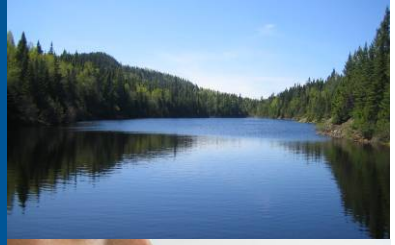




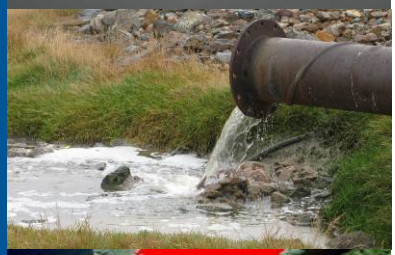


Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake/Joan Brook Network

Deployment Period
2017-09-06 to 2017-10-11

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division
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General

- The Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment and Climate Change Canada, maintains three real-time water quality and water quantity stations in close proximity to the Elross Lake Iron Ore Mine in western Labrador, near Schefferville, QC.
- The official name of each station is ELROSS CREEK BELOW PINETTE LAKE INFLOW, GOODREAM CREEK 2KM NORTHWEST OF TIMMINS 6, and JOAN BROOK BELOW OUTLET OF JOAN LAKE, hereafter referred to as the *Elross Creek Station*, the *Goodream Creek Station*, and the *Joan Brook Station,* respectively.
- Station sites were selected to monitor all surface water outflows from the Elross Lake and the DSO4 Project 2B mining sites. The Elross Creek Station is situated downstream of the Timmins 1 pit, and downstream of Pinette Lake. The Goodream Creek Station will serve to monitor potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek. The Joan Brook station is downstream of the five pits (Kivivic 1, 2, 3N, 4 and 5) which are included in the DSO4 Project 2B mining operation.
- The Water Resources Management Division will inform Tata Steel Minerals Canada Limited of any significant water quality events by email notification and by monthly deployment reports.
- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek and Joan Brook stations from September 6th, 2017 to October 11th, 2017, which was the fourth and final deployment period for the 2017 field season.

Quality Assurance / Quality Control

- Water quality instrument performance is tested at the beginning and end of its deployment period. The process is outlined in Appendix A.
- Instruments are assigned a performance rating (i.e., poor, marginal, fair, good or excellent) for each water quality parameter measured.
- Table 1 shows the performance ratings of five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) measured by instruments deployed at the water monitoring stations.
- **With the exception of water quantity data (stage height), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.

Table 1: Water quality instrument performance at the beginning and end of deployment

	Elross Creek		Goodream Creek		Joan Brook	
Stage of deployment	Beginning	End	Beginning	End	Beginning	End
Date	2017-9-5	2017-10-11	2017-9-6	2017-10-11	2017-9-6	2017-10-11
Temperature	Excellent	Excellent	Excellent	Poor	Excellent	Excellent
pH	Excellent	Excellent	Good	Poor	Fair	Good
Specific Conductivity	Excellent	Fair	Excellent	Excellent	Excellent	Good
Dissolved Oxygen	Excellent	Good	Excellent	Poor	Excellent	Excellent
Turbidity	Excellent	Good	Excellent	Excellent	Good	Excellent

- The performance of the temperature, pH and dissolved oxygen sensors at Goodream Creek was poor at the end of the deployment period. These poor readings may have been due to a faulty temperature probe on the instrument; however it appears to have worked properly for the duration of the deployment and may have only began to act up at the time of removal.
- The performance of all remaining sensors at all three stations were within acceptable limits during this deployment period (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period started on September 5th, 2017 at Joan Brook and September 6th, 2017 at Goodream and Elross Creeks. Continuous real-time monitoring continued at all three stations until October 11th, 2017. All three stations ran for the full deployment period with no operational issues.

Data Interpretation

- Data records were interpreted for each station during the deployment period for the following six parameters:

  (i.) Stage (m)
  (ii.) Temperature (^{o}C)
  (iii.) pH
  (iv.) Specific conductivity (µS/cm)
  (v.) Dissolved oxygen (mg/l)
  (vi.) Turbidity (NTU)

Stage

- **The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.
- During the deployment period covered by this report, stage height values ranged from 1.08 m to 1.19 m at Elross Creek, from 1.74 m to 2.02 m at Goodream Creek, which corresponded to a flow of 0.00 m^3/sec to 0.17 m^3/sec , and from 1.53 m to 1.87 m at Joan Brook (Figures 1, 2 and 3). Stage height is directly related to the volume of flow in a stream, as defined by a rating curve which is unique for every site.
- At Elross and Goodream Creeks there is a significant increase in Stage Height around October 8th (see inside red ovals) which corresponds with significant rainfall for the same period.

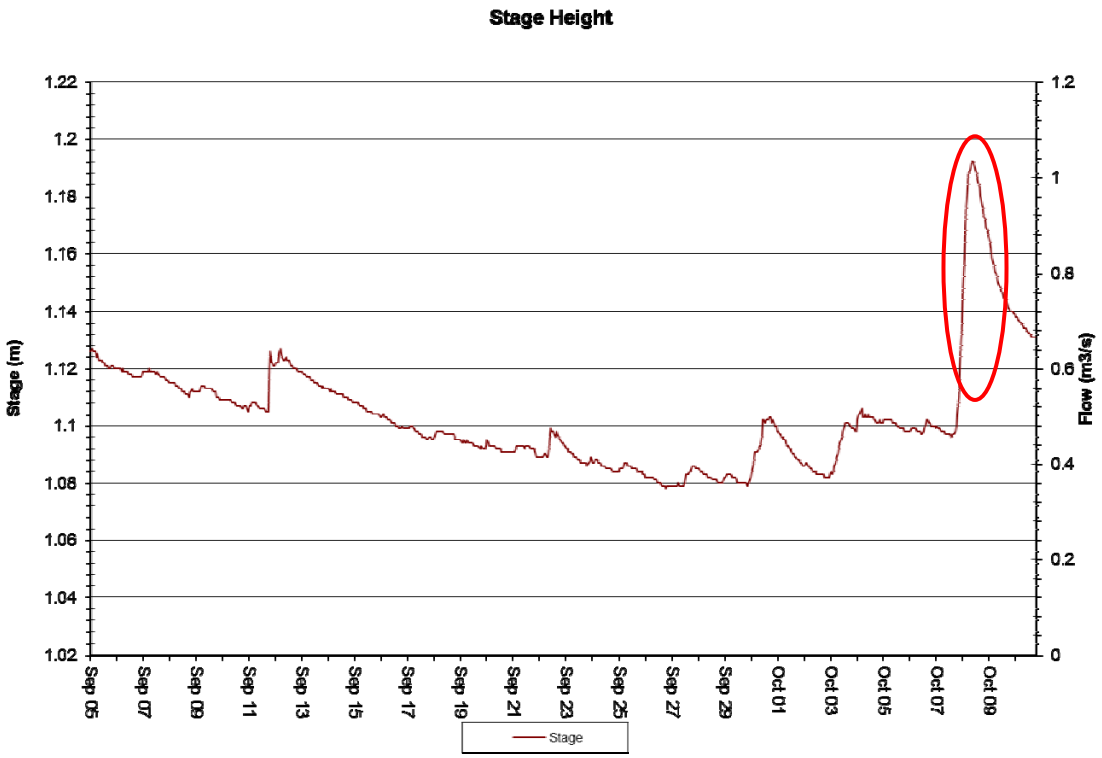

Figure 1: Stage Height (m) at Elross Creek – September 5, 2017 to October 11, 2017

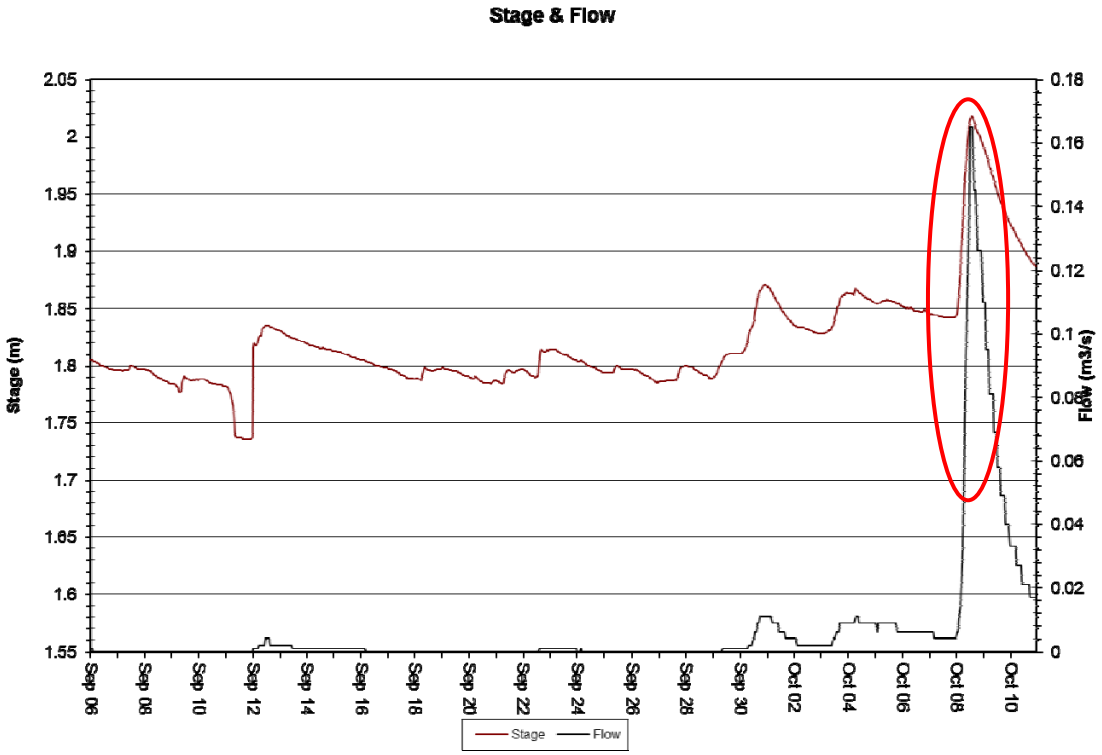

Figure 2: Stage Height (m) and Flow (m3/s) at Goodream Creek – September 6, 2017 to October 11, 2017

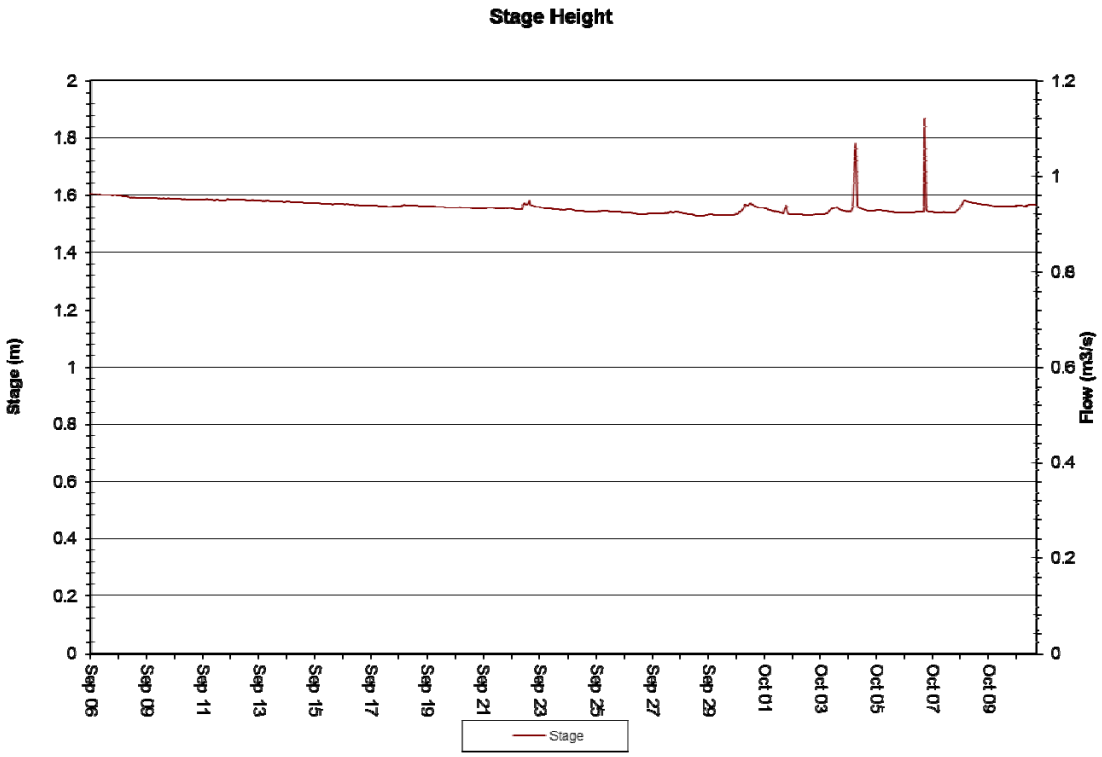

Figure 3: Stage Height (m) at Joan Brook – September 6, 2017 to October 11, 2017

Temperature

- **The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.
- During the deployment period covered by this report, water temperature ranged from 1.4˚C to 12.50˚C at Elross Creek, from 0.20˚C to 11.80˚C at Goodream Creek, and from 0.10 ˚C to 11.70 ˚C at Joan Brook (Figures 4, 5 & 6).
- All three stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- All three stations show a gently declining temperature trend which is consistent with the transition from late summer to early fall.

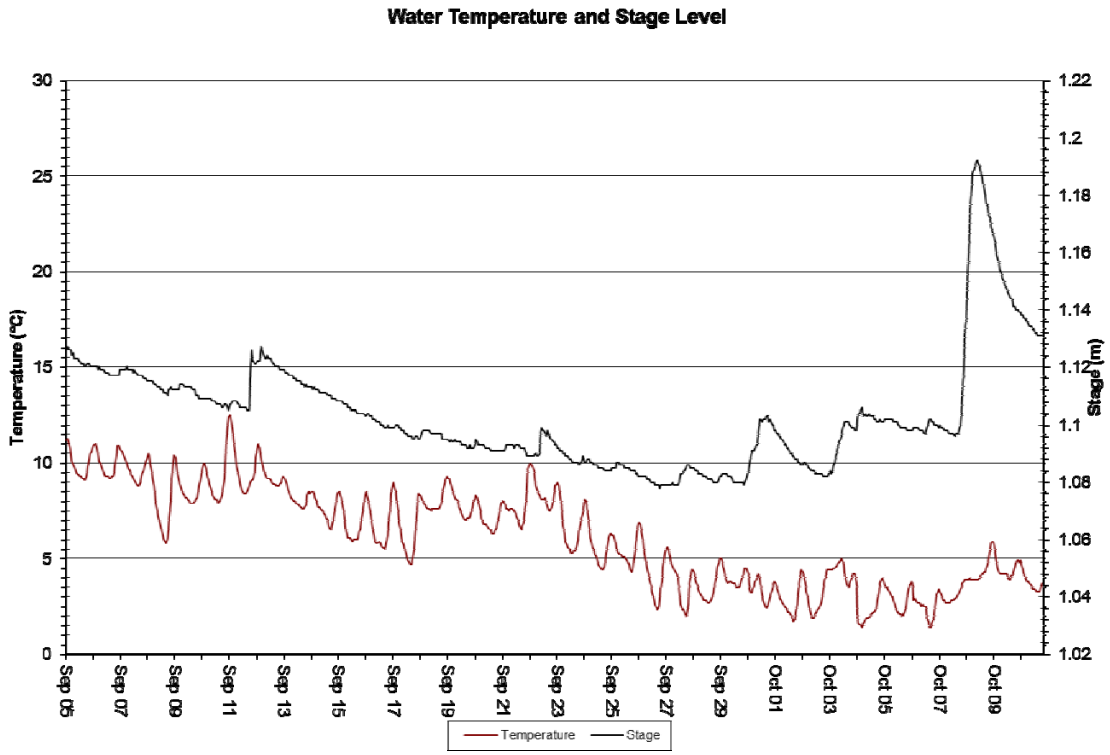

Figure 4: Temperature (°C) - Elross Creek – September 5, 2017 to October 11, 2017

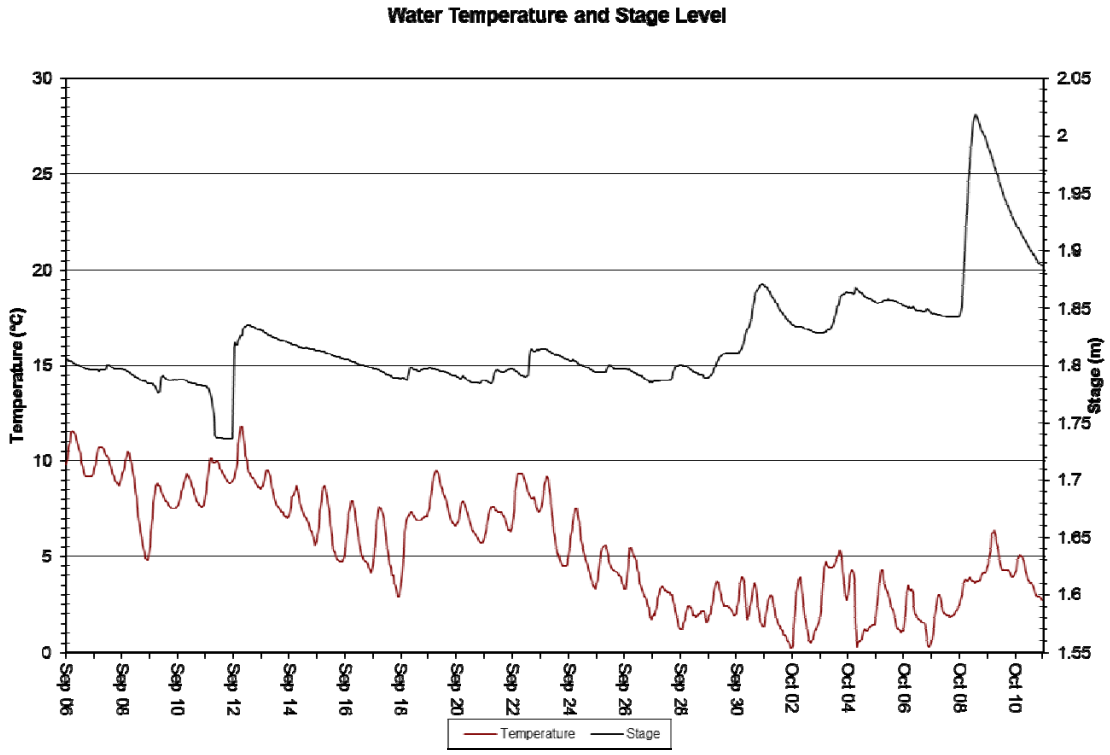

Figure 5: Temperature (°C) - Goodream Creek – September 6, 2017 to October 11, 2017

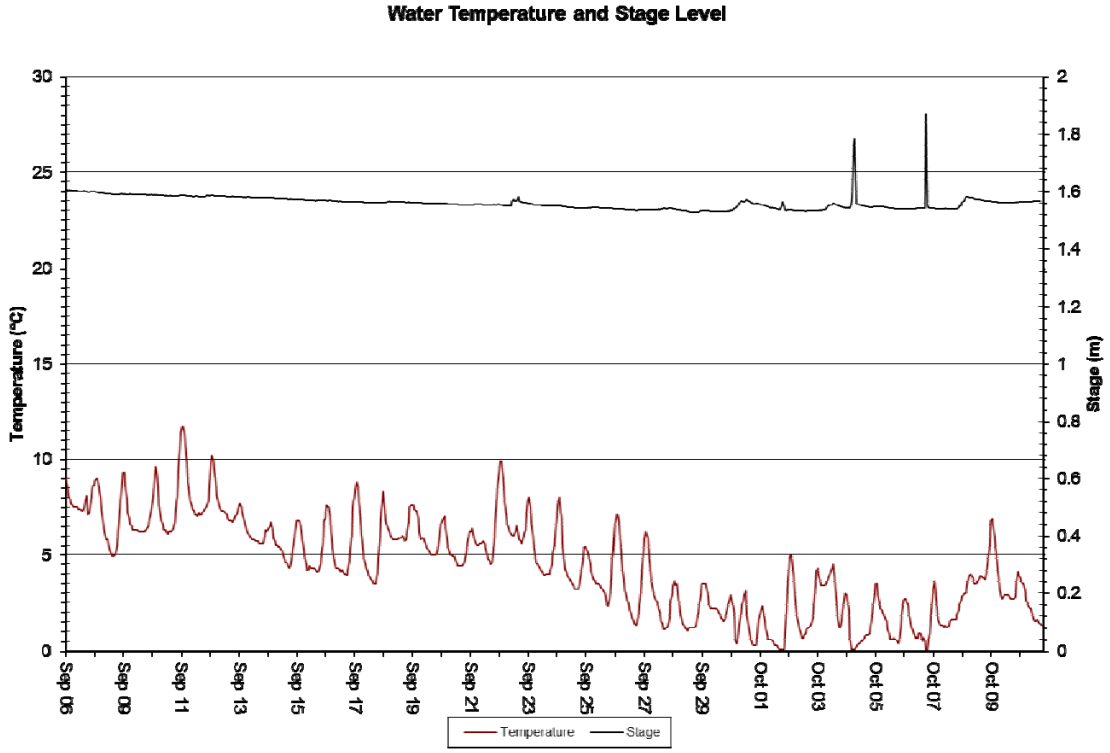

Figure 6: Temperature (°C) – Joan Brook – September 6, 2017 to October 11, 2017

pH

- **The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.
- During the deployment period covered by this report, pH values ranged from 5.90 units to 6.56 units at Elross Creek, from 5.30 units to 6.13 units at Goodream Creek, and from 6.21 units to 6.88 units at Joan Brook (Figures 7, 8 & 9).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is visible at all three stations.
- pH appears to be relatively stable at all three stations during this deployment period however during a peak in stage height around October 8th , which was caused by heavy rain, pH took a dip which was noticeable at Elross and Goodream Creeks (see inside red ovals).
- With a median value of 6.32 units, pH values at Elross Creek are very close to the minimum guideline set for the protection of aquatic life (i.e., 6.5 units), as defined by the Canadian Council of Ministers of the Environment (CCME) (2007). At Goodream Creek the median pH value is 5.93 units with all pH values below this minimum guideline range. At Joan Brook the median pH value is 6.72 units with values at, or just above, the minimum guideline range. It should be noted that acidic waters are quite common in Canada, particularly in boreal and northern ecoregions, and pH is often naturally below the 6.5 unit guideline.

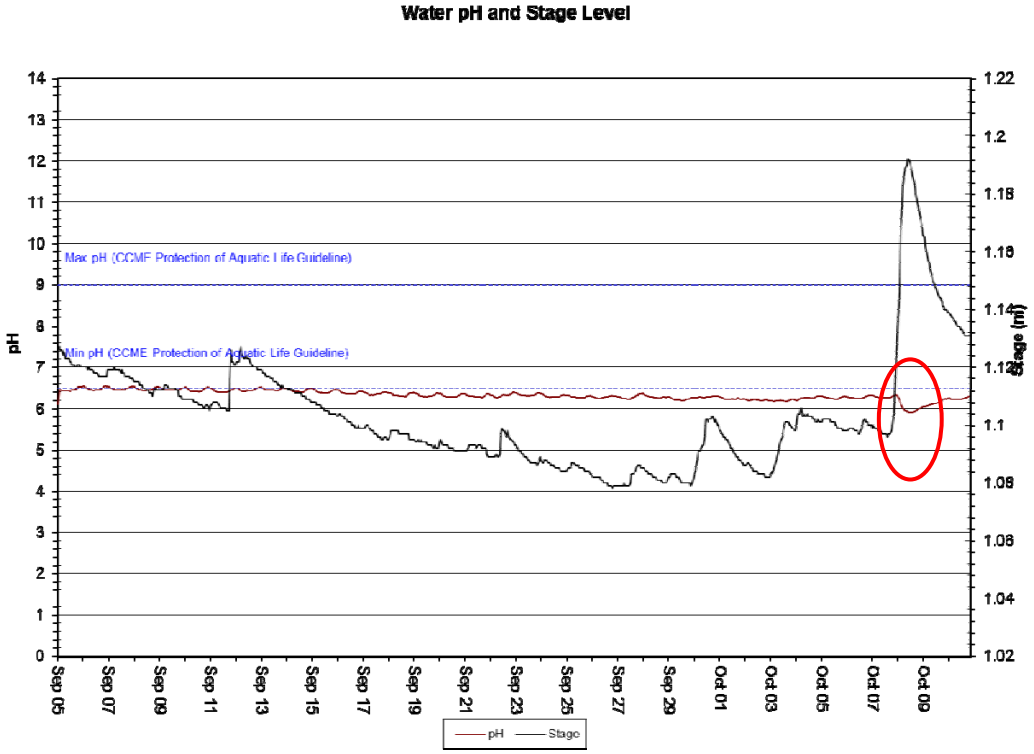

Figure 7: pH at Elross Creek – September 5, 2017 to October 11, 2017

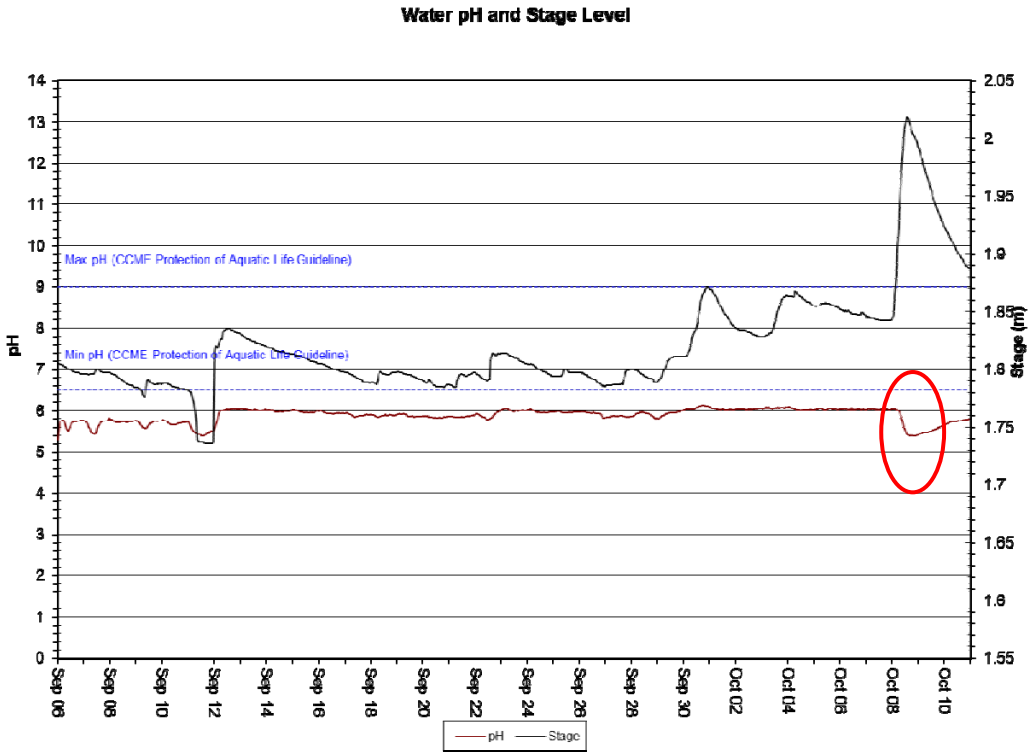

Figure 8: pH at Goodream Creek – September 6, 2017 to October 11, 2017

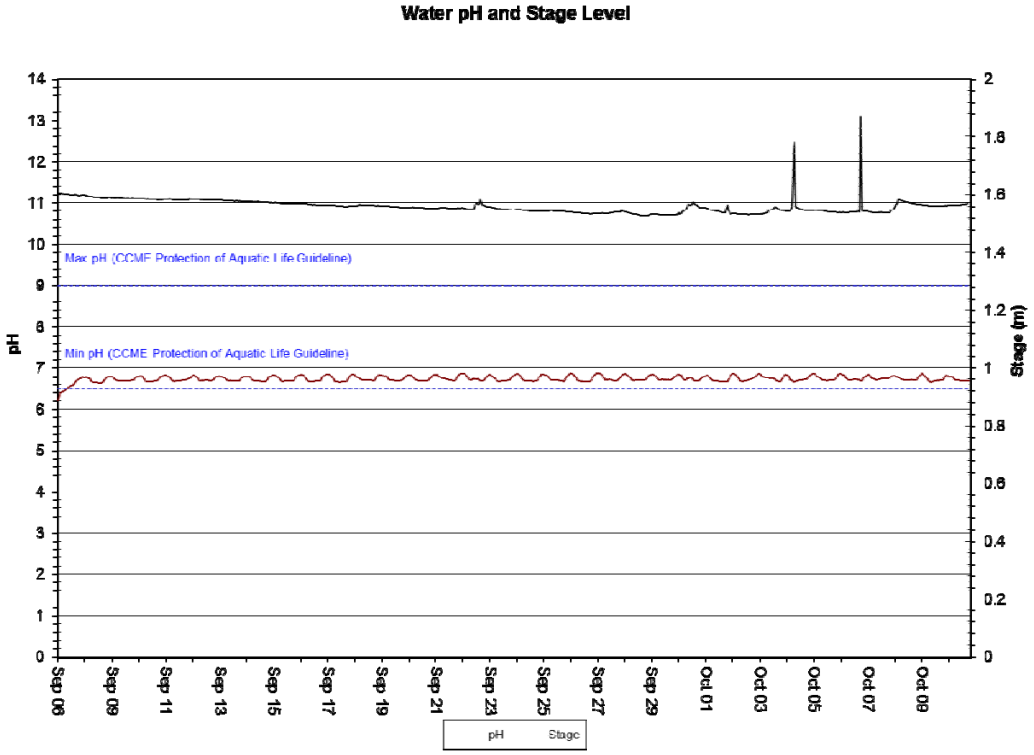

Figure 9: pH at Joan Brook – September 6, 2017 to October 11, 2017

Specific Conductivity

- **The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.
- During the deployment period covered by this report, specific conductivity ranged from 13.5 µs/cm to 21.2 µs/cm at Elross Creek, from 3.9 µs/cm to 8.9 µs/cm at Goodream Creek, and from 7.2 µs/cm to 9.3 µs/cm at Joan Brook (Figures 10, 11 & 12).
- During a peak in stage height around October 8th, which was caused by heavy rain, specific conductivity took a dip which was quite noticeable at Elross Creek (see inside red oval).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend.

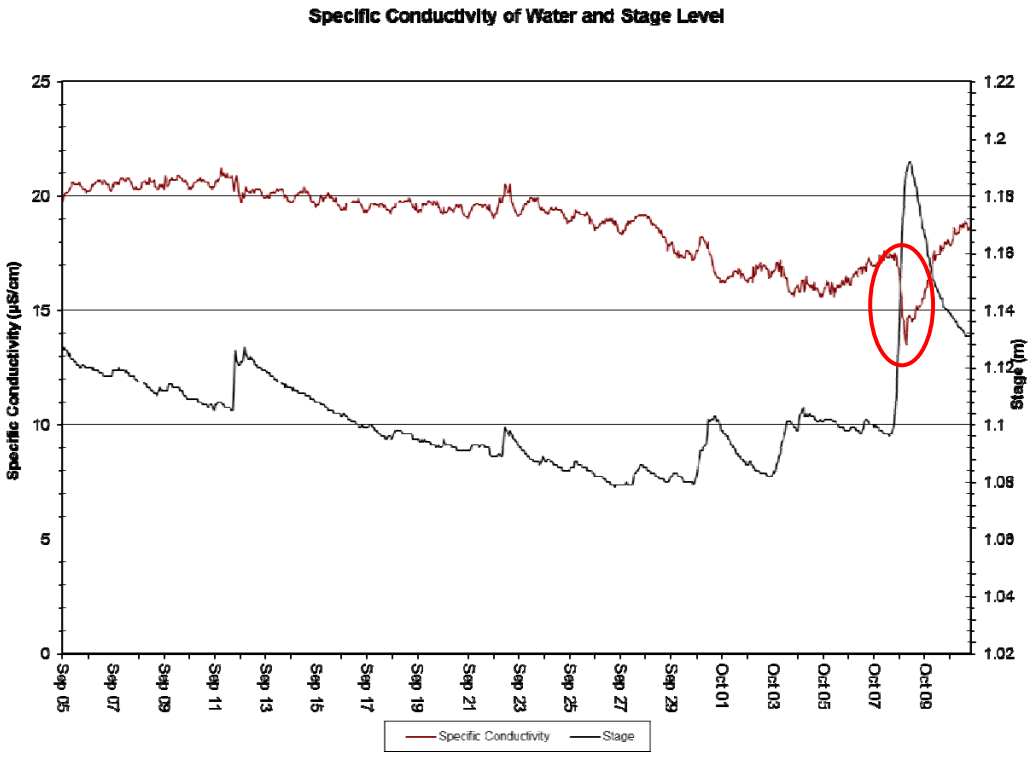

Figure 10: Specific Conductivity at Elross Creek – September 5, 2017 to October 11, 2017

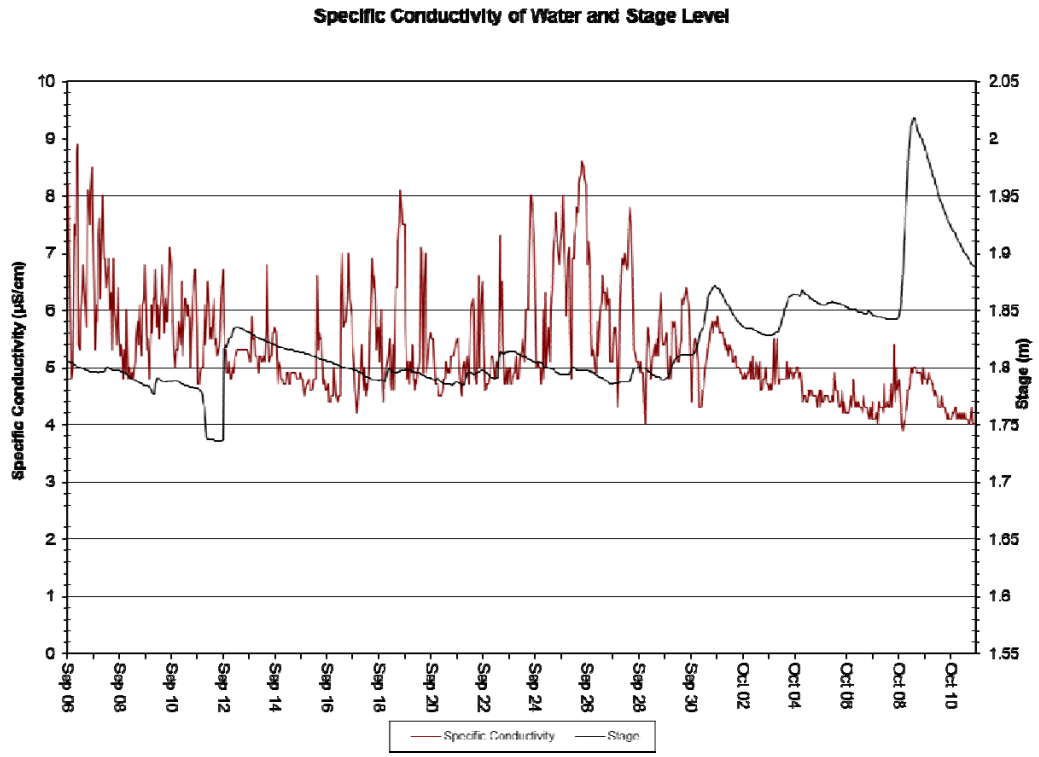

Figure 11: Specific Conductivity at Goodream Creek - September 6, 2017 to October 11, 2017

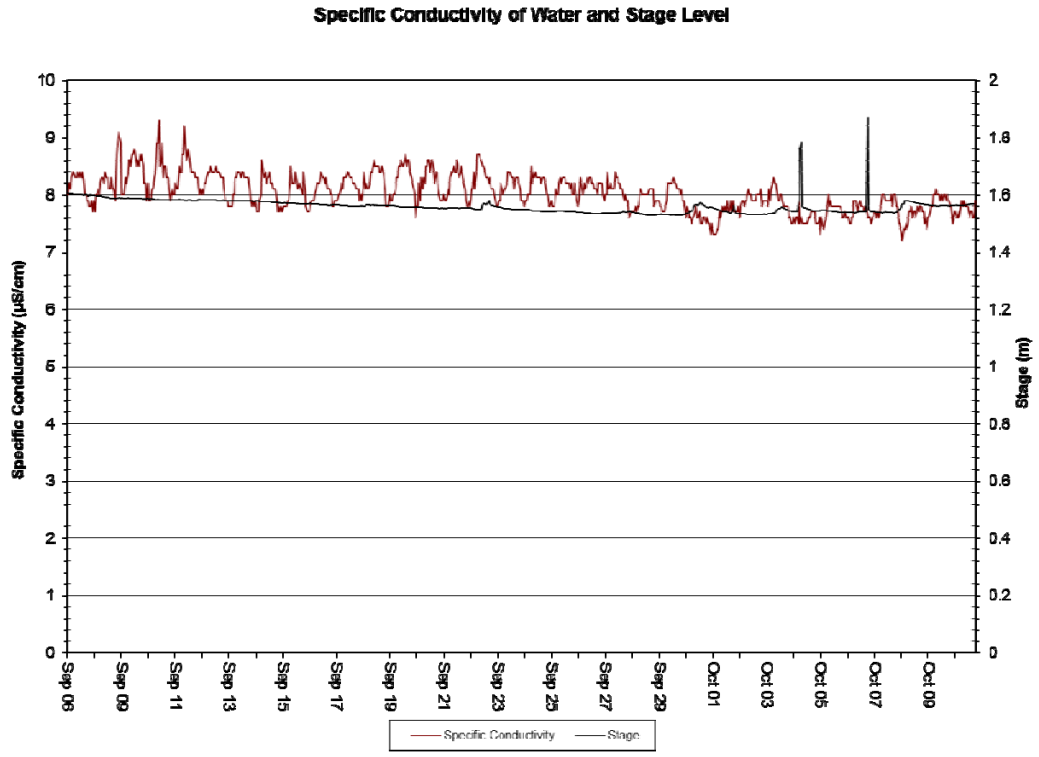

Figure 12: Specific Conductivity at Joan Brook – September 6, 2017 to October 11, 2017

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 9.36 mg/l (88.2% saturation) to 12.02 mg/l (97.4% saturation) at Elross Creek, from 4.93 mg/l (46.6 % saturation) to 13.04 mg/l (99.8% saturation) at Goodream Creek, and from 10.03 mg/l (92.8% saturation) to 13.15 mg/l (101.8% saturation) at Joan Brook (Figures 13, 14 & 15).
- At all three stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- At Elross Creek and Joan Brook the DO values are at, or above, both the minimum guideline set for other life stages (6.5 mg/l) and the minimum guideline set for the protection of early life stages(9.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007). At Goodream Creek there is a period early in the deployment (see inside red oval) when dissolved oxygen levels are affected by low flow conditions and fall below both of the recommended guidelines.

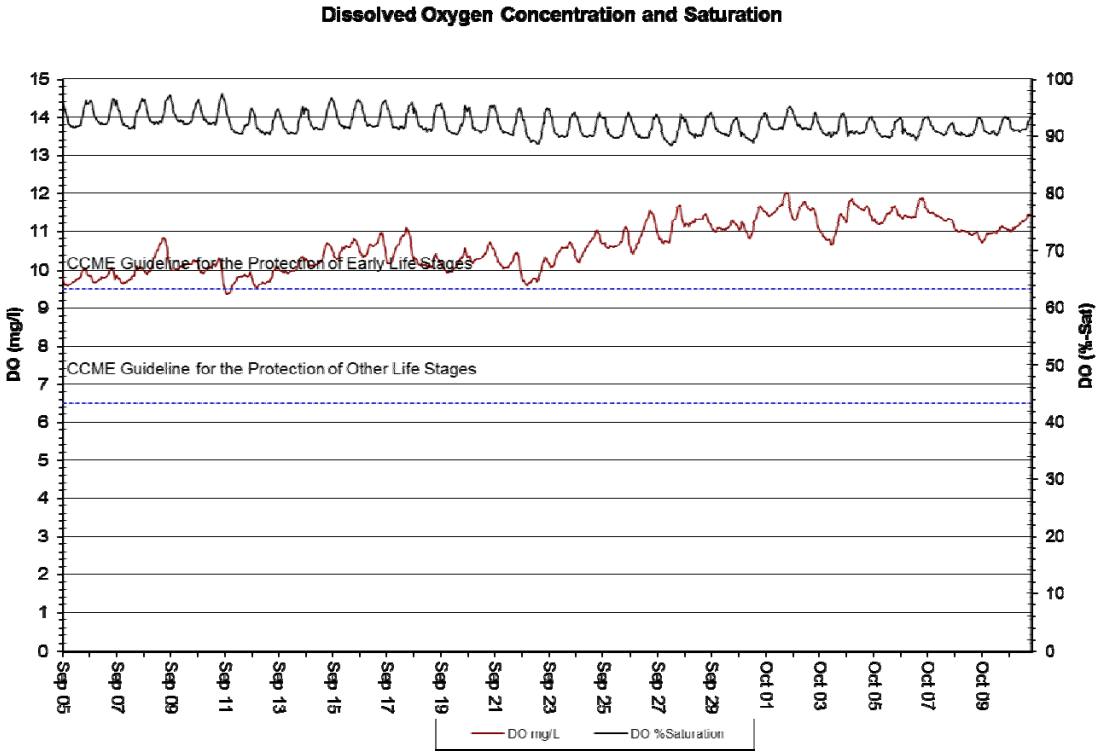

Figure 13: DO (mg/l & % Sat.) at Elross Creek – September 5, 2017 to October 11, 2017

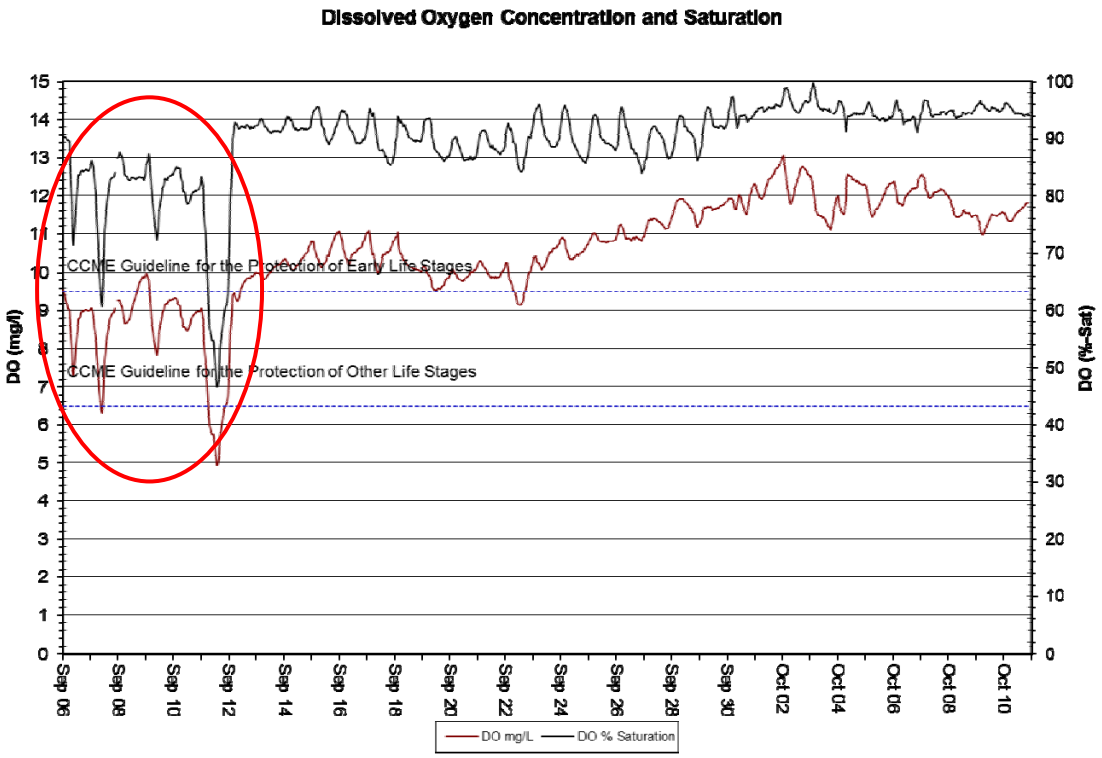

Figure 14: DO (mg/l & % Sat.) at Goodream Creek – September 6, 2017 to October 11, 2017

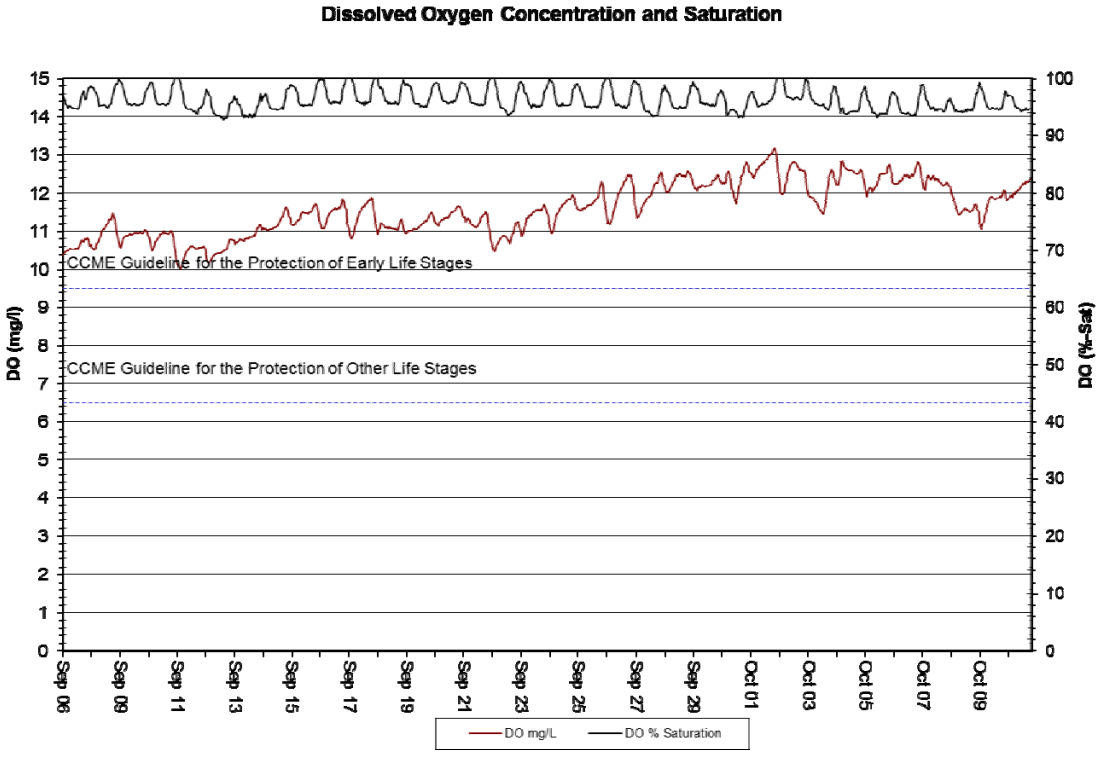

Figure 15: DO (mg/l & % Sat.) at Joan Brook – September 6, 2017 to October 11, 2017

Turbidity

- **The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request**.
- During the deployment period covered by this report, turbidity values ranged from 3.3 NTU to 68.0 NTU at Elross Creek, from 0.0 NTU to 3.2 NTU at Goodream Creek and from 0.0 NTU to 465.0 NTU Joan Brook (Figures 16, 17 & 18).
- At Elross Creek there are three distinct spikes in turbidity which correspond with higher stage height levels, while at Goodream Creek there is one occasion , and at Joan Brook there are two occasions where this is also the case (see inside red ovals).

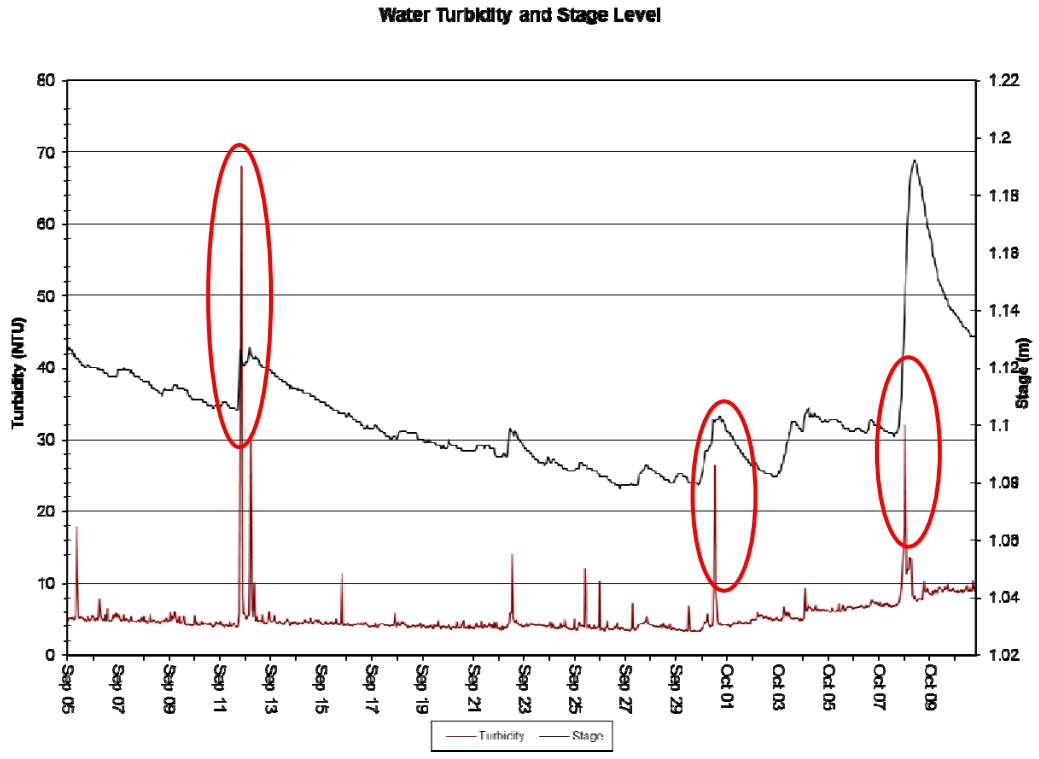

Figure 16: Turbidity (NTU) at Elross Creek – September 5, 2017 to October 11, 2017

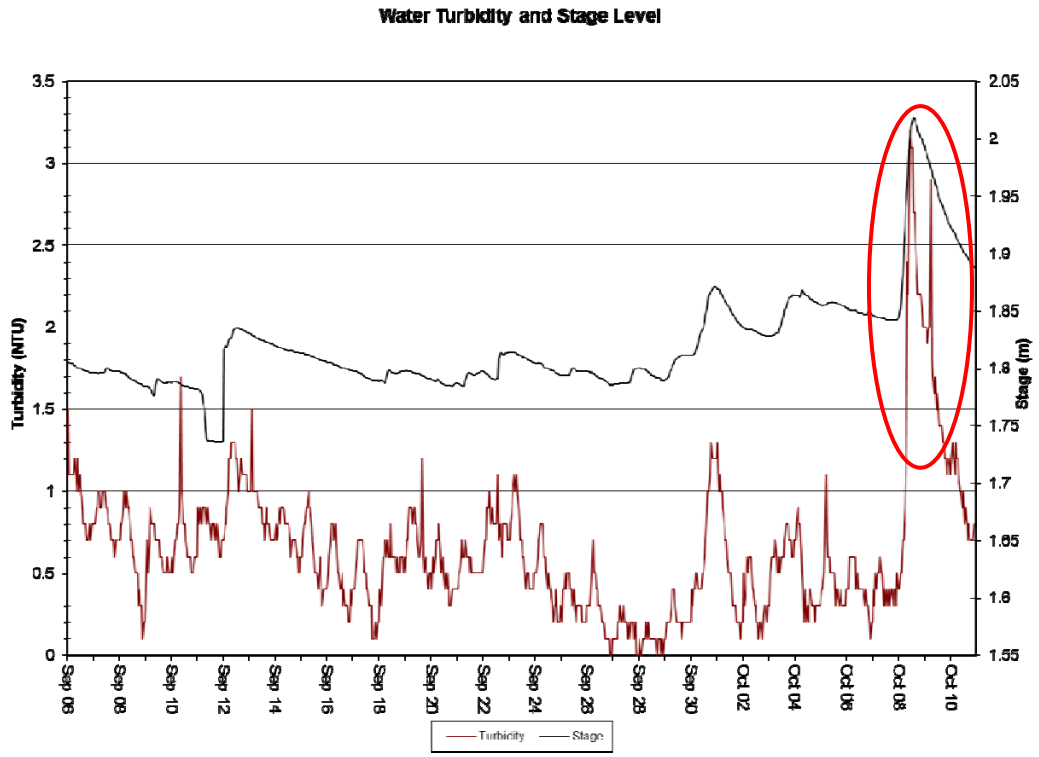

Figure 17: Turbidity (NTU) at Goodream Creek – September 6, 2017 to October 11, 2017

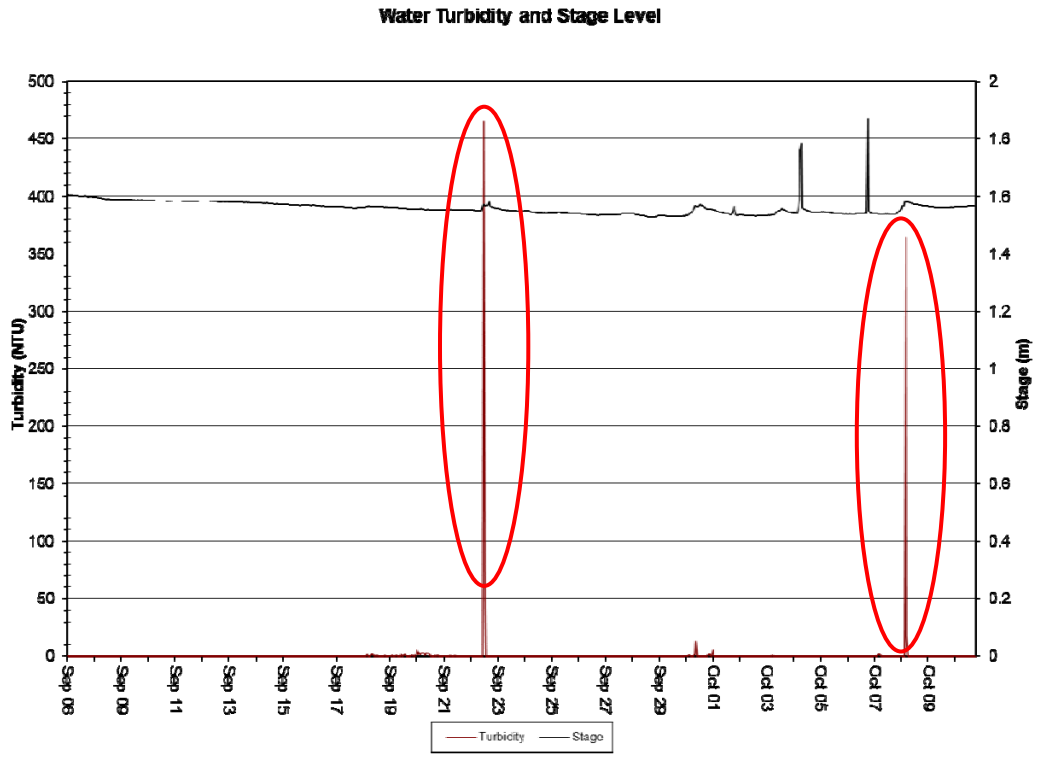

Figure 18: Turbidity (NTU) at Joan Brook – September 6, 2017 to October 11, 2017

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek, and Joan Brook stations from September 5th, 2017 to October 11th, 2017.
- Field instruments for all three stations performed well over the deployment period with only minor operational issues; however at the time of removal the instrument at Goodream Creek may have been experiencing issues with a faulty temperature probe.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For all three stations the stage height was typical for the late summer early fall season when hydrological conditions are affected by significant rainfall events which cause spikes that are relatively short lived.
    - For all three stations temperatures were typical of the late summer early fall season in this northerly location, and there is gentle declining trend.
    - During the deployment period covered by this report, pH values ranged from 5.90 units to 6.56 units at Elross Creek, from 5.30 units to 6.13 units at Goodream Creek, and from 6.21 units to 6.88 units at Joan Brook.
    - During the deployment period covered by this report, specific conductivity ranged from 13.5 µs/cm to 21.2 µs/cm at Elross Creek, from 3.9 µs/cm to 8.9 µs/cm at Goodream Creek, and from 7.2 µs/cm to 9.3 µs/cm at Joan Brook.
    - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 9.36 mg/l (88.2% saturation) to 12.02 mg/l (97.4% saturation) at Elross Creek, from 4.93 mg/l (46.6 % saturation) to 13.04 mg/l (99.8% saturation) at Goodream Creek, and from 10.03 mg/l (92.8% saturation) to 13.15 mg/l (101.8% saturation) at Joan Brook.
    - During the deployment period covered by this report, turbidity values ranged from 3.3 NTU to 68.0 NTU at Elross Creek, from 0.0 NTU to 3.2 NTU at Goodream Creek and from 0.0 NTU to 465.0 NTU at Joan Brook.

References

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. (Website: http://ceqg-rcqe.ccme.ca/download/en/222/)

APPENDIX A
Quality Assurance / Quality Control Procedures

As part of the Quality Assurance / Quality Control (QA/QC) protocol, the performance of a station's water quality instrument (i.e., Field Sonde) is rated at the beginning and end of its deployment period. The procedure is based on the approach used by the United States Geological Survey (Wagner *et al.* 2006)[1].

At the beginning of the deployment period, a fully cleaned and calibrated QA/QC water quality instrument (i.e., QA/QC Sonde) is placed *in-situ* with the fully cleaned and calibrated Field Sonde. After Sonde readings have stabilized, which may take up to five minutes in some cases, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde. If the readings from both Sondes are in close agreement, the QA/QC Sonde can be removed from the water. If the readings are not in close agreement, there will be attempts to reconcile the problem on site (e.g., removing air bubbles from sensors, etc.). If no fix is made, the Field Sonde may be removed for recalibration.

At the end of the deployment period, a fully cleaned and calibrated QA/QC Sonde is once again deployed *in-situ* with the Field Sonde, which has already been deployment for 30-40 days. After Sonde readings have stabilized, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde.

Performance ratings are based on differences listed in the table below.

	Rating				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (^{o}C)	≤ ±0.2	> ±0.2 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
pH (unit)	≤ ±0.2	> ±0.2 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
Sp. Conductance (µS/cm)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Sp. Conductance > 35 µS/cm (%)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Dissolved Oxygen (mg/l) (% Sat)	≤ ±0.3	> ±0.3 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
Turbidity <40 NTU (NTU)	≤ ±2	> ±2 to 5	> ±5 to 8	> ±8 to 10	> ±10
Turbidity > 40 NTU (%)	≤ ±5	> ±5 to 10	> ±10 to 15	> ±15 to 20	> ±20

[1] Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at *http://pubs.water.usgs.gov/tm1d3*

APENDIX B

Environment Canada Weather Data – Schefferville (September 5, 2017 to October 11 2017)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
9/5/2017	14.8	9.2	12	6	0	2.2
9/6/2017	14.3	7.3	10.8	7.2	0	0.2
9/7/2017	13.6	7.5	10.6	7.4	0	1.5
9/8/2017	11	0.7	5.9	12.1	0	0.5
9/9/2017	13.5	0.2	6.9	11.1	0	1.4
9/10/2017	15.1	5.6	10.4	7.6	0	0
9/11/2017	20.2	5.1	12.7	5.3	0	0
9/12/2017		9				
9/13/2017		7.8				
9/15/2017	8.2	1.7	5	13	0	0
9/16/2017	9.2	1.2	5.2	12.8	0	0
9/17/2017	11.6	-0.5	5.6	12.4	0	0
9/18/2017	13.4	-1.9	5.8	12.2	0	0.6
9/19/2017	13.5	7.9	10.7	7.3	0	0.2
9/20/2017	10.5	4.5	7.5	10.5	0	0
9/21/2017	10.6	3.9	7.3	10.7	0	0.5
9/22/2017	17.5	7.7	12.6	5.4	0	7.1
9/23/2017	12.1	0.2	6.2	11.8	0	0.7
9/24/2017	11.1	0.8	6	12	0	0
9/25/2017	6	0	3	15	0	1.3
9/26/2017	8.1	-3.8	2.2	15.8	0	0.4
9/27/2017	5.2	-5.1	0.1	17.9	0	1.5
9/28/2017	0.9	-2.2	-0.7	18.7	0	6.5
9/29/2017	4.2	-1.9	1.2	16.8	0	0.5
9/30/2017	6.8	1.4	4.1	13.9	0	7.9
10/1/2017	2.3	-1.6	0.4	17.6	0	0.7
10/2/2017	6.5	-2	2.3	15.7	0	0
10/3/2017	10	0.2	5.1	12.9	0	7.2
10/4/2017	10.3	-2	4.2	13.8	0	6.8
10/5/2017	3	-2	0.5	17.5	0	0.9
10/6/2017	2.5	-1.3	0.6	17.4	0	2
10/7/2017	2.2	-1	0.6	17.4	0	3.1
10/8/2017	11.2	1.1	6.2	11.8	0	16.6
10/9/2017	13	1.9	7.5	10.5	0	0
10/10/2017	7.8	1.5	4.7	13.3	0	0.8
10/11/2017	3.5	-0.6	1.5	16.5	0	0.2