table 3.4-1. Salmonid species periodicity and median monthly flows, both pre- and post-Project (flows in cfs).

*[Note: * = partial month]*.

Reach	Species	Months			
Mainstem	***Chinook***	Aug*	Sept*		
Reaches 1/2/3/4	Pre-Project	410	320		
	With Project	395	348		
	Coho	Sept*	Oct		
	Pre-Project	310	182		
	With Project	325	182		
	Sockeye	Aug	Sept		
	Pre-Project	422	313		
	With Project	395	329		
	Dolly Varden	Aug*	Sept	Oct	Nov*
	Pre-Project	388	313	182	110
	With Project	395	329	182	157

Reach	Species	Months			
	Rainbow	May*	Jun		
	Pre-Project	182	398		
	With Project	181	280		
Distributary Reach 1	***Chinook***	Aug*	Sept*		
	Pre-Project	4.08	3.18		
	With Project	3.93	3.46		
	Coho	Sept*	Oct		
	Pre-Project	3.08	1.81		
	With Project	3.23	1.80		
	Sockeye	Aug	Sept		
	Pre-Project	4.20	3.12		
	With Project	3.93	3.27		
	Dolly Varden	Aug*	Sept	Oct	Nov*
	Pre-Project	3.86	3.12	1.81	0
	With Project	3.93	3.27	1.81	0
	Rainbow	May*	Jun		
	Pre-Project	1.80	3.94		
	With Project	1.79	2.77		
Reach 3 Side Channels	***Chinook***	Aug*	Sept*		
	Pre-Project	64.8	50.6		
	With Project	62.5	55.0		
	Coho	Sept*	Oct		
	Pre-Project	49.0	28.8		
	With Project	51.3	28.8		
	Sockeye	Aug	Sept		
	Pre-Project	66.7	49.5		
	With Project	62.5	51.9		
	Dolly Varden	Aug*	Sept	Oct	Nov*
	Pre-Project	61.4	49.5	28.8	17.5
	With Project	62.5	51.9	28.8	24.8

Reach	Species	Months	
	Rainbow	May*	Jun
	Pre-Project	28.8	63.0
	With Project	28.6	44.3

Table 3.4-2. Approximate flows at which certain percentages of spawning and incubation habitat are protected, given an initial spawning flow of 450 cfs or median pre-Project and post-Project spawning flows (all values in cfs).

								Median flow during incubation months (Pre- and Post-Project)											
Reach	**Species**	**Month**	**Spawning Flow**	**≥ 98%**	**≥ 90%**	**≥ 80%**	**≥ 70%**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Mainstem	**Chinook**		450	155	125	73	55												
Reaches 1 - 4		***Aug - pre****	410	146	89	50	45	410	313	182	94	59	45	36	30	31	127	398	493
		Aug - post*	395	144	90	57	42	395	329	182	140	104	91	82	77	78	151	280	390
		Sep-pre*	320	116	40	28	22		313	182	94	59	45	36	30	31	127	398	493
		Sep-post*	348	137	70	43	32		329	182	140	104	91	82	77	78	151	280	390
	Coho		450	228	170	139	110												
		Sep-pre*	310	149	91	65	53		310	182	94	59	45	36	30	31	127	398	493
		Sep-post*	325	164	97	67	54		325	182	140	104	91	82	77	78	151	280	390
		Oct-pre	182	73	55	27	7			182	94	59	45	36	30	31	127	398	493
		Oct-post	182	73	55	27	7			182	140	104	91	82	77	78	151	280	390
	Sockeye		450	223	154	132	88												
		Aug - pre	422	202	143	112	73	422	313	182	94	59	45	36	30	31	127	398	493
		Aug - post	395	193	137	104	70	395	329	182	140	104	91	82	77	78	151	280	390
		Sep - pre	313	154	113	72	60		313	182	94	59	45	36	30	31	127	398	493
		Sep - post	329	163	89	64	51		329	182	140	104	91	82	77	78	151	280	390
	Dolly V		450	224	204	159	135												
		Aug - pre*	388	216	174	139	113	388	313	182	94	59	45	36	30	31	127	398	
		Aug - post*	395	217	177	141	114	395	329	182	140	104	91	82	77	78	151	280	

								Median flow during incubation months (Pre- and Post-Project)											
Reach	**Species**	**Month**	**Spawning Flow**	**≥ 98%**	**≥ 90%**	**≥ 80%**	**≥ 70%**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Mainstem	**Dolly V**	***Sep - pre***	313	198	146	119	85		313	182	94	59	45	36	30	31	127	398	
Reaches 1 - 4		***Sep - post***	329	88	85	85	62		329	182	140	104	91	82	77	78	151	280	
		Oct-pre	182	115	73	59	43			182	94	59	45	36	30	31	127	398	
		Oct-post	182	115	73	59	43			182	140	104	91	82	77	78	151	280	
		Nov-pre[*]	110	67	30	10	5				110	59	45	36	30	31	127	398	
		Nov-post[*]	157	151	121	83	45				157	104	91	82	77	78	151	280	
								May	**Jun**	**Jul**	**Aug**								
	Rain-bow		450	216	162	131	103												
		May - pre[*]	182	140	75	56	33	182	398	488	422								
		May - post[*]	181	139	71	45	13	181	280	390	395								
		Jun - pre	398						398	488	422								
		Jun - post	280	193	131	78	60		280	390	395								
Reach 1								**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**[*]
Distributary	**Chinook**		4.48	1.79	-	-	-												
		Aug - pre[*]	4.08	1.79	-	-	-	4.08	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Aug - post[*]	3.93	1.79	-	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Sep-pre[*]	3.18	1.79	-	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep-post[*]	3.46	1.79	-	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88

Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Median flow during incubation months (Pre- and Post-Project) Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Reach 1	Coho		4.48	2.26	2.20	2.16	2.11												
Distributary		Sep-pre[*]	3.08	1.79	-	-	-		3.08	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep-post[*]	3.23	1.79	-	-	-		3.23	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Oct-pre	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Oct-post	1.80	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
	Sockeye		4.48	2.23	2.18	2.13	2.07												
		Aug - pre	4.20	1.87	1.79	-	-	4.20	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Aug - post	3.93	1.79	-	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
		Sep - pre	3.12	1.79	-	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	4.91
		Sep - post	3.27	1.79	-	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	3.88
	Dolly V		4.48	2.26	2.19	2.13	2.07												
		Aug - pre[*]	3.86	1.97	1.79	-	-	3.86	3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Aug - post[*]	3.93	1.97	1.79	-	-	3.93	3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Sep - pre	3.12	1.90	1.79	-	-		3.12	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Sep - post	3.27	1.92	1.79	-	-		3.27	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Oct-pre	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Oct-post	1.81	1.79	-	-	-			1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	
		Nov-pre[*]	0.00	-	-	-	-				0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.96	
		Nov-post[*]	0.00	-	-	-	-				0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.79	

Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Median flow during incubation months (Pre- and Post-Project) Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Reach 1								**May**	**Jun**	**Jul**	**Aug**								
Distributary	**Rain-bow**		4.48	2.33	2.20	2.14	2.09												
		May - pre*	1.80	1.79	-	-	-	1.81	3.96	4.86	4.20								
		May - post*	1.79	1.79	-	-	-	1.80	2.79	3.88	3.93								
		Jun - pre	3.94	1.98	1.79	-	-		3.96	4.86	4.20								
		Jun - post	2.77	1.90	1.79	-	-		2.79	3.88	3.93								
								Aug	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul***
Reach 3 Side Channels	**Chinook**		71.2	2.3	2.0	1.7	1.3												
		Aug - pre*	64.8	2.3	2.0	1.5	1.0	68.3	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Aug - post*	62.5	2.3	2.0	1.5	1.0	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
		Sep-pre*	50.6	2.3	1.9	1.5	1.0		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep-post*	55.0	2.3	1.9	1.5	1.0		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Coho		71.2	5.3	2.3	2.1	1.8												
		Sep-pre*	49.0	5.2	2.3	2.0	1.7		51.7	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep-post*	51.3	5.2	2.3	2.0	1.7		54.1	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
		Oct-pre	28.8	5.2	2.3	1.9	1.6			30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Oct-post	28.8	5.2	2.3	1.9	1.6			30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Sockeye		71.2	5.3	2.3	2.1	0.7												
		Aug - pre	66.7	5.3	2.3	2.1	1.9	70.3	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Aug - post	62.5	5.3	2.3	2.1	1.9	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0

Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Median flow during incubation months (Pre- and Post-Project) Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Reach 3 Side Channels	**Sockeye**	***Sep - pre***	49.5	5.2	2.3	2.0	1.8		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	82.2
		Sep - post	51.9	5.2	2.3	2.0	1.8		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	65.0
	Dolly V		71.2	5.3	2.3	2.1	2.0												
		Aug - pre*	61.4	5.2	2.3	2.0	1.8	64.7	52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Aug - post*	62.5	5.2	2.3	2.1	1.8	65.8	54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Sep - pre	49.5	1.4	0.8	-	-		52.2	30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Sep - post	51.9	5.2	2.2	2.0	1.7		54.8	30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Oct-pre	28.8	4.9	2.1	1.8	1.4			30.3	15.6	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Oct-post	28.8	4.9	2.1	1.8	1.4			30.3	23.3	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
		Nov-pre*	17.5	2.4	2.1	1.7	1.4				18.4	9.9	7.5	6.0	5.0	5.1	21.1	66.4	
		Nov-post*	24.8	4.8	2.1	1.8	1.3				26.2	17.3	15.2	13.7	12.8	12.9	25.2	46.7	
								May	**Jun**	**Jul**	**Aug**								
	Rainbow		71.2	5.1	2.3	2.0	1.8												
		May - pre*	28.8	3.9	2.1	1.8	1.4	30.3	66.4	81.3	70.3								
		May - post*	28.6	3.9	2.1	1.8	1.4	30.2	46.7	65.0	65.8								
		Jun - pre	63.0	5.1	2.2	1.9	1.7		66.4	81.3	70.3								
		Jun - post	44.3	5.0	2.2	1.9	1.6		46.7	65.0	65.8								

								Median flow during incubation months (Pre- and Post-Project)											
Reach	Species	Month	Spawning Flow	≥ 98%	≥ 90%	≥ 80%	≥ 70%	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Grant Creek	Chinook		450	151	122	71	52												
All Reaches		Aug - pre*	410	146	94	50	43	410	313	182	94	59	45	36	30	31	127	398	493
		Aug - post*	395	145	94	56	40	395	329	182	140	104	91	82	77	78	151	280	390
		Sep-pre*	320	108	36	27	19		313	182	94	59	45	36	30	31	127	398	493
		Sep-post*	348	137	69	41	30		329	182	140	104	91	82	77	78	151	280	390
	Coho		450	226	167	136	92												
		Sep-pre*	310	149	93	64	48		310	182	94	59	45	36	30	31	127	398	493
		Sep-post*	325	160	102	65	51		325	182	140	104	91	82	77	78	151	280	390
		Oct-pre	182	73	53	23	7			182	94	59	45	36	30	31	127	398	493
		Oct-post	182	73	53	23	7			182	140	104	91	82	77	78	151	280	390
	Sockeye		450	221	151	129	75												
		Aug - pre	422	201	142	110	70	422	313	182	94	59	45	36	30	31	127	398	493
		Aug - post	395	192	136	102	67	395	329	182	140	104	91	82	77	78	151	280	390
		Sep - pre	313	151	53	70	56		313	182	94	59	45	36	30	31	127	398	493
		Sep - post	329	163	92	63	46		329	182	140	104	91	82	77	78	151	280	390
	Dolly V		450	243	203	160	134												
		Aug - pre*	388	216	173	139	111	388	313	182	94	59	45	36	30	31	127	398	
		Aug - post*	395	217	174	140	112	395	329	182	140	104	91	82	77	78	151	280	
		Sep - pre	313	166	146	121	79		313	182	94	59	45	36	30	31	127	398	
		Sep - post	329	185	148	122	49		329	182	140	104	91	82	77	78	151	280	

											Median flow during incubation months (Pre- and Post-Project)								
Reach	**Species**	**Month**	**Spawning Flow**	**≥ 98%**	**≥ 90%**	**≥ 80%**	**≥ 70%**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Grant Creek		***Oct-pre***	182	118	72	57	36			182	94	59	45	36	30	31	127	398	
All Reaches		***Oct-post***	182	118	72	57	36			182	140	104	91	82	77	78	151	280	
		Nov-pre*	110	66	29	10	5				110	59	45	36	30	31	127	398	
		Nov-post*	157	150	120	80	44				157	104	91	82	77	78	151	280	
								May	**Jun**	**Jul**	**Aug**								
	Rainbow		450	216	163	129	155												
		May - pre*	182	140	73	53	29	182	398	488	422								
		May - post*	181	139	69	41	12	181	280	390	395								
		Jun - pre	398	209	149	122	74		398	488	422								
		Jun - post	280	190	129	73	56		280	390	395								

4 DISCUSSION

The analysis provided in this report is based upon transects that were selected for habitat modeling as part of the Instream Flow Study conducted for the Project in 2013. Spawning habitat was, and continues to be, sparse in these reaches due to peak flows, relatively high gradient, and low gravel recruitment, resulting in predominantly cobble-boulder substrates.

In general, Grant Creek flows from January through mid-May and in the November through December period will be higher post-Project than they currently are pre-Project (see Table 3.4-1). It is also important to note that under pre-Project flows, the Reach 1 Distributary dries up when flows in Grant Creek drop below approximately 180 cfs. If Project mitigation measures include altering the entrance to the Reach 1 Distributary, fish habitat, especially spawning and incubation habitat, will increase in this reach.

With these higher November through mid-May flows, incubating salmonid eggs will be afforded higher rates of protection with the Project in place than under the pre-Project regime. As a result, incubation will not be significantly affected.

5 LITERATURE CITED

KHL (Kenai Hydro LLC). 2014. Grant Lake Hydroelectric Project (FERC No. 13212). Aquatic Resources – Grant Creek Aquatic Habitat Mapping and Instream Flow Study Final Report. Prepared by McMillen, LLC. June 2014.

Appendix 1: Spawning Analysis Figures

This appendix contains the following figures:

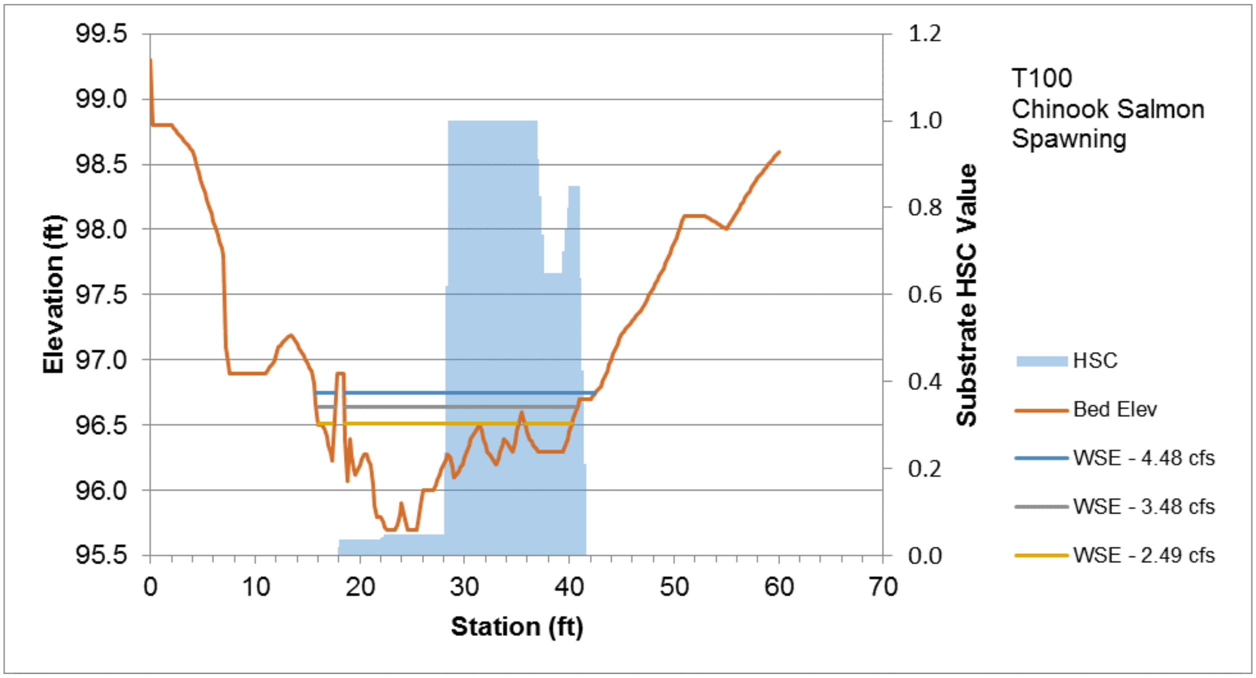

Figure A1-1. Transect 100 bed profile, Chinook spawning substrate values, and Water Surface Elevations (WSEs), 50 - 450 cfs (as measured at the Grant Creek gage).

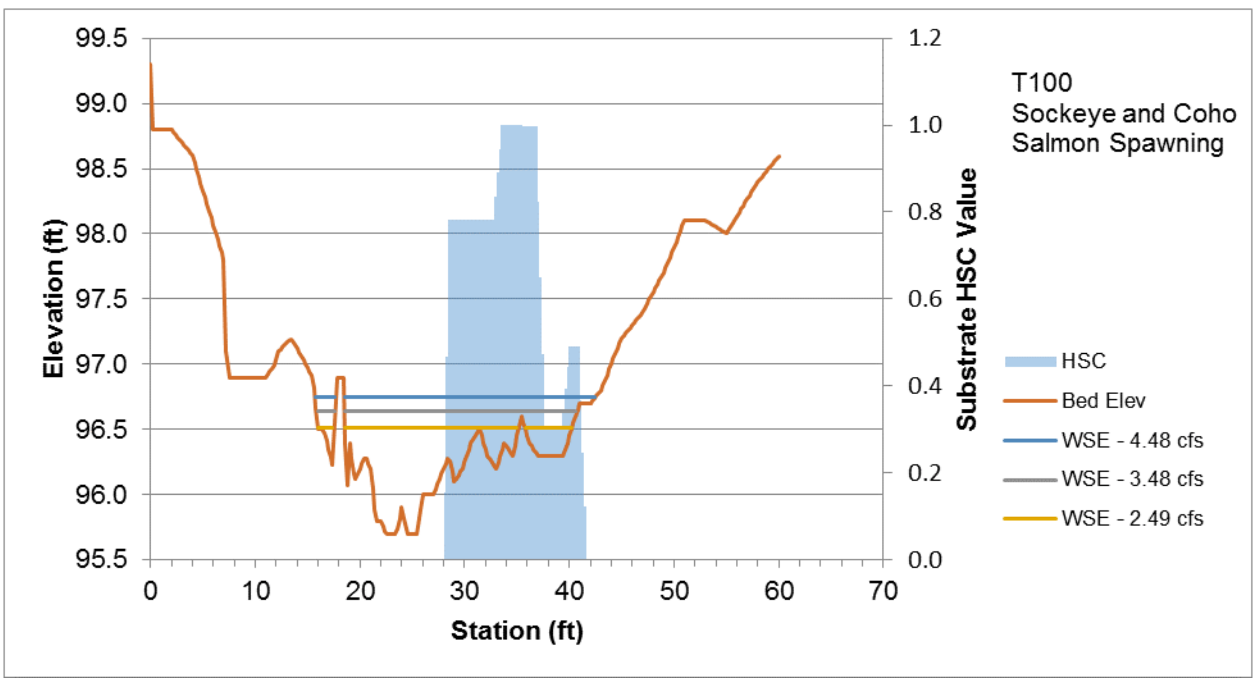

Figure A1-2. Transect 100 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

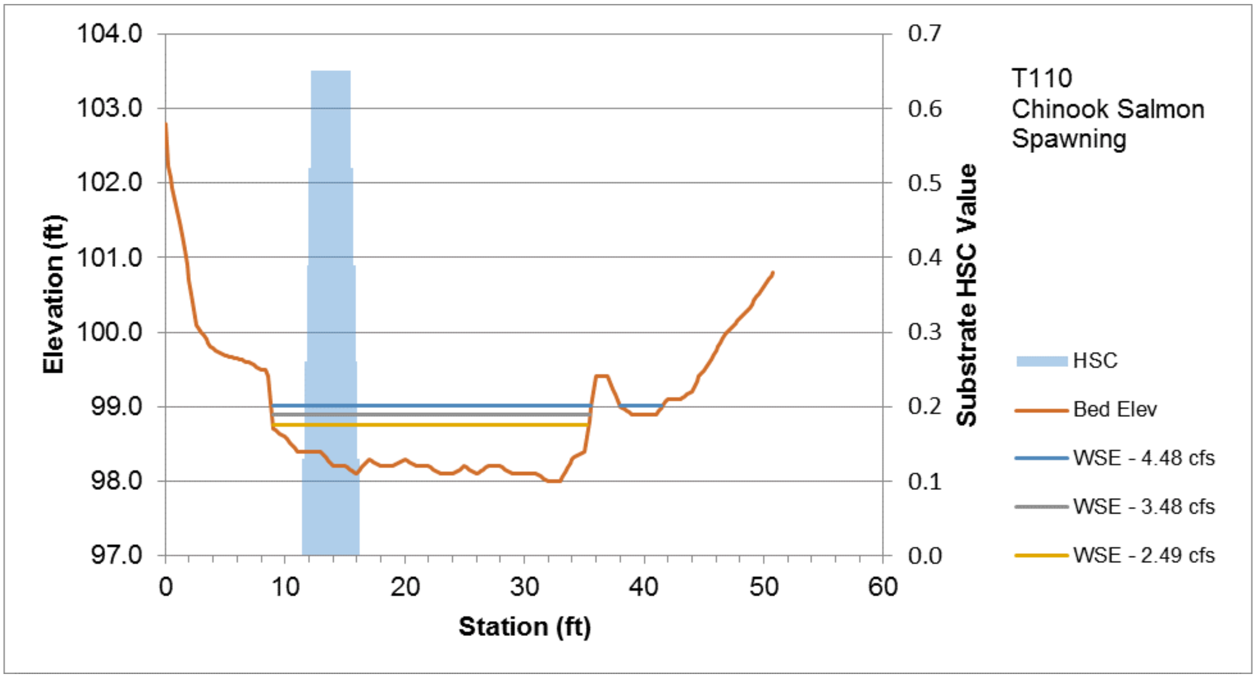

Figure A1-3. Transect 110 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

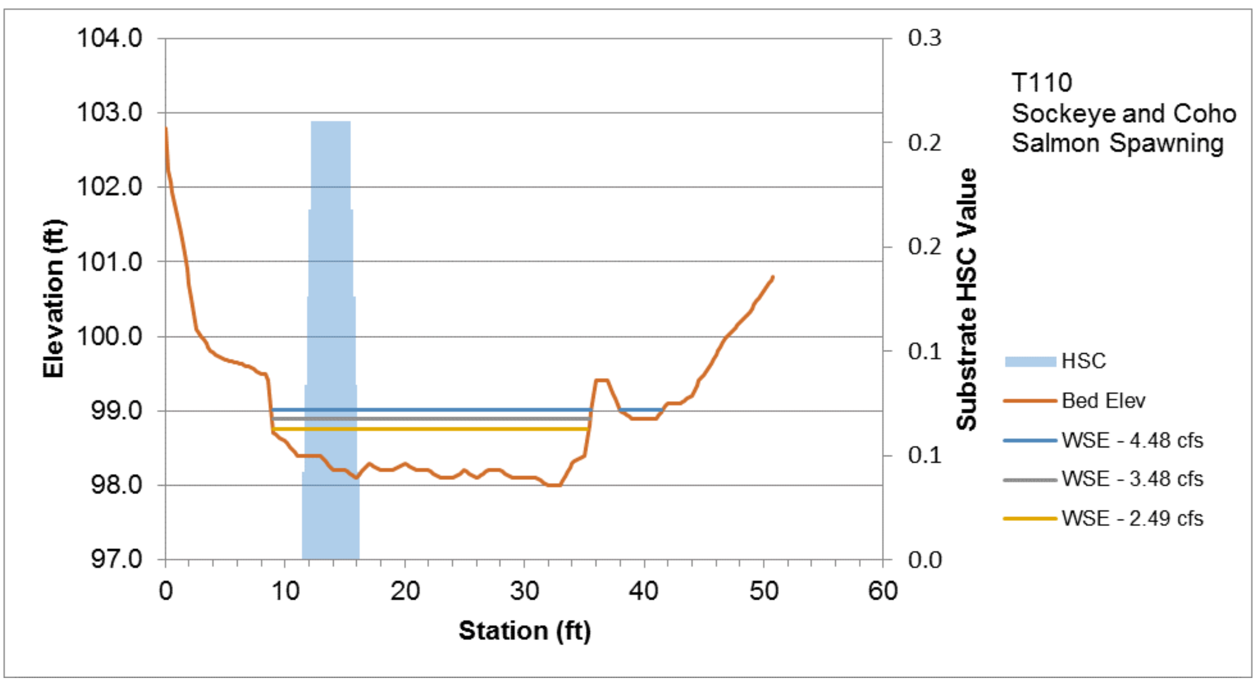

Figure A1-4. Transect 110 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

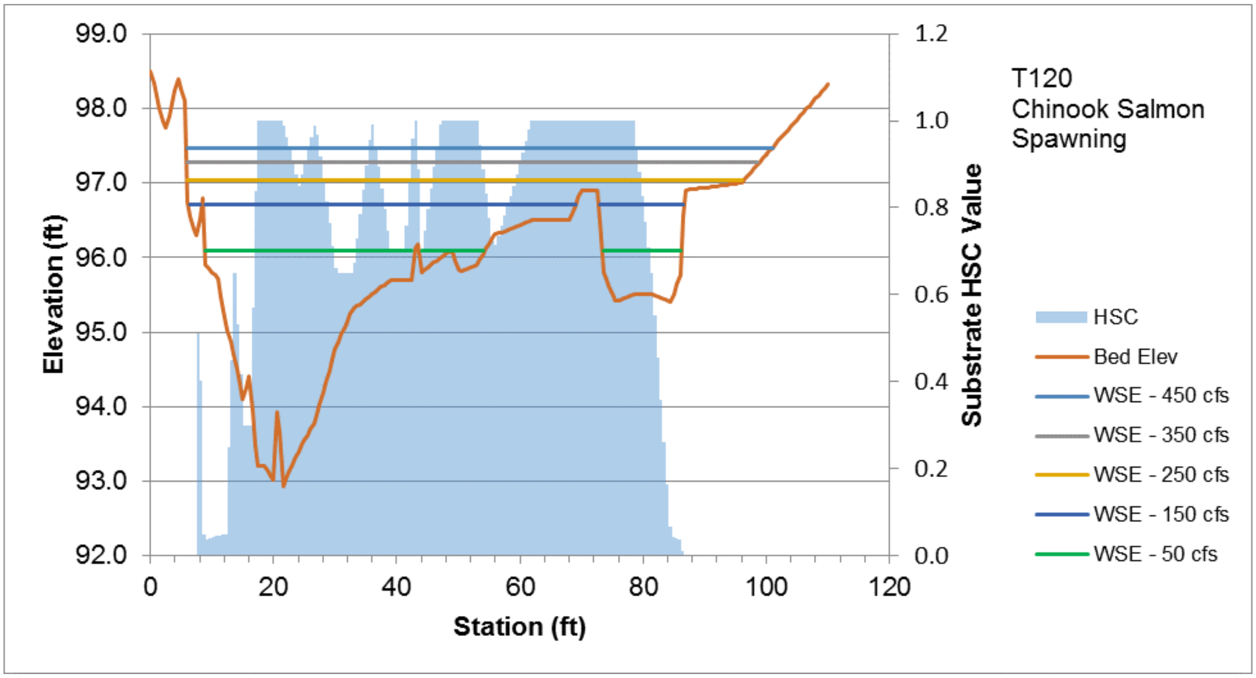

Figure A1-5. Transect 120 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

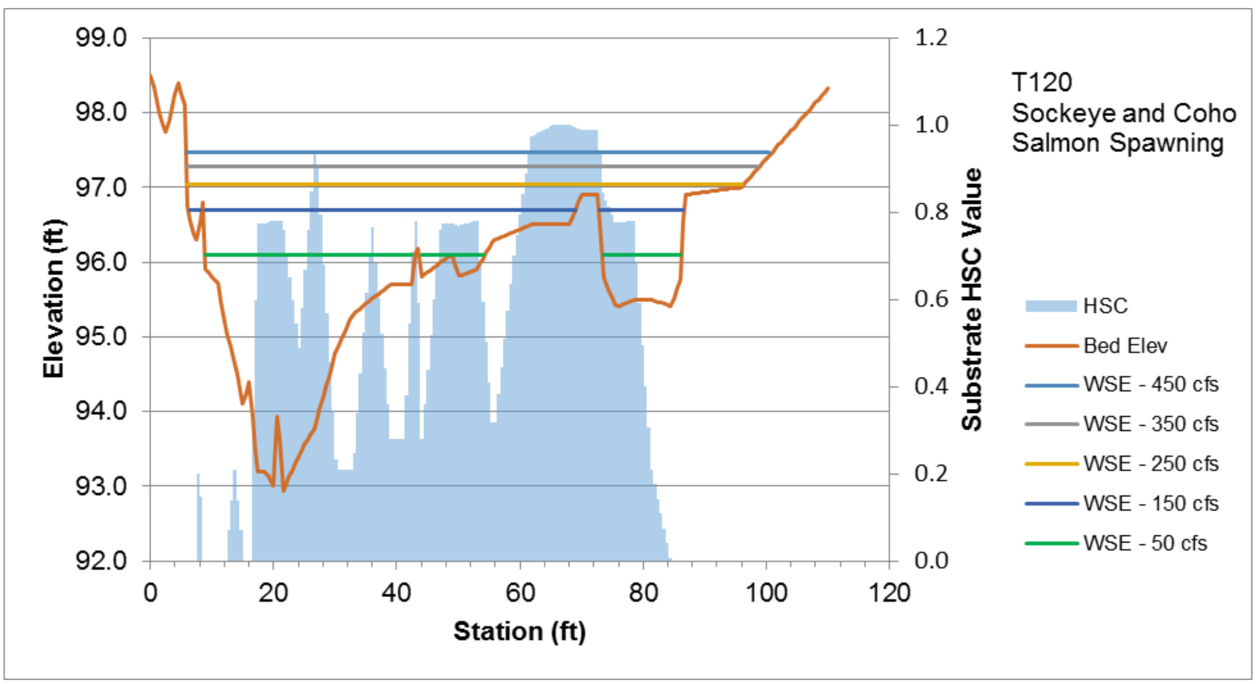

Figure A1-6. Transect 120 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

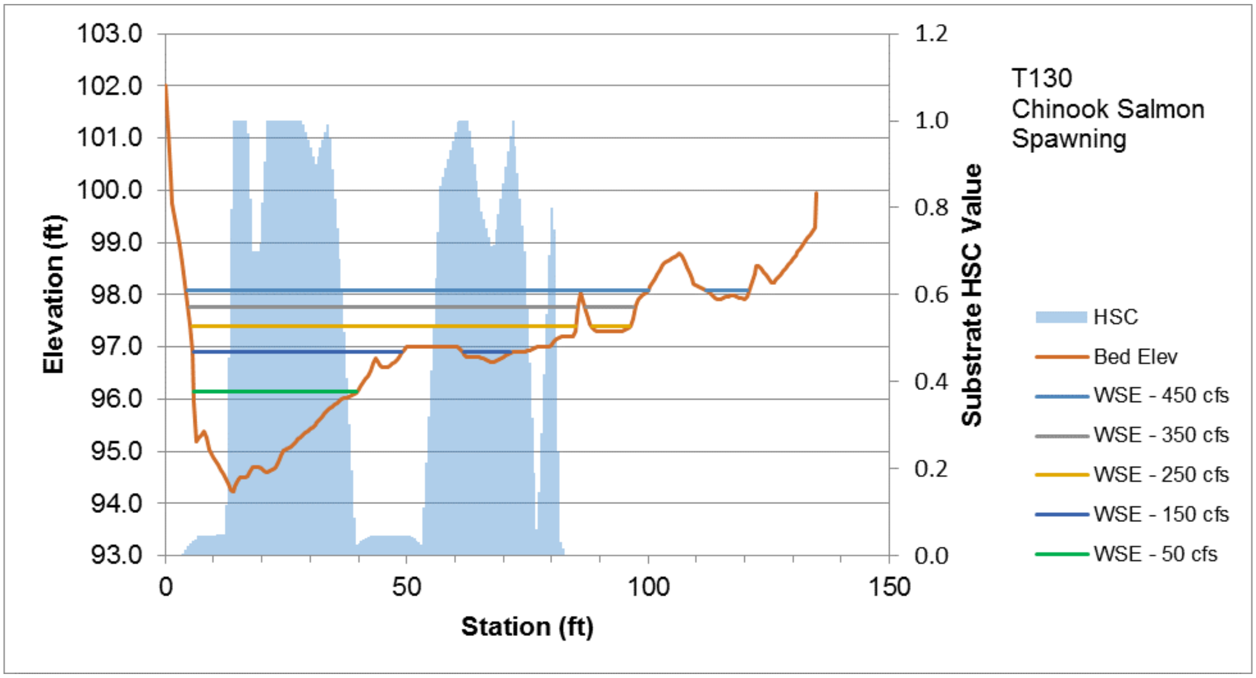

Figure A1-7. Transect 130 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

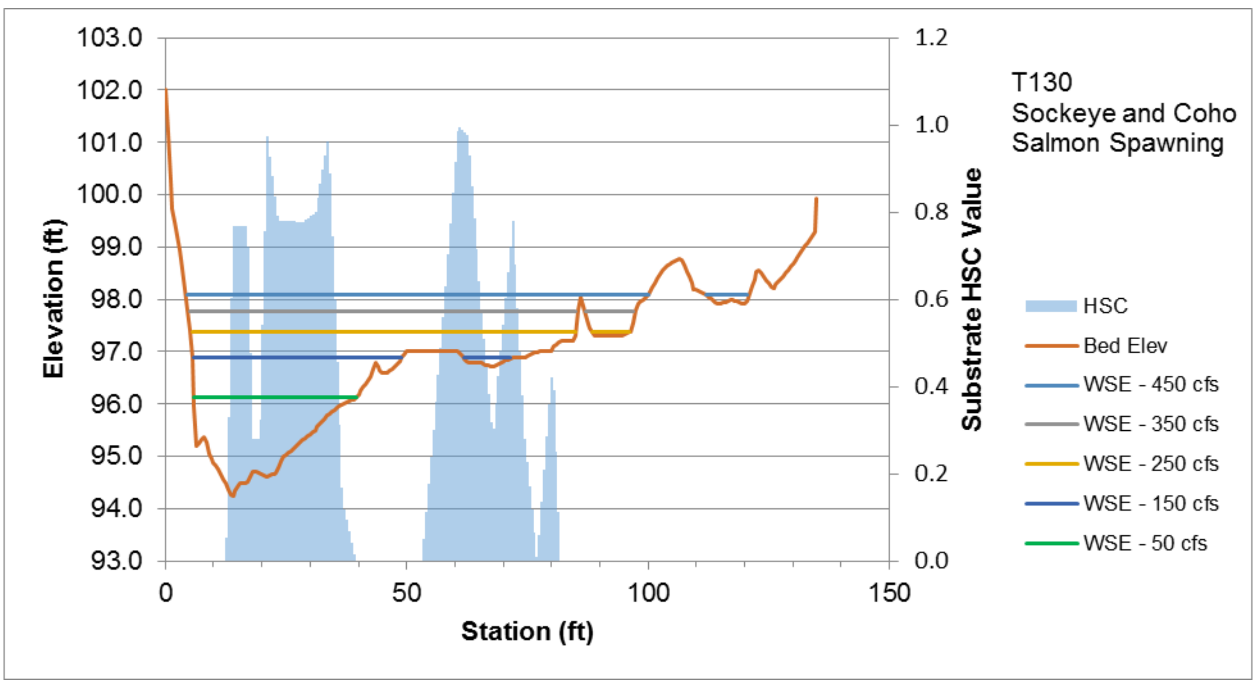

Figure A1-8. Transect 130 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

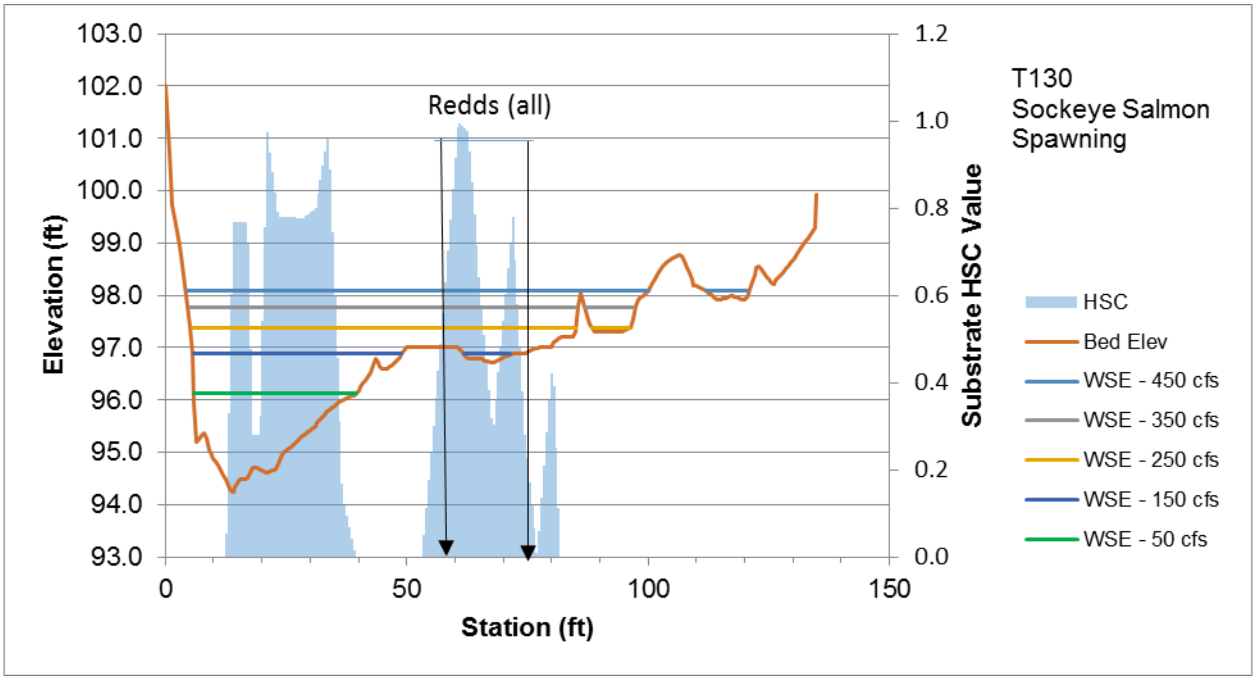

Figure A1-9. Transect 130 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

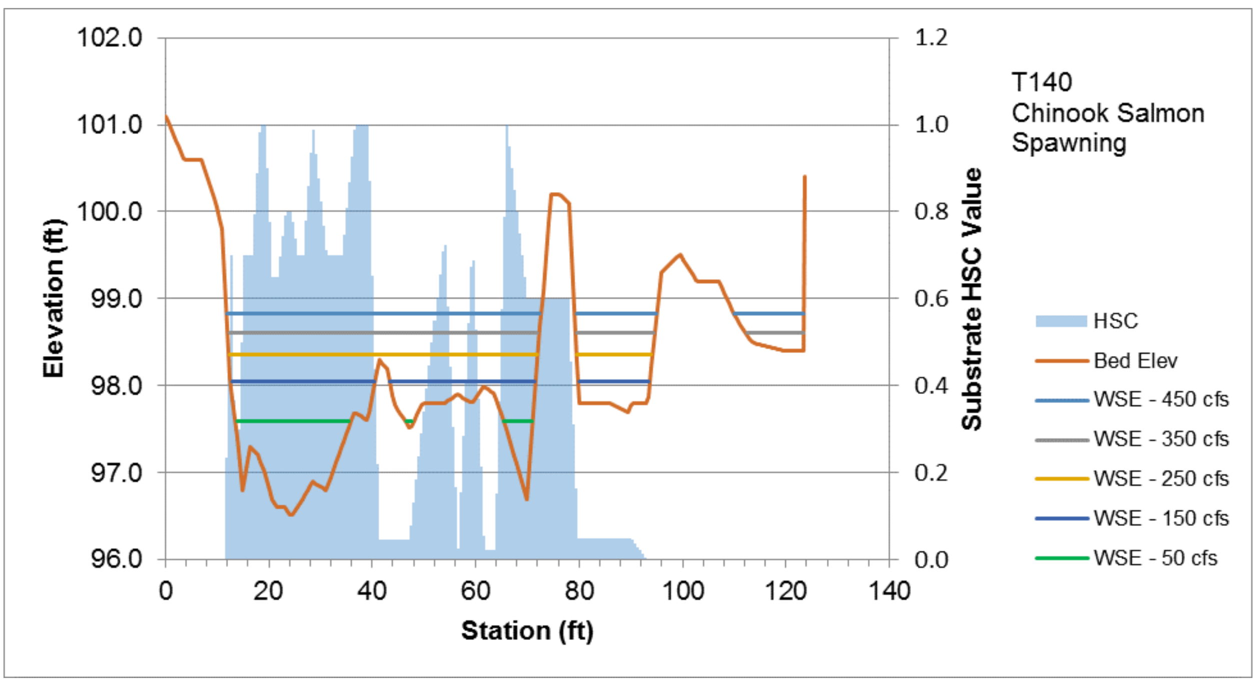

Figure A1-10. Transect 140 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

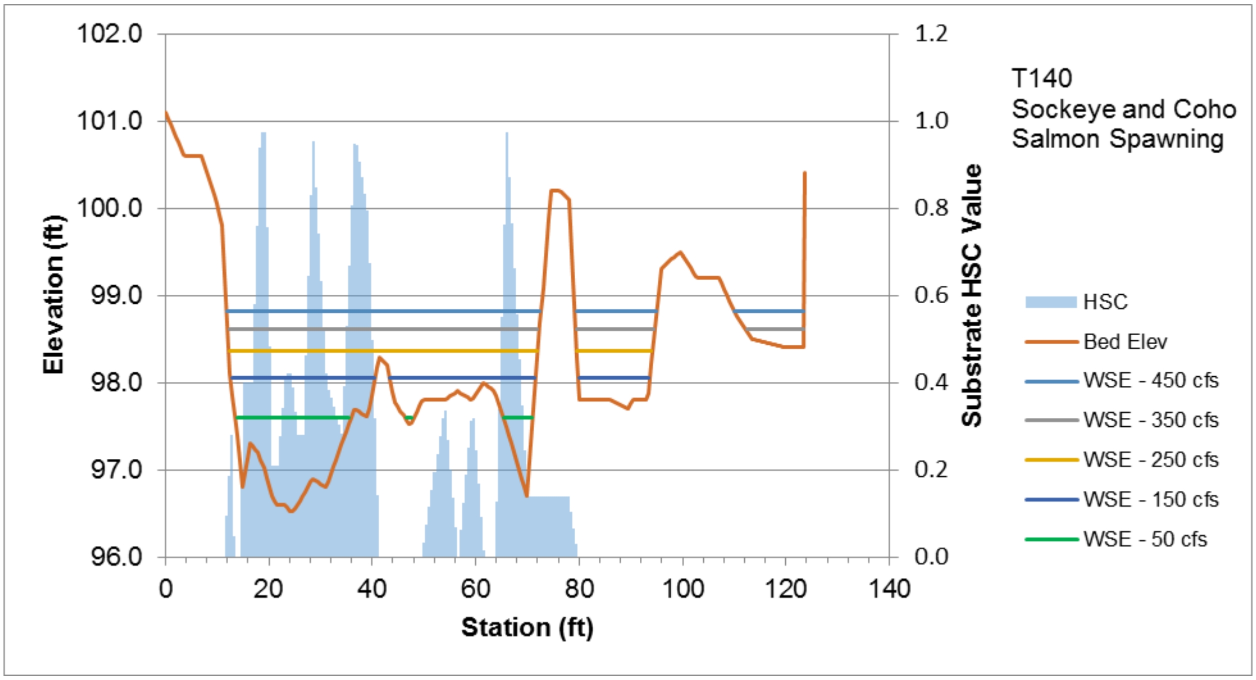

Figure A1-11. Transect 140 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

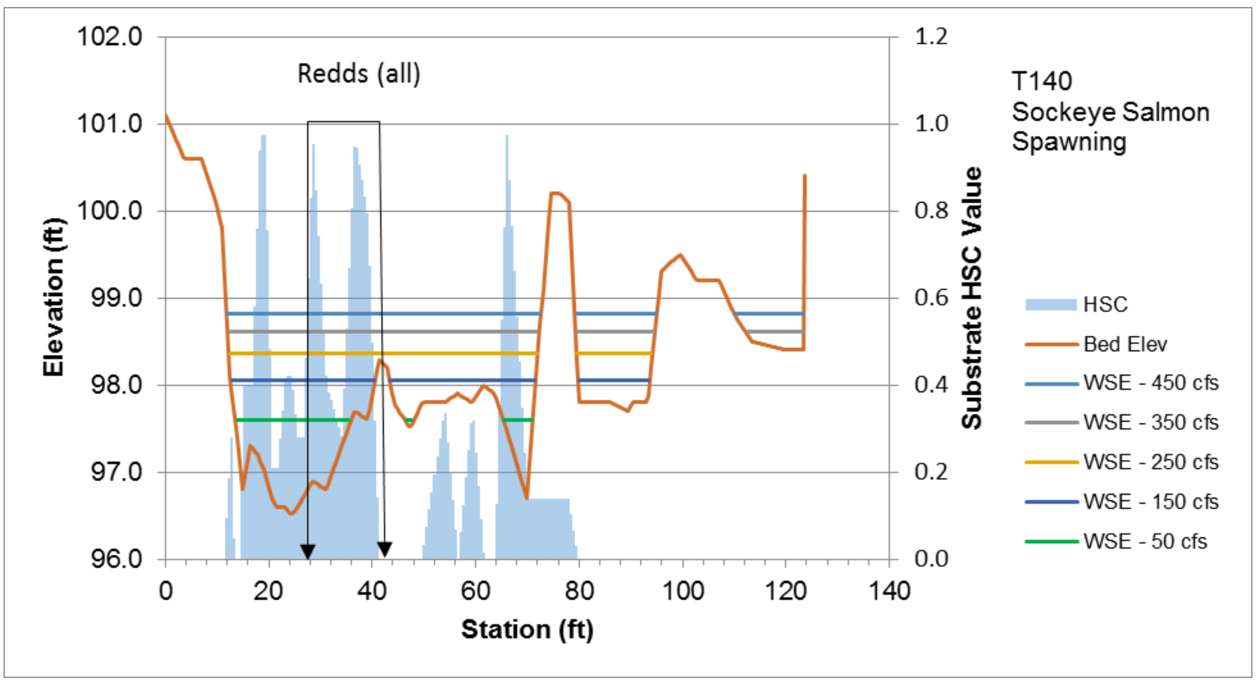

Figure A1-12. Transect 140 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

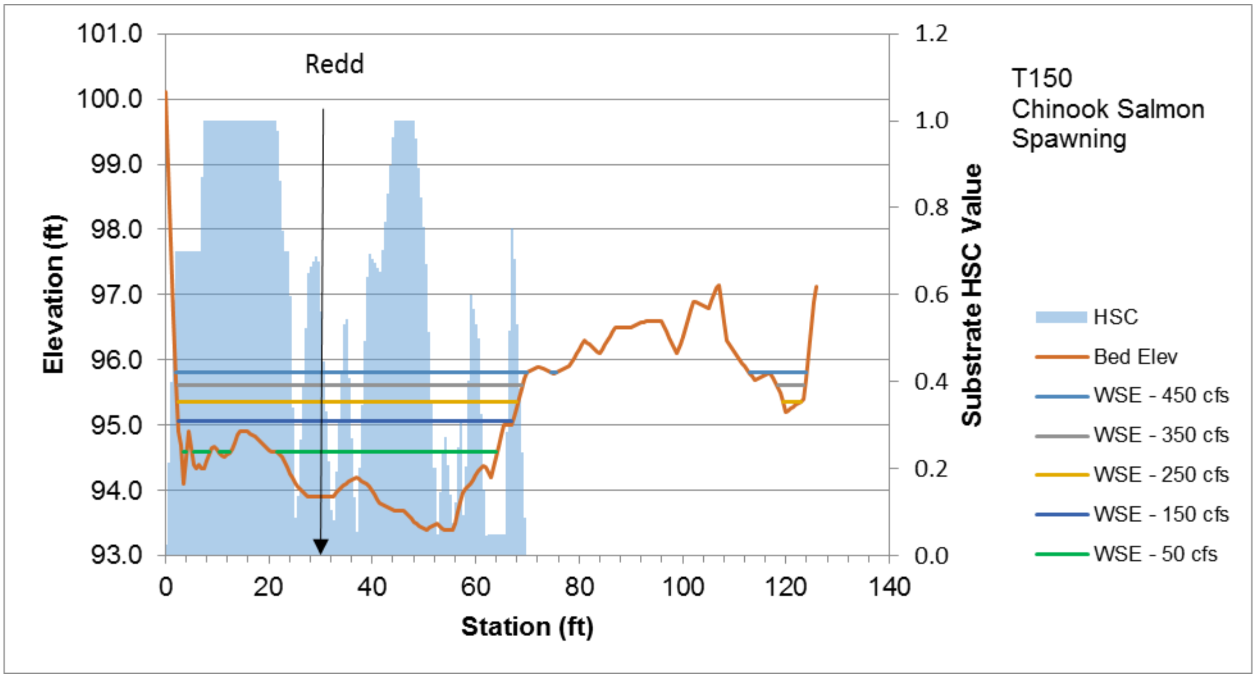

Figure A1-13. Transect 150 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

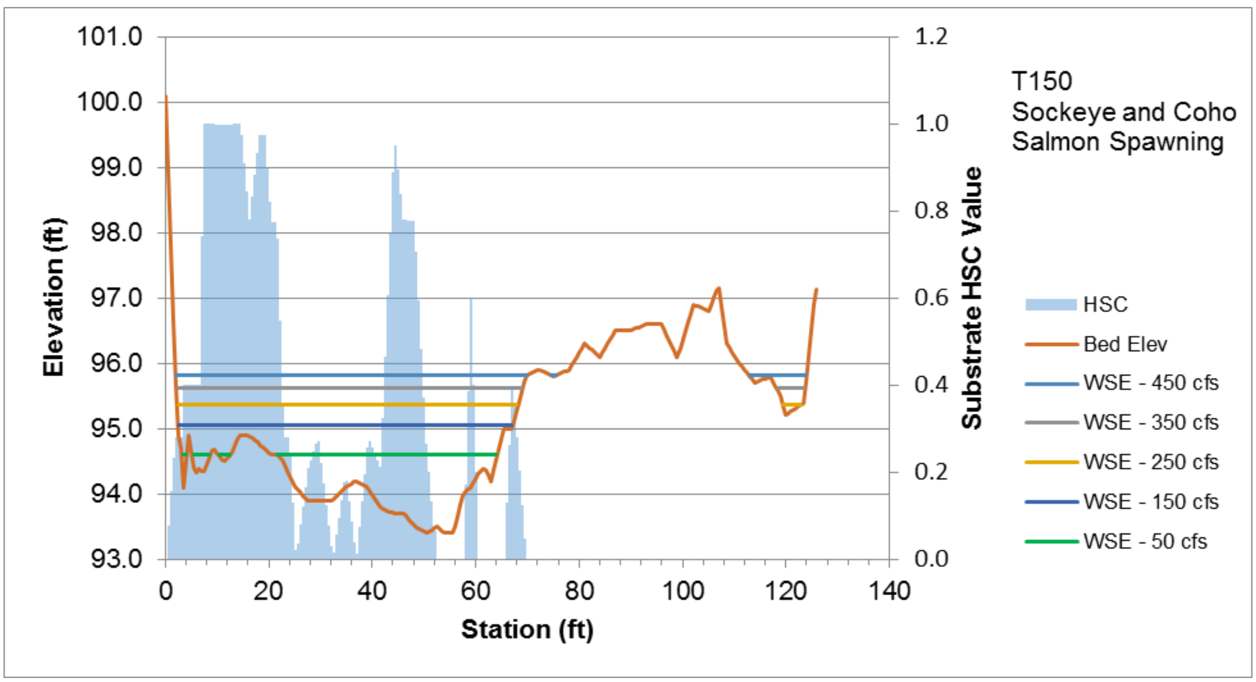

Figure A1-14. Transect 150 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

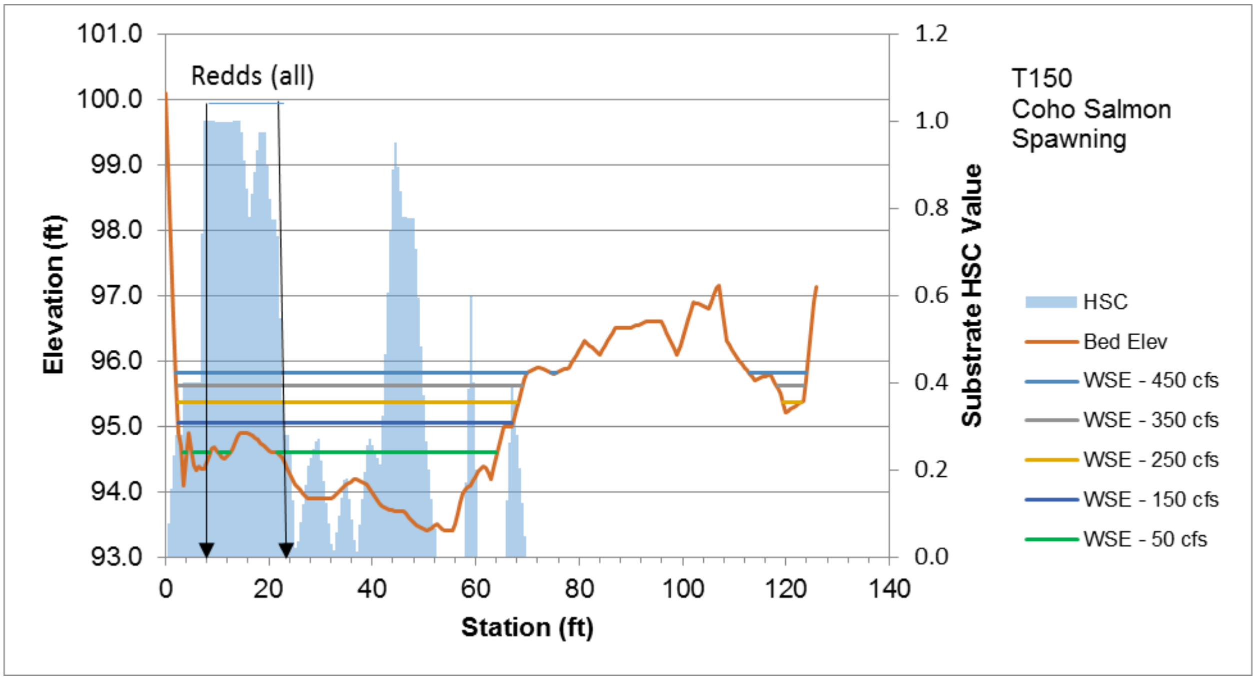

Figure A1-15. Transect 150 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs.

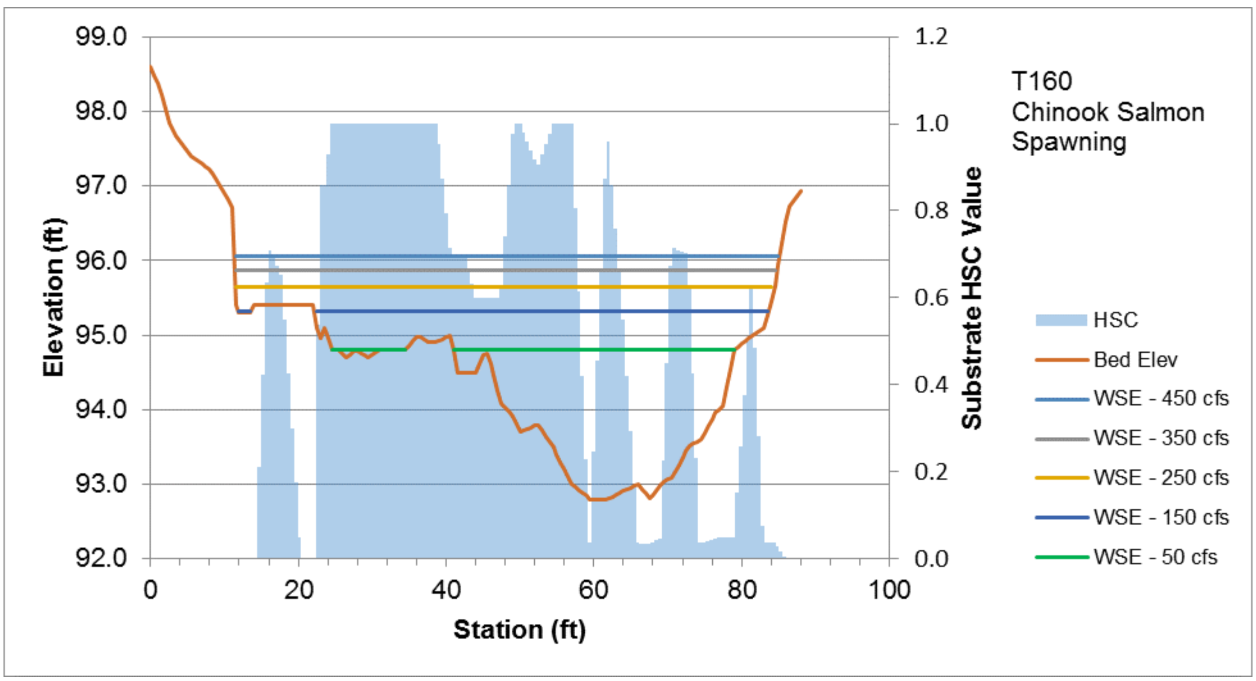

Figure A1-16. Transect 160 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

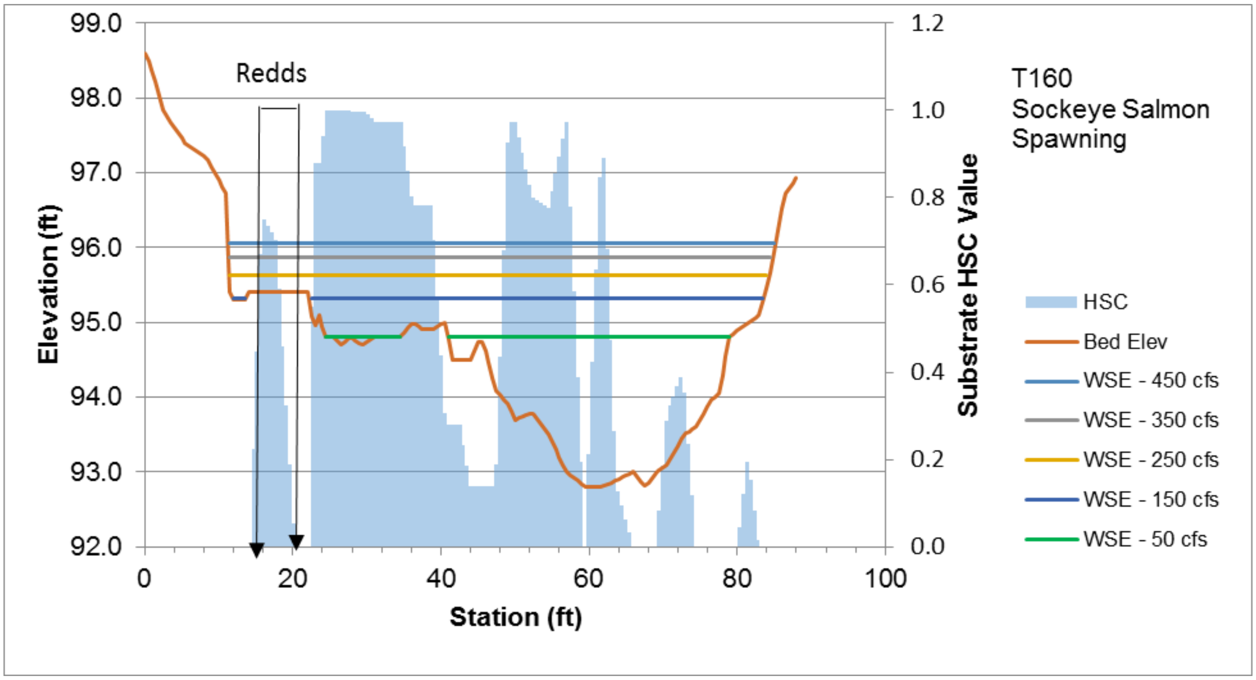

Figure A1-17. Transect 160 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

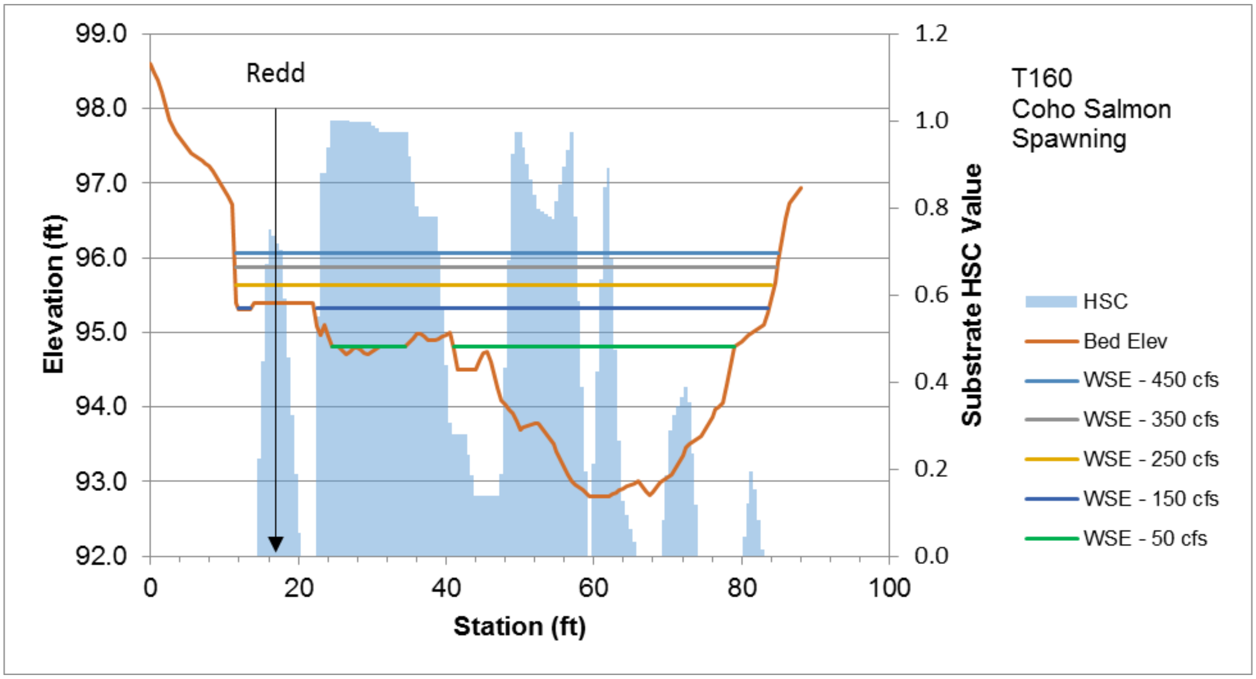

Figure A1-18. Transect 160 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs.

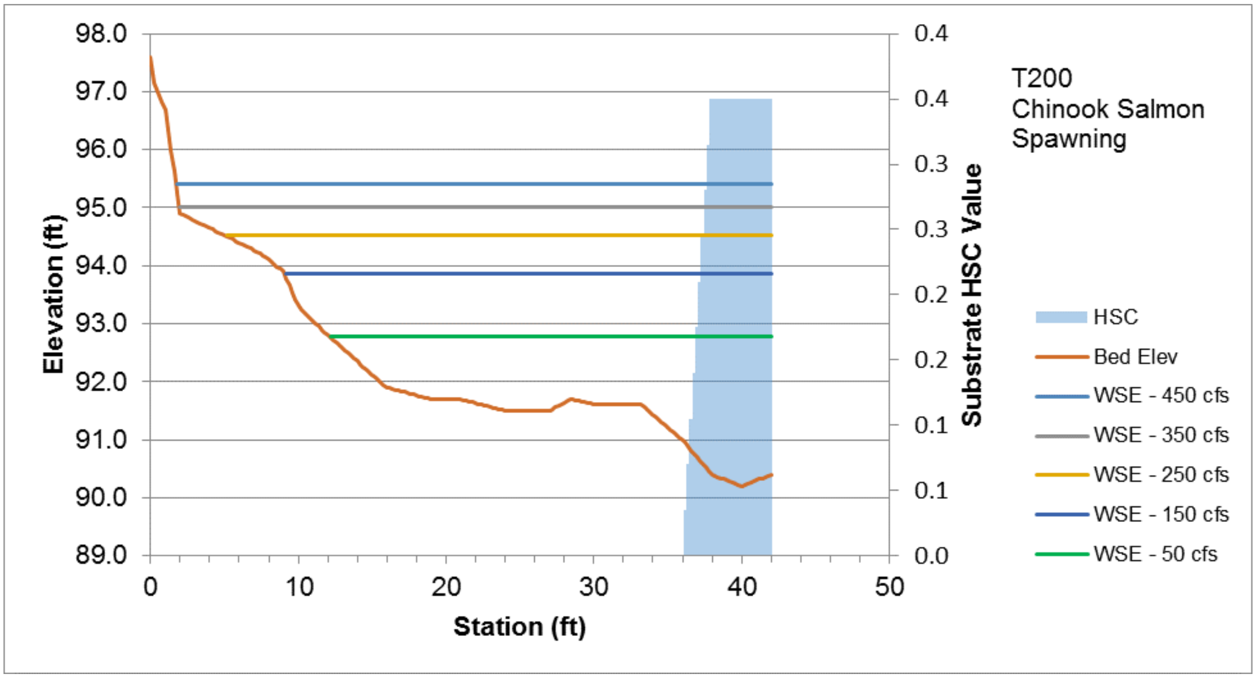

Figure A1-19. Transect 200 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

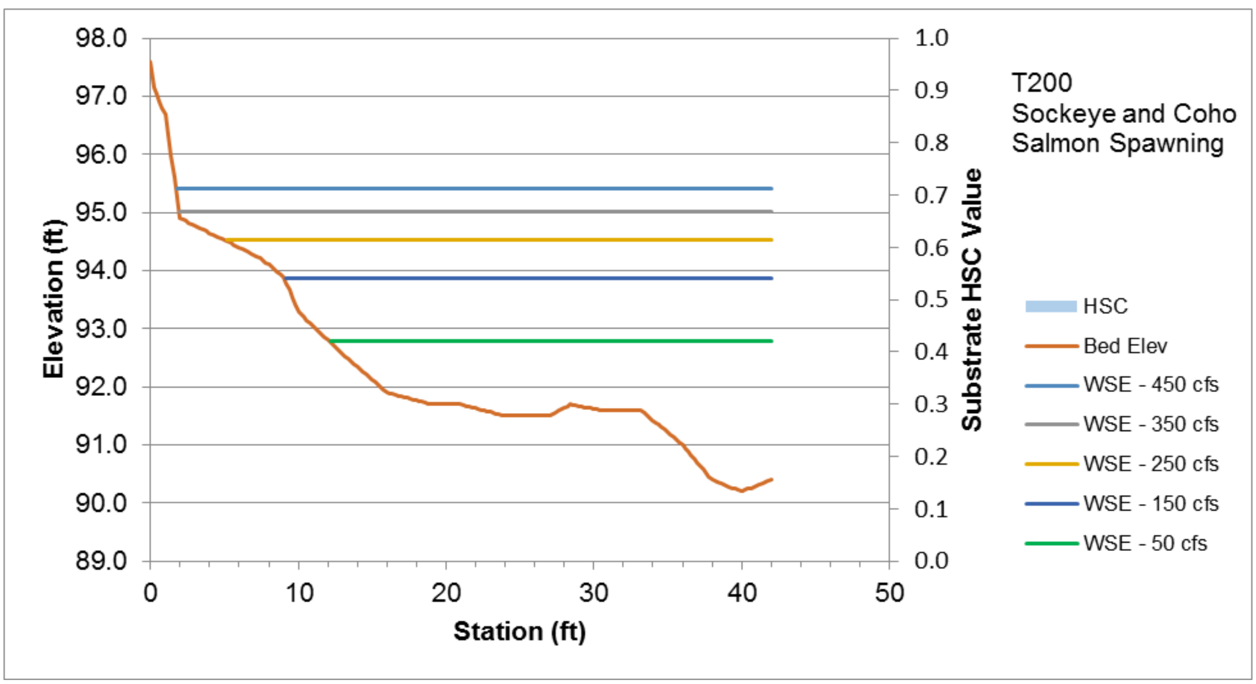

Figure A1-20. Transect 200 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

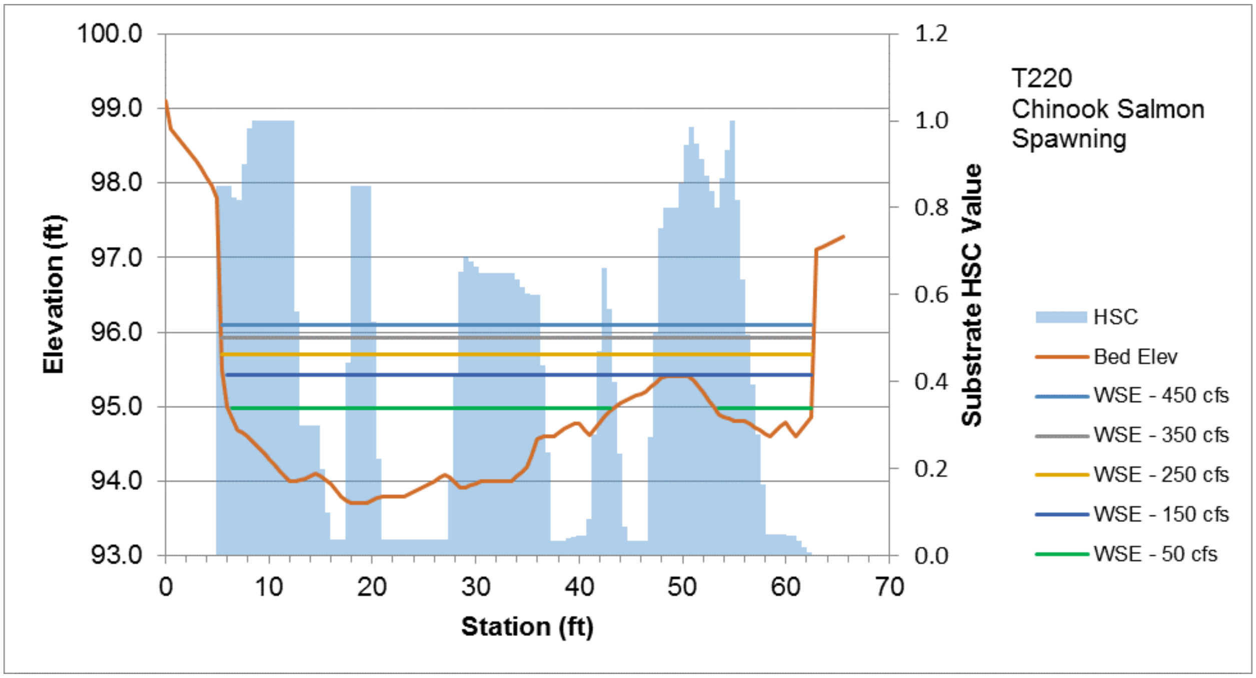

Figure A1-21. Transect 220 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

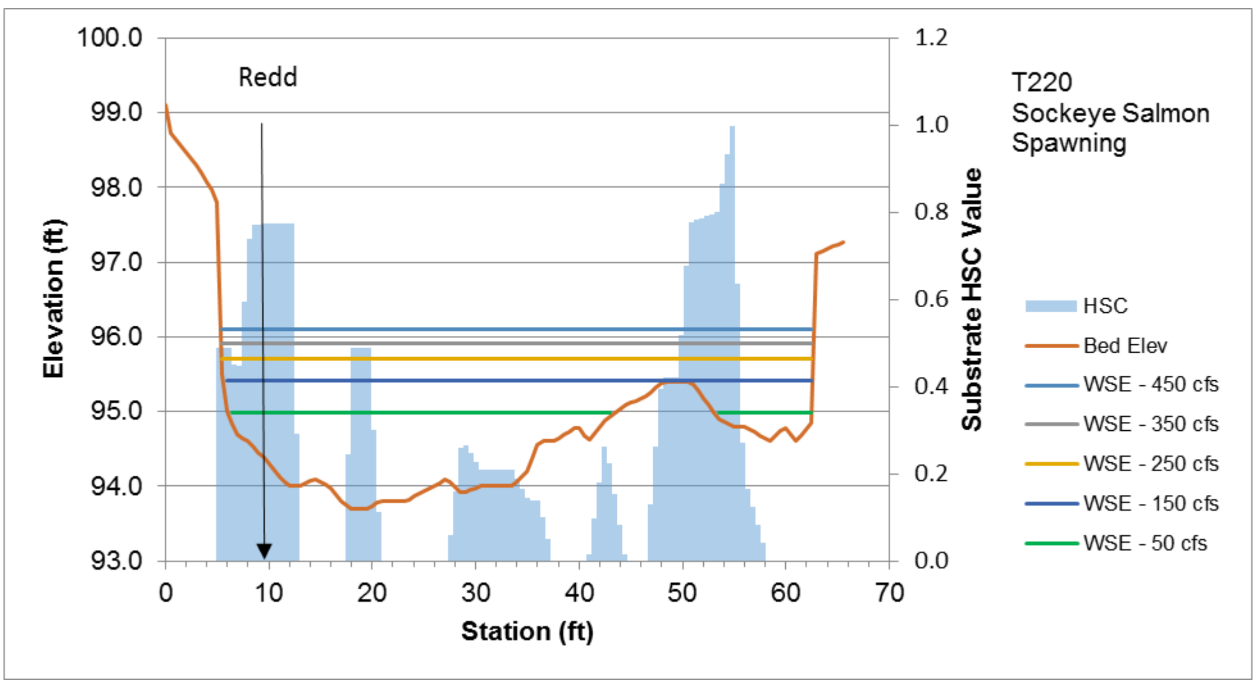

Figure A1-22. Transect 220 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

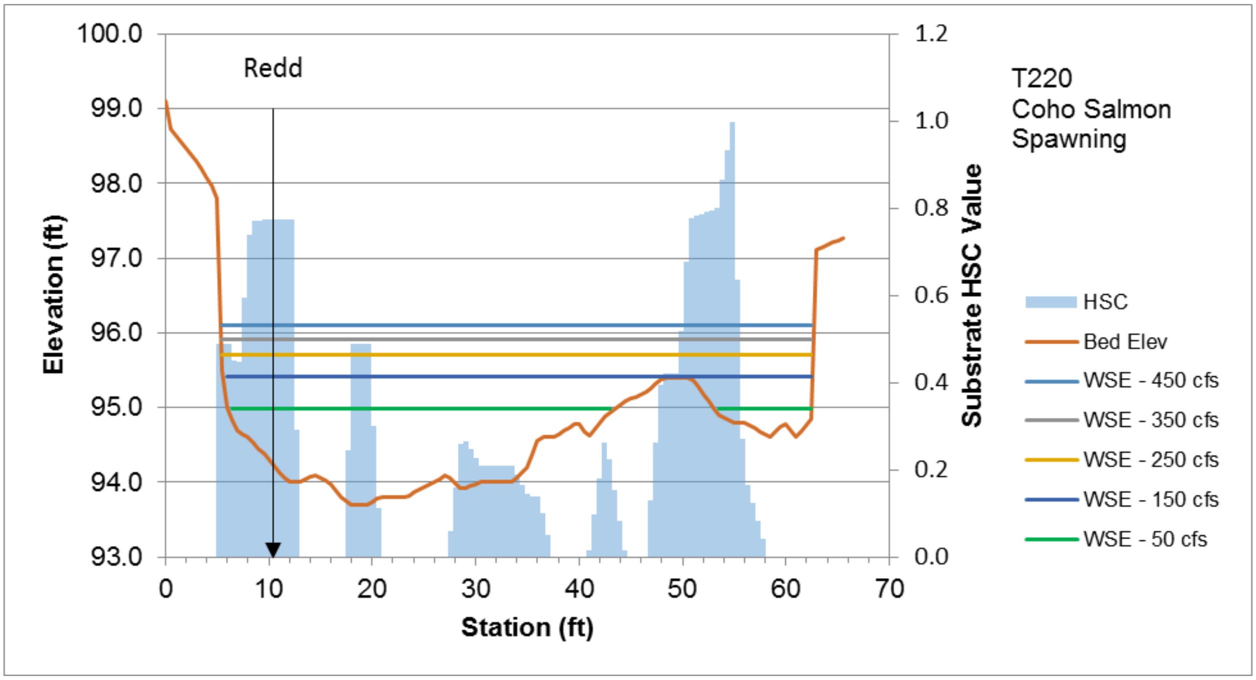

Figure A1-23. Transect 220 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs.

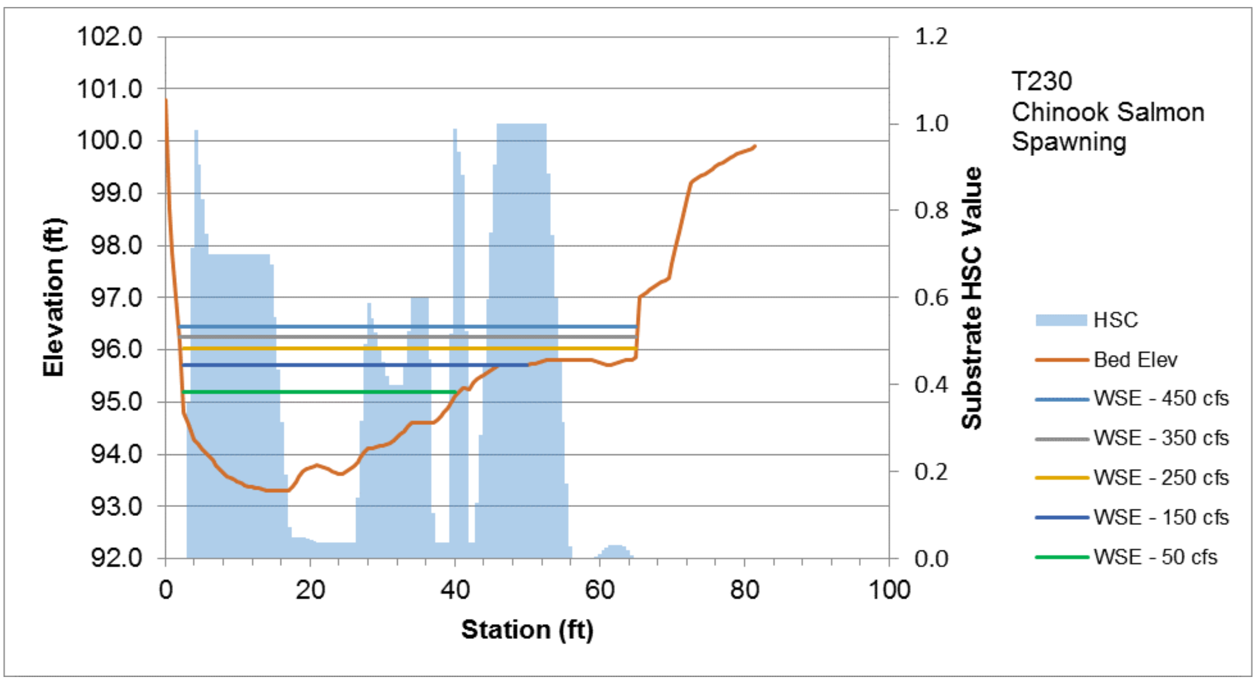

Figure A1-24. Transect 230 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

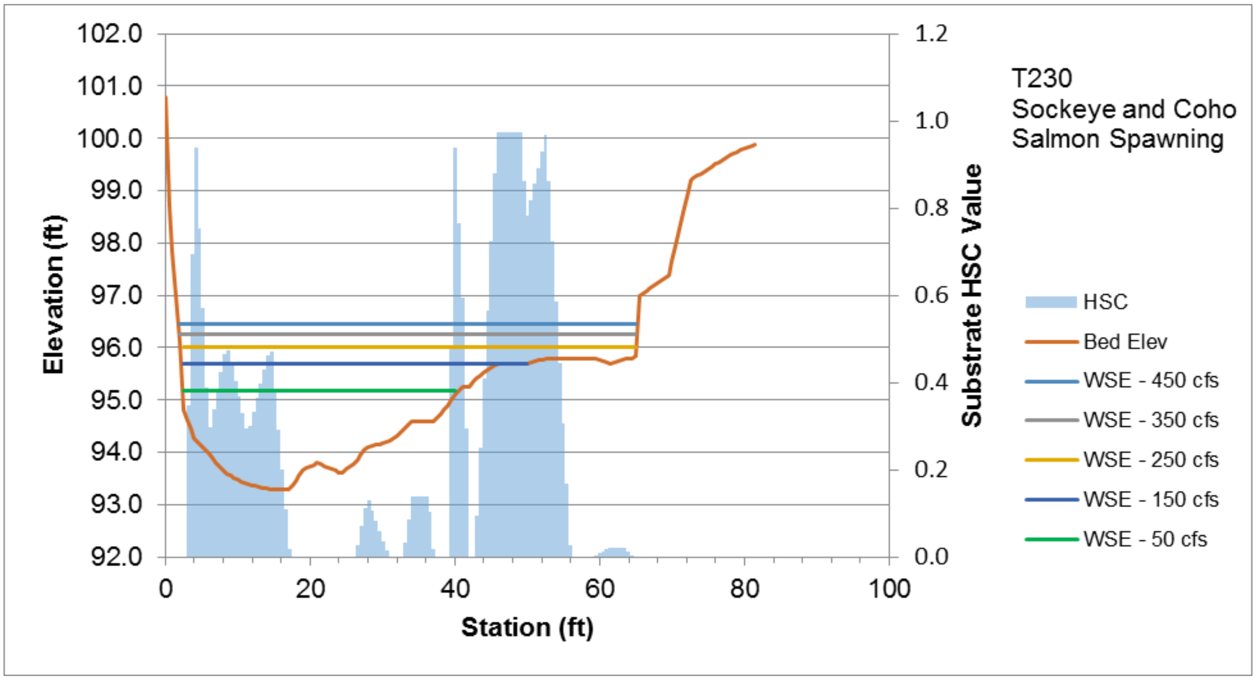

Figure A1-25. Transect 230 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

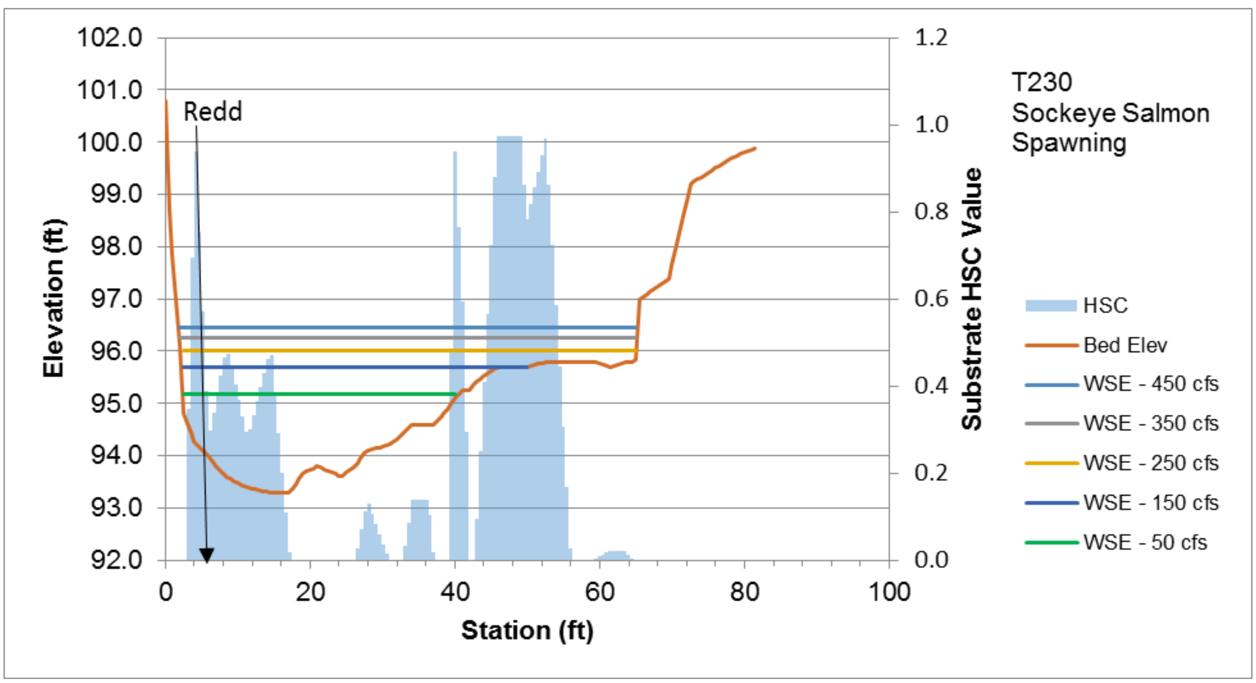

Figure A1-26. Transect 230 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

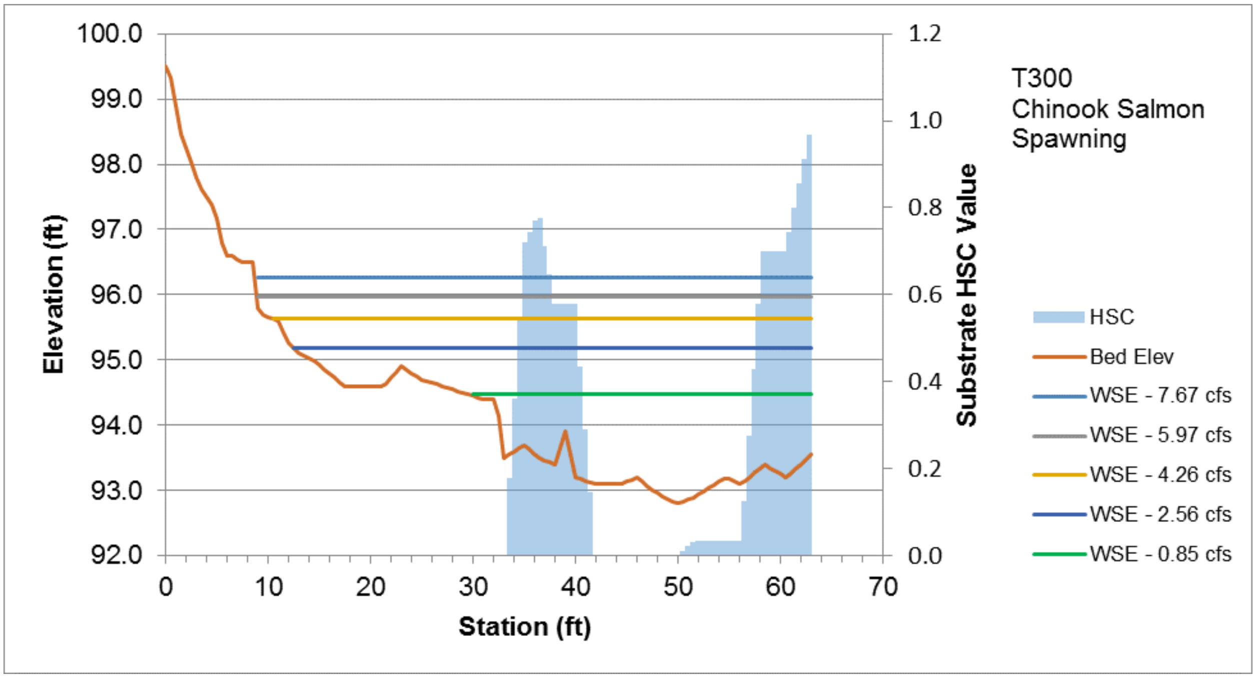

Figure A1-27. Transect 300 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

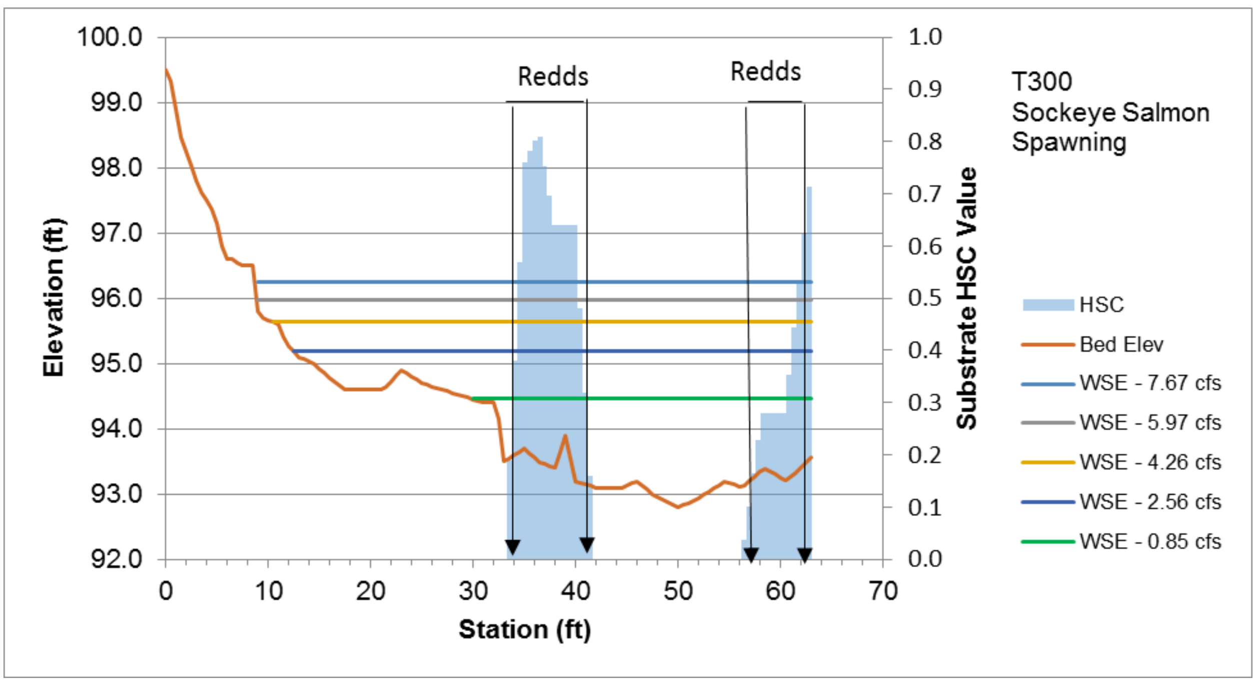

Figure A1-28. Transect 300 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

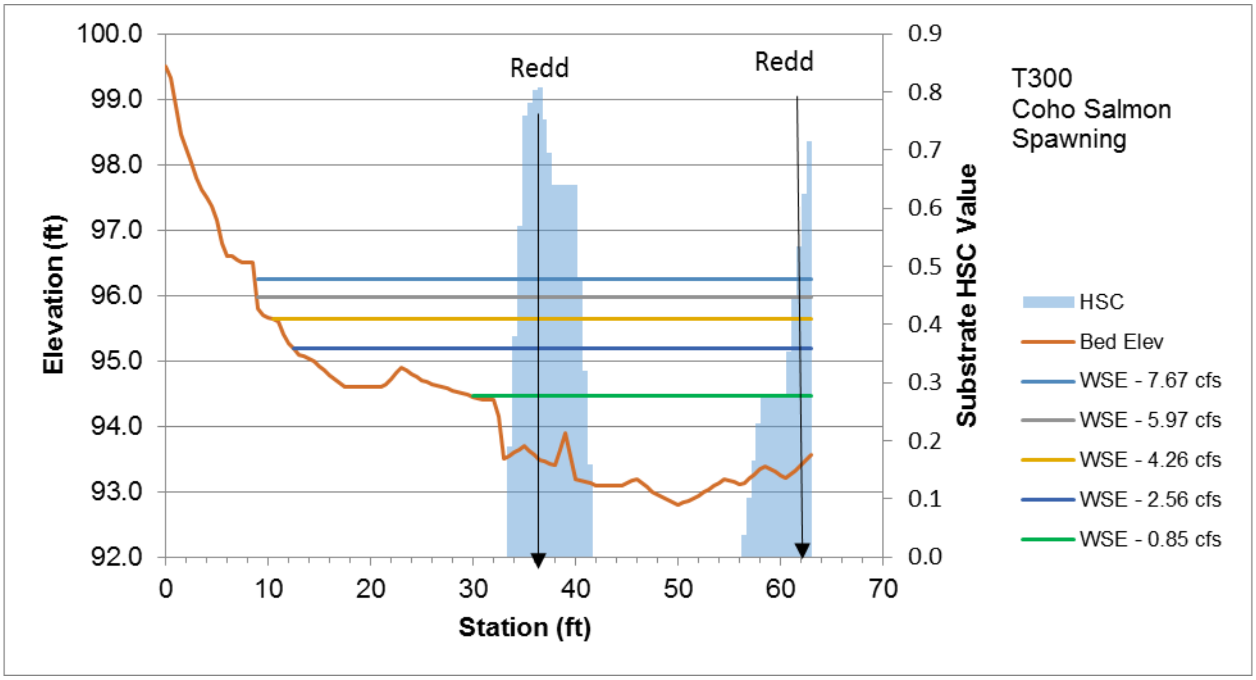

Figure A1-29. Transect 300 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

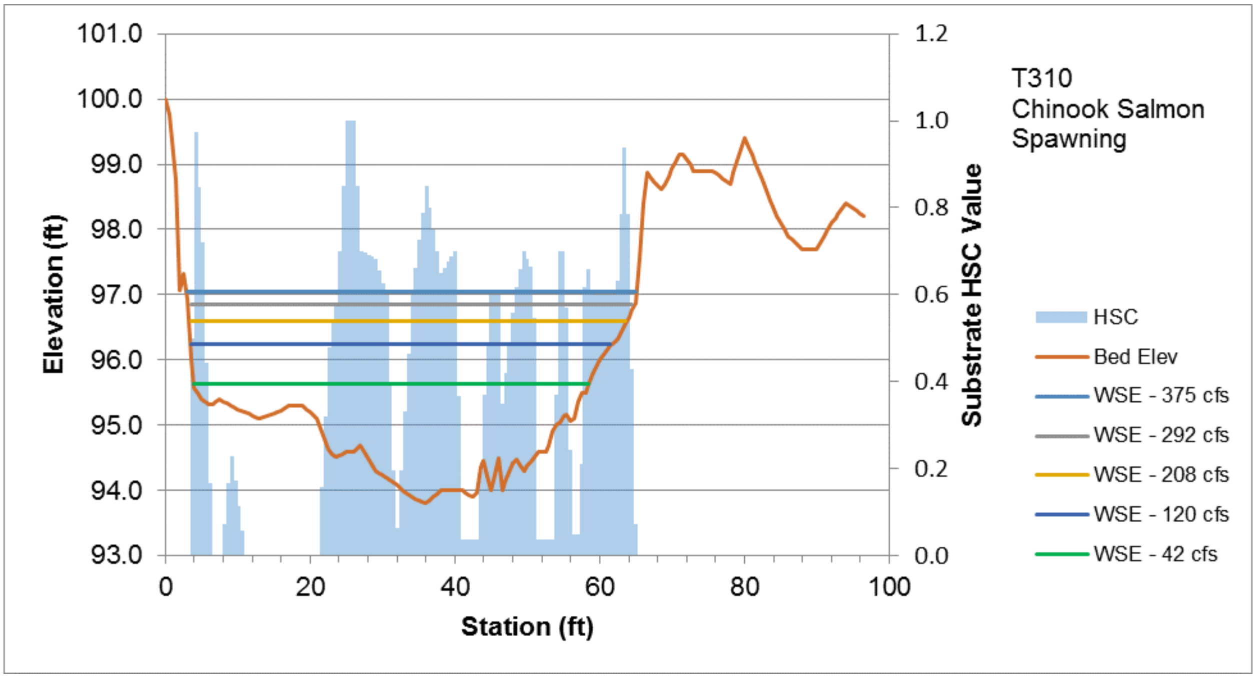

Figure A1-30. Transect 310 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

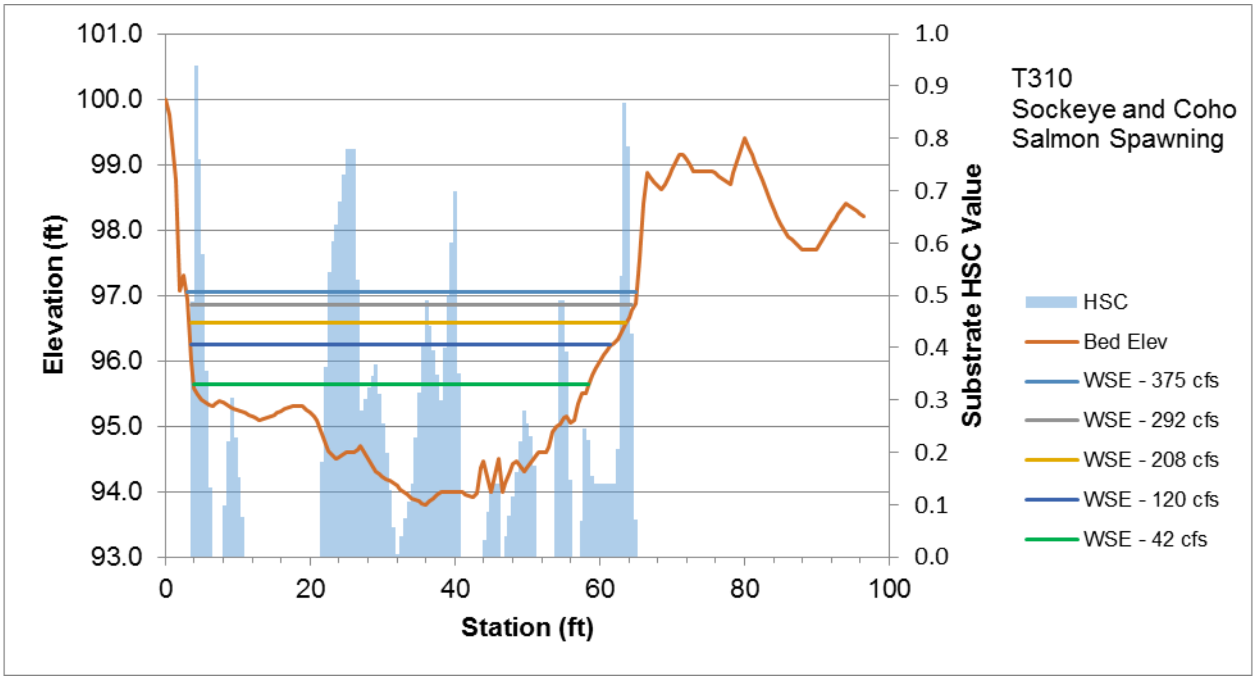

Figure A1-31. Transect 310 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

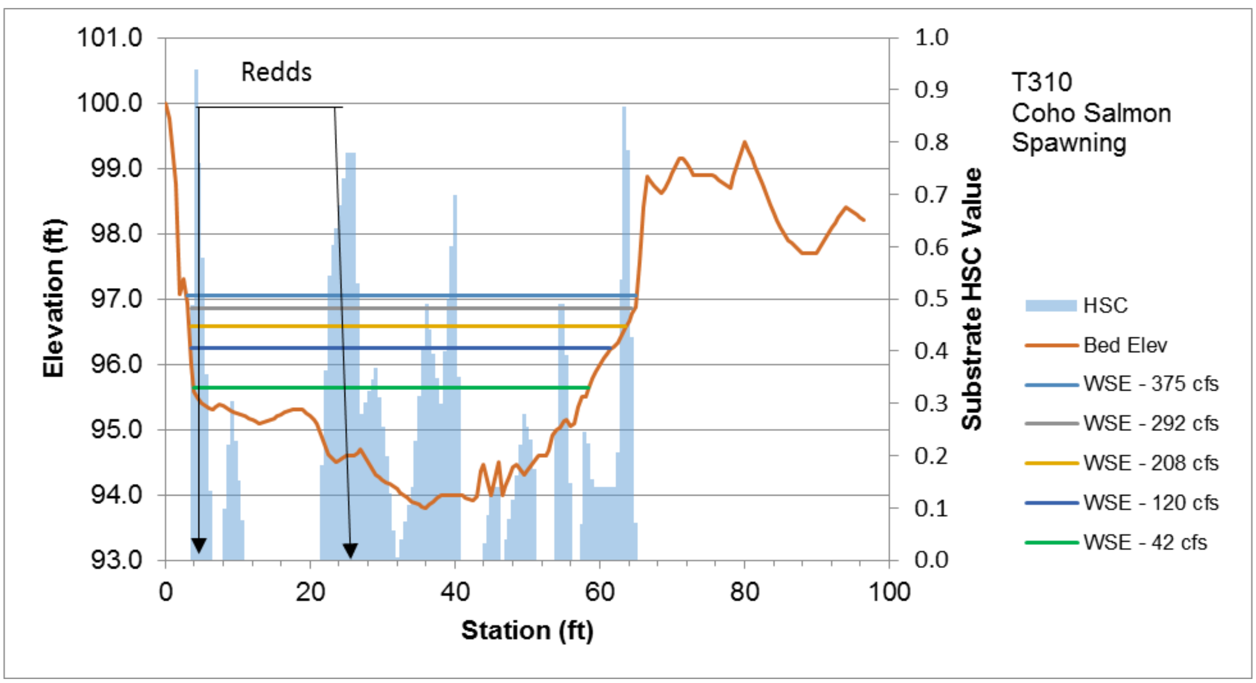

Figure A1-32. Transect 310 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

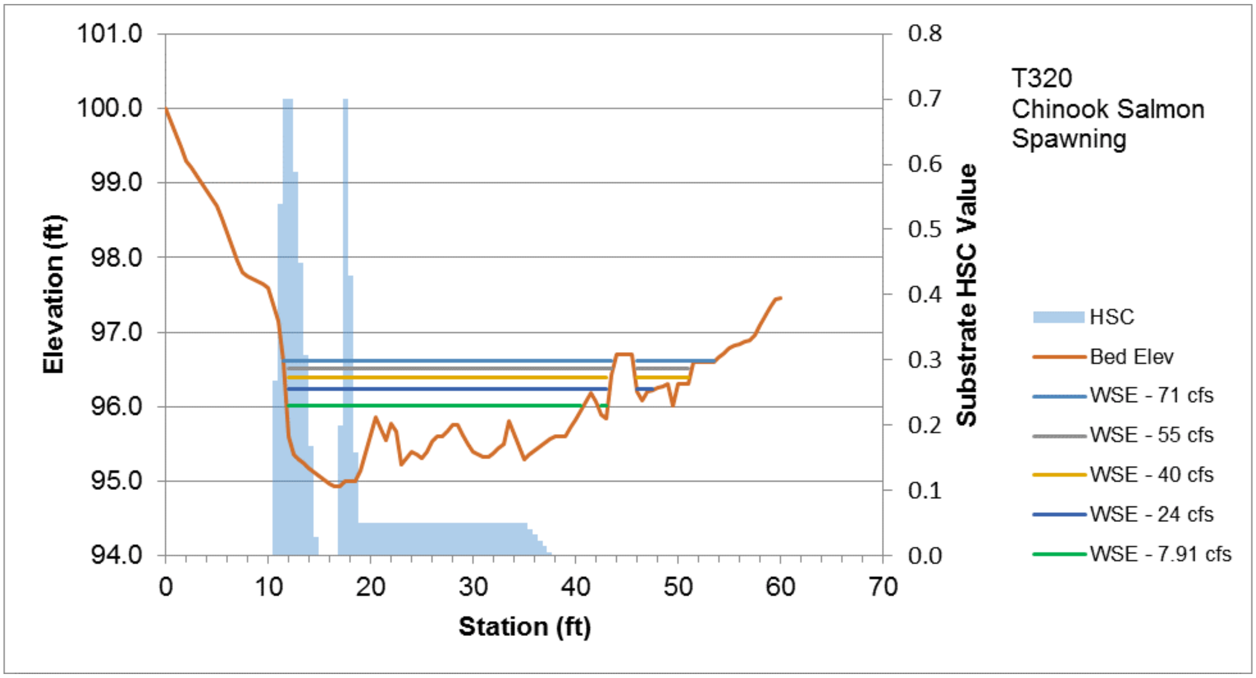

Figure A1-33. Transect 320 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

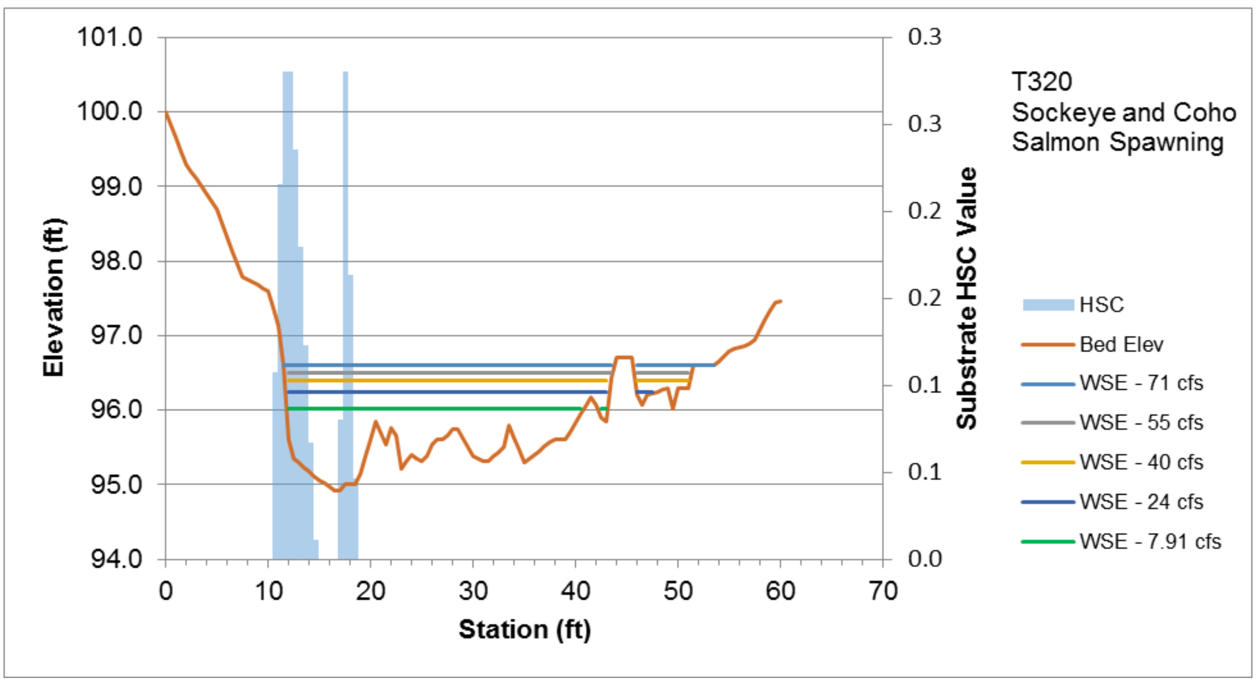

Figure A1-34. Transect 320 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

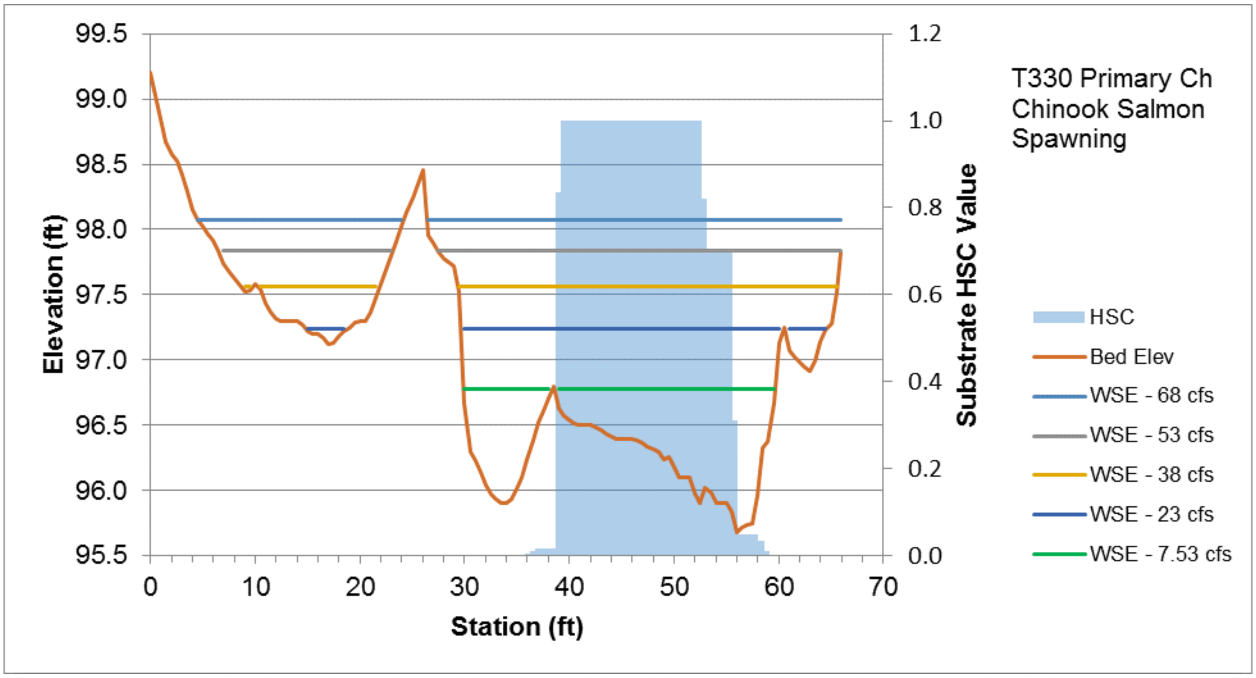

Figure A1-35. Transect 330 primary channel bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

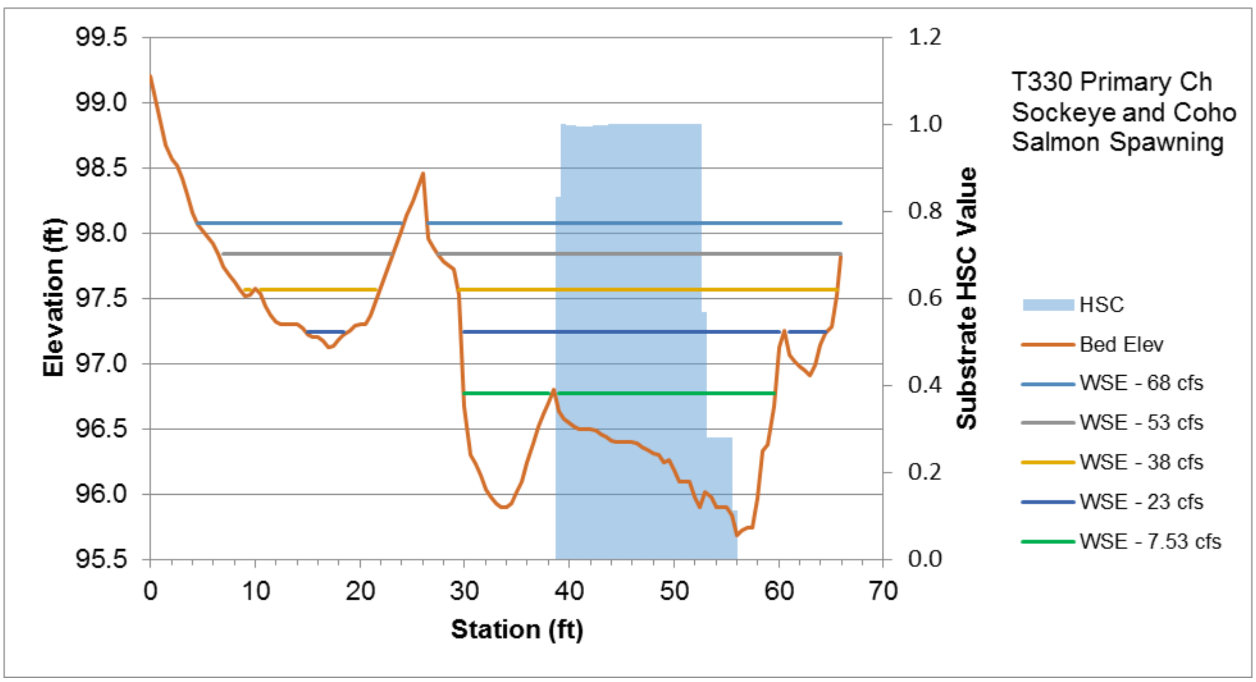

Figure A1-36. Transect 330 primary channel bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs (as measured at the Grant Creek gage).

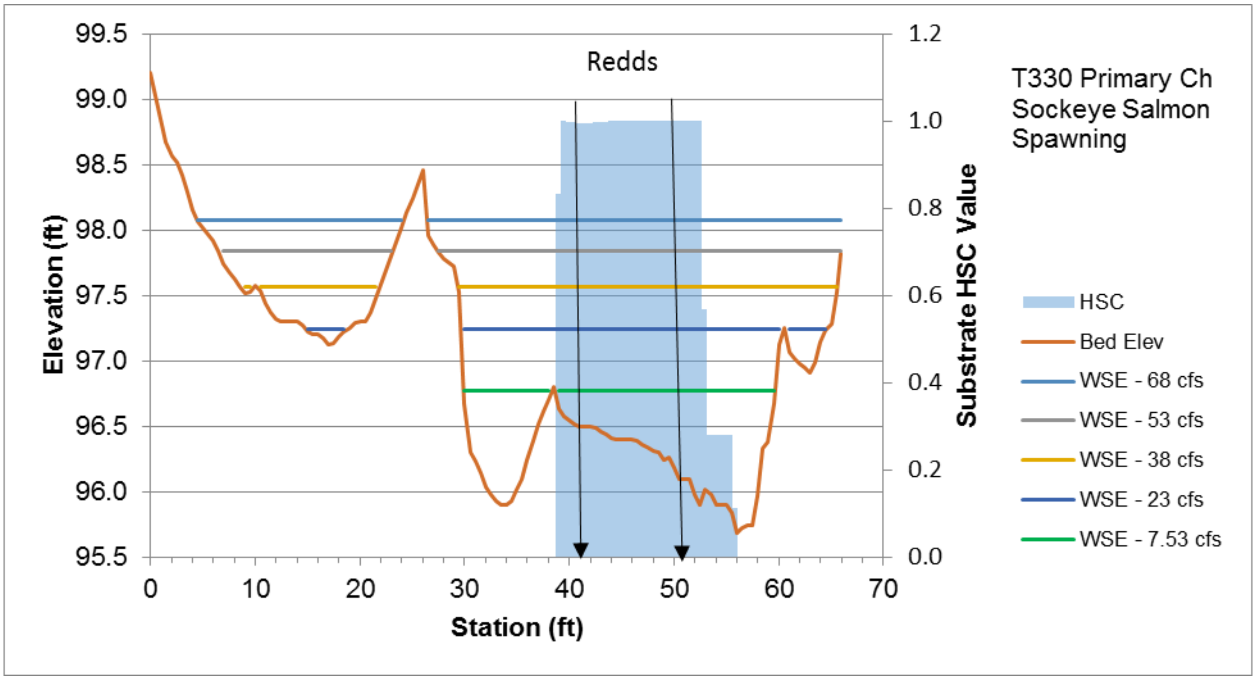

Figure A1-37. Transect 330 primary channel bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

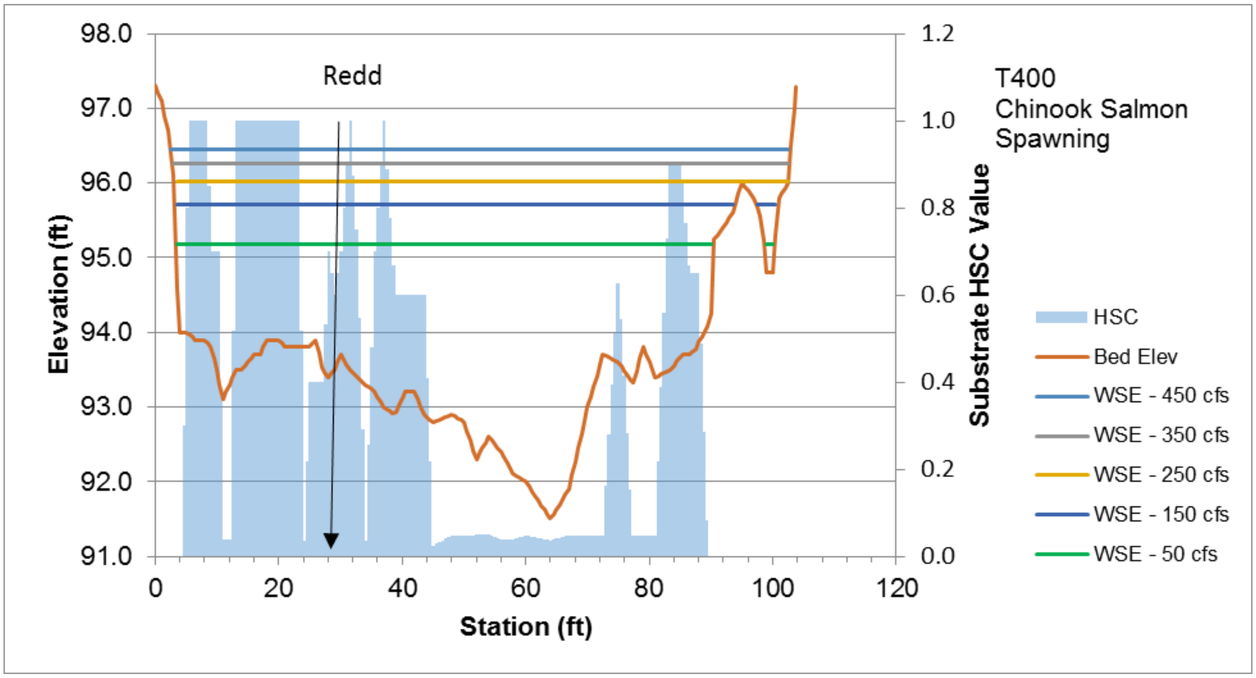

Figure A1-38. Transect 400 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

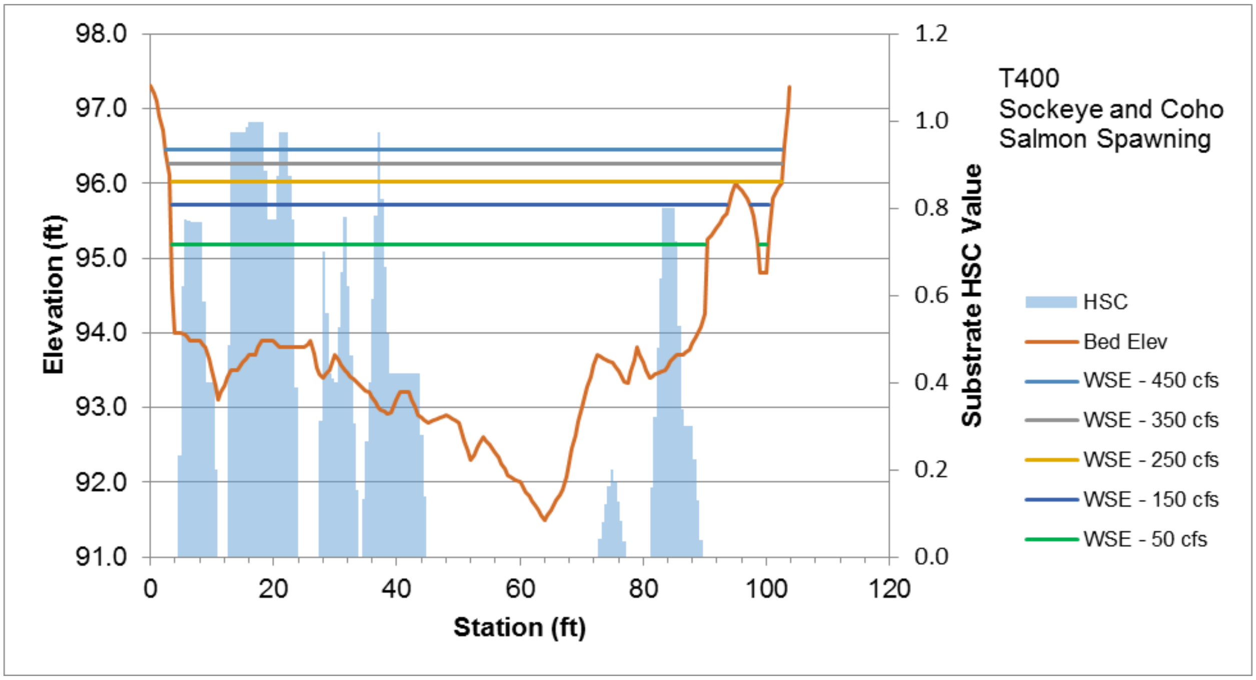

Figure A1-39. Transect 400 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

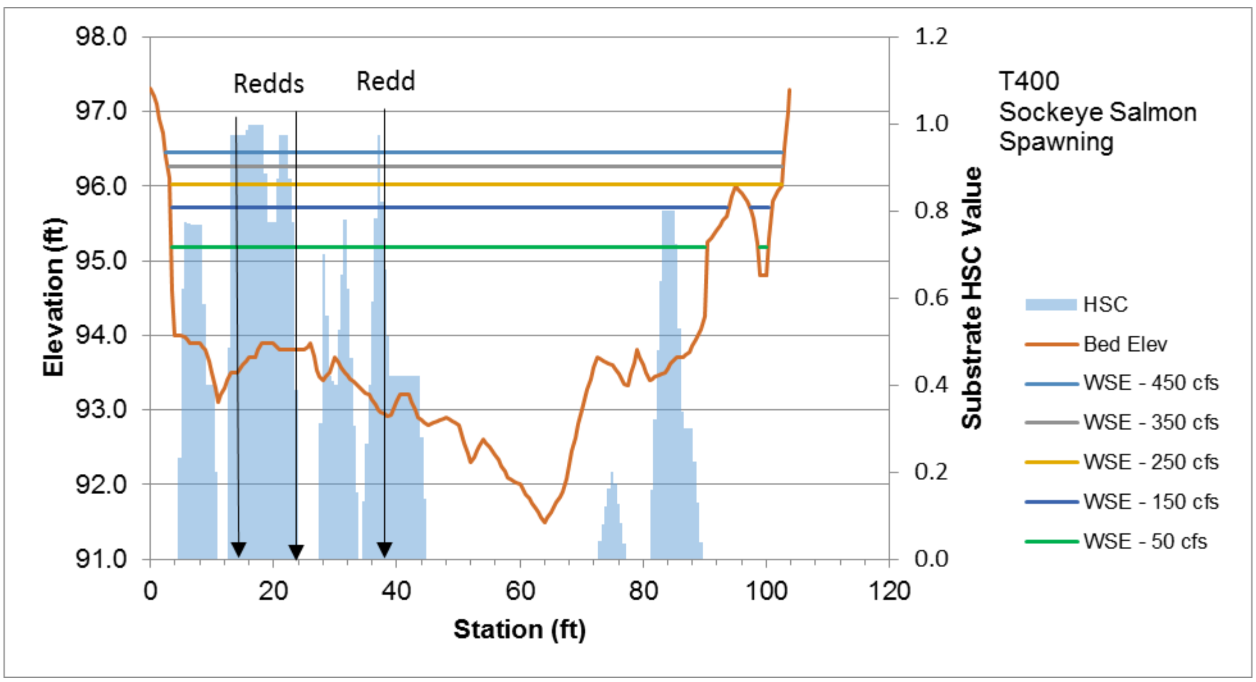

Figure A1-40. Transect 400 bed profile, sockeye spawning values, redd locations, and WSEs, 50 - 450 cfs.

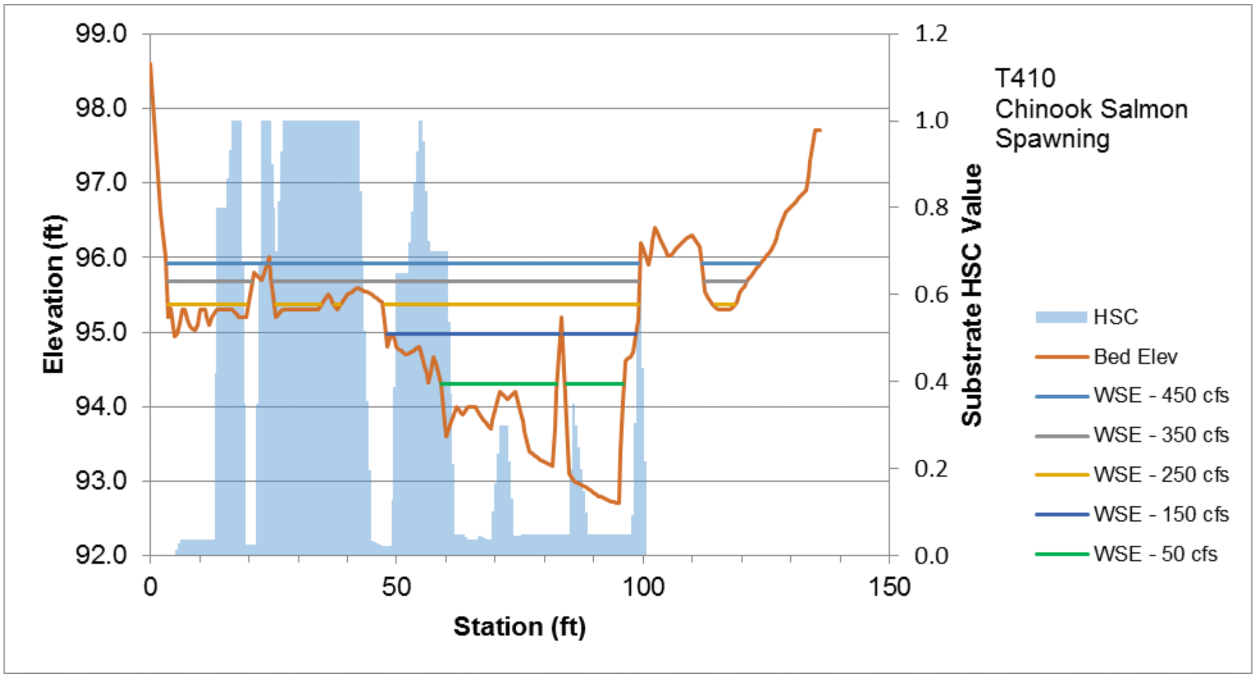

Figure A1-41. Transect 410 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

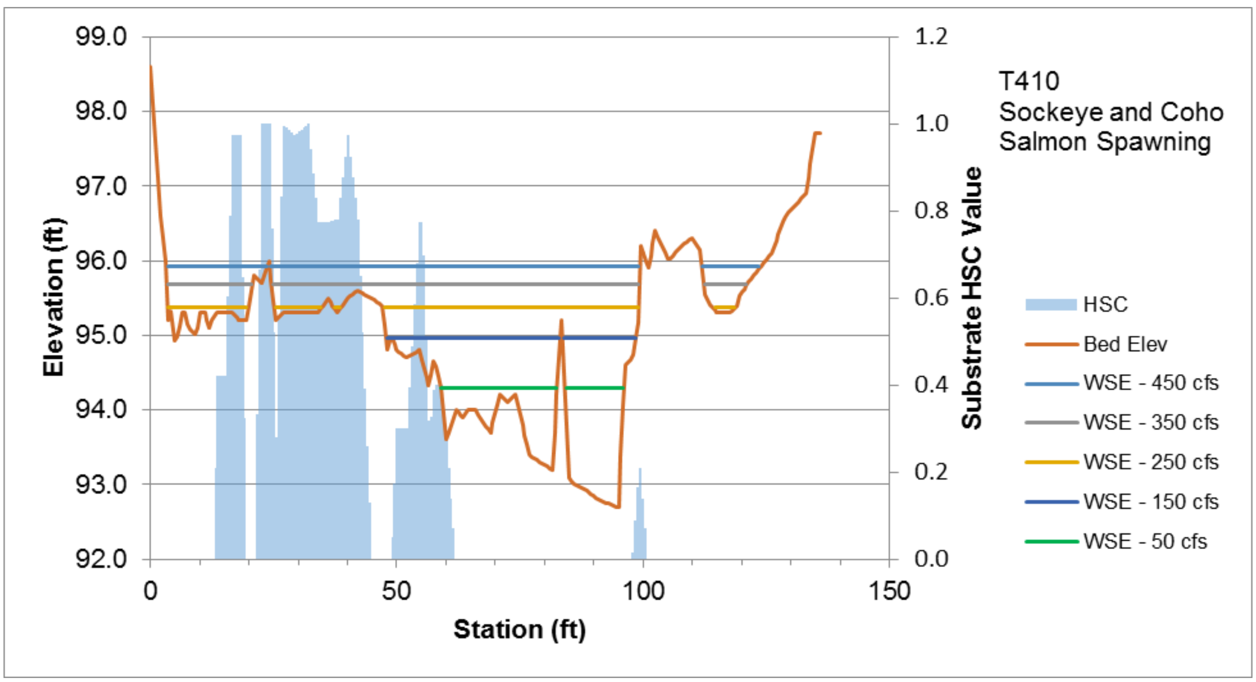

Figure A1-42. Transect 410 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

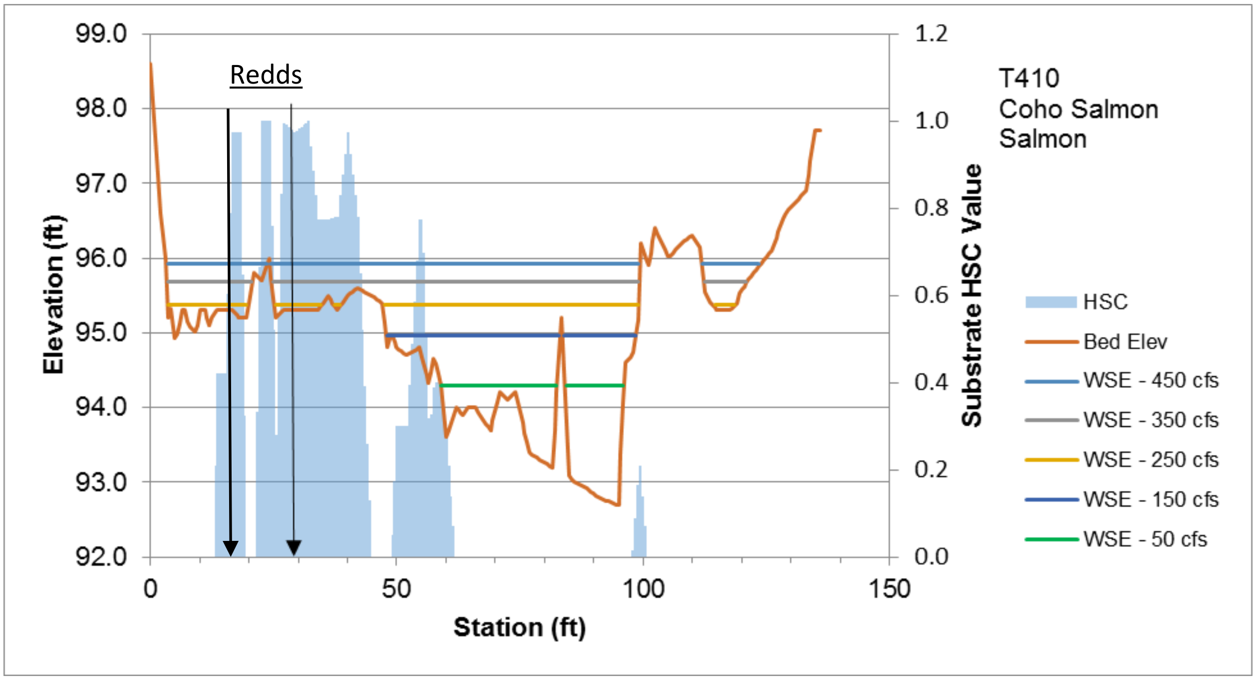

Figure A1-43. Transect 410 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs.

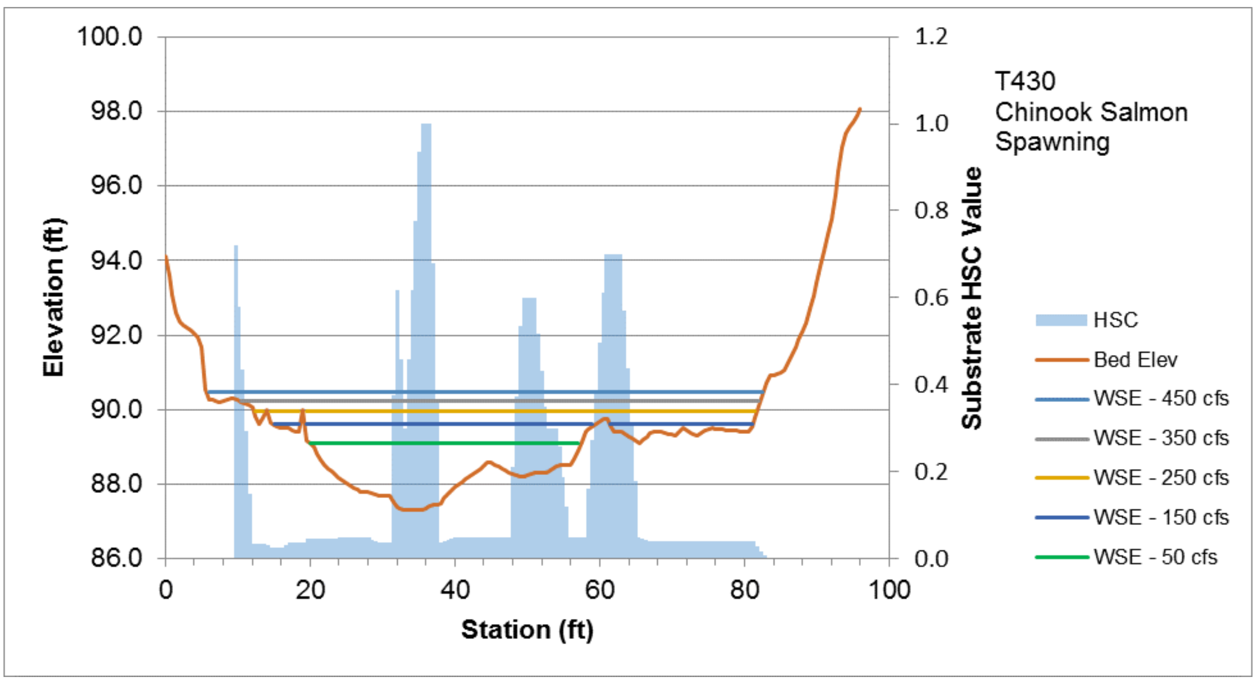

Figure A1-44. Transect 430 bed profile, Chinook spawning substrate values, and WSEs, 50 - 450 cfs.

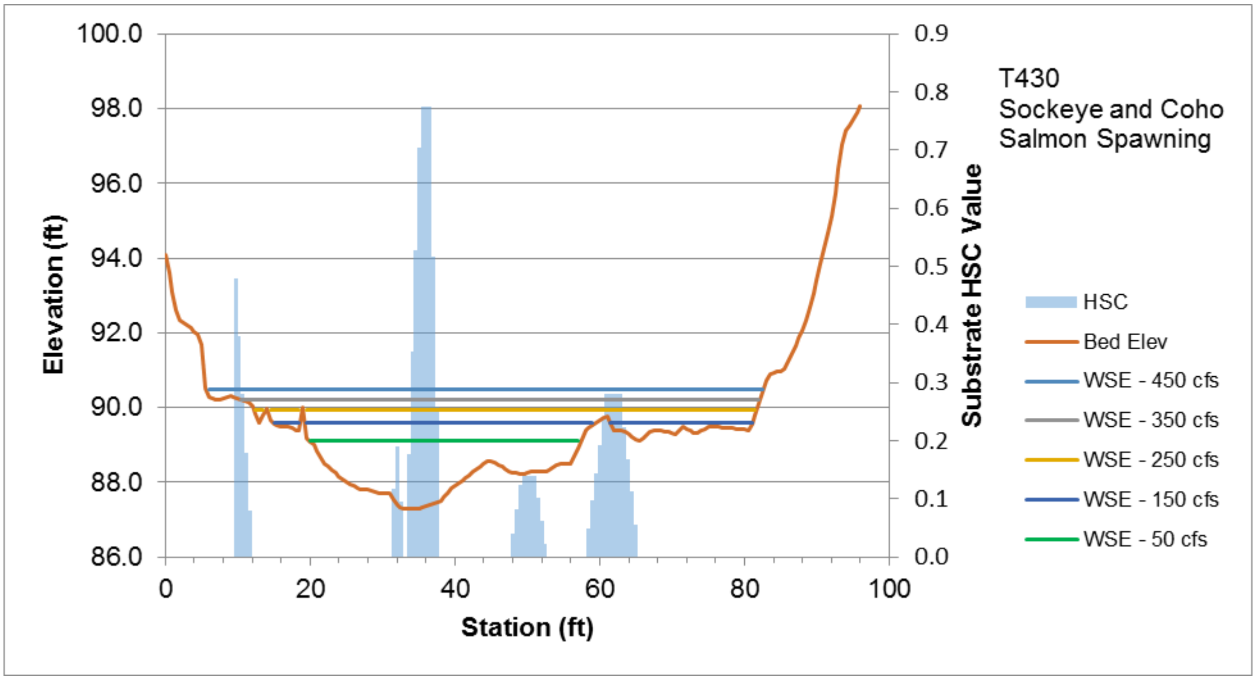

Figure A1-45. Transect 430 bed profile, sockeye and coho spawning substrate values, and WSEs, 50 - 450 cfs.

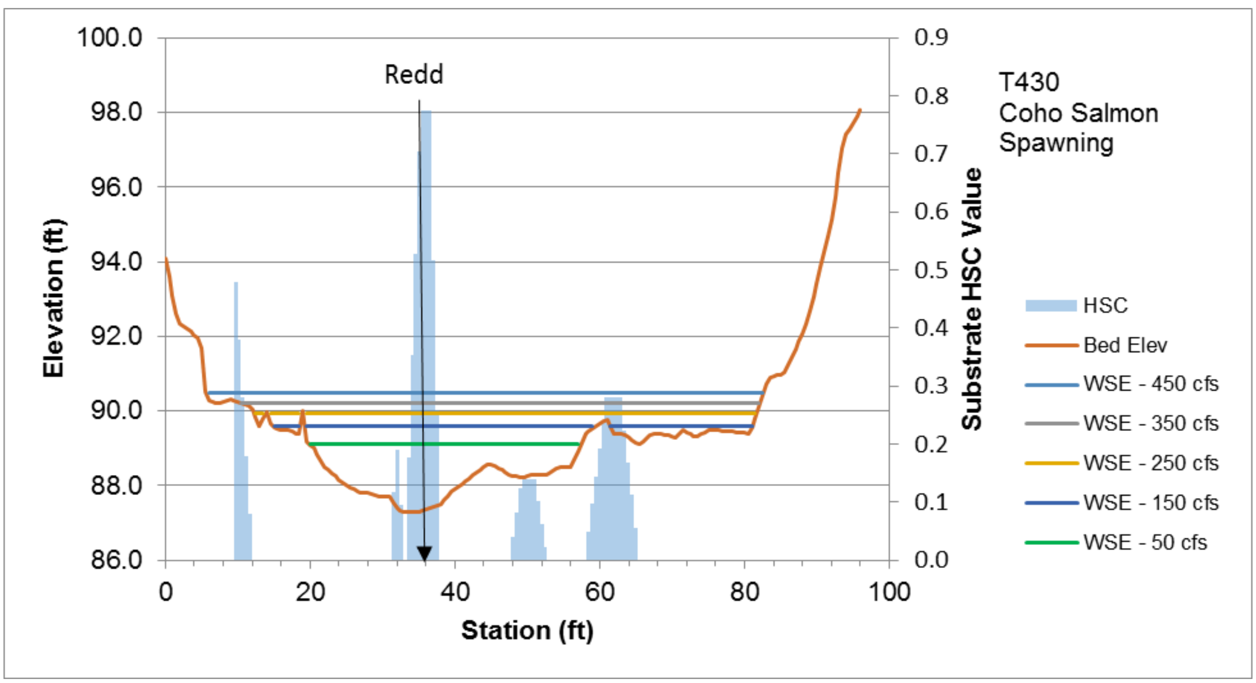

Figure A1-46. Transect 430 bed profile, coho spawning values, redd locations, and WSEs, 50 - 450 cfs.

Appendix 5: Grant Creek Habitat Time Series Analysis

Grant Lake Hydroelectric Project (FERC No. 13212)

Grant Creek Habitat Time Series Analysis

Draft Report

Prepared for
Kenai Hydro LLC

Prepared by

McMILLEN
DESIGN with Vision. BUILD with Integrity.

October 2014

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1 INTRODUCTION

This report is intended to address a request from the Instream Flow Work Group (Work Group) to conduct a habitat time series analysis for the salmonid life history stages present in Grant Creek for the Grant Lake Hydroelectric Project (Project). This effort requires a long-term hydrologic record to compare Grant Creek flows without the Project (i.e., pre-Project) to flows for the same time period, assuming the Project is on-line and operating as proposed (i.e., with-Project).

The goals and objectives of this analysis were as follows:

- Calculate habitat for the Grant Creek salmonid species and life history stages, as measured by Weighted Usable Area (WUA).
- Compare the amount of habitat for the Grant Creek salmonids pre-Project and with-Project for the period of record.
- Calculate gains or losses in habitat with the Project on-line.

2 METHODS

McMillen, LLC (McMillen) ran the previously calibrated Grant Creek Instream Flow models used for the Instream Flow Study. Much of the data or work products required for the habitat time series analysis were developed subsequent to the Aquatic Resources – Grant Creek Aquatic Habitat and Instream Flow Study Final Report (KHL 2014). Data required to conduct the habitat time series analysis are listed below:

- Hydrologic Record. McMillen developed a long-term hydrologic record that extended from Calendar Year (CY) 1948 through CY 2013. The record was developed for pre-Project flows and with-Project flows and is a composite record of actual and synthesized data.
- Grant Creek final transect weighting for all transects.
- Final Grant Creek WUA, incorporating all species and life history stages for all transects.

McMillen used RHABSIM (Riverine Habitat Simulation System) by Thomas R. Payne and Associates (now with Normandeau Associates, Arcata, CA) to produce WUA curves for all salmonid spawning and rearing life history stages.

McMillen used Microsoft Excel© to calculate daily WUA values, using Grant Creek periodicity, and synthesized or measured flows for the years 1948 through 2013, both pre-Project and with-Project. Daily WUA for each species and life history stage were then averaged for the appropriate dates, based upon the periodicity of the species and life history stages.

3 RESULTS

3.1 Target Species

Target species and life history stages are summarized in Table 3.1-1. Grant Creek periodicity is provided in Table 3.1-2.

Table 3.1-1. Potential target species and life history stages to be modeled in the Grant Creek Instream Flow Study.

Species	Spawning	Fry Rearing	Juvenile Rearing	Adult Rearing
Sockeye Salmon	✓			
Coho Salmon	✓	✓	✓	
Chinook Salmon	✓	✓	✓	
Rainbow Trout	✓	✓	✓	✓
Dolly Varden Char	✓	✓	✓	✓

Table 3.1-2. Life history and periodicity for Grant Creek salmonids.

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
Coho	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
Sockeye	Spawning												
	Incubation/Emergence												
Dolly Varden	Spawning												
	Incubation/Emergence												
	Fry (<60mm)												
	Juvenile												
	Adult												
Rainbow	Spawning												
	Incubation/Emergence												
	Fry (<50mm)												
	Juvenile												
	Adult												

3.2 Grant Creek Hydrology

As mentioned above, McMillen developed a composite, 66-year time series for Grant Creek for CY 1948 through CY 2013. Measured flows in Grant Creek were collected by the following:

- The U.S. Geologic Survey (USGS) (USGS gage 15246000 Grant Creek data – 1/1/1948 – 9/30/1958);
- Kenai Hydro LLC (KHL) (4/3/2013 – 12/31/2013); and
- Ebasco data (1981 – 1983, intermittent).

The record extension was based upon a correlation with overlapping Kenai River at Cooper Landing data (USGS 15258000) for the 1/1/1948 – 9/30/1958 period with the USGS data on Grant Creek. The hydrologic record was then extended from 10/1/1958 – 4/2/2013, excluding the Ebasco periods. That 66-year composite (measured and synthesized flows) record (pre-Project) was then revised to reflect the with-Project condition, producing two 66-year composite records for analysis.

3.3 Grant Creek Reach and Transect Weighting

Final Grant Creek transect and reach weighting were developed in consultation with the Work Group. A final transect weighting report was issued on August 4, 2014.

3.4 Grant Creek WUA

Once Grant Creek reach and transect weighting were established, KHL developed final WUA curves for the Grant Creek salmonid species and life history stages. These curves were then used to analyze daily flows for the 66-year period of record, pre-Project and with-Project. Results are provided below.

3.4.1 Chinook Salmon

WUA for Chinook salmon spawning and rearing are shown in Figures 3.4-1 to 3.4-3. With-Project WUA ranged from 96.9% of pre-Project for Chinook fry rearing, to 100.2% for Chinook juvenile rearing. Chinook spawning with-Project WUA was 99.5% of the pre-Project WUA.

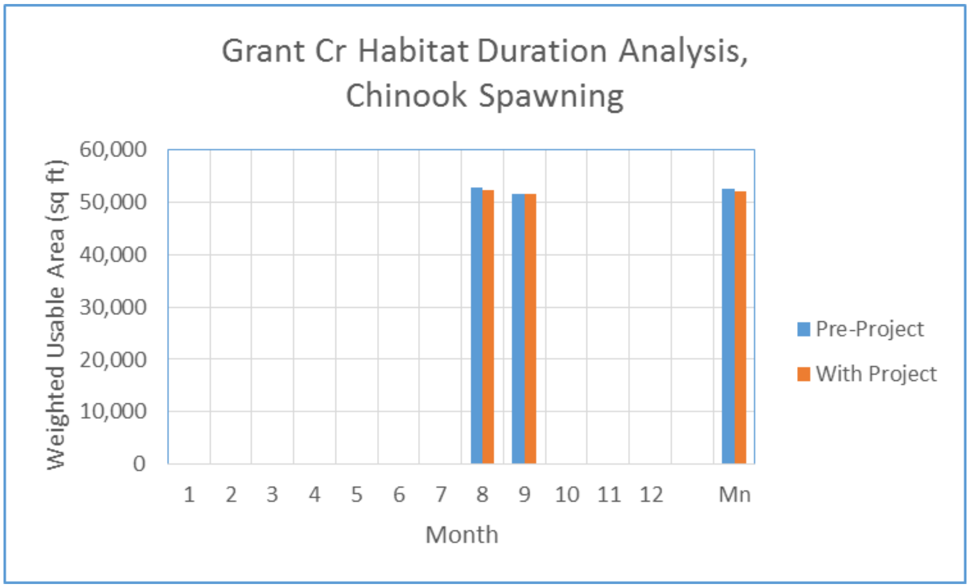

Figure 3.4-1. Chinook Spawning WUA

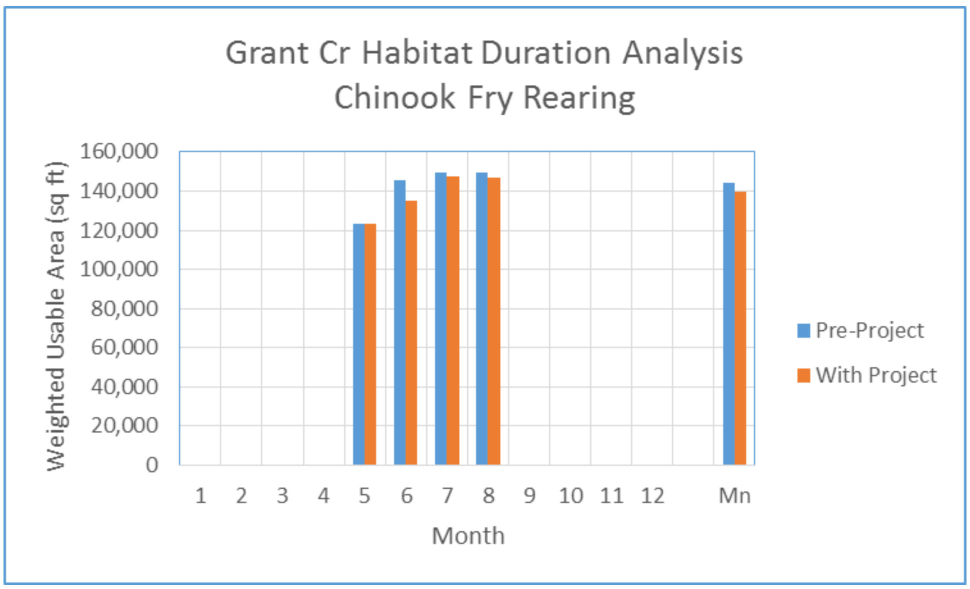

Figure 3.4-2. Chinook Fry Rearing WUA

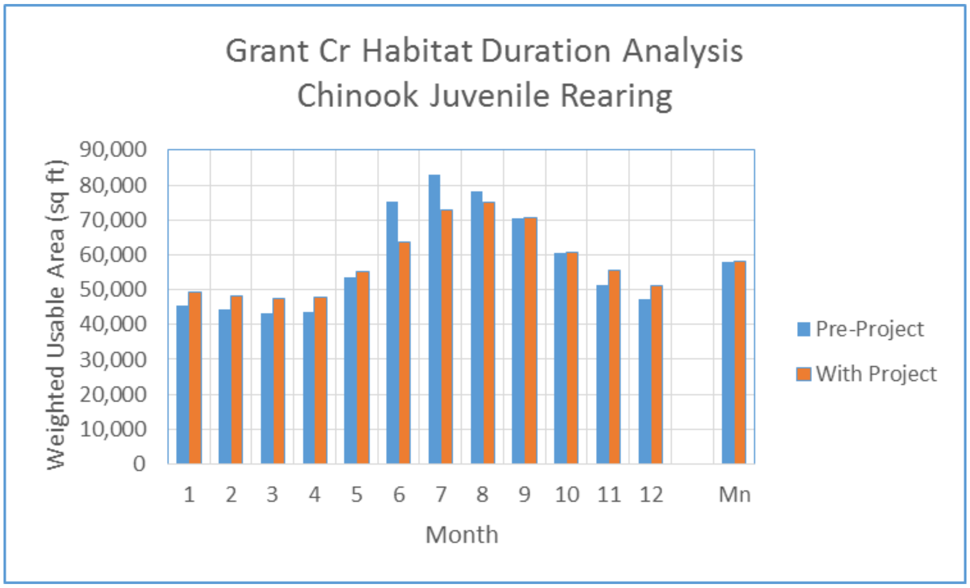

Figure 3.4-3. Chinook Juvenile Rearing WUA

3.4.2 Coho Salmon

WUA for coho salmon spawning and rearing are shown in Figures 3.4-4 to 3.4-6. With-Project WUA ranged from 99% of pre-Project for coho fry rearing, to slightly more than 100% for coho spawning. With-Project coho juvenile rearing WUA averaged 99.2% of pre-Project WUA; however, monthly with-Project WUA ranged from 93.9% to 103.8% of pre-Project WUA. With-Project WUA was generally higher than pre-Project WUA during the late fall – early spring months, when the Project would increase Grant Creek flows.

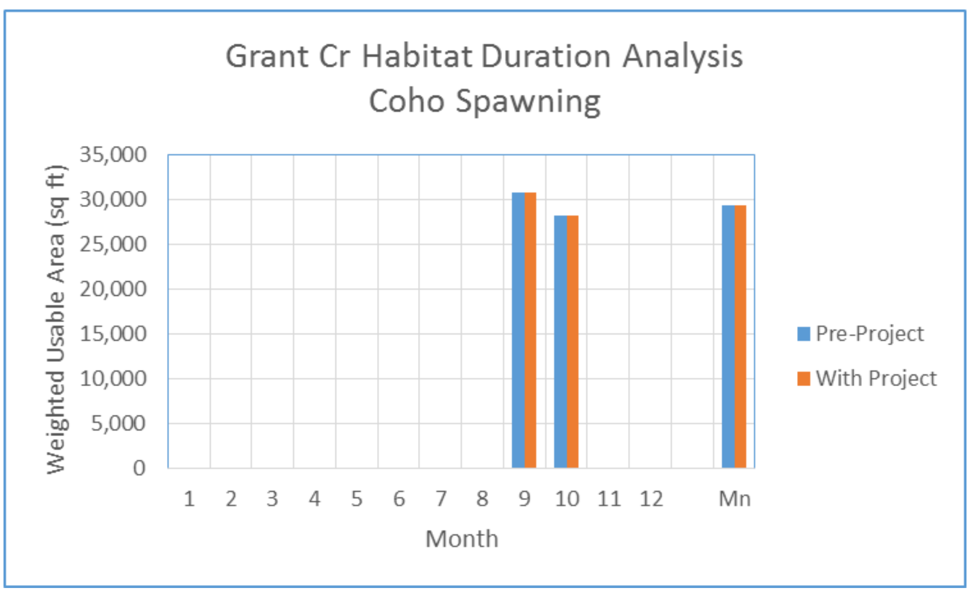

Figure 3.4-4. Coho Spawning WUA

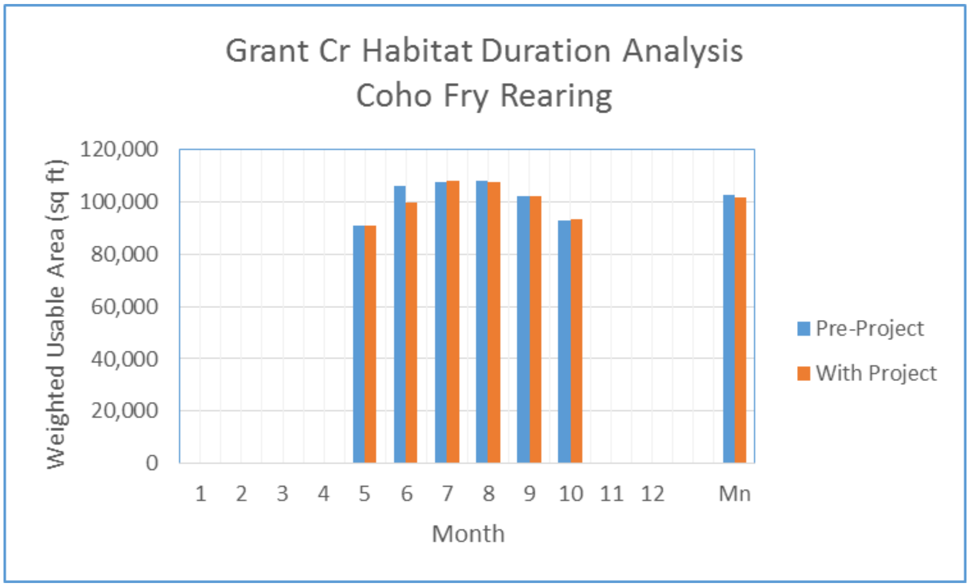

Figure 3.4-5. Coho Fry Rearing WUA

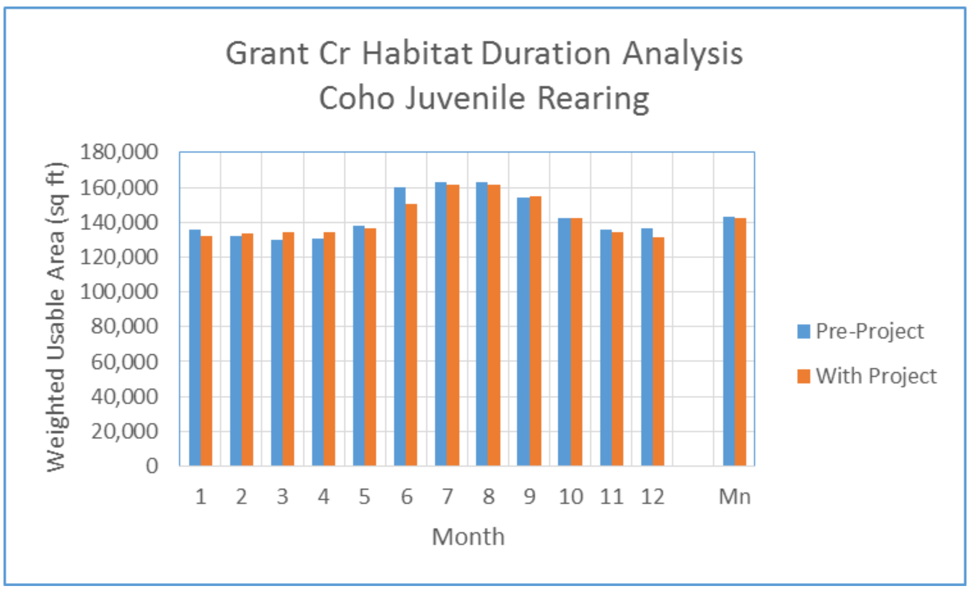

Figure 3.4-6. Coho Juvenile Rearing WUA

3.4.3 Sockeye Salmon

WUA for sockeye salmon spawning is shown in Figure 3.4-7. With-Project spawning WUA averaged 99% of pre-Project WUA, but ranged from 98.0% in August to 100.1% in September.

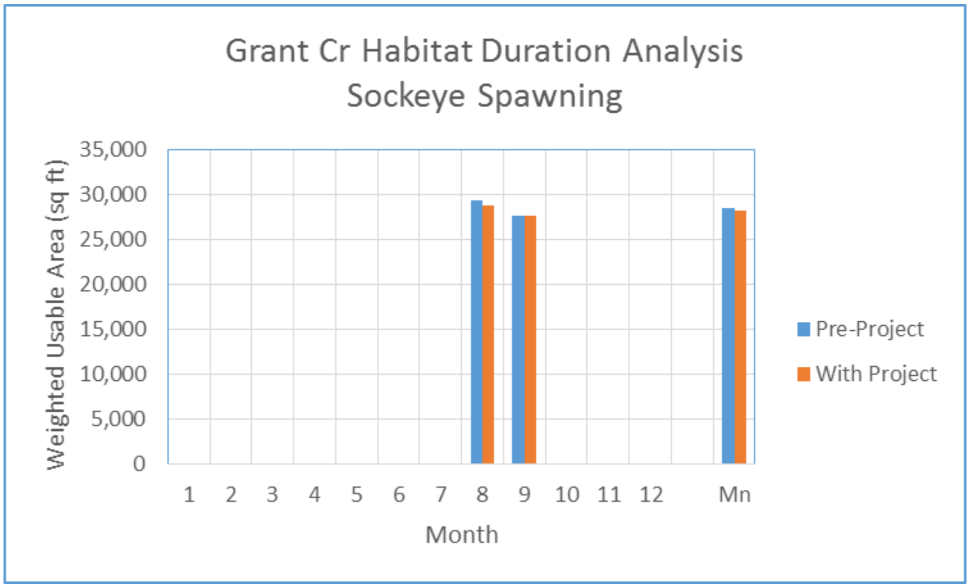

Figure 3.4-7. Sockeye Spawning WUA

3.4.4 Dolly Varden

WUA for Dolly Varden spawning and rearing are shown in Figures 3.4-8 to 3.4-11. With-Project WUA ranged from 96.5% of pre-Project WUA for Dolly Varden adult rearing to 102.9% for Dolly Varden juvenile rearing. Dolly Varden fry rearing post-Project WUA averaged 98.9% of the pre-project WUA, ranging from 94.9% to 100.6%. With-Project spawning WUA was slightly greater than pre-Project WUA (100.3%).

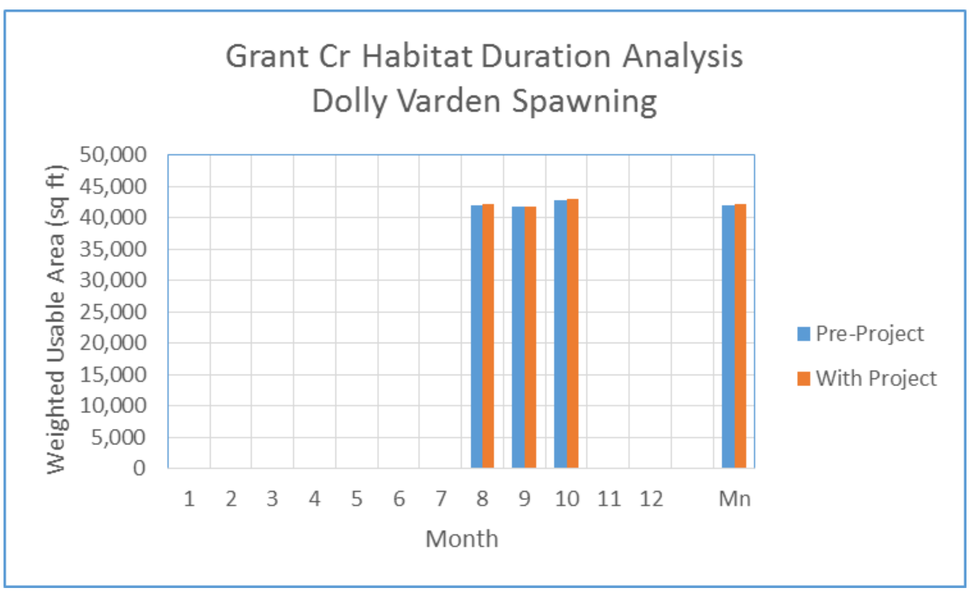

Figure 3.4-8. Dolly Varden Spawning WUA

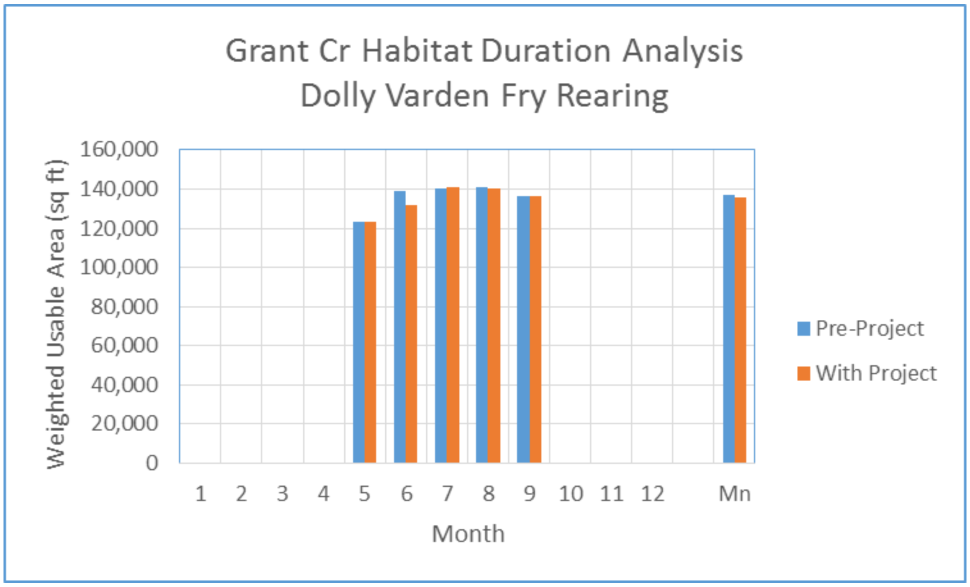

Figure 3.4-9. Dolly Varden Fry Rearing WUA

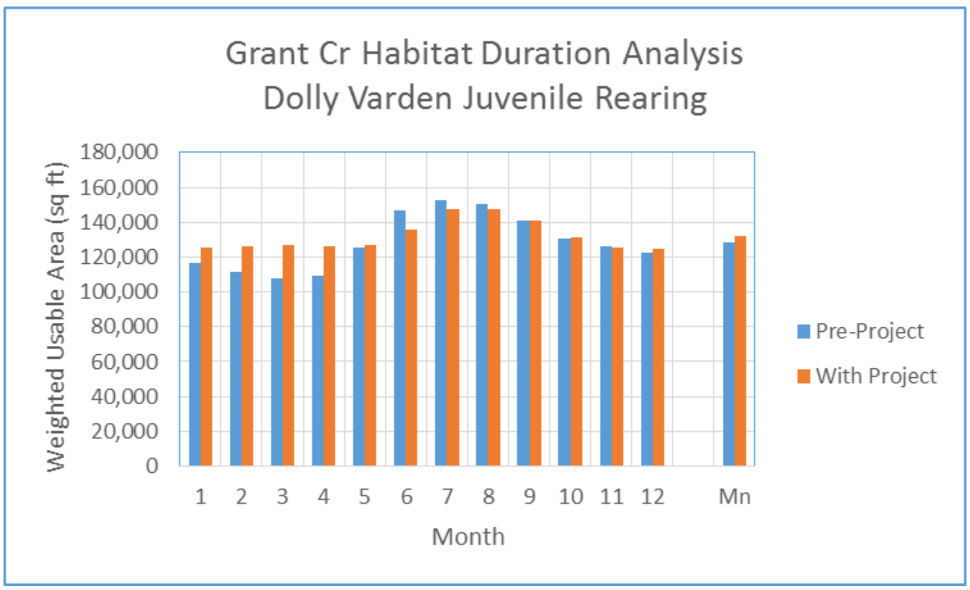

Figure 3.4-10. Dolly Varden Juvenile Rearing WUA

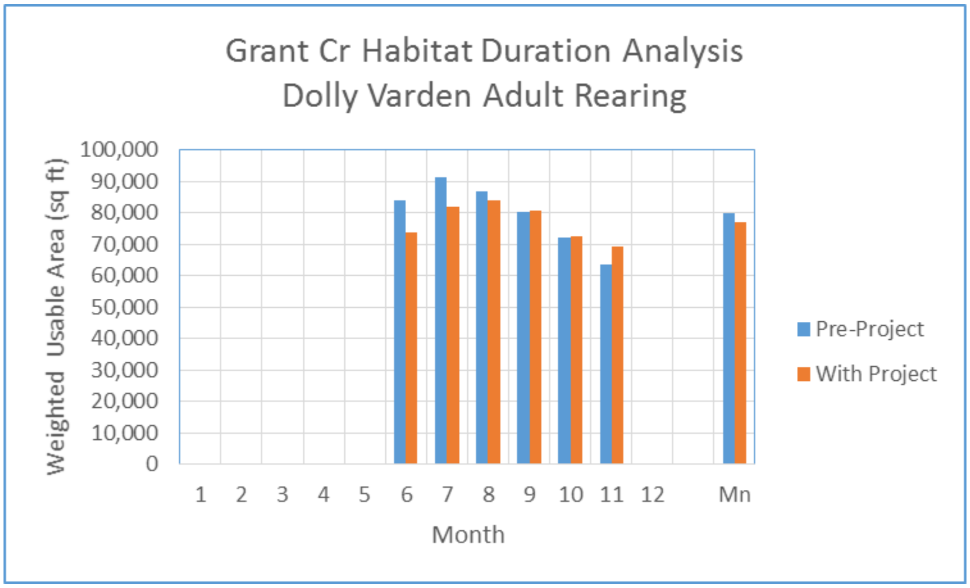

Figure 3.4-11. Dolly Varden Adult Rearing WUA

3.4.5 Rainbow Trout

WUA for rainbow trout spawning and rearing are shown in Figures 3.4-12 to 3.4-15. With-Project WUA ranged from 94.2% of pre-Project WUA for rainbow trout adult rearing to 101.4% for rainbow trout fry rearing. Rainbow trout juvenile rearing with-Project WUA averaged 99.3%, ranging from 88.9% – 106.8% of pre-Project WUA. Rainbow trout spawning with-Project WUA averaged 98.8% of pre-Project WUA, ranging from 98% to 100.1%.

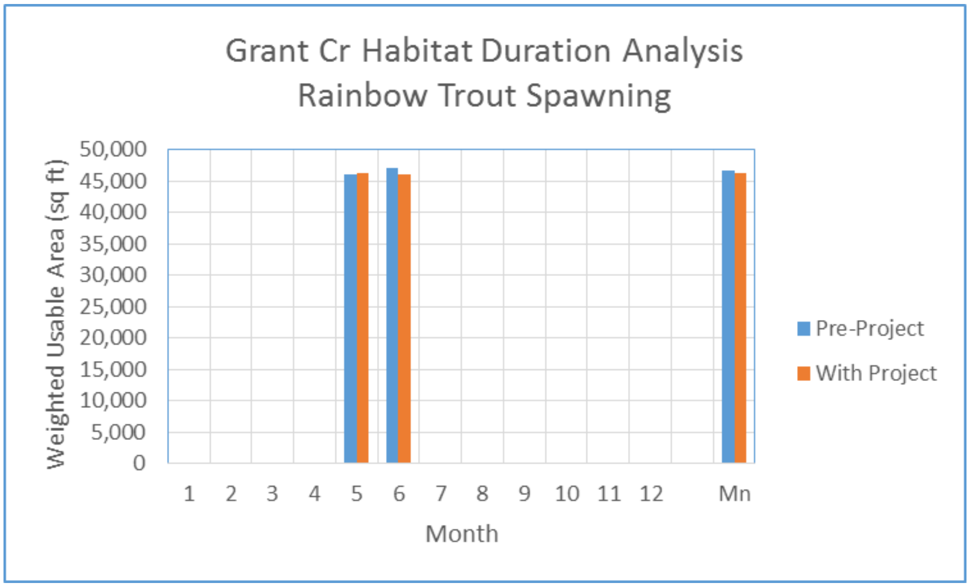

Figure 3.4-12. Rainbow Trout Spawning WUA

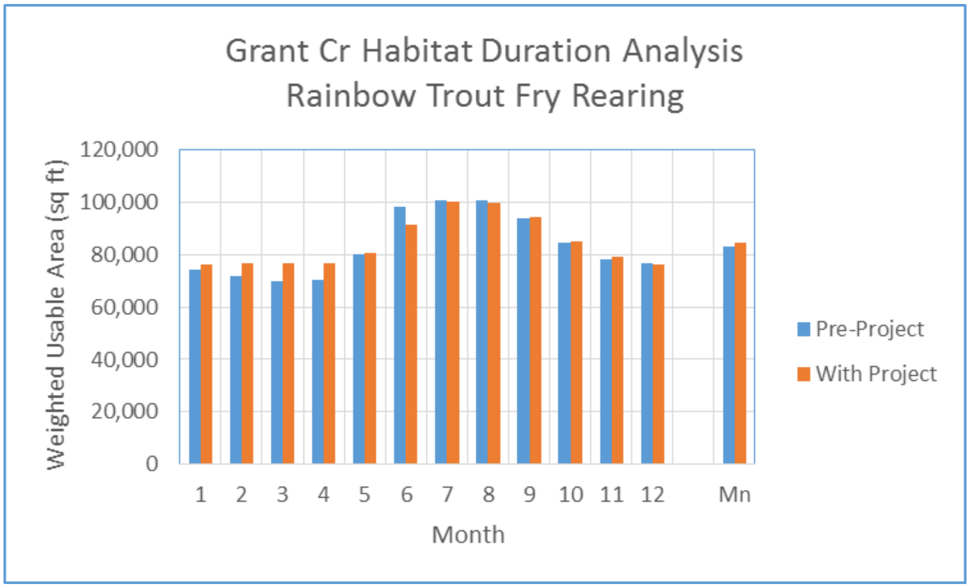

Figure 3.4-13. Rainbow Trout Fry Rearing WUA

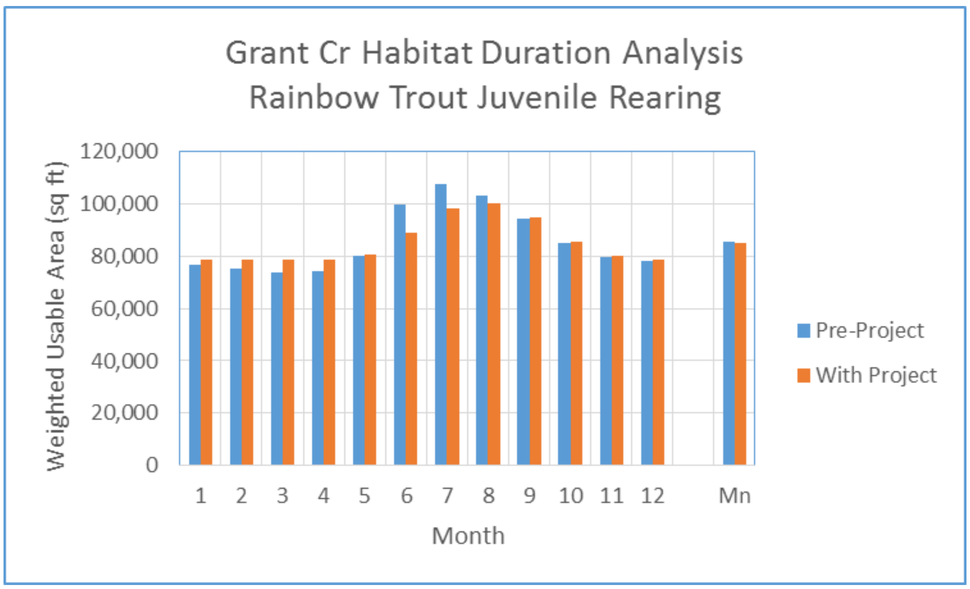

Figure 3.4-14. Rainbow Trout Juvenile Rearing WUA

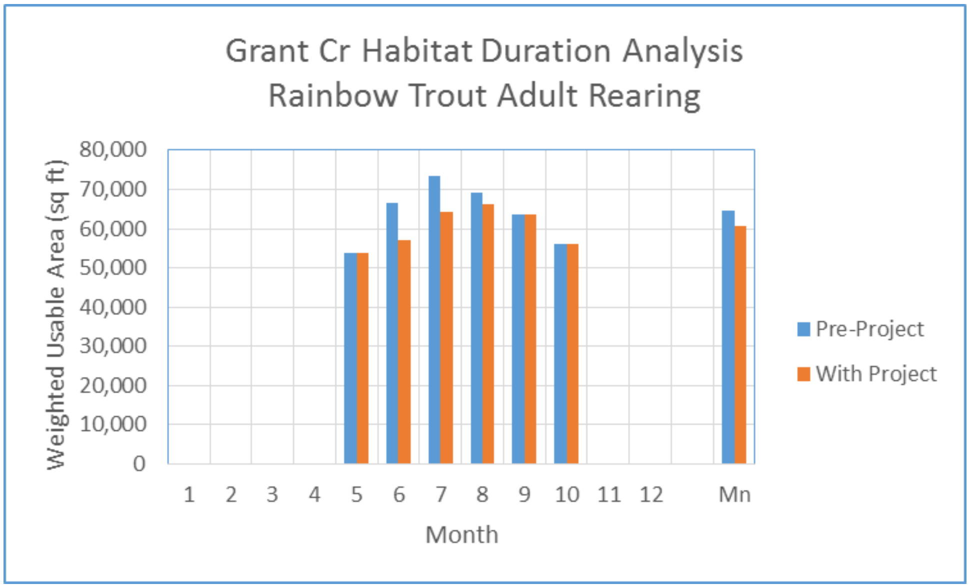

Figure 3.4-15. Rainbow Trout Adult Rearing WUA

3.4.6 Summary

Pre-Project and with-Project WUA for all species and life history stages are shown in Figures 3.4-16 to 3.4-19 and are listed in Table 3.4-1. Overall, with-Project WUA is nearly identical to pre-Project WUA (99.8%). With the exception of resident adult (i.e., Dolly Varden and rainbow trout) with-Project rearing WUA (96.7% of pre-Project WUA), with-Project WUA is within 0.1% or is greater than pre-Project WUA.

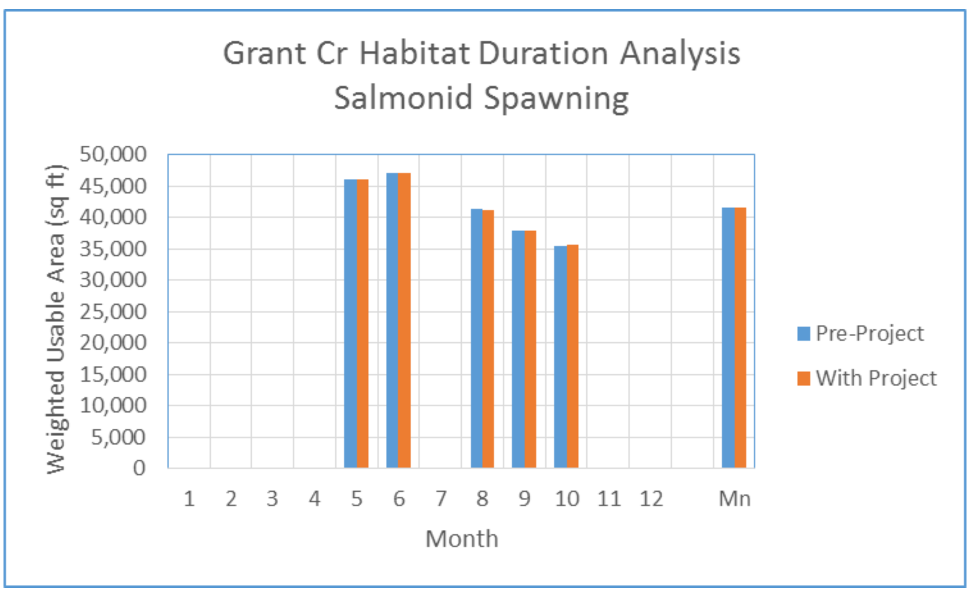

Figure 3.4-16. Salmonid Spawning WUA

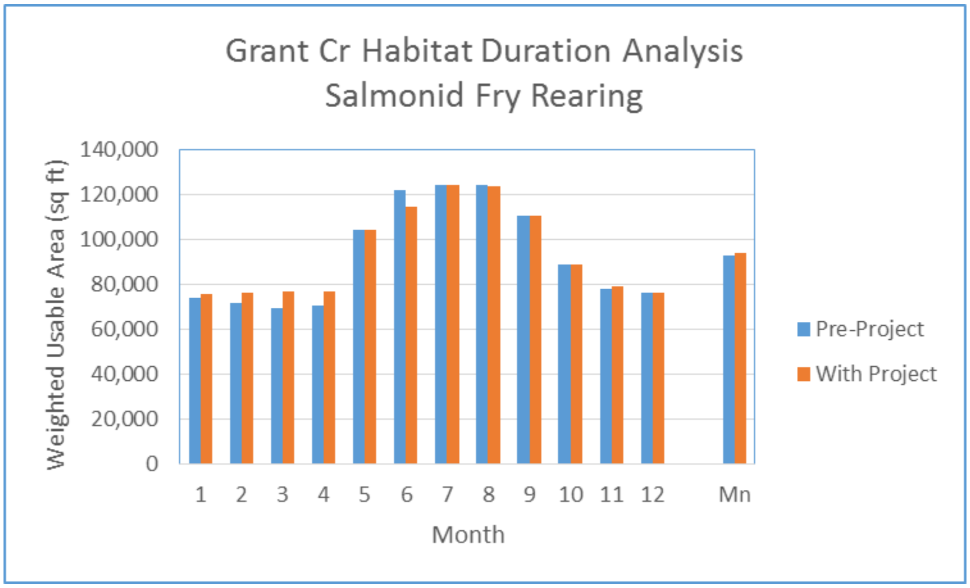

Figure 3.4-17. Salmonid Fry Rearing WUA

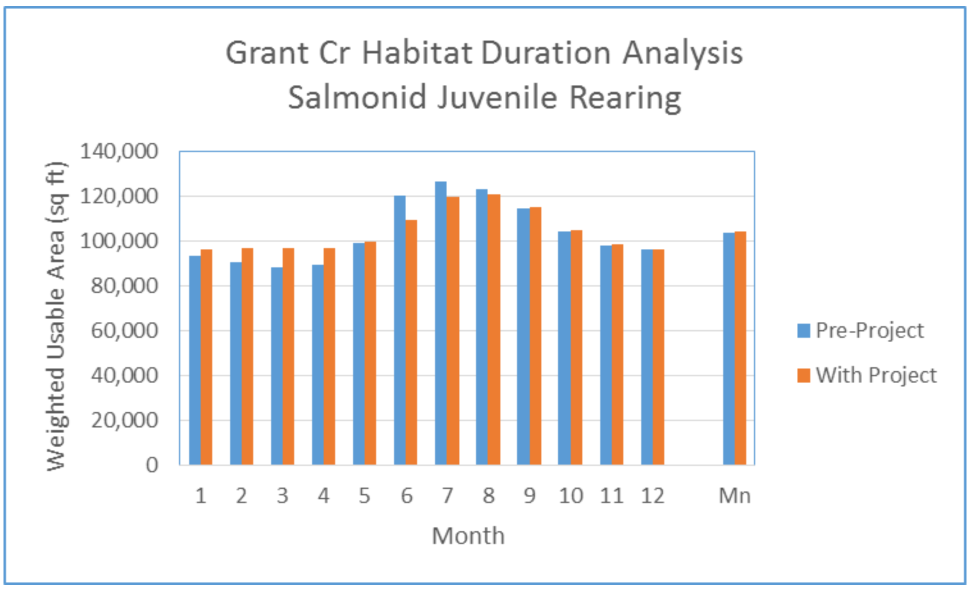

Figure 3.4-18. Salmonid Juvenile Rearing WUA

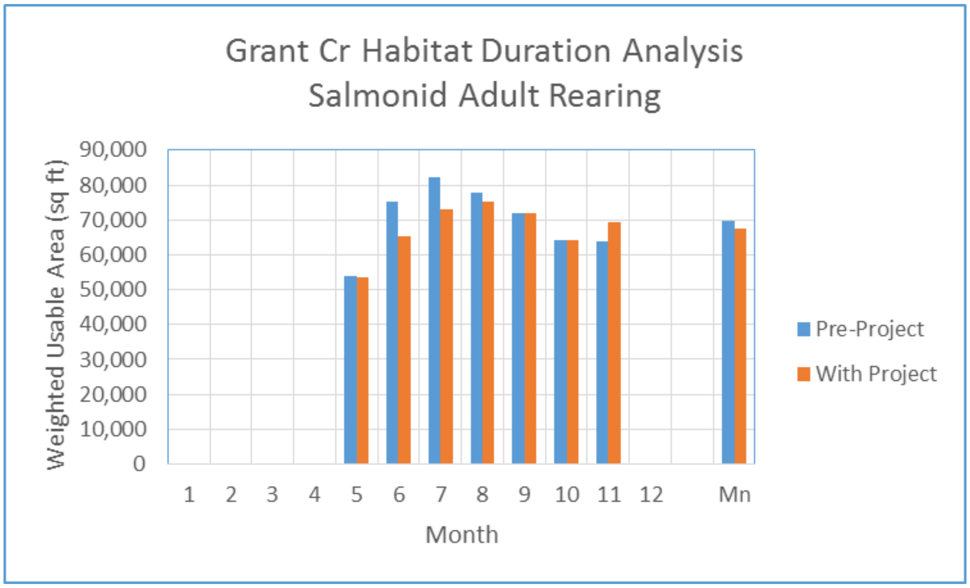

Figure 3.4-19. Salmonid Adult Rearing WUA

Table 3.4-1. Grant Creek pre-Project and with-Project WUA for life history stages.

Life Stage	Weighted Usable Area		
	Pre-Project	**With Project**	**Percentage**
Spawning	41,635	41,607	99.93%
Fry Rearing	93,043	94,060	101.09%
Juvenile Rearing	103,890	104,437	100.53%
Adult Rearing	69,868	67,553	96.69%
Mean	***77,109***	***76,914***	***99.75%***

The analysis provided in this report is based on final transect weighting, final WUA for each species and life history stage, and the 66-year hydrologic record for pre-Project and with-Project flows.

Overall, with-Project WUA is nearly identical to pre-Project WUA, at 99.8%. The lowest with-Project WUA is for Dolly Varden and rainbow trout adult rearing. Adult rearing periodicity for these species extends from mid-May to the end of November. Project flows are reduced during the summer (June – August), which are the reason for lower adult rearing with-Project WUA during this period. If resident fish adult rearing WUA were removed from the analysis, overall with-Project WUA would be 100.6% of the pre-Project WUA.

This analysis does not take into consideration potential mitigation and enhancement measures for the Project. For example, currently the Reach 1 distributary does not become wetted until flows in Grant Creek reach approximately 180 cfs; even when wetted, this distributary receives less than 1% of the Grant Creek flow. If this distributary were to be reconfigured to allow more water into the distributary and at lower Grant Creek flows, WUA for spawning and rearing in this distributary would increase significantly. This proposed enhancement measure, along with documented additional and more consistent flows in the Reach 2/3 side channel complex, will likely increase habitat availability during operations to a level above the current natural condition.

4 LITERATURE CITED

KHL (Kenai Hydro LLC). 2014. Grant Lake Hydroelectric Project (FERC No. 13212). Aquatic Resources – Grant Creek Aquatic Habitat Mapping and Instream Flow Study Final Report. Prepared by McMillen, LLC. June 2014.

Attachment E-3. Terrestrial Resources Study, Final Report Addendum

2014 Wildlife Resources Study Addendum
Terrestrial Resources Study Report
March 2015

1 INTRODUCTION

The 2014 Wildlife Resources Study documents the field work and associated data analysis completed by Kenai Hydro, LLC (KHL) in winter 2013-2014 and spring/summer 2014, respectively. The 2014 field work includes the following: 1) winter use of Grant Lake by moose; 2) winter waterbird use of the open water section of Grant Lake outlet to Grant Creek; and 3) presence of Northern goshawks along the proposed access route. The 2014 Wildlife Studies were conducted in accordance with the approved Study Plan (KHL 2013). This 2014 Wildlife Resources Study is an addendum to the *Grant Lake Hydroelectric Project Terrestrial Resources Study Report, June 2014* (referred to as the 2014 Final Report for the Terrestrial Resources Study; KHL 2014).

The Ebasco (1984) report and the 2013 wildlife studies as well as other readily available sources of information have been assimilated for a better understanding of Grant Lake wildlife resources. Data sources used in the wildlife resources results section are referenced in the 2014 Final Report for the Terrestrial Resources Study.

The subsections that follow provide a summary of the 2014 wildlife studies. The methods, results, and conclusions, as well as a summary of any variances from the 2013 Study Plan are provided for each study component. Relevant data from the previous Project wildlife studies are also incorporated within the relevant section.

1.1. Study Area

The 2014 wildlife study area is identical to that previously defined as the collective terrestrial resources assessment area in Figure 1.2-1 and the general vegetation study area shown in Figure 3.1-1 of the 2014 Final Report for the Terrestrial Resources Study. The Grant Lake area is characteristic of the diverse vegetation mosaic found in the mountainous interior of the Kenai Peninsula. The plant communities in the study area are described in Section 3 and Section 4 of the 2014 Final Report for the Terrestrial Resources Study and include coniferous forests, mixed conifer/deciduous forest, forested shrub communities, grass communities, riparian areas, stream banks, lake margins, and small meadows. This area of the Kenai Peninsula is subject to windthrow; a cataclysmic abiotic factor that can generate an entire new chain of seral plant succession in a given area. Trees already stressed by spruce beetle infestation may be more susceptible to windthrow events. This was evident during the 2013 and 2014 field seasons along the proposed Project access route. Many areas were difficult to traverse due to high concentrations of downed trees. Additional details on the study area can be found in Section 5 of the 2014 Final Report for the Terrestrial Resources Study. Study areas for each of the three 2014 wildlife study components are described below.

1.1.1. Raptor Nesting Survey

The Survey area is defined in the 2013 Study Plan as follows:

- The proposed development footprint of the Project (access roads, transmission line, Grant Creek, Grant Lake, powerhouse, and tunnel) and a buffer of 660 feet around Project development features. The 2014 field efforts occurred within the 2013 wildlife assessment area (see Figure 5.1-1of the 2014 Final Report for the Terrestrial Resources Study, KHL 2014) and focused exclusively on Northern Goshawk Broadcast Surveys along the newly defined Project route, as all other Raptor surveys were deemed complete. Two surveys were conducted in 2014 to complete the two year sampling period.

1.1.2. Waterbirds

The study area for wintering waterbirds is defined in the 2013 Study Plan as follows:

- The survey area for wintering waterbirds is located within the 2013 wildlife assessment area (see Figure 5.1-11of the 2014 Final Report for the Terrestrial Resources Study, KHL 2014) at the southern-most portion of Grant Lake at the source of Grant Creek. Two surveys were flown during the winter of 2013 - 2014.

1.1.3. Terrestrial Mammals

A study area was not defined specifically for mammals in the 2013 Study Plan (KHL 2013). Two winter surveys of the study area were conducted to determine the presence and travel paths of moose during the winter 2013 - 2014.

The 2013 - 2014 Moose Survey area was located within the 2013 wildlife assessment area (see Figure 5.1-1 of the 2014 Final Report for the Terrestrial Resources Study; KHL 2014) and included the area east of the Seward Highway and Alaska Railroad adjacent to the community of Moose Pass, extending past the eastern shoreline of Grant Lake. The Moose Survey area extended south between the highway and Grant Lake to Grant Creek, and included all Project facilities along Grant Lake, Grant Creek, and access road and transmission line routes.

1.2. Methods

The study method specific to each component of the 2014 Wildlife Studies Addendum, respectively, are described in the 2014 Final Report for the Terrestrial Resources Study (KHL 2014). A summary of methods used for the 2014 surveys is provided below.

1.2.1. Raptor Nesting Survey

2014 Northern Goshawk Broadcast Surveys - A ground-based survey for Northern goshawk territories was conducted along all linear Project facilities (access road, transmission line, powerhouse, detention pond, tailrace, intake, and penstock). The 2014 effort sampled the same fifteen points surveyed in 2013. The 2014 survey methods utilize the same methods used for the 2013 study effort; the U.S. Forest Service (USFS) Survey Methodology for Northern Goshawks in the Pacific Southwest Region (2000) and Woodbridge and Hargis (2006). Appendix 3b of the

2014 Final Report for the Terrestrial Resources Study contains further information about the Northern Goshawk Survey (KHL 2014).

1.2.2. Waterbirds

2013- 2014 Winter Waterbird Surveys–In order to determine if this area is being utilized by waterbirds during the winter period, wildlife biologists conducted an aerial survey of the Grant Lake outlet area in December 2013 and March 2014 to document waterbird use and the amount of open water habitat available. Biologists documented species, and number of individuals during the daylight survey.

1.2.3. Terrestrial Mammals

2013-2014 Winter Moose Surveys– Managers suspect that many moose depart the area in the late fall and winter in the Trail river drainage as well as the northeast portion of Grant lake through the low pass into Moose Creek (Selinger personal communication, August 2013). Two winter aerial surveys of the study area were conducted to determine the presence and travel paths of moose during the winter 2013- 2014. The first of the two Winter Moose surveys was conducted in December 2013, the second in March 2014. Surveys used methods for full coverage of the study area as described in detail in Gasaway et al. (1986).

1.3. Results

The following subsections present the results of the 2014 Wildlife Study effort as well as relevant data from the Ebasco (1984) and the 2013 Wildlife studies.

1.3.1. Northern Goshawk Survey

2014 Northern Goshawk Broadcast Surveys - Two separate survey events were conducted in 2014: the first on June 25 and the second on July 9 and 10, 2014. No Northern goshawks were detected during the surveys. The 2014 effort sampled the same fifteen points surveyed in 2013.

2014 Incidental Raptor Sightings – An adult bald eagle was observed flying over Lower Trail Lake on June 25, 2014; a pair of adult bald eagles was observed perched along Lower Trail Lake on July 10, 2014.

A merlin was detected on June 25, 2014, during the first field visit in the vicinity of the small island just south of the Trail Lake narrows, and again during the second field visit July 9 and 10, 2014.

Compilation of 2014 and 2013 Results – One adult female Northern goshawk was detected during the 2 year sampling period in 2013. The habitat in which it was detected has been described previously in the 2014 Final Report for the Terrestrial Resources Study (KHL 2014).

Lack of detection of this species does not indicate absence. Nesting goshawks are highly mobile and secretive. Positive detections that include vocal / visual responses are easily interpreted, whereas “no-detection” or negative data are difficult to prove (Woodbridge and Hargis 2006).

USDA (2000) discusses the disadvantages of broadcast acoustic surveys, including low detection rates. Low detection may be attributed to the ineffectiveness of eliciting responses at nonbreeding and or failed sites, and distance between call point and active nests. USDA (2000) suggests that response rates are lower and more highly variable at territories with failed reproductive attempts, and particularly at territories with non-breeding adults, relative to territories with active and successful nests.

In conclusion, the 2014 and 2013 surveys cannot conclusively determine the absence of Northern goshawks / nests or breeding territories along the access route. Suitable nesting and foraging habitat exist in the survey area and may be utilized by this species. This species is a year-round resident of the Chugach National Forest (USFS 1984). The majority of Northern goshawk nests discovered on the Seward Ranger District have been documented in old growth hemlock-spruce stands characterized by a closed canopy, large average diameter, gap regeneration, and an open understory (USFS 2008).

Additional 2014 Incidentals – Species that were observed incidentally during the 2014 field season include: Varied thrush, Lincoln's sparrow, orange-crowned warbler, hermit thrush, Swainson's thrush, Townsend's warbler, slate-colored junco, common raven, white-winged crossbill, yellow-rumped warbler, ruby-crowned kinglet, boreal chickadee, alder flycatcher, Wilson's warbler, fox sparrow, brown creeper, common loon, mew gull, pine siskin, pine grosbeak, yellow warbler, redpoll species, gray jay, goldeneye female with two chicks, red-breasted merganser, savannah sparrow, American robin, Arctic tern, and an American beaver.

1.3.2. Winter Waterbird Survey

Christmas bird count data from Moose Pass (1983, 1984 and 1985) list the following species in the region of the project area during the winter: Barrow's goldeneye, bufflehead, common goldeneye, common merganser, mallard and Northern pintail. Cumulative Christmas bird count data from Seward (30+ years) list: Trumpeter swan, gadwall, American green-winged teal, American wigeon, mallard, grater scaup, lesser scaup, harlequin duck, surf scoter, white-winged scoter, black scoter, long-tailed duck, bufflehead, common goldeneye, Barrow's goldeneye, hooded merganser, common merganser, red-breasted merganser, common loon, Pacific loon, red-throated loon, yellow-billed loon, horned grebe and red-necked grebe. Ducks can be categorized as "puddle ducks" or "diving ducks." Puddle ducks frequent shallow water areas such as marshes, ponds, and creeks and nest on adjacent dry uplands. Puddle ducks generally feed in shallow water on the seeds and tubers of aquatic plants, grass, and insects. Mallards and American widgeons are puddle ducks. Diving ducks or waterbirds including goldeneyes, mergansers and loons are primarily observed on the larger and deeper ponds, lakes, and rivers; feeding by diving for a variety of aquatic animals and plants. Scoter and grebe species, hooded mergansers, gadwalls, buffleheads and long-tailed ducks have not been documented on Grant Lake during any month by any study.

Open water winter waterbird surveys were flown in conjunction with the moose surveys on December 4. 2013 and March 27, 2014. The survey area has been defined previously, and was documented as a winter feeding area for a flock of mallards during the 1981-1982 field studies (Ebasco 1984). Open water habitat that supports waterbirds in the Seward Ranger District is limited during the winter (Benoit 2009).

December 4, 2013 Survey – During the December 2013 survey open water was limited to the south end of Grant Lake (Figure 1), and the Trail Lake narrows between Upper and Lower Trail Lakes (Figure 2). The remainders of Grant Lake, and Upper and Lower Trail lakes were ice-covered. A pair of trumpeter swans and one unidentified merganser species were the only waterfowl (total = 3) observed in the open water section at the south end of Grant Lake (Figure 3). No waterfowl were observed in the open water of the Trail Lake narrows.

Figure 1. December 4, 2013, open water at the south end of Grant Lake

Figure 2. December 4, 2013, open water in the Trail Lake narrows

Figure 3. December 4, 2013, location of the swans and merganser species at the south end of Grant Lake

March 27, 2014 Survey – During the March 2014 survey open water was again limited to the south end of Grant Lake (Figure 4). No waterfowl were observed on Grant Lake. However, five trumpeter swans and several unidentified diving ducks were detected in the open water area on the north portion of Lower Trail Lake just below the narrows (Figure 5). Several unidentified divers were also detected in the open water of the Upper Trail Lake south of Moose Pass. Open water conditions on Upper Trail Lake are shown in Figure 6.

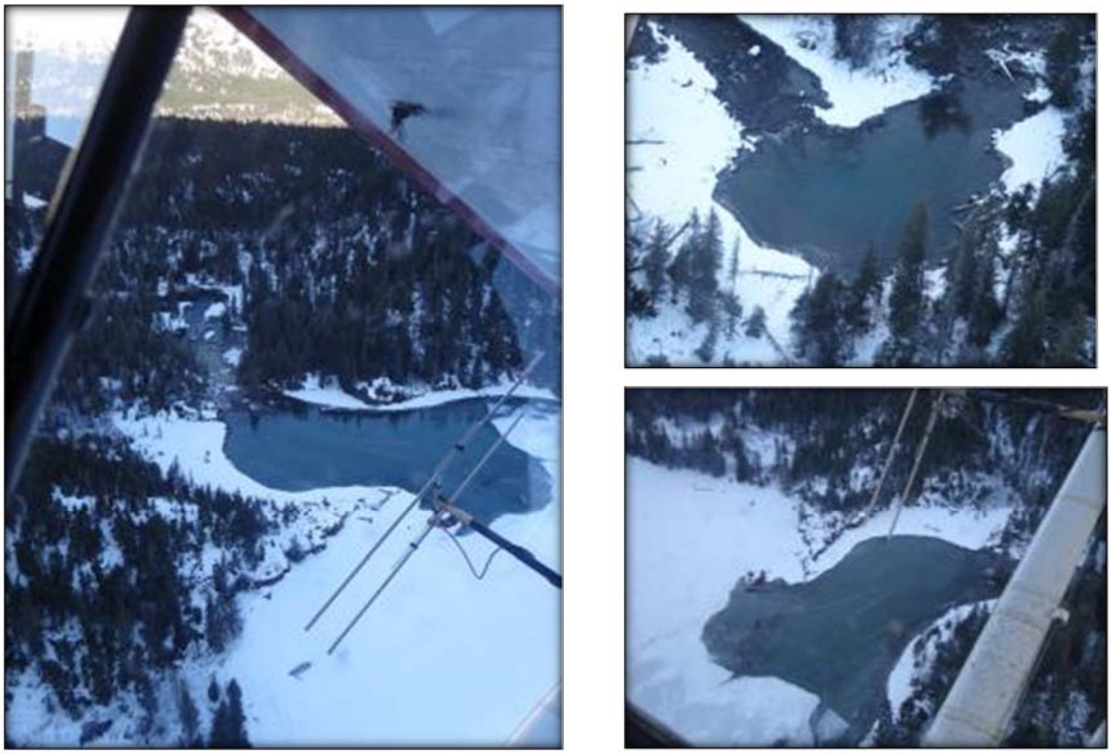

Figure 4. March 27, 2014, open water on Grant Lake

Figure 5. March 27, 2014, trumpeter swans and unidentified waterfowl on Lower Trail Lake

Figure 6. March 27, 2014, open water on Upper Trail Lake

Compilation of Results - Trumpeter swans were detected on March 3, 2013, on the east side of Lower Trail Lake (K. Graham personal communication April 23, 2013). It is purported that these birds over winter in this area. Apparently the location remains ice-free due to the high pressure of water flow through the Trail Lake narrows.

The 2013 – 2014 survey data support the suggestion that Grant Lake and narrows area between the Trail Lakes provide overwintering habitat to waterbirds. Merganser and goldeneye species feed primarily on aquatic invertebrates (goldeneyes) and crustaceans and fish (merganser). Ebasco (1984) documented the availability of the following aquatic food resources for diving ducks in Grant Lake: *Diptera*, *Plecoptera*, *Tricoptera*, *Bivalvia*, *Gastropoda* and *Gammaridae*. Prey concentrations and availability may provide wintering opportunities on Grant Lake and the Trail Lakes; however, the extent of the prey availability is unknown.

Trumpeter swans feed primarily on submerged vegetation. Grant Lake and the narrows may or may not provide foraging habitat for this species, but their presence in these area indicate that the swans are benefiting from the open water habitat in some way.

1.3.3. Winter Moose Surveys

Wintering moose in the Project area have specific habitat requirements including: 1) cover (shelter) from weather and predators; 2) food for nourishment; and 3) space to obtain food. Moose use cover for shelter against weather and predators. Thermal cover is used to help moose control their body temperature, especially during extreme weather and temperatures in winter. Wildlife diet selection is driven by the quantity and quality of available food in concert with the nutritional needs of the animal. Herbivores may become nutritionally stressed by a lack or shortage of food (quantity) or by a lack of highly nutritious food (quality) especially in winter.

Each wildlife species requires a certain amount of space to avoid or escape potential predators, obtain sufficient food for survival, and rest. Space requirements protect behavioral and social responses that ensure an animal's well-being. Wildlife space requirements vary by species, but, generally, the amount of space required is determined by the quantity and quality of food, and cover (habitat) found in an area. Other factors affecting space needs of wildlife include how large the animal is (larger animals require more space); the animal's dietary preferences (carnivores generally require more space than herbivores); and how well the animal can withstand crowded conditions. Space requirements (as a function of habitat quantity and quality) essentially determine the carrying capacity of the site for wildlife.

Moose surveys were flown in conjunction with the open water winter waterbird surveys on December 4, 2013 and March 27, 2014. The survey area has been defined previously.

December 4, 2013 Survey – No moose were observed during the survey. One large "digging" site was observed and photographed on the slope at the North end of Grant Lake (Figure 7). Tracks at this site were large, but both pilot and observer could not 100 percent verify that the site was disturbed by moose, as mountain goats tend to shuffle as they walk through snow creating large tracks. The digging site was estimated to have been created within the last seven days of the survey. Other than this site, there were no moose tracks observed anywhere in the 2013 Grant Lake wildlife study area. Grant Lake was completely snow free during the December survey (Figure 8). Any sign of movement across the lake as evidenced by tracks were non-existent.

Figure 7. December 4th 2013, digging site north end of Grant Lake

Figure 8. December 4th 2013, Grant Lake was snow free during the survey

March 27, 2014 Survey – No moose were observed in the 2013 Grant Lake wildlife study area during the survey. A cow and yearling pair were detected up the watershed from the Grant Lake Inlet (Figures 9 and 10), outside the study area. Moose tracks were detected on the East-West upper lake portion of Grant Lakes. The tracks crossed North-South/ South-North (Figure 9). Direction of travel could not be determined as the tracks were old and refrozen after being set in "slushy" conditions. Cover conditions indicated the current snow layer was very old; showing signs of repeated thawing and freezing. This type of snow often forms a very hard crust even a moose can walk over without leaving tracks.

Snow conditions on Grant Lake varied between the upper (east-west oriented section) and the lower (north – south oriented section) lake (Figure 11). The upper section exhibited repeated freeze / thaw characteristics. The only moose tracks found during the surveys appeared to have been made during a thaw / warm period on the lake as the tracks were estimated to be sunk 6-12" into the ice. During the survey, the ice appeared to be re-frozen. The lower section retained a deeper snow load, and did not appear to have experienced a freeze / thaw process at the time of the survey. This section of the lake was not subject to the prolonged sun exposure that the upper lake was experiencing during the spring.

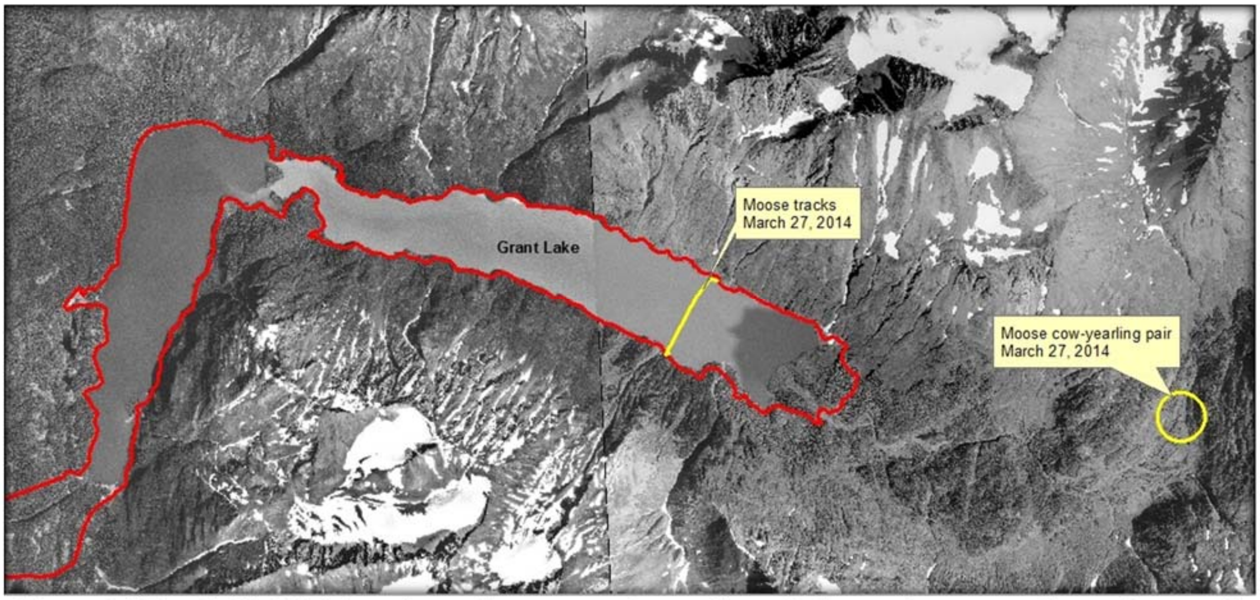

Figure 9. March 27, 2014, locations of moose tracks on Grant Lake, and cow- yearling pair east of Grant Lake inlet. Study area drawn in red.

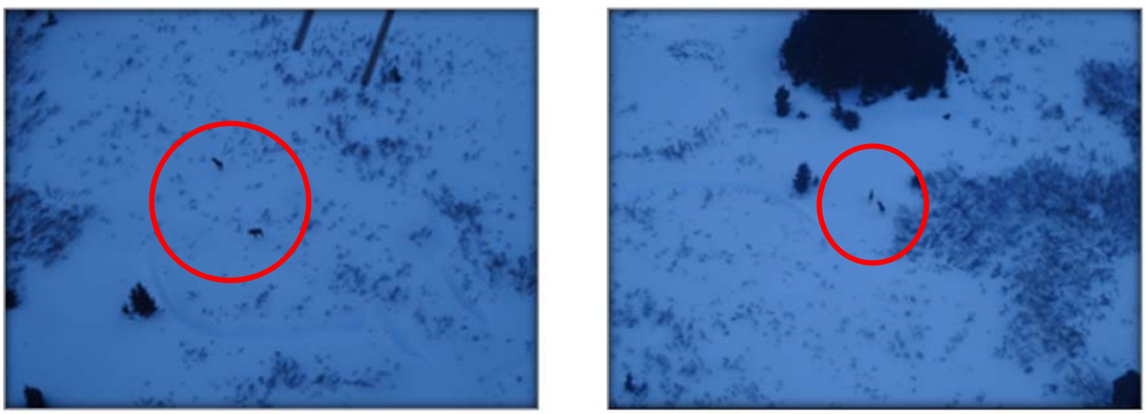

Figure 10. March 27, 2014, moose cow-yearling pair observed at location in Figure 9

Figure 11. March 27, 2014, snow conditions on Grant Lake during survey. Left photo: upper section, ice covered but snow free. Right photo: lower section, deeper snow load.

Compilation of Results –Primary limiting factors for moose in Alaska and the Kenai Peninsula are the availability of winter range, predation, collision mortality from vehicles and trains (Lottsfeldt-Frost 2000), and distance between feeding and hiding/ thermal cover (Renecker and Schwartz 1998). Chugach National Forest GIS data indicated that high-quality habitat is primarily in riparian areas along the river valleys, and is distributed throughout the Trail River watershed on all but the highest elevations (USFS 2008). The Alaska Department of Fish and Game (ADF&G) considers the overall habitat on the Seward Ranger District to be of low quality and capable of supporting only 2 to 5 moose per square mile (USFS 2008). ADF&G designate the moose density in GMU 7 as "chronically low" and that the severe winters coupled with deep snow conditions most likely contribute to high mortality rates in this area (McDonough 2010). USFS (2008) predictive modeling of moose winter range is displayed in Figure 5.3-6 of the 2014 Final Report for the Terrestrial Resources Study (KHL 2014). Results from the 2013 - 2014 Winter Moose surveys appear to support ADF&G's opinion of low moose numbers in the study area during the winter. There were no moose or tracks observed within the USFS (2008) predicted wintering habitat during the 2013 – 2014 aerial surveys; however lack of detection of moose during the two surveys does not indicate absence of moose in the study area during the winter.

1.4. Conclusions and Potential Impacts

This report provides an addendum to the 2014 Final Report for the Terrestrial Resources Study (KHL 2014). The objectives of the addendum are to:

- Ascertain the winter use of Grant Lake by moose;
- Delineate the winter waterbird use of the open water section of Grant Lake outlet to Grant Creek; and
- Detect the presence of Northern Goshawks along the proposed access route.

Wildlife presence in the Project area is contingent on many variables including habitat. Habitat is comprised of resources (water, food, and shelter) and environmental requirements (temperature, predators, and competitors) that determine the presence, survival, and reproduction of a species. Wildlife exhibits a propensity to occupy those habitats that provide the resources to fulfill the requirements necessary for the continuance of that species.

Potential impacts of the proposed project on Northern goshawks, winter waterbirds, and winter moose, are described below. Impact assessments will be refined based upon engineering feasibility work that will document infrastructural locations in relation to habitat for the species mentioned in this addendum, and will be included in the Draft License Application(DLA).

1.4.1. Northern Goshawks

Potential Impacts to Northern Goshawks have been stated in the 2014 Final Report for the Terrestrial Resources Study (KHL 2014).

1.4.2. Winter Waterbirds

Potential Impacts to Waterfowl - Changes in lake and creek outflow levels during the winter may indirectly impact waterfowl and waterbirds like trumpeter swans and diving ducks by decreasing or altering open water habitat at the mouth of Grant Creek and the outflow at the narrows. Decreased open water availability may lead to decreased resting and foraging habitat during the winter season.

Waterfowl that overwinter in the region and spend time on waterbodies in this area of the Kenai Peninsula are currently subject to the natural freeze up / thaw processes during the winter. The possible project related alterations to open water habitat are not predicted to impact the overall waterfowl population of the Kenai Peninsula.

1.4.3. Winter Moose

Potential Impacts to Moose – Changes in lake levels during the winter may indirectly impact moose by altering travel routes across Grant Lake. Altered lake levels may impact ice thickness necessary for transit. Moose density in this region of the Kenai Peninsula has been documented as low (McDonough 2010). The possible Project related alterations habitat are not predicted to impact the overall moose population of the Kenai Peninsula.

1.5. Variances from FERC-Approved Study Plan and Proposed Modifications

The 2013 - 2014 wildlife resources effort followed the March 2013 Study Plan objectives and methodologies. There are no variances to report.

2 LITERATURE CITED

All other references can be found in the Literature Cited section of the 2014 Final Report for the Terrestrial Resources Study.

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