Black Canyon Hydroelectric Project
FERC Project No. P-14110
Revised Fish Passage Study Plan
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Prepared for
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1 INTRODUCTION

Black Canyon Hydro, LLC, (BCH) plans to file an application with the Federal Energy Regulatory Commission (FERC) for an original license for the Black Canyon Hydroelectric Project (Project), FERC Project Number P-14110, and associated facilities on the North Fork Snoqualmie River, approximately 4 miles northeast of North Bend in King County, Washington. The Project has a proposed generation capacity of 25 megawatts (MW) and would be located entirely on private lands.

Intake Alternative A

Alternative A would consist of the following new facilities: (1) an 8-foot-high, 162.4-foot-long inflatable rubber diversion with an associated water intake structure; (2) a natural or roughened fish passage channel; (3) a variable pooling area behind the diversion with a normal water surface elevation of 971 feet above mean sea level and a maximum pooling of 2.83 acres; (4) a power conduit tunnel consisting of an approximately 450-foot-deep vertical tunnel into an approximately 8,350-foot-long, 9-foot-diameter horizontal tunnel and penstock; and (5) for access, Alternative A would utilize an existing logging road to minimize disturbance, and require only 825-feet of additional road.

Intake Alternative B

Alternative B would consist of the following new facilities: (1) a control sill to maintain a consistent river bottom elevation, which would allow water, fish, sediment, large woody debris, and whitewater recreationists to pass unimpeded, with an associated water intake structure; (2) a power conduit tunnel consisting of an approximately 450-foot-deep vertical tunnel into an approximately 9,175-foot-long, 9-foot-diameter horizontal tunnel and penstock; and (3) for access, Alternative B would utilize an existing logging road to minimize disturbance, and require only 500-feet of additional road.

Powerhouse

The power conduit tunnel and penstock from either Alternative A or B would terminate at the powerhouse proposed upstream of Ernie's Grove. Initially, the PAD described the powerhouse as being a metal building approximately 60-feet-wide by 100-feet-long. However, as a result of construction from the power conduit tunnel, an underground powerhouse of similar dimensions may be feasible. Tailrace dimensions have also been revised from a 60-foot-wide by 100-foot-long tailrace, to a 24-foot-wide by 200-foot-long tailrace. Whether above or below ground, the powerhouse would include two Francis turbine generator units, one rated at 16 MW and the other rated at 9 MW, as well as

appurtenant facilities (switchyard, maintenance building, etc.). Additionally, a temporary, 2,600-foot-long construction access road would extend from the powerhouse to the North Fork Road (while avoiding Ernie's Grove).

Transmission

As presented in the PAD, transmission would consist of a 4.2-mile-long, 115-kilovolt overhead transmission line that transmits project power to the regional grid (transmission line would be an over-build of an existing transmission line with only approximately 0.65 miles of new transmission). However, an additional option, depending on minimum instream flow requirements, land use designations, and cost, may be to have the Project connect to the existing 34 kV transmission line running from the existing Black Creek Hydroelectric Project to Snoqualmie Falls. A transmission line could be run from the powerhouse back through the power conduit to the intake structure. From the intake structure a buried or overhead transmission line would only have to travel approximately 6,745-feet along an existing logging road through clear cuts.

The project would operate in run-of-river mode. The combined maximum hydraulic capacity of the two project turbines would be 900 cubic feet per second (cfs). The project would divert water from a 2.6-mile-section of the North Fork Snoqualmie River referred to as the Project Reach.

BCH filed a Notice of Intent (NOI) and the associated Pre-Application Document (PAD) to commence the FERC Integrated Licensing Process (ILP) on March 27, 2012. In response to the subsequent study requests filed by FERC staff and other stakeholders and as detailed in 18 CFR 5.11, BCH is required to submit relevant resource study plans. This includes a study of fish passage within the Project reach which follows the requirements of 18 CFR 5.11(b)-(e).

1.1 1.1 Revisions to Proposed Study Plans

BCH filed a total of 16 Proposed Study Plans (PSPs), including a Proposed Fish Passage Study Plan, on September 7, 2012. The various agencies, tribes, and stakeholders participating in the Black Canyon Hydro ILP were allowed 30 days to formally comment the PSPs. After the formal comment period ended, BCH held two days of meetings with project participants to discuss the study plans. Based on the level of interest expressed at these meetings, BCH created an Aquatic Resources Work Group and invited project participants to join. The ARWG met in December 2012 to discuss studies related to aquatic resources, instream flows, and fish passage. With respect to the latter, the

ARWG will continue to meet in 2013 and 2014 to advise BCH on fish passage investigations, and to participate in the development of Protection, Mitigation and Enhancement (PM&E) measures that can be implemented to minimize or mitigate undesirable project impacts on fish passage.

Fish passage studies will be coordinated with other project studies so that potential project impacts are fully considered, and appropriate PM&E measures are identified. If FERC issues a license for the project, and the project is constructed, BCH will monitor passage success as part of its commitment to monitoring and adaptive management to minimize risk to aquatic resources.

The goals, objectives, methods, and expected outputs of the studies described below differ in only a few respects from those presented in the Proposed Fish Passage Study. In their comments on the Proposed Fish Passage Plan, agency and stakeholder representatives encouraged BCH to consider alternatives to the inflatable dam or other structure originally proposed to divert water from the North Fork into the water intake. At the study plan review and ARWG meetings, BCH presented a conceptual design of a water diversion system ("Plan B") that does not require use of a physical barrier to impound and divert flows, but would rely instead on a constriction to maintain sufficient depth to divert water through a screened water intake over the desired range of flows. The structures would be designed so that fish could swim upstream through the constriction while the project is operating, and water, fish, sediment, and wood could pass downstream as they do under pre-project conditions. Ideally, the selected design would result in a structure that requires little maintenance so that desired fish passage conditions are likely to persist over the life of the project .

Project participants requested that BCH explore this design concept further along with other alternatives that would reduce potential impacts on fish migrating in up- or downstream directions. They also emphasized that the water intake system be equipped with screens that would minimize entrainment or injury of fish, especially downstream-migrating trout fry, during project operation. This study plan describes a process for developing and evaluating alternative project designs, modes of operation, and long-term maintenance measures that achieve these objectives.

2 STUDY DESCRIPTION AND OBJECTIVES

In accordance with 18 CFR §5.11(d)(1), this section describes the goals and objectives of the Fish Passage Study and the information to be obtained. This document describes the

process that BCH will implement to identify different water diversion, intake, and discharge structures and configurations, and evaluate them with respect to their ability to avoid injuring or killing fish, or to prevent or delay fish from swimming up- and downstream. BCH will also investigate how fish passage conditions in the Project Reach are likely to change in response to changes in streamflows, hydraulics, and habitat structure in the North Fork caused by the Project. This analysis will require input from and coordination with several other studies.

The Fish Passage Study will be conducted in consultation with members of the ARWG and other biologists and engineers who possess expertise in fish passage and familiarity with the biophysical attributes of the North Fork Snoqualmie River. Interested parties will be invited to assist with the identification and evaluation of design alternatives for maintainable water diversion, intake, and discharge structures that enable fish and other organisms to pass without significant delay injury, or mortality (relative to existing conditions) through the associated reaches of the North Fork. The final engineering designs for the structures will be developed based on ARWG input and FERC guidance and approval.[1]

Several design alternatives will be considered for the water diversion, intake, and discharge structures. Biological, engineering feasibility, and cost criteria will be used to rank each alternative, and engineering schematics will be developed for those that have the greatest potential to meet Project objectives. Hydraulic conditions (e.g., flow patterns, turbulence, water depths, and velocities) and other physical attributes (e.g., bed roughness, screen orientation and mesh sizes) known to affect fish passage success will be analyzed for each alternative for the range of streamflows expected to occur when the Project is operating.[2] This information will be used along with other relevant study results to identify engineering designs and operational guidelines that achieve the energy producing goals of the project, provide adequate fish passage conditions throughout the year, and do not contribute to undesirable changes in fish passage conditions in the Project Reach over time.

The specific objectives of the study are to:

[1] The Fish Passage Study will result in the development of preliminary (i.e., 30 percent level) engineering designs that have been vetted with project participants and that BCH intends to submit to FERC as part of its license application. After a license has been issued for the project, the engineering designs for the Project will be subjected to constructability reviews and finalized prior to the preparation of construction bid documents.
[2] See Hydrology, Instream Flow, and Hydropower Potential and Project Economics study plans.

- Define desired fish passage conditions within the Project Reach and at points where will be diverted from and returned to the North Fork Snoqualmie under anticipated project operations.
- Identify multiple design alternatives for Project diversion, intake, and discharge structures that would potentially satisfy the goals of the project.
- In consultation with outside experts, evaluate and rank the design alternatives with respect to selected biological, technical feasibility, and cost criteria.
- For the most promising alternatives, evaluate their fish passage suitability with respect to the swimming abilities of target fish species, and the range of flows expected when the project is operational.
- In consultation with the ARWG, select and refine the preferred design alternatives.
- Evaluate the potential impacts of Project flows on fish passage within the Project Reach. Identify measures that can be taken to eliminate or improve the passability of existing fish passage barriers, and avoid creating new barriers to fish movements within the Project Reach.

3 STUDY AREA

For the purposes of this study, the upper boundary of the study area is defined by the upstream edge of the maximum pooling created by the diversion of water from the North Fork. The lower boundary is located approximately 100 meters downstream of the point where water from the tailrace is discharged back into the river (Appendix A). The section of river between the water intake and the tailrace discharge point is referred to as the Project Reach. It features steep banks and valley sidewalls, and a relatively steep gradient (average 3.4 percent) over its 2.6-mile length, that is characterized by falls and riffles.

4 RESOURCE MANAGEMENT GOALS

In accordance with 18 CFR §5.11(d)(2), this section describes resources management goals of agencies or Indian tribes with jurisdiction over the resources to be studied.

BCH is not aware of any applicable resource management goals of agencies or Indian tribes with jurisdiction over fish passage within the vicinity of the Project. Additionally, none were indicated by the relevant comments or study requests. However, BCH would appreciate any stakeholder input on this subject, particularly from the U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife.

5 EXISTING INFORMATION

In accordance with 18 CFR §5.11(d)(3), this section describes existing information on fish passage within the Project study area, and the need for additional information.

Several fisheries studies and habitat inventories conducted previously in the North Fork Snoqualmie River have identified known or putative fish barriers (Sweeney et al. 1981; R.W. Beck and Associates 1985; Thompson et al. 2011) within the Project study area. Although these studies were not intended to identify fish barriers in the Project Reach, and in fact did not include surveys of the entire reach, they all described Fantastic Falls, present at the lower end (RM 3.1) of the Project Reach as impassible to fish. Fish passage conditions within the Project study area, including the difficult-to-access Black Canyon segment, were inventoried by a crew of experienced fisheries biologists retained by BCH to conduct fish and fish habitat surveys in 2012 (Jamie Thompson, personal communication). Based on the observed distribution of rainbow trout, mountain whitefish, largescale suckers, sculpins, and dace in the lower river, these species are unable to ascend Fantastic Falls under all flow conditions. The 2012 inventory identified several other potential fish passage barriers and recommended that they be evaluated further in subsequent studies.

A wide range of design options and specifications for fish passage suitable for the development of water diversion, intake, and discharge structure design alternatives are described in the following reference documents:

- Anadromous Salmonid Passage Facility Design (NOAA Fisheries 2011),
- Draft Fishway Guidelines for Washington State (WDFW 2000), and
- Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (WDFW 2009).

Fish passage performance criteria are addressed in the following reports:

- Fisheries Handbook of Engineering Requirements and Biological Criteria (Bell 1990),
- Mill Creek Fish Passage Assessment (Burns et al. 2009), and
- New Concepts in Fish Ladder Design: Analysis of Barriers to Upstream Fish Migration (Powers and Orsborn 1985).

Additional information that will be developed through other project studies, and that will be useful in the context of the proposed Fish Passage Study, includes:

- Fish presence, timing, and population characteristics (Aquatic Resources Study),

- Historical streamflows and those predicted under future project conditions (Hydrology and Hydropower Potential and Project Economics studies), and
- Hydraulic and fish habitat conditions within the Project reach under historical and future conditions (Instream Flow Study).

6 NEXUS TO PROJECT

In accordance with 18 CFR §5.11(d)(4), this section describes any nexus between Project operations and effects on fish passage.

The proposed project may affect the passage of fish and other aquatic organisms in the North Fork as a result of the proposed water diversion, intake, and discharge structures. The proposed project may include modifications to the existing channel that would, at times, alter local hydraulic and structural conditions to the detriment of fish.

7 METHODS

In accordance with 18 CFR §5.11(d)(1) and §5.11(d)(5), this section provides a detailed description of the proposed Fish Passage study methodology, including data collection and analysis techniques, or objectively quantified information, sampling strategy, and a schedule including appropriate field season(s) and the duration (see "Schedule" heading below for schedule).

7.1 Fish Passage Structures

The process for designing appropriate fish passage conditions at individual project structures will generally be as follows:

- Define desired fish passage conditions (objectives) associated with water diversion, intake, and discharge structures under anticipated project operations.
- For each structure, identify and conceptually design a range of fish passage alternatives that would potentially satisfy the defined objectives.
- In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the defined objectives and specified biological, technical, and cost criteria.
- Refine and select a preferred alternative for each structure.

7.1.1 Define objectives and criteria for evaluating fish passage success at structures under anticipated Project conditions.

The general objectives and criteria for evaluating fish passage at the water diversion, intake, and discharge structures will be defined by reviewing and citing relevant literature. The State of Washington has available two manuals (WDFW 2000 and WDFW 2009) that provide design guidance for fish passage. This information will be supplemented with relevant federal guidance in designing appropriate fish passage facilities (NOAA Fisheries 2011). These guidelines provide the regulatory framework under which project approvals can be expected and are based upon proven approaches to designing fish passage facilities. WDFW has also suggested the two following preliminary objectives, which will be further developed along with other objectives in the ARWG:

- Passage should be as similar to current baseline conditions as possible; and
- Minimize maintenance, specifically instream maintenance activity.

Literature-derived information and the results of other related studies will be used to define fish passage objectives, and to later identify and evaluate different design alternatives. For example, information on the migratory habits and swimming ability of fish and other aquatic organisms present in the North Fork will be gleaned from previous studies and scientific literature. Likewise, biological, physical, and economic evaluative criteria will abstracted from the literature or derived from BCH studies. The Aquatic Resources Study will collect relevant information, such as the number and type of aquatic species, and the number, age and size structure, and migratory habits of fish present within the study area. The Aquatic Resources and Instream Flow studies will characterize existing and expected physical habitat conditions, including the type and quality of habitat available at different flows. The ecological requirements of the target fish species and size classes will be derived from a review of the scientific literature and regulatory agency guidance documents, and through consultation with knowledgeable experts. This information will be summarized as general objectives that can be used to evaluate each design alternative relative to expected fish passage conditions and outcomes.

7.1.2 For each structure, identify and conceptually design a range of fish passage alternatives that would potentially satisfy the objectives defined.

Due to the number and species of fish present in the study area, the specificity of agency promulgated fish passage design criteria, and guidance received from representatives of regulatory agencies participating in this project, only a few design alternatives may be

recommended for each structure. A goal of three conceptual alternatives, each representing a unique fish passage solution, will be developed for fish passage at the water diversion, intake, and discharge structures. Designs will likely include standard, widely accepted approaches, but could also include designs that are more experimental or tailored to the unique conditions of the North Fork.

Additionally, each design alternative will be modeled to determine flow variablity, turbulence, depths, velocities, and surface elevations in the vicinity of the structures over the range of flows expected under post-project conditions. The values estimated for these parameters will be compared to state and federal fish passage criteria and guidelines. The preliminary design alternatives will be refined based on this information and made available for review.

7.1.3 In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the objectives defined.

An alternatives analysis will be performed to compare the pros and cons as well as the benefits and costs of each alternative. The various alternatives that were developed to a conceptual design level will be evaluated based on the following feasibility criteria (among other general objectives developed during the process described in Section 7.1.1):

- Site conditions (e.g., ease of construction, minimal environmental disturbance);
- Effectiveness of final design in passing relevant fish species and life stage types under the expected flow regime;
- Effects on other biophysical processes and resources (e.g., minimizing disturbance of terrestrial habitat);
- Engineering and operational constraints; and
- Cost.

7.1.4 Select a Preferred Alternative

Based on the results of the consultation and evaluation of fish passage alternatives, and other study plans, BCH will select a preferred alternative fish passage design. The selected water diversion, intake, and discharge structure designs will be developed to the 30 percent engineering design level.

7.2 Fish Passage in Project Reach

7.2.1 Characterize existing natural fish passage barriers within the study area based on the swimming abilities of the fish species present, and then assess their passability under a range of anticipated project flows.

This study component will document the physical characteristics of existing natural fish passage barriers within the study area and, based upon the swimming abilities of the fish species present, determine whether they are passable under existing and predicted post-project flows.

Available scientific literature identifies methods for evaluating the ability of specific species and age classes of fish to pass upstream at specific river bed features, such as chutes and waterfalls, or to navigate various combinations of water velocity, bed slope, and length in locally steep river reaches. We propose to initially map the river and identify the most likely locations where fish passage barriers currently exist or are likely to exist under post-project flow conditions.

The methods developed by Powers and Orsborn (1985) will then be used to determine which of the previously identified river features in the study area are natural fish passage barriers. The approach considers the swimming capabilities of resident fish species and life stages, along with observed spatial and flow-dependent variations in local water surface elevations and hydraulic characteristics. For this project, the primary fish species of interest are cutthroat and rainbow trout. Their size, abundance, and presence within the study area will be documented in the Aquatic Resources Study. Based on known swimming capabilities for these species, we will be able to determine whether, to what degree, and under what flow conditions a putative barrier blocks the upstream movement of fish. The information developed under several of the studies, including the Aquatic Resources, Instream Flow, Hydrology, and Fish Passage studies, will likely be considered in combination to determine how much flow should be maintained in the Project reach during different times of the year.

7.2.2 Identify measures that can be taken to eliminate or improve the passability of existing fish passage barriers, and avoid creating new barriers to fish movements within the Project Reach.

The results of the fish passage inventory of the Project Reach will inform decisions regarding minimum flows and project operations, with the goal of maintaining or improving fish passage conditions within the reach under post-project conditions.

Cascades or other fast water areas that have potential to block or delay fish under post-project flows will be identified and, if feasible, recommended for physical modification to create conditions that are more conducive for fish passage.

8 PROGRESS REPORTING

In accordance with 18 CFR §5.11(b)(3), this section describes provisions for periodic progress reports, including the manner and extent to which information will be shared; and the time allotted for technical review of the analysis and results.

Study reports will be submitted as required by the FERC Integrated Licensing Process (ILP). The most recent schedule, issued by FERC in Appendix B of Scoping Document 1, includes a number of opportunities for progress reports, exchange of analysis and results between stakeholders, and information sharing. After proposed study plans are filed with FERC there will be a study plan meeting and comment period before a revised study plan is filled and a comment period passes. Once studies begin, the ILP also has deadlines for an Initial Study Report to be submitted, an Initial Study Report Meeting, and an Initial Study Report Meeting Summary. However, this schedule is subject to change by FERC staff and should not necessarily be relied upon. It is BCH's understanding that any changes to the ILP plan and schedule will be noticed by FERC staff.

Progress on the Fish Passage studies will be described in memoranda and presented at regular meetings of the Aquatic Resource Work Group, but no less frequent than at 3 month intervals. The progress reports will describe the status of the studies, design updates, significant findings, and any adjustments or changes necessary to meet study objectives. The progress reports will be discussed at ARWG meetings.

9 SCHEDULE

In accordance with 18 CFR §5.11(b)(2), the schedule for conducting the study is provided in Table 1 below.

Table 1. Resource Study Schedule

Component	Completion Date*
Define fish passage objectives for the water diversion, intake, and discharge structures under anticipated project operations.	February – June 2013
Identify a range of conceptual fish	June – December 2013

passage alternatives that would potentially satisfy the objectives defined.	
In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the selected biological, technical, and cost criteria. Select preferred design alternatives.	September 2013 – December 2013
Characterize existing natural fish passage barriers within the study area based on the swimming abilities of the fish species present, and then assess their passability under a range of anticipated project flows.	June – November 2013
Prepare Initial and Final Study Reports.	December 2013 – February 2014

*Dates based on schedule created and presented by FERC in Scoping Document 1 and subject to change.

10 LEVEL OF EFFORT AND COST

In accordance with 18 CFR §5.11(d)(6), the anticipated level of effort and cost are provided in Table 2 below.

The estimated cost of this work is approximately $65,000.

Table 2. Level of Effort and Cost

Task	Labor and Expenses
Define fish passage objectives for the water diversion, intake, and discharge structures under anticipated project operations.	$5,000
Identify a range of conceptual fish passage alternatives that would potentially satisfy the objectives defined.	$20,000
In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the selected biological, technical, and cost criteria. Select preferred design alternatives.	$10,000
Characterize existing natural fish	$15,000

passage barriers within the study area based on the swimming abilities of the fish species present, and then assess their passability under a range of anticipated project flows.	
Prepare Initial and Final Study Reports.	$15,000
Total	**$65,000**

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12 APPENDIX A: Fish Passage Study Area