

Draft License Application
Grant Lake Hydroelectric Project (FERC No. 13212)

Kenai Hydro, LLC

March 2015

TABLE OF CONTENTS

CONTENTS AND DEFINITIONS

List of Tables	viii
List of Figures.....	xiv
List of Acronyms and Abbreviations.....	xix

INITIAL STATEMENT

EXHIBIT A: PROJECT DESCRIPTION

1 Contents and Purpose of This Exhibit	A-1
2 General Project Description.....	A-1
3 Project Area and Vicinity.....	A-2
4 Proposed Project Facilities.....	A-5
4.1. Grant Creek Diversion.....	A-11
4.2. Grant Lake Intake	A-11
4.3. Tunnel and Surge Chamber	A-11
4.4. Penstock and Surge Tank	A-12
4.5. Tailrace	A-12
4.6. Tailrace Detention Pond	A-13
4.7. Powerhouse	A-13
4.8. Transmission Line/Switchyard.....	A-13
4.9. Appurtenant Facilities	A-14
4.10. Access Roads.....	A-14
5 Project Lands	A-15

EXHIBIT B: PROJECT OPERATIONS AND RESOURCE UTILIZATION

1 Contents and Purpose of This Exhibit	B-1
2 Project Site Selection and Proposed Operations.....	B-1
2.1. Project Site Alternatives	B-1
2.1.1. Crescent Lake.....	B-1

2.1.2. Ptarmigan Lake/Creek	B-1
2.1.3. Falls Creek	B-1
2.1.4. Grant Lake/Creek.....	B-2
2.2. Project Facility Designs, Processes, and Operations Alternatives	B-3
2.2.1. Configuration Alternatives.....	B-3
2.2.2. Proposed Design	B-7
2.2.3. Grant Lake Operational Model	B-7
2.3. Project Operations During Adverse, Average, and High Water Years	B-8
2.3.1. Adverse Water Years	B-8
2.3.2. Average Water Years	B-8
2.3.3. High Water Years	B-8
3 Existing Resource Utilization.....	B-9
3.1. Plant Control.....	B-9
3.2. Annual Plant Factor	B-9
3.3. Dependable Capacity and Average Annual Energy Production	B-9
3.3.1. Project Flow Data	B-9
3.3.2. Flow Duration Curves.....	B-10
3.3.3. Critical Streamflow	B-13
3.3.4. Storage Capacity	B-13
3.3.5. Rule Curve	B-16
3.3.6. Tailwater Rating Curve.....	B-17
3.3.7. Power Plant Hydraulic Capacities and Capabilities.....	B-18
4 System and Regional Power Needs.....	B-19
5 Future Resource Utilization.....	B-21
6 References.....	B-21

EXHIBIT C: CONSTRUCTION SCHEDULE

1 Contents and Purpose of This Exhibit	C-1
2 Construction Schedule.....	C-1
3 Commencement of Commercial Operation.....	C-1
4 Previously Constructed, Unlicensed Water Power Structures or Facilities.....	C-1

EXHIBIT D: PROJECT COSTS AND FINANCING

1	Contents and Purpose of This Exhibit	D-1
2	Original Costs.....	D-1
3	Estimate of the Amount Payable if the Project were to be Taken Over Pursuant to Section 14 of the Federal Power Act	D-1
4	New Construction Costs	D-1
5	Average Annual Costs	D-3
5.1.	Cost of Capital.....	D-4
5.2.	Local, State and Federal Taxes.....	D-4
5.3.	Depreciation and Amortization	D-4
5.4.	Operations & Maintenance Expenses.....	D-4
5.5.	Protection, Mitigation, and Enhancement Expenses (PM&E)	D-5
6	Value of Project Power.....	D-5
6.1.	Contingency Spinning Reserve	D-5
6.2.	Estimated Average Annual Value of Power.....	D-6
7	On-peak and Off-peak Values of Project Power.....	D-7
8	Alternative Energy Sources	D-7
9	Consequence of License Application Denial.....	D-8
10	Sources and Extent of Financing	D-9
11	Cost to Develop the License Application	D-9

EXHIBIT E: ENVIRONMENTAL ANALYSIS

1	Introduction.....	E-1
1.1.	Purpose of Exhibit E.....	E-1
1.2.	Traditional Licensing Process (TLP) Schedule	E-1
1.3.	Document Organization	E-3
2	Proposed Action and Alternatives.....	E-3
2.1.	Proposed Action	E-3

2.1.1. Proposed Project Boundary.....	E-3
2.1.2. Proposed Project Facilities.....	E-4
2.1.3. Proposed Project Safety	E-13
2.1.4. Proposed Project Operations.....	E-13
2.1.5. Proposed Environmental Measures.....	E-14
2.2. Requested PM&E Measures.....	E-16
2.3. No Action	E-16
2.4. Alternatives Considered but Eliminated.....	E-17
2.4.1. Project Site Alternatives	E-17
2.4.2. Project Facility Designs, Processes, and Operations Alternatives.....	E-19
2.4.3. Alternative Energy Sources	E-23
2.4.4. Consequence of License Application Denial	E-24
3 Consultation and Scoping.....	E-24
3.1. Consultation.....	E-24
3.2. Scoping	E-26
3.3. Response to Comments on the Draft License Application.....	E-29
3.4. REA Notice	E-29
4 Environmental Analysis	E-30
4.1. Cumulative Effects	E-30
4.1.1. Geographic Scope	E-30
4.1.2. Temporal Scope	E-31
4.2. Applicable Laws.....	E-31
4.2.1. Section 401 of the Clean Water Act	E-31
4.2.2. Section 404 of the Clean Water Act	E-31
4.2.3. Endangered Species Act	E-31
4.2.4. Magnuson-Stevens Fishery Conservation and Management Act	E-31
4.2.5. Coastal Zone Management Act.....	E-32
4.2.6. National Historic Preservation Act	E-32
4.2.7. Wild and Scenic Rivers Act.....	E-32
4.2.8. The National Trails System	E-33
4.3. General Description of River Basin	E-33
4.3.1. Topography	E-33
4.3.2. Hydrology	E-37
4.3.3. Climate	E-38
4.3.4. Land and Water Uses	E-39
4.4. Geological and Soil Resources.....	E-43
4.4.1. Affected Environment.....	E-43
4.4.2. Environmental Analysis.....	E-61
4.4.3. Proposed Environmental Measures.....	E-64
4.4.4. Cumulative Effects Analysis.....	E-65
4.4.5. Unavoidable Adverse Impacts	E-65

4.5. Water Quality and Quantity	E-65
4.5.1. Affected Environment.....	E-65
4.5.2. Environmental Analysis.....	E-86
4.5.3. Proposed Environmental Measures.....	E-89
4.5.4. Cumulative Effects Analysis.....	E-90
4.5.5. Unavoidable Adverse Impacts	E-90
4.6. Aquatic Resources	E-91
4.6.1. Affected Environment.....	E-91
4.6.2. Environmental Analysis.....	E-195
4.6.3. Proposed Environmental Measures.....	E-242
4.6.4. Cumulative Effects Analysis.....	E-244
4.6.5. Unavoidable Adverse Impacts	E-244
4.7. Terrestrial Resources	E-244
4.7.1. Affected Environment.....	E-247
4.7.2. Environmental Analysis.....	E-307
4.7.3. Proposed Environmental Measures.....	E-333
4.7.4. Cumulative Effects Analysis.....	E-336
4.7.5. Unavoidable Adverse Impacts	E-337
4.8. Recreation and Land Use Resources	E-337
4.8.1. Affected Environment.....	E-337
4.8.2. Environmental Analysis.....	E-352
4.8.3. Proposed Environmental Measures.....	E-358
4.8.4. Cumulative Effects Analysis.....	E-361
4.8.5. Unavoidable Adverse Impacts	E-362
4.9. Aesthetic Resources	E-362
4.9.1. Affected Environment.....	E-362
4.9.2. Environmental Analysis.....	E-375
4.9.3. Proposed Environmental Measures.....	E-384
4.9.4. Cumulative Effects Analysis.....	E-384
4.9.5. Unavoidable Adverse Impacts	E-385
4.10. Cultural Resources	E-385
4.10.1. Affected Environment.....	E-385
4.10.2. Environmental Analysis.....	E-390
4.10.3. Cumulative Effects Analysis.....	E-393
4.10.4. Unavoidable Adverse Impacts	E-393
4.11. Socioeconomics.....	E-394
4.11.1. Affected Environment.....	E-394
4.11.2. Environmental Analysis.....	E-398
4.11.3. Proposed Environmental Measures.....	E-400
4.11.4. Cumulative Effects Analysis.....	E-400
4.11.5. Unavoidable Adverse Impacts	E-400
4.12. Developmental Analysis.....	E-400
4.12.1. Power and Economic Benefits of the Project	E-400

4.12.2. Costs of Environmental Measures	E-401
4.12.3. Comparison of Alternatives	E-401
4.13. Consistency with Comprehensive Plans.....	E-402
4.13.1. Bureau of Land Management. South central Alaska water resources study: Anticipating water and related land resource needs. October 1981.	E-402
4.13.2. Alaska Department of Natural Resources. Fish Creek management plan. August 1984.....	E-402
4.13.3. Alaska Department of Fish and Game. Palmer Hay Flats State Game Refuge. December 2002.	E-402
4.13.4. Alaska Department of Fish and Game. Susitna Flats State Game Refuge. March 1988.	E-403
4.13.5. Alaska Department of Fish and Game. Catalog of waters important for spawning, rearing, or migration of anadromous fishes. June 2014.	E-403
4.13.6. Department of Fish and Game. Anchor River/Fritz Creek Habitat Area. June 1989.	E-403
4.13.7. Alaska Department of Fish and Game. Mendenhall Wetlands State Game Refuge. March 1990.	E-403
4.13.8. Alaska Department of Fish and Game. Anchorage Coastal Wildlife Refuge. February 1991.	E-403
4.13.9. Alaska Department of Fish and Game. Minto Flats State Game Refuge. March 1992.	E-403
4.13.10. Alaska Department of Fish and Game. Kachemak Bay/Fox River Flats Critical Habitat Areas. December 1993.....	E-403
4.13.11. Alaska Department of Fish and Game. Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area. July 1994.	E-403
4.13.12. Alaska Department of Fish and Game. Tugidak Island Critical Habitat Area. June 1995.	E-403
4.13.13. Alaska Department of Fish and Game. McNeil River State Game Refuge and State Game Sanctuary, draft. November 1995.	E-404
4.13.14. Alaska Department of Fish and Game. Kenai River comprehensive management plan. December 1997.....	E-404
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.	E-404
4.13.16. Alaska Department of Fish and Game. Yakataga State Game Refuge June 1999.	E-404
4.13.17. Alaska Department of Fish and Game. Kenai Peninsula brown bear conservation strategy. June 2000.....	E-404
4.13.18. Department of Agriculture, U.S. Forest Service. Chugach National Forest revised land and resource management plan. May 2002.	E-404
4.13.19. Alaska Department of Natural Resources. Alaska's Outdoor Legacy: Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2009-2014. July 2009. ..	E-404
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.....	E-404
5 References.....	E-406

Exhibit E Attachments

- Attachment E-1. Licensing Consultation Record
- Attachment E-2. Aquatic Mapping and Instream Flow Study, Addendum
- Attachment E-3. Terrestrial Resources Study, Final Report Addendum

EXHIBIT F: GENERAL DESIGN DRAWINGS AND SUPPORTING INFORMATION

1 Contents and Purpose of this Exhibit.....F-1

Exhibit F Attachments

- Attachment F-1. Preliminary Supporting Design Report
- Attachment F-2. Preliminary Facility Design Drawings

EXHIBIT G: PROJECT BOUNDARY MAPS

1 Contents and Purpose of This ExhibitG-1

Exhibit G Attachments

- Attachment G-1. Project Boundary Maps

List of Tables

Exhibit A – Project Description

Table A.4-1. General characteristics of the proposed Grant Lake Project facility.....	A-9
Table A.5-1. Tabulation of federal lands within the proposed Project boundary, by township, range and section.....	A-15

Exhibit B – Project Operations and Resource Utilization

Table B.3-1. Grant Creek monthly flow statistics, in cfs (calendar years 1948-2013).....	B-10
Table B.3-2. Grant Creek annual and monthly daily average flow exceedance percentile, in cfs (calendar years 1948-2013).....	B-11
Table B.3-3. Grant Lake storage and surface area relative to lake elevation.	B-16
Table B.3-4. Grant Lake Project Maximum and Minimum Operating Conditions.	B-18

Exhibit C – Construction Schedule

[No tables.]

Exhibit D – Statement of Costs and Financing

Table D.4-1. Summary of estimated costs associated with construction of major Project works. (All costs in 2015 dollars.).....	D-2
Table D.5-1. Annual operation and maintenance costs.	D-4
Table D.6-1. Contingency spinning reserve.	D-6
Table D.8-1. HEA generation facilities.	D-8

Exhibit E – Environmental Analysis

Table E.1-1. Milestones associated with filing of the Project DLA.	E-2
Table E.2-1. General characteristics of the proposed Grant Lake Project facility.	E-7
Table E.2-2. KHL proposed environmental measures.....	E-14
Table E.2-3. HEA generation facilities.....	E-23
Table E.3-1. List of consulted parties.	E-24
Table E.3-2. Major consultation engagements to date.....	E-26
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.....	E-37
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).....	E-38

Table E.4-3. Mean monthly and annual precipitation and temperature based on NOAA records1 and Grant Creek weather station (GC 200 – based on 9/15/2011-6/17/2014 period of record).....	E-39
Table E.4-4. Relative erodability integrating erosion susceptibility with wave energy potential.	E-53
Table E.4-5. Summary of incipient motion calculations at 385 cfs.....	E-60
Table E.4-6. Potential geomorphic responses from Project operational conditions.	E-63
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).	E-71
Table E.4-8. Water quality parameters sampled in Grant Lake, Grant Creek and Trail Lakes Narrows, calendar year (CY) 2013.	E-73
Table E.4-9. Water quality sampling results for the Grant Lake GLTS site – 2009, 2010, and 2013. 1,2.....	E-74
Table E.4-10. Water quality sampling results for the Grant Lake GLOut site – 2009, 2010, and 2013. 1,2.....	E-75
Table E.4-11. Water quality sampling results for the Grant Creek GC200 site – 2009, 2010, and 2013. 1,2.....	E-77
Table E.4-12. Water quality sampling results for the Trail Lake Narrows site – 2013. 1,2....	E-78
Table E.4-13. Comparison of mean monthly temperatures at shallow Grant Creek depths and Grant Creek – 2009-2013.....	E-86
Table E.4-14. Proposed monthly and annual powerhouse flows and watershed inflows for Grant Lake Project.	E-87
Table E.4-15. Upstream, downstream and net passage of pink, Chinook, sockeye and coho salmon across the weir in Grant Creek, 2013.	E-97
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.....	E-98
Table E.4-17. Visual counts of sockeye, Chinook and coho salmon above and below the weir in Grant Creek, 2013.....	E-100
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.....	E-108
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.	E-109
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	E-110
Table E.4-21. Age-at-return for coho, Chinook and sockeye salmon sampled in Grant Creek, 2013.....	E-111
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.	E-111
Table E.4-23. General freshwater life history of Chinook, coho and sockeye salmon returning to Grant Creek, 2013.....	E-112
Table E.4-24. Number of Chinook, sockeye, pink, and coho salmon recovered during carcass surveys on Grant Creek, 2013.....	E-112
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.	E-113

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.....	E-129
Table E.4-27. The number of unique detections of radio-tagged adult salmon by species and reach within Grant Creek.....	E-129
Table E.4-28. Location of salmon redds within different channel areas of Grant Creek.	E-130
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.	E-131
Table E.4-30. Number of detections for radio tagged Chinook, sockeye, and coho salmon in aquatic habitats of Grant Creek, 2013.....	E-132
Table E.4-31. Weekly passage of rainbow trout and Dolly Varden across the weir in Grant Creek, 2013.....	E-133
Table E.4-32. The travel time and length of residence of radio-tagged rainbow trout detected in Reach 5 of Grant Creek.....	E-134
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.	E-137
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.	E-137
Table E.4-35. Number of fish captured in minnow traps by month for upper Grant Creek from April through October 2013.....	E-138
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.	E-142
Table E.4-37. Habitat use by location based on mobile telemetry surveys for radio-tagged rainbow trout in Grant Creek, AK, 2014.	E-143
Table E.4-38. The number of radio-tagged rainbow trout and Dolly Varden detected by reach within Grant Creek, Alaska 2013.....	E-143
Table E.4-39. The date of last detection for 18 radio-tagged adult rainbow trout in Grant Creek, Alaska, 2013.	E-147
Table E.4-40. Number of minnow traps, total effort, and number of fish captured in lower Grant Creek from April through October 2013.	E-148
Table E.4-41. Number, proportion, and CPUE for fish caught in Lower Grant Creek from April through October of 2013.	E-148
Table E.4-42. Number, proportion and CPUE of fish caught in lower Grant Creek with minnow traps from April through October, 2013.	E-149
Table E.4-43. Numbers of fish collected from minnow trapping in lower Grant Creek from April through October 2013.	E-150
Table E.4-44. Number of fish captured in minnow traps in different reaches of lower Grant Creek from April through October 2013.	E-151
Table E.4-45. CPUE for fish captured in minnow traps in different reaches of lower Grant Creek from April through October 2013.	E-151
Table E.4-46. Number and density of salmonids observed during night time snorkel surveys in lower Grant Creek in April 2013.	E-154
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.	E-155
Table E.4-48. Number and density of salmonids observed during night time snorkel surveys in lower Grant Creek in May 2013.	E-155

Table E.4-49. The number of fish released and recovered by species for the two flow blocks and their corresponding trap efficiencies.....	E-156
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.	E-157
Table E.4-51. Number of minnow traps, total effort, number of fish captured and CPUE in the Trail Lake Narrows in July 2013.	E-160
Table E.4-52. Number, proportion and CPUE of fish caught in the Trail Lake Narrows with minnow traps in July 2013.....	E-160
Table E.4-53. Number and proportion of catch for fish seined in beach areas of the Trail Lake Narrows in July 2013.....	E-163
Table E.4-54. Angling station and number and size and weight of rainbow trout and Dolly Varden observed in July 2013.....	E-164
Table E.4-55. Mesohabitats found in Grant Creek.	E-168
Table E.4-56. Aquatic habitats found in Grant Creek.	E-168
Table E.4-57. List of macroinvertebrate taxa collected at Grant Creek sampling sites GC100 and GC300, 2009 and 2013.	E-189
Table E.4-58. Grant Creek macroinvertebrate population density and taxa richness metrics, 2009 and 2013. 1,2.....	E-190
Table E.4-59. Grant Creek macroinvertebrate population composition by percent metrics, 2009 and 2013.1.....	E-191
Table E.4-60. Grant Creek macroinvertebrate functional feeding group metrics based on entire sample from each site, 2009 and 2013.....	E-191
Table E.4-61. Grant Creek macroinvertebrate biotic indices and habitat assessments, 2009 and 2013.....	E-192
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.....	E-193
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.	E-193
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.	E-194
Table E.4-65. Average1 concentrations of chlorophyll a from periphyton collected in Grant Creek, 2009 and 2013.	E-194
Table E.4-66. Grant Lake salmonid species and life history stages.	E-196
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.....	E-199
Table E.4-68. Mesohabitat assessment sites (revised from KHL 2010c).	E-208
Table E.4-69. Calibration flows, Grant Creek (as measured in the mainstem).	E-209
Table E.4-70. Calculations of flow in side channels, lobes, and tributaries, as related to the Grant Creek flow. 1.....	E-209
Table E.4-71. Flow portioning in Grant Creek for PHABSIM study.	E-210
Table E.4-72. Salmonid species and life history stages to be modeled in the Grant Creek Instream Flow Study.	E-211
Table E.4-73. Life history stages modeled at each Grant Creek transect.	E-212

Table E.4-74. Grant Lake salmonid species and life history stages.	E-213
Table E.4-75. Summary of transect and reach weighting.	E-215
Table E.4-76. Proposed Grant Creek engineering flows and salmonid species and life history periodicity.	E-217
Table E.4-77. Grant Creek spawning WUA.	E-219
Table E.4-78. Grant Creek fry rearing WUA.	E-220
Table E.4-79. Grant Creek juvenile and adult rearing WUA.	E-221
Table E.4-80. Transects used to model spawning habitat on Grant Creek.	E-224
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).	E-225
Table E.4-82. Grant Creek pre-Project and with-Project WUA for life history stages.	E-239
Table E.4-83. Species evaluated for connectivity in Grant Creek.	E-240
Table E.4-84. Discharge (cfs) for meeting salmonid passage criteria in Reach 5, Grant Creek.	E-241
Table E.4-85. Upland vegetation types, acres, and percentages within the vegetation study area.	E-247
Table E.4-86. Wetlands and waters – summary within wetlands assessment area.....	E-258
Table E.4-87. Wetlands and waters within the 2014 wetlands assessment area (detailed). ...	E-271
Table E.4-88. Raptors detected during site specific studies and year of study.....	E-277
Table E.4-89. Bird species and breeding habitats in the 2013 wildlife study area. 1	E-279
Table E.4-90. Qualitative assessment of avian species presence in sampled 2013 wildlife study area vegetation classification.	E-283
Table E.4-91. Qualitative assessment of avian species presence in non-sampled Project area vegetation classification.....	E-287
Table E.4-92. Waterfowl species detected during 2010 studies.	E-290
Table E.4-93. Acres of upland vegetation types affected by the Project.	E-311
Table E.4-94. Total area and percentages of upland vegetation types affected by the Project.	E-311
Table E.4-95. Estimated direct and indirect impacts to wetlands and waters.....	E-315
Table E.4-96. Potential impacts to wetlands and waters by Project infrastructure type.....	E-323
Table E.4-97. Proposed Project mitigation ratios and ILF preservation credit requirements in acres.	E-335
Table E.4-98. Numbers of trail users by type and location.	E-346
Table E.4-99. Harvest within Game Management Unit 7 (ADF&G 2013).	E-349
Table E.4-100. Viewer group and expected values for the viewshed.....	E-362
Table E.4-101. Distance zones (USFS 1995).	E-365
Table E.4-102. Viewer groups and exposure period.....	E-365
Table E.4-103. Attractiveness classes and description (USFS 1995).	E-366
Table E.4-104. Scenic class matrix (USFS 1995).	E-366
Table E.4-105. Unit key matrix.	E-367
Table E.4-106. AHRS sites located within the Project area.	E-386
Table E.4-107. Summary of cultural resources and their eligibility status.....	E-389
Table E.4-108. Case Mine District contributing and non-contributing elements.	E-390
Table E.4-109. Summary of the estimated effect of the project for historic properties.	E-392
Table E.4-110. Kenai Peninsula Borough land ownership information (KPB 2005).....	E-394

Table E.4-111. Population growth in the Kenai Peninsula Borough (KPB 2010).	E-396
Table E.4-112. Income and occupations in Kenai Peninsula Borough (2013 U.S. Census Data).	E-397
Table E.4-113. Employment in the Kenai Peninsula Borough (2013 U.S. Census Data). 1 ..	E-398
Table E.4-114. KHL monthly manpower estimates and associated payroll expenditures for construction of the Grant Lake Project.	E-399
Table E.4-115. Summary of parameters and assumptions used for the economic analysis of the Grant Lake Project.	E-401
Table E.4-116. Summary of cost, power benefits, and net benefits of the Grant Lake Project. (All costs in 2015 dollars).....	E-402

Exhibit F – General Design Drawings and Supporting Information

Table F.1-1. Summary of design drawings for the Grant Lake Project.....	F-1
---	-----

Exhibit G – Project Boundary Maps

[No tables.]

List of Figures

Exhibit A – Project Description

Figure A.3-1. Location map of Project vicinity.....	A-3
Figure A.4-1. General Project features and facilities.....	A-7

Exhibit B – Project Operations and Resource Utilization

Figure B.3-1. Grant Lake average annual hydrograph.	B-10
Figure B.3-2. Grant Lake monthly flow duration curves (calendar years 1948-2013).....	B-12
Figure B.3-3. Grant Lake annual flow duration curves with Project and without Project conditions (calendar years 1948-2013).....	B-13
Figure B.3-4. Grant Lake storage capacity curve.	B-14
Figure B.3-5. Grant Lake surface area curve.....	B-15
Figure B.3-6. Grant Lake rule curve.....	B-17
Figure B.3-7. Grant Lake tailwater rating curve.....	B-18
Figure B.3-8. Project power generation vs. net head.....	B-19
Figure B.4-1. HEA's load forecast.	B-20
Figure B.4-2. HEA's load duration curve.....	B-20

Exhibit C – Construction Schedule

Figure C.2-1. Grant Lake Project, schedule.....	C-3
---	-----

Exhibit D – Statement of Costs and Financing

[No figures.]

Exhibit E – Environmental Analysis

Figure E.2-1. General Project features and facilities.	E-5
Figure E.4-1. Location map of Project vicinity.	E-35
Figure E.4-2. Land status, ownership, water rights, and mineral claims in the Project vicinity.	E-41
Figure E.4-3. Geologic lineament, Grant Lake Project area.....	E-45
Figure E.4-4. Grant Lake shoreline geomorphology and relative erosion potential.....	E-51
Figure E.4-5. Water quality, temperature, and hydrology study locations, 2013	E-67
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.....	E-69
Figure E.4-7. Comparison of historical and 2013 mean daily flow records.	E-70

Figure E.4-8. Daily mean water temperatures all Grant Creek main channel sites – 2013.....	E-79
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.....	E-81
Figure E.4-10. A comparison of daily mean water temperatures for Grant Creek, CY 2009 – 2014.....	E-82
Figure E.4-11. Daily mean water temperature profiles in Grant Lake near the proposed intake structure.....	E-83
Figure E.4-12. Comparison of daily mean water temperatures in Grant Lake near the proposed intake structure – 2013-June 2014.....	E-84
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.....	E-85
Figure E.4-14. Grant Creek reaches.....	E-93
Figure E.4-15. The A-frame weir used on Grant Creek to count adult salmon, rainbow trout and Dolly Varden in 2013.....	E-96
Figure E.4-16. Observer efficiency relationships for sockeye, Chinook and coho salmon in Grant Creek, 2013.....	E-99
Figure E.4-17. Visual surveys of Chinook salmon location in Grant Creek, 2013.....	E-101
Figure E.4-18. Visual surveys of coho salmon location in Grant Creek, 2013.....	E-103
Figure E.4-19. Visual surveys of sockeye salmon location in Grant Creek, 2013.....	E-105
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.....	E-107
Figure E.4-21. Spawning locations for Chinook salmon in Grant Creek, 2013.....	E-115
Figure E.4-22. Spawning locations for coho salmon in Grant Creek, 2013.....	E-117
Figure E.4-23. Spawning locations for sockeye salmon in Grant Creek, 2013.....	E-119
Figure E.4-24. Spawning locations for pink salmon in Grant Creek, 2013.....	E-121
Figure E.4-25. Mobile telemetry detections for radio tagged Chinook salmon in Grant Creek, 2013.....	E-123
Figure E.4-26. Mobile telemetry detections for radio tagged sockeye salmon in Grant Creek, 2013.....	E-125
Figure E.4-27. Mobile telemetry detections for radio tagged coho salmon in Grant Creek, 2013.....	E-127
Figure E.4-28. Mobile telemetry detections for radio tagged rainbow trout in Reach 5 of Grant Creek, 2013.....	E-135
Figure E.4-29. Location of minnow traps placed in Grant Creek, 2013.....	E-139
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.....	E-141
Figure E.4-31. The length-weight relationship of radio-tagged adult rainbow trout in Grant Creek, 2013.....	E-142
Figure E.4-32. Mobile telemetry detections for radio tagged rainbow trout in Reach 1-4 of Grant Creek, 2013.....	E-145
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.....	E-150
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.....	E-152

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.	E-152
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.	E-153
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.	E-158
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.	E-159
Figure E.4-39. Location of minnow traps and angling stations in the Trail Lake Narrows, 2013.	E-161
Figure E.4-40. Grant Creek mesohabitats.	E-169
Figure E.4-41. Aquatic habitats.	E-181
Figure E.4-42. Grant Creek instream flow transect locations.	E-203
Figure E.4-43. Average Grant Creek pre-Project and with-Project flows.	E-218
Figure E.4-44. Grant Creek spawning WUA.	E-222
Figure E.4-45. Grant Creek fry rearing WUA.	E-222
Figure E.4-46. Grant Creek juvenile and adult rearing WUA.	E-223
Figure E.4-47. Chinook spawning WUA.	E-230
Figure E.4-48. Chinook fry rearing WUA.	E-230
Figure E.4-49. Chinook juvenile rearing WUA.	E-231
Figure E.4-50. Coho spawning WUA.	E-231
Figure E.4-51. Coho fry rearing WUA.	E-232
Figure E.4-52. Coho juvenile rearing WUA.	E-232
Figure E.4-53. Sockeye spawning WUA.	E-233
Figure E.4-54. Dolly Varden spawning WUA.	E-233
Figure E.4-55. Dolly Varden fry rearing WUA.	E-234
Figure E.4-56. Dolly Varden juvenile rearing WUA.	E-234
Figure E.4-57. Dolly Varden adult rearing WUA.	E-235
Figure E.4-58. Rainbow trout spawning WUA.	E-235
Figure E.4-59. Rainbow trout fry rearing WUA.	E-236
Figure E.4-60. Rainbow trout juvenile rearing WUA.	E-236
Figure E.4-61. Rainbow trout adult rearing WUA.	E-237
Figure E.4-62. Salmonid spawning WUA.	E-237
Figure E.4-63. Salmonid fry rearing WUA.	E-238
Figure E.4-64. Salmonid juvenile rearing WUA.	E-238
Figure E.4-65. Salmonid adult rearing WUA.	E-239
Figure E.4-66. Natural resources study area.	E-245
Figure E.4-67. Upland vegetation types.	E-247
Figure E.4-68. Updated 2014 wetland assessment area.	E-255
Figure E.4-69. Wetland and waters types - global indicator map.	E-259
Figure E.4-70. Wetland and waters types - Grant Creek.	E-261
Figure E.4-71. Wetland and waters types - Grant Lake-intake.	E-263
Figure E.4-72. Wetland and waters types - Grant Lake-NW elbow.	E-265
Figure E.4-73. Wetland and waters types - Grant Lake-island east.	E-267
Figure E.4-74. Wetland and waters types - Grant Lake-east end.	E-269

Figure E.4-75. Major brown bear forage and denning habitat (Ebasco 1984)	E-293
Figure E.4-76. Major brown bear forage and denning habitat (USFS 2008)	E-295
Figure E.4-77. Mountain goat observations in study area 1982 (Ebasco 1984).....	E-299
Figure E.4-78. High value brown bear, mountain goat, moose habitat, and moose winter range (USFS 2008).	E-301
Figure E.4-79. Dall's sheep observations in study area 1982 (Ebasco 1984).....	E-303
Figure E.4-80. Moose range on study area (Ebasco 1984).....	E-305
Figure E.4-81. General Project features, facilities, adjacent cleared areas and right-of-ways	E-309
Figure E.4-82. Impacts to wetlands/waters – overview.....	E-317
Figure E.4-83. Impacts to wetlands/waters – west.	E-319
Figure E.4-84. Impacts to wetlands/waters – east.....	E-321
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).....	E-328
Figure E.4-86. Project location.....	E-339
Figure E.4-87. Project vicinity recreation resources.....	E-342
Figure E.4-88. Trail Lake.....	E-343
Figure E.4-89. Vagt Lake trailhead.....	E-343
Figure E.4-90. INHT along western side of Vagt Lake.....	E-343
Figure E.4-91. Total trail users, 2014.	E-345
Figure E.4-92. Trail users by type, 2014.	E-345
Figure E.4-93. Grant Lake trail.....	E-346
Figure E.4-94. Grant Lake Trail through meadow.	E-346
Figure E.4-95. Floatplane tie up, Trail Lake.....	E-347
Figure E.4-96. Game management Unit 7.	E-348
Figure E.4-97. Kenai Area Plan, enlargement of Grant Lake designation.	E-351
Figure E.4-98. INHT corridor re-route flagging.....	E-357
Figure E.4-99. Unit keys.....	E-367
Figure E.4-100. Looking south across Trail Lakes toward Kenai Lake-view from aircraft...E-368	E-368
Figure E.4-101. Unit 1: Trail Lakes Valley.	E-369
Figure E.4-102. Looking south across Grant Lake from Grant Lake Trail.	E-370
Figure E.4-103. Unit 2: Grant Lake West.....	E-371
Figure E.4-104. Looking west across Grant Lake, view from aircraft.	E-372
Figure E.4-105. Unit 3: Grant Lake East.	E-373
Figure E.4-106. Location of key views.....	E-376
Figure E.4-107. Key View 1: Before.....	E-377
Figure E.4-108. Key View 1: After.	E-378
Figure E.4-109. Key View 2: Before.....	E-379
Figure E.4-110. Key View 2: After.	E-379
Figure E.4-111. Key View 3: Before.	E-380
Figure E.4-112. Key View 3: After.	E-381
Figure E.4-113. Key View 4: Before and after.	E-382
Figure E.4-114. General Kenai Peninsula land ownership delineation (KPB 2005).....	E-395
Figure E.4-115. Land use in the Kenai Peninsula Borough (KPB 2005).	E-395

Exhibit F – General Design Drawings and Supporting Information

[No figures.]

Exhibit G – Project Boundary Maps

[No figures.]

List of Acronyms and Abbreviations

ACE	Alaska Center for the Environment
ADEC	Alaska Department of Environmental Conservation
ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act
ADCP	Acoustic Doppler Current Profiler
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation & Public Facilities
AEA	Alaska Energy Authority
AHRS	Alaska Heritage Resources Survey
APDES	Alaska Permit Discharge Elimination System
APE	Area of Potential Effect
APP	Avian Protection Plan
ARRC	Alaska Railroad
ARWG	Aquatic Resources Work Group
ASCI	Alaska Stream Condition Index
ATV	all-terrain vehicle
AUC	Area-Under-the-Curve
AWC	Anadromous Waters Catalog
Bcf	billion cubic feet
BE	Biological Evaluation
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Bureau of Land Management
BMP	Best Management Practices
CEA	Chugach Electric Association
CEII	Critical Energy Infrastructure Information
CFC	Cooperative Finance Corporation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIAA	Cook Inlet Aquaculture Association
CIRI	Cook Inlet Region, Inc.
CMT	culturally modified trees
CPUE	catch-per-unit-effort
CRWG	Cultural Resources Work Group
CWA	Clean Water Act

CZMA	Coastal Zone Management Act
DOE	determination of eligibility
DLA	Draft License Application
EA	Environmental Assessment
ECM	Environmental Compliance Monitor
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera/Plecoptera/Trichoptera
ESA	Endangered Species Act
ESCP	Erosion and Sediment Control Plan
FERC	Federal Energy Regulatory Commission
FL	fork length
FLA	Final License Application
FPA	Federal Power Act
FPP	Fire Prevention Plan
fps	feet per second
ft	feet
GIS	geographic information system
GPS	global positioning system
GVEA	Golden Valley Electric Association
HBI	Hilsenhoff Biotic Index
HGM	hydrogeomorphic
HPMP	Historic Properties Management Plan
HSC	habitat suitability criteria
HVAC	heating, ventilating, and air conditioning
IFIM	instream flow incremental methodology
IFSG	Instream Flow Subgroup
ILF	in-lieu fee
INHT	Iditarod National Historical Trail
INHTRP	Iditarod National Historic Trail Re-routing Plan
KPB	Kenai Peninsula Bureau
KHI	Kenai Hydro, Inc.
KHL	Kenai Hydro, LLC
km	kilometer
kV	kilovolt
KRSA	Kenai River Sportfishing Association
KRSMA	Kenai River Special Management Area

KRWF	Kenai River Watershed Foundation
LB	left blank
LWD	large woody debris
m	meter
MBTA	Migratory Bird Treaty Act
MCC	motor control center
MCE	maximum credible earthquake
Mcf	thousand cubic feet
MEA	Matanuska Electric Association
mg/L	milligrams/liter
ML&P	Municipal Light & Power
mm	millimeter
MOA	Memorandum of Agreement
MW	megawatt
MWh	megawatt hour
NAVD 88	National American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NGVD 29	National Geodetic Vertical Datum of 1929
NHI/HRC	National Heritage Institute/Hydro Reform Coalition
NHPA	National Historic Preservation Act
NOAA Fisheries	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	U.S. Department of Interior, National Park Service
NPV	net present value
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRWG	Natural Resources Work Group
NWI	National Wetland Inventory
O&M	operation and maintenance
OCMP	Operational Compliance Monitoring Plan
PAD	Pre-Application Document
PHABSIM	Physical Habitat Simulation
PM&E	protection, mitigation and enhancement
Project or Grant Lake Project	Grant Lake Hydroelectric Project

PSAP	Public Safety and Access Plan
RB	right bank
RBCA	Resurrection Bay Conservation Alliance
RCA	Regulatory Commission of Alaska
REA	Ready for Environmental Analysis
RNA	research natural area
ROW	right-of-way
RTE	rare, threatened, and endangered
RUS	Rural Utilities Service
SCORP	State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SDR	Supporting Design Report
SES	Seward Electric System
SHPO	State Historic Preservation Officer
SPCCP	Spill Prevention, Control and Containment Plan
Tcf	trillion cubic feet
TCF	The Conservation Fund
TCP	traditional cultural property
THPO	Tribal Historic Preservation Officer
TWG	Technical Working Group
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VMP	Vegetation Management Plan
WAA	wetlands assessment area
WOUS	waters of the U.S.
WSE	water surface elevation
WUA	weighted usable area