Black Canyon Hydroelectric Project
FERC Project No. P-14110
Revised Water Quality Study Report
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1 EXECUTIVE SUMMARY

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, King County, Washington. The Project has a proposed generating capacity of 25 megawatts (MW) and would be located predominantly on private lands. The combined maximum hydraulic capacity of the four project turbines would be 900 cubic feet per second (cfs). The minimum hydraulic capacity at which power can be generated is 40 cfs. The run-of-river project (i.e., no water impoundment) would divert water from an approximately 2.7-mile section of the river between river mile (RM) 5.3 and 2.6. This reach is referred to as the Project Reach.

As required by the Integrated Licensing Process of FERC, BCH conducted several studies to evaluate a wide range of potential impacts associated with the Project.

A baseline water quality study was conducted over a 10 month period to measure basic water quality parameters including temperature, dissolved oxygen, pH and turbidity on an approximately monthly basis and dissolved nutrients and certain pesticides on a quarterly basis.

RESULTS SUMMARY

Water quality measurements for the above listed parameters met state water quality standards designated for this section of the North Fork Snoqualmie River with two exceptions.

The 7-DADMax temperature standard of 16°C established for Core Summer Salmonid Habitat was periodically exceeded during low river flow and high air temperature periods during late summer.

The pH measurements recorded in situ were mostly within the 6.5 - 9.5 mg/L range prescribed for all aquatic life use categories in WAC 173-201A-200. There was one outlier which occurred at the lower sampling location in August, again, when river flows were at a minimum.

Nitrogen and phosphorus levels were generally low in the North Fork. No pesticides were detected in any samples. These results were consistent with prior study findings on the North Fork. The overall water quality within the North Fork Snoqualmie River is considered to be very good.

2 INTRODUCTION

2.1 OVERVIEW

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 generating capacity of 25-megawatts (MW) and would be located predominantly on private lands. The combined maximum hydraulic capacity of the four project turbines would be 900 cubic feet per second (cfs). The run-of-river project would divert water from an approximately 2.7-mile-section of the North Fork.

2.2 PROJECT DESCRIPTION

Intake

The following description of intake features reflects an evolution in project design since the filing of the Pre-Application Document (PAD) through scoping, stakeholder comment, and study results. As a result of completing relevant studies, two possible design alternatives have been developed for the intake. These Alternatives are called Alternative C and D. Both alternatives involve bulk water screening located at approximately river mile 5.3, on the same river bend and point-bar as Alternative A. Alternative C uses a vertical plate screening system, and Alternative D uses a horizontal plate screening system.

Both alternatives would have a (1) control sill to control the normal water surface elevation and maintain a consistent river bed elevation for a side channel bulk-water intake. The control sill would consist of a concrete weir with boulders inset on the surface over top of a sheet pile cutoff wall to capture hyporheic flow. The sill would be at the newly established grade of the river bed and would allow uninterrupted flow through a natural looking re-profiled river as a roughened channel series of step pools, riffles, and boulder weirs. (2) An intake structure with a coarse trashrack, jib crane, and radial gate with sluiceway located on the east bank of the river. Diverted water would be conveyed through; (3) an open channel to a; (4) head gate control structure and into a; (5) fish and debris screening structure. (6) Fish and debris would be screened and bypassed back into the river. Screened water would then flow through a power conduit to the underground powerhouse. (7) Access to the intake site would use an existing logging road and approximately 400 feet of new roadway extending to the intake site.

Powerhouse

The powerhouse location would be located underground beneath the selected intake site. This would include a (1) 450-feet tall, 30-foot diameter vertical shaft to allow space for the power penstock(s), elevator, stairs, ducting, mechanical, and electrical chases. Screened water from the intake screen system would be delivered down a (2) vertical power penstock(s) to the powerhouse. The powerhouse would (3) use four Pelton Turbines each rated at 6.25-MW, as well as appurtenant facilities. The (4) powerhouse substation and (5) elevator building would be located near the intake structure.

Tailrace

The tailrace will be an approximately (1) 8,600 foot long 12 foot diameter tunnel, and is anticipated to be constructed primarily in bedrock. The tailrace water return to the North Fork would be located at approximately the same location as proposed in the PAD at approximately river mile 2.6.

Transmission

Transmission would consist of a 34.5-kilovolt underground transmission line and overhead transmission that transmits project power to the regional grid. The transmission line would be sited predominantly on an existing power line corridor. The transmission line would originate at the powerhouse substation located at the intake site at river mile 5.3. Subsurface transmission would follow the vertical shaft to the underground powerhouse, and down the 1.6 mile long tunnel. After exiting the tunnel the transmission would travel underground 1.0 miles on new and existing roads then 4.2 miles as 34.5-kilovolt overhead transmission line predominantly following an existing power line corridor to the point of interconnection. The point of interconnection is located at an existing overhead transmission line near the intersection of 396th Drive SE and SE Reinig Road approximately 0.4 miles from the City of Snoqualmie. A new switch and substation would be added at the point of interconnection to transform voltage from 34.5-kilovolt to 115-kilovolt.

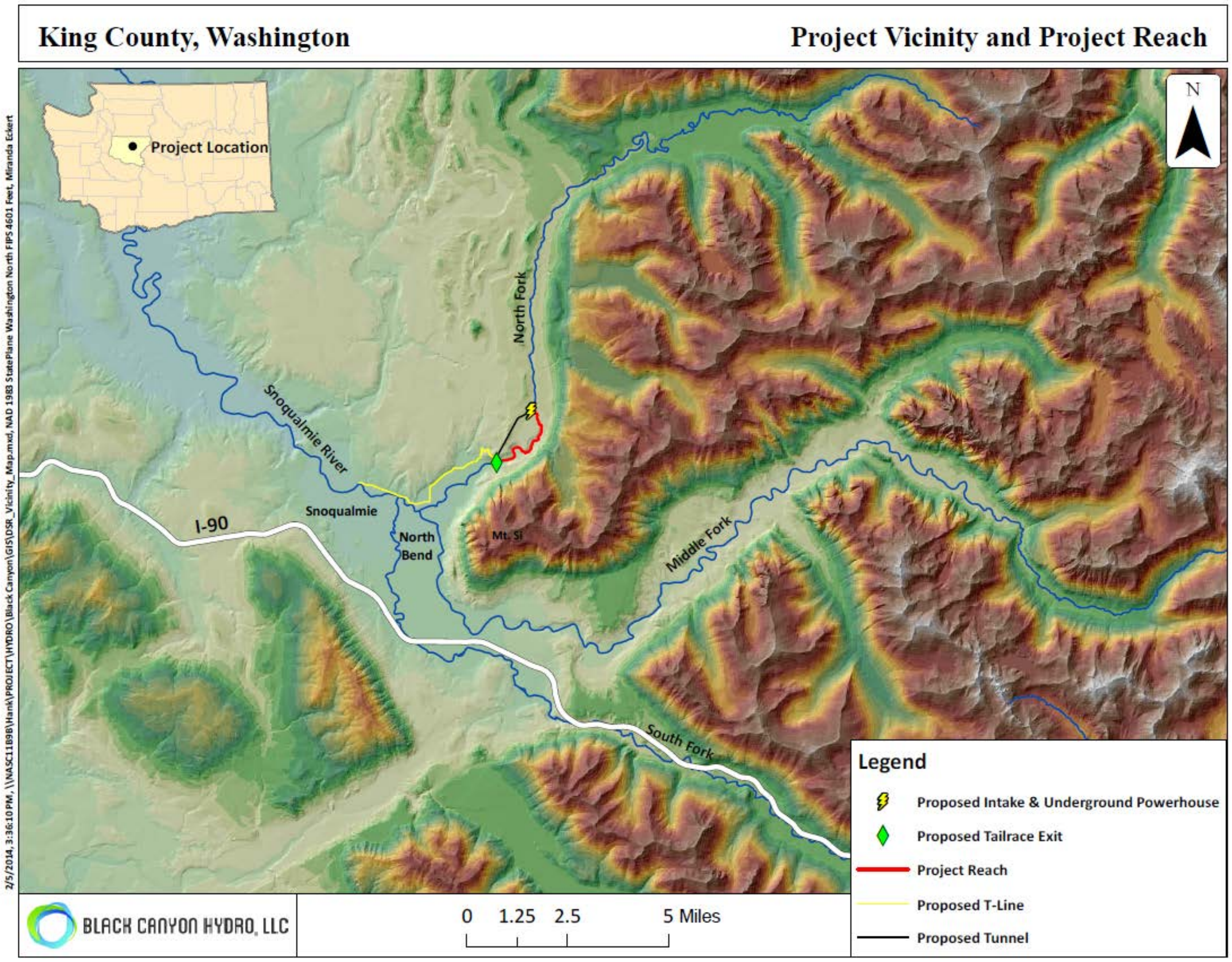

Figure 1 - Project vicinity, principal feature locations, and reach.

3 DESCRIPTION OF STUDY

3.1 PURPOSE

Black Canyon Hydro 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 submitted relevant resource study plans on January 7, 2013. The Water Quality Study is being conducted by Black Canyon Hydro, LLC to address FERC regulations (18 Code of Federal Regulations [CFR] 4.41) for water quality information related to the Project.

The Water Quality Study was conducted according to the Revised Water Quality Study Plan (Black Canyon 2013). The Study Plan described the purpose, objectives, approach, and methods for the evaluation of the water quality of the proposed water source for the Project. The Water Quality Study includes a comprehensive laboratory analysis to support a license application to FERC, including (1) measurements of parameters listed in Washington Administrative Code (WAC) 173-201A-200 excluding bacteria; (2) sampling for the presence of pesticides, and; (3) measurement of nitrogen and phosphates, (18 CFR 5.18(b)).

3.2 STUDY GOALS AND OBJECTIVES

The goals of the study are to determine if the current numeric water quality standards (listed in WAC 173-201a) are being met. The study has three principal objectives:

1. Literature review of existing pertinent water quality data for the North Fork Snoqualmie for historical and comparative purposes.
2. Water quality sampling for temperature, dissolved oxygen, pH, turbidity, nutrients and pesticides.
3. Water temperature modeling to determine the effects of Project operation on water temperatures.

3.3 EXISTING INFORMATION

Changes in water quality resulting from water diversion for hydropower generation have been reported in the scientific literature (Kibleer 2011). Water quality parameters such as water temperature that are sensitive to changes in discharge have been linked to changes in habitat quality and structure, and corresponding shifts in the distribution and abundance of fish and macroinvertebrate species (Miller et al. 2007). Thermal response to flow reductions in the Project Reach is a function of stream size and orientation, hydraulic conditions, degree of shading, and the influence of groundwater inputs. Reductions in the volume of water in the Project Reach may lead to temperature changes below diversions. Reduced discharge may increase interactions between surface water and groundwater. Based on temperature models for hydropower production, Meier et al. [2003] reported that in unshaded stretches of placid flow, diversion will increase water temperatures, whereas steep, shaded streams with rapid flow will resist temperature changes when dewatered (Kibler 2011).

The Washington Administrative Code (WAC) includes fresh water use designations and water quality standards associated with these water uses (WAC 173-201A-200 and WAC 173-201A-602). Appendix A summarizes the fresh water use designations for the North Fork, between its confluence with the Snoqualmie River main stem and river mile 17, where Sunday Creek meets the North Fork. The Project area is wholly within this segment of the North Fork. The segment of the North Fork affected by the Project is designated for use as "Core summer salmonid habitat" and as "Extraordinary quality primary contact waters."

Water quality in the North Fork sub-basin is generally very good. The sub-basin is almost entirely forested within a patchwork of federal, state and private ownership. Over 97 percent of the sub-basin is forestry land. The final 2.5 miles of the North Fork flow through designated rural residential areas that include small-scale livestock and other agricultural operations.

According to the Snoqualmie Watershed Quality Synthesis Report (Kaje, 2009), the North Fork showed no evidence of water quality impairment except for temperature; however, the North Fork sub-basin is a basin of concern for temperature during the summer months despite the area's forested nature. There have been minor failures to meet standards; however, in some cases the failure may have been a localized problem. Forestry practices and natural conditions are the most likely causes of high temperatures (Kaje, 2009). The presence of a broad, low-gradient, east-to-west oriented valley in the upper basin also may naturally promote warm temperatures. The valley aspect is very exposed to late summer solar heating, and the effect may be compounded by a slow, meandering river channel.

Temperature

In 2006, the North Fork met the state temperature standard of 16 °C near the Middle Fork confluence, except for a critical period lasting 1 to 2 weeks. Natural conditions contribute to these warm temperatures in the North Fork. The channel migration zones for portions of the upper North Fork are wide, allowing for considerable solar input even when mature riparian vegetation exists. Tree heights also appear to vary suggesting that shading on portions of the North Fork will likely improve over time as trees mature (Ecology, 2011).

The North Fork basin is a "basin of concern" for water temperature (Kaje, 2009). The 16°C 7-day average of the daily maximum temperatures (7-DAD Max) standard applies to the North Fork as far upstream as the Sunday Creek confluence, in the middle of the valley described above. The 12°C standard applies to the river and associated tributaries further upstream.

During Ecology's TMDL effectiveness study, temperature near the mouth of the North Fork (at 428th Avenue SE) exceeded the 16°C standard on a few occasions, but summer sampling was limited to the month of August (Ecology, 2008). Ecology's draft temperature TMDL study collected continuous data in the summer of 2006 at the same location (Ecology 2006). The standard was exceeded for approximately three weeks in July, with a maximum 7-DADMax value of 19.0°C (Figure 7).

The North Fork is cooler than the Middle Fork by several degrees, according to Ecology's continuous data from July 2006. That finding is supported by thermal infrared data collected during the same period – the North Fork has a discernible cooling influence on flow from the Middle Fork.

Fecal Coliform Bacteria

According to the Snoqualmie Watershed Water Quality Synthesis Report, the North Fork is not impaired by fecal coliform bacteria (Kaje, 2009). The entire length of the North Fork is classified as Extraordinary Primary Contact for purposes of fecal coliform standards.

Dissolved Oxygen

Available data shows that dissolved oxygen (DO) concentration meets state standards in the North Fork.

pH

Washington State Department of Ecology reports the North Fork meets standards for pH.

Nutrients

Nitrogen and phosphorus levels were generally low in the North Fork.

3.3 PROJECT NEXUS TO WATER QUALITY

In determining whether to issue a license for this project, the Commission considers a number of public interest factors, including water quality.

4 STUDY METHODS

In accordance with 18 CFR §5.11(d)(1) and §5.11(d)(5), this section provides a detailed description of the study methodology. The study will include (1) a literature review of existing information on water quality in the project area (2) baseline water quality monitoring for temperature, dissolved oxygen, pH, turbidity, nitrogen and phosphorus nutrients, pesticides, ; and (3) temperature modeling estimating potential effects of project operation on water temperature.

4.1 LITERATURE REVIEW

Information available from studies conducted near the Project Reach or within the Project Reach is included herein.

4.2 BASELINE WATER QUALITY MONITORING

Water quality monitoring was conducted to establish baseline levels and to evaluate surface water quality as per WAC 173-201standards. Sampling locations are shown in Figure 2.

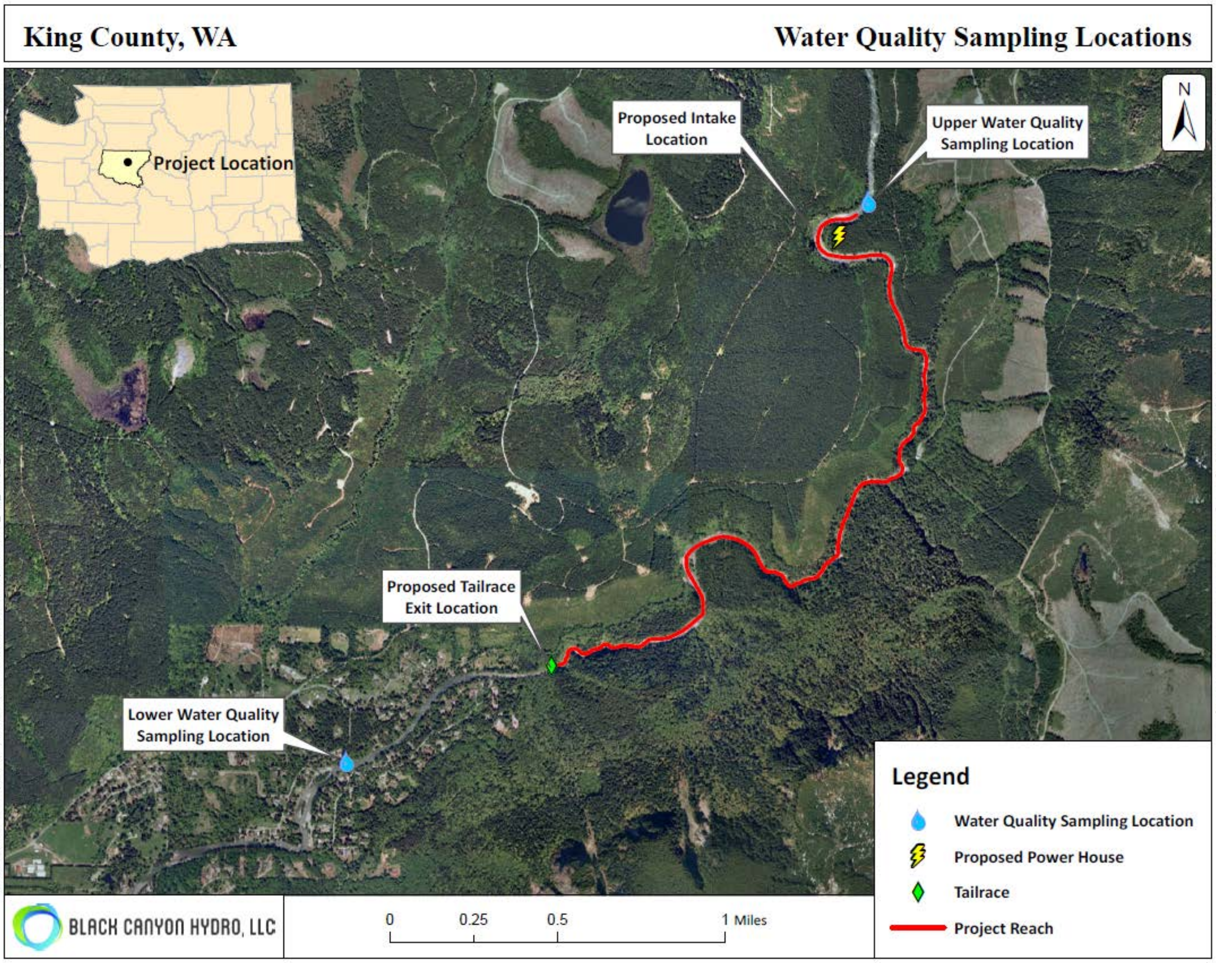

Figure 2 - Sampling location for water quality parameters.

Constituents measured at the sampling locations are summarized in Table 1and Table 2. Items listed in Table 1 were measured using in situ field probes. Samples sent to labs for analysis are summarized in Table 2 with the method code for laboratory analysis.

Table 1 - Field Analysis Water Quality Parameters and Sampling Frequency

Parameter	Frequency
Temperature	Continuously recorded at 15-minute intervals
Dissolved Oxygen	Monthly
pH	Monthly

Table 2 - Laboratory Analysis Parameters, Sampling Frequency, and Method Code.

Parameter	Frequency	Method Code
Turbidity	Monthly	SM 2130B
Pesticides	Quarterly	Gas Chromatography
● Diazinon	Quarterly	8270 GCMS
● Chlorpyrifos	Quarterly	8270 GCMS
● Dimethoate	Quarterly	8270 GCMS
● Malathion	Quarterly	8270 GCMS
● Ethyl Parathion	Quarterly	8270 GCMS
● Sulfotepp	Quarterly	8270 GCMS
● Disulfoton	Quarterly	8270 GCMS
● Methyl Parathion	Quarterly	8270 GCMS
● Phorate	Quarterly	8270 GCMS
Nutrients	Quarterly	
● N-Ammonia	Quarterly	EPA 350.1M
● N-Nitrate	Quarterly	Calculated
● N-Nitrite	Quarterly	EPA 353.2
● Nitrate + Nitrite	Quarterly	EPA 353.2
● Total Phosphorus	Quarterly	SM 4500 PE
● Ortho-Phosphorus	Quarterly	SM 4500 PE
● Total Kjeldahl Nitrogen	Quarterly	EPA 351.2

4.3 TEMPERATURE MODELING

BCH will develop a water flow model to help predict project temperature impacts. The model will estimate the travel time and thus exposure to heating or cooling influences in both the Project Reach and the proposed tailrace tunnel to assist in developing predictions about project effects on water temperature.

For hydroelectric projects utilizing a long tunnel, the Washington Department of Fish and Wildlife recommends an evaluation of:

- Heat conduction from the walls of the tunnel during low diversion flow; and
- Energy dissipation heat gain in the powerhouse bypass valve or through a turbine operating inefficiency at maximum diversion flow.

5 RESULTS

The study results are summarized by constituent. In the event of a non-detect testing limits are provided.

5.1 BASELINE WATER QUALITY MODELING

5.1.1 Temperature

Temperatures recorded as part of the study are shown in Figure 3 as 7-DADMax. The 7-DADMax is the 7 day average of the daily maximum temperature. WAC aquatic life temperature criteria in fresh water are shown as well as supplemental criteria developed by Ecology specific to the North Fork of the Snoqualmie River.

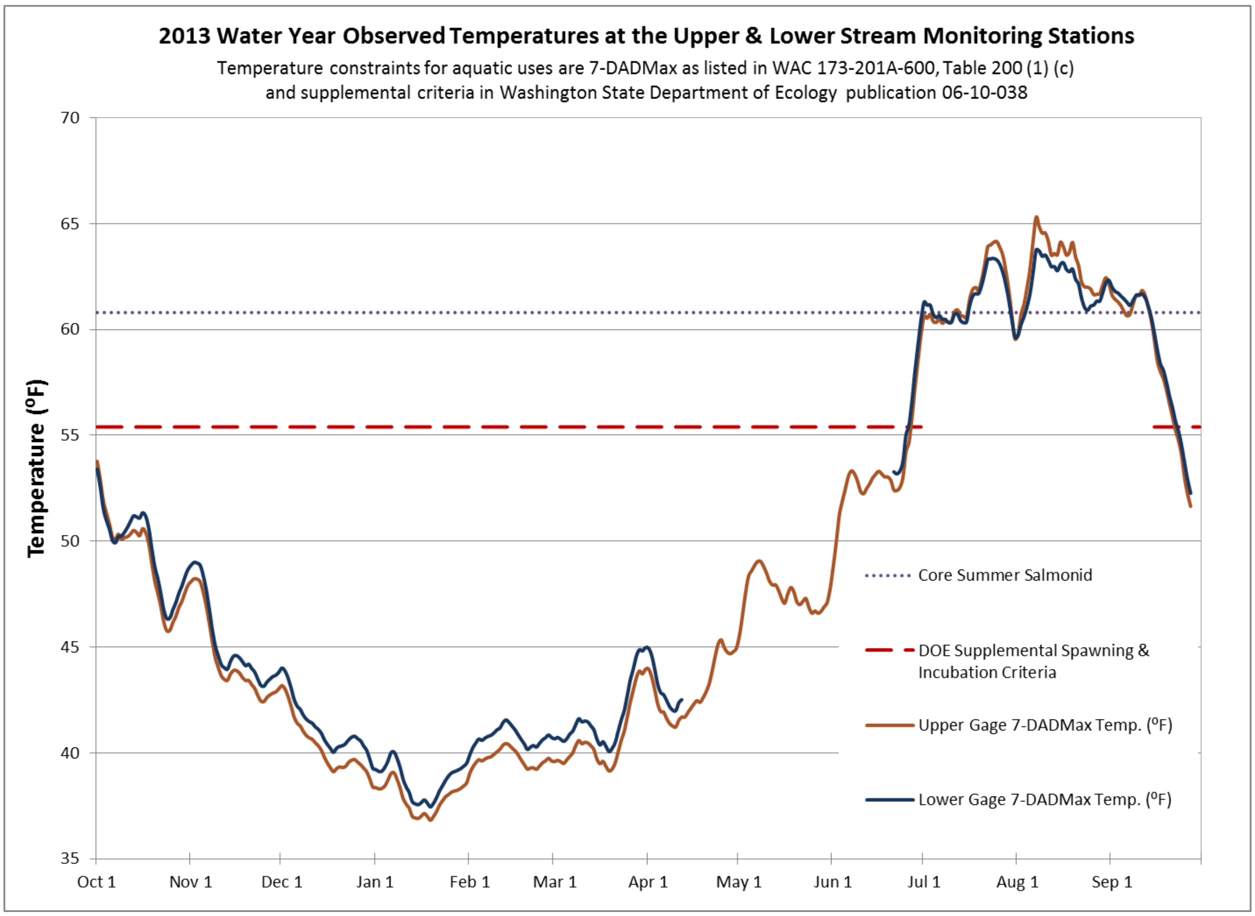

Figure 3 - 7-DADMax temperatures and relevant water quality criteria and constraints.

There are notable trends in the data from the up- and downstream gages with respect to the functional role of the project reach on temperature in the North Fork. During the fall and winter months the temperature at the downstream end of the reach is warmer than the upstream gage location. The reverse is true during the summer months. This temperature signature is indicative of the influence of groundwater inflows that are known to occur in the project reach.

Groundwater remains at a relatively constant temperature throughout the year in comparison to surface water temperatures which are largely influenced by seasonal changes in air temperature and solar radiation. Figure 4 shows the average groundwater temperatures across the United States. From this figure groundwater in the project area would be expected to be in the range of 52 or 53º F (11.1 or 11.7º C). Also shown in this figure are local ground temperatures. These represent the stable average ground temperatures greater than 30 feet below the surface which remain constant over the course of the year. There is a close correlation between these values in any given location across the country. In the area of the project site the ground temperature is indicated as 53º F (11.7º C). Both groundwater and ground temperature are relevant to the project and its potential effects on water temperature in the project reach.

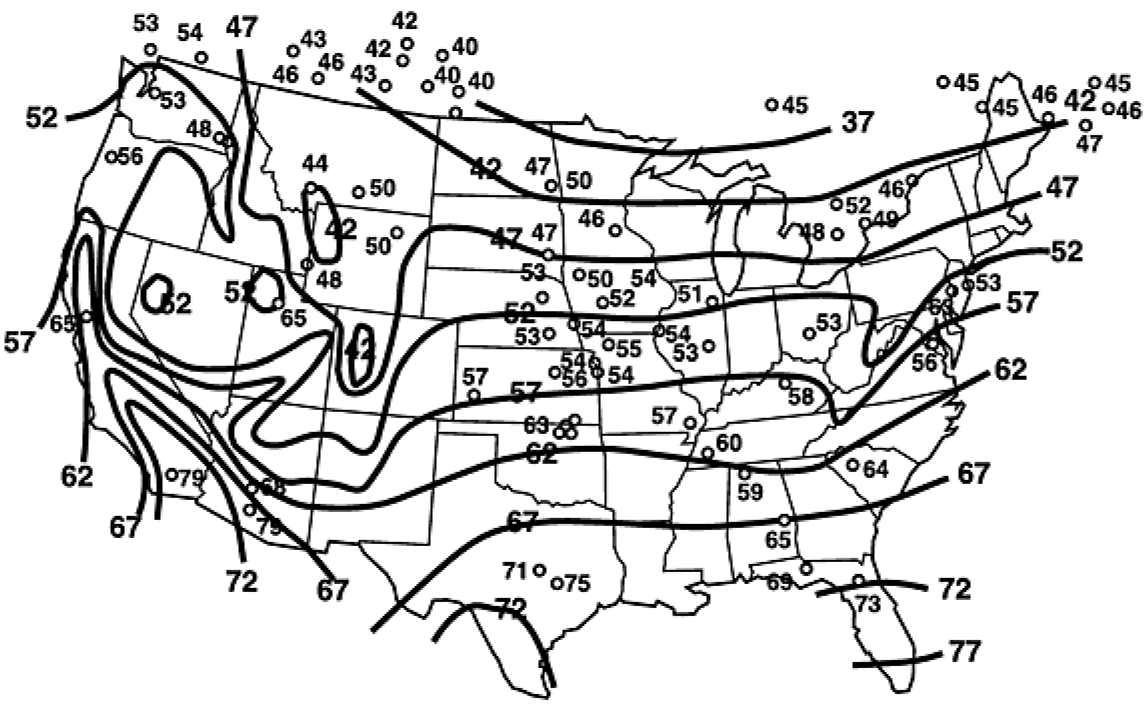

Figure 4 – Groundwater temperature contours across the US with spot ground temperatures.

The groundwater and ground temperatures are relevant to the project in at least two ways. First, the inflow of groundwater springs into the North Fork in the project reach is well known and is used as a drinking water source for the City of Snoqualmie. These springs flow continuously throughout the year and provide inflow to the project reach. As shown in Figure 4 this water is likely in the temperature range of about 53 º F (11.7º C). In comparison, surface water temperatures in the North Fork vary from about 37 to 65º F (2.8 to 18.3º C). Thus, inflows of groundwater will, in the winter, tend to increase the temperature in the North Fork, and in the summer they will tend to lower the temperature in the project reach. This latter effect is clear in the water temperature data in Figure 3 above.

Secondly, the tailrace facility is proposed to be a 12 foot diameter tunnel that will be up to 450 feet below the ground surface at the project intake and exit just above the level of the river at the discharge point 2.6 miles downstream. The 8,600 foot long tailrace tunnel will be expected to be at the average ground temperature for the area of 53º F (11.7º C). Thus, water flowing through the tunnel will be influenced by the temperature of the surrounding bedrock and will tend to be warmed in the winter and cooled during the summer. The amount of this effect will vary with time and discharge as transit times through the tunnel vary from about 19 to almost 41 minutes depending on the volume of flow through the project. The amount and effectiveness of heat exchange between the bedrock and the water will vary as a function of these relationships. Therefore, it is expected that at low flows (longer transit time and less water volume) there would likely be greater effects of this heat exchange and proportionally greater cooling in the project water in the summer months. The inverse would likely be the case during higher project flows in the winter months.

5.1.2 Dissolved Oxygen

Dissolved oxygen levels recorded over the course of the study are presented in Figure 4. All measurements were at or above accepted solubility thresholds for oxygen dissolved in water. All measurements taken were above the dissolved oxygen criteria for aquatic life in fresh water as listed in WAC 201A-200 Table 3.

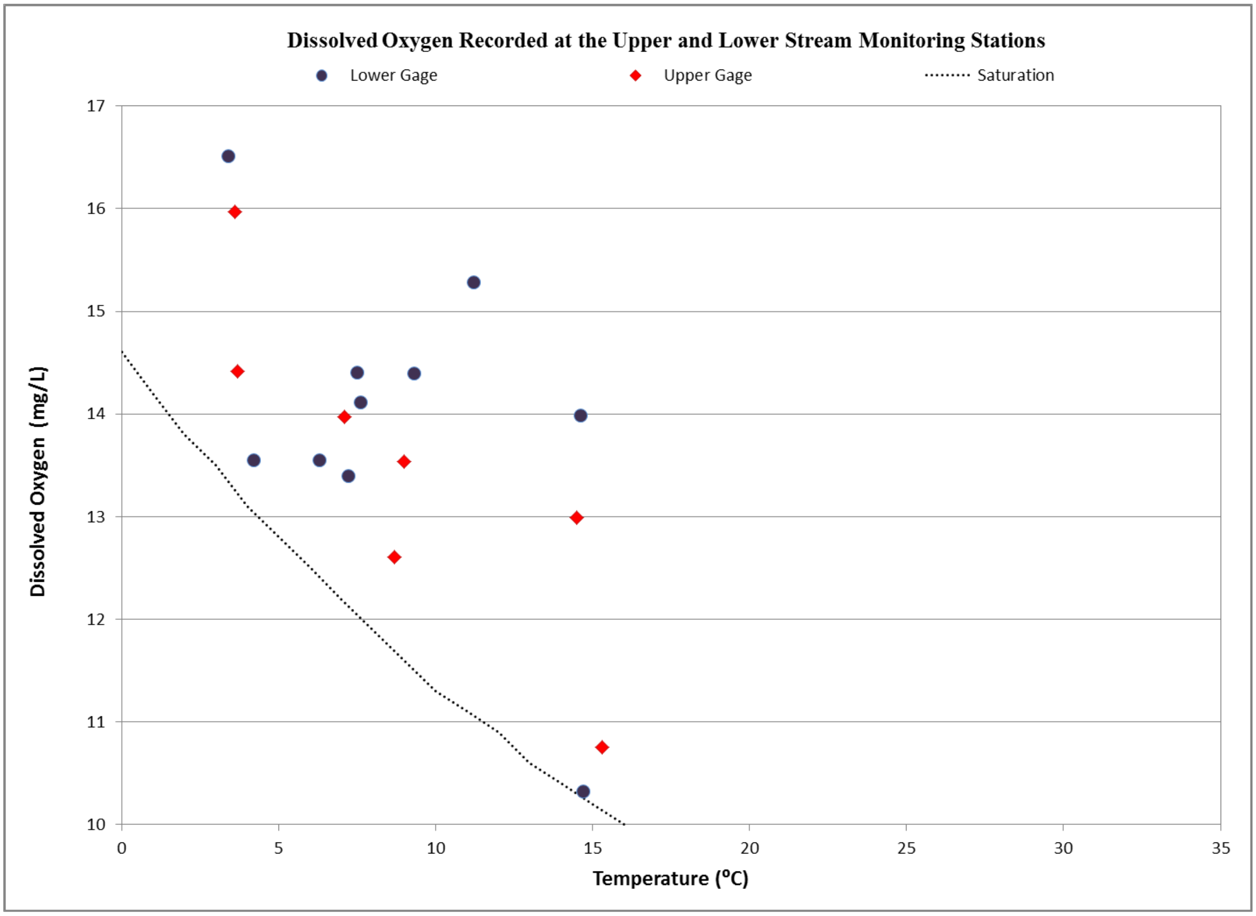

Figure 4 - Dissolved oxygen (mg/L) measured at the upper and lower monitoring stations.

Table 3 - Aquatic life dissolved oxygen criteria in Fresh Water (WAC 173-201A-200).

Category	Lowest 1-Day Minimum
Char spawning and rearing	9.5 mg/L
Core summer salmonid habitat	9.5 mg/L
Salmonid spawning, rearing, and migration	8.0 mg/L
Salmonid rearing and migration only	6.5 mg/L
Non-Anadramous interior redband trout	8.0 mg/L
Indigenous warm water species	6.5 mg/L

5.1.3 pH

pH measurements recorded in situ were mostly within the 6.5 - 9.5 mg/L range prescribed for all aquatic life use categories in WAC 173-201A-200. There was one outlier which occurred at the lower sampling location in August when flows were at a minimum.

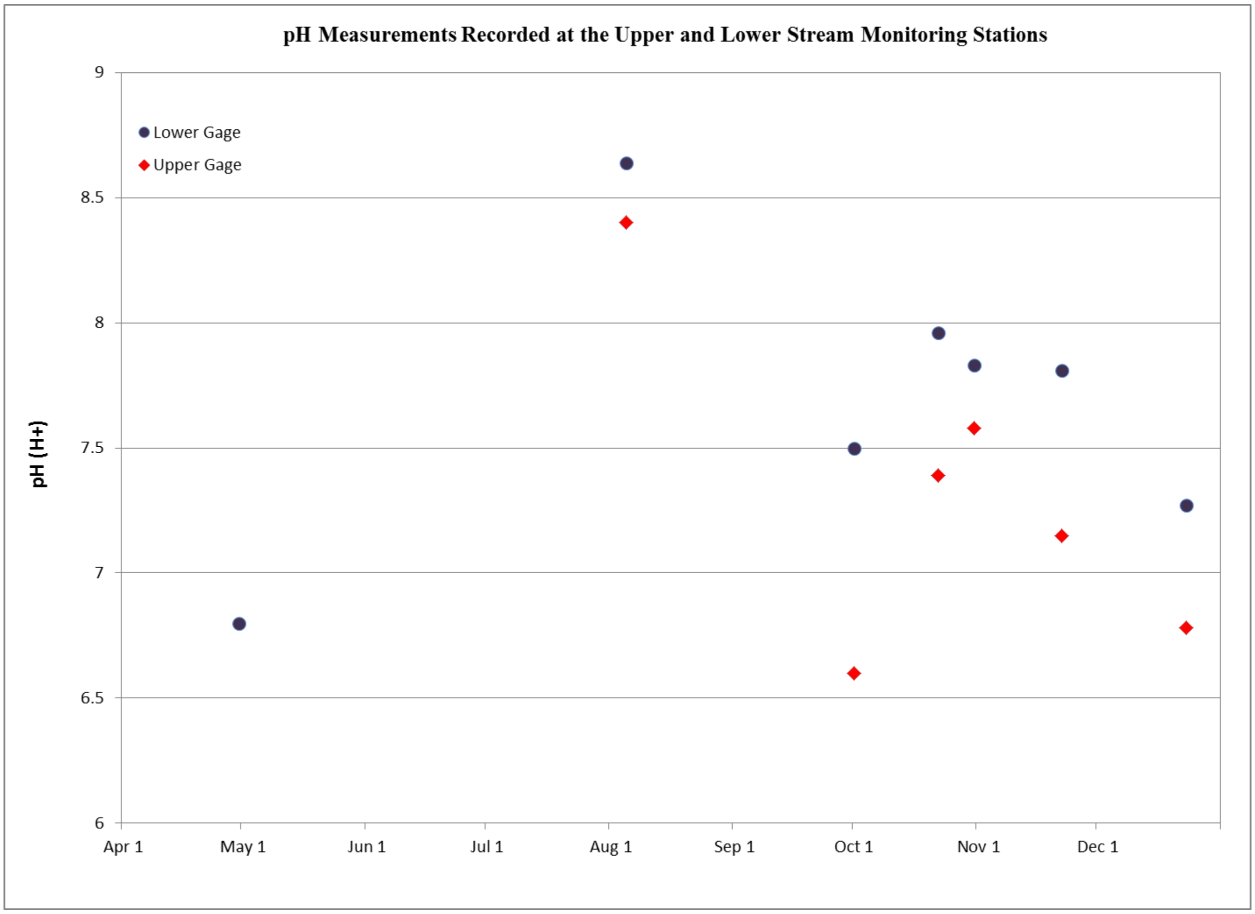

Figure 5 - pH measurements recorded in situ at the upper and lower sample sites.

5.1.4 Turbidity

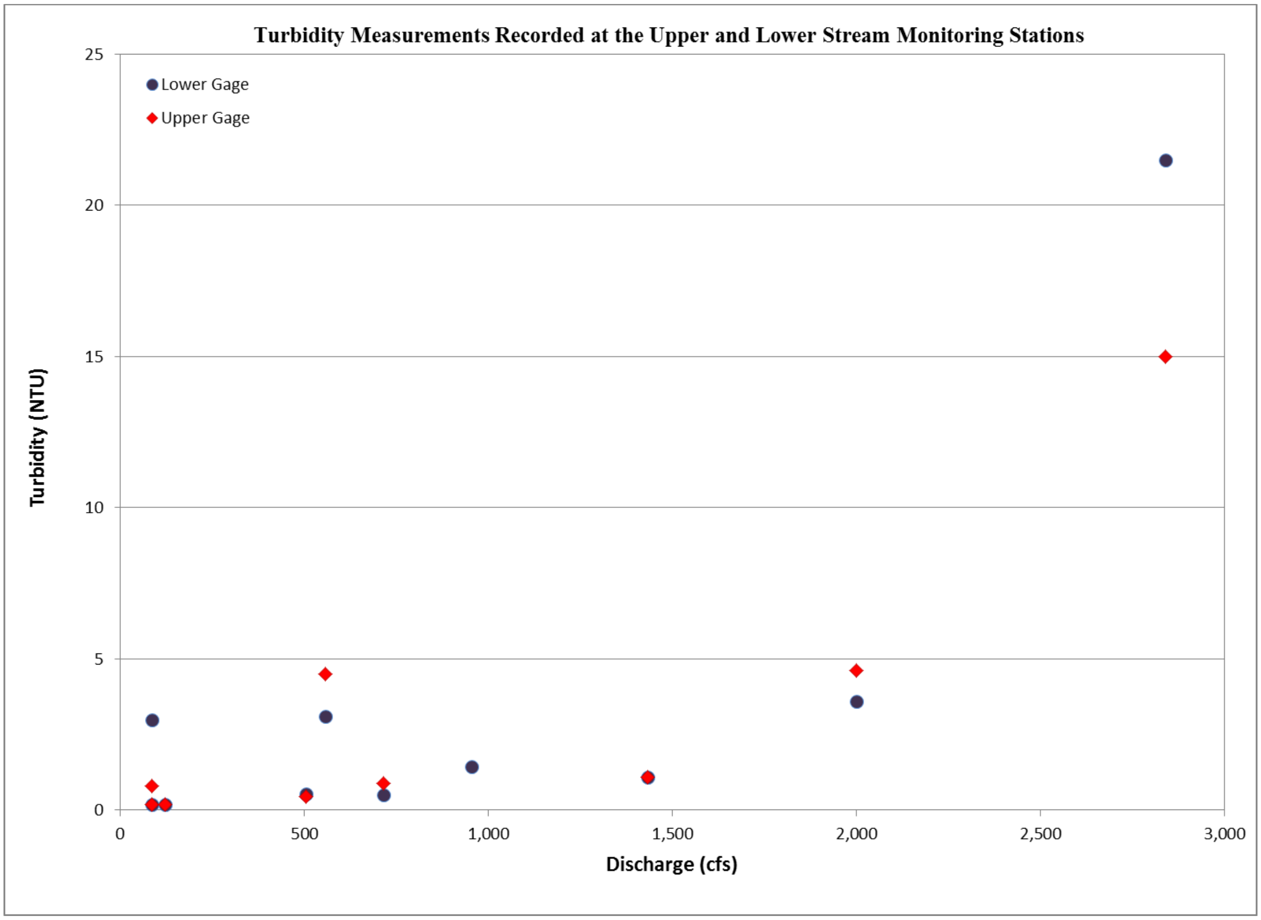

Figure 6 - Turbidity measurements recorded at a range of flows.

5.1.5 Pesticides

No pesticides were detected over the course of the study. Detection limits are listed in Table 4.

Table 4 - Detection limits for selected pesticides.

Pesticide	Detection Limit (mg/L)
Diazinon	0.20
Chlorpyrifos	0.20
Dimethoate	0.20
Malathion	0.20
Ethyl Parathion	0.20
Sulfotepp	0.20
Disulfoton	0.60
Methyl Parathion	0.20
Phorate	0.20

5.1.6 Nitrogen and Phosphorus

Nitrogen and Phosphorus levels are presented in Table 5 and Table 6 for the lower and upper sample locations respectively.

Table 5 - Nitrogen and Phosphorus results for the lower sample location.

Constituent	RL	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
N-Ammonia	0.010	0.019	0.079	<0.010 U	0.041
N-Nitrate	0.010	0.128	0.193	0.213	0.163
N-Nitrite	0.010	<0.010 U	<0.010 U	<0.010 U	<0.010 U
Nitrate + Nitrite	0.010	0.128	0.193	0.213	0.163
Total Phos	0.008	<0.008 U	<0.008 U	<0.008 U	0.13
Ortho Phos	0.004	<0.004 U	<0.004 U	<0.004 U	0.007
Total Kjeldahl N	1.00	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U

Table 6 - Nitrogen and Phosphorus results for the upper sample location.

Constituent	RL	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
N-Ammonia	0.010	-	0.087	0.016	0.016
N-Nitrate	0.010	-	0.181	0.187	0.187
N-Nitrite	0.010	-	<0.010 U	<0.010 U	<0.010 U
Nitrate + Nitrite	0.010	-	0.181	0.187	0.154
Total Phos	0.008	-	<0.008 U	<0.008 U	<0.008 U
Ortho Phos	0.004	-	<0.004 U	<0.004 U	<0.004 U
Total Kjeldahl N	1.00	-	< 1.00 U	< 1.00 U	< 1.00 U

Nutrient loading in the system is minimal. Only nitrate was detected at measurable levels and is most likely present from natural processes e.g. decay of organic material.

5.2 TEMPERATURE MODELING

Time of water travel was calculated for the Tailrace and the Project Reach for flows between 45 cfs and 900 cfs. See Tables below. Travel time through the Tailrace was calculated using an approximately 12-ft diameter tunnel using a slope of .25%. Manning's equation was used to calculate flows through the tunnel. Travel time was based on an 8,600-ft Tailrace.

Travel time through the Project Reach was calculated using surface LiDAR information with an assumed Manning's "n" of .06. HEC RAS modeling was then used to calculate the average travel time through the Project Reach.

Table 7 – Time of water travel through Tailrace

% Flow	Flow	Travel Time
	ft^3/s	minutes
100	900	18.7
90	810	18.6
80	720	20.2
70	630	19.5
60	540	20.7
50	450	20.7
40	360	22.2
30	270	23.7
20	180	27.4
10	90	37.1
5	45	40.7

Table 8 – Time of water travel through Project Reach

% Flow	Flow	Travel Time
	ft3/s	minutes
100	900	45.6
90	810	47.4
80	720	49.2
70	630	51.6
60	540	54.0
50	450	57.6
40	360	61.8
30	270	67.8
20	180	76.8
10	90	95.4
5	45	116.4

Travel time calculations indicate the total time flows may be exposed to ambient temperature conditions, i.e. groundwater/subsurface in the tunnel or outdoor air temperature in the Project Reach. As noted in the discussion above the average ground temperature in the project area is around 53º F (11.6º C). This is warmer than surface water temperatures during the winter and cooler during the summer. Therefore, water running through the project will tend to be warmed during the winter and cooled during the summer in comparison to surface water running down the river channel. The amount of this effect will be dependent on the complex relationship between water volume and transit time through the project facilities. There will be less effect when project flows are high and travel times are short. The effect will be greater when project flows are lower and transit times are longer. Therefore, it is likely that there would be more net cooling during the summer, when project flows are lower and hence have longer travel times, and less of a warming effect during the winter when the inverse conditions apply.

5.3 TEMPERATURE EFFECTS ON FISH

It is also helpful to provide context to the discussion of temperature in the North Fork on the fish populations that reside there. In general the North Fork provides a temperature regime that falls within the optimal range for rainbow trout (Oncorhynchus mykiss) and Cutthroat trout (O. clarki) that reside in the North Fork, including the project bypass reach. Bell (1986) reports the optimum temperature range for rainbow from 54 to 66º F (12.2 to 18.9º C). A similar range for cutthroat trout is 49 to 55º F (9.4 to 12.8º C) (Bell 1986). Both of these species have upper limits of tolerance in the range of these species as 71 and 73º F (21.7 and 22.8º C) for rainbow and cutthroat, respectively. Other literature indicates that these upper limits for members of the Oncorhynchus genus are generally in the 75 to 77º F (23.5 to 25º C) (Brett 1952, Bell 1986, So. Cal. Edison 2007). Bell (1986) lists the upper lethal limit for rainbow trout at 85º F (29.4º C) and others also report similar high values (So. Cal. Edison 2007). These would apply to populations that were acclimated to conditions generally much warmer than are experienced by fish in the North Fork.

These data are helpful in reviewing the potential effects of project operation on fish populations in the North Fork. In general the North Fork provides temperatures that fall in the optimal range for these species for the majority of the year. During the summer, the river can reach temperatures in the range of 65º F (18.3º C) which still falls well within the range of tolerance for both species. Our data have demonstrated that groundwater inflows in the project bypass reach tend to lower the temperature of the North Fork as it passes through this segment of the river. The proposed project operations will not affect this beneficial effect in the bypass reach. During the summer, project flows through the tailrace tunnel will be exposed to average ground temperatures that are in the range of 53º F (11.6º C) that will tend to lower the temperature of the water. This will further cool water in the North Fork below the project reach. The benefit of this additional cooling will enhance habitat conditions for fish downstream of the project reach.

6 DISCUSSION

In conclusion to the Water Quality Study Report a summary of key findings is presented.

- Dissolved oxygen and turbidity are within the thresholds identified in WAC 173-201A-200.
- Temperature and pH are mostly within the thresholds identified in WAC 173-201A-200. Standards are exceeded at times of very low flow with water temperatures above 16°C.
- Groundwater inflows in the project bypass reach tend to moderate water temperatures in the project area, slightly increasing temperatures in the winter and lowering temperatures in the summer.
- Water flowing through the project will be subject to heat exchange with bedrock in the tunnel walls acting in a similar way to groundwater inflows though varying with flow volume and time of travel through the tunnel.
- The natural range of temperatures in the North Fork are well within the range of tolerance of the resident trout populations in the project reach.
- The effects of project operations are expected to moderate water temperatures in the North Fork by providing slight warming in the winter and cooling in the summer.
- No pesticides are entering the river at detectable levels.
- Nutrient loading in the system is minimal. Only nitrate was detected at measurable levels and is most likely present from natural processes e.g. decay of organic material.

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APPENDIX A - WAC 173-201A-602: USE DESIGNATIONS FOR FRESHWATER BY WRIA

TABLE 602	Aquatic Life Uses						Recreation Uses			Water Supply Uses				Misc. Uses				
Use Designations for Fresh Waters by Water Resource Inventory Area (WRIA)	Char Spawning /Rearing	Core Summer Habitat	Spawning/Rearing	Rearing/Migration Only	Redband Trout	Warm Water Species	Ex Primary Cont	Primary Cont	Secondary Cont	Domestic Water	Industrial Water	Agricultural Water	Stock Water	Wildlife Habitat	Harvesting	Commerce/Navigation	Boating	Aesthetics
Skykomish River and May Creek (above Gold Bar at river mile 41.2): All waters (including tributaries) above confluence (Except where designated Char).		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Skykomish River, North Fork, beginning below Salmon Creek at latitude 47.8790 longitude –121.4594) to headwaters (including tributaries).	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Skykomish River, South Fork, and Beckler River: All waters (including tributaries) above the confluence.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Snohomish River from mouth to latitude 47.942 longitude -122.1719 (southern tip of Ebey Island at river mile 8.1).[1]			✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Snohomish River from latitude 47.942, longitude -122.1719 (southern tip of Ebey Island at river mile 8.1) to below Pilchuck Creek at latitude 47.9045 longitude -122.0917.			✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Snohomish River from below Pilchuck Creek (latitude 47. 9045 longitude -122.0917) to confluence with Skykomish and Snoqualmie River (river mile 20.5).		✓						✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River from mouth to confluence with Harris Creek (latitude 47.7686 longitude -121.9605; Sect.5 T25N R6E)			✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River and tributaries from and including Harris Creek (latitude 47.7686 longitude -121.9605; Sect.5 T25N R6E) to west boundary of Twin Falls State Park on south fork (river mile 9.1).		✓						✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River, South Fork, from west boundary of Twin Falls State Park (river mile 9.1) to headwaters (including tributaries).		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River, North Fork, from mouth to Sunday Creek.		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River, North Fork, and Sunday Creek: All waters (including tributaries) above the confluence.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River, Middle Fork, from mouth to Dingford Creek (Except where designated char).		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Snoqualmie River, Middle Fork, and Dingford Creek: All waters (including tributaries) above the confluence.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓