TO: Tom Tebb
Director, Office of Columbia River
Washington State Department of Ecology
1250 Alder Street
Union Gap, WA 98903

Mike Kaputa
Director, Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: Request for Comments on the Scope of the Programmatic Environmental Impact Statement (PEIS) for the Icicle Creek Water Resource Management Strategy (Icicle Strategy)

DATE: May 4, 2016

Dear Dir. Tebb and Dir. Kaputa,

The Washington State Department of Ecology (Ecology) directed the Chelan County Natural Resource Department (CCNRD) to develop a PEIS for the Icicle Strategy. Currently, the potential project package established by the Icicle Work Group (IWG) is open to public comment. Comments will be used to inform a draft State Environmental Policy Act (SEPA) PEIS for the Icicle Strategy. Trout Unlimited (TU) appreciates the opportunity to provide comments during the scoping period.

The purpose of the SEPA PEIS is to address probable significant adverse impacts associated with implementation of a suite of projects within the Icicle Creek basin aimed at enhancing stream flow and habitat conditions for fisheries and other aquatic organisms, improving operations and water storage at historical reservoirs within the Alpine Lakes Wilderness, maintaining water security and supply reliability for out of stream users of Icicle Creek water, and reinstating water reserves that will facilitate growth/development in Chelan County.

TU sits on the IWG Steering Committee and has worked with IWG membership to ensure the proposed package aligns with TU's mission to conserve, protect, and restore North America's coldwater fisheries and their watersheds. These projects include:

- Efficiency upgrades for Icicle Peshastin Irrigation District (IPID) and Cascade Orchards Irrigation Company (COIC)
- Domestic conservation and efficiencies
- Diversion screening upgrades (IPID, COIC, and City of Leavenworth)

- Eightmile Lake restoration and Alpine Lakes reservoir management optimization and automation
- Leavenworth National Fish Hatchery water conservation and water quality improvements, intake rehabilitation, and Structure #2 operational improvements
- Icicle Creek habitat improvements/land acquisitions
- Fish passage and tribal fishery improvements
- Water markets/banks
- Instream Flow Rule amendment

TU understands that a primary purpose of the SEPA PEIS is to help clarify resources and information that will inform programmatic environmental review for the Icicle Strategy as well as individual environmental review processes for each project. TU takes seriously its role within the IWG and wishes that the Icicle Strategy have a lasting positive benefit for the people and environment in North Central Washington. Moreover, TU understands that the IWG approved the current suite of projects for public comment and SEPA review, but that it does not necessarily represent the final project package or approval of individual projects in the PEIS.

TU has the following concerns and comments that should be addressed during the SEPA review and PEIS development:

1. An article on the Icicle Strategy in the April 22, 2016 print issue of the Wenatchee World noted that in the opinion of the IWG, "If implemented in full, the (Icicle Strategy) will support area population growth while also supplying fish and irrigators with the water they need through 2050." TU is concerned that the ability of the proposed project package meeting Icicle Creek demands through 2050 is not substantiated because no assessment has been conducted specifically addressing future water supply and climate scenarios in the Icicle Creek basin. Potential impacts of a changing climate in the Pacific Northwest include reduced snowpack and decreased summer stream flows. IWG guiding principles include instream flow objectives of 60 cfs in drought years and 100 cfs in non-drought years. TU encourages the IWG to review the attached analysis of Icicle Creek water/climate conditions performed by Dick Rieman and TU-Washington Water Project staff and urges the IWG to procure a water supply and climate change analysis from a team of experts such as the University of Washington Climate Impacts Group. It does not seem prudent to move a final project list forward without first securing water supply information so the Icicle Strategy is built on sound science and solid fundamentals.

2. TU understands that the success of the Icicle Strategy hinges on implementation of the full suite of proposed projects. However, it is unclear what projects have been identified to replace those in the proposed package should any one become unattainable due to logistics, lack of public support, unanticipated expenses, or other reason(s). TU strongly urges the IWG to develop a list of proposed project alternatives that will also meet IWG guiding principles and that are practical, feasible, and implementable. In addition to identifying potential replacement projects should one of the proposed projects drop from the final package, a comprehensive list of project alternatives will also demonstrate that the final package contains projects that have the greatest conservation benefit for the most effective cost.

3. TU understands that the National Environmental Policy (NEPA) process must be undertaken by a lead federal agency. At this time no lead agency has been identified. TU recommends identification of a federal agency that will serve as the lead during NEPA processes and procedures.

4. TU understands that IWG flow objectives may focus on LNFH historic channel flow. TU wonders if flow objectives ought to be observed at the USGS gauge station above the Snow Creek confluence since this location has an established, long-running monitoring record that may be useful in historic, contemporary, and future analyses.

5. Multiple parties have indicated concerns about changes to the lakes in the Alpine Wilderness area. TU urges the Department of Ecology and Chelan County to take these concerns seriously and work closely with the Forest Service to determine what can and cannot be constructed or designed in that area.

6. Project implementation is an on-going process in Icicle Creek like most watersheds throughout North Central Washington. TU and numerous other entities are currently working on restoration projects within the Icicle Creek and Wenatchee River basins and will continue to manage these projects independent of the Icicle Strategy process.

7. Future materials should clearly articulate benefit/cost information for projects envisioned by the IWG. TU recommends that this process be undertaken independent of the IWG.

TU supports collaborative efforts to develop a holistic water resource management strategy for Icicle Creek and commends the work of member organizations, tribes, agencies, and individuals who have spent significant time to participate. The needs of fish, farms, and families must be balanced to ensure the region supports healthy ecosystems, maintains a robust economy, and shares the costs of the Icicle Strategy among the various users.

Sincerely,

Lisa Pelly

Lisa Pelly
Director, Trout Unlimited-Washington Water Project

Michael Wyant

Mike Wyant
President, Icicle Valley Chapter of Trout Unlimited

Stream flow, temperature, and snow water equivalent in Icicle Creek basin, Washington: historic conditions and potential future scenarios

Trout Unlimited-Washington Water Project[1] and Dick Rieman[2]

[1]Trout Unlimited-Washington Water Project, 103 Palouse Street, Wenatchee, WA, 98801
[2]Concerned citizen (please direct questions to Cody Gillin, Project Manager with Trout Unlimited-Washington Water)

Background

Trout Unlimited-Washington Water Project and Leavenworth resident Dick Rieman conducted an examination of Icicle Creek stream flow and climate conditions. Analyses focused on historical conditions but also included some effort to understand possible future scenarios. USGS stream gauge station #12458000 on Icicle Creek above the Snow Creek confluence provided baseline stream flow data. Public data repositories for SNOTEL site #791 at Stevens Pass, University of Washington Climate Impacts Group (CIG), and National Weather Service Cooperative Observer Program (COOP) provided historical and future temperature data. Snow water equivalent (SWE) data were provided by the University of Washington Climate Impacts group. Future stream flow projections were derived from National Stream Internet (NSI) attribute data joined to the National Hydrography Dataset (NHD) streamlines geospatial layer.

Methodology

USGS gauge station #12458000 was operational 1937-present with a 23-year period of decommission 1971-1993. This analysis utilized all available data for complete water years (1937-1970 and 1994-2015). Stream flow data (cubic feet per second or cfs and acre feet or ac-ft) were evaluated numerically and graphically by examining raw data, trends/patterns, and measures of central tendency. Evaluated time periods included annual, monthly, daily, and center time (date by which half the total annual water volume flowed past the gauge station). Annual data were considered based on the water year calendar October 1-September 30.

Monthly stream flow data were compared with monthly water demand placed on Icicle Creek by existing out of stream uses and minimum instream environmental flows outlined by the Icicle Working Group (IWG). Out of stream uses vary by month and include Icicle-Peshastin Irrigation District (IPID), Leavenworth National Fish Hatchery (LNFH), Cascade Orchards Irrigation Company (COIC), and City of Leavenworth (Leavenworth). Minimum environmental flow restoration objectives described in the IWG Guiding Principles are 60 cfs for drought years and 100 cfs for normal years. Note that this analysis used drought year environmental flow values of 60 cfs when calculating demand so all years are considered drought years. Demand for out of stream uses and environmental flows outlined in the IWG guiding principles are referred to as IWG water demands.

Median monthly temperatures for SNOTEL site #791 (Stevens Pass) were evaluated for the entire period of record (1984-2013).

COOP historical mean monthly temperature raster data were compared with CIG Western US Hydroclimate Scenarios Project projected 2040s mean monthly temperature data derived from the CMIP3 global model archive for the A1B emissions scenario. CIG and COOP data were resampled to a finer resolution to facilitate visualization at the scale of the Icicle Creek basin. Raster data were quantified and percent change in watershed area comprised by the raster classes was calculated.

Historical mean monthly SWE data were compared with future data. SWE data were resampled to the same cell size as temperature data to facilitate visualization. All geospatial data were analyzed using ESRI ArcMap 10.4. All graphs were developed using Microsoft Excel. Numerical calculations were conducted using both ESRI ArcMap 10.4 and Microsoft Excel.

Results and Observations

Historical Data: Stream Flow

Mean volume of water passing USGS gauge station #12458000 was approximately 450,000 ac-ft in 1937 and 442,000 ac-ft in 2015 (Fig. 1). Linear regressions suggested total mean monthly water volumes are increasing each month from November 1-March 31 and decreasing each month from April 1-October 31 (e.g., Figs. 2, 3, 4). Mean center time at USGS gauge station #12458000 was May 27 in 1937 and May 8 in 2015 (Fig. 5). Variability of center time (range of center time date) increased through the period of record. During the two gauge station periods of operation, the earliest center time date during the early period occurred on April 30, 1960. Nearly 25% of center time dates during the recent period of operation occurred earlier than April 30, including two dates in early March and one date in late February (Fig. 5).

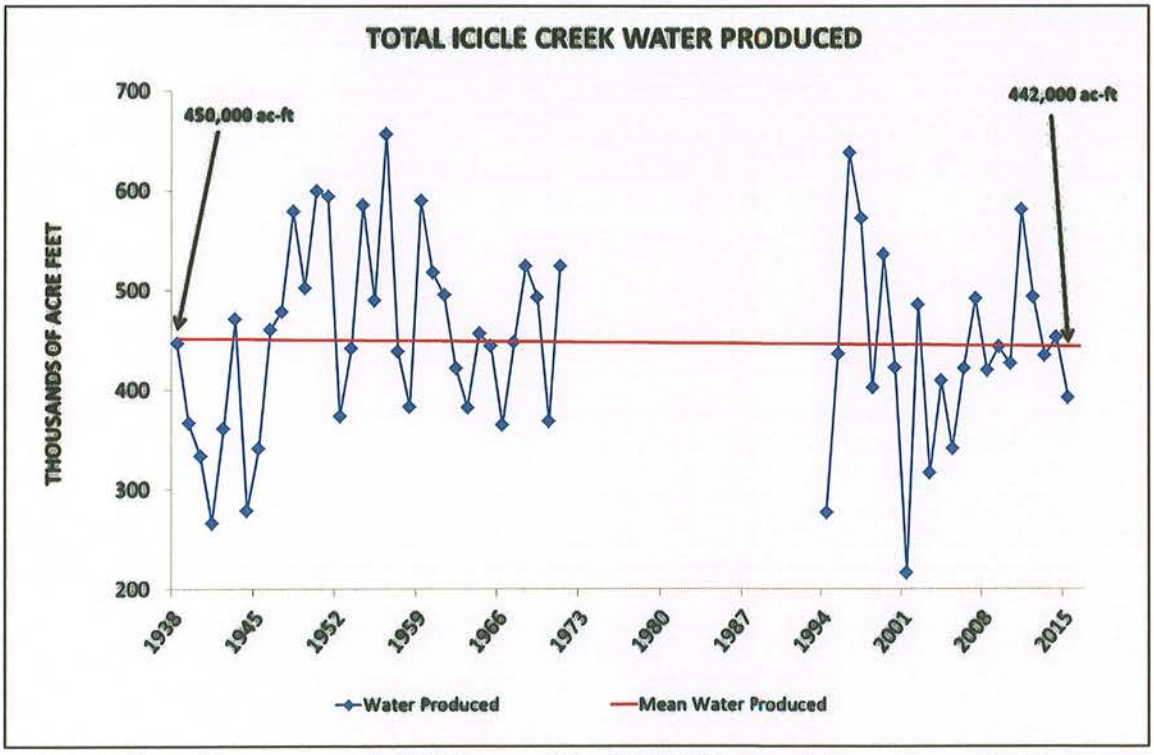

Figure 1. Total volume of water measured at USGS gauge station #12458000 was variable on an annual basis but on average remained relatively unchanged through the period of record.

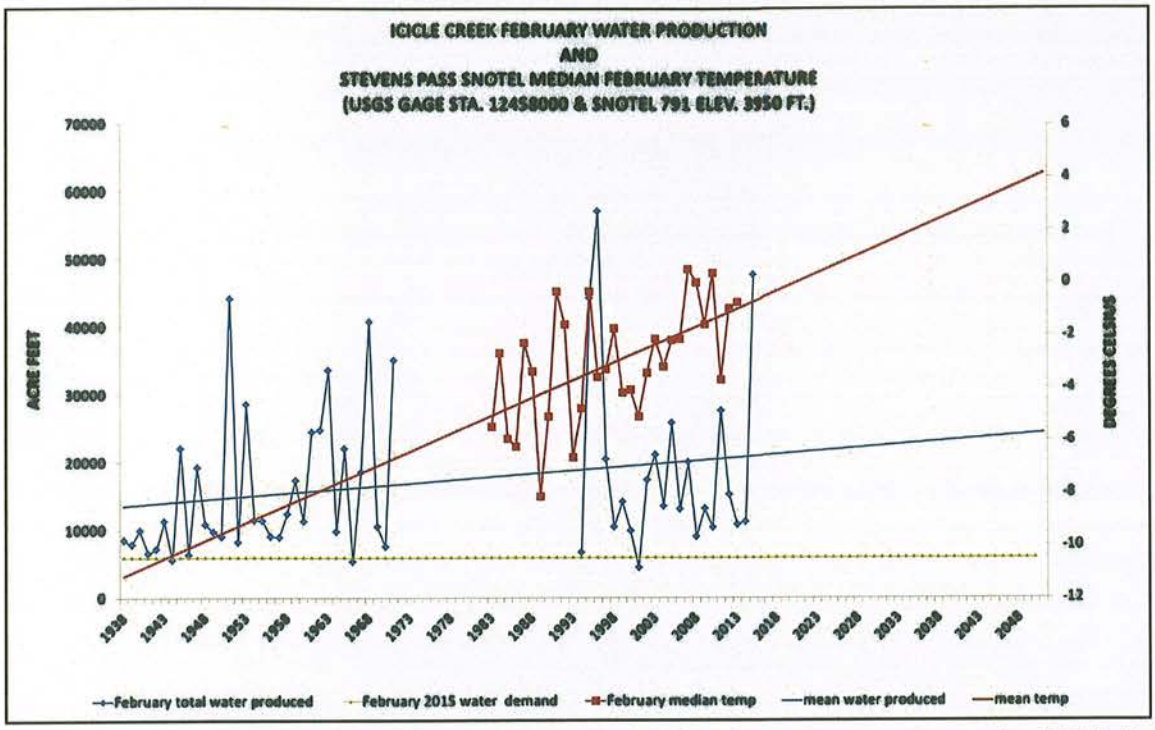

Figure 2. Total volume of water measured at USGS gauge #12458000 and median temperature measured at SNOTEL site #791 increased for the month of February. The same result (increased water production and temperature) was found for all months during the period November 1-March 31).

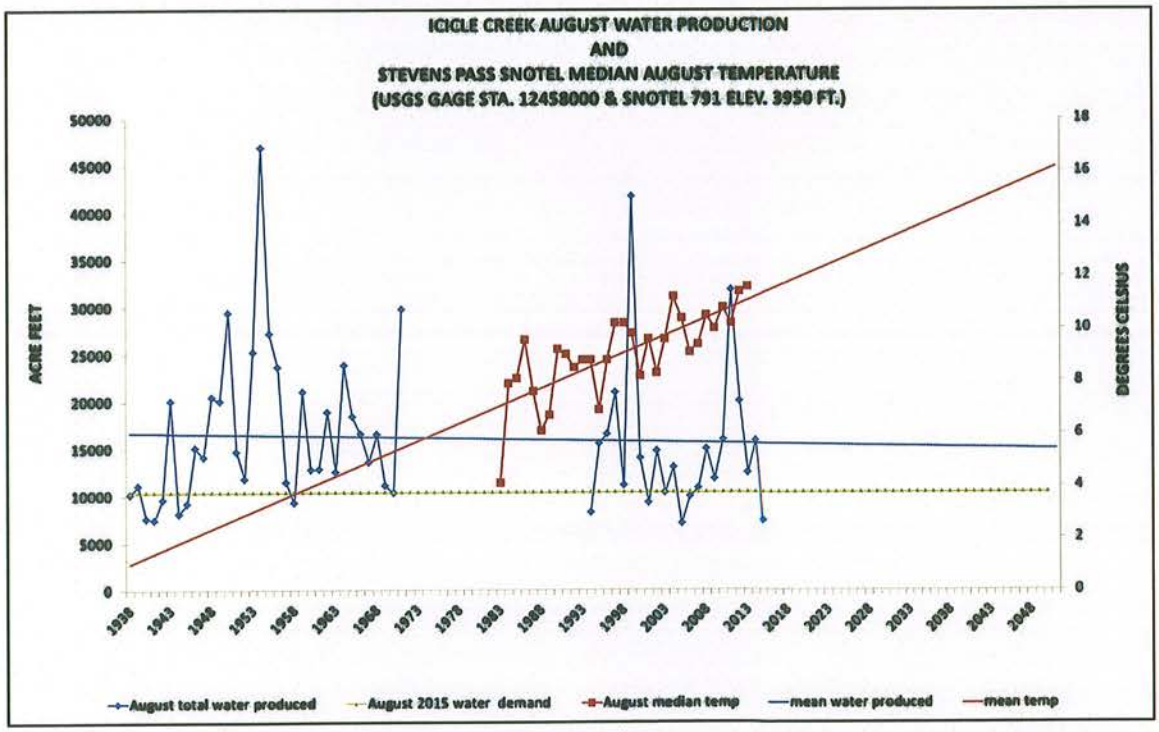

Figure 3. Total volume of water measured at USGS gauge #12458000 decreased and median temperature measured at SNOTEL site #791 increased for the month of August. The same result (decreasing water production and increasing temperature) was found for all months during the period April 1-October 31).

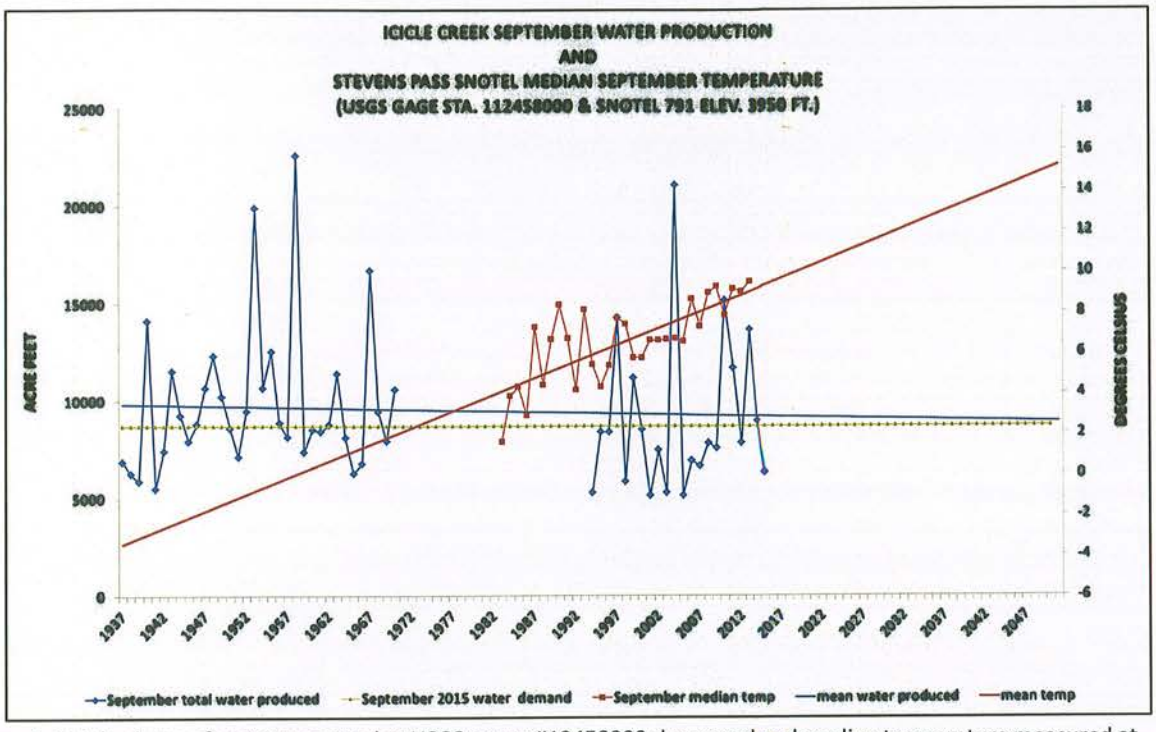

Figure 4. Total volume of water measured at USGS gauge #12458000 decreased and median temperature measured at SNOTEL site #791 increased for the month of September. The same result (decreasing water production and increasing temperature) was found for all months during the period April 1-October 31).

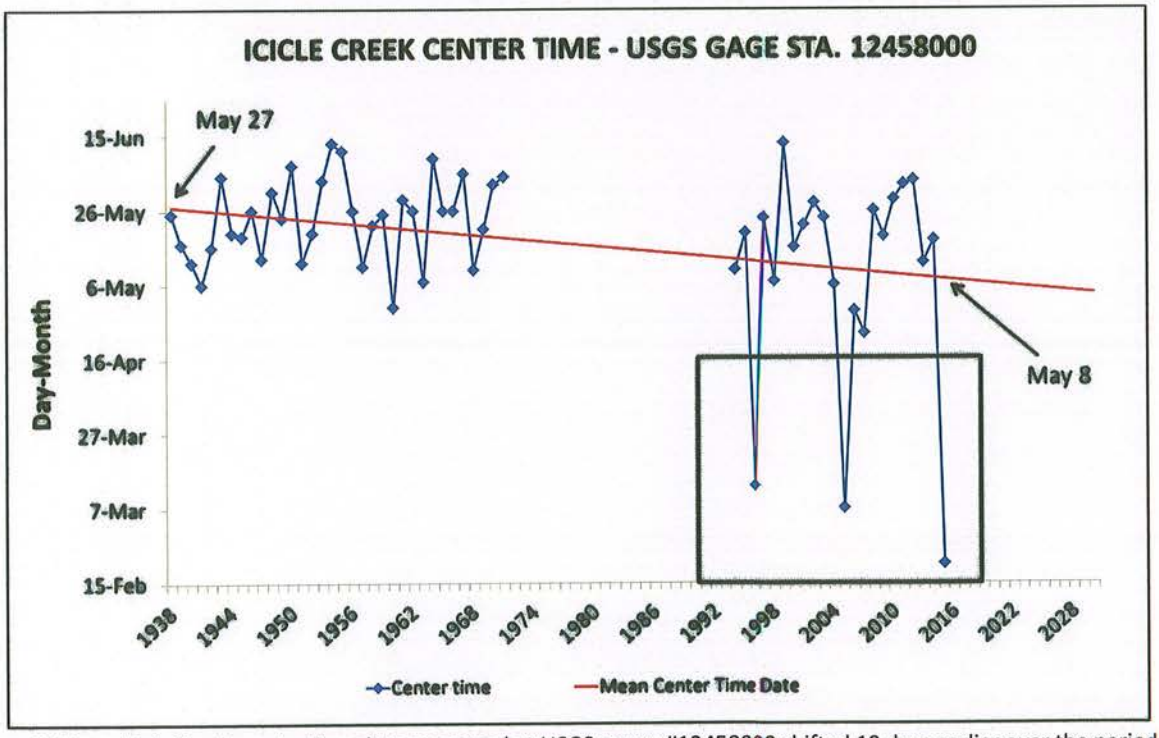

Figure 5. Mean Icicle Creek center time date measured at USGS gauge #12458000 shifted 19 days earlier over the period of record. Note three dates (boxed) occurred on March 13 or earlier 1996-2015.

Historical Data: Temperature

Linear regressions of median temperatures suggested increasing temperatures for all months at SNOTEL site #791 (e.g., Figs. 2, 3, 4). Temperature increases ranged from a minimum of 1.2°C in June to a maximum of 4.8°C in September (Table 1). Average median monthly temperature increase was 3.0°C. SNOTEL data may be biased and this analysis did not research a bias nor apply a bias correction.

Table 1. Median monthly temperatures measured at SNOTEL site #791 (Stevens Pass) increased during the period of record 1984-2013.

Stevens Pass SNOTEL Data: Linear Regression of Median Monthly Temperatures				
Month	**1984 (°C)**	**2013 (°C)**	**Change (°C)**	**Change (Percent)**
Oct	1.7	4.2	2.5	147.1
Nov	-3.0	0.4	3.4	113.3
Dec	-6.0	-2.1	3.9	65.0
Jan	-5.1	-1.2	3.9	76.5
Feb	-5.0	-1.1	3.9	78.0
Mar	-2.7	-0.6	2.1	77.8
Apr	-1.0	0.8	1.8	180.0
May	1.1	3.4	2.3	209.1
Jun	4.8	6.0	1.2	25.0
Jul	7.5	10.2	2.7	36.0
Aug	7.3	11.2	3.9	53.4
Sep	4.3	9.1	4.8	111.6
Mean	0.3	3.4	3.0	97.7

IWG Water Demands and Historical Stream Flow Conditions

Historical mean daily flows at USGS gauge station #12458000 were compared with Icicle Creek July-October IWG water demands for the recent period of gauge operation (1994-2015). Recorded mean daily flows would not have met total instantaneous IWG demands 32.7% of the time (884 of 2706 days) (Table 2). IWG water demand was greater than mean daily flows most often in August (34%) and September (63%). Total monthly water production during the same time period would not have met IWG demands for 27% of the August data (6 of 22 years) and 68% of September data (15 of 22 years) (Figs. 3, 4). Demand deficits ranged from 27-3316 ac-ft (0.5-54 cfs) for August and 165-3563 ac-ft (2.8-60.0 cfs) for September.

Table 2. Number of days when IWG demand would not have been met by mean daily flows in Icicle Creek measured at USGS gauge station #12458000 (deficit days are in red text).

HISTORICAL PERIOD 1994-2015				
Year/Month	July	August	September	October
1994	4	29	30	23
1995	0	1	30	0
1996	0	1	19	0
1997	0	0	0	0
1998	0	12	30	26
1999	0	0	2	0
2000	0	16	20	0
2001	6	29	30	10
2002	0	2	21	31
2003	1	16	30	12
2004	0	11	0	0
2005	15	31	29	2
2006	0	19	30	31
2007	0	15	29	0
2008	0	0	23	2
2009	0	9	22	14
2010	0	3	0	0
2011	0	0	0	0
2012	0	0	19	13
2013	0	9	4	0
2014	0	0	15	1
2015	24	30	30	23
Total Days	682	682	660	682
Days Below Demand	50	233	413	188
Pct. Days Below Demand	7%	34%	63%	28%

Future Projections: Snow Water Equivalent

Climatologists predict climate change impacts to the region will include air and water temperature increases, decreased April 1 SWE, and reduced summer base flow conditions (among other effects) (e.g., 2014 USDA Climate Change Vulnerability and Adaptation in the North Cascades Region, Washington). This analysis resampled regional geospatial data to a finer resolution to facilitate visualization at the Icicle Creek watershed scale. Temperature and SWE investigations focused on March-April data as these factors during March-April play a key role in determining runoff timing and water supply availability throughout the arid summer months. CIG data indicate April 1 SWE will decline, with an increase in the portion of the watershed containing snowpack below 800 mm SWE and a much smaller portion of the watershed containing snowpack above 800 mm SWE (Fig. 6). The largest decrease is in Icicle Creek watershed area with more than 1000 mm April SWE, which historically represented 20.86% of the basin but is projected to decline to 2.30% (Table 3).

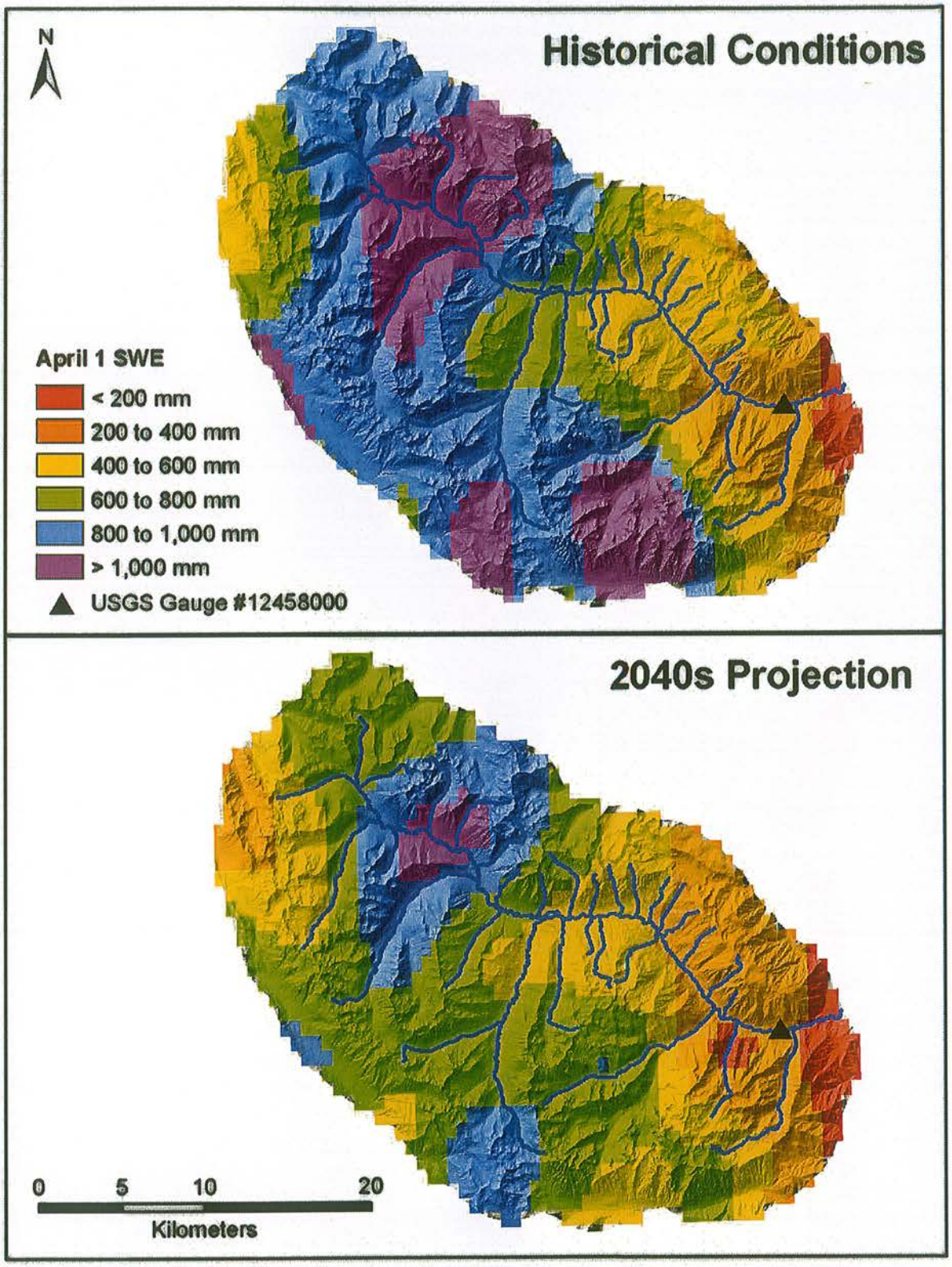

Figure 6. April 1 snow water equivalent (SWE) in the Icicle Creek watershed is projected to decline, with the greatest reductions occurring in the portion of the basin historically comprising snowpack greater than 1000 mm SWE.

Table 3. April 1 snow water equivalent (SWE) less than 800 mm is projected to increase and 800 mm or greater is projected to decrease.

	Historical Conditions		*2040s Projection*		
April 1 SWE (mm)	**Acres**	**Percent of Catchment Area**	**Acres**	**Percent of Catchment Area**	**Percent Change**
< 200	3,665.14	1.73%	7,502.19	3.54%	51.15%
200 to 400	21,045.92	9.91%	35,570.34	16.77%	40.83%
400 to 600	33,227.34	15.65%	45,038.80	21.23%	26.23%
600 to 800	30,935.01	14.57%	87,097.85	41.06%	64.48%
800 to 1000	79,197.45	37.29%	32,025.30	15.10%	-147.30%
> 1000	44,301.18	20.86%	4,872.91	2.30%	-809.13%

Future Projections: Temperature

According to the 2014 United States Department of Agriculture report *Climate Change Vulnerability and Adaptation in the North Cascades Region, Washington* a current warming trend in the Pacific Northwest is expected to continue with mean warming of 2.1°C by the 2040s. This analysis compared COOP historical temperature observations with CIG Western US Hydroclimate Scenarios Project forecasted 2040s mean monthly temperature data. A focus was placed on late winter and spring months (February-May) as this period is critical to dry season water supplies (possible snow accumulations or snow melt, depending on weather/climate). In general, temperatures are predicted to increase for all months analyzed across the Icicle Creek basin. March was used to exemplify the trend as it is a transitional month that can be more like winter or spring depending on variability of inter-annual conditions. Temperatures increased for all locations in the basin. The greatest change was for temperatures below -2°C, which historically comprised 23.16% of the Icicle Creek basin but are projected to comprise just 0.78% of the basin by the 2040s (Table 4, Fig. 7).

Table 4. Temperatures in the Icicle Creek basin are projected to continue a current increasing trend with the largest change for temperatures historically less than -2°C.

	Historical Conditions		*2040s Projection*		
Mean Temperature (°C)	**Acres**	**Percent of Catchment Area**	**Acres**	**Percent of Catchment Area**	**Percent Change**
< -2	49,137.77	23.16%	1,600.68	0.78%	-2,969.82%
-2 to -1	92,833.73	43.76%	47,736.31	23.28%	-94.47%
-1 to 0	53,023.91	25.00%	96,212.80	46.92%	44.89%
0 to 1	10,018.38	4.72%	49,706.30	24.24%	79.84%
1 to 2	4,597.81	2.17%	9,780.28	4.77%	52.99%
> 2	2,517.81	1.19%	7,093.44	3.46%	64.51%

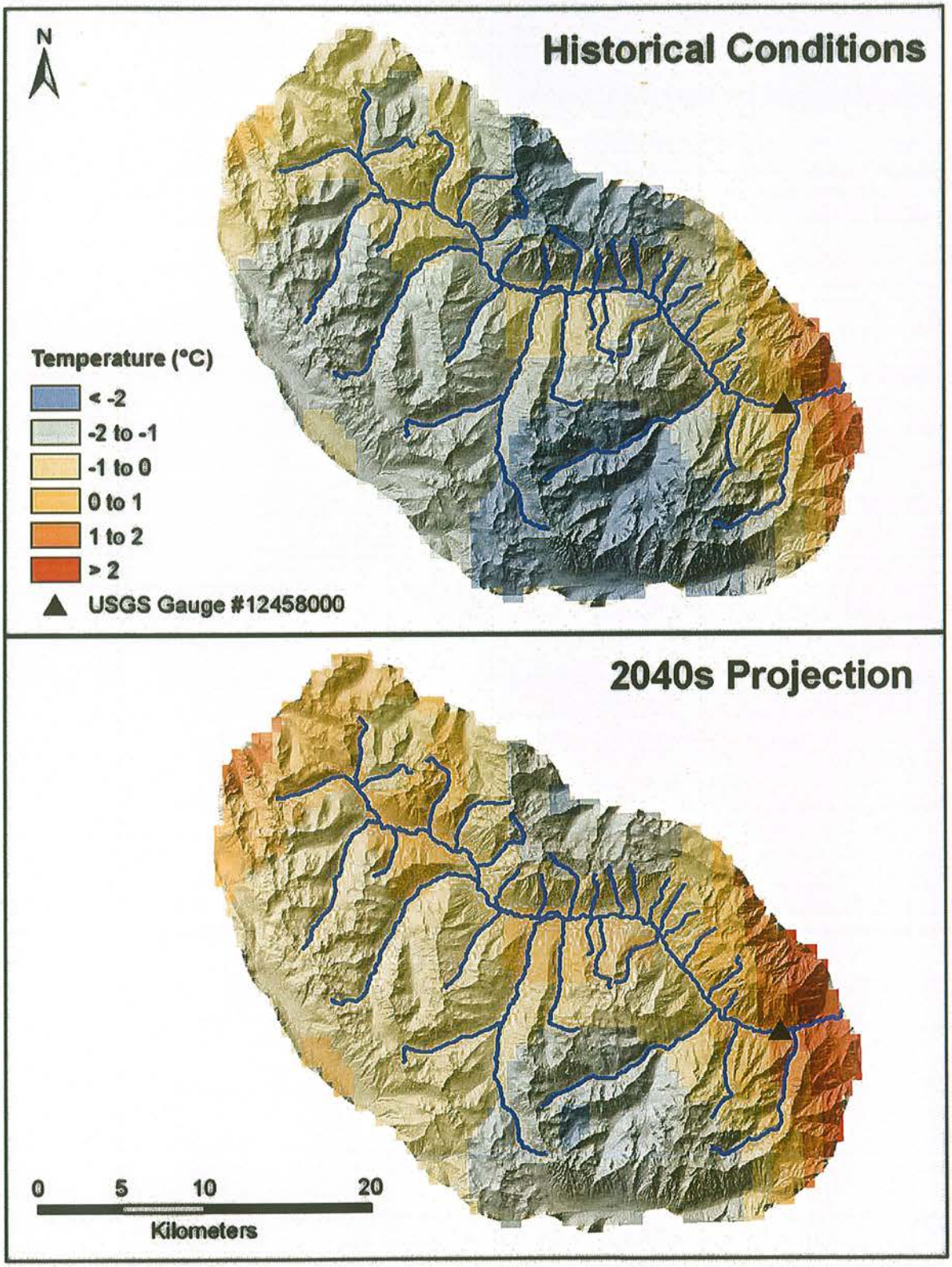

Figure 7. Mean March temperatures in the Icicle Creek basin are projected to increase, with large declines in watershed area historically comprised of mean March temperatures below -1°C.

IWG Water Demands and Future Summer Stream Flow Conditions

In general, climatologists predict reduced summer stream flows as a result of climate change in the region. A review of literature and climate models revealed variable percent of flow reduction from historical conditions. For example, National Stream Internet data indicated a mean summer (June-September) reduction of 39.33% and mean August reduction of 63% in Icicle Creek at the confluence with Snow Creek by the 2040s. The 2014 National Climate Assessment Northwest Regional Report by the United States Global Climate Research Program suggested 40-50% reduction of flows in the Wenatchee River near Icicle Creek. Since no future stream flow data specifically developed for the Icicle Creek basin were available, this analysis considered a 35% reduction in July-October Icicle Creek flows for the historical period 1994-2015 measured at USGS gauge station #12458000. The period July-October was considered because aforementioned evaluations determined historical flows would not have met IWG demands most often during these months. IWG demand was greater than mean daily flows applied with a 35% reduction most often in August (71%) and September (89%) when IWG water demand would not be met for a majority of days (Table 5). Historical Icicle Creek flows applied with a 35% reduction to simulate potential climate change impacts would not have met IWG demand for the entire month of September in 15 of 22 years.

Table 5. Historical Icicle Creek flows measured at USGS gauge station #12458000, when applied with a 35% reduction to simulate potential climate change impacts, would not meet IWG demand for a majority of the typical low-flow period July-October.

35% FLOW REDUCTION				
Year/Month	July	August	September	October
1994	13	31	30	25
1995	1	15	30	0
1996	0	16	30	19
1997	0	11	20	0
1998	7	31	30	31
1999	0	0	23	18
2000	0	25	30	10
2001	17	31	30	16
2002	0	20	30	31
2003	13	31	30	16
2004	10	25	4	0
2005	30	31	30	26
2006	4	31	30	31
2007	6	31	30	11
2008	0	19	30	17
2009	0	27	30	20
2010	0	18	13	4
2011	0	0	27	0
2012	0	10	30	14
2013	6	31	23	0
2014	0	19	28	15
2015	31	31	30	29
Total Days	682	682	660	682
Days Below Demand	138	484	588	333
Pct. Days Below Demand	20%	71%	89%	50%

Interpretation and Conclusions

The purpose of this study was to examine stream flow, temperature, and SWE in the Icicle Creek basin. Investigations yielded a trend of increasing stream flow during the period November 1-March 31 and decreased stream flow during the period April 1-October 31 in Icicle Creek measured at USGS gauge station #12458000. Center time date became earlier through the gauge station period of record. Median monthly temperatures at SNOTEL site #791 at Stevens Pass increased for all months. Icicle Creek basin SWE declined and temperature increased when historic conditions were compared with projected future conditions.

Current IWG materials indicate an instream flow demand of 60/100 cfs and conservation benefit of 47/77 cfs in drought/normal years. This analysis utilized only drought year instream flow demand of 60 cfs. IWG water demand was compared with historical flows measured at the gauge station. Mean daily and mean monthly demand deficits occurred during the period of record, including several instances of deficits greater than the 47 cfs drought year conservation benefit. If the analysis had considered a 100 cfs normal year demand the frequency and quantity of the demand deficit would increase.

A 35% reduction of historical stream gauge mean daily flow data for July-October during the recent period of gauge operation was used to simulate potential future conditions. IWG demand was frequently not met under this scenario, particularly in August, September, and October. Deficits greater than the 47 cfs drought year conservation benefit occurred in each month, with some months exceeding a 47 cfs deficit every day (e.g., September 1998, August 2001, September 2003). Furthermore, there are many October months with large deficits that could not be closed by proposed projects since much of the normal year conservation benefit is associated with irrigation/reservoir management effective only during the irrigation season (ending in September). Note that although this scenario is hypothetical, the authors selected a value for the percent reduction in stream flows based on a review of pertinent literature.

This analysis utilized Icicle Creek stream flow data to evaluate how IWG water demand compared with historical and potential future Icicle Creek flow conditions. Furthermore, the analysis investigated historic temperatures measured near the headwaters of the Icicle Creek basin and also compared historic temperature and SWE data with projected future temperature and SWE conditions across the entire Icicle Creek basin to gain a fundamental understanding of recent and potential future climate conditions. All data utilized were publicly available and the authors encourage interested parties to contact them with questions or data requests.

The study examined data trends and applied straightforward methods such as sums, measures of central tendency, simple linear regressions, and percent changes. No test of statistical significance was applied. Resampling of geospatial data was meant to facilitate visualization and may not be the most appropriate method for analysis. The authors do not claim to be climate experts. Rather, results of this analysis highlighted the need for an expert evaluation of future water supply, instream flow, and climate conditions in the Icicle Creek basin. Such an evaluation has been utilized in other resource planning endeavors and can be a valuable tool when planning projects and making decisions that impact ecosystem health and human communities.