Harrop-Procter Watershed Protection Society

Harrop, Slater, Procter and Narrows Creeks 2023 Streamflow & Water Quality Monitoring Results

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Know Your Drainage

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Acronyms

- CFU……..Colony Forming Units
- FEC……Filtration Exemption Criteria
- GCDWQ……Guidelines for Canadian Drinking Water Quality
- HPCC…… ….Harrop-Procter Community Cooperative
- HPWPS……Harrop-Procter Watershed Protection Society
- KEI…….Kootenay-Columbia Environmental Innovations Ltd.
- MX2001……A model of sensor which measures water level
- NTU……..Nephelometric Turbidity Unit
- QHR……Qualified Hydrometric Reviewer
- RISC……..Resources Information Standards Committee
- SG……Staff Gauge
- SWTO…… Surface Water Treatment Objectives

Background

Kootenay-Columbia Environmental Innovations Ltd. (KEI) was retained by the Harrop-Procter Watershed Protection Society (HPWPS) to conduct streamflow (i.e., discharge) monitoring at Harrop Creek, Slater Creek, Narrows Creek and Procter Creek starting in the spring of 2020, and report on water quality metrics sampled by HPWPS's board members. Water quality samples were analyzed using desktop water quality instruments owned by HPWPS or by Passmore Laboratories.

The HPWPS is a sister organization of Harrop-Procter Community Cooperative (HPCC), which manages forests within the monitored watersheds and runs a sawmill utilizing the harvested timber. HPCC's mandate is to "practice socially and environmentally progressive forestry that protects local watersheds while creating sustainable jobs in our community." The HPWPS's mandate is to ensure "that the Community Forest's day-to-day operations are undertaken with water protection and other ecological values in mind." HPWPS provides oversight and input into community forest management. It also undertakes education, outreach and research.

Harrop and Narrows Creeks have been monitored for their water quality and discharge since 2002, while Procter and Slater Creeks began being monitored in the spring of 2021. The monitoring aligns with the HPWPS and HPCC's mandates and is intended to ensure that both organizations have the information they need to fulfill their mandates.

As of 2023, Living Lakes Canada (LLC), a water stewardship non-governmental organization, has offered additional funding to ensure that the data collected at Harrop and Proctor Creeks is of the best quality possible. To do this, Living Lakes Canada has offered to compensate KEI for any additional site visits and flow measurements over the contract between KEI and HPWPS to collect the best possible data at those two sites. In return, the data from those sites is made available through the Columbia Basin Water Hub, a free database created and managed by LLC.

Study Objectives and Scope

Based on KEI's roles and responsibilities, its objectives were to collect, analyze, and report on discharge data in line with the BC Hydrometric Resources Information Standards Committee (RISC) standards. The discharge data is presented in this report and is provided alongside a comprehensive spreadsheet containing each calculation used to calculate the discharge data.

KEI also presents the water quality data for the four creeks in the scope, including:

- specific conductivity,
- pH,
- turbidity,
- verified E. coli,
- fecal (thermotolerant) coliforms, and
- total coliforms.

Results and Discussion

The following sections will display the streamflow and water quality results of the 2023 monitoring season. The importance and purpose of each monitoring metric are outlined, and all trends observed in the data are discussed.

Since many of the residents of Harrop and Procter villages rely on surface water for their consumption, all aspects of the water quality will be discussed compared to the Drinking Water Treatment Objectives for Surface Water in BC (SWTO). The SWTO includes standards for untreated source water and treated water. The SWTO is limited to monitoring microbiological parameters such as bacteria (coliforms), protozoa and viruses in addition to turbidity. When comparison is needed outside the SWTO's scope, the Guidelines for Canadian Drinking Water Quality (GCDWQ) will be referenced.

Referencing the water quality samples collected by the HPWPS board members and analyzed either by themselves or by an accredited lab is in no way meant to be used to make decisions on the potability of drinking water. To determine the potability of drinking water, the first step is to consult with Interior Health and follow their source-specific requirements for determining water potability. This analysis aims to observe general water quality and quantity trends over the long term only.

Streamflow

The streamflow has been collected following the BC Hydrometric RISC standards by KEI since 2021. The following is a summary of the monitoring results for 2023.

MX2001 Failures

All four creeks were measured using MX2001 (Figure 1) water level sensors, which in 2023 were proven to contain faulty hardware. The hardware failure led to batteries being rapidly consumed without warning or reason, resulting in total data loss between site visits. Only after multiple failures throughout the East and West Kootenays were brought to ONSET’s attention did ONSET investigate the hardware.



Figure 1: ONSET MX2001 Water Level Sensor

Onset's investigation proved that MX2001s manufactured during the COVID-19 pandemic suffered from hardware defects, which led to the loss of power to the unit and the complete loss of collected data. Refunds were awarded to the HPWPS for the three MX2001s that were purchased after 2020. The Refunds were used to purchase Solinst Levelogger 5s, which are submersible pressure transducers that were installed at Slater, Narrows and Proctor in 2024. The MX001 at Harrop was working at the time of the other failures and did not qualify for a refund as it was purchased before 2020; thus, it is still in operation at the site.

Ice and Leaf Litter Blockages at Slater Creek

As shown in Figure 2 and Figure 3, leaf and ice buildup at the grizzly grate at Slater Creek, immediately downstream of the water level sensor, led to inaccurate streamflow data while the blockages occurred. Consequently, the streamflow data collected at Slater is less accurate as the blockages occur incrementally, and no visual or written record is available to confirm when the blockages were present.



Figure 2: Leaf Litter Blockage at Slater Creek



Figure 3: Ice Blockage at Slater Creek

Narrows Creek Control Change

In hydrology, the term "control" refers to a physical characteristic of a stream which determines the water level at a location throughout various stream flows. The control at the Narrows Creek streamflow monitoring location consists of large boulders and cobbles which create a pool. Narrows Creek suffered from a significant change in its control during the 2022 freshet, and a lesser change occurred during the 2023 freshet. The control did not appear to change significantly during the 2024 freshet.

Calculating accurate streamflow from water level, also called “stage,” requires that the control remains stable from year to year. If a control is unstable, an alternative to ensure the data quality remains high is to collect five or more flow measurements at unique steam flows to create a new stage-discharge relationship for each monitoring year.

As seen in Figure 4, the stage (the water level) during periods of low flow in the summer and winter months changed significantly at the Narrows Creek station. The result is that the station will require 5-6 flow measurements at unique stage levels each year that the control changes to calculate even reasonably accurate flow data. Further, 2-3 additional flow measurements would be required at low flows to calculate low-flow data accurately. Locations further upstream have been scouted, but none appear significantly better than the current location.

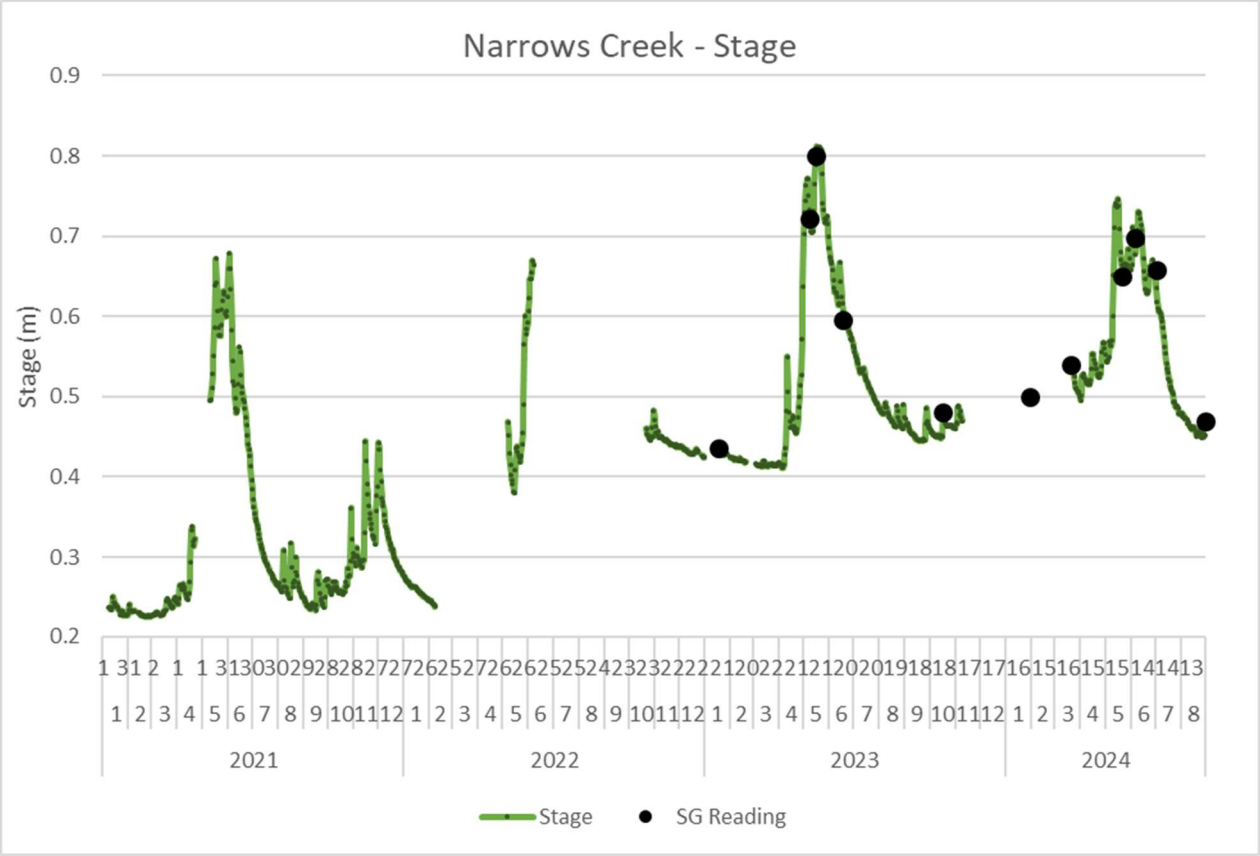


Figure 4: Stage At Low Flow Conditions Showing A Shift Due To a Change of the Control

Streamflow Magnitude

As seen in the hydrograph for each creek on the following pages, 2023 had significantly lower flows than 2022 but were more significant in terms of peak flows than both 2021 and 2020. The freshet consisted of two distinct peaks and was generally earlier than in past years. A drawn-out freshet, as seen in 2023, is likely to lead to less turbidity in the creeks and less damage to built infrastructure such as water boxes and intakes.

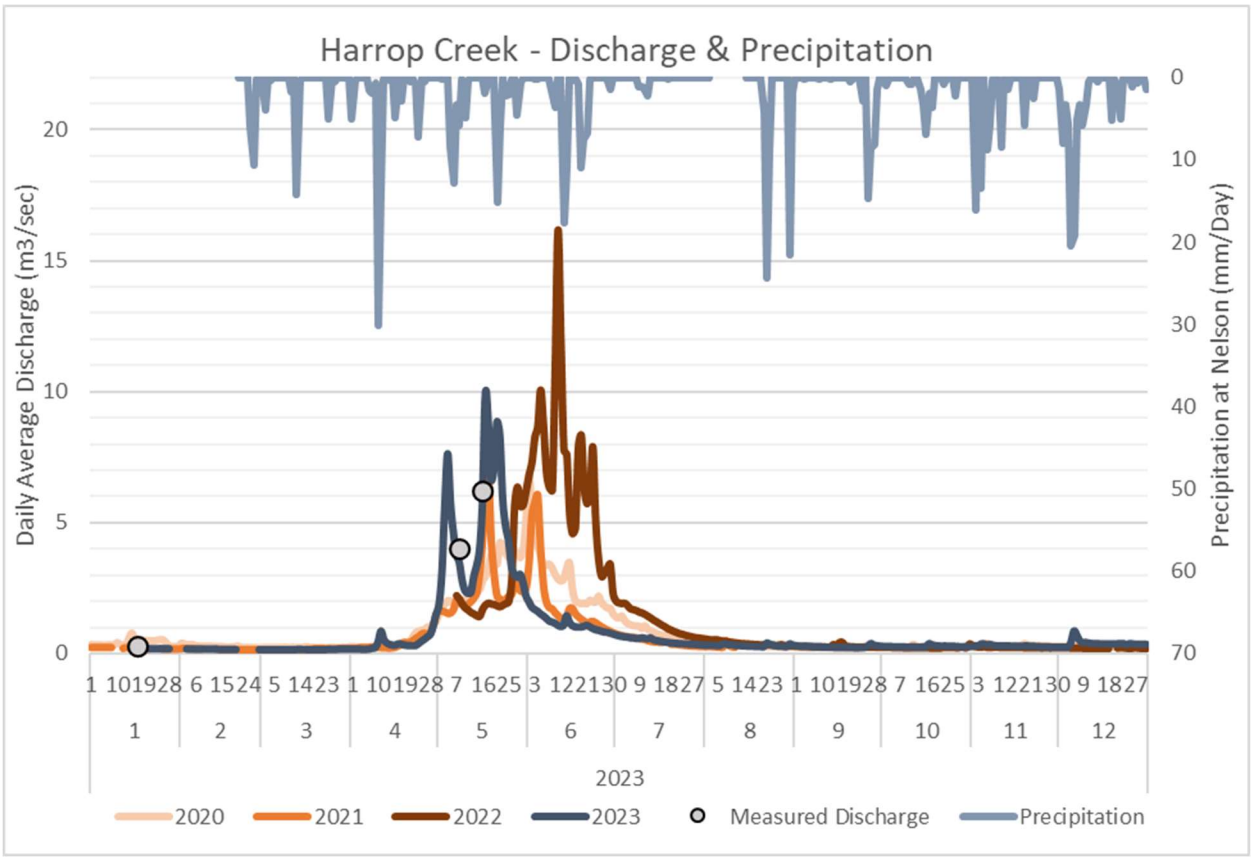
Station Performance

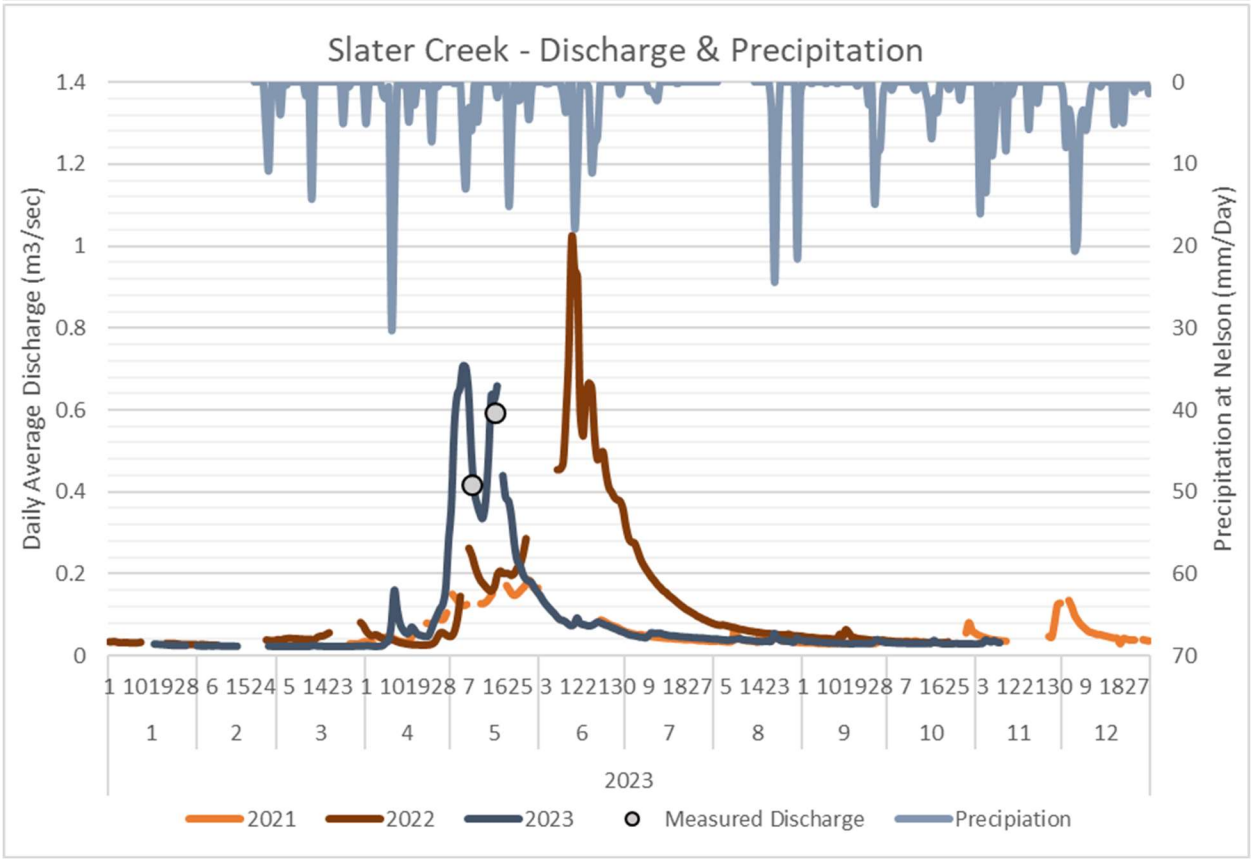
The controls are all considered to be stable except for Narrows Creek. A stable control indicates that stream flow measurements will likely match the stage-discharge relationship (SDR) from year to year. Stream flow measurements can be compared to the SDR to indicate the overall accuracy of the SDR. As of the end of 2024, each creek has the following average percent deviation from their established SDR:

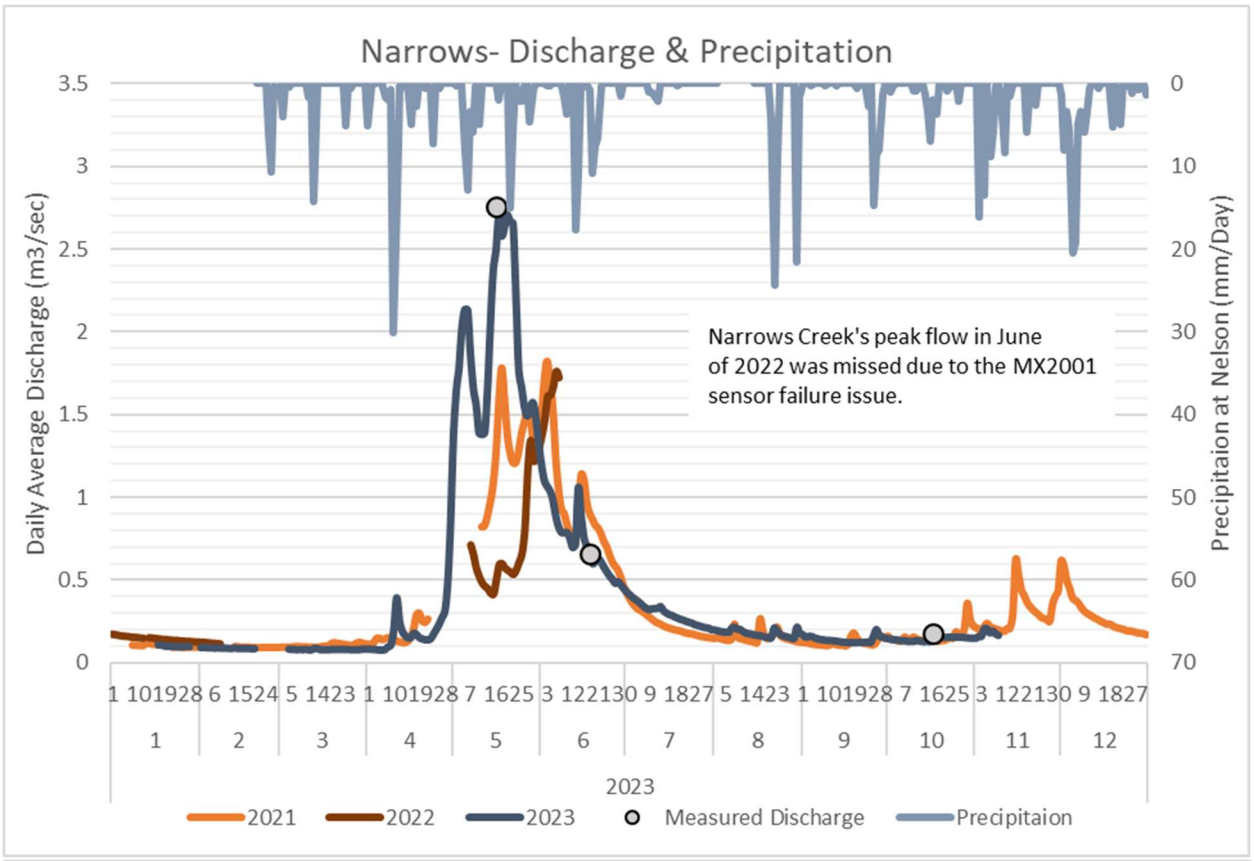
- Harrop Creek: 8.1%
- Slater: 5.4%
- Narrows: 6.3%
- Procter: 5.7%

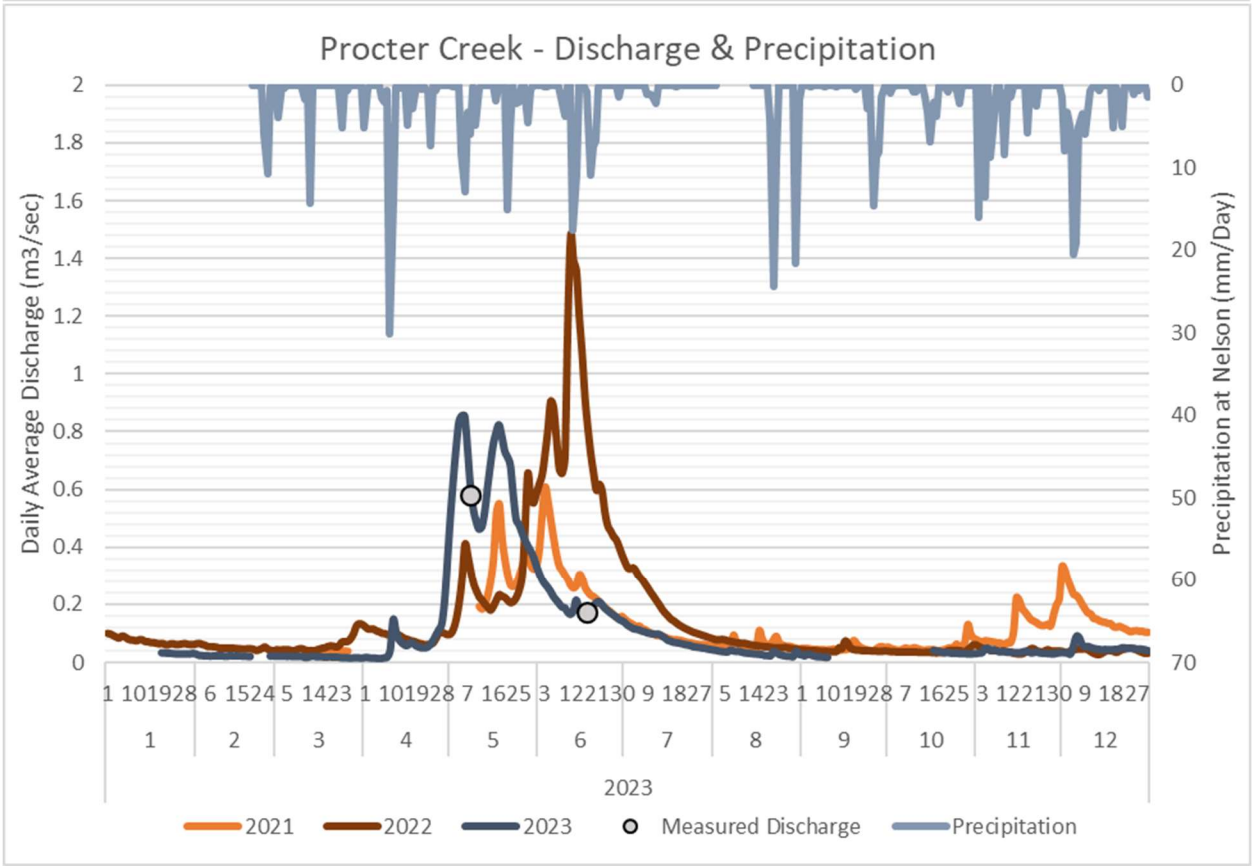
Narrows Creek has a new SDR that was created following the significant control change in 2022. The remaining creeks have SDRs that were initiated when KEI began monitoring each creek. Harrop Creek also has a compound SDR which is comprised of an SDR for flows below a designated stage and a separate SDR for flow above that designated stage.

In 2023, there were also fewer data losses due to the MX2001 issue than in 2022. This is partly due to Living Lakes Canada providing loaned sensors to the project while HPWP's MX2001s were being returned to Onset for warranty.


Harrop Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation at Nelson (mm/Day)
0
5
10
15
20
0
10
20
30
40
50
60
70
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1
2
3
4
5
6
7
8
9
10
11
12
2023
2020
2021
2022
2023
Measured Discharge
Precipitation


Slater Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation at Nelson (mm/Day)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
10
20
30
40
50
60
70
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1
2
3
4
5
6
7
8
9
10
11
12
2023
2021
2022
2023
Measured Discharge
Precipiation


Narrows- Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitaion at Nelson (mm/Day)
Narrows Creek's peak flow in June of 2022 was missed due to the MX2001 sensor failure issue.
2023
2021
2022
2023
Measured Discharge
Precipitaion


Procter Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation at Nelson (mm/Day)
2023
2021
2022
2023
Measured Discharge
Precipitation

Turbidity

Turbidity is a commonly monitored water quality parameter as it indicates potential pathogens in the water, provides a surface area upon which bacteria can grow, and negatively impacts water treatment by decreasing the effectiveness of UV and chlorine disinfection and prematurely clogging filters (B.C. Ministry of Forests and Range, 2010) (BC Ministry of Health, 2012). Additionally, turbidity is cost-effective to monitor. Because of the value of turbidity data and ease of monitoring, the dataset collected by HPWPS's board members for the 2023 monitoring periods is of excellent value for analyzing water quality in all four creeks.

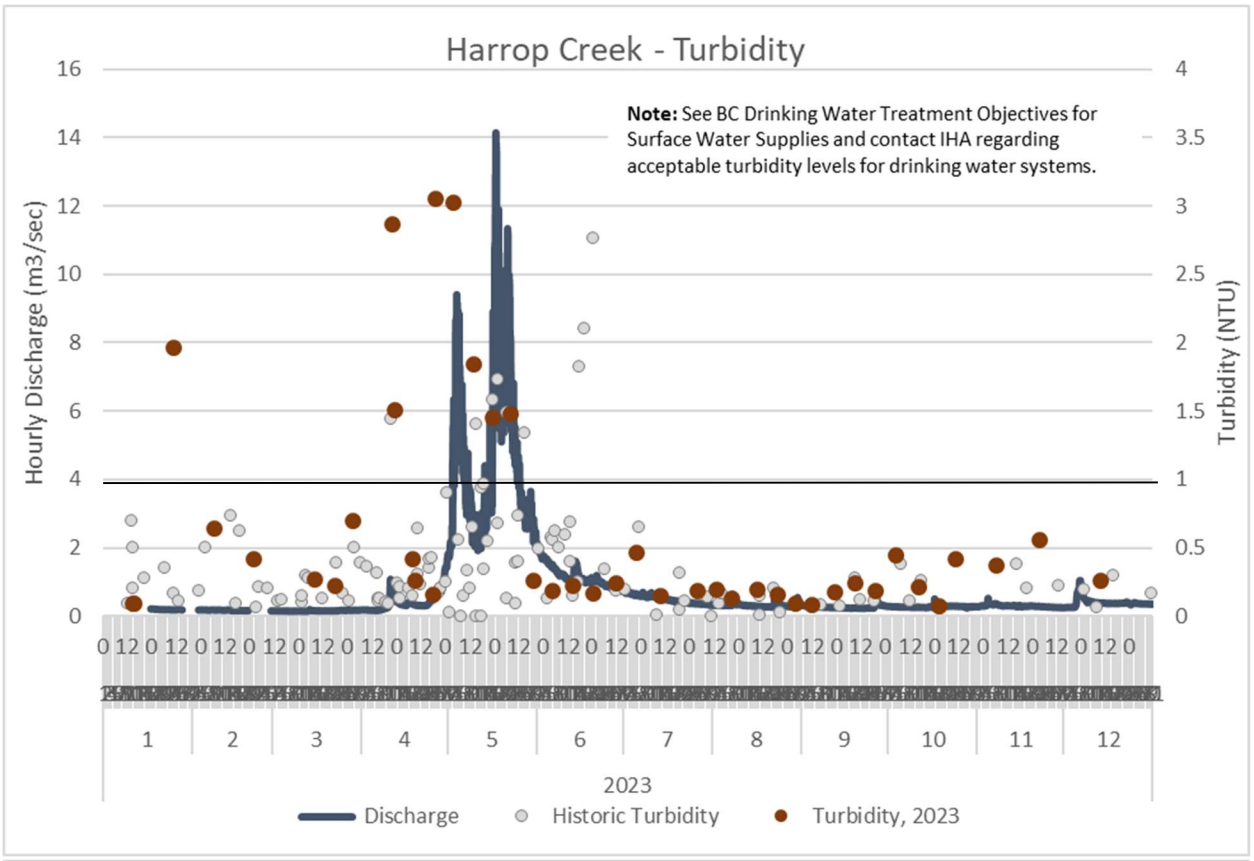
The SWTO sets the requirements for the treatment of surface water, including turbidity. While the villages of Harrop and Procter do not treat their water, the standards can be useful for comparison to the current untreated source water but cannot be extrapolated to determine potability. The SWTO notes that for treated water, turbidity "is generally acceptable [in source water] when less than 1 NTU [nephelometric turbidity unit]"(BC Ministry of Health, 2012). Turbidity becomes visible when greater than 5 NTU.

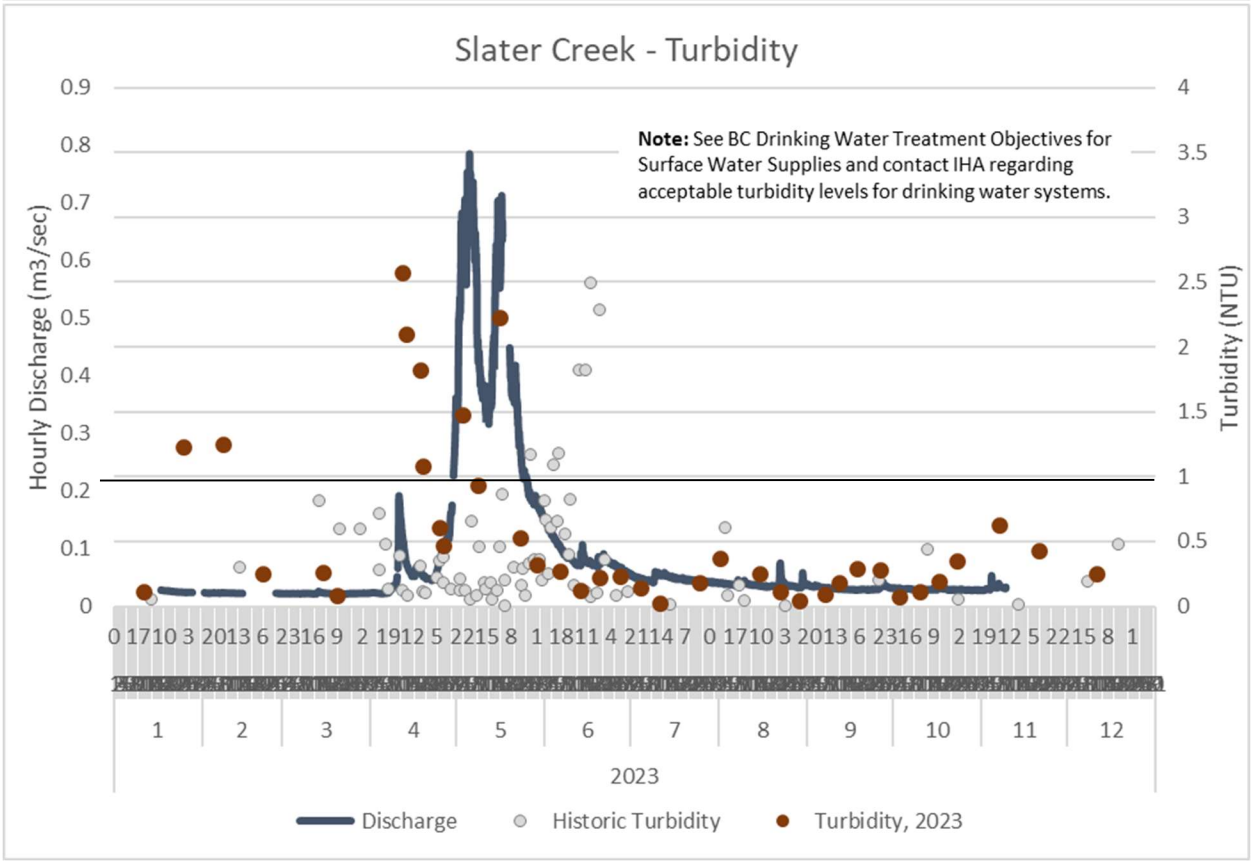
Turbidity Results

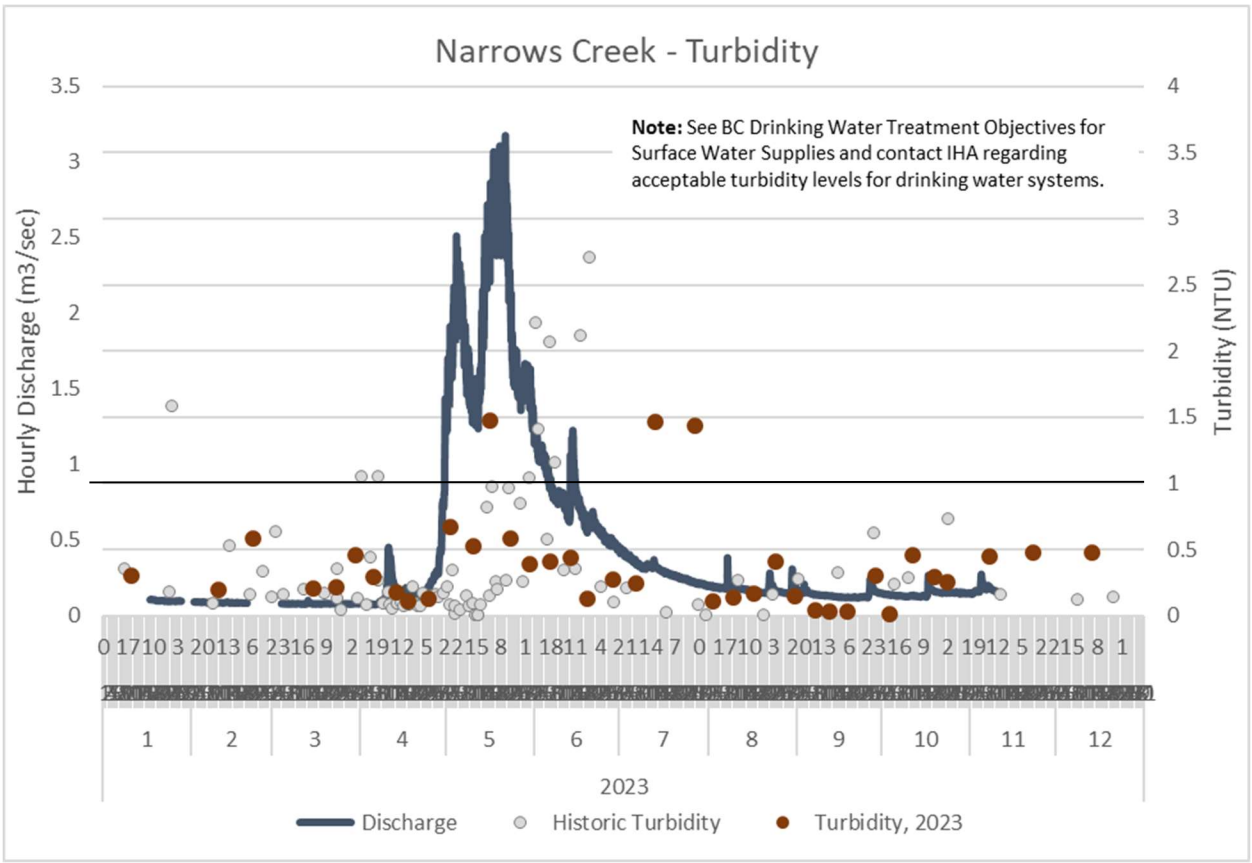
Reviewing the data in the graphs below shows that all four creeks have reported turbidity values above 1 NTU, though this is normal for all major creeks in the West Kootenays during times of high flows. It is somewhat difficult to compare each creek as turbidity samples were not necessarily collected on the same date or time. However, we can observe the number of turbidity samples above 1 NTU.

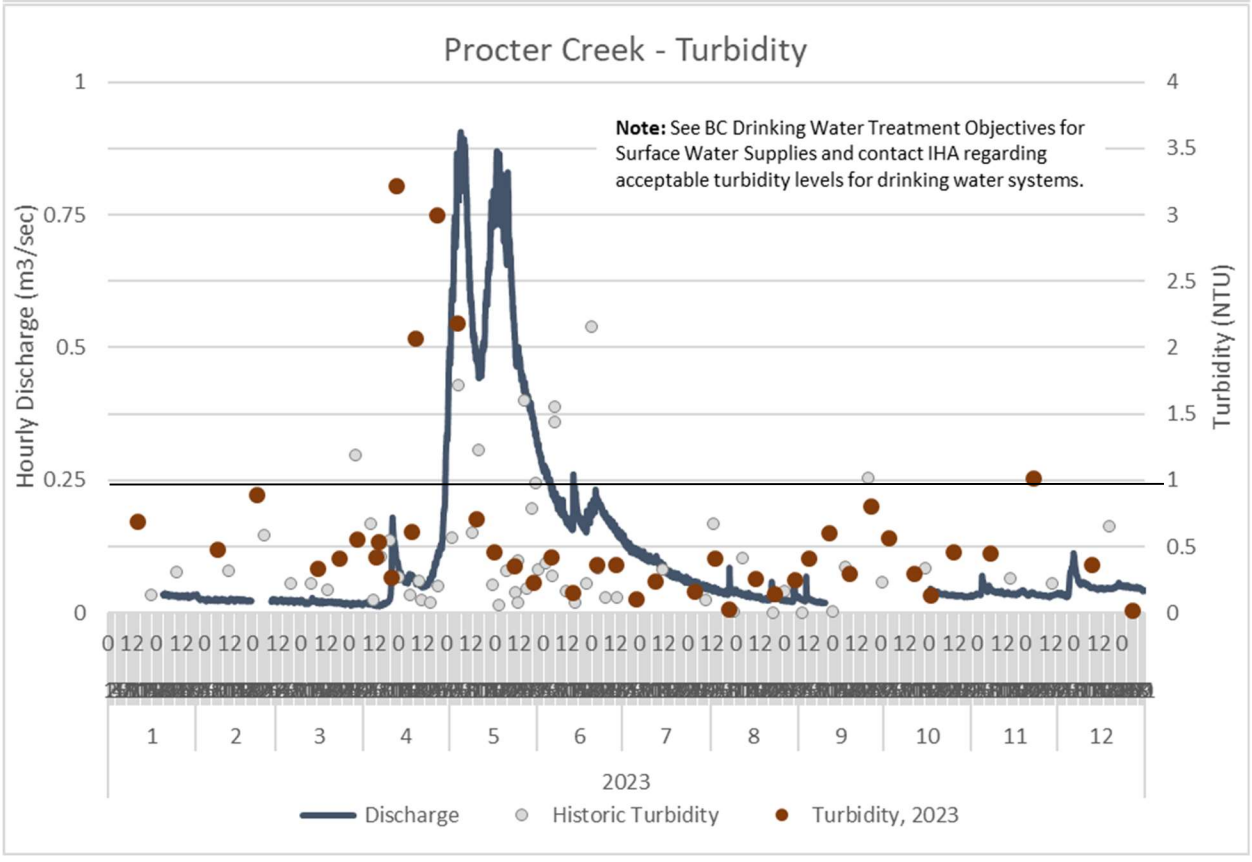
- Harrop: 8
- Slater: 8
- Narrows: 3
- Proctor: 5

When observing the points above 1 NTU, we can see that no results came back above 5 NTU, with most of the high turbidity results coming in between 2.5 and 3.5 NTU. Narrows saw the least high turbidity results, with only three at about 1.5 NTU.


Harrop Creek - Turbidity
Note: See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Hourly Discharge (m3/sec)
Turbidity (NTU)
2023
Discharge
Historic Turbidity
Turbidity, 2023


Slater Creek - Turbidity
Note: See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Hourly Discharge (m3/sec)
Turbidity (NTU)
2023
Discharge
Historic Turbidity
Turbidity, 2023


Narrows Creek - Turbidity
Note: See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Hourly Discharge (m3/sec)
Turbidity (NTU)
2023
Discharge
Historic Turbidity
Turbidity, 2023


Procter Creek - Turbidity
Note: See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Hourly Discharge (m3/sec)
Turbidity (NTU)
2023
Discharge
Historic Turbidity
Turbidity, 2023

Coliforms

Coliforms may be the most critical water quality parameter commonly monitored as certain coliforms, such as E. coli, are known to be detrimental to human health. Unfortunately, compared to physical and chemical water quality parameters such as pH or turbidity, coliforms must be analyzed in an accredited laboratory, have moderately high analysis costs, and must be analyzed within a short period after sampling.

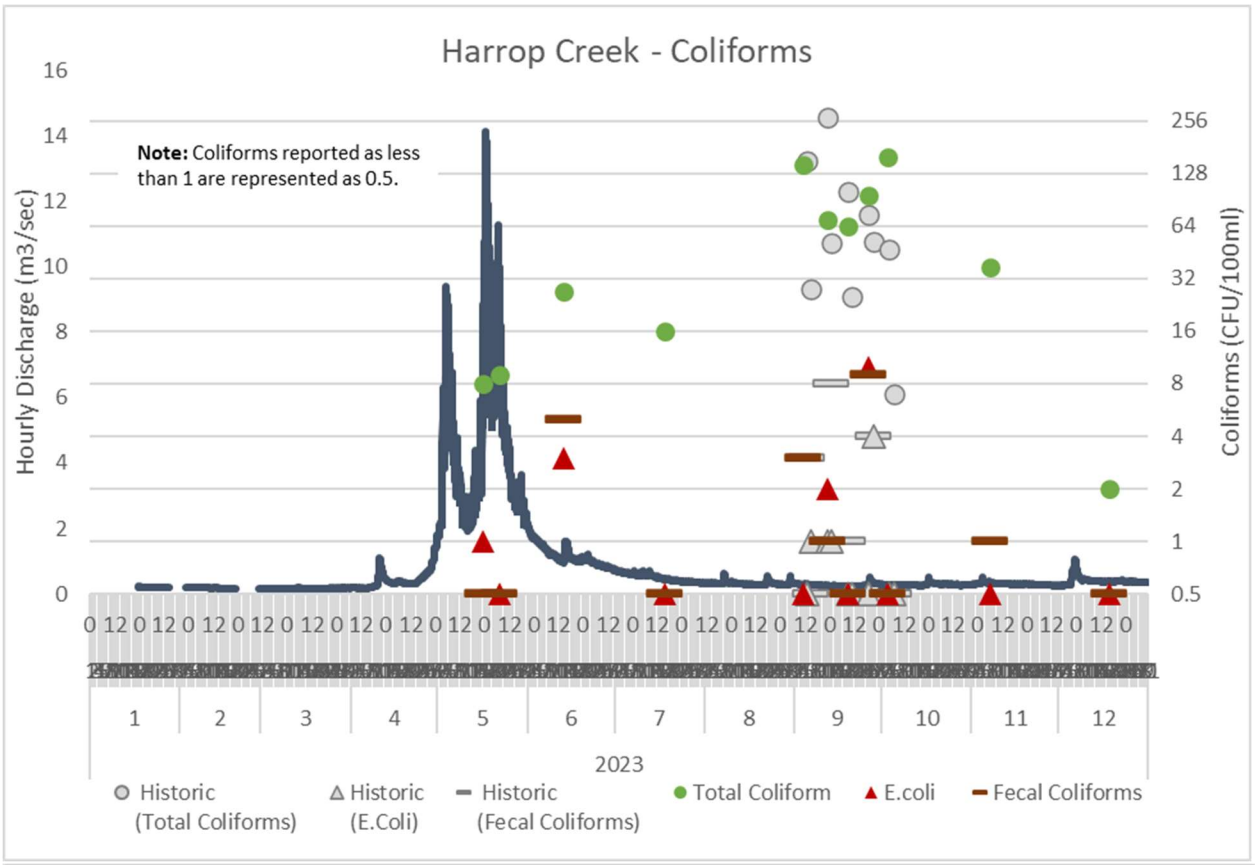
For treated water, the Surface Water Treatment Objectives (SWTO) limits E. coli, fecal coliforms and total coliforms to zero detectable colony-forming units per 100mL (CFU/100mL). The only guidance it gives on the presence of E. coli in untreated water is in the criteria for filtration exception (FEC). Water providers must meet this criterion, among others specified specifically by Interior Health, to be exempted from the requirement for filtration treatment. The limits state that "[t]he number of E. coli in raw water does not exceed 20 CFU/100 mL (or if E. coli data are not available less than 100 CFU/100 mL of total coliform) in at least 90% of the weekly samples from the previous six months."

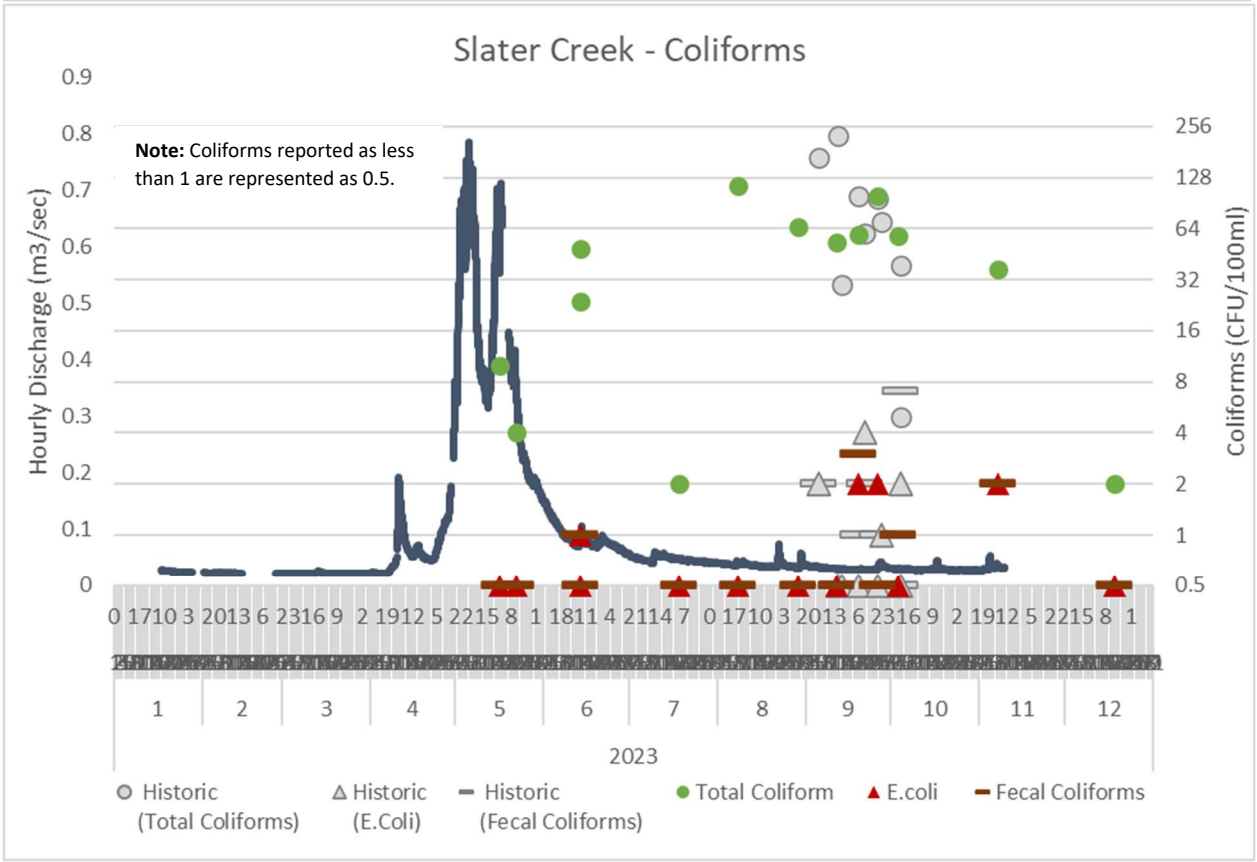
Coliform Results

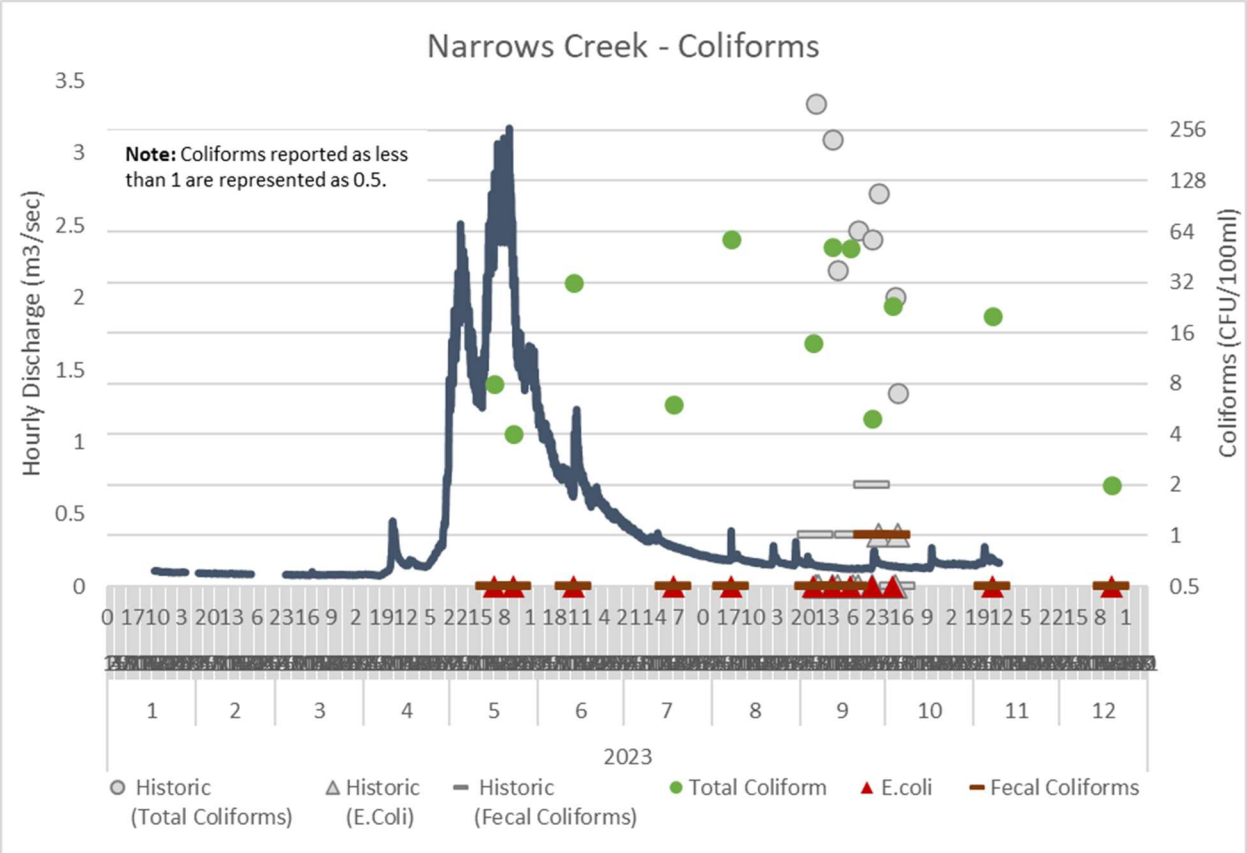
As the villages of Harrop and Procter do not provide water treatment nor weekly testing, the FEC requirements can only be used to provide context for the results and are not an indicator of potability. The 2023 HPWPS monitoring program only collected five coliform samples over 30 days each fall, supplemented by monthly samples throughout the summer.

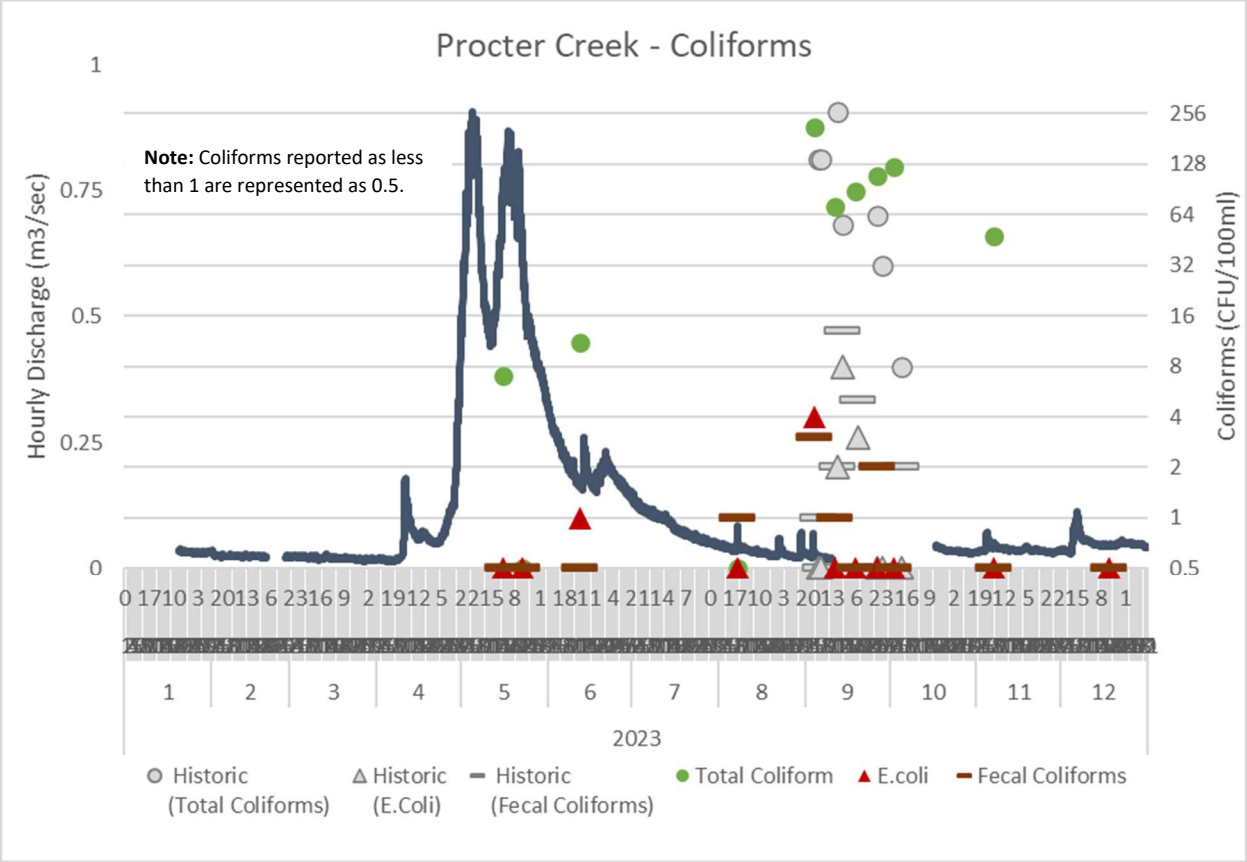
No results from the E. coli samples returned values greater than 20 CFU/100 mL. However, coliforms, including E. coli, were present in raw water at lower limits. Thus, if water is not adequately treated within individual households through boiling or filtration and UV disinfection, E. coli will be present in consumed water, which is above the limits set out in the SWTO of no detectable coliforms per 100ml.

2023 was the first year that coliform sampling was conducted during the freshet and summer months. This sampling proved that coliforms are present not only during the fall but also earlier in the year. Sampling in the winter has not been conducted to date. Of the four creeks, Narrows showed the best results, with only two samples testing positive, with 1 colony forming unit (CFU)/100ml, and no positive results for E.coli. Historic sampling results also show that Narrows Creek has returned the fewest positive results for coliforms.


Harrop Creek - Coliforms
Note: Coliforms reported as less than 1 are represented as 0.5.
Hourly Discharge (m3/sec)
Coliforms (CFU/100ml)
2023
Historic (Total Coliforms)
Historic (E.Coli)
Historic (Fecal Coliforms)
Total Coliform
E.coli
Fecal Coliforms


Slater Creek - Coliforms
Note: Coliforms reported as less than 1 are represented as 0.5.
Hourly Discharge (m3/sec)
Coliforms (CFU/100ml)
2023
Historic (Total Coliforms)
Historic (E.Coli)
Historic (Fecal Coliforms)
Total Coliform
E.coli
Fecal Coliforms


Narrows Creek - Coliforms
Note: Coliforms reported as less than 1 are represented as 0.5.
Hourly Discharge (m3/sec)
Coliforms (CFU/100ml)
3.5
3
2.5
2
1.5
1
0.5
0
256
128
64
32
16
8
4
2
1
0.5
0 1710 3 2013 6 2316 9 2 1912 5 2215 8 1 1811 4 2114 7 0 1710 3 2013 6 2316 9 2 1912 5 2215 8 1
1 2 3 4 5 6 7 8 9 10 11 12
2023
Historic (Total Coliforms)
Historic (E.Coli)
Historic (Fecal Coliforms)
Total Coliform
E.coli
Fecal Coliforms


Procter Creek - Coliforms
Note: Coliforms reported as less than 1 are represented as 0.5.
Hourly Discharge (m3/sec)
Coliforms (CFU/100ml)
1
0.75
0.5
0.25
0
256
128
64
32
16
8
4
2
1
0.5
0 1710 3 2013 6 2316 9 2 1912 5 2215 8 1 1811 4 2114 7 0 1710 3 2013 6 2316 9 2 1912 5 2215 8 1
1 2 3 4 5 6 7 8 9 10 11 12
2023
Historic (Total Coliforms)
Historic (E.Coli)
Historic (Fecal Coliforms)
Total Coliform
E.coli
Fecal Coliforms

Specific Conductivity

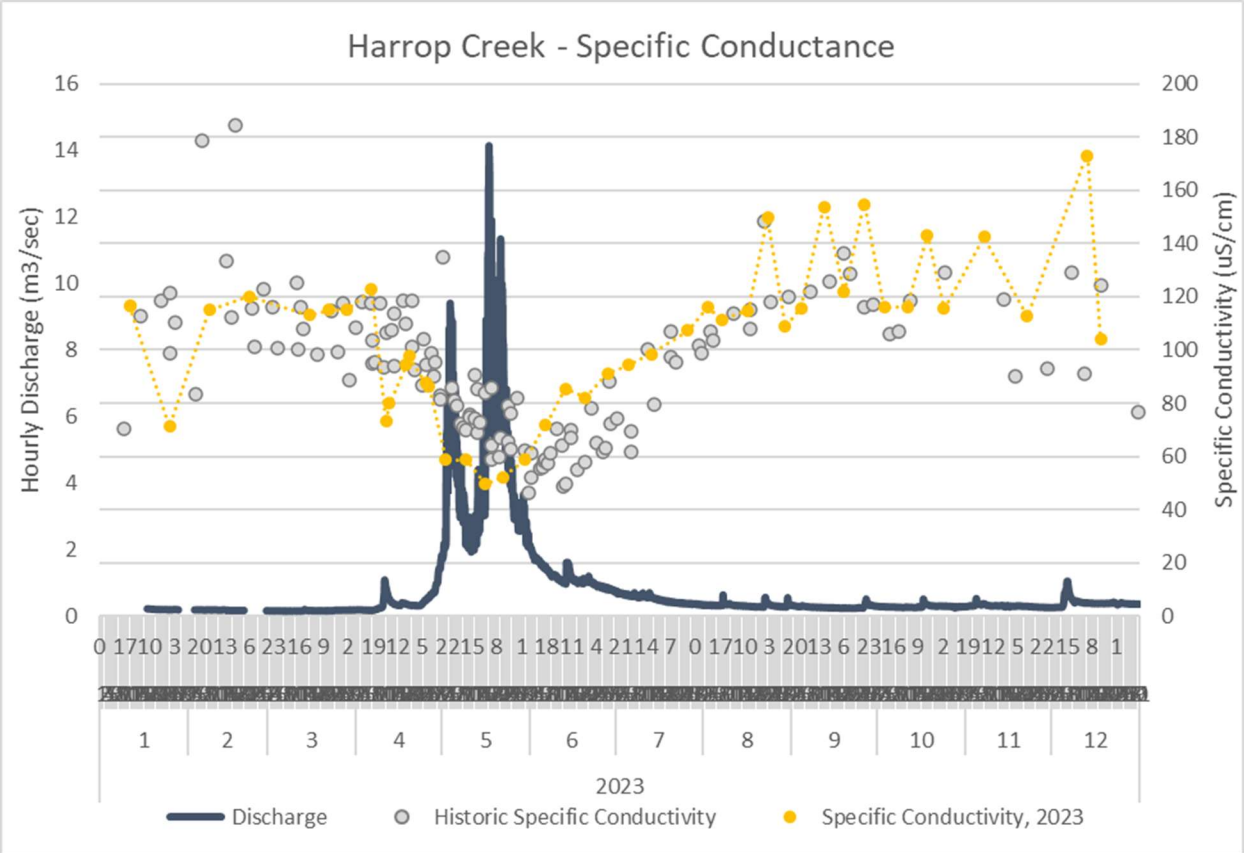
Specific conductivity, sometimes referred to as specific conductance, is a measure of the ability of electricity to pass through water when corrected for temperature. Conductivity increases with increased dissolved ions (B.C. Ministry of Forests and Range, 2010) , which can be broken up into two sources: naturally occurring and artificially introduced. Naturally occurring ions are present in groundwater since the water in contact with rocks and minerals dissolves ions naturally over time, creating more conductive water. Surface water runoff is generally associated with low conductivity, so conductivity levels will drop when streamflow is mainly comprised of surface runoff, such as snow melt and rain. And the opposite is true as well: when water is sourced primarily from groundwater, conductivity levels will rise.

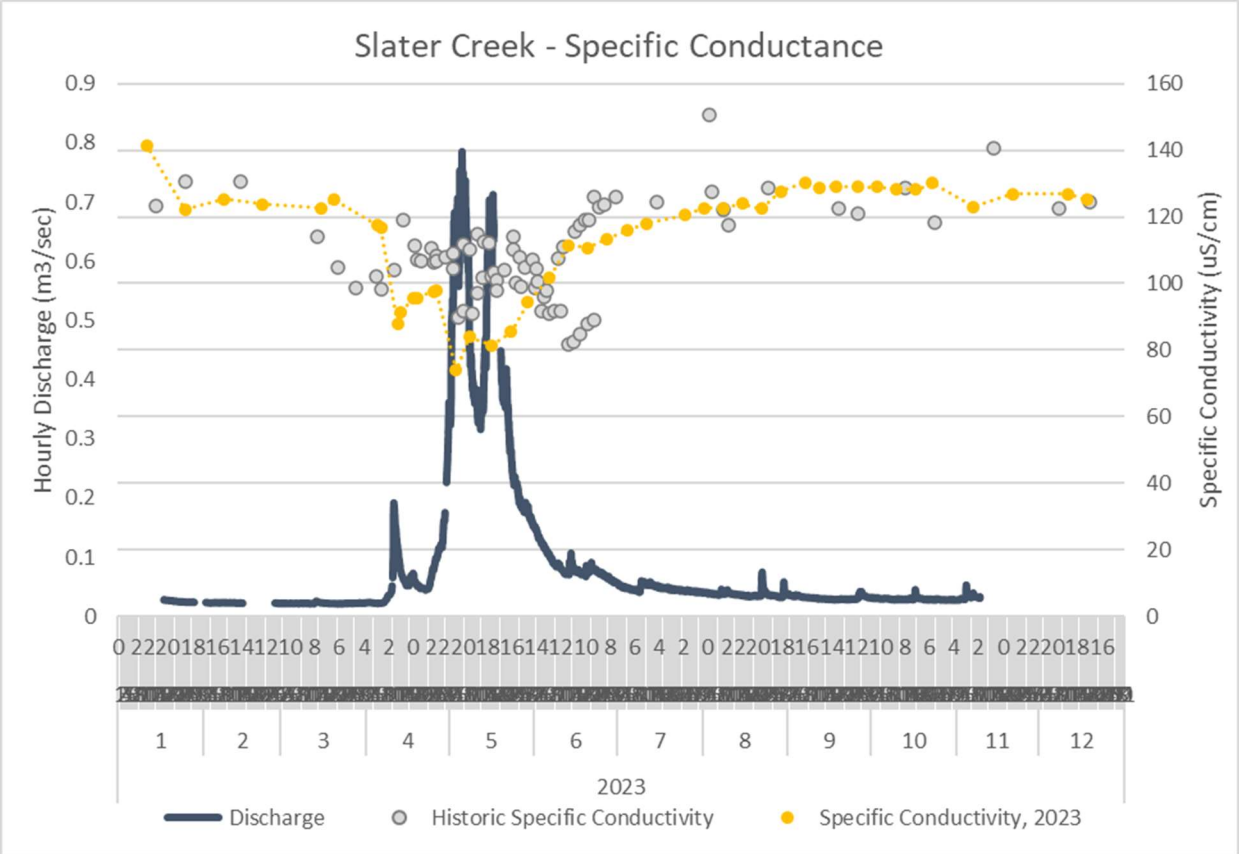
Conductivity monitoring can also identify non-natural sources of dissolved ions, such as pollutants, in a water body. Pollutants like salt applied to roads or landfill leachate often have high conductivity levels. If abnormal conductivity readings are recorded, this could indicate pollutants entering a stream.

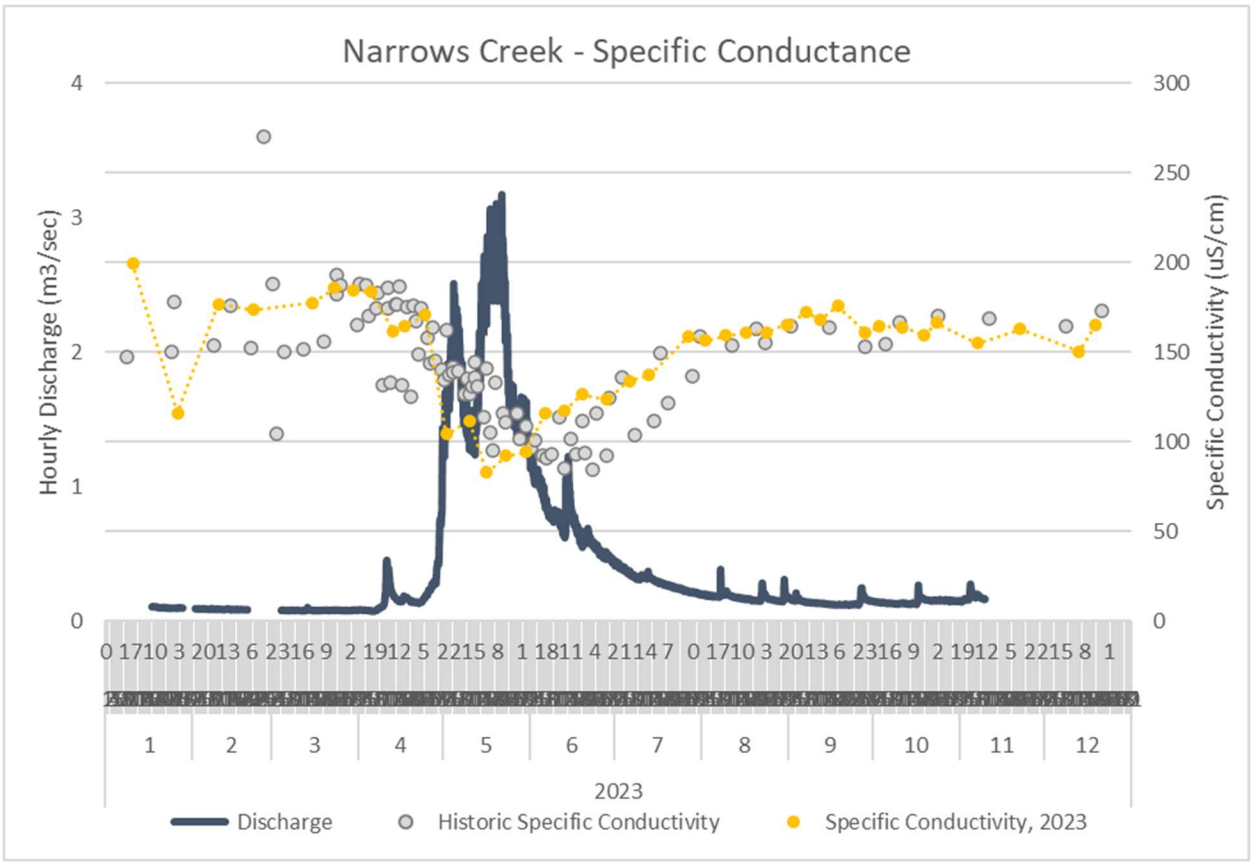
Specific Conductivity Results

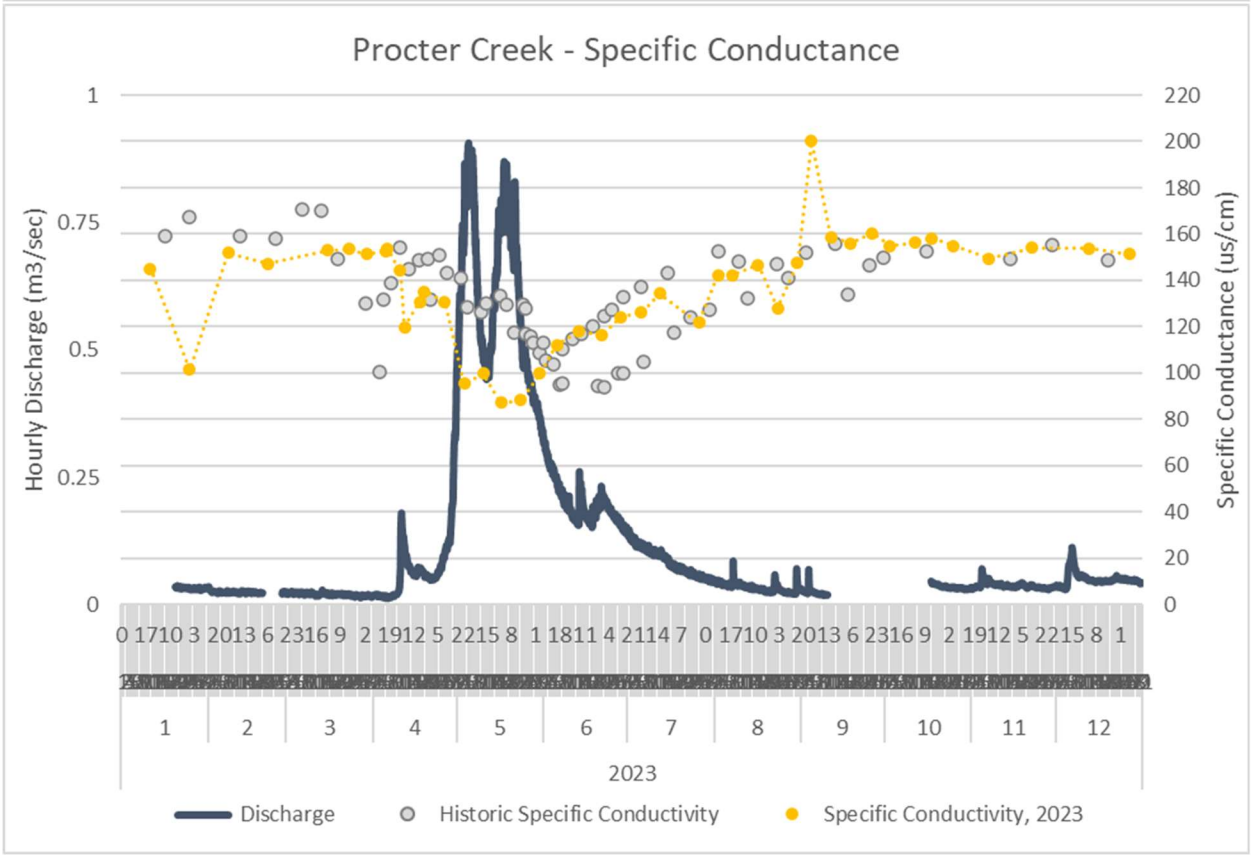
Trends for specific conductivity during low and high flow periods were established throughout the 2021-2022 monitoring years, with no significant shifts in background conductivity being observed. Individual spikes and dips did occur at each creek, though they have not been tied to any identified non-natural sources of dissolved ions. It is recommended that calibration, cleaning and record-keeping best practices be reviewed to validate the reading if data spikes are observed.

While most creeks observed one to two spikes, which may be attributed to metering or handling errors, Harrop Creek observed the most considerable and repeated specific conductivity variation from August to December 2023. Considering that the trend is going up and down, as opposed to in just one direction, it is thought that this may also be caused by sample handling or metering errors. However, its significance warrants further investigation. KEI recommends following this trend in the 2024 data while ensuring that best practices are used when collecting, storing and metering Harrop's Samples. KEI also recommends that some specific conductivity samples from Harrop Creek be sent to Passmore Laboratories to confirm the validity of the results.


Harrop Creek - Specific Conductance
Hourly Discharge (m3/sec)
Specific Conductivity (uS/cm)
2023
Discharge
Historic Specific Conductivity
Specific Conductivity, 2023


Slater Creek - Specific Conductance
Hourly Discharge (m3/sec)
Specific Conductivity (uS/cm)
2023
Discharge
Historic Specific Conductivity
Specific Conductivity, 2023


Narrows Creek - Specific Conductance
Hourly Discharge (m3/sec)
Specific Conductivity (uS/cm)
0
1
2
3
4
0
50
100
150
200
250
300
0 17 10 3 20 13 6 23 16 9 2 19 12 5 22 15 8 1 18 11 4 21 14 7 0 17 10 3 20 13 6 23 16 9 2 19 12 5 22 15 8 1
1 2 3 4 5 6 7 8 9 10 11 12
2023
Discharge
Historic Specific Conductivity
Specific Conductivity, 2023


Procter Creek - Specific Conductance
Hourly Discharge (m3/sec)
Specific Conductance (us/cm)
0
0.25
0.5
0.75
1
0
20
40
60
80
100
120
140
160
180
200
220
0 17 10 3 20 13 6 23 16 9 2 19 12 5 22 15 8 1 18 11 4 21 14 7 0 17 10 3 20 13 6 23 16 9 2 19 12 5 22 15 8 1
1 2 3 4 5 6 7 8 9 10 11 12
2023
Discharge
Historic Specific Conductivity
Specific Conductivity, 2023

pH

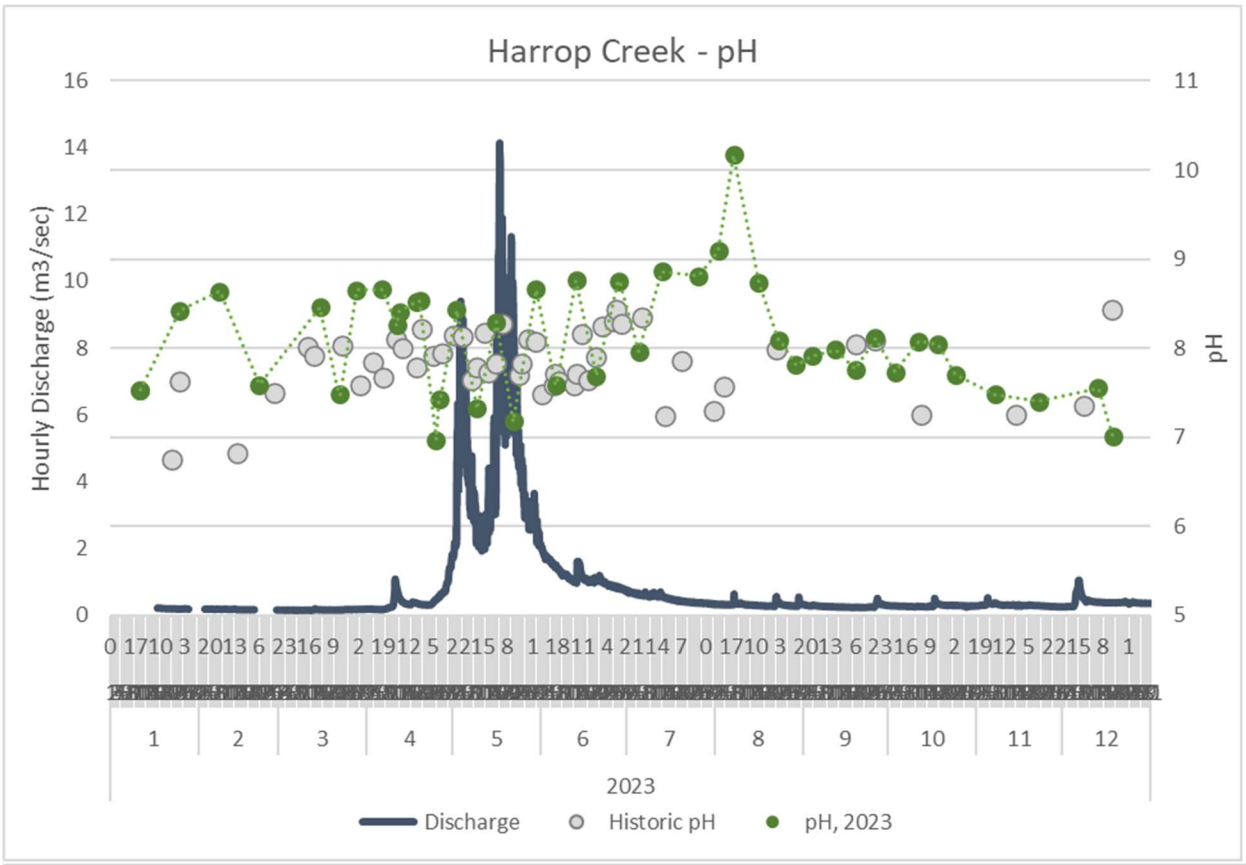
pH measures the activity of hydrogen ions within a liquid, which indicates whether the liquid is acidic, basic or neutral. The pH scale ranges from 0 to 14, with pH less than 7 being acidic, pH equal to 7 being neutral, and pH greater than 7 being basic. The scale is represented in log form, meaning a pH of 5 is ten times more acidic than a pH of 6.

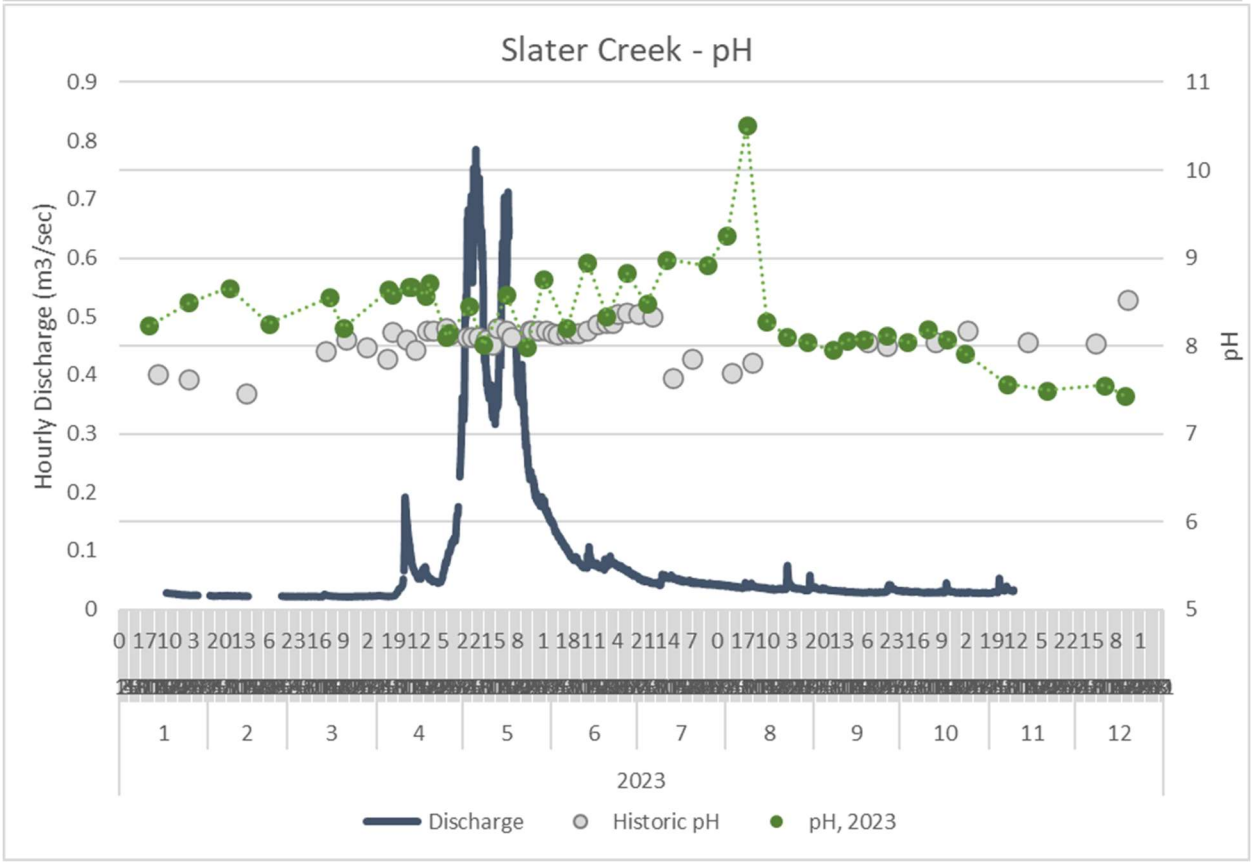
The importance of pH in drinking water is threefold: one is that water that is either too basic or too acidic would be harmful to human health. Another important aspect is optimizing the effectiveness of drinking water treatment. The most important in most scenarios is that acidic water is prone to leaching metals from plumbing components (Health Canada, 2023), the most concerning being lead.

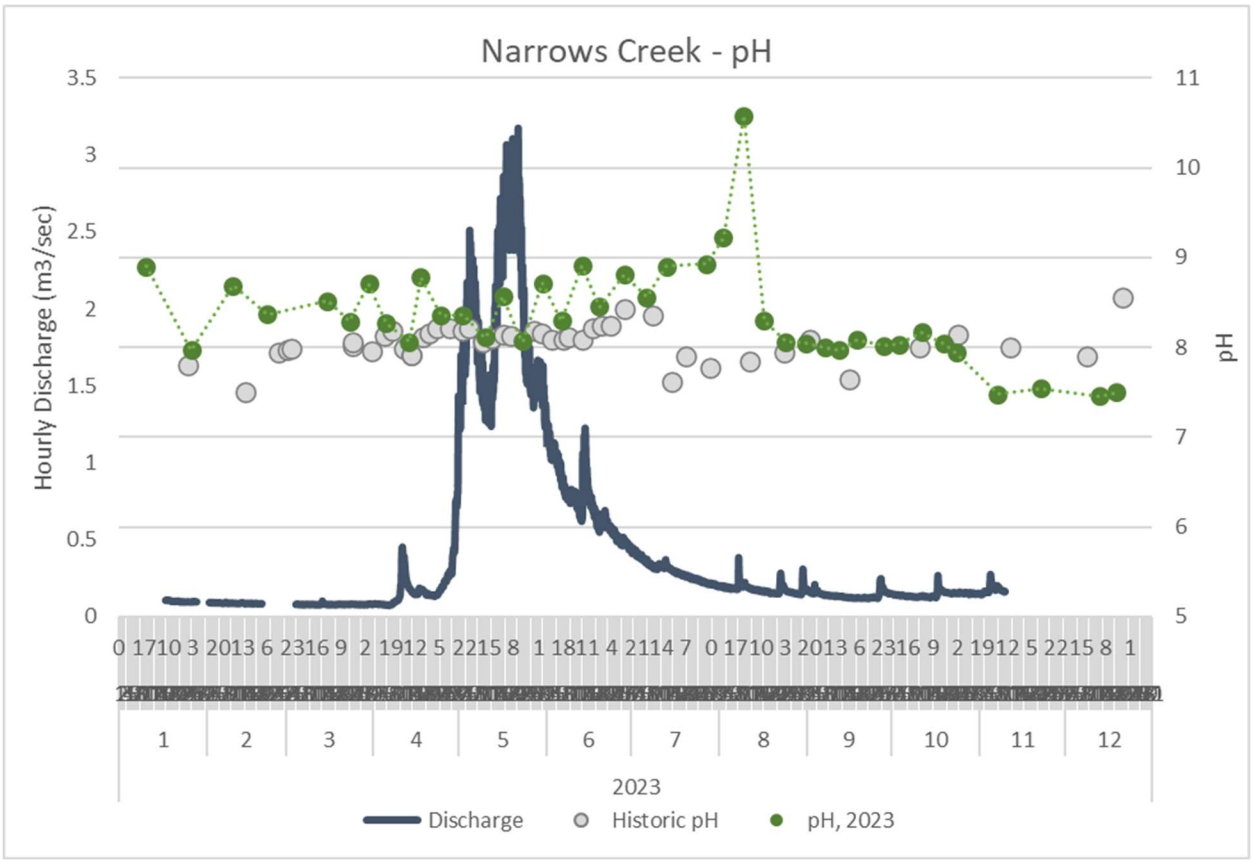
The SWTO does not set limits for pH, so the Guidelines for Canadian Drinking Water Quality (GCDWQ) is the best resource for referencing suitable pH levels in drinking water. The limits outlined in the GCDWQ for pH in drinking water are between 7.0 and 10.5.

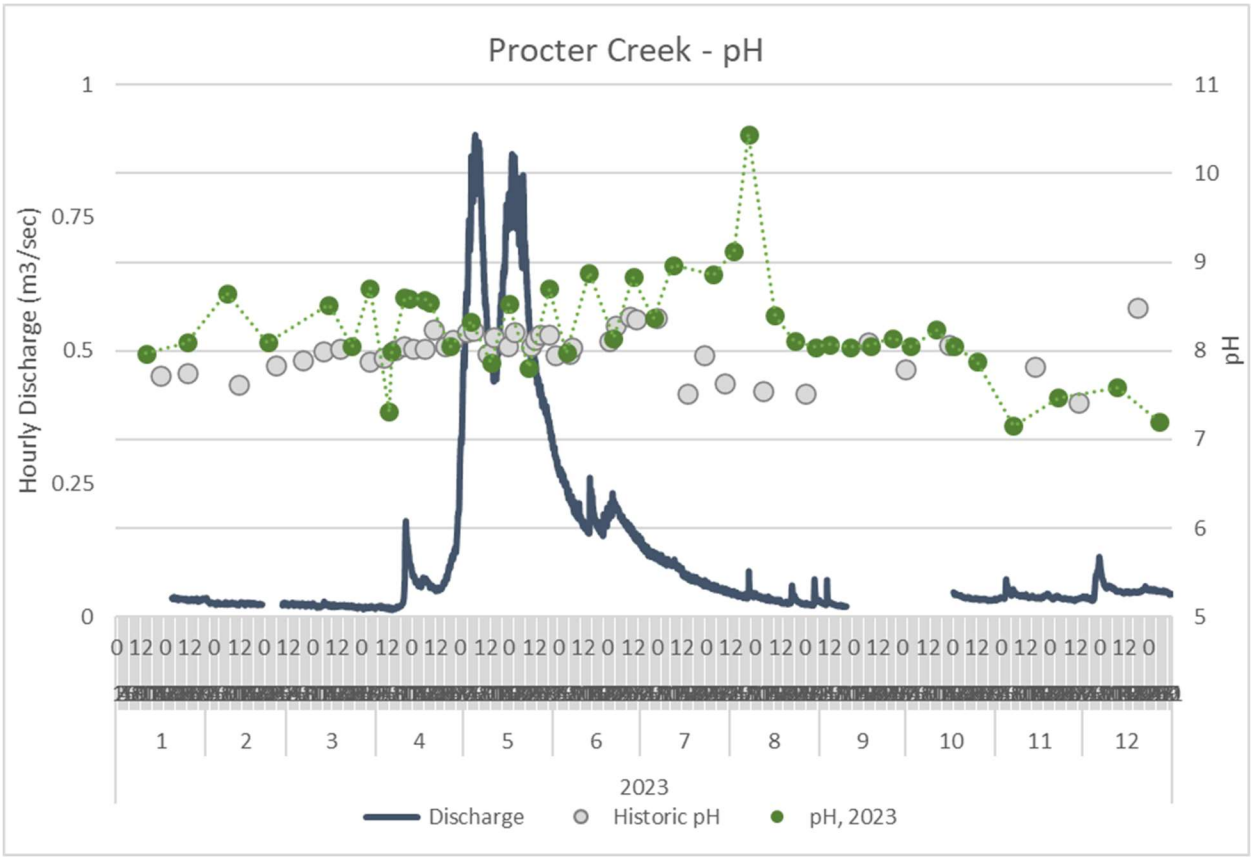
pH Results

The HPWPS board members began analyzing pH in 2022 using a handheld pH meter. During that period, all results from all four creeks were within the guidelines, except for one result at Harrop Creek, showing a pH of 6.97. The results also show a clear up-down pattern before resulting in a high pH reading at each site on August 7th, 2023. The readings become more consistent after the high pH reading on August 7th. It can be assumed that the pattern of these results indicates that difficulties in consistent metering occurred early on in 2023 but were sorted out through proper calibrations and handling practices in the fall. Regardless, the average of the results tracks in line with data collected in past years, which Passmore Laboratories analyzed.


Harrop Creek - pH
Hourly Discharge (m3/sec)
pH
2023
Discharge
Historic pH
pH, 2023


Slater Creek - pH
Hourly Discharge (m3/sec)
pH
2023
Discharge
Historic pH
pH, 2023


Narrows Creek - pH
Hourly Discharge (m3/sec)
pH
2023
Discharge
Historic pH
pH, 2023


Procter Creek - pH
Hourly Discharge (m3/sec)
pH
2023
Discharge
Historic pH
pH, 2023

Disclaimer

The discharge data collected for Harrop-Procter Watershed Protection Society has been collected to meet the BC Hydrometric RISC Standards v.2 released in 2019. All data grades assigned to the discharge data have been assigned by Rory Gallaugher, AScT, Principal of Kootenay Environmental Innovations Ltd. (KEI). The data grades, if applied, are intended to assist users of the discharge data in understanding KEI's considerations on how the data was collected and analyzed and how the site conditions met the requirements presented in standards requirement criteria Table 1-1 of the RISC Standards.

Per the RISC Standards, grading hydrometric data is a subjective practice based on the Qualified Hydrometric Reviewer's (QHR's) interpretation of the RISC Standards and the data collected. In practice, each QHR may grade data differently based on their interpretation of the instrumentation, field procedures used, and data calculation and assessment. The RISC standards are intended to support data collection using calibrated equipment to provide standardization for review and audits and support the archiving of hydrometric data of known quality.

Further, data grades only apply for the period reported in the report. Changes to the creek morphology, watershed, or climate may change the water level and creek discharge in ways not reported by this data. Therefore, it is recommended that, should the data presented in this report be used for engineering purposes, or where there is any chance of damage or harm to personal property or health, KEI expects that the engineer using the data to apply their own data grade, based on their own interpretation of the data. KEI will not be held liable for any damages that occur due to the use of this data.

Water quality data is collected by third-party individuals most of the time and, depending on the metric, is analyzed at accredited third-party labs or by the third party collecting the data. Though water quality data are presented in the report with an emphasis on the Province of British Columbia's Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia, KEI makes no representation as to the potability of the water. For questions regarding the potability of drinking water, KEI recommends contacting the water supplier and Interior Health.

References

B.C. Ministry of Forests and Range. (2010). *Compendium of Forest Hydrology and Geomorphology in British Columbia.* Victoria: Province of British Columbia.

BC Ministry of Health. (2012). *Drinking Water Treatment Objectives (microbiological) for Surface Water Supplies in British Columbia v. 1.2.* Victoria: The Province of BC.

Health Canada. (2023, February 8). *Guidelines for Canadian Drinking Water Quality - Summary Tables*. Retrieved from Government of Canada: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html