January 2017 Carson Land Resources Management Ltd.
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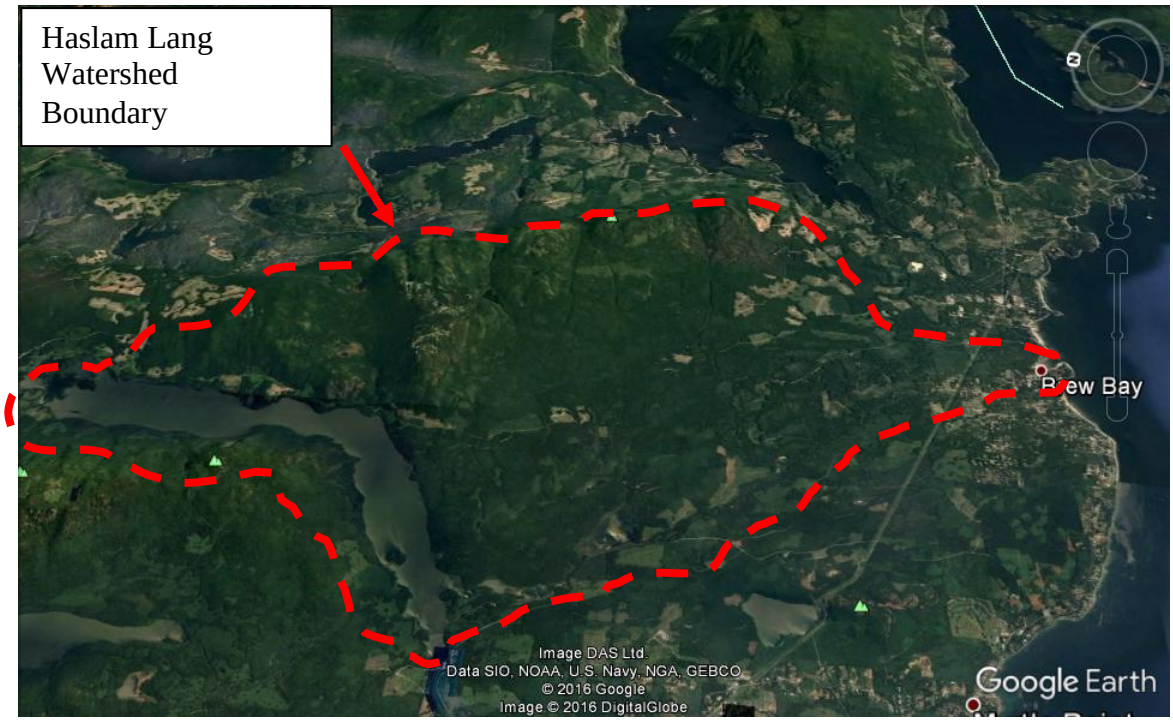
Haslam Lake Lang Creek
Water Quality and Quantity
Monitoring Program for 2016



Prepared for
Powell River Salmonid Enhancement Society
Funded by BC Timber Sales and
the Powell River Community Forest

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Submitted by

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Summary

British Columbia Timber Sales and the Powell River Community Forest provide funds to the Powell River Salmonid Enhancement Society for monitoring water quality throughout the Haslam Lang Community Watershed. This report reviews 2016 data collected (as well as selected historic data to demonstrate trends) and discusses results generated by the water quality monitoring program to date.

In mid 2016, the automated monitoring station located at the Salmon Enhancement Society Counting Station at the mouth of Lang Creek was upgraded with new sensors and a more sophisticated reporting framework. The site continues to record stage, rainfall, and water and air temperature on a continuous basis (15 min intervals). These have been made available on line on a monthly basis. Turbidity measurements have been dropped because of poor performance of sensors and high cost in maintenance.

Bi-monthly, on-site sampling conducted by Salmon Enhancement Society staff has continued at six strategic locations within the watershed throughout the 2016 season. This data has been evaluated taking into account all of the 1998 to 2016 data and provides an excellent historic record of variability of water quality parameters. Nineteen years of data collection does not show any significant difference or recognizable trends in water temperature at critical locations within the watershed.

In addition to bi-monthly monitoring, continuous water temperature recorders have been employed in 2016 on Anderson Creek, Blackwater Creek and at the hatchery on upper Lang Creek. This data is also of high quality and records minor temperature fluctuations during the critical maximum water temperatures of midsummer. Stage- discharge measurements were conducted at the low level of stream flow (<1 m^3/sec) to refine the existing stage discharge curve need to build the annual hydrograph.

The data collected over 2016 supports the general conclusion that, although there have been considerable forestry operations under way in 2016, these did not have a measurable negative impact on water quality at either Haslam Lake or Lang Creek drinking water intakes or SES intakes on Lang Creek. The water temperature data collected along Anderson Creek shows no recognizable trend over the past 19 years in spite of accelerated harvesting activity in that sub-basin.

For the forest industry, the measured absence of negative water quality impacts is crucial for supporting their working presence in a community watershed. The water quality monitoring program provides invaluable management information for watershed planners and should be continued.

The tables and figures presented in this report represent just a small portion of the total data set collected under this monitoring program. All digital data is archived by the Powell River Salmonid Enhancement Society and is freely available to interested parties. This report will be made available on line at www.prsalmon.org

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I. INTRODUCTION

British Columbia Timber Sales and the Powell River Community Forest have provided on going support to the Powell River Salmon Enhancement Society in 2016 with funds to monitor water quality within the Haslam Lang Community Watershed. The purpose of water quality monitoring is to:

- provide information for resource management planning and decision making at the community and regional level;
- establish baseline levels in support of specific criteria/objectives development and attainment reporting;
- provide information on the status, health, trends and uses of water resources; and
- employ and train persons from local communities to foster interest and involvement in community watersheds.

This report presents only a brief summary of the Water Quality data.

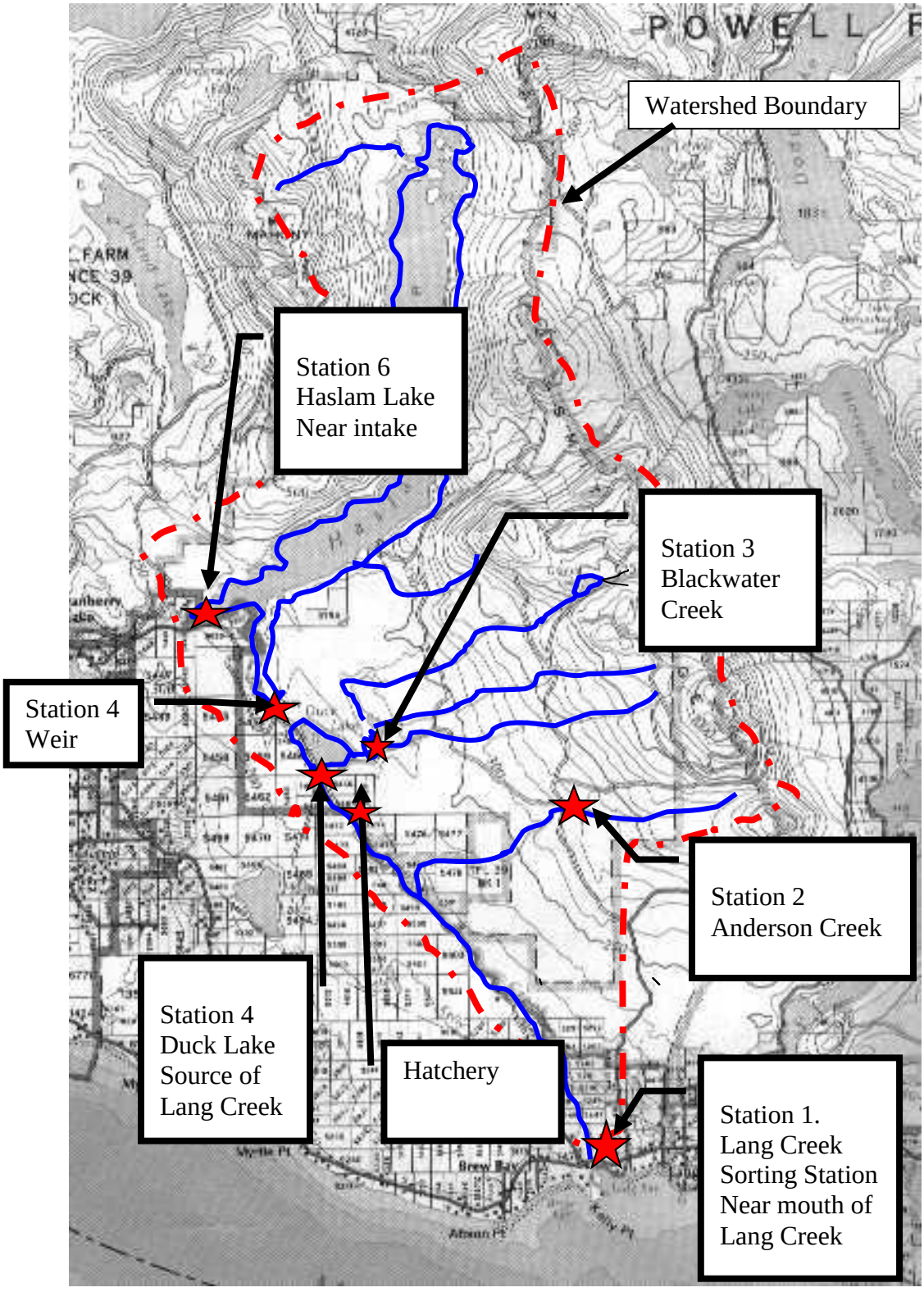
II. METHODOLOGY

The sites chosen for water sampling (as listed in Table 1) are similar to those developed in the original program and are located on the map on Figure 1.

Table 1. Schedule for Monitoring Sites

Station	Sampling Interval	Sampling For
Station 1 Lang Creek Sorting Station Provincial Identification Number E220912	Continuous Bi-monthly	Water temperature, stage, air temperature, and rainfall. Portable meter to check on continuous recorders.
Station 2 Anderson Creek Provincial Identification Number (4 km upstream of E220913)	Continuous Bi-monthly	Water temperature. Portable meter for turbidity, pH, specific conductivity, temperature and stage.
Station 3 Black Water Creek Provincial Identification Number E220914	Continuous Bi-monthly	Water temperature. Portable meter for turbidity, pH, specific conductivity, temperature and stage.
Station 4 Outlet of Duck Lake Provincial Identification Number E220915	Bi-monthly	Portable meter for turbidity, pH, specific conductivity, temperature, and lake level.
Station 5 Upper Lang Creek Hatchery	Continuous	Water temperature.
Station 6 Haslam Lake (near intake)	Bi-monthly	Portable meter for turbidity, pH, specific conductivity, temperature and lake level.

Figure 1. Location of Monitoring Stations within Haslam Lang Community Watershed



III SAMPLING PROCEDURES

A. Analysis using portable meters

Bi-monthly analysis of water temperature, pH, turbidity and salinity were conducted using portable meters. Before sampling, the meters were calibrated with standard solutions following directions supplied by the meter manufacturers.

B. Automated samplers

Automated stage,water and air temperature and rainfall recorders have been reinstalled at the mouth of Lang Creek (Sorting Station). It is now possible to download stage and water quality data directly from the PRSES website. Automatic temperature recorders are located at the Hatchery and on Anderson and Blackwater Creeks. They sample at 15 minute intervals and are downloaded either once or twice a year.

IV. RESULTS AND DISCUSSION

Results and discussion of data collected during the course of the monitoring program are presented below. Some water temperature data was collected at 15 minute intervals, others hourly, over the whole year. Portions of the original digital data used to develop the figures and tables shown in the report whereas the whole database is archived at the office of the Powell River Salmon Enhancement Society office as excel spreadsheets and graphs.

A. Water Quality

1. Turbidity measurements with portable meter

Turbidity events throughout the Haslam Lang Watershed are episodic and easily missed with spot sampling. However, given the technical difficulties of acquiring good continuous turbidity data, a sufficient number of spot recordings provide an indication of the range of turbidity events that can be expected at any given location. Now that we have more than 3,270 samples taken at 6 sites over 19 years we are able to characterize water quality characteristics and trends with a considerable degree of accuracy.

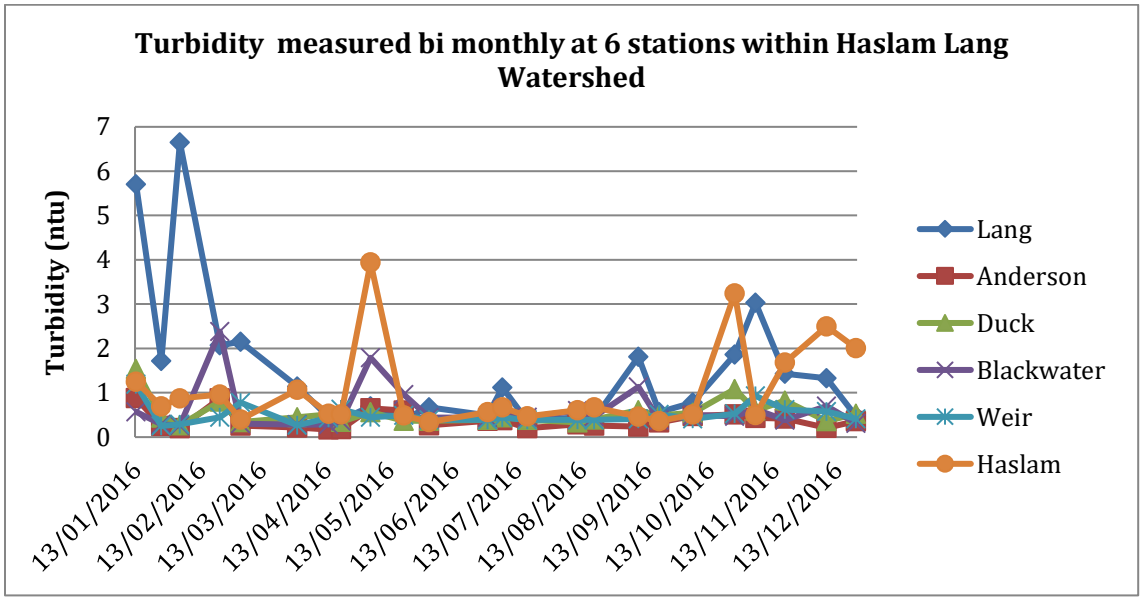
Table 2 shows turbidity data collected in 2016 at 6 sites and flags those with a turbidity in excess of 1 NTU. Turbidities in excess of 1 ntu occurred 12 times out of 24 samples on lower Lang Creek whereas they occurred only 2 times at the outlet of Duck Lake. Anderson, the primary tributary flowing directly into the Lower Lang Creek had no measured turbidity events during the same period. The only 2 turbidity events in excess of 5 ntu in 2016 were rcorded on lower Lang Creek. The reader should be aware that occasionally much higher turbidity readings have likely occurred, particularly on lower Lang Creek but remained unrecorded by the bimonthly sampling. This is unavoidable in the absence of a working automated turbidity recorder.

Table 2. Turbidity Values for Bi-monthly samples taken in 2016 (>1 NTU highlighted in yellow, >5 ntu in red font)

Date	Lang	Anderson	Duck	Blackwater	Weir	Haslam
January-13-16	5.7	0.88	1.54	0.57	1.19	1.25
January-25-16	1.72	0.25	0.44	0.29	0.25	0.69
February-03-16	6.65	0.2	0.27	0.26	0.29	0.87
February-22-16	2.07	0.87	0.8	2.38	0.45	0.96
March-03-16	2.15	0.26	0.34	0.3	0.78	0.4
March-30-16	1.14	0.22	0.45	0.28	0.27	1.07
April-14-16	0.45	0.17	0.51	0.28	0.43	0.53
April-20-16	0.39	0.18	0.35	0.36	0.63	0.51
May-04-16	0.69	0.65	0.56	1.79	0.45	3.94
May-20-16	0.41	0.6	0.37	0.96	0.49	0.49
June-01-16	0.67	0.27	0.37	0.44	0.39	0.34
June-29-16	0.49	0.37	0.39	0.44	0.39	0.56
July-06-16	1.12	0.38	0.45	0.62	0.44	0.67
July-18-16	0.36	0.2	0.39	0.45	0.39	0.47
August-11-16	0.45	0.29	0.33	0.6	0.39	0.61
August-19-16	0.42	0.26	0.4	0.46	0.39	0.67
September-09-16	1.81	0.24	0.61	1.13	0.41	0.46
September-19-16	0.56	0.33	0.49	0.38	0.51	0.36
October-05-16	0.78	0.48	0.55	0.5	0.41	0.51
October-25-16	1.86	0.51	1.08	0.47	0.53	3.24
November-04-16	3.03	0.43	0.6	0.63	0.93	0.5
November-18-16	1.43	0.42	0.82	0.38	0.62	1.68
December-08-16	1.33	0.21	0.36	0.7	0.58	2.5
December-22-16	0.47	0.36	0.53	0.31	0.41	2.01

On Figure 2 spot turbidities are provided for the 2016. At all stations, turbidity events are most common between October and March and are usually associated with heavy precipitation, overland flow and an order of magnitude greater discharge than base flow. Turbidities rarely exceed 2 NTU for all sites between Sept and March. As in previous years, the samples collected at the Haslam Lake site were taken immediately adjacent to the intake along the shoreline. These periods of elevated turbidity were associated with wave action along an unprotected shoreline during times of high lake levels. Based on Powell River's raw water sampling program, this surface turbidity is not felt at the intake.

Figure 2.



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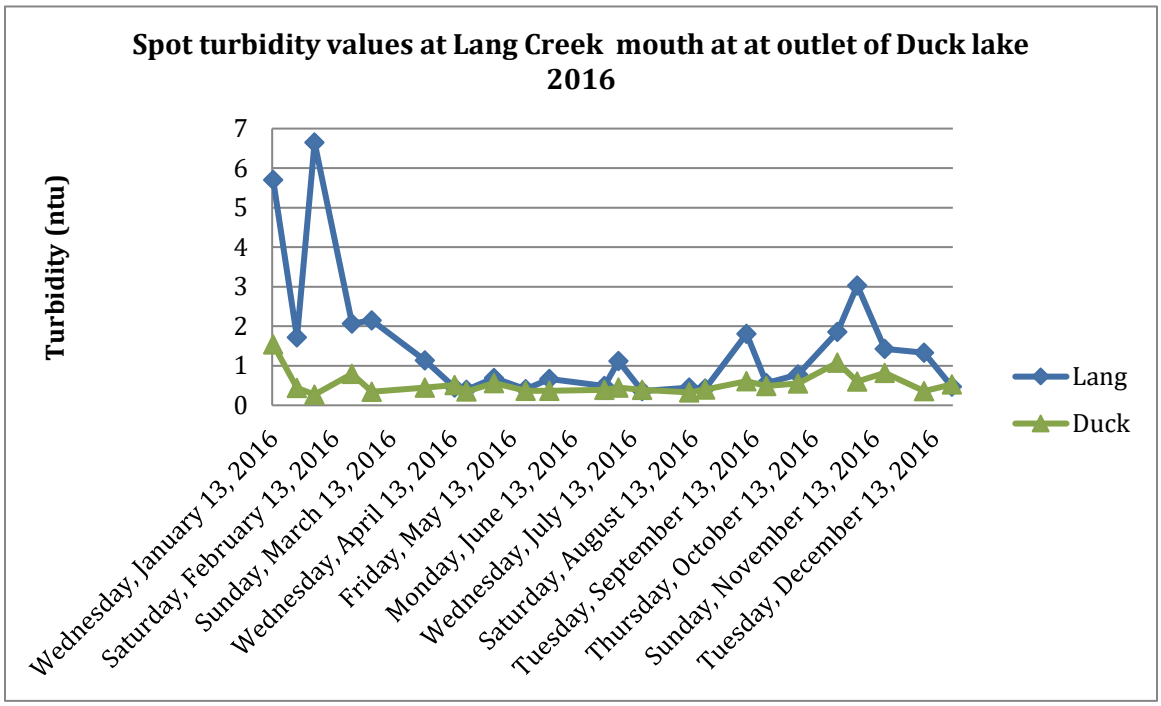
A closer look comparing spot bimonthly turbidities on upper and lower Lang Creek show the recognized major additions of fine sediment being generated along the stream banks of Lang Creek. In 2016 the largest turbidity events on upper Lang (Duck Lake) were not generated from Black water Creek as in previous years. They may have been generated locally near the bFSR bridge iste itself.

Figure 3.



These major differences between lower Lang Creek and Upper Lang Creek (Duck Lake outlet) and Anderson Creek are summarized in compiling all of the turbidity events that have been sampled under this monitoring program since 1999. See Figures 4, 5 and 6 below. It is apparent that Lower Lang Creek has by far the highest proportion of higher turbidity samples. As explained this is a result of the Lang Creek river bed being incised into the the finer textured glacial and glacial lacustrine deposits on its path between DuckLake outlet and the mouth below the PRSES sorting station.

Figure 4

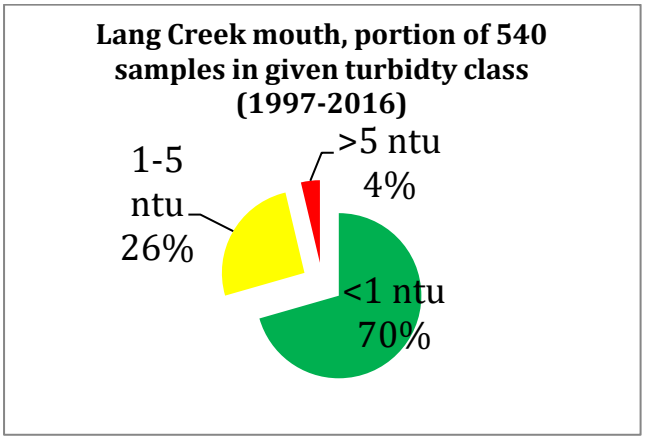


Figure 5

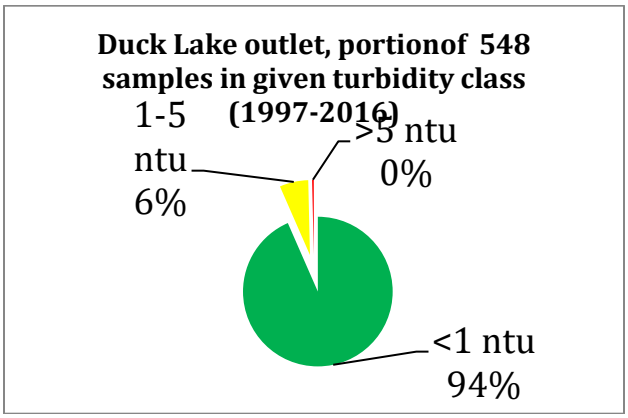
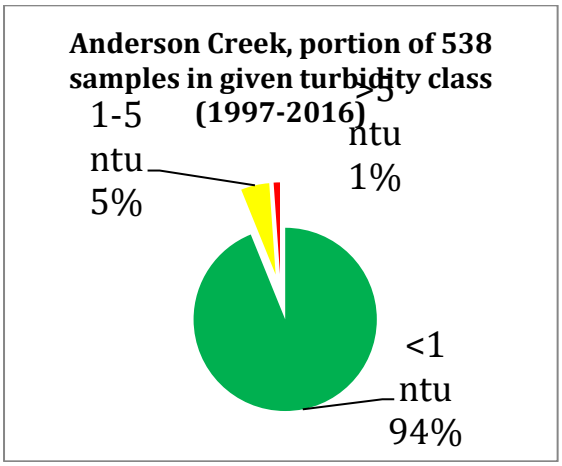


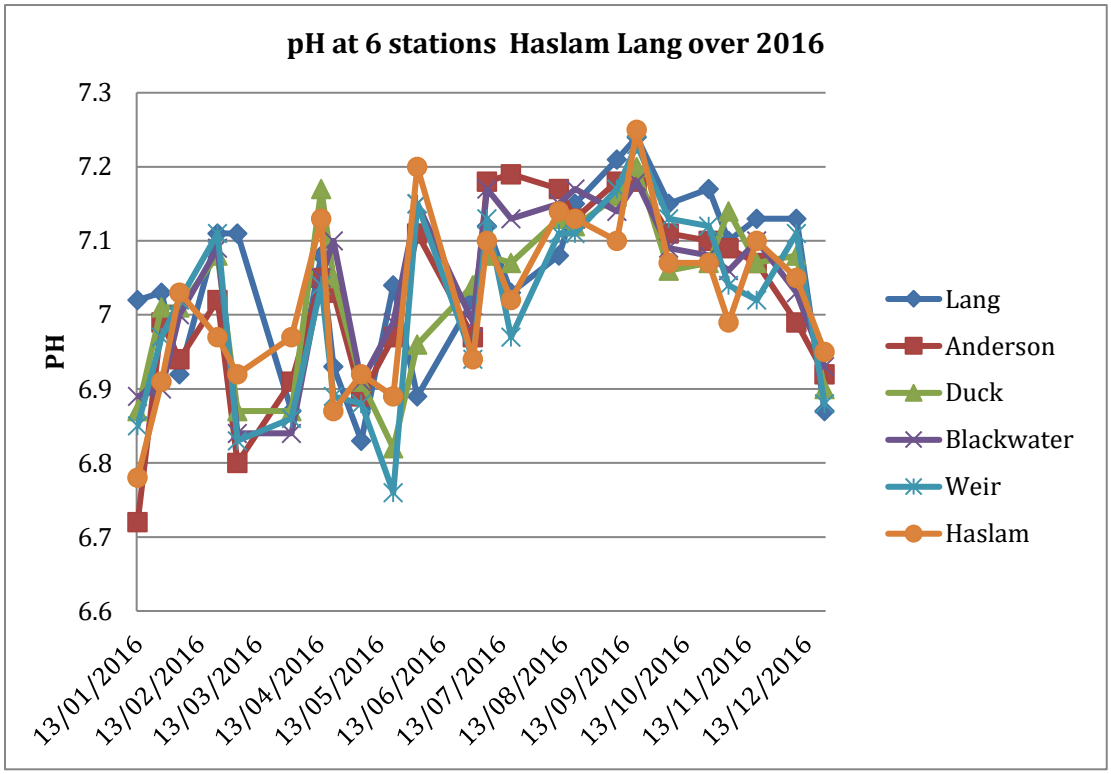
Figure 6



2. pH with Portable Meter

Figure 7 shows the variability of pH over 2016 for the 6 sampling sites within the watershed. The pH is found to be near neutral for most recorded measurements. All other factors being equal, pHs tend to be slightly higher in the summer months and lower in winter and spring when groundwater (and basic salts) makes up a smaller portion of the discharge.

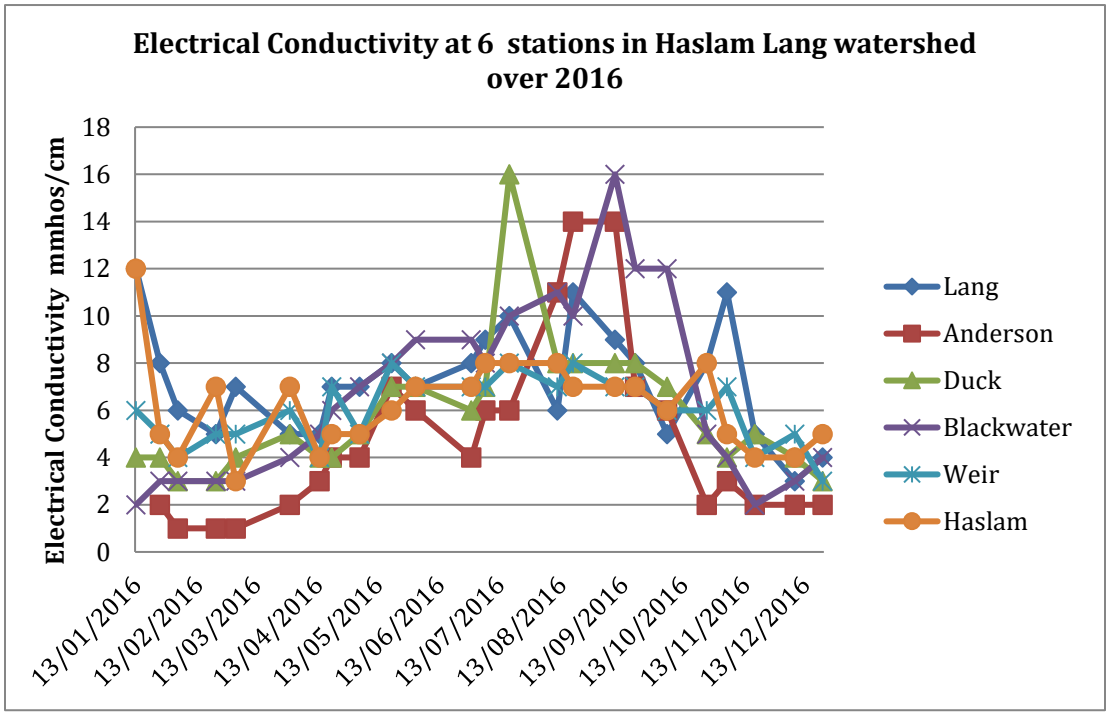
Figure 7



3. Electrical Conductivity

In all sampling to date (see Figure 8), the data indicates extremely low electrical conductivity meaning that dissolved salts are available in only very low concentrations throughout the watershed. The slightly higher E.C. measure in summer at Duck Lake, Anderson Creek and Blackwater Creek might possibly be related to slightly higher ground water inputs and the nature of the Duck Lake Forest road surface that has occasionally been dust- treated in the past.

Figure 8



B. Water Temperature Monitoring Results

1. Bi-monthly Manual collection from 6 sites within the watershed

Figure 9 shows the bi monthly water temperature taken at 6 sites over 2016. It has a similar pattern with the water temperature data taken from the previous 5 years shown on Figure 10. Highest summer temperatures of (>23 ° C) are recorded at the surface of lakes, (Haslam, Slough, Duck) lowest summer temperatures from small streams under forest cover (Anderson and Blackwater Creek) and intermediate summer temperatures on streams where warmer lake water is cooled as it flows through forested riparian zone (Lang).

Figure 9.

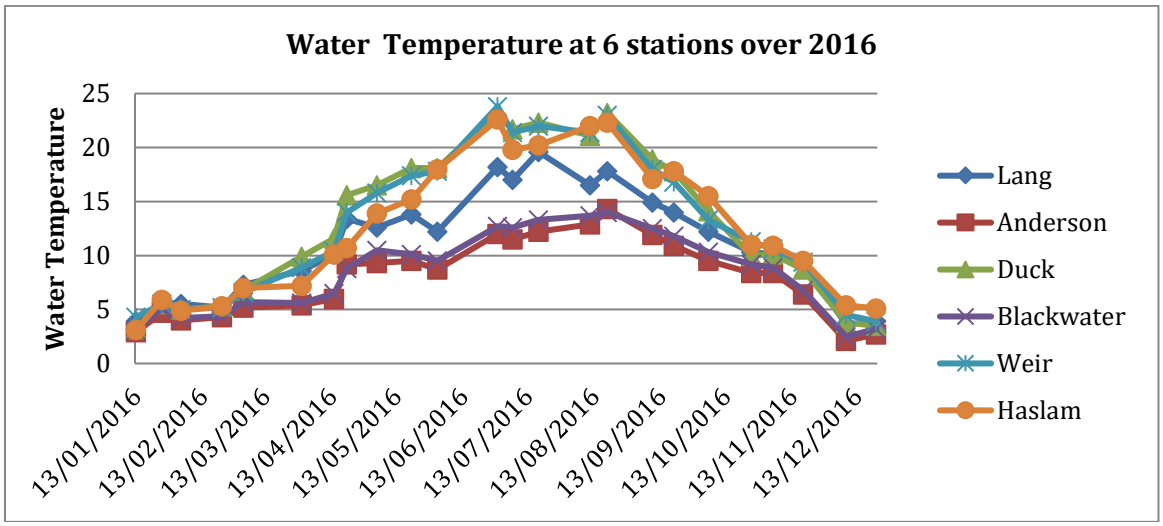


Figure 10

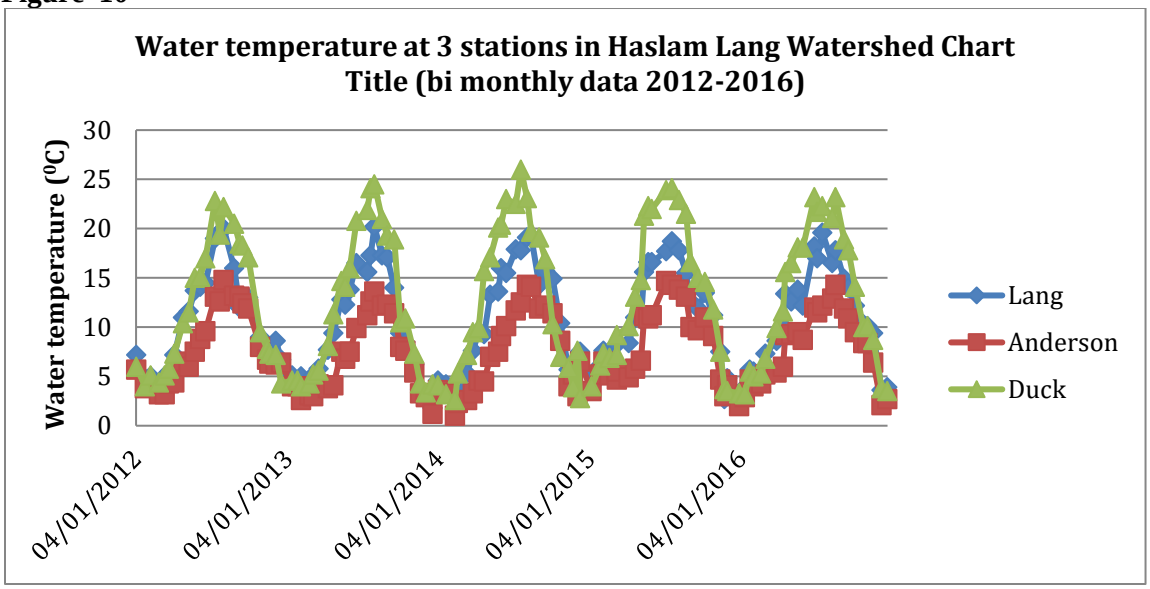


Figure 11 and 12 show cumulated data taken bimonthly over the last 19 years on Lang Creek and Anderson Creek. No noticeable trend in increasing water temperature is noted in spite of the significant harvesting that has been conducted in the watershed. This suggests that present cautionary management within and adjacent to riparian areas has been effective.

Figure 11

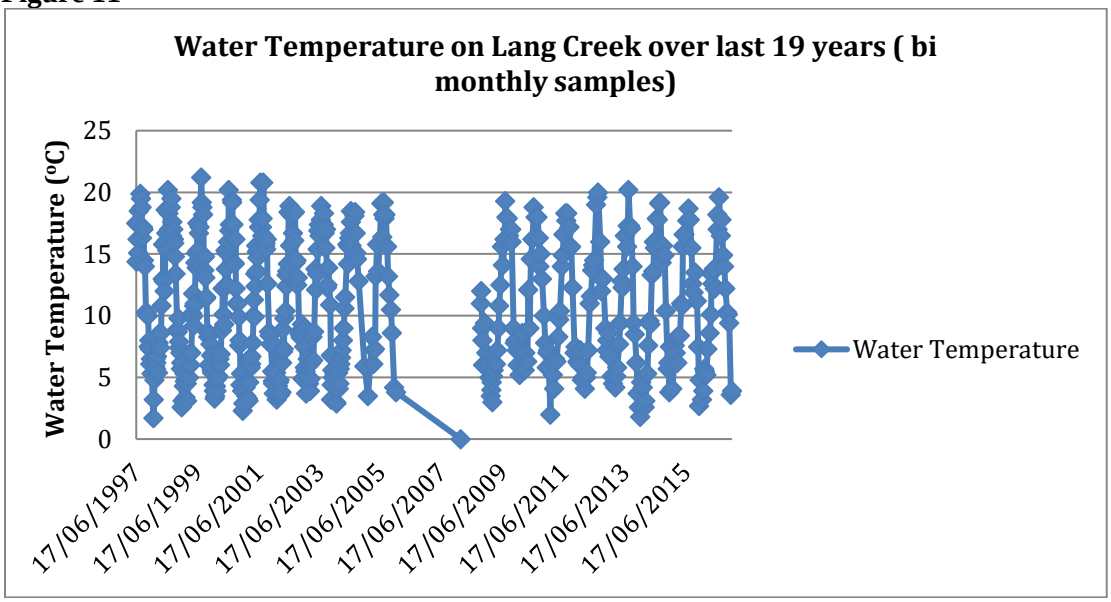
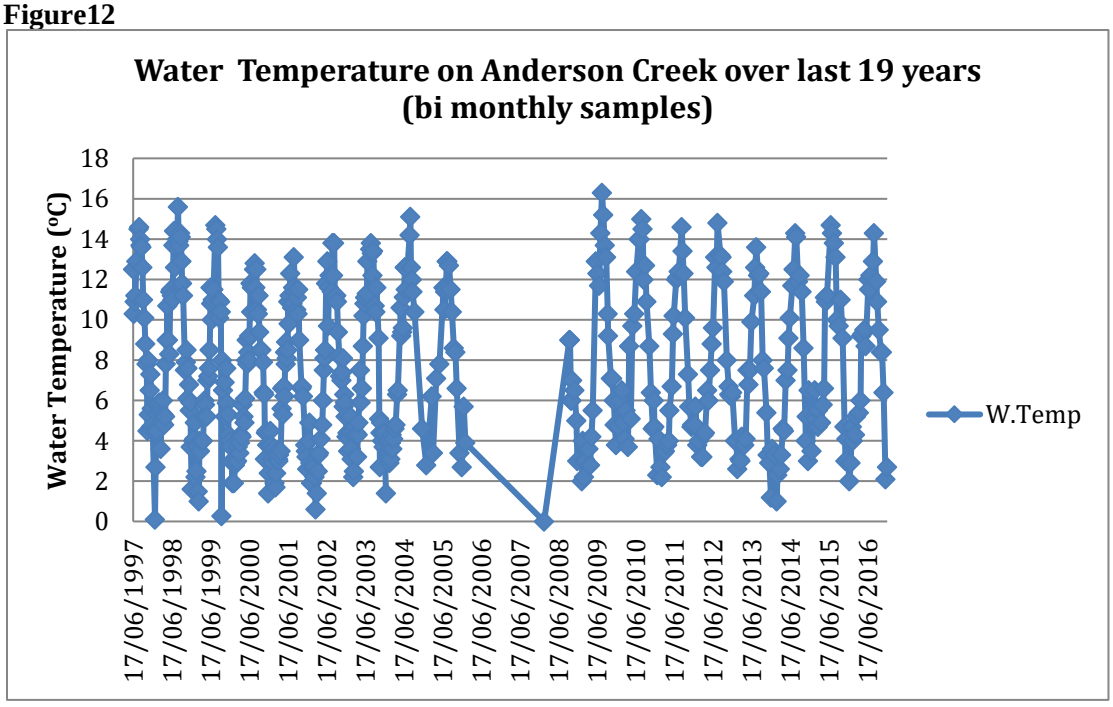


Figure12

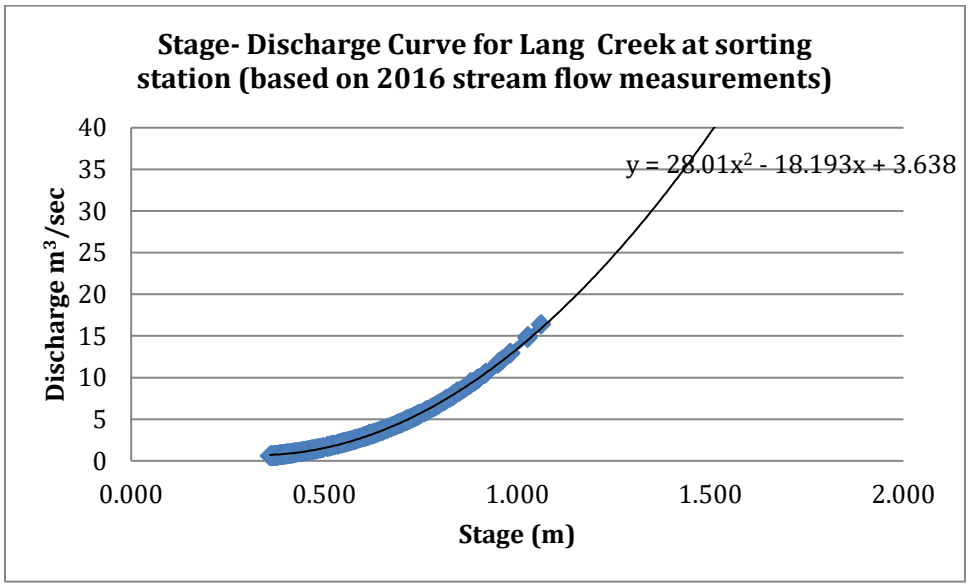


C. Water Quantity and Timing of Flows

On Figure 13 the updated stage discharge curve is presented. Low discharge flows were measured this summer to ensure the calculated discharges accurately reflect the actual discharge of Lang Creek. As there were no measurable changes to the banks inundated by higher stage levels, higher discharge levels were not included in the calibration transects. On Figure 13 the Lang hydrograph used for 2016 data is presented.

Daily changes in discharge of more than 100% are commonly recorded during winter storms. As has been discussed in previous reports, Haslam and Duck lakes create a major hydrological and water quality buffer for the majority of the watershed. Anderson Creek, being unbuffered, is a major storm water contributor during peak flows on lower Lang Creek. However, looking back on historic turbidity data, Anderson Creek almost always has much lower turbidity levels than Lang Creek. From this we can infer that a disproportionate amount of the turbidity measured at the mouth of Lang Creek is generated within Lang Creek Channel itself.

Figure 13



The 2016 hydrograph for the lower Lang Creek is presented on Figure 14. 2016 discharge on Lang Creek mirrored 2015 discharge as shown on Figure 15.

Figure 14

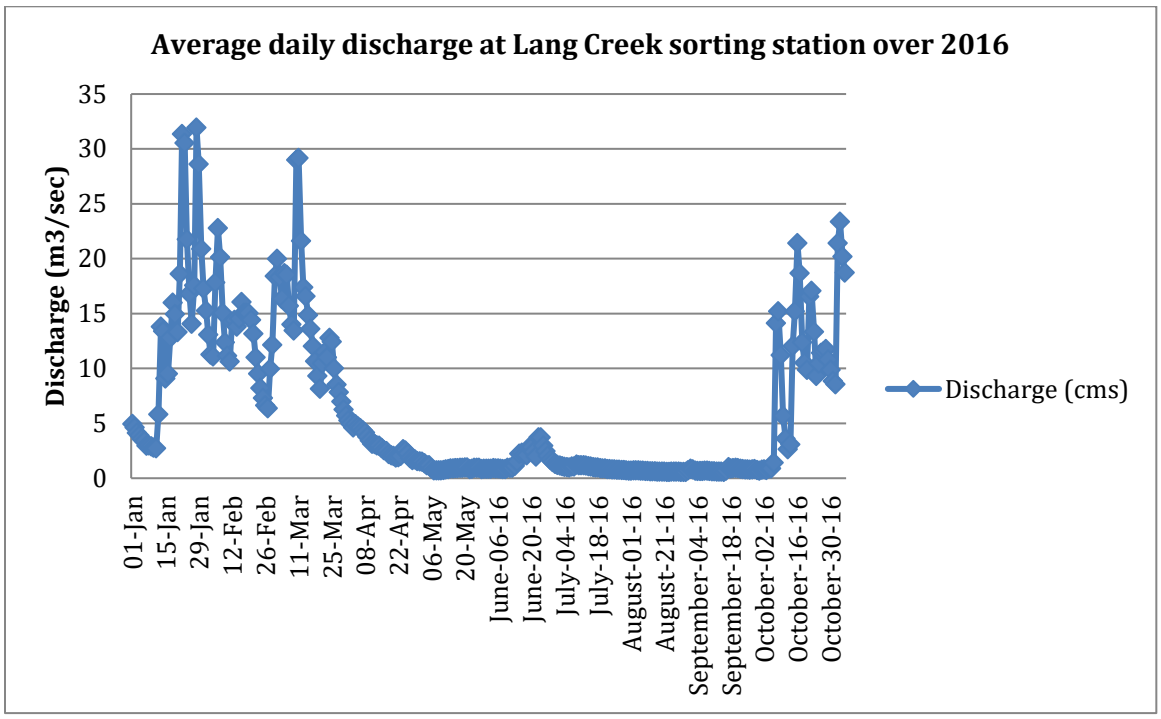
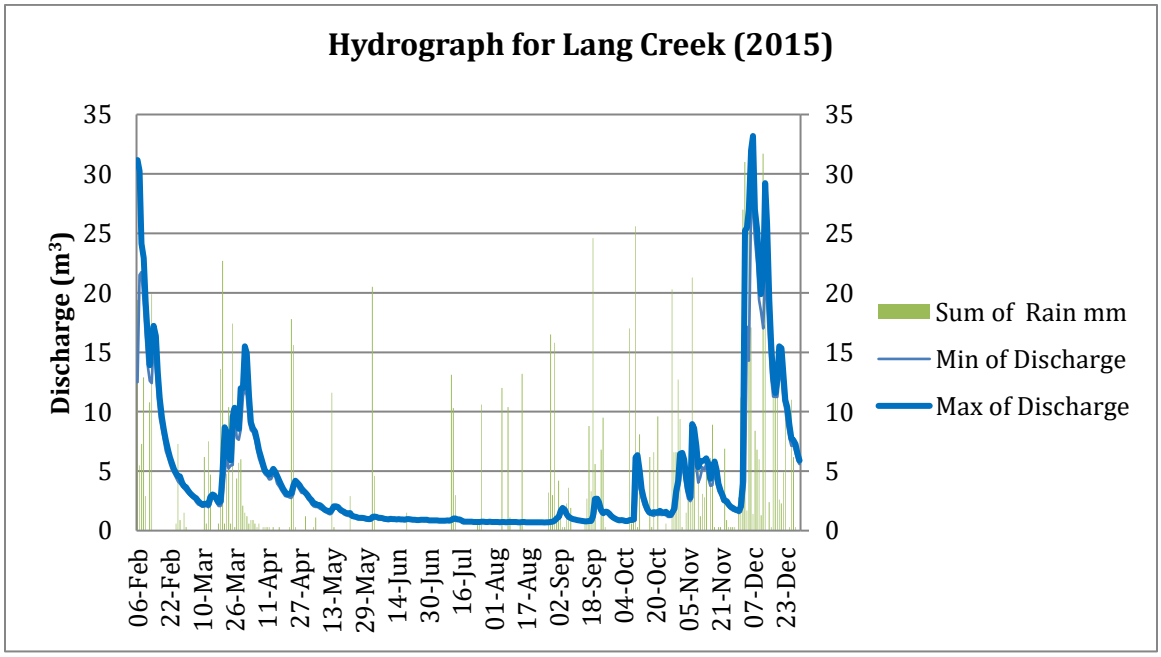


FIGURE 15



V. CONCLUSIONS AND RECOMMENDATIONS

The 2016 data collected by the Salmon Enhancement Society continues to support the general conclusion that neither water quantity nor quality has been adversely impacted by present forest harvesting operations. On going evaluation of historic data collected over the last 19 years within the Haslam drainage indicates that the watershed is capable of supplying raw water of sufficient quantity and good quality at the Haslam Lake Intake.

Some general water chenmistry analysis is recommended for summer low flow and peak autumn flow to document pH, TTS, turbidity, CaCO3 equivalent, TOC, colour, N, P, total metals and fecal coliform. These results should be compared to analysis completed between 2000 and 2010.

The Brew Bay Water Users Group and the Powell River Salmon Enhancement Society, holding the two water licenses on Lang Creek, continue to deal with the periodic natural turbidity events that characterize lower Lang Creek. It is now well documented that these turbidity pulses on Lang Creek are unrelated to any forestry triggered disturbances upstream. It is worth repeating that all water users are dependent on the weir for summer storage on Haslam Lake and maintaining summer low flow on Lang Creek. Careful management of Haslam Lake level via the Powell River city's slough weir is crucial for maintaining adequate water flow at the Brew Bay intake during late summer and early autumn.

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