Black Canyon Hydroelectric Project
FERC Project No. P-14110
Geology and Soils Study Plan
November 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 and would be located entirely on private lands.

The Project design being proposed has been updated in response to stakeholder input. BCH has developed potential alternatives for the intake structure, powerhouse, and transmission route.

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 overbuild 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.

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 geology and soils, 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 describe existing geology and soils as well as any potential impacts of Project construction and operation. Specifically, the objectives of the study are to:

- Evaluate slope stability.
- Locate relevant bedrock within the Project area.

3 STUDY AREA

The study area of the Geology and Soils Study Plan is the area of physical disturbance related to Project construction and operation. Additionally, there will be a heavy emphasis placed on slope stability in the vicinity of the diversion and powerhouse (and slope immediately above the powerhouse). Beyond the site of the diversion and powerhouse, efforts to identify bedrock will focus primarily on the proposed tunnel corridor.

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.

Section 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the Project, as well as power and developmental values.

Describing the project effects on geology and soils in the area of physical disturbance related to Project construction and operation is necessary to fulfill the Commission's responsibilities under the National Environmental Policy Act (NEPA). Ensuring that potential environmental measures associated with geology and soils related to the Project are analyzed is relevant to the Commission's public interest determination.

5 EXISTING INFORMATION

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

5.1 Geology

The following description of existing information related to the geology in the vicinity of the Project was copied from Section 5.1.1 of the Pre-Application Document (BCH 2012). The geology of the Upper Snoqualmie Basin is complex and unique in terms of the scale and extent of glacially derived sediments in the area. The unique aspect of the glacial history of the Upper Snoqualmie area is its location at the historical margins of both continental glaciers that entered the Puget Sound from Canada, and alpine glaciers that

descended from the Cascade Mountains. The confluence of these two glacial environments provided for large accumulations of sediment.

According to the U.S. Geological Survey, much of the surficial deposits within the project area are a result of glaciation related to the Cordilleran Ice Sheet during the Pleistocene epoch. The dominant types of surficial deposits in the project area are recessional outwash deposits. Recessional outwash deposits are composed of stratified sand and gravel, moderately to well sorted, and well-bedded silty sand to silty clay, deposited in proglacial and ice-marginal environments. Largely plane-bedded outwash and foreset deltaic deposits are common in the lowlands, but fine-grained deposits from ice-damned lakes in major west-draining alpine valleys and at low altitudes are also present along the Snoqualmie and Skykomish River valleys.

The PAD filed for the Calligan project describes local geologic material as ranging from Mesozoic to Quaternary in age with bedrock consisting of slightly metamorphosed sedimentary rocks (Snohomish PUD, 2011a). Primarily, greywacke-sandstone and argillite, with less amounts of phyllite and slate. The bedrock in the so-called "Calligan Formation" (to the northwest of the Project area) is part of a Mesozoic mélange belt and contains lenticular inclusions of sandstone and lesser amounts of greenstone, metagabbro, chert and other lithogligies in a sheared matrix of argillite.

According to the Final Environmental Assessments issued in response to the Calligan and Hancock projects, bedrock in the area is commonly mantled by veneer of quaternary colluvial soils or by glacial drift (FERC, 2002). The sedimentary rocks are primarily hard, competent rocks which have weakly metamorphosed and deformed by folding and shearing. The glacial drift includes kame terrace deposits, recessional outwash, and till. The kame deposits consist of a heterogeneous fluvial deposit. The fluvial outwash deposits are clean to silty sands and gravels, with thin beds of silt and fine sand. There is also a mixture of silty sandy gravels with boulders and cobbles.

Appendix H of the PAD includes a map of the Snoqualmie Watershed Geology and the associated key created by the King County Department of Natural Resources and Parks Water and Land Resources Division.

5.2 Soils

Section 5.1.1 of the Pre-Application Document (PAD) includes a discussion of soil types in the vicinity of the Project as provided by the U.S. Department of Agriculture's Natural

Resources Conservation Service (BCH 2012). Additionally, Appendix G of the PAD includes a map, key, and soil summary as provided by the Web Soil Survey Tool provided online by the National Resources Conservation Service.

6 NEXUS TO PROJECT

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

Construction and operation of the Project may have an impact on geology and soils in the immediate vicinity. A geology and soils study will help to identify the most effective, least impact route for the proposed tunnel corridor as well as evaluate any potential slope stability issues related to Project construction and operation.

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 Objective 1: Literature Review

- Initially, available information from applicable federal, state, and local natural resources agencies relevant to geology and soils will be reviewed. Additionally, if possible, any records or past geology and soils studies performed by current or historic land managers will be reviewed and summarized. Well log records in the area may also be helpful in characterizing area geology and soils.

7.2 Objective 2: Preliminary Geotechnical Assessment

- Conduct a site investigation of soil, rock, fault distribution and bedrock properties on and below all project facilities to determine their engineering properties including how they will interact with, on or in the proposed construction. With adequate identification and appropriate design, soil and slope hazards can be determined in advance, and design parameters developed to reduce risk, and provide a high likelihood for project success without adverse impacts.

- Non-intrusive methods will be used to conduct a preliminary geotechnical assessment. The purpose of this initial work will be to provide useful information regarding the thickness of soil overburden, as well as depth and quality of underlying bedrock. The proposed methods are seismic refraction and electrical resistivity tomography (ERT).
- An ERT methodology will be performed along three profile lines approximately 250 feet in length. The three proposed profiles will be located approximately at:
    - Intake Structure: in the vicinity of the intake structure.
    - Powerhouse/Penstock: across the orientation of the penstock descending downslope towards the proposed powerhouse ; and
    - Powerhouse: to characterize the soils and geology in the area of the powerhouse.

7.3 Objective 3: Data Processing and Analysis

- Process data collected from Objectives 1 and 2 and produce a document summarizing results and recommendations related to design, construction and operation.
- Identify any additional information required to complete necessary design and construction necessary to complete a License Application.
    - If Objective 3 identifies additional information needs, there may be a need to complete a drilling program to identify the most efficient and effective orientation of the tunnel corridor.

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*
Proposed Study Plan Meeting	October 8, 2012
Proposed Study Plan Comments Due	December 6, 2012
File Revised Study Plan	January 7, 2013
Revised Study Plan Comments Due	January 22, 2013
Literature Review	2013
Preliminary Geotechnical Assessment	2013
Data Processing and Analysis	2013
Initial Study Report filed with FERC	February 6, 2014
Initial Study Report Meeting	February 21, 2014
Initial Study Report Meeting Summary	March 10, 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 $35,250.

Table 2. Level of Effort and Cost

Task	Labor and Expenses
Literature Review	$5,000
Preliminary Geotechnical Assessment	$24,250
Data Processing and Analysis	$3,000
Field Visits and Meetings	$2,500
Digital Renditions	$500
Total	$35,250

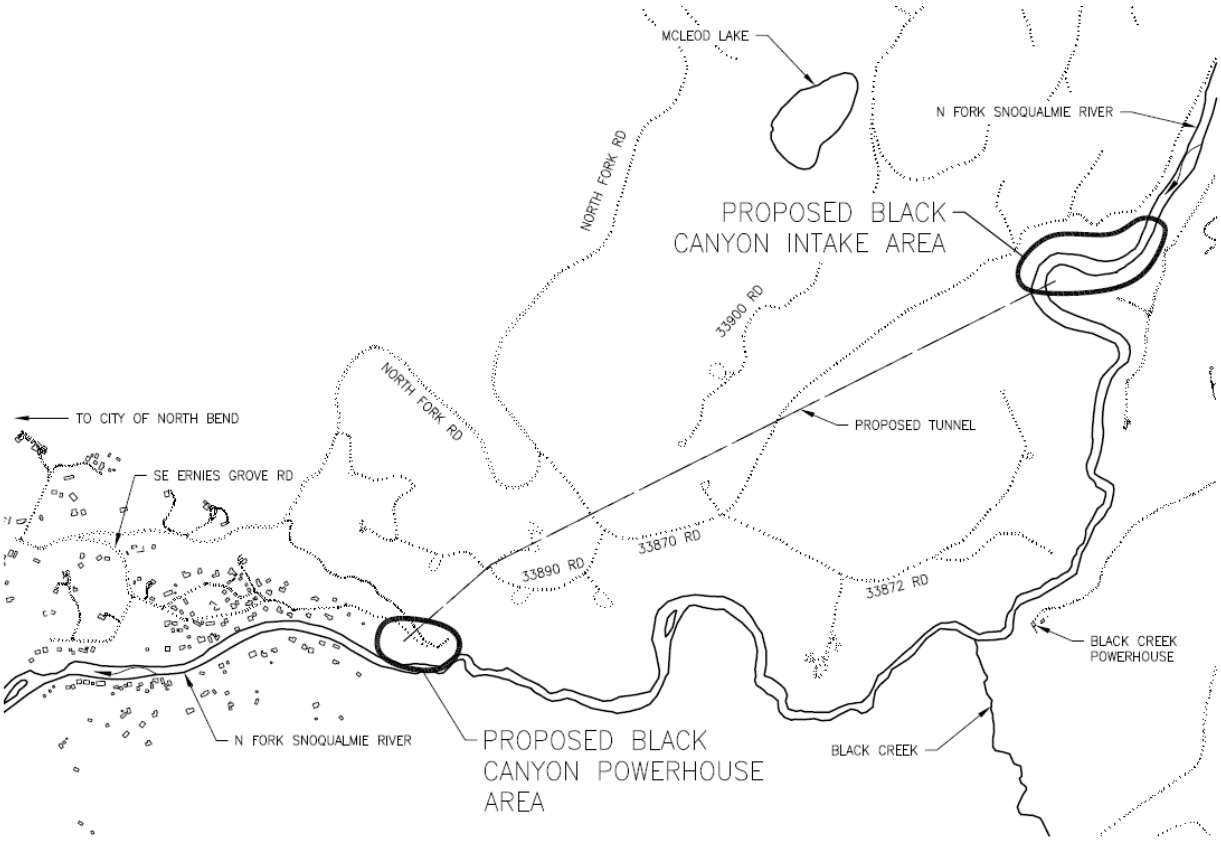
11 REFERENCES

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

FERC. 2002. Final Environmental Assessment, Application for License Amendment, Calligan Creek Project, FERC Project No. 8864, Washington. Federal Energy Regulatory Commission, Office of Energy Projects, Division of Environmental and Engineering Review, Washington, DC, February 2002.

Snohomish PUD. 2011a. Pre-Application Document, Calligan Creek Project, FERC Project No. 13948, Washington. September 2011.

12 APPENDIX A: Geology and Soils Study Area



*Preliminary Geotechnical Assessment approximately within two circled areas.