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Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
ATTN: DHAC, PJ-12.2
888 First Street, N.E.
Washington, D.C. 20426

Project No. 14110-001 – Washington
Black Canyon Hydroelectric Project
Black Canyon Hydro, LLC (BCH)

Re: BCH Response to Agency and Stakeholder Comments on 2nd Year Groundwater Study Report

Dear Secretary Bose,

Black Canyon Hydro (BCH) submitted the 2nd Year Groundwater Study Report for agency and stakeholder review on June 10, 2015. A corrected errata version was submitted immediately thereafter on June 11, 2015. On June 15, 2015 BCH provided a notice of public meeting to be held on June 23, 2015 at 1:00pm at City of Snoqualmie City Hall to review the results of the study. BCH thereafter submitted the study results meeting summary on July 10, 2015. Agencies and stakeholders provided comments on the study report and made requests for additional information and further study. Commenting was concluded on August 10, 2015.

FERC Staff made comments and issued requests for additional information (1). Comment letters were also received from the Snoqualmie Tribe (2), King County (3), City of Snoqualmie (4) Gray & Osborne/City of Snoqualmie (5), David Zarett/THR,LLC/Eric Traut/Deana Pollard Sacks (6), THR,LLC/Susan Wilkens (7), Lynda Roberts (8) and Andrew Heintz (9). All comment letters referenced above were reviewed by BCH.

Comments on the groundwater study results and requests for additional groundwater study will be responded to in accordance with 18 CFR § 5.15 of the Commission's regulations. Comments that do not directly pertain to the study results, review meeting summary or criteria for requesting additional study will not be responded to in this forum. BCH will reference comments by author number listed above. Response to comments will be grouped when multiple

authors raise the same issue. Selected comments will have a **bold header** and all BCH responses will be in *italics*.

FERC Staff (1)

1. To determine the hydraulic groundwater-surface water interaction between the North Fork Snoqualmie River and the Canyon Springs aquifer, you were required to install and screen a fourth piezometer (P4) adjacent to P2. The screen intervals would be separated by the maximum extent possible to allow for quantifying the magnitude and direction of the vertical hydraulic gradient within the Canyon Springs aquifer. The Updated Groundwater Study Report failed to mention the installation of P4. In your responses to comments on the study report and meeting, due on September 8, 2015, please provide a thorough technical discussion of the conditions encountered that prevented the installation of this fourth piezometer, and the technical reasons why eliminating the piezometer did not compromise the study objectives as required by section 5.15(f) of the Commission's regulations.

BCH Response to 1,6,7

A field determination was made that installation of P4 adjacent to P2 would be unnecessary. The study plan included a second hole because the plan assumed there would be a direct groundwater connection observed between the river and the aquifer at the location of P4 and P2. Completion of P2 demonstrated there was no direct connection at that location, and the depth interval between the river bed elevation and the top of the aquifer included at least 35 feet of dusty dry soil and over 100 ft. of unsaturated soil. These field conditions clearly illustrated that co-located piezometers would be ineffective in measuring a vertical gradient in groundwater between the river and the aquifer at that location. Elimination of a second hole did not compromise the study objectives, which were effectively addressed at that location with the data provided by completion of P2.

Upon completion of P2 in the field, the professional geologist on site assessed the P2 soil samples, soil moisture, and zone of saturation. The apparent zone of saturation was located at approximate depth 176 ft. below ground. Later monitoring of P2 indicated a stable water surface elevation below that at approximate depth 180 ft. below ground. Bedrock was encountered at approximate depth 218 ft. below ground. The river bed elevation in the vicinity of P2 corresponds to approximate depth 65 ft. below ground. There was no zone of

saturation at the approximate river bed elevation. Below the river bed elevation the P2 soil samples included an interval approximately 35 ft. thick with zero moisture. The samples were dusty dry, and there were no signs of oxidation that would indicate periodic wetting and drying. Signs of oxidation in the soil samples were first noted below this level at depth 166 ft. below ground. Based on these observations demonstrating P4 would be a dry hole at the proposed location if installed per plan with a screening level that bracketed the elevation of the riverbed.

Shane Cherry, Licensed Geologist

2. You also were required to provide a geochemical analysis of connectivity that included sampling and analysis of wells, springs and surface water for inorganic constituents, and general chemistry parameters. The study report indicates that you completed the sampling, but does not provide a comprehensive discussion of the results. We recommend that you include in your draft license application, a thorough discussion of the results of the inorganic samples, and their utility in defining the recharge components to the aquifer.

BCH Response to 1

Inorganic sampling of the river, springs and piezometers was performed during November 2014 and April 2015 for the parameters listed in the following:

Study and QA Plan,
Geochemical Characterization,
Black Canyon Hydropower Project
FERC P-14110
and Canyon Springs Aquifer
November 2014

All samples were processed and data reviewed. Comparison of routine chemistry and field parameters between the November 2014 and April 2015 groundwater, spring, and river samples do not reveal any significant differences that consistently and clearly characterize the spring samples as being either a groundwater or river source. A dry season round of sampling was collected on August 27, 2015 from the river, springs and seeps. Piezometer wells will be sampled the third week of September 2015. BCH will produce a summary report of all data collected during wet & dry season sampling, a review of relevance or any indication of relationships between surface and groundwater sources based on the

results of inorganic sampling. BCH will submit the report with the Draft License Application.

3. The study report stated that a large, previously unknown area east of the North Fork Snoqualmie River provides recharge to the Black Canyon Aquifer and the City of Snoqualmie water-supply springs. The report also identified a thin zone of saturation above bedrock at the P2 and P3 locations, with an unsaturated zone over 150-foot-thick below the stream bottom to the top of the water table at the P2 location. In order to confirm that these findings do not represent a temporal anomaly, we recommend that you continue to collect seasonal water level measurements in all piezometers through December 2015 (summer to winter 2015 season). We also recommend that you include in the draft license application the following information to support your findings:
    a. Average monthly water-level elevation measurements from all three piezometers;
    b. Utilizing all available wells and sprig discharge locations, prepare groundwater elevation flow maps showing the direction of the horizontal component of groundwater flow from both the east and west areas adjacent to the North Fork Snoqualmie River, and the Canyon spring(s) discharge area; and
    c. Groundwater balance/recharge analysis for the Canyon Springs aquifer utilizing precipitation over the previously known recharge areas, newly defined area(s), and any seepage loss observed/measured along the North Fork Snoqualmie River.

BCH Response to 1

Water level monitoring of the wells has continued since their installation. Recording sensors have been placed in P-2 and P-3 since March 2015. The water level in P-1 has remained minimally above the bedrock layer, approximately one foot, and has varied less than one foot. P-1 is measured routinely but does not use a sensor. BCH will continue to monitor water levels and prepare the information requested in a-c above utilizing available information. BCH will attempt to estimate seepage loss at and above the elevation of Canyon Springs within the bypassed reach on the west side of the river. The information requested above will be submitted with the Draft License Application.

4. To quantify the outflow contribution of Canyon Springs to the North Fork Snoqualmie River, you were required to collect samples during the wet season and a dry season (late summer/early fall) for laboratory analysis of stable isotopes of Oxygen (^{18}O and ^{16}O) and Hydrogen (^{2}H and ^{1}H), as well as for

major cation and anions, and general chemistry parameters. The Updated Groundwater Study Report provided the results of the November 2014, February 2015, and April 2015 sampling events, but failed to mention a sampling event for the dry period.

In your response to comments on the study report and meeting, due on September 8, 2015, please explain why this sampling was not conducted and why eliminating this information does not compromise the study objectives as required by section 5.15(f) of the Commission's regulations. An analysis of these parameters collected during the dry season is important because it would eliminate the effect of direct precipitation over the project area, and help to differentiate if there are any additional dry-season sources of recharge to the Black Canyon Aquifer.

If the samples were collected as requested, use the geochemical information from the water samples to analyze and calculate the amount and source of recharge water to Canyon Springs. Please include a comparison of these data with the results of the November 2014, February 2015, and April 2015 sampling events in your draft application.

If samples were not collected as requested, additional sampling and analysis of the dry season water quality may be needed and the samples should be collected prior to September 30 of this year to prevent delaying the filing of your license application. Once collected, we recommend that you use the geochemical information from the water samples to analyze and calculate the amount and source of recharge water to Canyon Springs. Please also provide a comparison of these data with the results of the November 2014, February 2015, and April 2015 sampling events. We recommend that the results be filed in your draft license application.

BCH Response to 1,3,5,6,7

The Groundwater Study Report discussed that the data collected during November, February, and April adequately addressed the objective of the groundwater study because of the strong similarity between the springs and the groundwater and the weaker similarity between the river and the springs. However, while the data are relevant and may meet the general objective, none of these samples are from the low-flow period and as such do not meet the specific requirements as required by collecting a

low-flow sample as describe in section 5.15(f) of the Commission's regulations.

For this reason, low-flow samples were collected from the river, springs, and seeps on August 27, 2015, the day before the heavy rain that was predicted and occurred the following few days. The piezometers will be sampled in the third week of September; P-1 will not be sampled if it contains insufficient water level, as suggested by the low water level recorded in it throughout the summer. All of these samples will be analyzed for the same routine inorganic constituents and stable isotopes as were analyzed for the November and April sampling events.

The data collected to date, as presented in the Groundwater Study Report are useful to understand the source of water to the springs and the relative contribution of the river to the springs. A brief review of the process of inquiry follows:

Concern for the City of Snoqualmie water supply elicits the question:

> *Will reduction in streamflow within the bypass reach impact City water supply by reducing recharge to the groundwater by a measureable or meaningful amount within the bypass reach during hydropower production?*

Meaningful reduction to City springs could be assumed to occur if discharge from the springs is recharged to a significant degree by groundwater recharge from the river within the bypass reach. The primary question that the geochemistry investigation is seeking to answer follows:

> *Is groundwater recharge from the river within the bypass reach a significant source of water to the City springs?*

A hypothesis, which is stated as if true, is then either supported or refuted by the data.

> *Hypothesis: Recharge to the groundwater from the river within the bypass reach is a significant source of water to the springs.*

Using the process of scientific inquiry, if the hypothesis is true, and we measure the geo- chemical signature of the river, springs, seeps and groundwater quarterly throughout the year, then we should observe a significantly stronger

geochemical similarity between the river and the springs and a weak or small similarity between the river and groundwater.

To date, the data shows a weak similarity between the isotopic signature of the river and the springs, but they show a strong similarity between the groundwater and the springs. As such, the data refute the hypothesis that the proposed bypass reach provides significant recharge to the springs. While the data refute this hypothesis, it is also true that the data do not refute the hypothesis that no recharge from the river occurs within the bypass reach. However, that hypothesis would not be possible to refute or support.

If the low-flow data are consistent with the conceptual model that has been developed from the geochemical, water level, topographic, and geologic data presented in the Groundwater Study Report, then there should be sufficient and seasonally representative data to refute the stated hypothesis and to conclude that recharge from the bypass reach does not provide a significant amount of water to the City springs.

Laura Strauss, LG, LHg

BCH will submit a final report comparing the results of all four sampling periods and their interpretation as to the relationship of groundwater source to spring water discharge as requested above with the Draft License Application.

5. In your responses to comments on the study report and meeting, due on September 8, 2015, please compare the findings of the seismic-wave analysis of AMEC 2012 Geophysical study for the proposed intake area with the boring analysis in the Updated Groundwater Study, which concludes that a glacial hardpan aquitard prevents recharge to the Canyon Springs aquifer from stream-flow losses from the North Fork Snoqualmie River.

BCH Response to 1,2,3,7

With reference to the following report:

August 17, 2012
AMEC Project 2-915-17460-0
Preliminary Geophysical Study
Black Canyon Hydroelectric Project
FERC Project No. P-14110
King County, Washington

The seismic wave analysis performed at the intake site line shows that all the P-wave velocities were less than 5,000, which according to the stated method would indicate that there is no rock (which is usually indicated by 10,000 or above) and no saturated groundwater (usually 5,000 or above). The other resistivity profile is not conclusive, it is speculated. As seen in the other non-intake report profiles, similar resistivity may be boulders, not bedrock. The interpretation that the river is losing water here is unsubstantiated speculation at the time without any other investigated basis other than the assumption that by virtue of proximity, the river should match the groundwater level and/or lose water. That would be true if the river is not effectively "perched" on low permeability material that prevents it from draining into the underlying strata. Note the following statement from the conclusions section of the above referenced report:

Intake Structure Profile 1 – of the three profiles, bedrock was least evident at this site. An interpretation of the bedrock surface as provided by Global is shown. The ERT plot is interpreted to show a bedrock at 15 to 20 feet below ground surface near the center of the profile, but sloping steeply away at each end of the profile. Typically, seismic P-wave velocities for competent bedrock would be 10,000 feet per second or more. If bedrock is present it would be highly fractured and decomposed. Seismic P-wave velocities of groundwater would be 5,000 feet per second, however measured velocities were lower than this. Given the proximity to the river, it was expected that a groundwater table would have been encountered. This plot suggests the river is "losing" flow into the underlying gravelly formation in this stretch, which may be the case.

Conclusions and Recommendations - On the basis of the evaluation, these geophysical methods appeared to be effective at evaluating the depth to bedrock. Figures 2 and 3 appear to have shown reasonable interpretations of bedrock depths and orientation based on our observations of site topography and bedrock outcrops at the site. Geophysical methods will need to be combined with test borings in areas where deeper gravel or landslide deposits are present such as the Intake site. Once definitive bedrock contacts can be identified, geophysical methods will be useful for inferring the shape of the bedrock surface between borings.

Subsequent to this report BCH completed the P-2 bore hole at the intake site. The bore logs are included in the Groundwater Report as Appendix B. The bore log for P-2 indicates a layer of hardpan and consolidated fines, crumbly, gray and dry at about 66 ft. below ground. This layer is about 6 ft. thick here.

The seismic acoustic line and the P-2 bore hole are located approximately 400 ft. apart. Some variability in findings may be expected as a result. However, the data collected from the bore hole, with recovered cores, is very definitive and far more certain and precise than seismic acoustic investigative methods.

An impermeable, or low permeability layer lying under the river in this location is supported by the bore hole data showing a hardpan layer at P-2 at elevation 945 ft., which is about the same elevation as the lowest riverbed elevation immediately to the south of P-2. In addition, a tight, hardpan and/or cemented layer are evidenced in the river bank and bed along this section of river from the intake downstream to the beginning of the rock canyon at RM 4.7. Furthermore, discharge differential measuring as provided in the Groundwater Study Report was not able to detect, with statistical significance, any appreciable loss of discharge in the 2500 ft. long reach in excess of 3cfs.

6. Figure 6 in the Updated Groundwater Study appears to have incorrectly plotted Samples E-1-2 and E-3-2. In your responses to comments on the study report and meeting, due on September 8, 2015, please correct figure 6, and re-interpret the data and conclusions as needed.

BCH Response to 1,5,7

Item 6 of FERC Appendix A indicates that data points for April 2015 sampling shown on Figures 5 and 6 are inconsistent with the isotope results summarized on Table 5. The technical memo submitted to Whitewater Engineering on June 9, accidentally included the draft version of Table 5 that was included in the draft technical memo submitted on June 1. Isotope Tracer Technologies re-analyzed the data and sent results of the re-analysis on May 29, 2015. The data was incorporated into the project files and was used to update the graphs and Table 5. The draft and final technical memos include graphs that reference the most recent (re-analyzed) lab results. However, these memos inadvertently did not include the updated Table 5 (it needed to be replaced as it was already prepared before receiving the new results). The updated Table 5 is included with this memo, as is the report from Isotech Tracer Technology. This updated Table 5 indicates that results are from the May 29 data submittal. Please replace the previous Table 5 with this updated table in order for the graph to be consistent with the reported data.

Commenters 2,5,7

The above commenters questioned whether the discharge differentials measured between the upper stream discharge gage at the Intake and the middle stream discharge gage located approximately 2500 ft. downstream was indicative of a losing river reach. There was also argument that this would be a significant source of recharge for Canyon Springs.

BCH Response to 2,5,7

Measurements were taken 3 times during low flow periods from August until early October 2014. Measured flows ranged from 61.3cfs to 115cfs. The maximum average discharge differential of any of the three measurement periods was 2.98cfs. BCH states that this variability is not significant given the limits of precision of the measuring method. BCH maintains that a result of between 4 and 7.5cfs or greater (depending on flow) would need to be observed to be considered a statistically valid differential. BCH believes that the main result of this method was to determine that a loss of greater than 4 to 7.5cfs (depending on flows) over the measured reach was not occurring.

In the event that the maximum observed differential of 2.98cfs was in fact accurate and occurring as measured during October 9, 2014, when average flows were around 100cfs, the infiltration rate would be about 1.3 vertical ft. per sq. ft. of (wetted) river bottom surface area per day.

Based on aerial photos of the subject river reach on June 8th, 2015, at approximately 100cfs flow, based on USGS Gage 12142000 located 4 miles upstream, there would be approximately 195,000 sq. of wetted river bottom area located between the two gages within the approximately 2500 ft long reach. (Photo of wetted surface area polygon method)

Hence:

Loss of 2.98cfs/195,000sq.ft. x 60seconds x 60mins x 24hrs = ft./day/sq. ft. of infiltration.

By most measures this would be considered very slow, indicative of a very tight substrate. Considering the separation in elevation between the river bottom and the underlying aquifer at P-2 of over 100ft of dry strata, it does not appear likely that infiltration from the river is a significant source of aquifer recharge. Furthermore, if this is a pathway it will not be interrupted by hydro operations as

there will be minimum flow requirements that will maintain the wetted river bottom contact area of potential infiltration.

Commenters 2,3,7

The above commenters question the validity of the presence of hardpan or other such strata that may result in the river being perched essentially from RM 5.3 down to RM 4.7. Some commenters propose that the riverbed is in fact soft and porous based on their field observations.

BCH Response

BCH had licensed geologist Shane Cherry examine the riverbanks and bottom to the extent accessible between the Intake at RM 5.3 and the head of the Canyon at RM 4.7. The observations and conclusions are presented in the Groundwater Study Report and strongly suggest that the river is in fact perched throughout this reach. Ample visual evidence is provided as well as a map of contacts observed. As stated by one commenter, "hardpan" is a colloquial term with a potential range of description. BCH does not dispute this variance, and perhaps could be more concise in geologic descriptions, but Mr. Cherry's observations concluded that the geologic contact that underlies the river within this reach functions as an aquatard. There is a range of characteristics of compacted glacial till along this reach; some places are quasi-cemented, some places with excess fines, some places where there appears to be a periodic "top-seal" of silt which becomes crusty.

The "hardpan" glacial till layer identified in the P-2 bore hole log was a lens about 6 feet thick. Mr. Cherry observed hardpan contacts along the river bank ranging in thickness from 6-8 ft., continuous into and presumably under the river.

Certain strata exposures may be prone to weathering, scouring and periodic burying due to river processes. BCH does not doubt that one may find areas of impermeable strata weathering, or differential hardness.

The conclusion of an impermeable layer under the river combines the observations of little measured flow differential (loss) between gages, bore log strata indicating a compacted hard layer six feet thick below river elevation and isotope data indicating a week relationship between river chemistry and spring chemistry. The presence of dry geologic strata under the river elevation to the extent of more than 100 ft. before encountering groundwater makes this the most likely scenario.

BCH did not attempt to determine the overall extent of such a barrier layer of "hardpan". Compacted glacial till appears to be a relic of glaciation, originating from the NW as a thick ice sheet moving to the SE, halting at the base of the hillslopes to the east and then receding. Based on the abutting slopes, post glacial recession drainage landforms and intersecting hanging basins it would appear likely that this layer would have diminished moving eastward and be significantly interrupted, eroded, broken up and swept away during rupture of glacial meltwater ice dams and constant erosional processes intensified along the base of the abutting hillslopes. Noteworthy are the absence of any post glacial surface water courses crossing the east side of the river valley south of Hancock Creek to just south of the Intake site. Also note the absence of any seeps, springs or run-off on the east bank of the river upstream of the intake until one reaches Hancock Creek. Based on these observances and post glacial meltwater processes, any previously formed underlying confining till layer would likely be disrupted, leaving a deep trough of unconsolidated glacial outwash deposits.

This concludes the extent of the BCH response to comments on the 2nd Year Groundwater Study Report. BCH will continue to move forward in a collaborative way that allows for meaningful stakeholder participation, while at the same time, respecting the time constraints and other obligations imposed by the FERC's ILP. All stakeholders are encouraged to contact BCH at either (360) 738-9999 or cspens@tollhouseenergy.com any time with any input related to this proceeding.

Sincerely,

Chris Spens
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