

The Development of a Hydrologic Cycle and Rating Curve For Topping Creek

2023/24 Flow Monitoring Period

Report prepared for the City of Rossland and RDKB ReDi Community Grants

By Bill Coedy, Rossland Streamkeepers/Rossland Society for Environmental Action

September 2024

Topping Creek Hydrologic Station

(GPS coordinates 49.1081, -117.820)

Located at the City of Rossland Topping Creek weir at Hwy 3 near Red Mnt Resort



Preamble

The 2023/24 deliverables for this project were to continue with the long term development of a Hydrological Cycle or Hydrograph and Discharge Rating Curve for Topping Creek. This hydrological information is important to water managers and planners, especially for the City of Rossland, as the data can be used in the prediction of creek carrying capacity in terms of water

abundance to water users and ecosystem health. Extreme fluctuation of water flows can cause floods during times of snowmelt combined with spring rains or lead to limitations or restrictions of water use during drought conditions throughout the summer and fall.

The 2023/24 annual Hydrologic Cycle was developed from the continuous hourly monitoring of water levels at the City of Rossland Topping Creek Weir by a HOBO pressure transducer water level logger. A Rating Curve for flow and discharge was verified to previous year measurements and further developed from six independent discharge measurements taken upstream from the hydrology station using salt dilution QQ instrumentation and methods. This report compares the 2022/23 with 2023/24 hydrograph and discharge data.

Why monitor water level and flow?

A Hydrograph is useful to compare seasonal water level cycles. It tells us about the peak flows through water level changes throughout the year. Our mountain streams can be flashy during major snow melt times in the Spring and during extreme precipitation events from thunderstorms. With the added complication of climate warming, this can manifest in either flooding, or extended periods of summer drought well into October. This report compares the hydrographs or seasonal water level cycles for the years 2022/23 and 2023/24.

A Rating Curve, developed by measuring discharge (cubic meters per second) at that particular water level, is useful as one can estimate the discharge easily from from an observation of the water level indicated by a Staff Gauge or measuring stick at the hydrology station. The level of discharge, or rate of flow, can overwhelm culverted streams and cause flooding. This has occurred several times in the past in Trail Creek where overburden debris has dammed culvert entrances. This report comments on the 2023/24 measurements added to the 2022/23 Rating Curve.

Supportive Funds

Grant funding was provided by the City of Rossland in the amount of \$867 and the RDKB ReDi Community Grant of \$830. The City of Rossland grant represents year 2 of a 4 year commitment.

Results

A modification was made to the positioning of the station as a result of key hydrology observations made in 2022/23. The stage station was repositioned along the weir (away from the head wall effect and lowered) in October 2023 to allow measurements during low levels in Fall and Winter without the sensor freezing.

Unfortunately, the HOBO data logger electronics and battery storage malfunctioned in early winter and had to be replaced in April 2024. This was not anticipated as the logger was only a year old and the replacement cost of \$1200 was not built into the 2023/24 budget. Equipment was obtained from the Rossland Streamkeepers and will need to be replaced next year.

Topping Creek hydrologic data is currently stored in the publically assessable Columbia Basin Water HUB database under the Rossland Streamkeepers organization. (see <https://data.cbwaterhub.ca/>). The HUB is managed by Living Lakes Canada.

Hydrological Work Visits

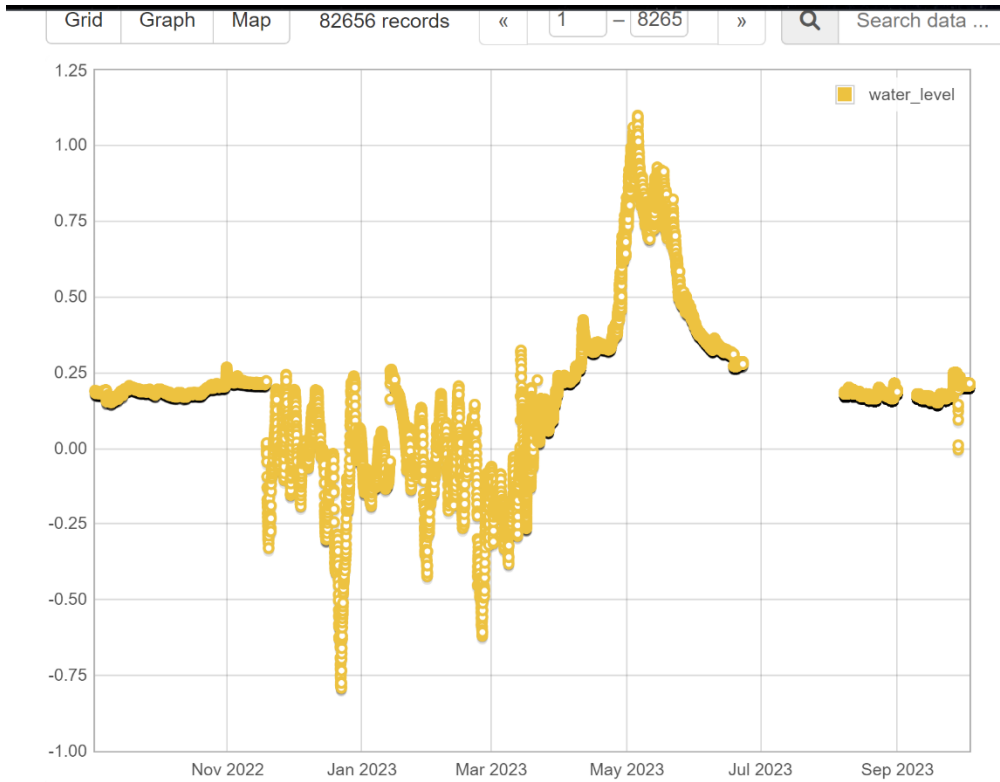
The following table documents the work visits to the Topping Creek Hydrological Station in 2023/24. At least six (6) visits were made throughout the year for station maintenance, logger data upload and salt dilution flow measurements for discharge determinations. The Table indicates observed measurement data for water temperature, water level from the staff gauge and corresponding water level from the logger and discharge data determined from flow measurements. The Table also contains temperature, pH and conductivity measurements. Conductivity is very low in Topping Creek with a range between 18 and 45 uS/cm. This is approximately 10 times lower than conductivity in lower Trail Creek.

Topping Creek Water Level Logger
 location: 49.1081 Lat -117.820 Long
 Installed: 1 September 2022; programmed to measure at 1 hour intervals
 Logger: MX2001-04-SS-S/TI-S top21266038 & sensor2120596
 Staff gauge: 0.210 m ; Water level Reference: 0.210 m
 Staff Repositioned same site: 3 Oct 2023
 Old Staff gauge: 0.220 m ; New staff: 0.330 m; Offset by 1.5x
 Logger replaced 15 April 2024 with similar HOBO MX2001 SNTop21869143 & sensor21773968

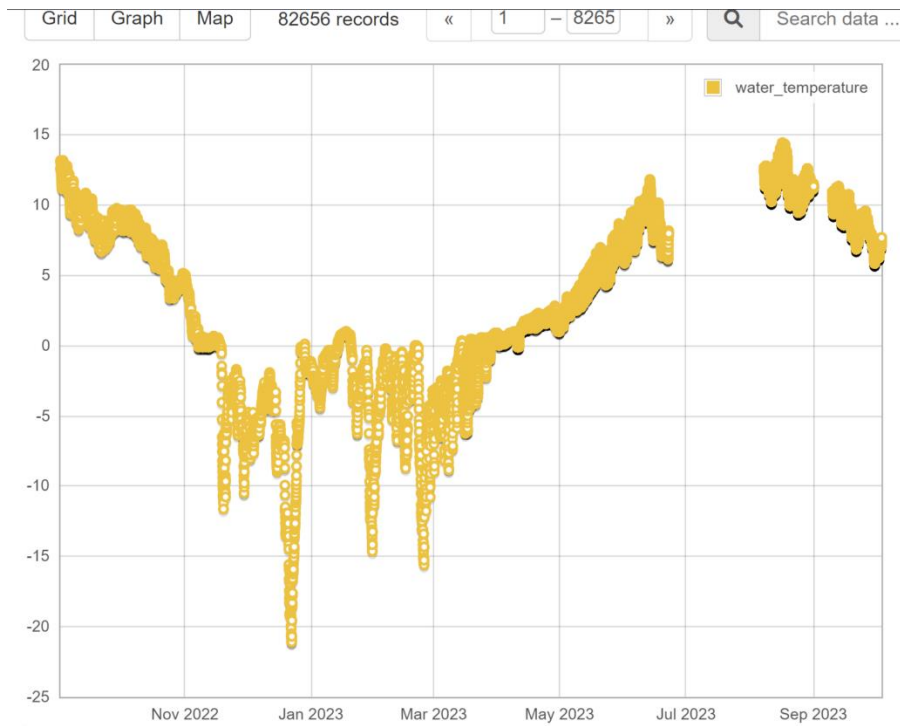
Date	Time	Staff		WL logger		Cond		Grade
		new m	new site(m)	Temp C	pH	uS/cm	Q, cms	
19-Sep-22	10:45	0.3	0.3	7.89		47.1	0.0064	
15-Jan-23	15:00	0.315						
11-Feb-23				-1.67				
01-Mar-23				-1				
03-May-23	10:00							
22-May-23	13:20	0.885	1.04					
29-May-23	11:00	0.615	0.615			17.5	0.398	
03-Jun-23	12:00	0.525						
08-Jun-23	17:50	0.45	0.45			24	0.112	
18-Jun-23	11:20	0.413	0.41	8.09		27	0.072	
06-Jul-23	16:00	0.357	0.354			32	0.038	
07-Jul-23	11:00	0.357	0.36	10.8				
31-Aug-23		0.285	0.279					
01-Sep-23		0.285	0.279			45.4	0.008	
03-Oct-23	14:30	0.335	0.335	7.69				
04-Oct-23		0.33	0.33					
23-Oct-23	14:30	0.35	0.345	5.87	8	24.5	0.0323	
06-Dec-23	16:00	0.745	0.74	1				
25-Jan-24	14:00	0.385 na		1				
14-Apr-24	12:00	0.55	0.55	3.69		29	0.418 A	
15-Apr-24	17:00	0.66	0.66					
27-Apr-24	12:30	0.64	0.634	3.27		33	0.655	
15-May-24	19:00	0.71	0.71	5.36		15.2	1.128 C	
04-Jul-24	13:50	0.415	0.419	10.4	7.3	25.5	0.114	
26-Aug-24	12:30	0.335	0.335	10.6	7.66	44	0.013 C	
01-Sep-24	14:00	0.32	0.3199	11.6				

Hydrograph

The hydrograph for 2022/23 is displayed below. As was mentioned in the 2022/23 Report, unstable measurements during winter was caused from low water and cold air effects on the logger sensor. The station was repositioned to deeper water and away from the observed head wall wave affect which occurred in the spring. A rapid spring freshet occurred mid May with peak water levels reaching 1.1 m.



Below, is a graph of the seasonal water temperature for 2022/23. As seen in the above hydrograph, a data gap occurs for the period mid June to mid July as a result of low battery failure on the logger. Highest water temperature recorded was 14 C in September.

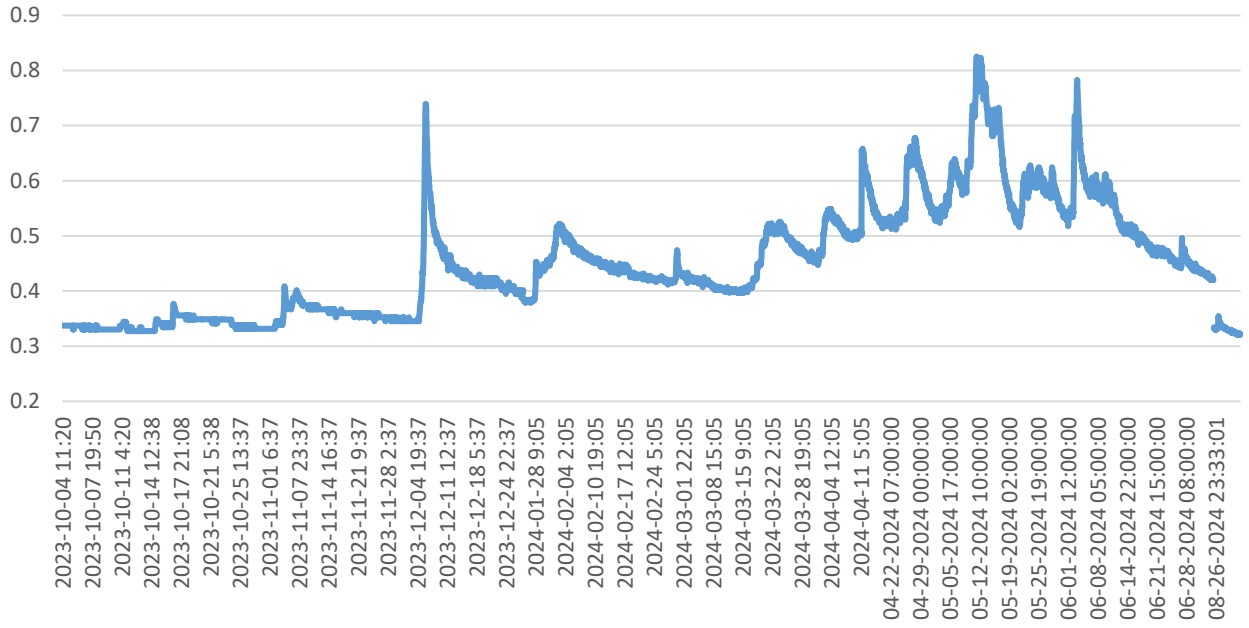


The hydrograph for 2023/24 is indicated below. Two days of rain in early December 2023 caused flash flooding conditions which is generally seen in the Spring. Water levels jumped to over 0.7 m on Dec 6 2023. Compared to 2023, a prolonged steady freshet occurred through the months of late March, April and May. Freshet was steady with peak water levels observed on April 15 (0.66m), on April 27 (0.69 m), on May 6 (0.64 m) and on the highest peak on May 11 of 0.82 m. This was considerably lower than 2023.

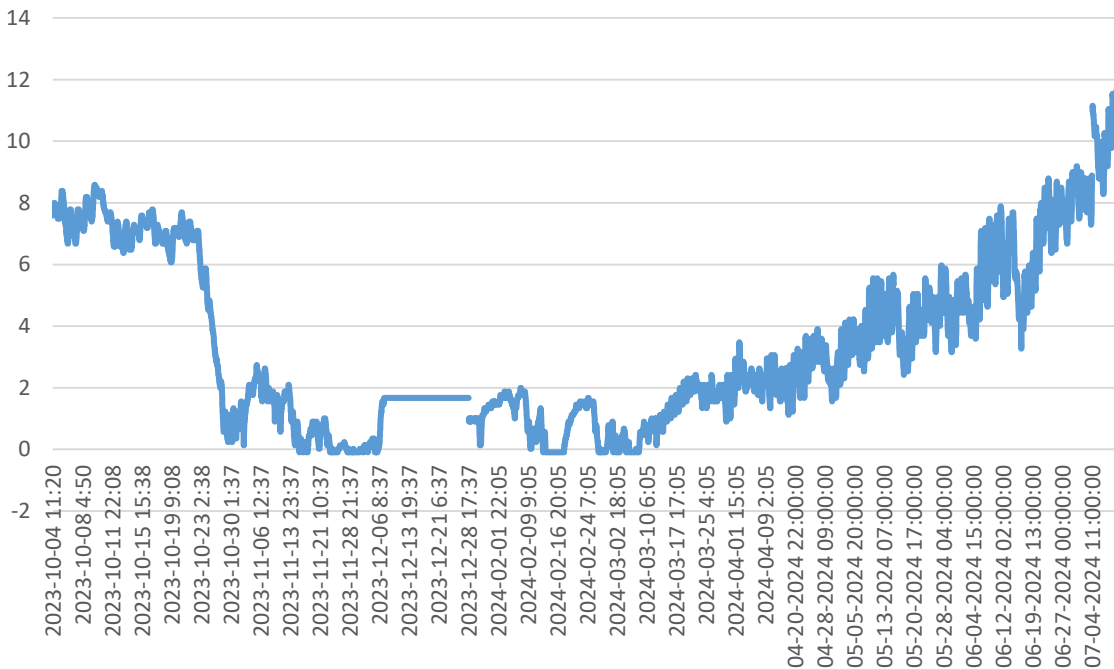
Unfortunately, battery power loss prevented data upload for the period Dec 29 2023 to Jan 25 2024. Batteries were changed out but logger malfunction occurred again between April 11 and April 15 2024. The logger was replaced on April 15 with a spare. However low battery power occurred once more in July and resulted in data loss between 4 July 2024 to 26 August 2024. Fortunately, the data loss occurred over a period of relatively unchanged flows. It appears that the HOBO logger requires more frequent battery change so that at least 6 visits per year will be required in the future.

There is no other available hydrological data for Topping Creek to make historical comparisons.

Water Level (m) Oct 2023 to Sept 2024



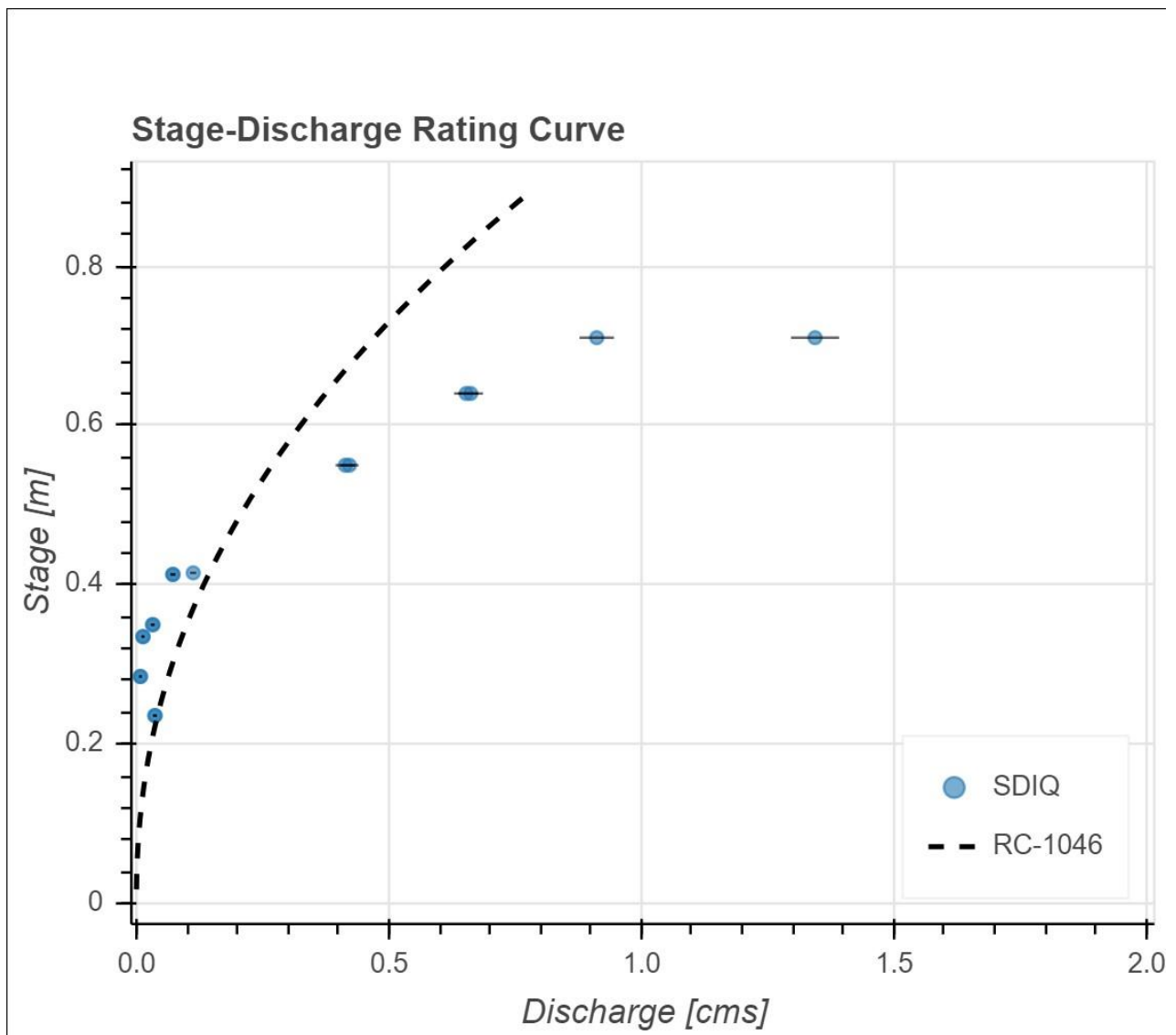
Water Temperature (C) Oct 2023 to Sept 2024



Except where data loss has been noted, continuous data was collected throughout the seasons of 2023/24 including spring freshet. Coldest water temps of -0.1 C throughout Dec and Jan and Feb. There was gradual water warming up to 6 C by peak freshet in mid May. Topping Creek reached a high of 11.6 C by September.

Stage - Rating Curve

More data from flow measurements in 2023/24 were added to the Stage-Rating Curve created in 2022/23. Discharge was determined from salt dilution flow measurements during different water levels.



Discharge can be estimated from the curve by simply noting the water level from the Staff gauge on the weir. Peak water level during the 2024 season was during spring freshet on 12

May 2024; this corresponded to 1.3 cms from the Rating Curve. Extreme rainfall on Dec 6 2023 related to 1.1 cms discharge. Lowest water levels in September relate to a discharge of 0.03 cms.

The Rating Curve requires annual verification. To ensure curve accuracy, more flow measurements will be taken between 0.4 to 0.6 m in 2024/25.

Workplan for 2024/25

1. Maintain the hydrometric station by changing logger batteries every 2 months and removing debris or rocks at the well and staff gauge.
2. Submit grant funding to purchase and replace the spare HOBO logger with a Solinst logger.
3. Record water level on the staff gauge and off-load logger data; upload data to Living Lakes Canada water HUB database.
4. Perform water flow measurements using salt dilution QQ methods especially in the Rating Curve gap area of 3 – 4 m. Verify the Rating Curve.
5. Perform a station record survey. Inquire with land surveyors if there is a BM nearby to determine absolute water elevation.