Black Canyon Hydroelectric Project
FERC Project No. P-14110
Proposed Fish Passage Study Plan
September 2012

Prepared for
Black Canyon Hydro, LLC
3633 Alderwood Avenue
Bellingham, WA 98225

Table of Contents

List of Tables

1 INTRODUCTION

Black Canyon Hydro, LLC, (BCH) ultimately plans to file an application 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 (North Fork), 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.

The Project would consist of the following new facilities: 1) a 8-foot-high, 162.4-foot-long inflatable rubber diversion with associated fish passage and intake structures; (2) 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; (3) a power conduit tunnel consisting of an approximately 450-foot-deep vertical tunnel into an approximately 8,300-foot-long, 12-foot-diameter horizontal tunnel and penstock connecting to; (4) a 60-foot-long, 100-foot-wide metal powerhouse with two Francis turbine units, one rated at 16 MW and the other rated at 9 MW; (5) a 200-foot-long, 24-foot-wide tailrace; (6) a 4.2-mile-long, 115-kilovolt overhead transmission line that transmits project power to the regional grid (transmission line would be an overbuild of an existing transmission line with only approximately 0.65 miles of new transmission); (7) a 0.75-mile-long and a 0.5-mile-long extension of two existing logging roads that lead to the project facilities; and (8) appurtenant facilities (switchyard, maintenance building, etc.).

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.

BCH filed a Notice of Intent (NOI) and the associated Pre-Application Document (PAD) to commence the FERC Integrated Licensing Process 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).

2 STUDY DESCRIPTION AND OBJECTIVES

In accordance with 18 CFR §5.11(d)(1), this section describes the goals and objectives of the study and the information to be obtained. The goal of this study is to identify and develop preliminary design(s) for a maintainable fish passage and water intake structure, that when combined with adequate fish passage flows in the Project Reach, would result in passage conditions that are similar to those that currently exist for fish and aquatic organisms in the North Fork Snoqualmie River. This study, in combination with related Fisheries, Hydrology, and Instream Flow studies, will produce and consider, in consultation with biologists and engineers from state and federal regulatory agencies, and other knowledgeable individuals, various fish passage alternatives that could be implemented to achieve the energy producing goals of the project while providing fish passage.

Alternatives for fish passage will be identified and the preliminary engineering schematics for each will be developed concurrently with the design of the diversion and water intake structures. These alternative designs will be evaluated to determine water depths, velocities, and surface elevations associated with each fish passage structure over a range of post –diversion flow conditions (estimated after the other studies results indicate likely instream flow requirements). This information will ultimately be used along with other relevant study results to design a final fish passage structure where conditions remain suitable 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:

- Define objectives for fish passage at the diversion under anticipated project operations.
- Identify a range of conceptual fish passage alternatives that would potentially satisfy the objectives defined.
- In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the objectives defined.
- 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.
- Compare any impacts of the alternative fish passage structures on passability with the passability impacts of natural fish passage barriers within the study area.

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 at the Project, and the need for additional information.

A wide range of design options and specifications for fish passage suitable for the diversion and intake 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 (Fisheries Study),
- Historical streamflows and those predicted under future project conditions (Hydrology Study), 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 diversion and water intake. The proposed project may include a channel spanning structure that would, at times, act as a physical impediment to some fish passage.

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 study methodology, including data collection and analysis techniques, or objectively quantified information, sampling strategy, and a schedule 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 developed under the following process:

- Define objectives for fish passage at the diversion under anticipated project operations.
- For each structure, identify and conceptually design a range of fish passage alternatives that would potentially satisfy the objectives defined.
- In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the objectives defined.
- Select a preferred alternative.

7.1.1 Define objectives for fish passage at the diversion under anticipated project operations.

The general objectives for fish passage at the diversion 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.

Additionally, in order to define these objectives, and to later evaluate alternatives, the results of other related studies will need to be used. For example, the species type and age will affect the impact of a barrier. Biological, physical, and economic performance criteria will generally be developed in other BCH studies or found in other literature. The Fisheries Study will collect biological information, such as the minimum size of fry that can be expected at the intake and the abundance and size of fish within the study area, and characterize existing biological and physical habitat conditions, including the available range of habitat present. 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 for the conditions and outcomes expected to result from it.

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 lack of diversity of fish species present in the study area, the prevalence of accepted design guidance, and input received by regulatory agencies for this project, there may be very few acceptable design alternatives. A goal of three conceptual alternatives, each representing a unique fish passage solution, will be developed for fish passage at the diversion. Designs will likely include standard, widely accepted approaches and could also include designs that are more experimental. The designs should be developed to cover a range of different options but without an undue amount of pre-judging, otherwise viable creative approaches may be missed.

The alternative will be modeled to determine water depths, velocities, and surface elevations in the vicinity of the structures for a range of flows and to assess fish passage

conditions throughout the year. Designs will be developed at the conceptual level, and will be 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 resource areas (e.g. minimizing disturbance of terrestrial habitat);
- Operational constraints; and
- Cost.

Additionally, each fish passage alternative will be evaluated to determine water depths, velocities, and surface elevations associated with each fish passage structure over a range of post –diversion flow conditions (estimated after the other studies results indicate likely instream flow requirements).

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.

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.

Multiple fish passage barriers within the study reach likely limit how much habitat fish can access once they descend the first barrier. The Fisheries Study will help determine the magnitude and timing of fish presence within the study area, along with the size and vigor of the fish. This study will characterize existing natural fish passage barriers within the study area based upon the swimming abilities of the fish species present, and then assess whether any of the barriers are likely passable under some range of 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 pass various combinations of 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 (Fisheries Study). This information, along with information will be used to identify locations where river features are the most likely to present fish passage barriers.

The methods developed by Powers and Orsborn (1985) will then be used in the field 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 Fisheries Study. Snoqualmie Falls, located several miles downstream of the project, is a natural barrier to upstream fish movement that prevents anadromous salmonids from reaching the study area. Using the proposed approach, 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 Instream Flow, Fisheries, 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 (Instream Flows Study).

7.2.2 Compare any impacts of the alternative fish passage structures on passability with the passability impacts of natural fish passage barriers within the study area.

The evaluation of fish passage structures and calculation of water depths, velocities, and surface elevations associated with the preferred design, combined with the results of other study plans, will provide the information necessary to compare fish passability under a diversion scenario with existing impediments to fish passability within the study area.

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.

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 objectives for fish passage at the diversion under anticipated project operations.	February – June 2013
Identify a range of conceptual fish passage alternatives that would potentially satisfy the objectives defined.	June – December 2013
In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the objectives defined.	June – July 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.	See "Fisheries Study Plan"
Prepare Initial and Final Study Reports.	December 2013 – March 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 $17,500.

Table 2. Level of Effort and Cost

Task	Labor and Expenses
Define objectives for fish passage at the diversion under anticipated project operations.	$1,500
Identify a range of conceptual fish passage alternatives that would potentially satisfy the objectives defined	$10,000
In consultation with outside experts, evaluate the fish passage design alternatives identified relative to the objectives defined.	$1,000
Compare any impacts of the alternative fish passage structures on passability with the passability impacts of natural fish passage barriers within the study area.	$2,000
Prepare Initial and Final Study Reports.	$3,000
Total	$17,500

11 REFERENCES

BCH (Black Canyon Hydro, LLC). 2012. Pre-application document for Black Canyon Hydroelectric Project FERC Project No. 14110. March 27.

Burns, B, Powers, P.D., Bates, K.K., and Kidder, J. 2009. Mill Creek Fish Passage Assessment. Prepared for Tri State Steelheaders. October.

Fu, X.C., T. Tang, W.X. Jiang, F.Q. Li, N.C. Wu, S.H. Zhou, and Q.H. Cai. 2008. Impacts of small hydropower plants on macroinvertebrate communities. Acta Ecological Sinica 28(1): 45-52.

Mann, J. 2009. Mirabel Fish Screen Reconfiguration Feasibility and Alternatives Study. Sonoma County Water Agency, Santa Rosa, California. December.

NOAA Fisheries (National Marine Fisheries Service). 2011. Anadromous Salmonid Passage Facility Design. NOAA Fisheries Northwest Region, Portland, Oregon. July.

Powers, P.D., and J.F. Orsborn. 1985. New Concepts in Fish Ladder Design: Analysis of Barriers to Upstream Fish Migration, Volume IV of IV: Investigation of the Physical and Biological Conditions Affecting Fish Passage Success at Culverts and Waterfalls. 1982-1984 Final Report, Project No. 198201400. BPA Report DOE/BP-36523-1. Bonneville Power Administration. 134 pp. August.

Wahl, T.L. 1995. Hydraulic Testing of Static Self-Cleaning Inclined Screens. Prepared for The First International Conference on Water Resources Engineering. American Society of Civil Engineers. August.

———. 2000. Hydraulic Tests of Proposed Coanda-Effect Screens for Fulton Ditch: Phase I Test Results, U.S. Bureau of Reclamation. June.

———. 2001. Hydraulic Performance of Coanda-Effect Screens. Journal of Hydraulic Engineering, June, 2001, 480-488. Available at http://www.usbr.gov/pmts/hydraulics_lab/pubs/PAP/PAP-0877.pdf.

———. 2003. Design Guidance for Coanda-Effect Screens. Publ. No. R-03-03. US Department of the Interior Bureau of Reclamation, Denver, Colorado. July.

Wahl, T.L. and Einhellig, R.F. 2000. Laboratory Testing and Numerical Modeling of Coanda-Effect Screens. 2000 Joint Conference on Water Resources Engineering and Water Resources Planning & Management. July 30 – August 2.

WDFW (Washington State Department of Fish and Wildlife). 2000. Draft Fishway Guidelines for Washington State. Available at http://wdfw.wa.gov/publications/00048/. April.

———. 2009. Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual, Washington Department of Fish and Wildlife. Olympia Washington. Available at http://wdfw.wa.gov/publications/00061/.

12 APPENDIX A: Fish Passage Study Area