Black Canyon Hydroelectric Project
FERC Project No. P-14110
Proposed Instream Flows Study Plan
September 2012

Prepared for
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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 instream flows 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.

To protect physical and biological components and processes that are influenced by the flow regime in rivers, seasonally varying instream flow and ramping rate requirements are typically imposed by state and federal regulators as a condition for the licensing of new hydroelectric projects. As defined by the State of Washington instream flows are flows needed to protect and preserve instream resources and values, such as fish, wildlife and recreation. Ramping rate is the rate of change in river stage or flow that results from the diversion or release of water due to project operations. In the context of hydroelectric project licensing/relicensing, instream flows and ramping rates have traditionally focused on the protection of sensitive or economically important fish species.

In this study, we emphasize the importance of evaluating potential project effects and mitigation options based on a consideration of the full range of ecological components, functions, and processes of the North Fork. For this reason, we use the term "environmental flows" when referring to the various streamflow-mediated components that will be investigated and considered in decisions related to project operation and resource protection and mitigation. Environmental flows do not have a formal legal or regulatory meaning, but nevertheless are meant to provide a logical basis for recommending flows that are prescribed in the Clean Water Act, Section 401 Water Quality Certification issued by the Washington State Department of Ecology, and subsequently included in the FERC license for the project. In this study, we use the term to refer to flows in the Project Reach that satisfy Section 401 requirements, as well as additional allocations of flow that achieve other desirable ecological and social objectives, such as increased opportunity for recreation.

The basic premise of this study is that environmental flows can be identified and implemented that preserve the ecological integrity and enhance the benefits provided by the North Fork, including recreation and hydropower. As currently conceived, the Project will divert between 90 cfs and 900 cfs of flow from the North Fork at RM 5.0. The water will be conveyed from the intake in a buried pipeline to a powerhouse, where turbines and a generator will generate electricity, and then discharged back into the North Fork at RM 2.4 via a 200-foot long tailrace. Although streamflows in areas downstream of the tailrace discharge point may be affected to some degree by project operations, because this is a run-of-river project, the primary hydrologic impact of the project will be an

attenuation of flows in the Project Reach. As described in the Hydrology Study Plan, water diversion will increase the frequency and duration of low-to-moderate flows, and decrease the magnitude and variability of moderate flows in the Project Reach. No change is expected in the frequency or duration of very low flows in the Project Reach since the project will not likely be operated during the summer baseflow period. Similarly, only minor changes are expected in the magnitude and timing of high flows, since flows in this range are commonly on the order of several thousand cubic feet per second. For example, annual peak flows measured over the past 80 years at USGS Gage 12142000, located 4.3 miles upstream of the intake, average 8,100 cfs (median, 7660 cfs) – far greater than the 900 cfs maximum hydropower generation capacity of the project.

Two additional points warrant mentioning with respect to project operations: (1) the project will not store and release water, and therefore will not result in artificially high (i.e., peaking) or low flows downstream of the powerhouse; and (2) flows will be diverted from the North Fork into the intake only if environmental flow requirements for the Project Reach are met. This means that streamflows must exceed the environmental flow in effect at that particular time by at least 90 cfs before water can be diverted from the river. In late summer, when streamflows in the North Fork are at their lowest levels, the amount of surplus water available is unlikely to exceed the prevailing environmental flow by 90 cfs. Therefore, water will not likely be diverted and power will not be generated at this time.

At other times of the year, when flows exceed the environmental flow threshold by at least 90 cfs, the Project Reach will receive less water than it otherwise would have. Assuming that the project will divert as much water as its design allows, flows in the Project Reach will be maintained at constant levels until flows at the intake exceed the environmental flow by 900 cfs. Flows in excess of this amount (i.e., maximum capacity) will pass into the Project Reach. Depending on how rapidly the North Fork hydrograph is rising or falling, flow levels in the Project Reach would be expected to change when the minimum and maximum design flows (i.e., 90 cfs and 900 cfs) are exceeded. Because rapid and unnatural flow fluctuations may affect the movements and life cycle activities of fish and other aquatic organisms, the rate and direction of change in flow, or ramping rates, and their potential effects on aquatic biota in the Project Reach will be evaluated.

Project-induced changes in flow may affect other biophysical processes and beneficial uses of the North Fork within and downstream of the Project Reach, including large

wood and sediment transport, fish habitat, water temperatures, and recreational boating. These same processes and activities, as well as project economic viability, will be affected by the chosen design parameters of the project, environmental flow requirements, and the hydrology of the North Fork. Future hydrologic conditions are expected to change as a result of the local effects of global warming on precipitation and runoff. The effects of these variables on streamflows will be evaluated in the Hydrology Study, and on power generation in the Hydropower Potential and Project Economics Study. Additional investigations that will inform environmental flow specifications will be performed in the Fisheries Study and Fish Passage Study, as described in their respective study plans. This study will inform project design and management with the goal of avoiding or mitigating potential unwanted project impacts.

With this in mind, several objectives are proposed for the Environmental Flows Study:

- Objective 1: Identify/clarify priority and management goals for flow-dependent biological, recreational, and other resources in the study area.
- Objective 2: Investigate the effects of project-related flow modifications on fish, fish habitat, and other aquatic resources in the study area.
- Objective 3: Recommend flow-related measures that would protect or improve existing conditions, or that would avoid, reduce, and/or compensate for impacts caused by the project.
- Objective 4: Identify opportunities for modifying project operations to create flows that improve aquatic habitat and increase opportunities for high quality recreational experiences, relative to existing conditions.

The Environmental Study will be coordinated with other BCH licensing studies that are intended to inform decisions regarding project infrastructure and operations, conserve natural resources, and provide increased opportunities for recreation. Representatives of local, state and federal government agencies and tribes, and other interested stakeholders will be invited to provide input, review and comment on proposed methods and results of the study, and participate in the development of environmental flows and mitigation measures, and long-term monitoring plans.

3 STUDY AREA

The Environmental Flows study area comprises the proposed Project Reach of the North Fork Snoqualmie River, and 0.5-mile sections of river immediately up- and downstream of the Project Reach. The 2.6-mile long Project Reach extends from the point of diversion at the water intake (RM 5.0) downstream to the point where water is returned to

the river via the powerhouse tailrace channel (River Mile 2.4). The 0.5-mile sections of river above and below these two points are included in the study area so that a baseline can be established to enable an evaluation of the project's effects on the rate of change in river stage and discharge once it has been constructed.

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.

Fish and other aquatic species that make up the biological community of the North Fork represent a valuable and unique natural resource. Although the project area is located upstream of Snoqualmie Falls, and is therefore above the anadromous fish zone, the Northwest Power and Conservation Council has designated the section of the North Fork that includes the proposed Project Reach a "Protected Area". Conventional (storage dam) hydroelectric development is discouraged in these areas due to the risk it poses to local fish and wildlife populations.

This stretch of river has been recommended to Congress by the US Forest Service (USFS) for inclusion in the national Wild and Scenic River system based on its outstanding recreation value and resident trout fishery (USFS 1990). The National Park Service has reviewed documents related to the Project and has offered guidance and comments to FERC regarding relevant resource management goals (NPS 2012).

The Washington State Department of Ecology (Ecology) recommends minimum instream flows for streams and rivers that are intended protect a range of instream values and to prevent the over-appropriation of water for out-of-stream uses. The Snohomish River Basin Instream Resources Protection Program (IRPP) established minimum instream flows for the North Fork, as measured at USGS Gage 12143000, for specified dates during the year. The Supplemental Environmental Impact Statement for the IRPP concluded that the minimum flows would protect fish habitat and improve recreational boating opportunities in the North Fork.

The proposed study will assist in the development of measures to conserve ecological and recreational values of the North Fork. Specifically, it will investigate the effects of the project on instream resources and recreational opportunities under a range of plausible operational scenarios. Environmental flows will be developed that, in combination with other structural and operational features of the project, conserves fisheries and other

aquatic resources in affected areas of the North Fork throughout the year. The project's primary goals are to maintain or improve ecological components and functions, and to improve opportunities for fishing and boating in the project area relative to existing levels. When presented with information gained through this and other studies, FERC will need to decide whether the proposed action is in the public's best interest, as measured by the environmental and social costs and benefits of the project.

5 EXISTING INFORMATION

In accordance with 18 CFR §5.11(d)(3), this section describes existing information on instream flows at the Project, and the need for additional information.

5.1 Habitat vs. Flow Simulations

In 1985, the consulting firm R.W. Beck and Associates conducted an instream flow study within the Project Reach of the North Fork on behalf of its client, the Weyerhaeuser Corporation (R.W. Beck and Associates 1985). Weyerhaeuser was exploring the feasibility of constructing a hydroelectric facility on the North Fork that was similar in many respects to the project being proposed by Black Canyon Hydro, LLC. The purpose of the 1985 instream flow study was to simulate changes in habitat availability as a function of flow using the Instream Flow Incremental Methodology (IFIM; Milhous et al. 1984). IFIM is an instream flow decision-making tool that includes hydraulic (PHABSIM) and habitat (HABTAT) modeling components. In the 1985 study, water depth, water velocity, and substrate composition were measured at three flows (range 32 – 800 cfs) at 1 to 2 ft intervals along 14 transects within two study reaches in the Project Reach. The study reaches were located near the upstream and downstream ends of the proposed Project Reach, and sampled all but the steepest, most turbulent areas of the channel.

The IFG4 hydraulic simulation model was used to predict water depth and velocity at each sampling point for a range of flows. Habitat preference curves developed for different life stages of rainbow trout, which the researchers thought were the dominant fish species in the study area, were applied to the hydraulic output to quantify the amount and spatial distribution of weighted useable area (WUA, an index of habitat availability) for a range of flows within the two study reaches. The resulting WUA versus stream discharge curves were used to identify flows at which habitat was maximized for each life stage of both species. A habitat optimization matrix was constructed for each month of the year that defined the amount of WUA present for each life stage at flows 50, 60,

70, 80, and 90 percent monthly exceedance flows, which were calculated from historical streamflow records.

The 1985 IFIM study found that flows at which spawning and adult rainbow trout habitat was maximized (300 cfs and 225 cfs, respectively) were higher than those that maximized juvenile and fry rainbow trout habitat (l70 cfs and 50 cfs), when averaged across the two study sites. The WUA estimates and flow exceedance information were used to generate several instream flow scenarios for the North Fork, taking into consideration the timing and habitat requirements of different rainbow trout life stages. Based in part on the results of the IFIM study, the Washington Department of Ecology promulgated instream flow rules for the North Fork in 1988 under the Snohomish River Basin Instream Resources Protection Program (Chapter 173-507 of the Washington Administrative Code). Minimum instream flows were specified at semi-monthly intervals for normal and critical water years (Table 2). The compliance point for the specified flows is approximately located at the point of discharge of the proposed powerhouse tailrace).

5.2 Fisheries Data

Fish populations and habitat in the Snoqualmie River Basin have been surveyed on several occasions over the past several decades; summaries of these studies may be found in the BCH Pre-Application Document (BCH 2012). In 2008-2010, the upper Snoqualmie River and several of its tributaries, including the North Fork, were surveyed by WDFW biologists as part of Puget Sound Energy's efforts to relicense the Snoqualmie Falls Hydroelectric Project (FERC No. 2493). The results of the survey included information on fish species composition, abundance, distribution, age, and life history data WDFW (2011). The North Fork was sampled up- and downstream of the proposed Project Reach; however, the Project Reach was not sampled due to time constraints.

BCH has initiated additional fisheries research to characterize fish populations and habitat in the study area. Using the same methods applied earlier by WDFW (2011) researchers, BCH biologists will inventory fish populations and habitat in the Project Reach, as well as in up- and downstream control reaches, during the summer of 2012. This information will be used to identify fish species/ life stages and other aquatic resources that will be targeted in the Environmental Flows study.

5.3 Additional Information Needed

As discussed elsewhere, updated information is needed on the timing and relative abundance of different fish species and other aquatic species in the North Fork. This information will be obtained through a literature review and fisheries studies proposed in the Fisheries Study Plan. Similarly, updated statistical analyses of streamflow data are needed to characterize the existing flow regime, which can then be related to the ecological components, functions, and processes of the North Fork in areas that are likely to be affected by the proposed project. These analyses will be performed in the Hydrology Study.

A major part of the Environmental Study will entail the application of IFIM methodology to evaluate project impacts and develop environmental flows for the Project Reach. The hydraulic data collected in the 1985 IFIM study (R.W. Beck and Associates 1985) appear adequate as input to a more current version of the PHABSIM hydraulic model. Additional measurements may be taken to better define river discharge-stage relationships and roughness coefficients within the two study reaches. The relative weighting assigned to the IFIM study transects will be updated based on data collected in the Geomorphology, Sediment and Wood Transport Study.

Based on comments received from other licensing participants, the habitat preference criteria used to develop habitat vs. discharge curves for rainbow trout in the 1985 IFIM study are out-of-date and need to be updated. Additional criteria will need to be developed for rainbow trout and other species of fish and aquatic organisms that will be evaluated in the Environmental Flow study. We propose to develop new habitat preference criteria based on a review of current scientific literature, information obtained from other IFIM studies, and consultation with Ecology, WDFW, and other knowledgeable experts.

6 NEXUS TO PROJECT

In accordance with 18 CFR §5.11(d)(4), this section describes any nexus between Project operations and instream flows.

When reviewing a hydropower license application, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and other socioeconomic benefits. To do this effectively, the Commission requires up-to-date, reliable information on existing resources, an accurate

description of the effects the project may have on these resources, and recommendations on how effects that are not in the public interest can be avoided, minimized, or mitigated.

Potentially detrimental effects of the project include alteration of hydrologic and hydraulic processes, especially in the Project Reach, where flow attenuation will be accompanied by reductions in water volume, depth, velocity, and surface area. Project infrastructure and operations are also likely to alter sediment and large wood transport and depositional processes, which may affect in turn the morphology of the channel and availability and quality of habitat over time. These and other project-related effects may adversely affect local fish and aquatic macroinvertebrate populations. Although these physical and biological effects will be primarily limited to the Project Reach, there is potential for them to influence ecological components, functions, and processes in areas downstream of the project.

This study will inform project management decisions so that undesirable project impacts can be avoided or mitigated in the future.

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).

The Environmental Flows Study will comprise the following objectives:

7.1 Objective 1: Identify priority and management goals for flow-dependent biological, recreational, and other resources in the study area.

- In consultation with agency, tribal, and private stakeholders, identify priority ecological, recreational, and developmental resources that will be the focus of environmental flows.
- Clarify management goals for flow-dependent resources in the study area.
- Compile existing information on fish and macroinvertebrate populations, habitat, recreation, and other flow-dependent resources within the study area.

7.2 Objective 2: Investigate the effects of project-related flow modifications on fish, fish habitat, and other aquatic resources in the study area.

- Collect additional flow, hydraulic, channel morphology, substrate, etc. data needed to model the hydraulic characteristics of the Project Reach, relying as much as possible on the 1985 IFIM study.
- Compile habitat preference criteria for key species/life stages of fish and other organisms (i.e. macroinvertebrates) that are to be included in the updated IFIM study.
- Rerun hydraulic and habitat simulation models to predict habitat availability as a function of flow for selected species and life stages.
- Describe habitat availability in the Project Reach under the existing (baseline) flow regime based on IFIM modeling results and other information.
- Describe habitat availability in the Project Reach under different project infrastructure and operation scenarios, and compare to baseline conditions.
- Based on IFIM model results and other information, describe the potential effects of the project on populations of fish and other aquatic organisms in the Project Reach.

7.3 Objective 3: Identify flow-related measures that would protect or improve existing conditions, or that would avoid, reduce, or compensate for impacts caused by the project.

- Identify opportunities for modifying project operations to create a flow regime in the Project Reach that benefits resident fish, habitat, and increase opportunities for high quality recreational experiences, relative to existing conditions.
- Identify flows that will provide for the unrestricted movements of fish and other aquatic organisms in the Project Reach, subject to flow availability.
- Evaluate ramping rate effects on target species and recommend rates for water diversion and discharge that conserve ecological, recreation, and other resources in the Project Reach.
- In consultation with agencies, tribes, and stakeholders, develop environmental (instream) flow rules for the Project Reach, and ramping rate recommendations for water withdrawal and discharge.

7.4 Objective 4: Develop a research and monitoring plan to ensure that environmental flows are being met.

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*
Identify priority management goals for flow-dependent biological, recreational, and other resources in the study area.	February – March 2013
Investigate the effects of project-related flow modifications on fish, fish habitat, and other aquatic resources in the study area.	April – August 2013
Develop monitoring plan to ensure that environmental flows are being met and operational changes made, if appropriate.	December 2013 – January 2014
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 $28,500.

Table 2. Level of Effort and Cost

Task	Labor and Expenses
Identify priority management goals for flow-dependent biological, recreational, and other resources in the study area.	$3,500
Investigate the effects of project-related flow modifications on fish, fish habitat, and other aquatic resources in the study area.	$17,000
Develop a monitoring plan to ensure that environmental flows are being met and operational changes made, if appropriate.	$4,000
Prepare Initial and Final Study Reports.	$4,000
Total	$28,500

11 REFERENCES

Milhous, R. T. , D. L. Wegner, and T. Waddle, 1984. User's Guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper 11. U.S.D.I. Fish and Wildlife Service, Office of Biological Services. FWS/OBS—81/43 Revised.

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12 APPENDIX A: Instream Flow Study Area