COLUMBIA RIVER TREATY HYDROMETEOROLOGICAL COMMITTEE

2019 ANNUAL REPORT

1 OCTOBER 2018 – 30 SEPTEMBER 2019

Akamina Pass 2 snow station re-installation

Stephanie Smith*	B.C. Hydro, Canadian Chair
Georg Jost	B.C. Hydro, Canadian Member
William Proctor	U.S. Army Corps of Engineers, U.S. Co-Chair
Ann McManamon	Bonneville Power Administration, U.S. Co-Chair

DECEMBER 2019

COLUMBIA RIVER TREATY HYDROMETEOROLOGICAL COMMITTEE

2019 ANNUAL REPORT

Introduction

The Columbia River Treaty Hydrometeorological Committee (CRTHC) was established in September 1968 by the Entities. The CRTHC is responsible for planning and monitoring the operation of the hydrometeorological data collection network in accord with the Columbia River Treaty (CRT). It also assists the Entities in matters related to hydrometeorological and water supply forecasting. This report summarizes CRTHC activities during the 2019 water year (1 October 2018 – 30 September 2019). The Annual Report focuses on:

- Station Adequacy
- Computer Systems and Data Acquisition and Exchange
- Forecasting Procedures
- Review of the 2019 CRT water supply forecasts
- Other activities of the Committee

In addition to this Annual report, the CRTHC publishes a Supplemental report, which contains general information that does not typically change from year to year. Appendices in the supplemental document include:

Appendix A – Introduction to the CRTHC terms of reference
Appendix B – Terms of reference for the CRTHC
Appendix C – Process for reviewing hydrometeorological data networks
Appendix D – List of contributors of hydrometeorological data
Appendix E – Data communication and storage systems
Appendix F – Data exchange reports
Appendix G – Treaty studies, models, and volume and streamflow forecast requirements
Appendix H - Adjusting Inputs to Approved Forecast Procedures

2019 ANNUAL REPORT

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See 2019 Supplemental Report for a list of acronyms used in this report

2019 Annual Summary

The Columbia River Treaty Hydrometeorological Committee (CRTHC) was established in September 1968 by the Entities and is responsible for coordinating hydrometeorological data collection, data exchange, and water supply forecasting for the CRT projects in accordance with the Treaty and otherwise assisting the Entities, as needed. The Committee consists of the following four members:

UNITED STATES SECTION	**CANADIAN SECTION**
Ann McManamon, BPA Co-Chair	Stephanie Smith, B.C. Hydro, Chair
William Proctor, USACE Co-Chair	Georg Jost, B.C. Hydro, Member

The CRTHC conducted bi-monthly conference calls and met in person twice during the 01 October 2018 – 30 September 2019 period:

Meeting 82: 6 June 2019, BCHydro

Meeting 83: 26 September 2019, USACE

In addition, the CRTHC members conducted several phone conference calls to discuss impending water supply forecast decisions or provide guidance for ongoing projects. The CRTHC maintains a list of all action items arising from these meetings in Schedule 1, attached to the end of the main body of the Annual Report, which details the outstanding action items and the list of actions completed this year. The 2018 CRTHC Annual Report was completed in December 2018 and distributed prior to the end of the year.

Stations

The CRTHC routinely reviews the basin gauging network for adequacy and at this time believes that the station network is adequate for Treaty purposes. The CRTHC process for reviewing proposed changes to the operation of stations within the hydrometeorological network is described in Appendix C of the Supplemental Report. The process is intended to ensure that changes made to the network do not adversely affect the monitoring, planning, and operations of Treaty facilities.

Fauquier climate

B.C. Hydro installed a new automated climate station at Fauquier Water Treatment Plant in the fall of 2018 (FAQ), with the intention that after a suitable period of overlap, the new auto station would replace the Fauquier manual observations. Fauquier is used in several of the Canadian water supply forecasts and is designated a Treaty station. Unfortunately the climate observer station discontinued without a period of overlap with the new FAQ station, so the new station is being used as a direct replacement for FQR climate station.

Akamina Pass snow pillow

The Akamina Pass snow pillow site in Alberta which is used in the Libby water supply equation was damaged by a forest fire in 2018. The CRTHC approved a proposed procedure to estimate those data during the 2019 forecasting season. The station has since been re-established as Akamina 2, but the location still severely altered by the fire (see photo on report cover). The USACE will continue to use the estimation procedure for Akamina in the Libby forecast in 2020, and will revisit updating the water supply forecast procedures to eliminate use of the Akamina snow station.

Other Station changes

Fernie snow course (2C07) was clear cut and no longer able to be sampled. BCH proposed the station be discontinued, and the USACE agreed.

The BC River Forecast Centre proposed automating the ***Gray Creek Upper (and Lower snow courses*** in the Kootenay basin. As FORTIS BC funds the two stations,

they countered that they can only afford to support one automated station. After a review of the station data, the BC RFC recommended upgrading the Gray Creek Lower snow course and discontinue the Upper station, which is prone to vandalism. BC Hydro agreed as the Lower station is currently used internally for the Salmo / Seven Mile forecast procedure.

The climate station located ***Arrow Reservoir at Nakusp*** (NAK) reservoir gauge was removed as it was a poor location for collecting climate data accurately. It is considered a support station. There is an ECCC climate auto station nearby (Nakusp CS 1145297, WMO ID 71216).

The BC Hydro Mount Fidelity climate station FDL was discontinued in favour of a new auto station installed in 2017 by Parks Canada – Glacier NP Mount Fidelity 2 (Parks) FID2. The ECCC Treaty climate station Glacier NP Mount Fidelity continues to operate as well.

The CRTHC continues to add to and re-shape its station database for use primarily in monitoring station adequacy, tracking station changes, and visualization of basin coverage. This database can now be used to generate maps of the Treaty station network like the example in Figure 1, and easily track changes to the network over time.

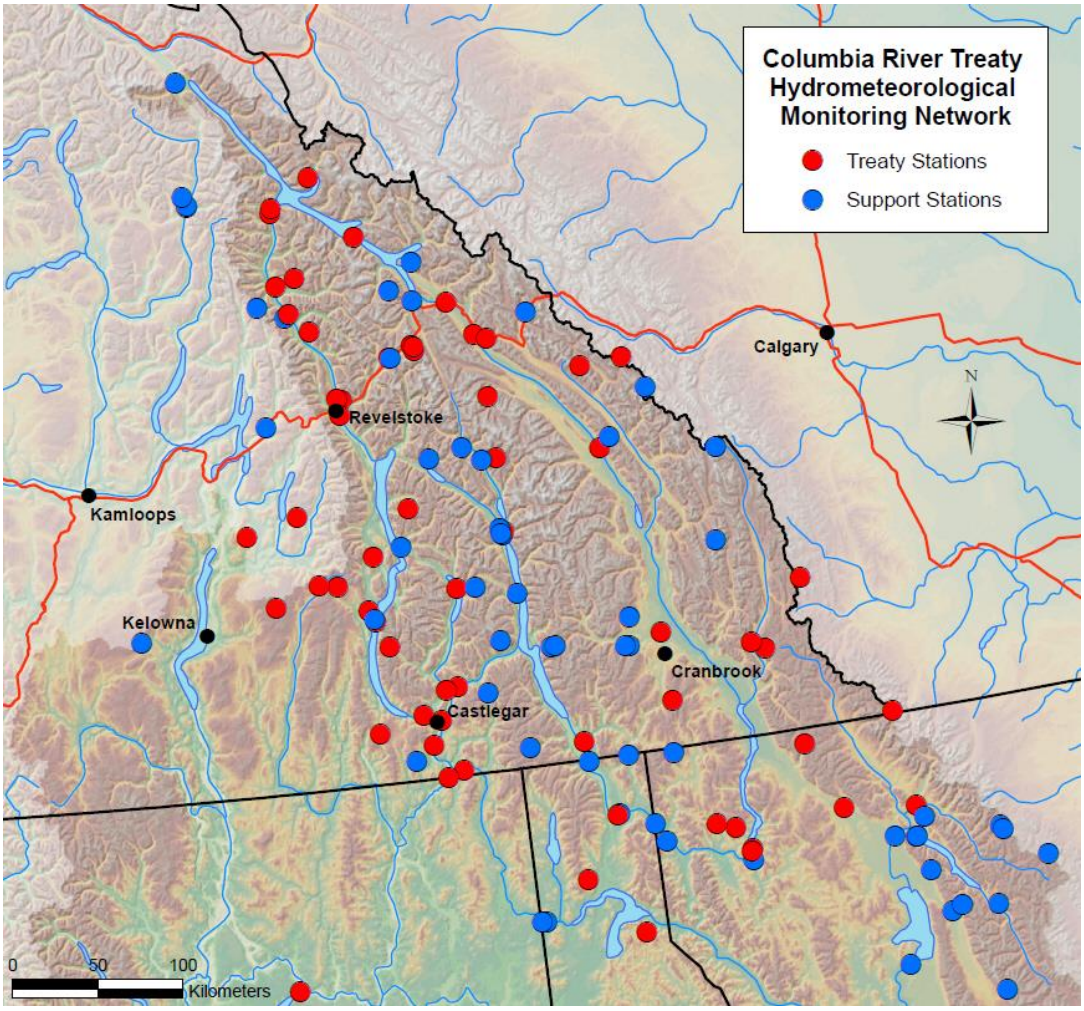


Figure 1: Map of Treaty and Support stations for the Upper Columbia Basin.

Computer Systems and Data Acquisition and Exchange

The committee continues to work toward better ways of documenting data exchange, changes to data networks, and staff contact information. The committee is continually improving protocols for official notification for changes to data reporting and creating a directory of contacts and staff at each entity for critical data exchange and validation issues. B.C. Hydro has shared global email addresses for reporting data issues.

Forecasting

Adjustments to Treaty Storage Regulation

In early April of 2019, an atmospheric river impacted the Snake drainage of the Columbia Basin generating significant precipitation and melting much of the low lying snowpack in the basin. During that time, natural Snake River flows at Lower Granite peaked at an estimated 230 kcfs and added an additional 10 Maf to the forecasted seasonal volume (roughly a 40 percent increase). This additional volume was not captured in the official April water supply forecasts which were issued on 3 April 2019 in the US and 4 April 2019 in Canada. However, precipitation north of the border tracked around normal since the beginning of the month and BC Hydro's internal model runs agreed with that assessment. In the Canadian portion of the basin, a similar increase from the official April Treaty forecast was not experienced. This dramatic increase in seasonal water supply volume caused some issues in the streamflow coordination of some of the projects for the second Treaty Storage Regulation (TSR) in April. Because streamflow forecasts for later months in the TSR are derived from the water supply forecasts, this resulted in unreasonable flow forecasts at some projects for June and July. Preliminary calculations discovered that using the official April Jan-July forecasts left some of the projects on the Snake River with percent of medians which were unrealistically low. From a planning perspective the use of those values increased the risk that Treaty planning for June and July would reflect unrealistic proportional draft and affect decisions regarding release of flow augmentation water for U.S. fisheries objectives. The Hydromet Committee proposed that projects impacted by the storm would use the 15 April 2019 forecast generated by the NWRFC which reflected the additional volume from the atmospheric river event. The Canadian projects and Libby (which were not impacted by the storm) would continue to use their official April forecasts.

Similar conditions occurred again in late May. There was another storm which occurred in the southern portion of the basin which increased the overall forecasted water supply seasonal volume and causing the percentages of some of the coordinated

streamflows to be unrealistic. The same approach was taken during May, with the mid-month water supply forecast being used for all but the Treaty projects which remained largely unaffected by these late season storms.

2019 Water Supply Forecasting Deviations

Despite extensive efforts to develop robust water supply forecasting procedures, there are times when adjustments must still be made to the inputs to the procedures during any given year. The CRTHC can agree to alter inputs to the prescribed Treaty water supply forecasting procedures if there is a strong justification and agreement that one of the inputs is unduly influencing the forecast results. The committee has a procedure to review any proposed changes and decide whether the change is considered to be justified.

The only water supply forecasting deviations in WY 2019 was the approved use of an estimation factor for Akamina Pass snow data for the Libby forecast.

POP Appendix 8 2019 Updates

There were two separate updates to POP Appendix 8 in 2019.

At the January 2019 CRTOC meeting, CRTOC accepted the following proposed update to POP Appendix 8 regarding the coordination of flows in June for the TSR/AER:

In the section on January through June Forecast Season, for the second TSR of the Month, Item 3 was added:

1. The forecasts for the remainder of the current month <u>and</u> the following month are coordinated with the appropriate organizations or agencies.
2. The residual volume (January-July volume less observed whole months and coordinated forecasts for current month and subsequent month) is shaped using the monthly distribution factors to come up with the remaining monthly streamflow values.
3. *In the month of June, the TSR extends beyond the January-July period and includes the two halves of August. The July monthly values and the August bi-monthly values are based on forecast values that are coordinated between the appropriate organizations and agencies.*

At the 27 September 2019 CRTOC meeting, the CRTOC approved the following update to POP Appendix 8 to delegate responsibility to the CRTHC to make changes to streamflow forecasts for the AER/TSR:

Hydrometeorological Adjustments:

From time to time, issues with computation of water supply forecasts or the forecasts for streamflow coordination for the TSR have arisen, e.g. missing data, questionable input values to forecasts, changes to the runoff distributions, or similar hydrometeorological issues. These issues have resulted in the need for in-season adjustments that are difficult to coordinate in real-time. At the 27 September 2019 CRTOC meeting, the CRTOC delegated responsibility to the CRT Hydromet committee to approve these adjustments and then provide documentation of the changes to the CRTOC.

2020 NWRFC ESP Water Supply Forecasts

The NWRFC will be changing the ESP forecasts which it provides for various forecast points in WY 2020. This year they will create ensembles which include 10-days of a short term forecast and ensembles that are forced with only historical weather sequences (climatology or 0 day). They are also providing an experimental set of ensembles which transition from short-term weather ensembles to longer term weather ensembles. With only two ESP sets with which the region has had some experience, the CRTHC is recommending that the ESP forecast with 10-days of a short-term forecast included be adopted for Treaty purposes and for operational decisions on the Columbia River system for WY 2020.

We also continue to recommend using the NWRFC generated forecasts available at the close of business on the 3rd working day of the month. In recent years, the Bureau forecast for Hungry Horse and the Corps forecasts for Dworshak and Libby have also been available by the 3rd working day. BC Hydro has committed to having a draft forecast available by noon on the 4th working day. This shift in schedule was able to make the flood risk management guidance available one day earlier this past year. We continue to recommend this same approach for this coming year.

The CRTOC approved the following dates for the upcoming year (WY20) for the ESP-based water supply forecasts generated by the NWS NWRFC. Those dates are:

December 4th
January 6th
February 5th
March 4th
April 3rd
May 5th
June 3rd

Water Supply Forecast Verification

The water supply forecasts and information on the hydrometeorology for the year are presented in the 2019 Annual Report of the Columbia River Treaty by the Entities (Section IV), and will not be repeated here. This section gives a brief overview of any lessons learned.

Canadian Projects

Precipitation, temperature, and snow

The following two figures summarize the observed conditions for the Canadian Columbia and Kootenay regions computed as an average of the stations reported in the monthly Canadian Water Supply Forecast update.

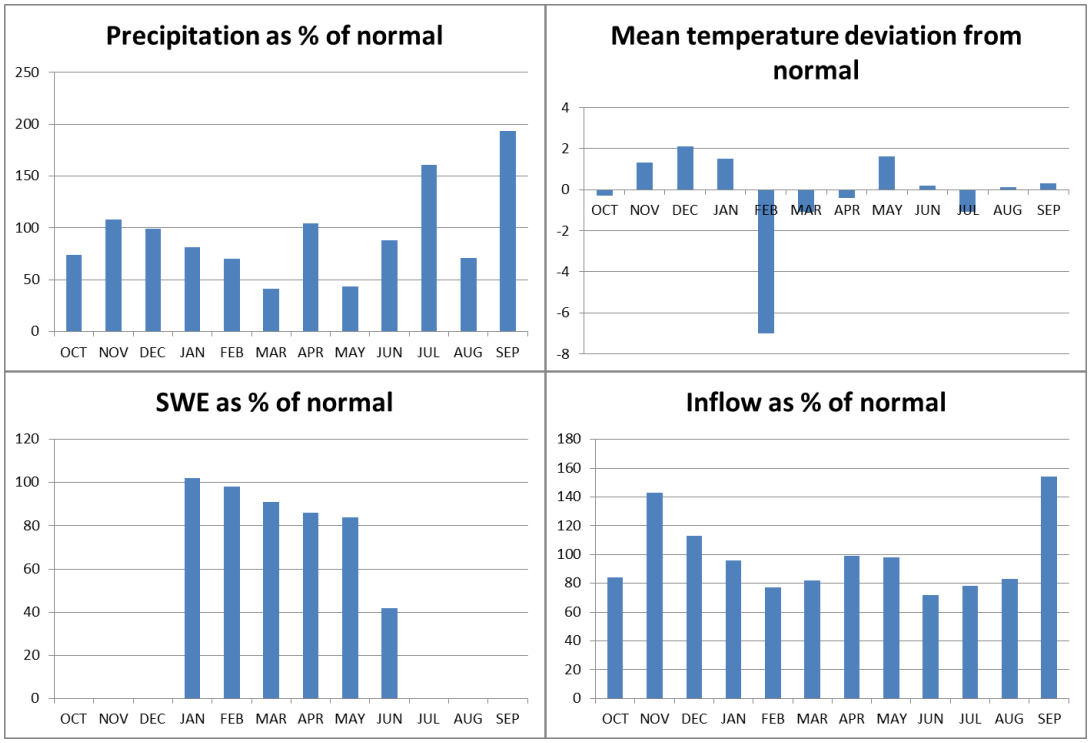


Figure 2. WY 2019 observed average monthly hydrometeorological conditions for Columbia region. Source: BC Hydro

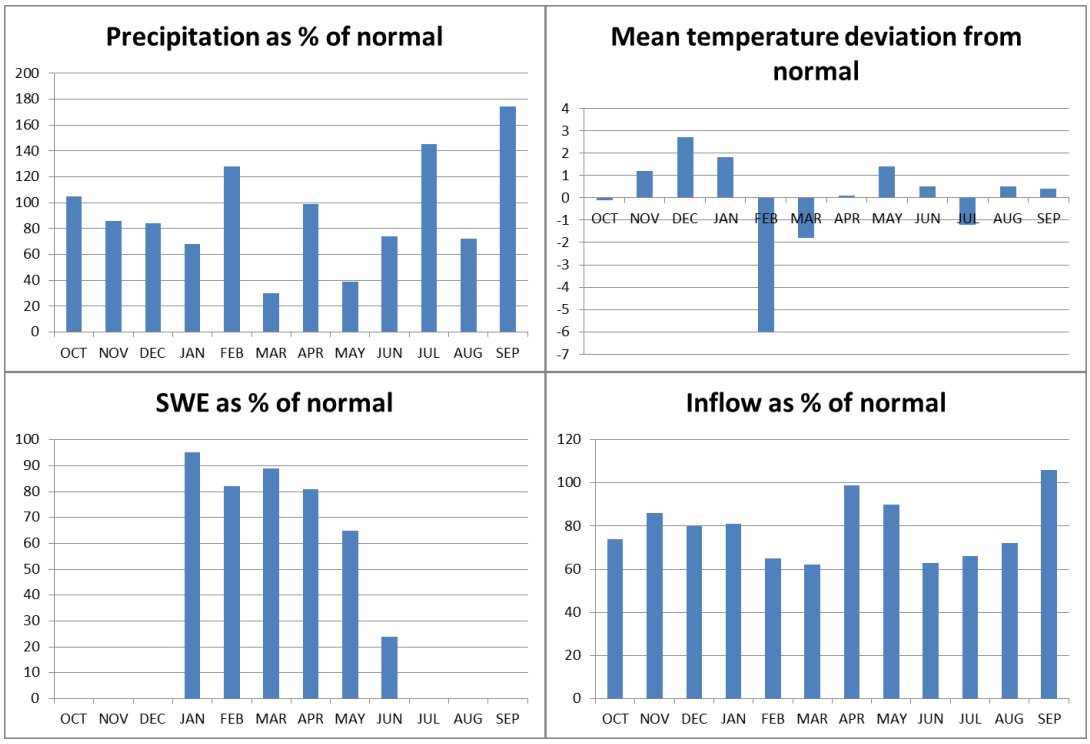
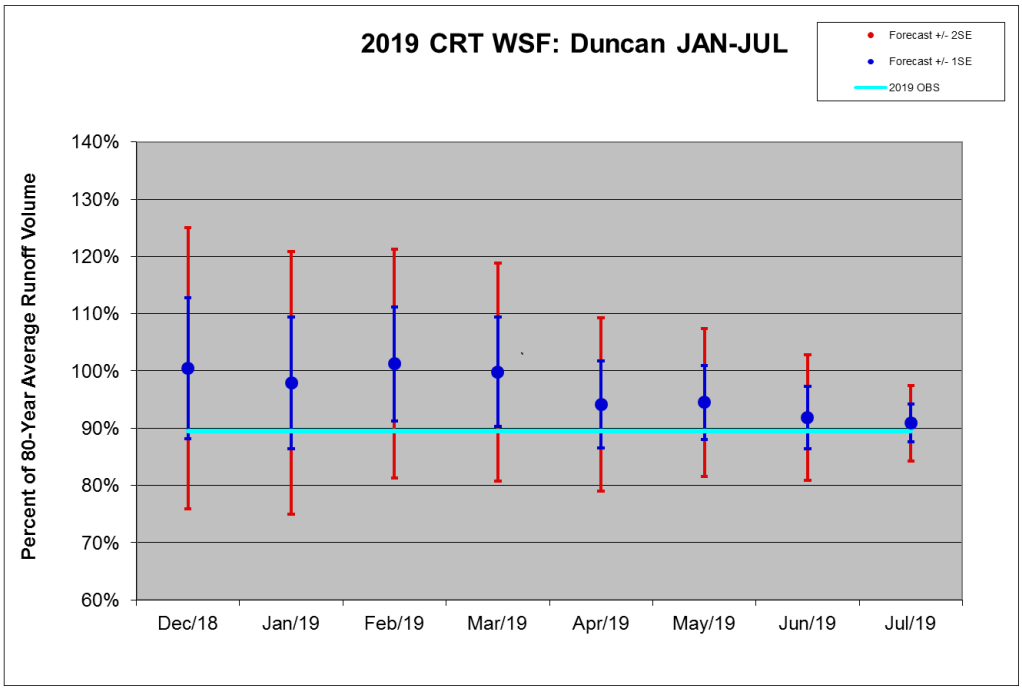


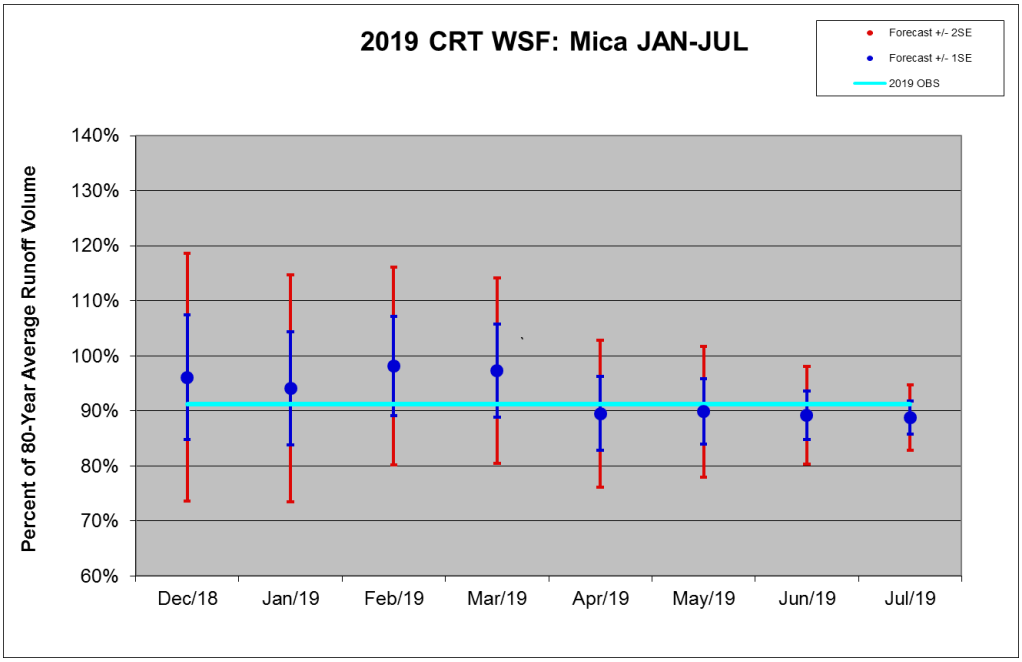
Figure 3. WY 2019 observed average monthly hydrometeorological conditions for Kootenay region. Source: BC Hydro

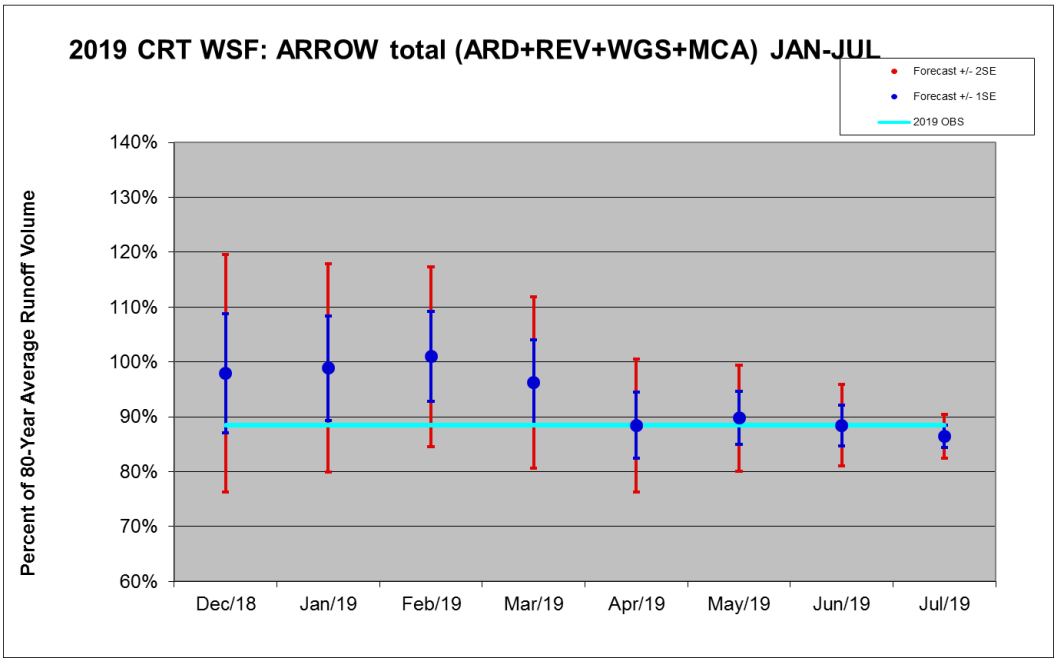
Forecasts

The WY 2019 forecasts and observed volumes for Canadian Treaty projects are shown in Figure 4 below.

- Observed inflows for Mica, Arrow and Duncan were within the ±1SE or ±2SE prediction bounds for both the Jan-Jul and Apr-Aug targets.
- Forecasts progressively converged towards (and in some cases dropped below) the observed volumes, which is consistent with the evolution of the weather pattern through the forecast season.
- The modest increases from January to February are attributed to sampling variability of snowpack data included in the models as the month of January actually saw below normal observed precipitation.
- Because of the progressive drying through the winter and spring months, forecasts issued during the first half of the season (namely through March) had large over-forecasting errors. In particular, well below normal precipitation in March was responsible for a significant drop in the forecast from March to April.




2019 CRT WSF: Mica JAN-JUL
Forecast +/- 2SE
Forecast +/- 1SE
2019 OBS
Percent of 80-Year Average Runoff Volume
140%
130%
120%
110%
100%
90%
80%
70%
60%
Dec/18
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19


2019 CRT WSF: ARROW total (ARD+REV+WGS+MCA) JAN-JUL
Forecast +/- 2SE
Forecast +/- 1SE
2019 OBS
Percent of 80-Year Average Runoff Volume
140%
130%
120%
110%
100%
90%
80%
70%
60%
Dec/18
Jan/19
Feb/19
Mar/19
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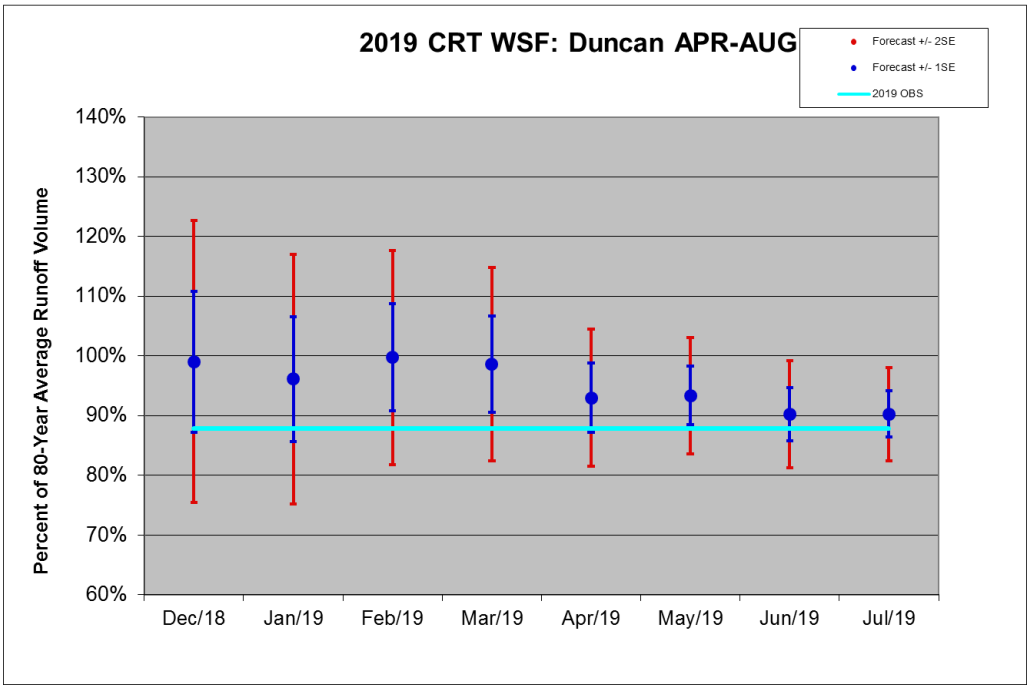
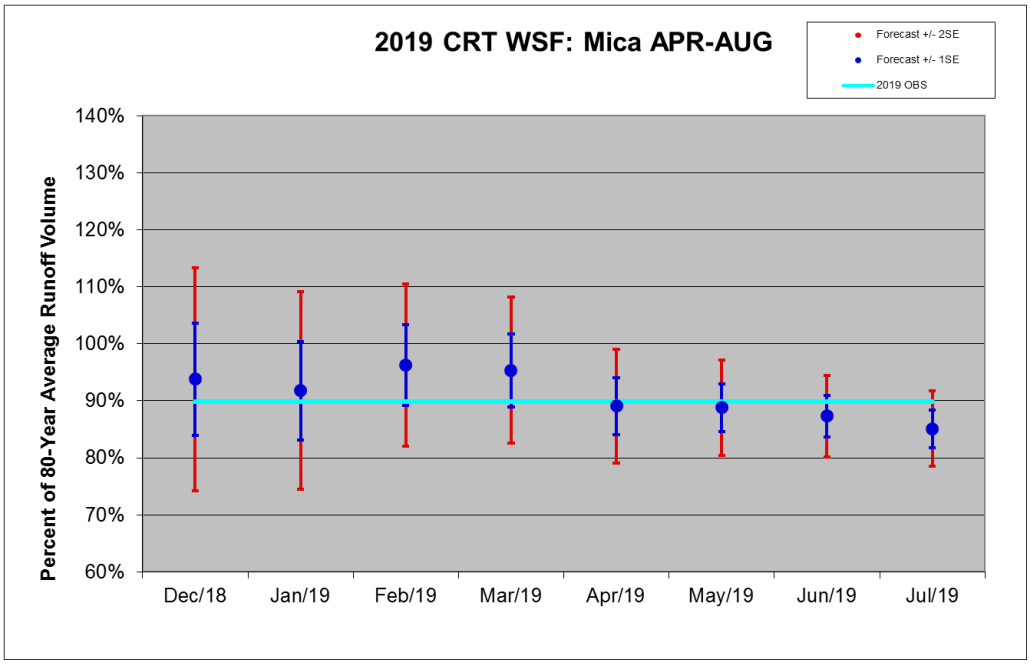
May/19
Jun/19
Jul/19


2019 CRT WSF: Duncan APR-AUG
Forecast +/- 2SE
Forecast +/- 1SE
2019 OBS
Percent of 80-Year Average Runoff Volume
140%
130%
120%
110%
100%
90%
80%
70%
60%
Dec/18
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19


2019 CRT WSF: Mica APR-AUG
Forecast +/- 2SE
Forecast +/- 1SE
2019 OBS
Percent of 80-Year Average Runoff Volume
140%
130%
120%
110%
100%
90%
80%
70%
60%
Dec/18
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May/19
Jun/19
Jul/19

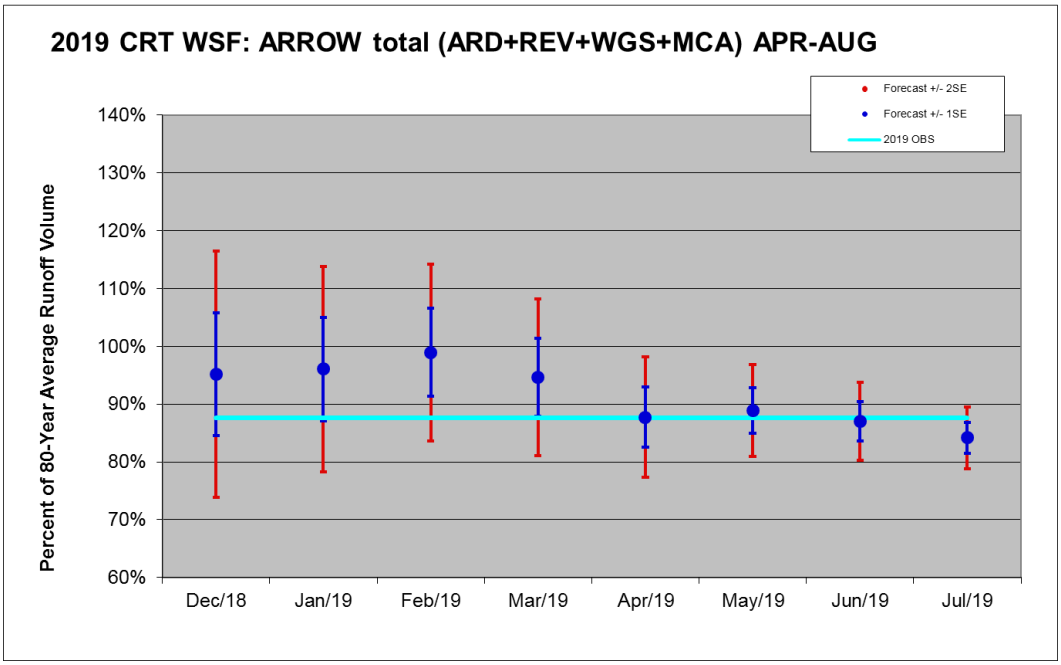

Figure 4. CRT forecast evolution compared to observed inflows for the Jan-Jul and Apr-Aug forecast targets

Libby

The Libby 2019 water supply forecast was below average every month, with slight fluctuations in the spring due to precipitation. The lower-than-average forecasts were due to a low snowpack and low precipitation.

The average basin precipitation in the Libby watershed through the fall, winter, and spring (October – June) was consistently below normal, ranging from 18 to 88 percent of average. In most months one or more precipitation station points observed greater than average precipitation, but the region as a whole experienced drier than normal conditions.

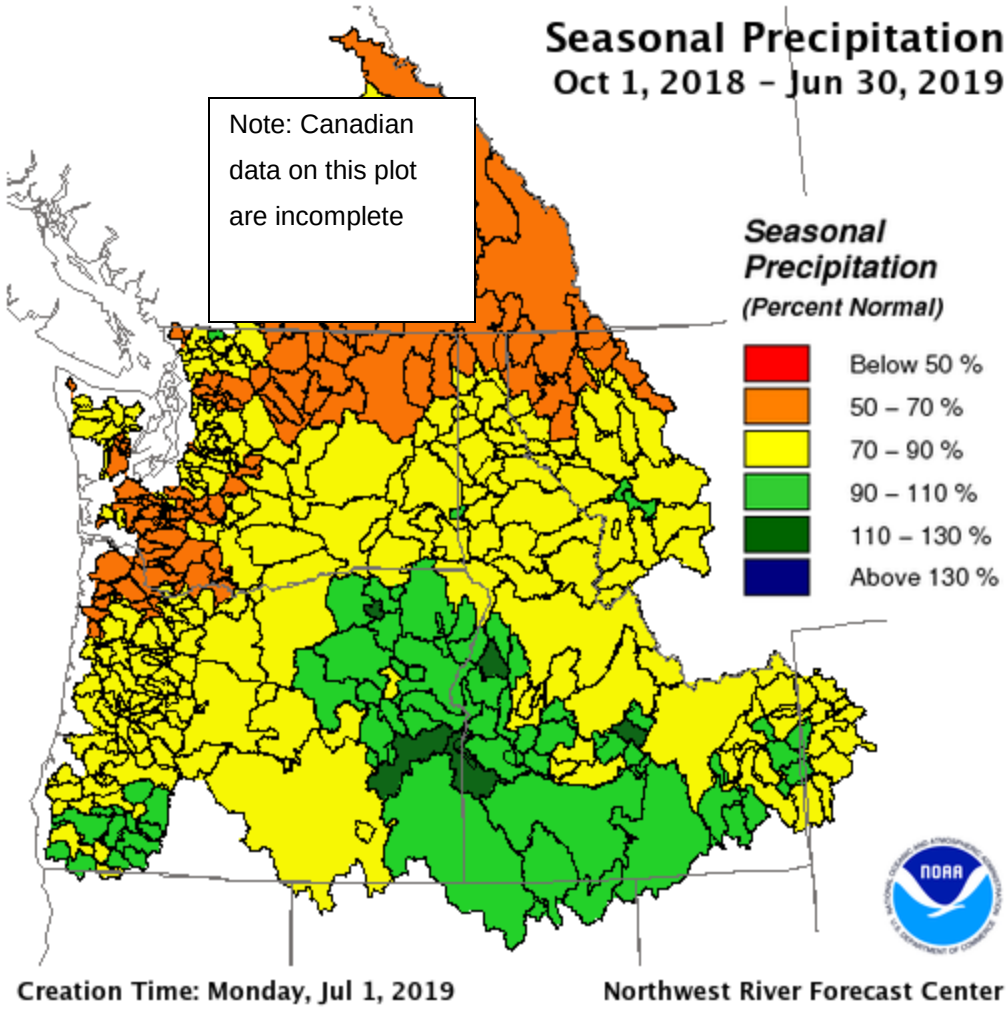

Figure 5 October – June 2019 Precipitation for the Columbia basin. Note the data for the Canadian portion of the data were determined to be incomplete. (Source: NOAA https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?date=10/01/2019&tab=1)

The snow accumulation at the SWE station points was also below average during water year 2019 for all locations, aside from East Creek in BC (which is located in the adjacent Duncan drainage), which reported slightly above average SWE in February, March and May. On 01 April 2019, the SWE at the snow accumulation at the station locations ranged from 56 to 98% of average. The snowpack stayed relatively stable in April reaching 75 percent of average on 01 May 2019, based on an average of the snow accumulation station points. By 01 June 2019, three of the seven snow water

equivalent sites used in developing the water supply forecasts were depleted of snow and the other five stations had roughly 70 percent of average snow water equivalent.

As seen in Figure 6 and Table 1 below, Libby Dam was over-forecasted for the seasonal volume forecasts issued every month. The over-forecasting was partially due to the statistical forecast unable to predict values far from the mean which were caused by the dry summer. In other words, a regression forecast can do a reasonable job of predicting runoff based on snow and precipitation that has occurred, but cannot predict runoff from future events (regressions essentially end up assuming average snow and precipitation for the future months). After a dry winter and spring, precipitation in the summer of 2019 was below normal every month (aside from July).

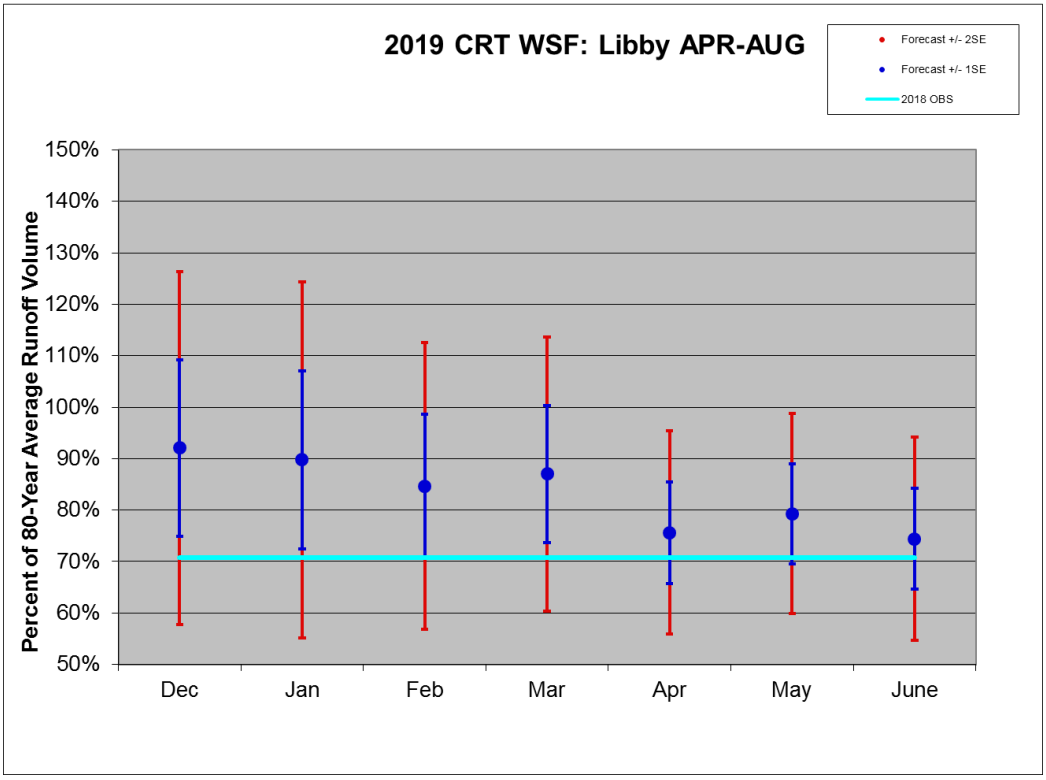

Figure 6 Seasonal forecast evolution including prediction bounds for Libby during the 2019 forecast season.

Month of Forecast	First-of-Month Apr-Aug Volume Forecast (KAF)*	Model Standard Error (KAF)	Number of Standard Errors Different Than Observed	Observed
Dec	5784	1076	1.2	71%
Jan	5639	1087	1.1	71%
Feb	5318	875	1	71%
Mar	5467	836	1.2	71%
Apr	4752	620	0.5	71%
May	4983	611	0.9	71%
June	4676	618	0.4	71%
Observed	4445			

Table 1 Summary of Libby April-August Water supply forecasts for 2019.

Schedule 1 CRTHC Action Items

Table 2 New / Outstanding Action Items 2019

Meeting Source	Description	Notes/Updates
OUTSTANDING ACTION ITEMS		
79.4.d.iii	Complete Collaborators letters for stations in Canada	
79.5.b.ii	Data connection and transfer issues between BPA and Corps	Eve James has met with Gunner Leffler and Dawning Liu to discuss. There have been two major issues with respect to data retrieval for BPA. Bill and Ann to set up meeting to discuss.
80.5.3	Protocol for managing updates to Canadian CROHMS stations and testing changes to the files - add a description of steps for requesting new CROHMS IDs from the CORPS.	document in Supplemental report?
81.2.b.ii	Information on new stations	Stephanie to provide station meta data for new pool elevation sites on Kootenay Lake and Revelstoke Reservoir so they can be added to HADS and other data retrieval processes
81.3.d.ii	ESP Hindcasting	Bill to provide report from Seattle District on their approach to ESP hindcasting and regression forecasting. Consider discussing with RFC how they conducted the hindcasting portion of the process. Possibly do this in conjunction with fall RMJOC II Climate Change meeting
81.4.d.i	Sharepoint Site - add contact information	Add recent organization charts and contact information for staff level contact and who should be contacted for which task.
82.5	Rick to send Scott 2010 Modified flows for FEWS input	
82.5	BCH will send data available in June for 2020 Mod Flows	
82.3.d	send out CRT contact list for hydromet related stuff	

83.2.a.ii	Seattle District to update Libby WSF to choose an equation that does not include Akamina	Seattle may not be able to find original files used to create the current forecast, in which case they will have to redo the forecasts
83.2.c.i	Logan to send link they use to access Fernie to Stephanie and Georg. BC to look for QC data for the station.	Pending in WY 2020
83.2.d.i	BCH to send info on new Fauquier at Water Treatment Plant station replacing Fauquier observer station.	Pending in WY 2020
83.2.e	BCH to confirm if error with GENIE sending last hour of Arrow reservoir data incorrectly has been corrected	Pending in WY 2020
83.3.b	Snow density correction BCH is planning to implement: ACTION: 83.3.b.i Seattle will email BC Hydro with stations they are using before updating equations and send data just to check. ACTION: 83.3.b.ii BC will check with Frank to see if it is BC wide . ACTION: 83.3.b.iii Contact the NRCS and NWRFC and inquire if they are using a correction for the density difference between glycol and water.	Pending in WY 2020
83.4.a	Get write-ups from the NWRFC on the change in the deterministic period of the 10 day forecast	Pending in WY 2020
83.4.d	Mid November 2019 phone call to check in on how current WSF is evolving and remind forecasters about need to request changes to CRTHC.	Pending in WY 2020
83.5.a	BPA to send Modified flows data format template to BCH	Pending in WY 2020

Table 3 Completed Action Items 2019

2018-19 Operating year		
Meeting Source	**Description**	**Notes/Updates**
80.5.4	BCH to add a number of sites to their CROHMS feed: hourly and daily T, P, SWE for Cariboo, Wildcat, Colpitti, Keystone, plus hourly Q data for Similkameen and Slocan at Crescent valley and T, P for Redstreak	
81.2.b.ii	Estimation for missing station data	Bill to send Seattle District proposal for estimating Akamina Pass data since it has been missing due to 2017 forest fire
81.3.c.i	Water Supply Forecast Coordination	BCH to look at adjusting how forecasts are prepared and possibly have same person do WSF and AER/TSR coordination so the person developing the forecasts has greater situational awareness
81.3.a	Water Supply Forecast Requirements Document	Add official adopted conversion factor and NIST standards for significant digits to Water Supply Forecasting procedure document
81.3.d.i	ESP Hindcasting	BCH to look at demonstration of hindcasting for Revelstoke. This effort will possibly involve calibrating the hydrologic components of the model. Conducting the hindcasting, and comparing to existing regression procedures results over the same time period. Period of record is 1984-present. The plan (no results) will be available for the CRTOC September meeting
81.3.c.ii	Water Supply Forecast Coordination	Bill to talk with Seattle District about using the capability to adjust inputs to forecast procedure

81.3.c.iii	Water Supply Forecast Coordination	Implement an early season phone call with all parties to talk about how the season looks early on, how we might want to coordinate any adjustments we might need as the season progresses.
81.3.c.iv	POP Appendix 8	During the next update of POP Appendix 8 include a section to reflect that June forecasts should not be distributed across the following months but rather let internal models be used to determine flows.