RESULTS OF WATER QUALITY MONITORING PROGRAM 2021

Haslam Lang Community Watershed

Project Number: 22-103
March 17, 2022

Client:
Powell River Salmon Society
5775 Ash Avenue
Powell River, BC V8A 4R3

Ryan Kremsater, M.Sc., GIT
STATLU ENVIRONMENTAL CONSULTING LTD.
1-45950 Cheam Avenue
Chilliwack, BC V2P 1N6

www.statlu.ca

EARTH WATER LAND

SUMMARY

The Powell River Salmon Society (PRSS) has formally monitored water quality within the Haslam Lang Community Watershed since 1997. The watershed supplies drinking water to the City of Powell River and the community of Brew Bay. It also provides important habitat for salmon species and the PRSS operates a Hatchery on Lang Creek. Maintaining water quality is important for providing healthy drinking water and maintaining clean salmon habitat.

The PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during the 2021 monitoring program and to compare the results with data from previous years. The PRSS recorded creek stage, turbidity, pH, salinity, and water temperature twice per month at six locations within the watershed. The measurements were taken at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Anderson Creek, Blackwater Creek, Haslam Lake, and the weir at the outlet of Haslam Lake named Slough Station. The water quality monitoring program, which began in 1997, provides a long history of data within the watershed which is a valuable tool for establishing baseline conditions. This allows land managers to detect potential problems and implement solutions to maintain good water quality before significant damage occurs.

The watershed received near normal precipitation in 2021, with a drier than normal February to August and wetter than normal September to November. This resulted in lower minimum stage and discharge measurements, and higher maximum discharge measurements in 2021 than recorded in 2020. The minimum discharge measurements on Lang Creek remained higher than discharge volumes recorded in 2018 and 2019. Turbidity, pH, and salinity generally varied within the normal and acceptable range for 2021. The average and minimum pH measurements were slightly more acidic (lower values) and more variable than values recorded in 2020. Salinity values near the end of 2021 decrease below values record at the beginning of the year and are starting to approach early 2018 levels. The data suggests that forest management strategies intended to protect water quality within the watershed are successful.

The maximum water temperatures within the watershed were warmer than in previous years. The warmer temperatures recorded during the bi-monthly sampling remained within normal limits recorded since 1997, but the bi-monthly sampling did not capture the June heat wave. The continuous data collection on Lang Creek at the Alex Dobler Salmon Centre recorded air and stream temperature during the heat wave. The station recorded a maximum air temperature of 34.9°C on June 27, 2021, followed by a maximum water temperature in Lang Creek of 25.9°C on June 28, 2021. This water temperature was approximately 4°C warmer than the highest temperatures recorded at other times during the summer. Other streams within the watershed could have experienced a similar temperature increase, and therefore, it is possible that water temperatures within the watershed during the June heat wave were the warmest on record.

CONTENTS

1.0 Introduction 1
2.0 Background 1
3.0 Methodology 2
4.0 Observations 4
5.0 Results 7
5.1 Precipitation and Air Temperature 7
5.2 Stage and Hydrograph 9
5.3 Turbidity 12
5.4 pH 15
5.5 Salinity 16
5.6 Water Temperature 18
6.0 Discussion 21
7.0 Conclusion 27
8.0 Limitations 28
9.0 Closure 29
References 30

APPENDICES

Appendix 1: Figure 1 Watershed Map 31
Appendix 2: Cummulative Precipitation Graphs 32

1.0 INTRODUCTION

The Powell River Salmon Society (PRSS) monitors water quality within the Haslam Lang Community Watershed with funding provided by British Columbia Timber Sales (BCTS) and the Powell River Community Forest (PRCF). The watershed provides important habitat for several fish species and the PRSS operates a hatchery on Lang Creek. The city of Powell River and community of Brew Bay source drinking water from the watershed.

As part of an ongoing water quality monitoring program, the PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during 2021 and to compare the results with previous years of monitoring.

2.0 BACKGROUND

Land managers have prioritized sustainable development within the Haslam Lang Community Watershed for over two decades. A water quality monitoring program began within the watershed in 1997 and a watershed management plan was implemented in 1999. Both initiatives aimed to study and maintain water quality to protect communities and natural ecosystems.

The Haslam Lake and Lang Creek Integrated Watershed Management Plan (IWMP) and subsequent watershed assessments, most recently completed in 2020, have guided sustainable development within the watershed by identifying resources at risk and effectively managing public interests. Management planning, watershed assessments, stakeholder involvement, and implementation of best management practices have provided sound scientific and practical guidance for sustainable development in the watershed.

The water quality monitoring program is a key component of the watershed management plan process. The data analysis can identify short-term changes and long-term trends in water quality within the watershed. This can allow land managers to respond to potential problems before they cause damage to watershed resources. If potential problems are identified, the data can guide management strategies to reduce risks within the watershed and to downstream resources.

The monitoring program also ensures that water license operators meet sustainability requirements throughout the year. One requirement is to maintain a minimum flow greater than 15 ft^3/s (0.42 m^3/s) in Slough Creek downstream of the storage dam at all times of the year, and this minimum should be increased to 25 ft^3/s (0.71 m^3/s) during October and November. Maintaining the minimum flow requirements and good water quality is key for sustainable development within the watershed.

Four watershed assessments have been completed; the first in 1999 (Carson, 2000), the second in 2003 (Carson, 2003), and the third in 2015 (Carson Land Resource Management, 2015). Statlu completed the fourth and latest watershed assessment in 2020 (Statlu, 2020). Additionally, Carson (2010) assessed how PRCF operations affect water quality within the Powell River area, including areas within the PRCF but outside the community watershed.

3.0 METHODOLOGY

The water quality monitoring program involves measuring the stage, turbidity, pH, water temperature, and salinity twice per month at six locations within the watershed. The measurements were recorded at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Blackwater Creek, Anderson Creek, Haslam Lake near the community water intake, and Haslam Lake at Slough Station (Figure 1 in Appendix 1). Continuous stream flow data is collected on Lang Creek at the Alex Dobler Salmon Center. The data, along with general observations and photographs taken during the sampling, were sent to Statlu for analysis.

Statlu prepared two graphs for each water quality variable (stage, turbidity, pH, water temperature, and salinity) and the six measurement locations are plotted on each graph. The first graph shows how the water quality for each location changed during 2021, and we compare the data to events that occurred during the year. The second graph compares the data recorded in 2021 to data recorded from 1997 to present. The long-term graphs shows how water quality within the watershed has changed over the history of monitoring and allows anomalous trends to be identified.

Statlu compared the six water quality variables to the continuous hydrograph data recorded on Lang Creek at the Alex Dobler Salmon Centre. We extracted the daily maximum and minimum discharge (water volume) from the continuous stream flow data and compared those values to previous years. We plotted the stream flow data with daily precipitation data collected at the same location, which shows how Lang Creek responds to short-term weather events. This also provides additional information about conditions within the watershed that preceded the bi-monthly water sampling dates.

The continuous water monitoring station on Lang Creek also records air temperature and creek water temperature. Statlu compared the daily temperature data on Lang Creek to the bi-monthly temperature data recorded within the watershed.

We compared monthly precipitation and temperature data collected during 2021 to the average monthly data collected during a 30-year period from 1981 to 2010. This data was recorded at the Powell River A climate station, located 130 m above mean sea level at the Powell River Airport, about 7 km southwest of Haslam Lake (Environment Canada, 2021).

4.0 OBSERVATIONS

The PRSS made field observations and took photographs within the watershed to record conditions that could influence the data (Photos 1 to 4). Factors such as flood events, low summer flows, landslides, and road conditions can affect water quality measurements.

The PRSS observed road dust on the surface of Blackwater Creek in early September. Blackwater and Anderson Creeks had tea-coloured water during sampling on January 13, 2021, which was completed following a rainstorm on January 12. Windy conditions were noted on Haslam Lake during several measurement days which can increase turbidity. In March, the PRSS noted increased sedimentation from runoff near the Duck Lake boat launch, upstream of the sampling site (Photo 4). They attributed the sedimentation to increased ATV usage and wet weather. The PRSS also recorded their third highest pink salmon return on record, which resulted in higher turbidity in Lang Creek from fish disturbing sediment near the sampling site.

Several known and ongoing concerns to water quality persist through 2021. Muddy banks on Blackwater Creek continue to be a sediment source. On Lang Creek, an unstable and slumping bank remains active upstream of the fish hatchery. A log jam in Haslam Lake near the sampling location disturbs lake sediment during windy conditions. These areas are known to reduce water quality measurements within the watershed.

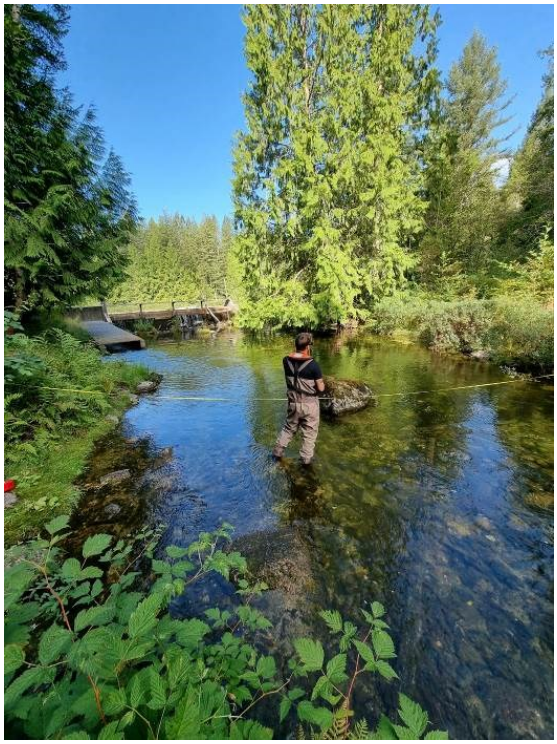


Photo 1: Sampling in August, 2021.

Photo 2: Blackwater Creek sampling on October 26, 2021.

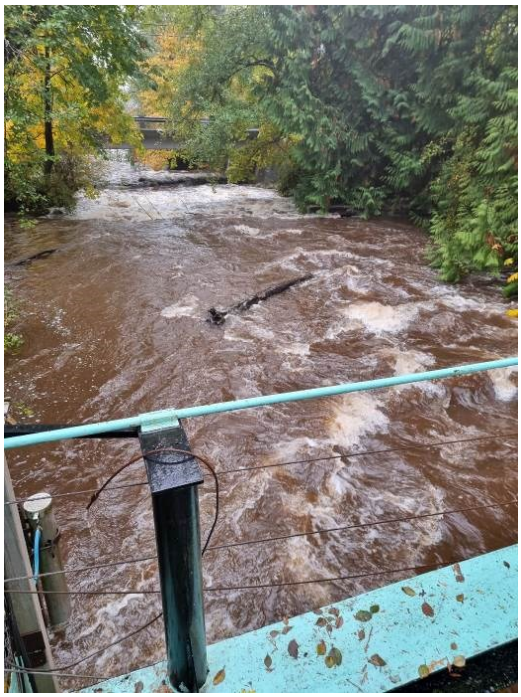


Photo 3: Lang Creek during high water on October 16, 2021.

Photo 4: Example of water transporting fine sediment off a road near Duck Lake on March 24, 2021.

5.0 RESULTS

5.1 Precipitation and Air Temperature

I compared the total monthly precipitation and mean monthly air temperature, recorded at the Powell River A climate station during 2021, to the monthly 30-year averages recorded from 1981 to 2010 at the same location (Figure 1). Precipitation and temperature data are missing on January 16, February 23, May 25, and December 19, 2021.

The total precipitation recorded during 2021 was 1231 mm, which is 5% less than the 1294 mm recorded in 2020, and 2% more than the 30-year average from 1981 to 2010 of 1206 mm per year (Environment Canada, 2022). The spring and summer of 2021 were drier than normal, and the fall was wetter than normal. Total precipitation between February and August in 2021 was 41% less than the 30-year average. From September to November, total precipitation in 2021 was 78% more than the 30-year average.

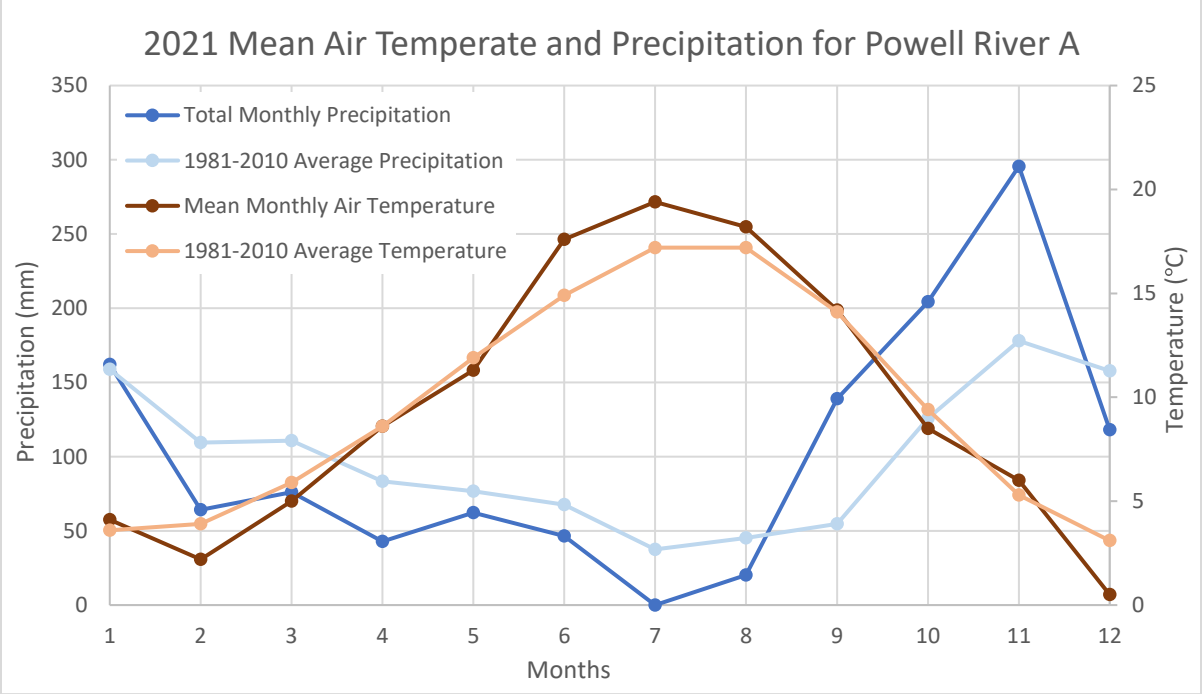


Figure 1: Mean air temperature (°C) and total monthly precipitation (mm) at the Powell River A climate station for 2021 compared to the 30-year average from 1981 to 2010.

Mean air temperature was below average in February and December, and above average in June, July, and August. The maximum average monthly temperatures typically occur in July. The average air temperature in July 2021 was 19.4°C, 2.2°C more than the 30-year average July temperature 17.2°C. A heat dome in June resulted in temperatures above 30°C in the watershed from June 25 to June 29. The hottest temperatures during this period were 37.0°C recorded at the Powell River A climate station and 34.9°C recorded at the Alex Dobler Salmon Centre (Environment Canada, 2022). The temperature recorded at the Powell River A climate station broke the all-time record of 34.4°C record on July 29, 1960.

The PRSS operates a rain gauge at the Alex Dobler Salmon Centre. This gauge, the Powell River, and the Powell River A climate stations recorded similar annual precipitation over 2021, with 1231 mm recorded at Powell River A, 1255 mm at Powell River, and 1235 mm at the Alex Dobler Salmon Centre (Figure 2). The total daily precipitation varies between the three sites. The Alex Dobler Salmon Centre and Powell River A climate stations recorded less precipitation than the Powell River station through the spring and summer, and more precipitation through the fall. Graphs for 2018, 2019, and 2020 show a similar result in 2019 and 2020, and a large difference in 2018 (Appendix 2).

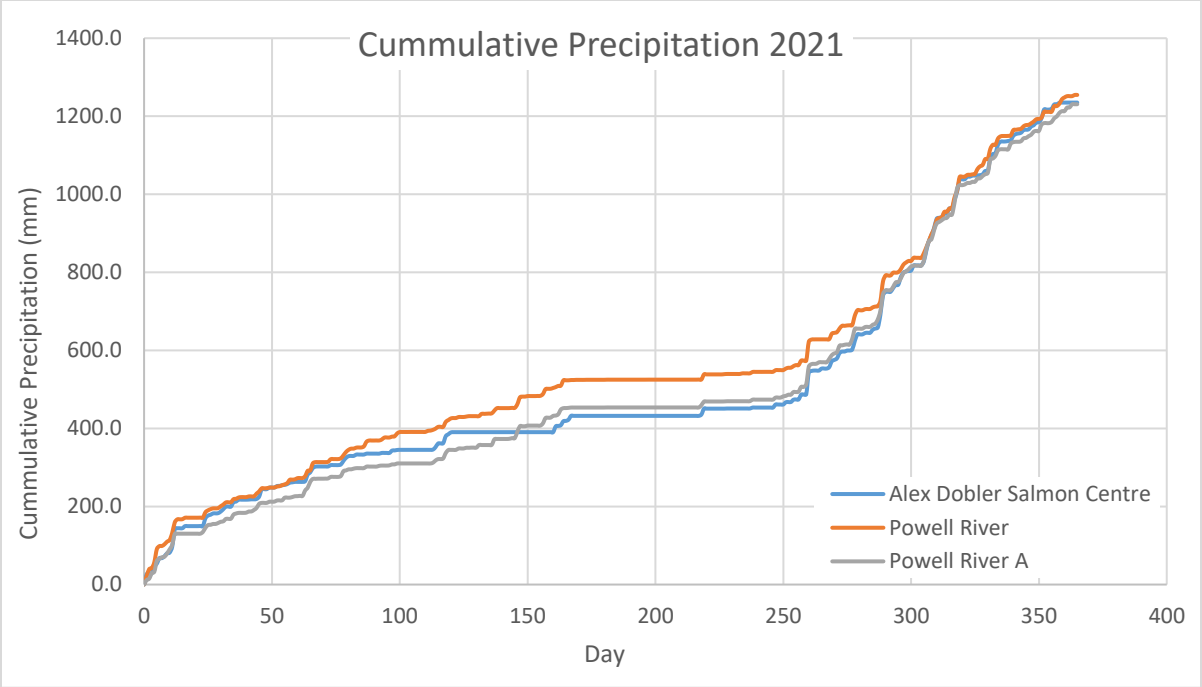


Figure 2: Cumulative precipitation recorded at three different climate stations near the Haslam Lang Watershed. The graph shows the three stations record similar annual precipitation with varying daily precipitation totals.

5.2 Stage and Hydrograph

Stage measurements record the height of the water surface relative to a known reference elevation (Figure 3). The stage data for Haslam Lake and Slough Station are plotted on a secondary axis as their stage reference points are geodetic elevations, which differ from the other four sampling locations. Despite having two different reference points, the stage data for all six sites shows water level variations within the watershed during 2020.

The stage measurements show that all watercourses have similar flow patterns from January to July and from October to December, as water level changes in response to periods of precipitation and dry weather. From June to September, the weir at Haslam Lake and Slough Station moderate water levels downstream in Lang Creek. The stage measurements for Haslam Lake and Slough Station continue to fall while Lang Creek maintains flow.

Most stage measurements for 2021 are similar to the 2020 values. The average stage measurements at all six sites range from 0.04 m lower to 0.03 m higher than the 2020 measurements. The maximum stage on most creeks is from -0.1 m lower to 0.08 m higher than the 2020 values. The maximum stage on Anderson Creek is an exception; the 2021 measurement was 0.33 m lower than the 2020 measurement. The minimum stage measurements in 2021 on Lang, Duck, Blackwater, and Anderson Creeks are similar to the 2020 values, ranging from 0.04 m lower to 0.02 m higher. The minimum stage readings at Slough Station and Haslam Lake in 2021 are 0.22 m and 0.21 m lower than the 2020 measurements. The 2021 stage measurements are consistent with variations recorded since 1997 (Figure 4).

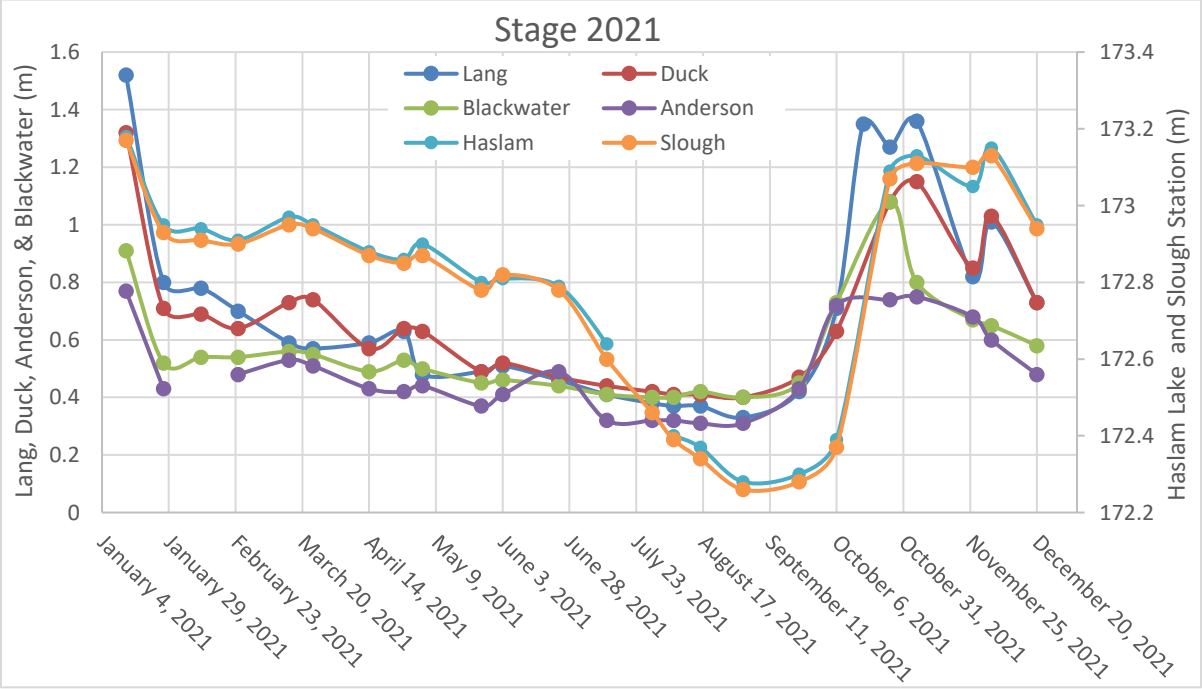


Figure 3: Stage discharge at six sites within the community watershed during 2021. Stage measurements for Haslam Lake and Slough Station are graphed on the secondary (right) axis.

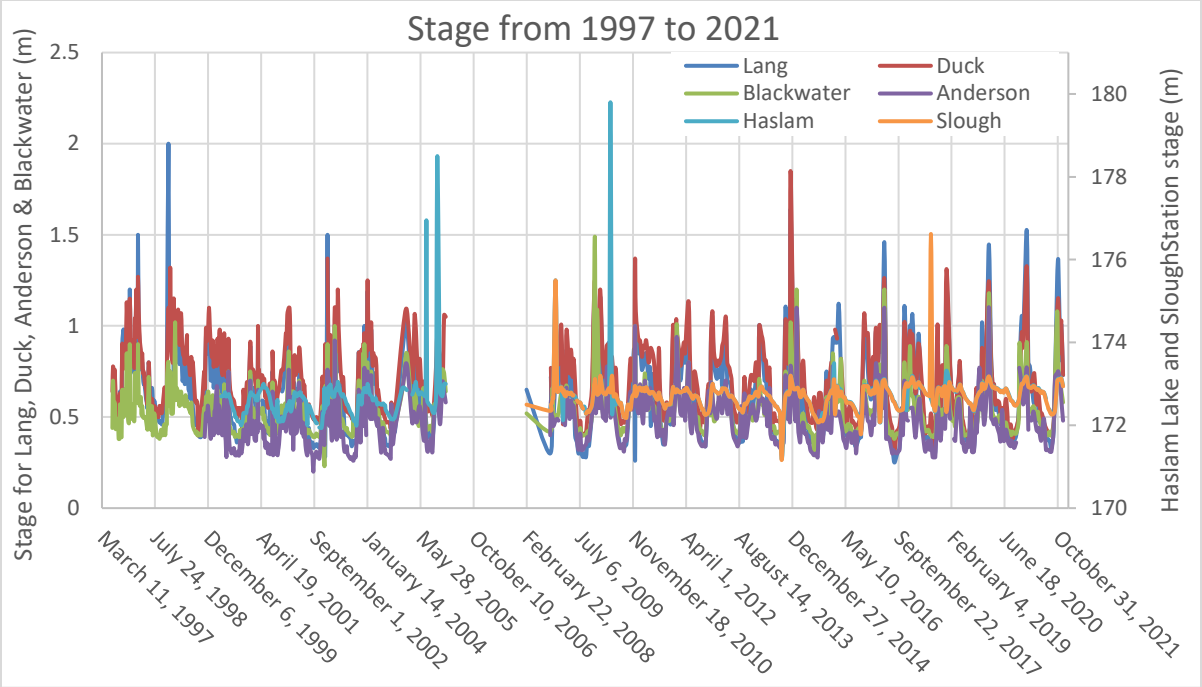


Figure 4: Stage discharge at six sites within the community watershed between 1997 and present. The stage for Haslam Lake and Slough Station are graphed on the secondary (right) axis.

Continuous data recording in Lang Creek during 2021 measured discharge rates throughout the day during 2021 (Figure 5). The maximum peak discharge in Lang Creek for 2021 was recorded on November 15 at 70.1 m^3/s. The lowest discharge was on September 7 at 0.49 m^3/s. The average discharge through 2021 was 7.56 m^3/s and the median discharge was 4.14 m^3/s. The 2021 maximum, median, and average discharge values are greater than those recorded in 2020 (Table 1). The maximum discharge is 19% greater, the average discharge is 25% greater, the median discharge is 52% greater than the 2019 values. The minimum discharge of 2021 is 32% less than 2020 minimum. All of the 2021 discharge statistics are greater than the 2019 and 2018 values (Table 1).

The highest single day rainfall of 2021 occurred on September 17 (Day 260). This storm did not cause high peak flows on Lang Creek because most of the precipitation refilled Haslam Lake, allowing the lake to overtop of the weir following the dry summer. After this date, smaller single day rain events in October and November resulted in higher peak flows because Haslam Lake was already at capacity.

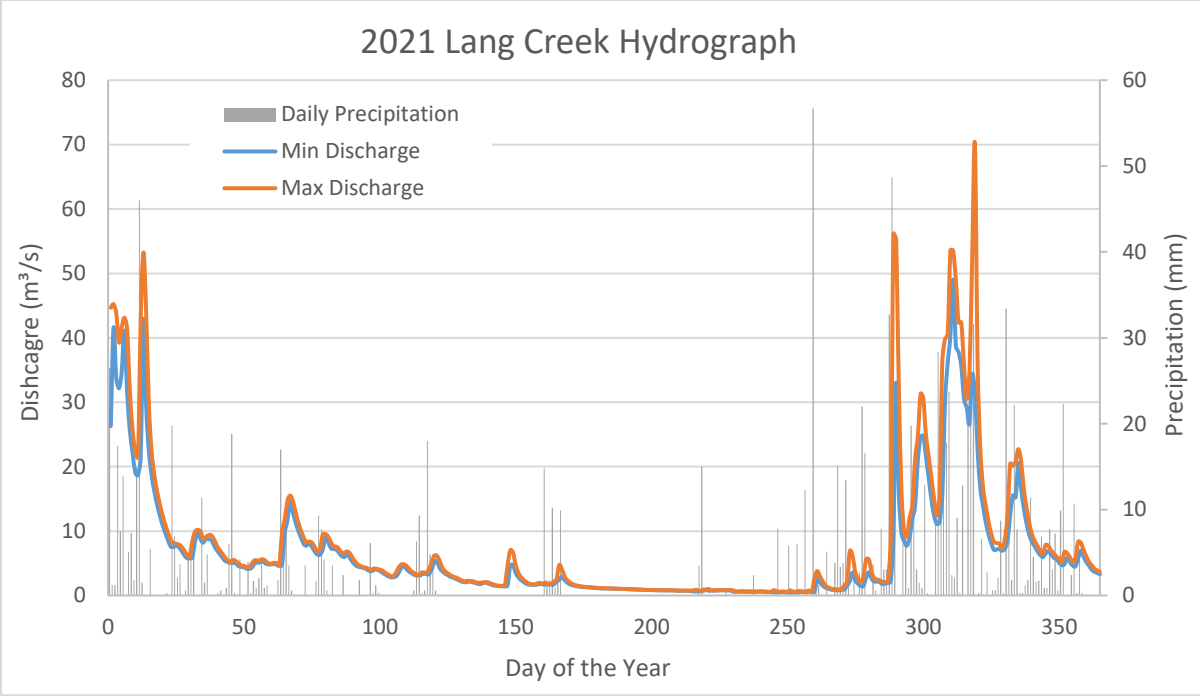


Figure 5: 2021 Hydrograph for Lang Creek. The minimum and maximum discharge (m³/s) is plotted against the total precipitation (mm) recorded at the same site.

Table 1: Yearly discharge rates of Lang Creek from 2018 to 2021.

Year	Maximum (m³/s)	Average (m³/s)	Median (m³/s)	Minimum (m³/s)
2018	49.9	6.02	3.99	0.382
2019	23.3	3.77	2.38	0.472
2020	59.1	6.07	2.70	0.722
2021	**70.1**	**7.56**	**4.14**	**0.490**

5.3 Turbidity

The bi-monthly turbidity measurements in 2021 were between approximately 0.23 NTU and 8.6 NTU, with average readings between 0.49 NTU and 1.58 NTU (Figure 6). The PRSS took an additional measurement on Lang Creek during a rainstorm on October 16, 2021, obtaining a turbidity value of 38.1 NTU.

The highest turbidity readings were measured in Lang Creek on January 13, October 16, and October 26, 2021, with a smaller turbidity spike on November 5 in Haslam Lake. Turbidity remained higher than normal in Lang Creek following the October 26 event before decreasing in December. Blackwater Creek has elevated turbidity levels during the summer from June to October and PRSS personnel noted that dust floated on the water surface at the beginning of September. Duck and Slough show minimal turbidity changes through the year.

The average bi-monthly turbidity levels in 2021 are similar to 2020 levels. Lang Creek had the maximum turbidity within the watershed between 2018 and 2021. The maximum turbidity reading during the normal bi-monthly monitoring was 8.6 NTU on October 26, about 22% greater than the maximum recorded in 2020. The maximum turbidity measured during a flood event on October 16 was 38.1 NTU, which is 31.1 NTU (441%) higher than the maximum recorded in 2020.

Turbidity data from 1997 to present shows low average turbidity with episodic spikes through the years (Figure 7). The data shows that average turbidity levels within the watershed are normal and that the turbidity spike during the October flood event is similar to high turbidity events previously recorded within the watershed.

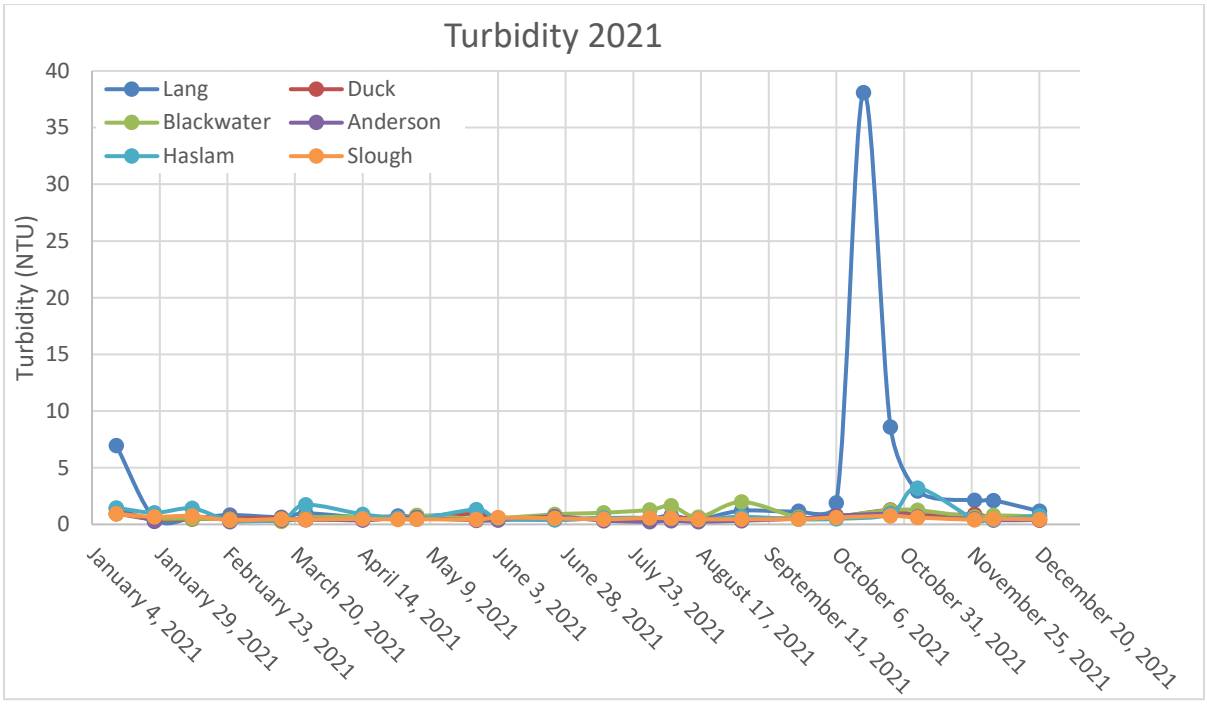


Figure 6: Turbidity measurements through 2021 at six sites within the Haslam Lang Community watershed.

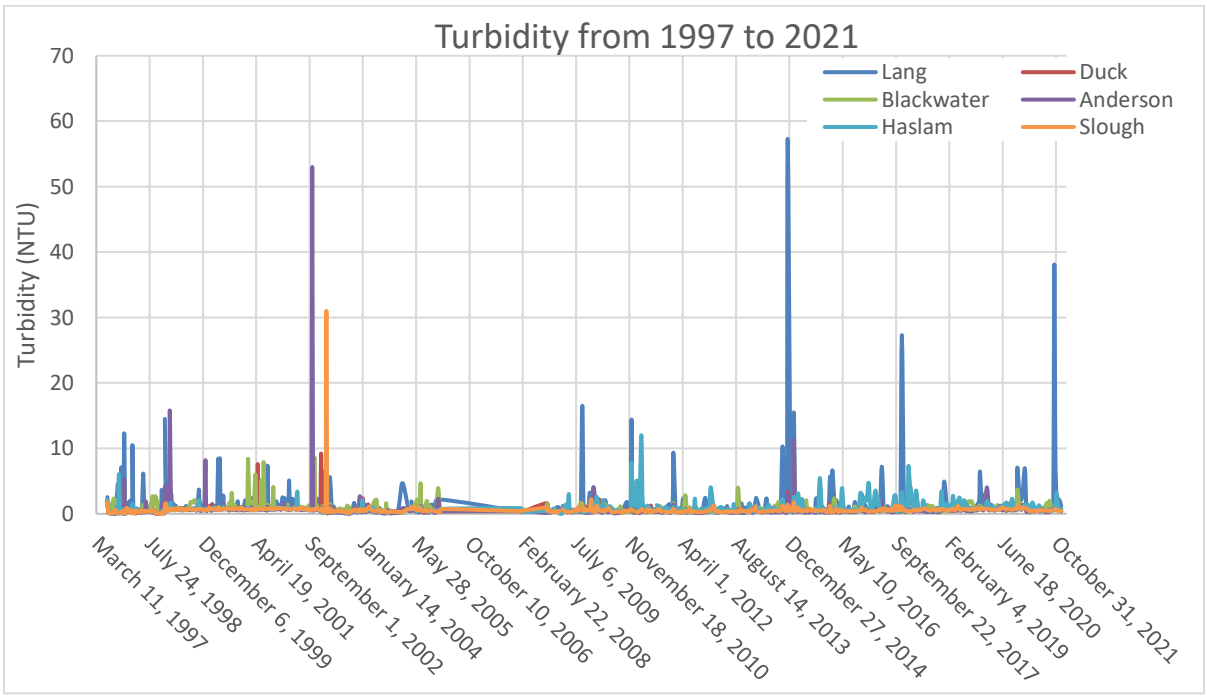


Figure 7: Turbidity at six sites within the Haslam Lang Community watershed between 1997 and present.

5.4 pH

The pH ranged between 6.5 and 7.2 within the watershed during 2021 (Figure 8). Average pH measurements in all creeks were lower (more acidic) than recorded in 2020. The 2021 averages were between 6.9 and 7.0, up to 0.1 (2%) less than the 2020 pH averages of 7.0 to 7.1 in all creeks. Maximum pH measurements of 7.2 occurred in January, February, August, November and December, and are 0.1 (1%) less than the maximum pH recorded in 2020. The minimum pH measurement of 6.5 occurred on November 5, 2021, on Lang Creek, and is 0.3 (5%) less than the minimum reading of pH 6.9 on Lang Creek in 2020, and 0.1 (2%) less than the 2020 minimum pH of 6.6 recorded on Anderson Creek.

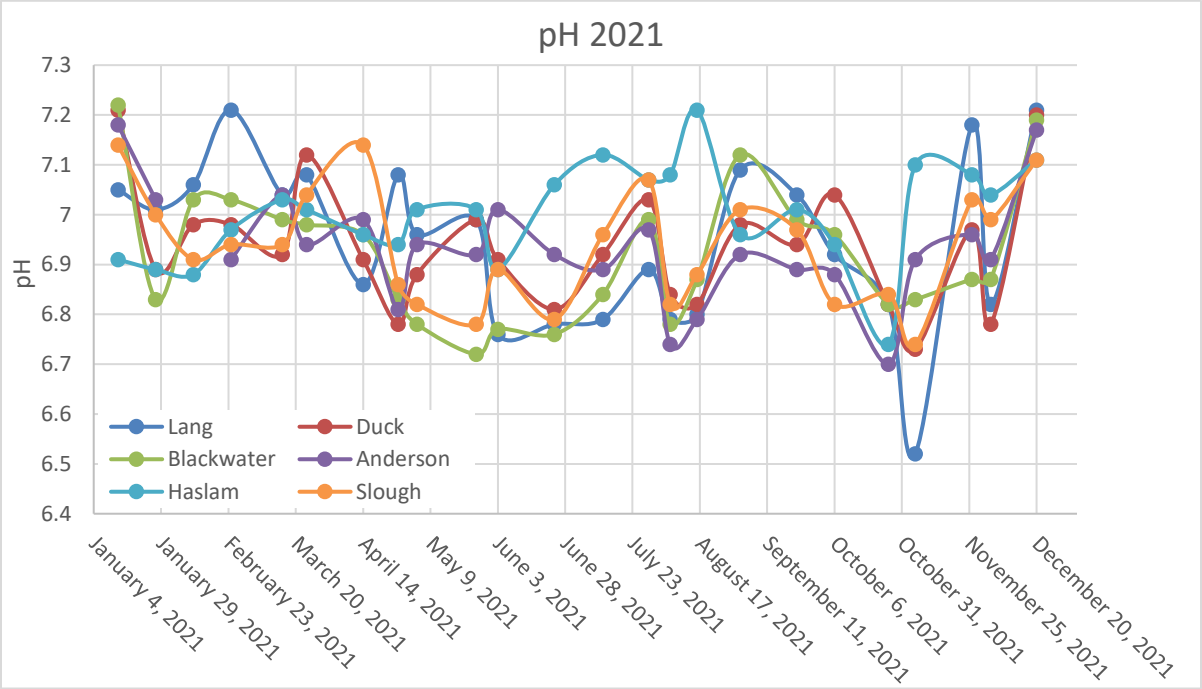


Figure 8: pH at six sites within the Haslam Lang Community watershed.

Variations in pH for the recorded history of each creek are shown in Figure 9. The minimum pH value in 2021 is slightly lower than normal variations within the past 5 years but remains near expected values. The pH range over the last 5 years generally varies between 6.7 and 7.3, which is less than the variability recorded from 1997 to 2013, which varied between 5 and 9.

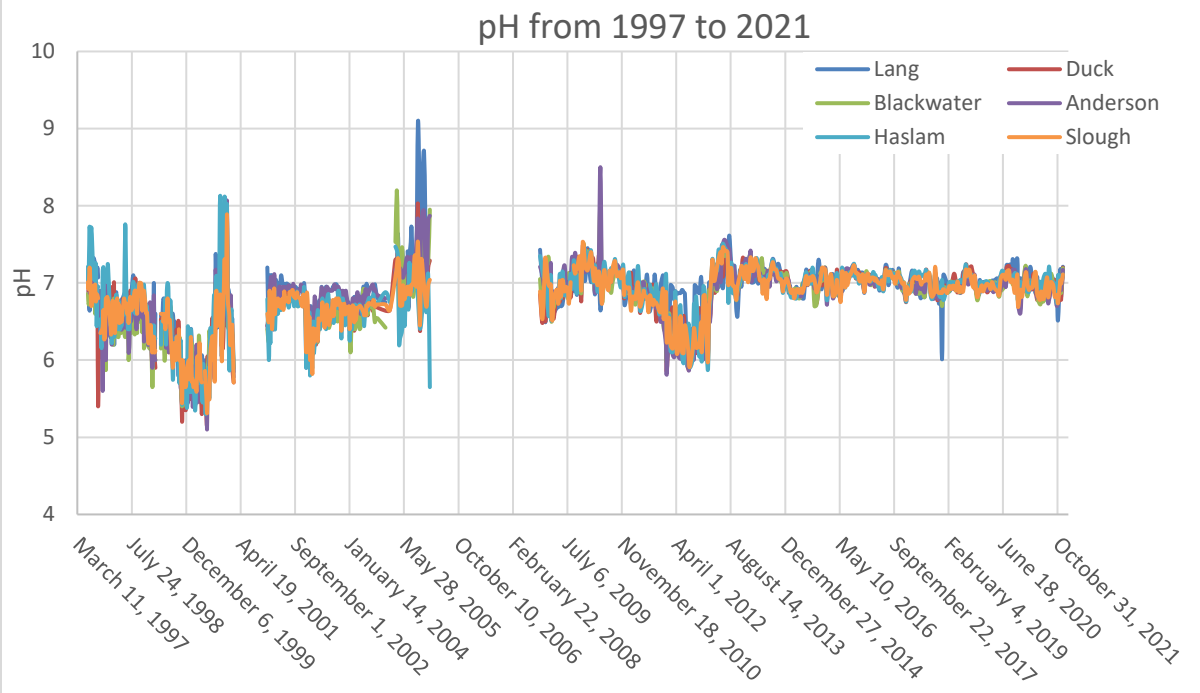


Figure 9: pH at six sites within the Haslam Lang Community watershed between 1997 and 2021.

5.5 Salinity

Salinity varied from about 2 ppm to 21 ppm at the six recorded sites during 2020 (Figure 10). Average salinity ranged from 8 ppm to 12 ppm for all the six measurement sites, which is similar to the 2020 averages between 9 ppm and 11 ppm. The average salinity for Duck, Blackwater, Anderson, and Sloughs is up to 4% less than the average in 2020. The average salinity in Haslam Lake and Lang Creek is about 1 ppm (12% and 10% respectively) greater than the average salinity recorded at these sites in 2020.

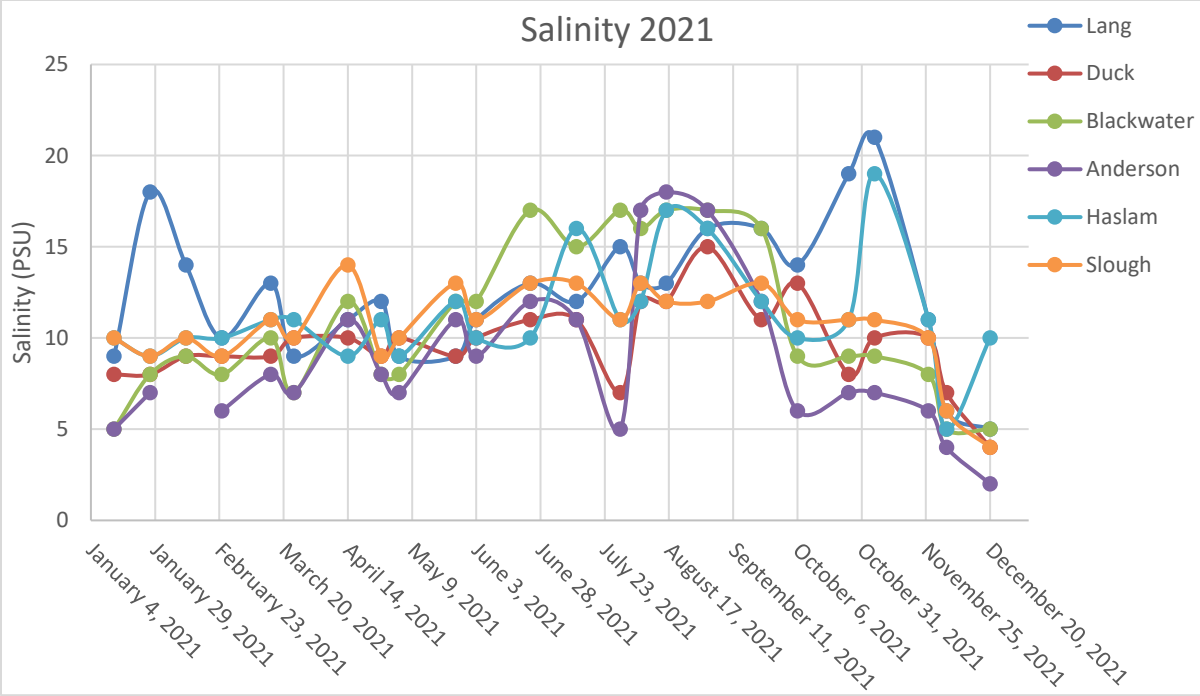


Figure 10: Salinity at six sites within the Haslam Lang Community watershed.

Most salinity measurements increase as time progresses from winter to summer. Maximum 2021 salinity measurements occurred on November 5 on Lang Creek and Haslam Lake. These maximum readings were 5 ppm (31%) and 7 ppm (58%) greater than the 2020 maximums on these creeks respectively. A lower salinity spike on Lang Creek also occurred January 27.

Salinity data from 1997 to present are graphed on Figure 11 with a gap between 2006 and 2008 when no monitoring occurred. Salinity data recorded from 1997 to 2006 are greater than salinity data recorded from 2008 to 2019. The abrupt decrease in salinity could result from equipment or measuring differences between the two periods. From 2009 to 2018, the salinity data for all six creeks varies from 0 ppm to 16 ppm and has average values between 4 ppm and 6 ppm. Salinity values started to increase at the end of 2018, and they continued to increase through 2019. The PRSS purchased a new salinity probe in 2020. It recorded similar, but slightly lower salinity levels in 2020 than in 2019. In 2021, salinity continues to drop, with a decrease in December resulting in the lowest salinity levels since early 2018. Overall, salinity levels in 2021 are similar to salinity readings in preceding years.

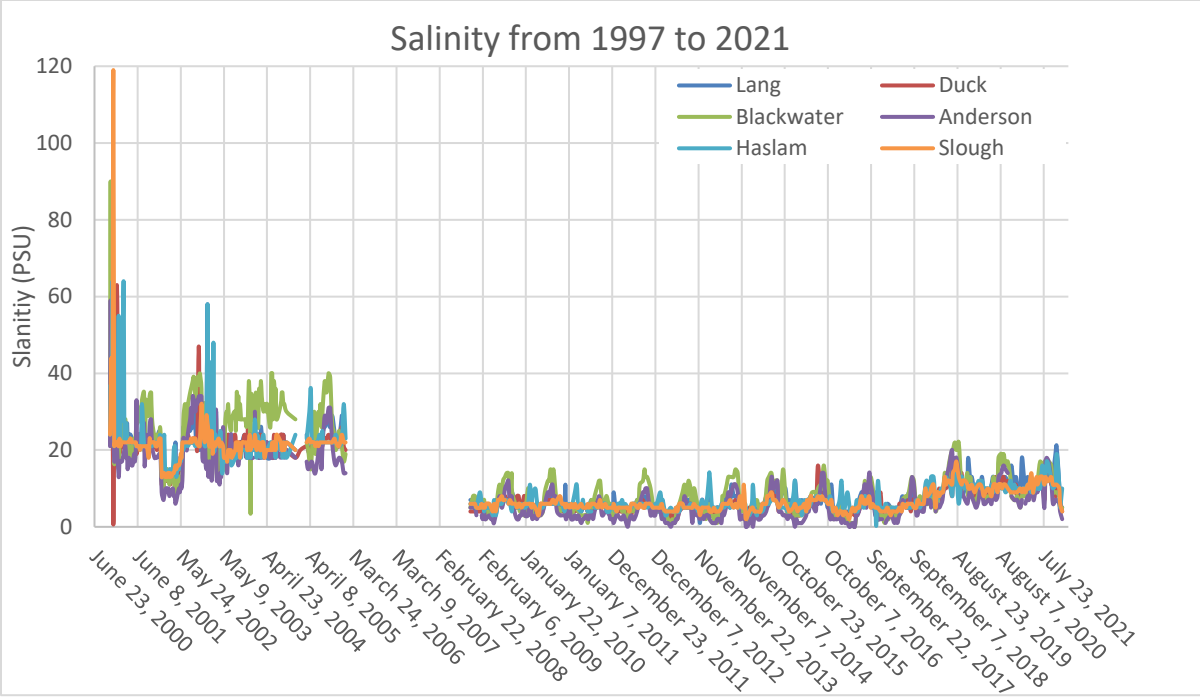


Figure 11: Salinity at six sites within the Haslam Lang Community watershed between 2009 and present.

5.6 Water Temperature

Average water temperatures within the watershed ranged from 8.6 °C to 13.2 °C for all six sites, which is similar to 2020. The temperatures are coldest during the winter and warmest during the summer (Figure 12). The maximum water temperatures recorded at all six sites were 0.9°C to 2.1°C warmer than in 2020. Duck Creek historically has the highest maximum water temperature within the watershed, and the trend continues in 2021 (Figure 13). The highest water temperature in 2021 was 25.7°C, 1°C warmer than in 2020, and the highest water temperature recorded in the watershed since 2014 when Duck Creek reached 26.0°C. The maximum bi-monthly water temperatures in 2021 remain within the normal variability recorded at the six sites from 1997 to present. The water temperature data has a similar trend to the air temperature data in Figure 1.

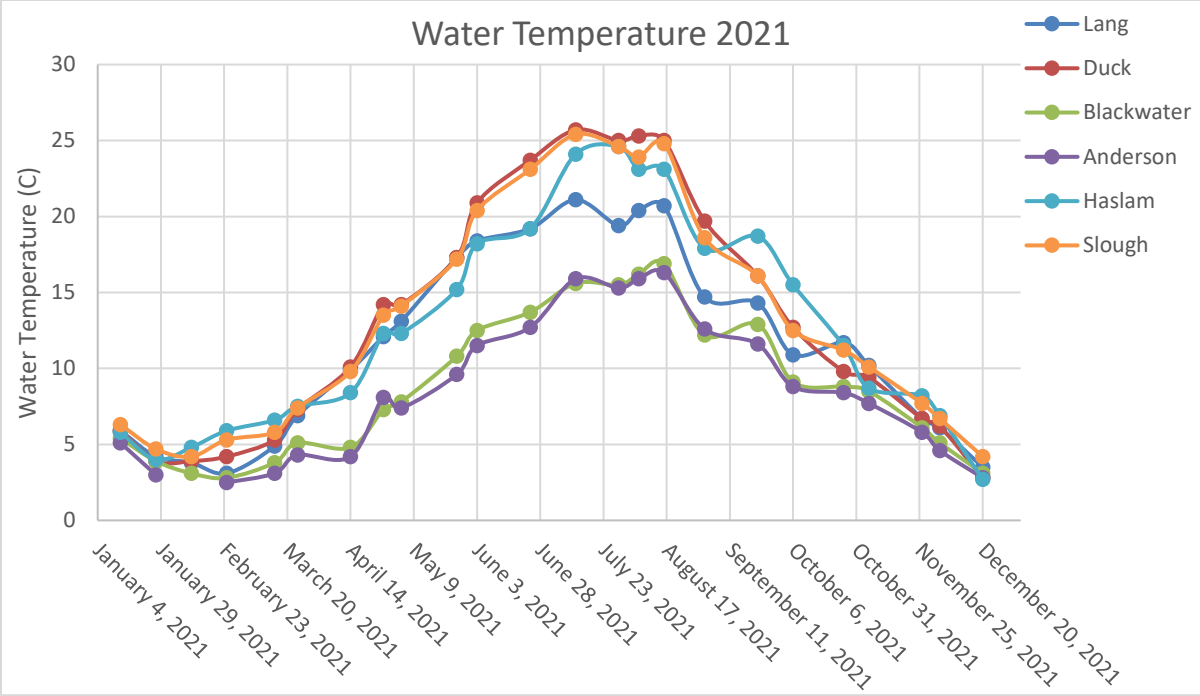


Figure 12: Water temperature measured at six sites within the Haslam Lang Community watershed.

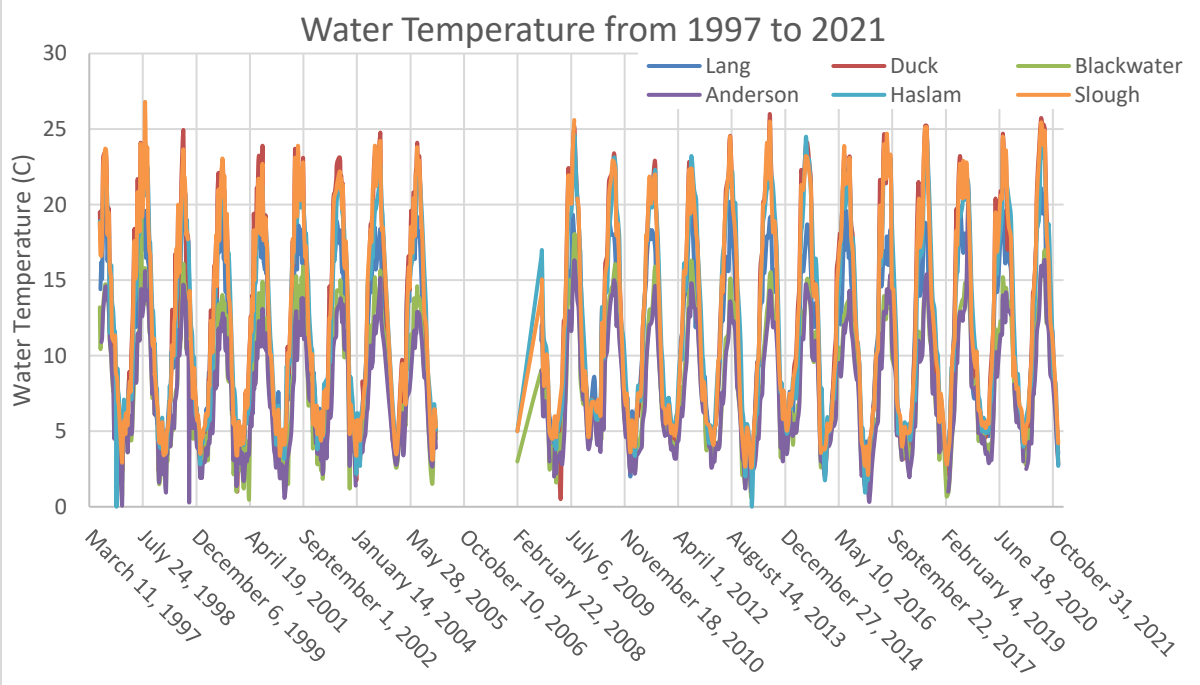


Figure 13: Water temperature at six sites within the Haslam Lang Community watershed between 1997 and present.

Continuous air and water temperature monitoring at Lang Creek shows how water temperature responded to weather events with more detail than the bi-monthly data monitoring (Figure 14). A heat dome in June broke temperature records across southwest BC, including at the Powell River A climate station (Section 5.1). The bi-monthly sampling recorded water temperatures on June 24 and July 12, just before and about 2 weeks after the heat dome. The continuous temperature monitoring at Lang Creek recorded data through the heat dome.

The heat dome in June resulted in temperatures above 30°C in the watershed from June 25 to June 29, with a maximum air temperature recorded at the Alex Dobler Salmon Centre of 34.9°C on June 27 (Environment Canada, 2022). Water temperature in Lang Creek increased about 4°C during this time, reaching a maximum temperature of 25.9°C on June 28, 2021. This temperature is warmer than temperatures recorded at any other point during the summer (Figure 14).

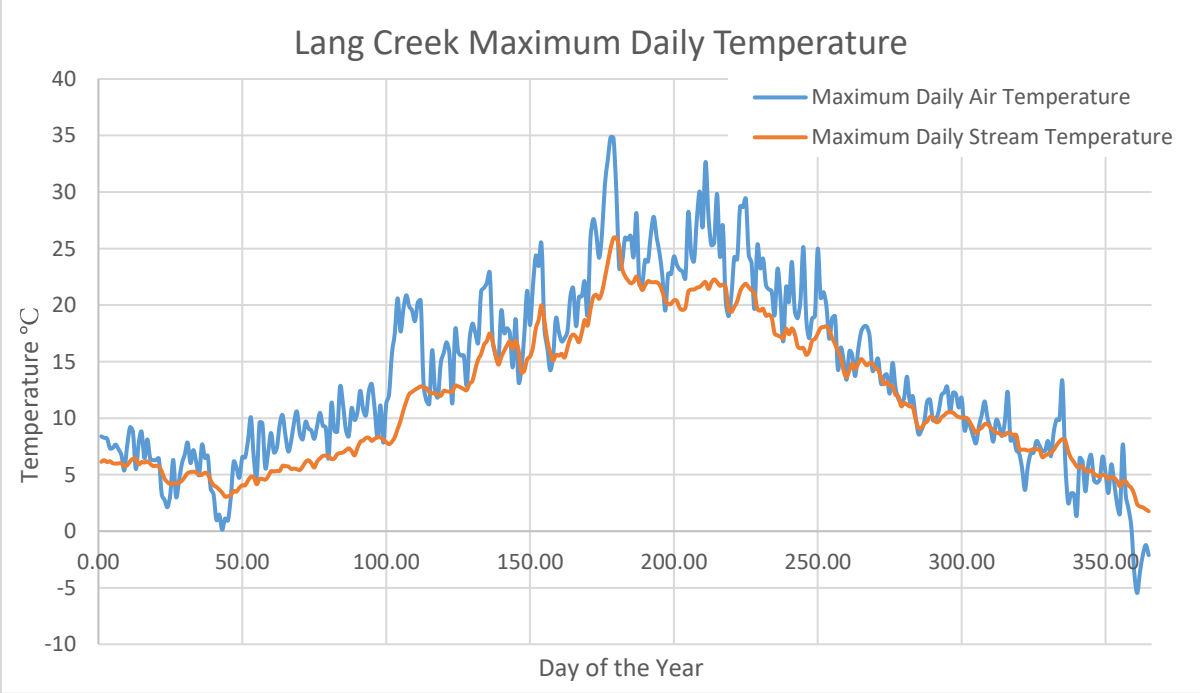


Figure 14: Continuous water and air temperature on Lang Creek recorded at the Alex Dobler Salmon Centre.

6.0 DISCUSSION

Climate, weather, and land use affect water quality within the Haslam-Lang community watershed. They determine how much precipitation and runoff contribute to stream flow versus inflow from groundwater. The volume of precipitation can determine how much erosive power streams have, which influence water quality. Land use within the watershed affects the amount of dust and sediment on road surfaces and the amount of potential contaminants within the watershed. This section aims to compare trends between variables to understand what caused anomalously high and low readings during 2021.

Climate and weather control how much water enters the watershed. The Powell River A climate station recorded 5% less precipitation in 2021 than in 2020, but 2% more than the 30-year average from 1981 to 2010. February to August was 41% drier than the 30-year average, while 78% more rain fell from September to November than the 30-year average. Summer temperatures were 6% to 13% higher than the 30-year average during June, July, and August. The combination of a drier than normal spring, and warmer than normal summer could have produced extreme water quality measurements within the watershed. Despite these conditions, most measurements within the watershed remain within normal levels and suggests the capacity of the watershed to mitigate short-term climate fluctuations has been effectively managed and maintained.

The stage measurements in 2021 are generally similar to the 2020 measurements for each creek. The creeks show similar variability throughout 2021, with peaks during the winter months and the lowest levels recorded during mid-September. The stage variability is similar to the continuous discharge data from Lang Creek. High measurements in both data sets occur after precipitation events. The discharge data shows little variability between June 19 (Day 170) and September 17 (Day 260) suggesting that water levels in Haslam Lake fell below the elevation of the weir that controls water flow into Lang Creek. Water levels likely overtopped the weir after a single-day storm that had the most intense daily rainfall of the year on September 17 (Day 260) and all subsequent spikes represent the full drainage area of the watershed.

The average discharge in Lang Creek during 2021 was 7.56 m^3/s, 25% greater than in 2020. The higher average discharge likely results from the above average precipitation that fell during fall 2021. The minimum discharge in Lang Creek was 0.49 m^3/s on September 7, at the end of a drier than normal preceding 8 months. The minimum discharge value occurs almost 2 weeks earlier than in 2020. The minimum discharge was 32% less than recorded in 2020, but remains greater than the 2019 and 2018 minimum discharge values, which shows water managers prioritized maintaining minimum flow levels within the watershed despite the drier and warmer than normal conditions.

The drier and warming summer conditions resulted in stage measurements that were 0.22 m and 0.21 m lower in Haslam Lake and Slough Station respectively than recorded in 2020. These stage differences are calculated from a geodetic elevation rather than a channel depth, and therefore should not be converted to a percent difference. The maximum discharges in 2021 were caused by three atmospheric river events in the fall. The largest event between November 13 and November 15 brought 75.4 mm of rain over the three day period and resulted in a Lang Creek discharge of 70.1 m^3/s, 19% greater than the maximum value recorded in 2020. Although we don't have a continuous long-term discharge record from Lang Creek, based on the observed rainfall, and the response of other rivers across southwest BC to the atmospheric rivers, we expect that the recorded maximum peak discharge in Lang Creek might represent approximately a 1-in-10-year flood magnitude and frequency.

The maximum 2021 turbidity measurements correspond to maximum discharges measurements in the creeks. Peak turbidity readings on January 13, October 26, and November 5 all occurred after precipitation events. Peak flows caused by heavy precipitation or rain on snow events can cause stream bank erosion and landslides, increasing water turbidity. Bank erosion on Lang Creek is an ongoing concern for the PRSS and may have contributed to the maximum reading of 8.6 NTU on October 26.

The peak turbidity readings are strongly influenced by when the sampling was done in relation to the heavy precipitation events. The maximum turbidity reading from the scheduled bi-monthly measurements was 8.6 NTU on October 26 following a week of wet weather. The PRSS conducted an additional test on October 16, 2021, during a storm and recorded a turbidity reading of 38.1 NTU, 343% greater than the peak recorded during the bi-monthly testing. This example shows that the bi-monthly testing captures water quality changes that occur from week to week, but does not capture short-term changes that occur over a few days, unless the sampling and short-term event intersect by chance.

Turbidity measurements in Blackwater Creek and Haslam Lake recorded elevated levels during the summer of 2020. The highest 2021 turbidity measurements on Blackwater Creek occurred during the summer with a reading of 1.98 NTU, 39% less than the peak value recorded in 2020. The PRSS often observes a sheen of dust on Blackwater Creek during the summer, which may contribute to the increased turbidity readings. Disturbances on the muddy banks from wildlife or human activity could also cause increased turbidity. Measurements on Haslam Lake did not record increased turbidity during the summer in 2021. Peak turbidity measurements on Haslam Lake occurred on November 5 after heavy rainfall and on March 24 during windy conditions. Other precipitation events through the year do not result in high turbidity measurements at Haslam Lake, making the November 5 measurement anomalous. The turbidity in Haslam Lake could be caused by sediment inflow from upstream sedimentation or from wind stirring up bank sediments near the measurement location. The 2021 maximum turbidity measurements in all creeks are similar to measurements recorded in 2020 and are within normal turbidity levels for the watershed.

The pH and salinity measurements recorded in 2021 have more variability than those recorded in 2020. Past salinity and pH measurements are generally greater in summer than during the first part of the year. The 2021 salinity measurements follow this trend, but with more volatility in the first half of the year. The pH measurements remain volatile throughout the year and do not show an average trend through the seasons. The increased variability in both salinity and pH could result from the below average precipitation received during the first part of the year. The ratio of groundwater to surface water and the amount of contaminants contained within precipitation and runoff influence the pH and salinity measurements. Ground water contains dissolved solids that increase pH and salinity, which could have resulted in higher than normal readings during the first part of the year when there was below average precipitation. Rainstorms can capture air pollution that decreases pH. The below average precipitation could have resulted in each rainstorm delivering more concentrated pollutants to the creek, resulting in larger pH decreases than would normally occur during spring rainfall. The sudden increase in rainwater could also dilute the groundwater and reduce salinity.

The lowest pH values and highest salinity values occur in October and November, which is similar to 2020. The low pH values typically results from increased contaminants flowing into the creeks from precipitation and runoff following dry summer weather. The increased salinity most likely results from increased erosion during high flow events but could also result from groundwater response as precipitation recharges younger water into the ground and pushes older, more saline water out into surface flow. The low pH and high salinity values recorded in October and November recovered to normal values in December. Despite the variability, the pH and salinity values recorded during 2020 are within the normal variability recorded from 1997 to present.

The 2019 and 2020 water quality reports by Statlu identified that salinity increased from 2018 to 2019, and remain elevated from 2019 to 2020. The PRSS purchased a new salinity probe for the 2020 monitoring program to ensure that the increased salinity measurements were not caused by equipment error. The measured salinity in 2020 was about 10% lower than in 2020, but remained greater than values recorded in early 2018. The salinity measurements near the end of 2021 suggest average salinity within the watershed continues to drop toward the levels recorded in early 2018. If the increased salinity resulted from equipment error, the salinity would have abruptly returned to early 2018 levels after the probe was replaced. The gradual increase and then decrease of salinity since 2018 indicates the trend is real and not a result of equipment error.

The 2021 data shows that most water quality remains within acceptable levels within the watershed. The relatively low levels of turbidity and salinity, along with relatively stable pH values suggest that watershed management practices have been effective in limiting sediment production and reducing the volume of water that transports sediment and contaminants from roads and ditches directly into streams.

The maximum water temperature is an important variable for stream health. Water temperatures can become too hot for aquatic life to survive and increasing water temperatures result in lower water oxygen levels. The heat dome in June broke the all-time temperature record at the Powell River A climate station as well as other temperature records across the province and resulted in temperatures above 30°C in the watershed from June 25 to June 29. The highest water temperature on Lang Creek was recorded on June 28 and was 4°C warmer than other water temperatures recorded during the summer. The heart dome occurred before Haslam Lake fell below the weir. If the heat dome had occurred during July or August when water levels in Lang Creek were lower, the resulting temperature increase could have been even larger. The bi-monthly sampling was completed on June 24 and July 12 and did not capture this temperature anomaly. It is possible that water temperatures on June 28 broke all-time records within the watershed.

The PRSS noted in past years that the sloughs are popular recreation areas and garbage can be left near the water. Water sampling for general chemistry parameters such as fecal coliform, total metals, and $CaCO_3$ equivalent were last completed in 2010 (Carson, 2017). Additional data collection of these parameters could quantify how human activity affects water quality and would be useful to maintain a robust baseline monitoring program.

The PRSS requested Statlu compare their rain gauge data from the Alex Dobler Salmon Centre to the nearby Powell River and Powell River A climate station data for the past several years. The data from 2019 to 2021 show the three stations record similar annual precipitation with a similar distribution over the year. The stations record different short-term precipitation totals, which likely result from natural variations in precipitation intensity across the area during a storm event and from the occasional day of missing data. The 2018 graph shows the three stations recorded different annual precipitation totals. The Powell River climate station did not record data during the first 102 days of 2018, and the Alex Dobler Salmon Centre rain gauge appears to have missed data during the second half of the year. The Alex Dobler Salmon Centre rain gauge currently provides an additional data source for the area in the event that one, or two, of the stations malfunction, as happened during 2018. The station also provides higher spatial resolution for the Powell River area, allowing the PRSS to capture rain events that pass over the watershed without passing over Powell River.

7.0 CONCLUSION

The Powell River Salmon Society (PRSS) has formally monitored water quality within the Haslam Lang Community Watershed since 1997. The watershed supplies drinking water to the City of Powell River and the community of Brew Bay. It also provides important habitat for salmon species and the PRSS operates a Hatchery on Lang Creek. Maintaining water quality is important for providing healthy drinking water and maintaining clean salmon habitat.

The PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during the 2021 monitoring program and to compare the results with data from previous years. The PRSS recorded creek stage, turbidity, pH, salinity, and water temperature twice per month at six locations within the watershed. The measurements were taken at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Anderson Creek, Blackwater Creek, Haslam Lake, and the weir at the outlet of Haslam Lake named Slough Station. The water quality monitoring program, which began in 1997, provides a long history data within the watershed which is a valuable tool for establishing baseline conditions. This allows land managers to detect potential problems and implement solutions to maintain good water quality before significant damage occurs.

The watershed received near normal precipitation in 2021, with a drier than normal February to August and wetter than normal September to November. This resulted in lower minimum stage and discharge measurements, and higher maximum discharge measurements in 2021 than recorded in 2020. The minimum discharge measurements on Lang Creek remained higher than discharge volumes recorded in 2018 and 2019. Turbidity, pH, and salinity generally varied within the normal and acceptable range for 2021. The average and minimum pH measurements were slightly more acidic (lower values) and more variable than values recorded in 2020. Salinity values near the end of 2021 decrease below values record at the beginning of the year and are starting to approach early 2018 levels. The data suggests that forest management strategies intended to protect water quality within the watershed are successful.

The maximum water temperatures within the watershed were warmer than in previous years. The warmer temperatures recorded during the bi-monthly sampling remained within normal limits recorded since 1997, but the bi-monthly sampling did not capture the June heat wave. The continuous data collection on Lang Creek at the Alex Dobler Salmon Centre recorded air and stream temperature during the heat wave. The station recorded a maximum air temperature of 34.9°C on June 27, 2021, followed by a maximum water temperature in Lang Creek of 25.9°C on June 28, 2021. This water temperature was approximately 4°C warmer than the highest temperatures recorded at other times during the summer. Other streams within the watershed could have experienced a similar temperature increase, and therefore, it is possible that water temperatures within the watershed during the June heat wave were the warmest on record.

8.0 LIMITATIONS

The recommendations provided in this report are based on observations made by Statlu and are supported by information Statlu gathered. Observations are inherently imprecise. Conditions other than those indicated above may exist on the site. If such conditions are observed or if additional information becomes available, Statlu should be contacted so that this report may be reviewed and amended accordingly.

This report was prepared considering circumstances applying specifically to Powell River Salmon Society and the forestry organizations which provide funding for the water quality sampling. It is intended only for internal use by the client for the purposes for which it was commissioned and for use by government agencies regulating the specific activities to which it pertains. It is not reasonable for other parties to rely on the observations or conclusions contained herein.

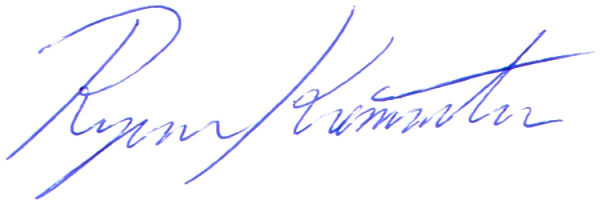
Statlu prepared the report in a manner consistent with current provincial standards and on par or better than the level of care normally exercised by Professional Geoscientists and Professional Agrologists currently practicing in the area under similar conditions and budgetary constraints. Statlu offers no other warranties, either expressed or implied.

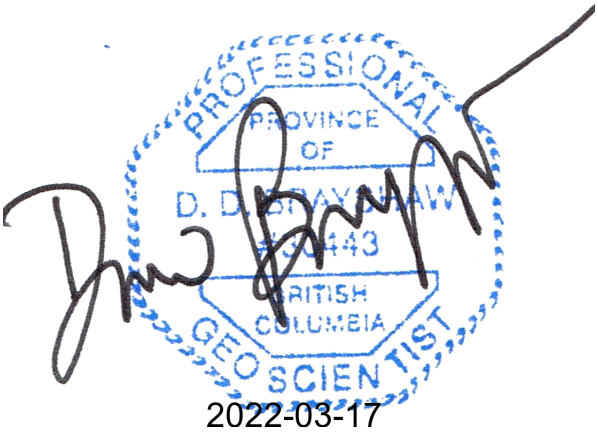
9.0 CLOSURE

Please contact me should you have any questions or if you require further clarification.

Yours truly

Statlu Environmental Consulting Ltd.





Prepared by:

Ryan Kremsater, M.Sc., GIT

Geoscientist

Reviewed by:

Drew Brayshaw, Ph.D., P.Geo.

Senior Hydrologist and Geoscientist

RK/DB/jb

Permit to Practice: 1000170

REFERENCES

BC Ministry of Environment and BC Ministry of Forests, 2001. Coastal Watershed Assessment Procedure Guidebook. Second Edition, version 2.1.

Burn, D.H., P.H. Whitfield, and M. Sharif, 2016. Identification of changes in floods and flood regimes in Canada using a peaks over threshold approach.

Carson, B. 2000. Watershed Assessment of Lang Creek Community Watershed, Powell River, B.C. Unpublished technical report prepared for the Watershed Advisory Committee by Carson Land Resources Management Ltd.

Carson, B. 2003. Watershed Assessment of Haslam Lake Lang Creek Community Watershed, Powell River, B.C. Unpublished technical report prepared for the Weyerhaeuser Company Ltd., Wester Forest Products Ltd., and B.C. Timber Sales.

Carson, B. 2010. Assessment of Water Quality Impacts of the Powell River Community Forest Operations within the Powell River area. Submitted to: Results Based Forest Management Ltd. Representing the Powell River Community Forest.

Carson, B. 2018. Haslam Lake Lang Creek - Water Quality and Quantity Data - Results of Monitoring Program for 2017. Unpublished technical report prepared for the Powell River Salmonid Enhancment Society.

Carson Land Resources Management Ltd, 2015. Haslam Lang Community Watershed – Coastal Watershed Assessment Procedure (CWAP) 2015 update. Unpublished technical report prepaored for Results Based Forestry Management Co. Ltd.

Environment Canada. 2021. Daily Data Report for Powell River A 2020. http://climate.weather.gc.ca/climate_data/hourly_data_e.html?hlyRange=2013-12-09%7C2019-04-29&dlyRange=%7C&mlyRange=%7C&StationID=51438&Prov=BC&urlExtension=_e.html&searchType=stnName&optLimit=yearRange&StartYear=1840&EndYear=2019&selRowPerPage=25&Line=0&searchMethod=contains&Month=12&Day=31&txtStationName=powell+river+a&timeframe=1&Year=2018

Integrated Watershed Management Plan (IWMP) Committee. 1999. Haslam Lake and Lang Creek Integrated Watershed Management Plan. Powell River.

Sentinel Hub, 2021. https://www.sentinel-hub.com/explore/sentinelplayground/

Statlu Environmental Consulting Ltd., 2020. Watershed Assessment – Haslam Lake and Lang Creek, Haslam Lang Community Watershed. Statlu Project #17-183.

Statlu Environmental Consulting Ltd., 2020. Water Quality Report for 2019, Haslam Lang Community Watershed. Statlu Project #20-103

Statlu Environmental Consulting Ltd., 2019. Waters Quality Report for 2018, Haslam Lang Community Watershed. Statlu Project #19-110

Wang T., A. Hamann, D. Spittlehouse, and C. Carroll. 2016. Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. PLoS ONE 11(6): e0156720. doi:10.1371/journal.pone.0156720. http://www.climatewna.com/help/ClimateBC/Help.html

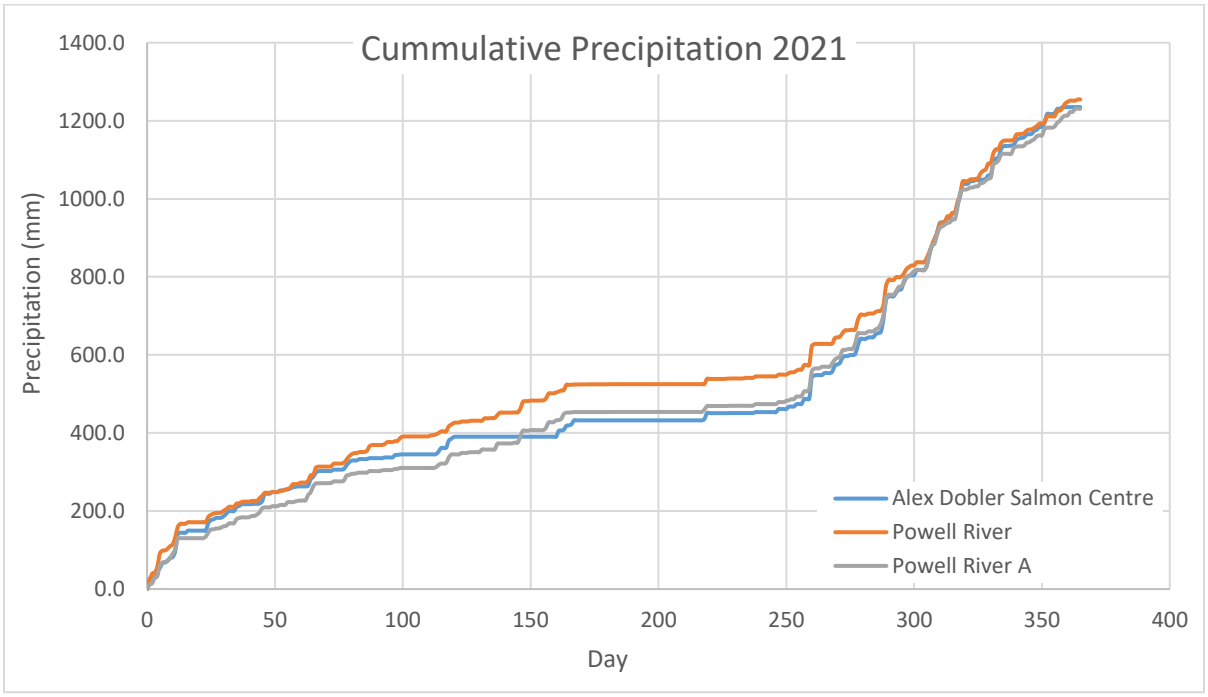
statlu
ENVIRONMENTAL CONSULTING

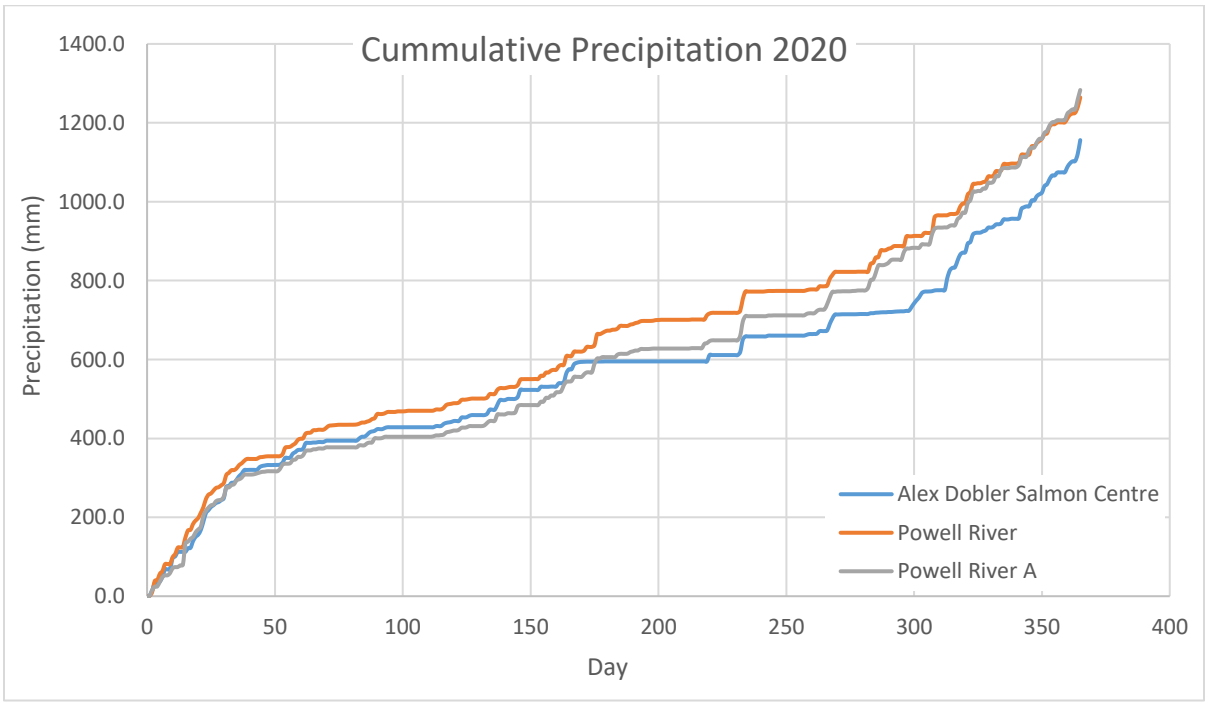
Figure 1: Monitoring Stations within Haslam Lang Community Watershed

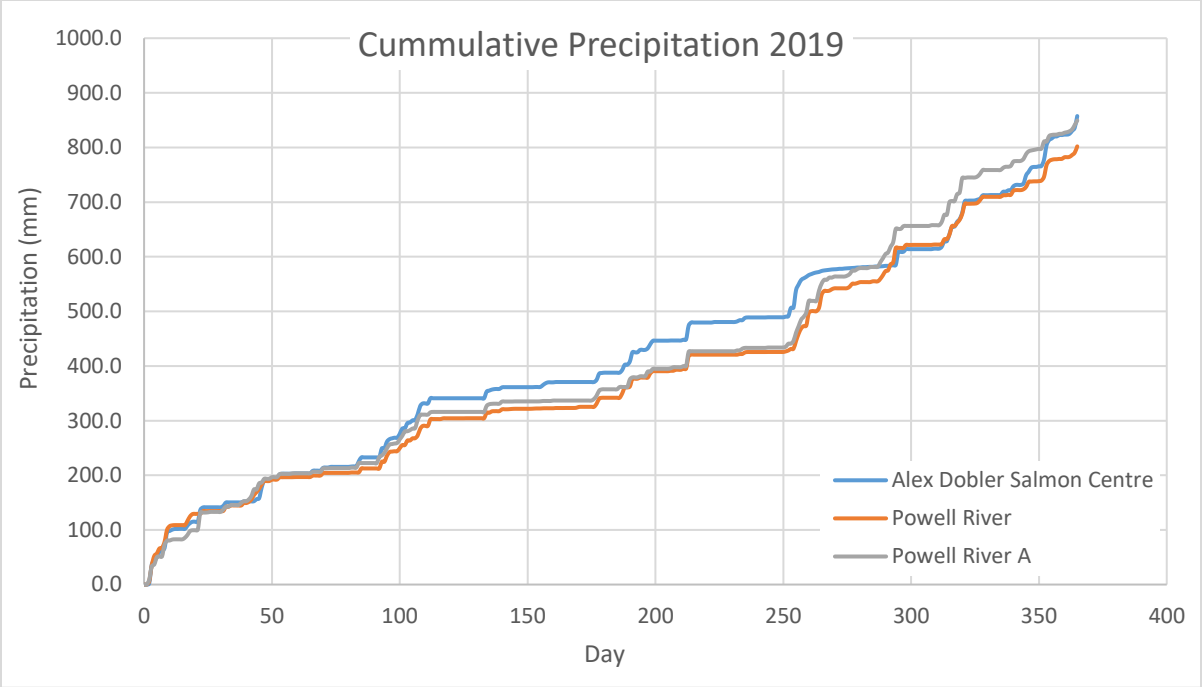
1:100,000

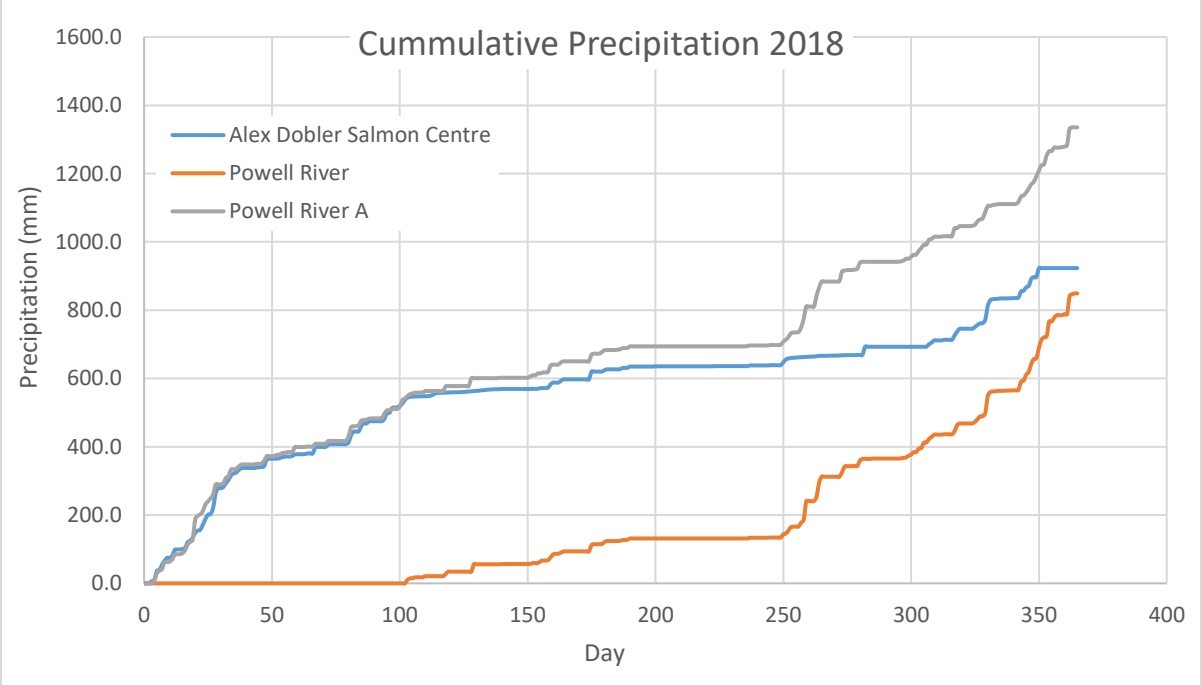
Client: PRSS
Date Saved: Mar 15, 2022
Project Number: 22-103

APPENDIX 2: CUMMULATIVE PRECIPITATION GRAPHS






Cummulative Precipitation 2019
Precipitation (mm)
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0
50
100
150
200
250
300
350
400
Day
Alex Dobler Salmon Centre
Powell River
Powell River A


Cummulative Precipitation 2018
Precipitation (mm)
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
0
50
100
150
200
250
300
350
400
Day
Alex Dobler Salmon Centre
Powell River
Powell River A