TECHNICAL MEMORANDUM

Client: Summit at Snoqualmie

Project: Snowmaking Water Rights Assistance

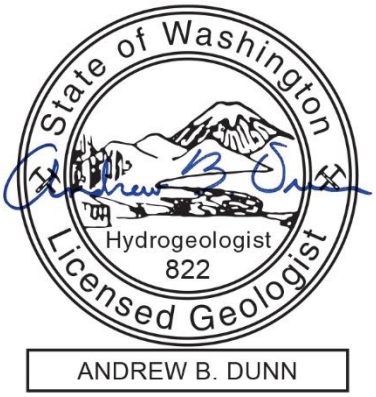
Project File: SAS 0230031.00.0001

Project Manager: Andrew B. Dunn, LG, LHG, CWRE

Composed by: Andrew B. Dunn, LG, LHG, CWRE

Subject: Pre-Application Consultation Supporting Document

Date: June 8, 2023



Signed: 06/8/2023

Background

This technical memorandum has been prepared by RH2 Engineering, Inc., (RH2) to provide additional documentation beyond that provided in the Washington State Department of Ecology (Ecology) Pre-Application Consultation Form. The Summit at Snoqualmie (Summit) is requesting a new surface water right to divert a total of approximately 15 cubic feet per second (cfs) and 300 acre-feet per year from three streams/drainage channels that are tributary to Coal Creek in Kittitas County, Washington (**Figure 1**). The points of diversion currently are proposed to be Webbski Weir, Reggie's Weir (Tunnel Creek), and the Hyak Creek Weir, which are all located in Water Resource Inventory Area (WRIA) 39 – Upper Yakima (**Figure 1**). The diverted water will be stored in multiple lined reservoirs (ponds) at Summit Central, capable of storing a combined total of approximately 155 acre-feet. When weather conditions are right, the water will be pumped from the reservoirs and used for snowmaking on Summit Central. All snow produced will remain within WRIA 39, and any portion of the snowmaking that is non-consumptive will continue in the hydrologic cycle and ultimately flow into Keechelus Lake, which is managed by the United States Bureau of Reclamation (Reclamation).

Summit would like to add 3 feet of snow to portions of Summit Central. This snowmaking would only occur under the correct weather conditions (as determined by wet bulb temperature that takes into account air temperature and humidity as shown in **Figure 2**) at approximately three specific times during the ski season:

- November 15 through 30 – Early Season: Make snow with the goal of establishing a firm base.
- January 1 through 15 – Mid Season: Replenish ski area after heavy Christmas and New Year Holiday use to prevent thin patches.
- February – Late Season: Add snowpack to extend skiing season later into the year.

Snoqualmie Pass Utility District

Summit currently gets all its water from the Snoqualmie Pass Utility District (District). This includes both potable use in lodges and water used for snowmaking when available. The District is not capable of providing the rate and volume of water that Summit would like to use for snowmaking; therefore, Summit decided to pursue this new water right application specifically for snowmaking. Summit will continue to be a customer of the District for its potable water use.

Meeting with Reclamation

On February 15, 2023, Mr. Tom McDonald (Cascadia Law Group, PLLC), Mr. Bill Granger (Re-Align Environmental), and Mr. Andrew B. Dunn (RH2) met with Mr. Chad Stuart (Yakima Field Office Manager) from Reclamation. The intent of this meeting was to determine if Reclamation would support, or oppose, or remain neutral on the proposal. Mr. Stuart explained that since all surface water in the watershed has been adjudicated and is spoken for, the proposed project could not impact Total Water Supply Available (TWSA). Therefore, any consumptive uses would need to be offset, water for water, as measured at the Parker Gage.

According to Mr. Stuart, Reclamation is able to hold mitigation water in its reservoirs to be released when needed to meet flow obligations downstream. Mr. Stuart said Reclamation defaults to Ecology with respect to consideration of whether mitigation is adequate and sufficient to allow issuance of a new, mitigated, water right.

Meetings with WDFW

Our team had multiple discussions with Mr. Steve Boessow at the Washington Department of Fish and Wildlife (WDFW) late in 2022 and early in 2023 to better understand what concerns WDFW might have with this proposal. Mr. Boessow provided some streamflow measurement records of Coal Creek (**Table 1**).

Table 1
WDFW Streamflow Measurements

Date	Flow (cfs)
October 20, 2004	26.5
August 18, 2022	1.25
August 24, 2022	0.59
September 1, 2022	0.56
September 19, 2022	0.36
October 6, 2022	0.30
October 19, 2022	0.62
November 1, 2022	30.1
November 15, 2022	10.35

Mr. Boessow explained that when Keechelus Lake is high, Gold Creek and Coal Creek flow independently into the lake (**Figure 3**); however, when the lake water level is low, Coal Creek flows into Gold Creek as the creeks flows across the exposed reservoir bed to reach the lake (**Figure 4**). Bull trout utilize Gold Creek (Northwest Indian Fisheries Commission, 2023). When Keechelus Lake is drawn down and flow is low in both Gold and Coal creeks, such as the late summer and early fall (**Table 1**), Mr. Boessow indicated that the flow from Coal Creek is critical to maintain flow in Gold Creek so that bull trout can make the journey across the exposed reservoir bed from the lake to Gold Creek to spawn in the fall.

Based on an invitation from Mr. Boessow on December 2, 2022, Mr. McDonald made a request on behalf of Summit for WDFW to study flows in Coal Creek and monitor fish presence during the 2023 field season. WDFW management was not able to include the requested Coal Creek work in the 2023 field season.

The following was relayed to Mr. McDonald from Mr. Boessow after discussion with his management:

- WDFW knows that adult and juvenile salmonids use Coal Creek all the way up to the ski areas
    - WDFW are not going to do any additional targeted searches for fish
- WDFW is not going to do any flow setting modelling such as Physical Habitat Simulation (PHABSIM) or System for Environmental Flow Analysis (SEFA)
    - WDFW can use the toe width method to create an optimal flow (between 12 and 25 cfs) above which water could be used.
- Even if WDFW set a minimum instream flow, there are no Ecology or United States Geological Survey gages to indicate when a diversion is allowed.

Mr. Boessow indicated that, “I have done a back of the envelope measurement of the toe width in Coal Creek. I can be available for a more detailed set of measurements in the proposed location of the diversion…”

Summit proposes to install four stream gages to start collecting data. One stream gage will be located at each of the three proposed points of diversion, and one will be in the lower reach of Coal Creek downstream of the points of diversion (**Figure 1**).

The flow data obtained from the point of diversion locations will allow Summit to better quantify the flow of water physically available at different times of the year at each point of diversion. The data from Coal Creek will be used both for better understanding the hydrology of the creek and for future regulation under a water right.

WDFW will be consulted prior to installation of a stream gage in Coal Creek, to make sure it is in a suitable location for determining when regulation needs to occur due to low flows. The current plan is for the Coal Creek gage to have telemetry that can be read in real time so that it can be used in the future for purposes of regulation if the water right is granted.

Making this water right interruptible, based on WDFW flow recommendations, will ensure that there are no impacts to fisheries resources, which is in the public interest.

Calculation of Consumptive Use

The intent of snowmaking is to convert water into snow so that it enhances the skiing experience. One benefit of this is that water is retained as snowpack for longer into the water year. Water that is diverted from a stream, stored in a reservoir, turned into snow, and then allowed to melt naturally to return to the water cycle is largely non-consumptive. However, it has been documented that there is a consumptive loss related to the water conversion from liquid to solid.

Evaporation from Nozzles

When water is sprayed from a snowmaking machine and turned into manufactured snow, the thermodynamics of the conversion from liquid to solid indicate that there is some consumptive loss. Past estimates have been made to quantify how much water is consumptively lost due to evaporation and sublimation at the snowmaking nozzles. **Figure 5** identifies the nozzle losses as compared to the ambient air temperature (Leaf, 2010).

Table 2 contains the average monthly minimum air temperature data for the anticipated snowmaking months of November through February, collected from the now defunct Snoqualmie Pass, Washington weather station over the period of record (January 1, 1910 through November 15, 2002) (Western Region Climate Center, 2023).

Table 2
Snoqualmie Pass Monthly Average Minimum Temperature Data (1910 through 2002)

Month	Average Minimum Temperature	
	Degrees Fahrenheit	Degrees Celsius
November	28.2	-2.1
December	23.5	-4.7
January	20.9	-6.2
February	23.3	-4.8
Average	**24.0**	**-4.4**

Considering an average minimum ambient air temperature of 24.0 degrees Fahrenheit (-4.4 degrees Celsius) during snowmaking, **Figure 5** suggests that the initial (consumptive) loss percentage for snowmaking at Summit Central would be approximately 8 percent. Our team proposes to use 8 percent as the consumptive use for snowmaking under this application.

Possible Mitigation of Consumptive Use

The current intent is to mitigate for consumptive use as measured under TWSA at the Parker Gage. Summit currently is considering purchase or lease of senior surface water rights from the Selah-Moxee Irrigation District water bank in the Yakima Basin. RH2 confirmed that this mitigation water is available. This mitigation water would be placed or left in the Trust Water Rights Program as mitigation for its consumptive use impact to TWSA.

Conclusion

Our team believes that a permit for a new appropriation for snowmaking at Summit Central can be granted for the following reasons:

1. Snowmaking is a beneficial use of water as other permits have been issued for this purpose in Washington State.
2. All consumptive use will be mitigated so that there will be no impact to TWSA; therefore, there will be no impairment of existing water rights.
3. Anecdotal evidence suggests, and streamflow monitoring will confirm, that water is physically available at the proposed points of diversion.
4. Legal availability is not a concern since there are no surface water closures in WRIA 39.
5. Public interest will be protected by working with WDFW to determine the minimum flow required in Coal Creek, below which water will not be able to be diverted from the points of diversion, to protect fisheries resources. Summit will install and maintain a stream gage on Coal Creek that will collect hydrologic data and be used for determining compliance with any minimum flow provisions.
6. Lined reservoirs will enable Summit to store water diverted when minimum flows are exceeded for later use when flows are not met.

Attachments

Figure 1 – Pre-Application Consultation Map

Figure 2 – Snowmaking Wet Bulb Temperature Chart

Figure 3 – Relationship of Coal and Gold Creek when Keechelus Lake Water Leve l is High

Figure 4 – Relationship of Coal and Gold Creek when Keechelus Lake Water Level is Low

Figure 5 – Initial Loss from Snowmaking as a Function of Ambient Air Temperature

References

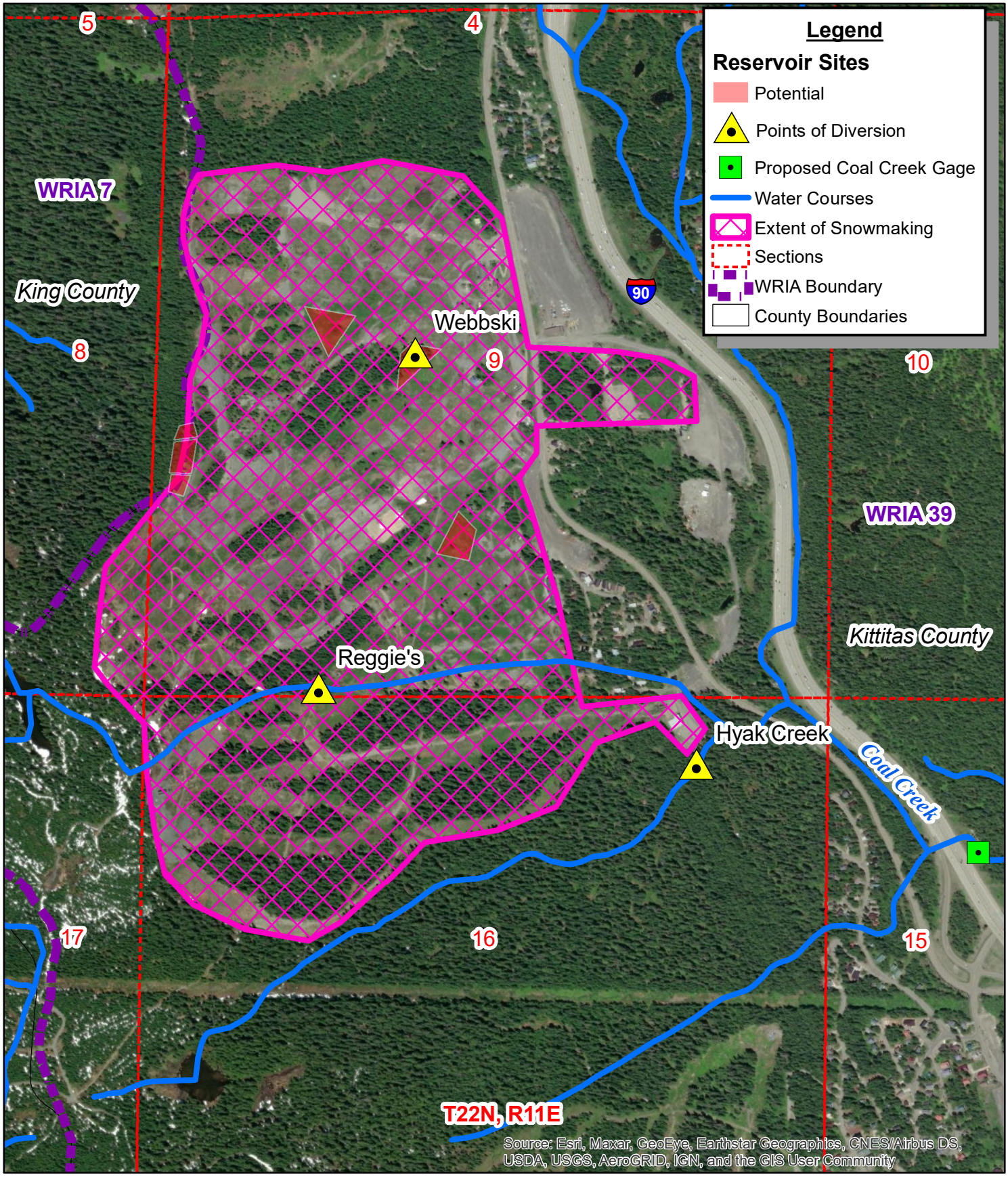
Leaf, C.F. (2010). *Evaluation of Consumptive Losses and Return Flows from Snow Making at Pajarito Mountain Ski Area Near Los Alamos, New Mexico*. Platte River Hydrologic Research Center General Technical Report, PRHRC GTR-17.

Northwest Indian Fisheries Commission (2023) *Statewide Integrated Fish Distribution Map*. (2023). Retrieved from: https://geo.nwifc.org/swifd/.

Snow State (2023). Snowmaking Wet Bulb Temperature Chart. Retrieved from: https://snow-state.com/snowmaking-charts/.

Western Regional Climate Center (2023). *Period of Record Monthly Climate Summary*. Snoqualmie Pass, Washington (457781). Retrieved from: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa7781.

Figures



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NORTH

1 inch = 1,000 feet

0 255 510 1,020 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

THE SUMMIT AT SNOQUALMIE

Figure 1
Pre-Application Consultation Map

Summit at Snoqualmie Snowmaking Application

Vicinity Map

ERE, Garmin, (c) reetMap contributors,

This map is a graphic representation derived from the Summit at Snoqualmie Geographic Information System. It was designed and intended for Summit at Snoqualmie staff use only; it is not guaranteed to survey accuracy. This map is based on the best information available on the date shown on this map.

Figure 2.

Snowmaking Wet Bulb Temperature Chart

Snow State
www.snow-state.com

Temp (°F)	Relative Humidity																
	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
14	9	9	10	10	11	11	11	11	11	12	12	13	13	13	13	14	14
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<	12	14	16	18	19	20	21	22	23	24	25	26	27	28	29 >
	Great Snowmaking				Good Snowmaking				Marginal Snowmaking					Borderline	Too Warm

The **wet bulb temperature** is critical measurement used to determine when conditions are favorable for snowmaking. The wet bulb temperature is the lowest temperature that can be obtained by evaporating water into the air. The "wet bulb cooling" process, also known as evaporative cooling, means temperatures are lowered by water evaporating into the air. The lower the relative humidity, the greater this cooling effect will be. This process is useful for snowmaking, as the cooling of water droplets in the plume is aided by evaporation. The snowmaking process becomes possible at around a 28°F wet bulb and improves in efficiency dramatically as temperatures drop into the mid 20s. Slushy snow may be made with properly designed equipment in "borderline" conditions, but most home snowmaking equipment performs well in the lower 20s and below. While the snow may be wet at higher temperatures, dry and powdery snow is often produced with wet bulb temperatures in the teens. Learn more: www.snow-state.com

Figure 3. Relationship of Coal and Gold Creek when Keechelus Lake Water Level is High

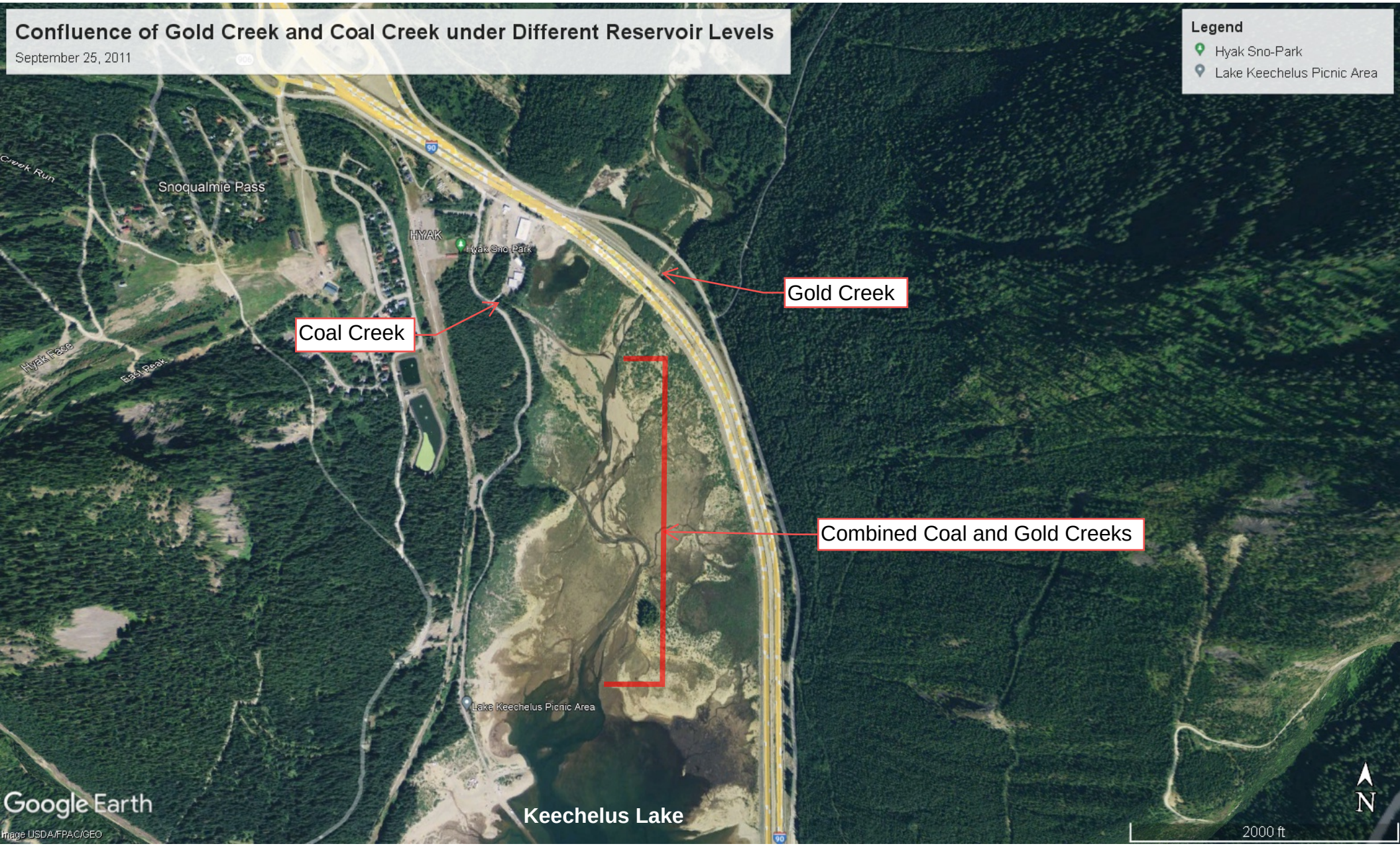

Figure 4. Relationship of Coal and Gold Creek when Keechelus Lake Water Level is Low

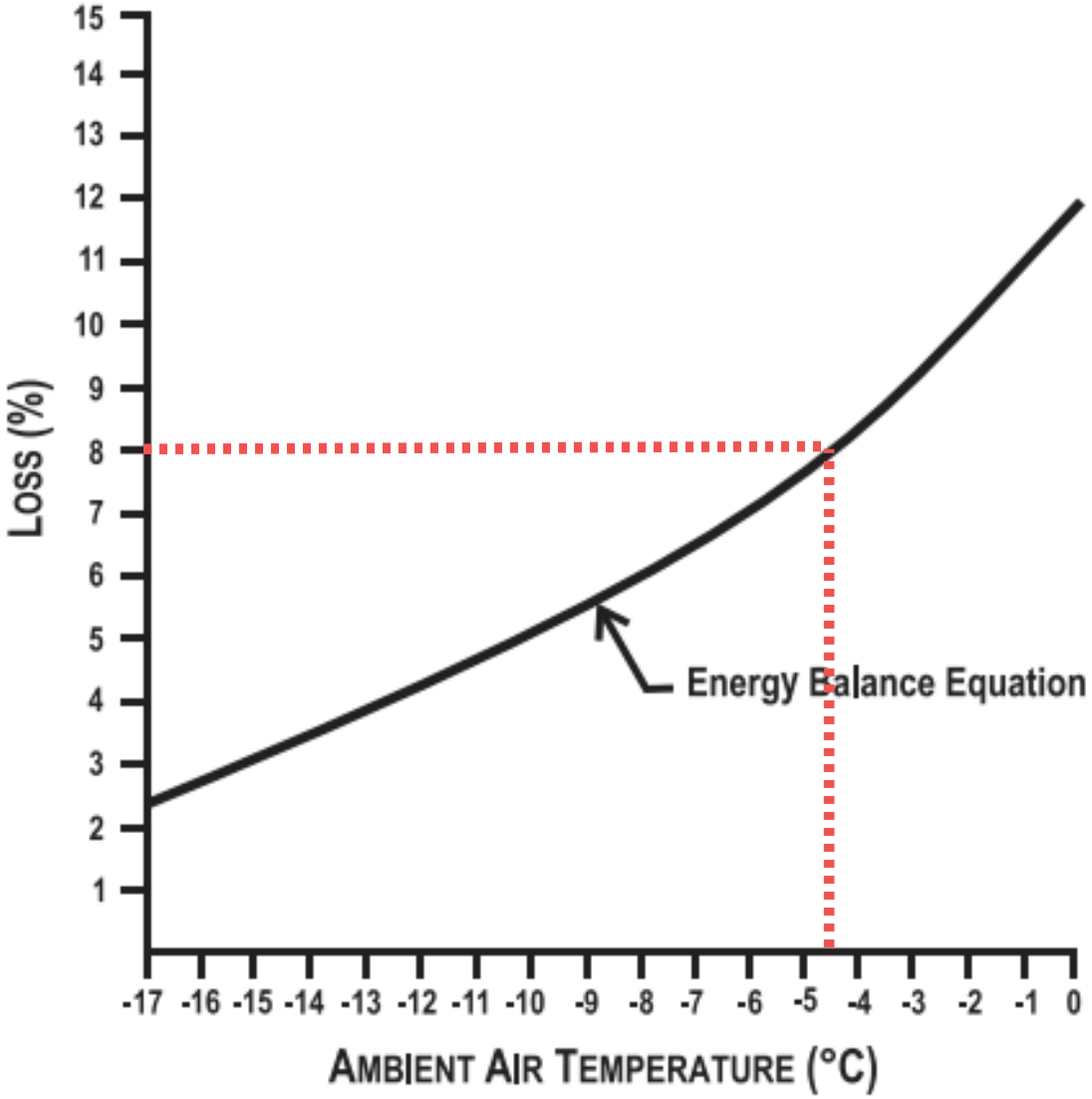

Figure 5. Initial Loss from Snowmaking as a Function of Ambient Air Temperature

(Modified from Leaf, 2010)