TECHNICAL MEMORANDUM 003

McMILLEN, LLC

To:	Mike Salzetti, HEA	Project:	Grant Lake Hydroelectric Project
From:	Cory Warnock	Cc:	Mort McMillen, Andre Ball, John Blum
Date:	June 27, 2014	Job No:	13-102
Subject:	Grant Lake Hydroelectric Project Operations and Fisheries Habitat		

1.0 INTRODUCTION

McMillen, LLC (McMillen) has been retained by Homer Electric Association (HEA) to provide licensing, natural resource and engineering support for the proposed Grant Lake Hydroelectric Project (Project) FERC License Application. The project would be located near the city of Moose Pass, Alaska, approximately 25 miles north of Seward, Alaska.

A suite of natural resource studies (fisheries, water resources, terrestrial, cultural and recreation/visual) were developed in collaboration with Stakeholders in 2012 and implemented in 2013 and 2014. While comprehensive and quantitative in their own right, these studies were further supplemented by data collected by HEA data in 2009/2010, as well as historical natural resource data collected on Grant Creek. Simultaneous with the natural resources work, HEA has been refining the Project infrastructural description and carrying out the engineering analyses required to accurately define the operational aspects of the project in preparation for License Application submittal.

1.1 Purpose and Scope

The purpose of this technical memorandum (TM) is to present HEA's proposed Grant Lake Hydroelectric Project operations, instream flow regime in Reach 5, and to discuss the potential impacts to fisheries and instream flows on Grant Creek. The operations analysis presented within this TM build upon previous studies. The scope of information presented in this TM is as follows:

- Summary of Grant Lake fisheries and water resources
- Proposed project infrastructure
- Proposed project operations and energy generation analysis
- Project impacts to fisheries habitat and instream flows

2.0 GRANT CREEK FISHERIES AND WATER RESCOURCES

Grant Creek is the only natural outlet from Grant Lake and is located at the south end of the lake (Figure 1, Appendix A). Grant Creek flows west from Grant Lake for about a mile before flowing into the Trail Lake Narrows. During the 2013/2014 natural resource studies, Grant Creek was divided into six different reaches (Reaches 1-6, Figure 1). All anadromous species are precluded from upstream movement into Grant Lake by an impassible falls located at the Reach 5 – Reach 6 transition. The only resident fish species that reside in Grant Lake are sculpin and stickleback. An extensive set of fisheries investigations were conducted in 2013, which documented four anadromous species of salmon (Chinook, Sockeye, Coho and Pink salmon) along with Rainbow trout and Dolly Varden char in Grant Creek. Species of sculpin and stickleback were also documented in Grant Creek.

Grant Creek experiences large variations in flow on a seasonal basis due to snowmelt in the early summer (June/July) and rainfall events later in the summer/fall. Minimum flows in late winter typically range between 15-20 cubic feet per second (cfs), while peak flows in the summer or fall exceed 1000 cfs frequently. The primary sediment input for Grant Creek is associated with the shearing of extremely angular material during episodic high flow events through the steep-walled canyon in Reach 5. Given the relatively low quality of the overall substrate composition in Reaches 1-4, spawning tends to be opportunistic and focused on areas where pockets of higher quality spawning substrates exists. Rearing tends to be associated with stream margins and a few primary side channels that exist.

Table 1 (Appendix A) documents the periodicity for the various life stages of the fish species discussed above, along with relevant Grant Creek streamflow statistics.

2.1 Fisheries and Habitat

Grant Creek is a high gradient stream with high streamflow velocities. High flows and velocities limit the amount of large woody debris (LWD) retained in the system, since there are only a few places where LWD will collect in the main channel. Most wood is found in the distributary and the Reach 2/3 side channels, where flows are greatly reduced and are protected from the main discharges in Grant Creek. The system is dominated by riffles in the lower four reaches and cascades in Reach 5. Pools are also generally lacking in the mainstem. As with LWD, the exception is in the side channels and distributary. The other major habitat found with some abundance is undercut banks, primarily in Reaches 1 and 4 (see Tables 2 and 3).

Low winter flows may affect incubation and winter rearing of juveniles and fry. Side channels, which provide excellent rearing habitat for juvenile fish, are either dry at lower flows (in the case of the distributary in Reach 1), or have extremely low flows during winter time (in the Reach 2/3 side channels) and may freeze. Spawning substrate throughout lower Grant Creek (Reaches 1 – 4) is limited, and salmonid spawning may be more a function of suitable substrates than preferred depths and velocities. Since much of the preferred substrates are found along the stream margins where they are dropped during high flows, eggs deposited along the banks at high flows may be subject to desiccation when those high flow recede. This may be a factor

especially early during the spawning period for Chinook and Sockeye salmon when they spawn on the receding hydrograph (see periodicity and hydrology data in Table 1 of Appendix A).

Table 2. 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 3. 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 (OHV)	10,096	302	0	0	0	0	0	0	2,455	7,339	0	0
UCB	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

2.2 Hydrology

The streamflow record utilized for the Grant Creek habitat assessment and energy analysis is a combination of recorded streamflow and record extension. Grant Creek has an 11-year USGS streamflow gage record for water years 1948-1958 at USGS gage 15246000. Intermittent streamflow monitoring was conducted in 1981-83, 2009 and from 2013 to present. A record extension was performed based on the USGS gage 15258000, Kenai River at Cooper Landing, record. A composite streamflow record was created for Grant Creek that represents of 66 years of daily streamflow data for calendar years 1948 through 2013. The Grant Creek hydrology and streamflow records are discussed in greater detail in a separate technical memorandum, TM001 Grant Creek Hydrologic Analysis (McMillen, 2014).

Monthly streamflow statistics for the Grant Creek composite record are provided in Table 1 of Appendix A. Based on the average annual hydrograph, flows are lowest, around 34 cfs, in Grant Creek during March and April. Flows begin to rise in May and June due to snow melt and tend to peak in July (503 cfs). Flow values then taper off by an order of magnitude from August through February (444 cfs to 43 cfs).

3.0 PROPOSED PROJECT INFRASTRUCTURE

As outlined in HEA's 2011 application for a preliminary permit, the proposed Project consists of constructing a new 5-Megawatt (approximate) hydroelectric facility on Grant Lake and Grant Creek near Moose Pass, Alaska. The new Project would divert water from Grant Lake and deliver the flow to a powerhouse located near the outlet of the existing Grant Creek natural, incised rock canyon downstream from Reach 5. The Project would include the following major components:

- An intake structure in Grant Lake.
- A tunnel extending from the lake intake to just east of the powerhouse.
- A penstock and surge tank located at the west end of the tunnel.
- A powerhouse with two Francis turbines providing an anticipated combined 5-Megawatt output. The maximum design flow will be approximately 385 cfs.
- Tailrace detention pond.
- Switchyard with disconnect switch and step-up transformer.
- An overhead or underground transmission line.
- Access road from the Seward Highway to the powerhouse and extending up to the intake structure at Grant Lake.
- A pole mounted disconnect switch where the transmission line intersects the main power distribution line.

The layout has been revised to minimize the Project footprint. The current design omits the construction of a diversion structure (dam) at the outlet of Grant Lake. All 13-feet of storage that will be utilized for power generation will be drawn from below the natural lake outlet. The tailrace channel, which returns flow from the powerhouse to Grant Creek, will be located at the upstream of Reach 4. This tailrace location ensures that the reaches with the best natural habitat for fish will

not be dewatered. The detention pond will be utilized to allow the powerhouse to meet the spinning reserve without resulting in drastic changes to in-channel flows.

4.0 PROPOSED PROJECT OPERATIONS

The proposed Project operations will utilize Grant Lake as a natural storage reservoir. This will allow the Project to regulate the lake outflow, which will result in year round power generation and consistent instream flows. On a typical year, Grant Lake will be operated following a rule curve. The rule curve will maintain the lake at the full level from mid-August through October. Beginning in November, when natural runoff begins to taper off, the lake level will be drafted to provide additional power generation. The lake will be lowered by a maximum of 13 feet during winter. In late spring and through mid-summer, the lake will be refilled with snowmelt runoff.

The regulated outflow from Grant Lake will be run through the powerhouse. With two, asymmetrically-sized turbines, the Project will be able to efficiently generate power over a range of discharges. After passing through the powerhouse, the flow will be returned to Grant Creek at the upstream end of Reach 4. In order to maintain a wetted channel throughout Grant Creek, instream flow releases are proposed for the Reach 5 and 6 section between Grant Lake and the powerhouse. The proposed instream flow releases would provide 10 cfs in Reach 5 during the Chinook spawning period and continue to provide 7 cfs through the Coho spawning period. During the remainder of the year, 5 cfs would be passed through Reach 5.

An energy generation model was developed to simulate the Project under these proposed operations. Utilizing the average daily inflows from the composite record, the anticipated annual energy production would be 19,500,000 kilowatt-hours. Table 4 (Appendix A) summarizes the average weekly flows in Grant Creek, with and without the Project.

5.0 PROJECT IMPACTS TO FISHERIES HABITAT AND INSTREAM FLOWS

The flow regime, as proposed, would increase winter flows while decreasing the peak flows found during snow melt and episodic rain events throughout the year. The Project, as proposed to be operated, would provide more stable flows throughout the year. Winter flows (November – February) would be increased over natural flows. The Project would closely mimic natural flows during March, April, September, and October. The Project would reduce mean flows during June, July and August period (Table 4).

Based on the proposed operational regime, the implications to the instream flows for Reach 5 and Reaches 1-4 are described below.

5.1 Reach 5 Instream Flows

HEA proposes to provide an instream flow through Reaches 5 and 6 accordingly (see Table 4 in Appendix A):

- 5 cfs (January 1 – July 31; November 1 – December 31. Rainbow trout spawning from May 16 – June 30)
- 10 cfs (August 1 – September 7; Chinook and Sockeye salmon and Dolly Varden char spawning)
- 7 cfs (September 8 – October 31; Sockeye and Coho salmon and Dolly Varden char spawning)

Flows are proposed to provide sufficient passage for adult salmonids which may utilize Reach 5. Surveys in 2013, however, indicated limited use of the canyon. Of the 388 adult salmon noted during the 2013 surveys, only 3 Sockeye and 2 Coho salmon were observed in Reach 5. These fish constitute 1.3% of the total observed population.

Connectivity for Sockeye and Coho salmon, based on the 2013 study, indicated that connectivity was provided at a flow of 10 cfs, with trout connectivity provided at a flow of 5 cfs *[Note: data for trout were re-analyzed after the submission to the Instream Flow study report]*. Chinook connectivity is achieved at flows ranging from 25 – 30 cfs; however, no Chinook have been observed in Reach 5.

HEA proposes additional flows in the Reach 2/3 side channels during the November – February period, which increases habitat for rearing salmonids in Grant Creek. This metric is discussed in the following section.

5.2 Reach 1-4 Flows

In general, maximum habitat (as measured by Weighted Usable Area, WUA) in Grant Creek occurs at flows ranging from approximately 300 cfs to 400 cfs, as measured at the Grant Creek stream gauge. There are specific instances when higher flows maximize WUA. In Reach1 (main channel), rearing habitat increases with flow throughout the modeled range. In Reach 3 (mainstem), habitat for spawning and fry, juvenile and adult rearing, is maximized at flows of approximately 100 cfs and then generally decreases as flow increases above 100 cfs..

A preliminary look at WUA for Chinook and Sockeye salmon indicates no net loss in spawning habitat, with a slight overall increase (approximately 1%). Coho salmon spawning habitat remains the same since flows during the spawning period are the same, pre- and post-project. Overall decreases in Dolly Varden and Rainbow trout adult rearing WUA is approximately 10% for the June – August period.

Due to reduced flows in the Reach 2/3 side channels during the summer months, there is a slight decrease in habitat during this period. However, there are marked increases in overwintering habitat for Chinook salmon, Dolly Varden char, and Rainbow trout. Overall, Chinook juvenile habitat increased by over 56%, Rainbow trout rearing increase by over 10%, and Dolly Varden

juvenile habitat increased by over 6%. The overall increase in habitat over this period was 17.2%. Coho salmon juvenile habitat decreased overall by 1%, ranging from a decrease of over 5% in WUA during January, to an increase of over 8% in November (Table 5).

In the Reach 2/3 side channels, flows are decreased during the June – August period. There are losses in fry, juvenile, and adult rearing WUA of 3%, 9% and 16% respectively in these side channels for this period.

Table 5. Changes in WUA for rearing salmonids in the Reach 2/3 side channels, comparing pre-Project to proposed Project flows.

Species/Life Stage	Jan	Feb	Nov	Dec	Mean
Chinook Juvenile	167.8%	178.6%	129.9%	150.2%	***156.6%***
Coho Juvenile	94.4%	96.7%	108.1%	96.8%	***99.0%***
Dolly Varden Juvenile	106.9%	116.0%	102.2%	101.5%	***106.7%***
Rainbow Juvenile	112.9%	123.0%	103.4%	105.1%	***111.1%***
Rainbow Fry	119.7%	127.2%	95.7%	108.7%	***112.8%***
Mean	***120.3%***	***128.3%***	***107.9%***	***112.5%***	***117.2%***

6.0 SUMMARY AND CONCLUSIONS

This technical memorandum was intended to provide specific details related to HEA's proposed operational regime for the Grant Lake Project. Also outlined, were HEA's proposed instream flow releases for Reaches 5 and 6 (bypass reach) that are intended to permit the small number of fish currently utilizing the area to continue to do so. Under natural conditions, Reach 5 has the least area of habitat suitable for spawning and rearing. The operational scenario outlined and the resulting instream flows in Reaches 1-4 should provide a more stable condition that amplifies and maintains habitat in the mainstem and side channels. The side channels are highly valued for their habitat that provides some of the best spawning and rearing potential in Grant Creek. Based on the analysis of the proposed Project operations that has been conducted, this increase in habitat in the Reach 2/3 side channel complex will far exceed any loss of habitat that may occur in Reach 5 area.

HEA has proactively developed this operational scenario and associated instream flow regime based both upon the data that was collected during the 2013 study program and the quality amount of consultation that has taken place with all of the Stakeholders. We want to emphasize that the scenario described in this memo represents a realistic and somewhat unique opportunity for HEA to responsibly develop the Grant Lake Project while at the same time, positively impact the aquatic environment by generating more abundant, stable and consistent habitat than is currently present under natural conditions. HEA looks forward to discussing this memo with the Stakeholders, answering questions and collaborating on the details related to this proposal. The ultimate goal for HEA as it relates to Stakeholder consultation is to develop the most collaborative FERC License Application possible. We sincerely hope that this memo and the associated discussions during our July 2014 meeting will greatly assist in that development.

7.0 REFERENCES

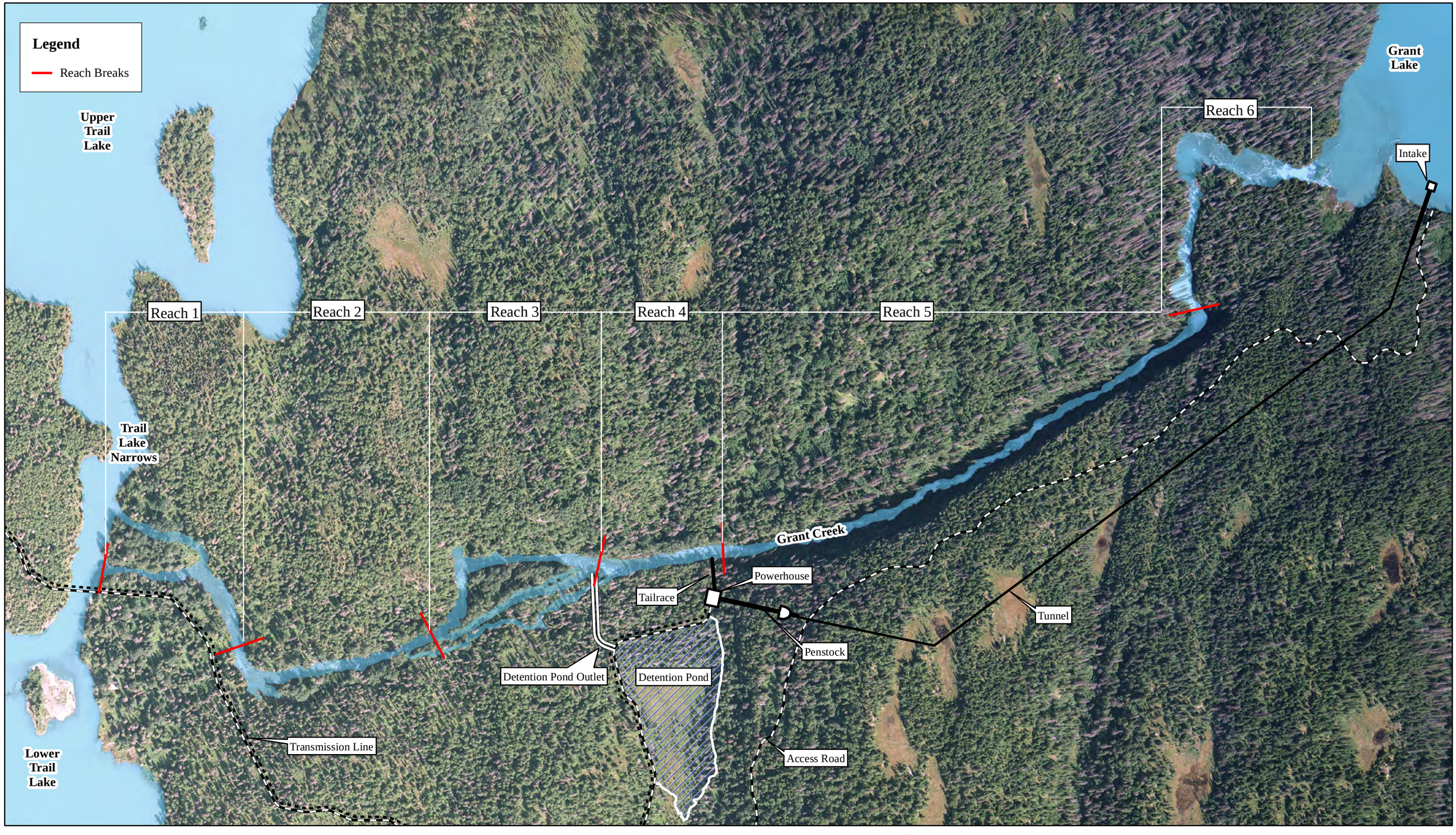
McMillen, 2014. TM 001: Grant Creek Hydrologic Analysis. Prepared for Homer Electric Association.

8.0 APPENDIX A

Figure 1. Grant Creek Reaches and Project Infrastructure

Table 1. Grant Creek Biology, Hydrology, and Operations Summary

Table 4. Grant Creek Instream Flows under Natural Conditions and with Project Operations



REV	DATE	BY	DESCRIPTION

N

Drawing Scale:

0 150 300 600 Feet

McMillen, LLC
1401 Shoreline Drive
Suite 100
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 #P-13212

TM003: Grant Lake Hydroelectric Project Operations and Fisheries Habitat

Figure 1.
Grant Creek Reaches and Project Infrastructure

DESIGNED	A. Ball
DRAWN	A. Ball
CHECKED	C. Warnock
ISSUED DATE	6/18/2014
DRAWING	
SCALE:	1:4,000

Table 1. Grant Creek Biology, Hydrology, and Operations Summary Table

	Stage	Species		January				February				March				April				May				June				July				August				September				October				November				December			
Biology	Spawning	Chinook																																																	
		Coho																																																		
		Sockeye																																																	
		Dolly Varden																																																
		Rainbow																																																	
	Incubating	Chinook																																																
		Coho																																																	
		Sockeye																																																	
		Dolly Varden																																																
		Rainbow																																																	
	Juveniles	Chinook																																																
		Coho																																																	
		Sockeye																																																	
		Dolly Varden																																																
		Rainbow																																																	
	Fry	Chinook																																																
		Coho																																																	
		Sockeye																																																	
		Dolly Varden																																																
		Rainbow																																																	
	Adult	Dolly Varden																																															
		Rainbow																																																

				January	February	March	April	May	June	July	August	September	October	November	December
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	1 MW Unit (75 cfs)		Running	Running	Running	Running	Running	Off	Running	Running	Running	Off	Off	Running
		4 MW Unit (310 cfs)		Off	Off	Off	Off	Running	Running	Running	Running	Running	Running	Running	Off

Table 2. Grant Creek Instream Flows under Natural Conditions and with Project Operations

			January				February				March				April				May				June				July				August				September				October				November				December			
Biological Parameters	Instream Flow Release (Reach 5)	(cfs)	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	5	10	10	10	10	10	7	7	7	7	7	7	7	5	5	5	5	5	5	5	5
	Main Channel Flow (Reach 1-4) - Natural		55	51	51	52	47	45	41	39	36	34	32	31	30	31	35	45	69	101	152	227	318	382	431	483	494	517	507	496	484	469	440	402	379	347	379	364	280	272	216	184	159	133	109	99	92	74	67	63
	Main Channel Flow (Reach 1-4) - with Project		133	128	128	128	124	119	115	106	36	34	33	30	30	30	35	46	68	97	155	224	199	260	310	360	370	390	388	375	365	347	395	399	395	374	372	365	282	273	212	187	234	207	185	180	172	150	141	147
	Approximate Reach 2/3 Side Channel Flow - Natural		9	8	9	9	8	7	7	6	6	6	5	5	5	5	6	8	12	17	25	38	53	64	72	81	82	86	84	83	81	78	73	67	63	58	63	61	47	45	36	31	26	22	18	16	15	12	11	10
	Approximate Reach 2/3 Side Channel Flow - with Project		22	21	21	21	21	20	19	18	6	6	5	5	5	5	6	8	11	16	26	37	33	43	52	60	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	Maximum Elevation																																																	
	Drafting/Filling		Drafting																				Filling																								Drafting			
	Minimum Elevation																																																