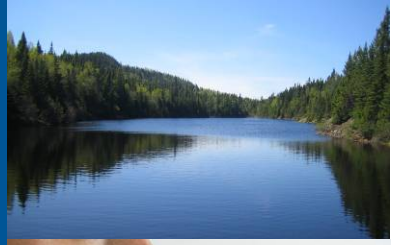




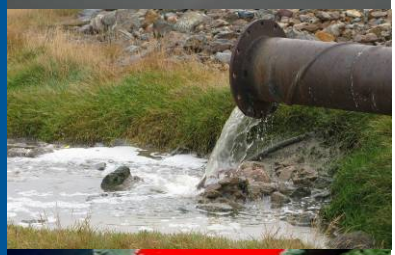


Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake/Joan Brook Network

Deployment Period
2017-07-11 to 2017-08-09

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division
St. John's, NL, A1B 4J6 Canada

Prepared by:

Ian Bell
Environmental Scientist

Department of Municipal Affairs & Environment
Water Resources Management Division
PO Box 2006, Corner Brook, NL, A2H 6J8

t. 709.637.2431
f. 709.637.2541
e. ianbell@gov.nl.ca

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 July 11th, 2017 to August 9th, 2017, which was the second 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	2017-7-11	2017-8-9	2017-7-12	2017-8-9	2017-7-12	2017-8-8
Temperature	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
pH	Excellent	Excellent	Excellent	Marginal	Excellent	Excellent
Specific Conductivity	Excellent	Excellent	Excellent	Good	Excellent	Excellent
Dissolved Oxygen	Excellent	Excellent	Excellent	Poor	Excellent	Excellent
Turbidity	Excellent	Good	Excellent	Excellent	Excellent	Excellent

- The performance of the pH sensor at Goodream Creek was marginal, and the performance of the dissolved oxygen was poor, at the end of the deployment period (Table 1). These marginal and poor performances may have been due to calibration drift over the deployment period.
- 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 July 11th, 2017 at Elross Creek and at July 12th, 2017 at Goodream Creek and Joan Brook. Continuous real-time monitoring continued at Joan Brook until August 8th and at Goodream and Elross Creeks until August 9th, 2017. All three stations ran for the full deployment period with only minor 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 1.09 m to 1.17 m at Elross Creek, from 1.81 m to 1.99 m at Goodream Creek, which corresponded to a flow of 0.00 m^3/sec to 0.11 m^3/sec, and from 1.53 m to 1.58 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 all three stations there is a significant increase in Stage Height around August 4th to 5th. (see inside red ovals) which corresponds with significant rainfall for the same period.
- Please note that stage height data for Joan Brook was missing during several significant periods due to technical issues with the data transmission system.

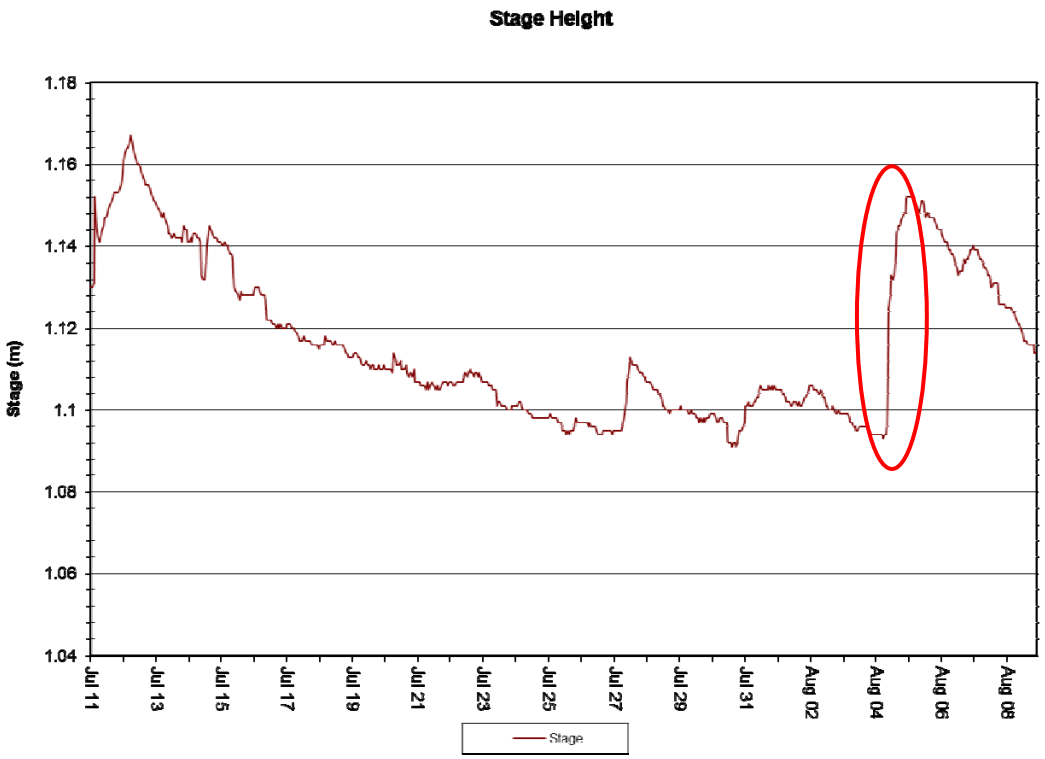

Figure 1: Stage Height (m) at Elross Creek – July 11, 2017 to August 9, 2017

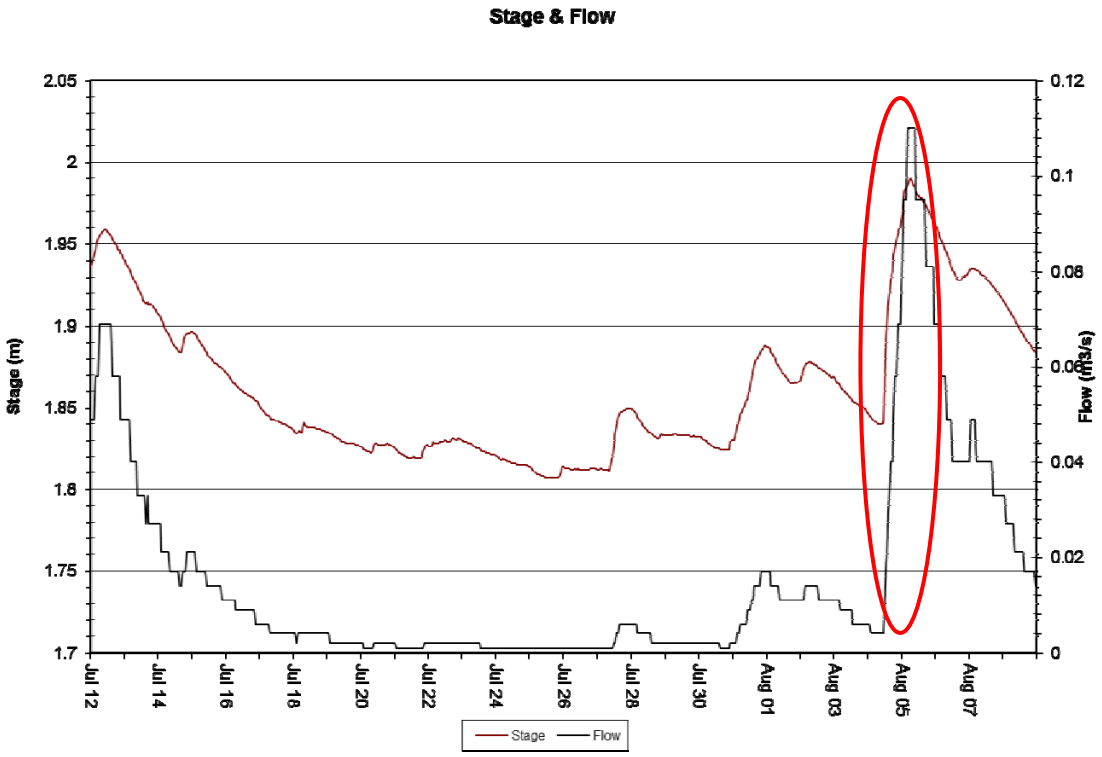

Figure 2: Stage Height (m) and Flow (m3/s) at Goodream Creek – July 12, 2017 to August 9, 2017

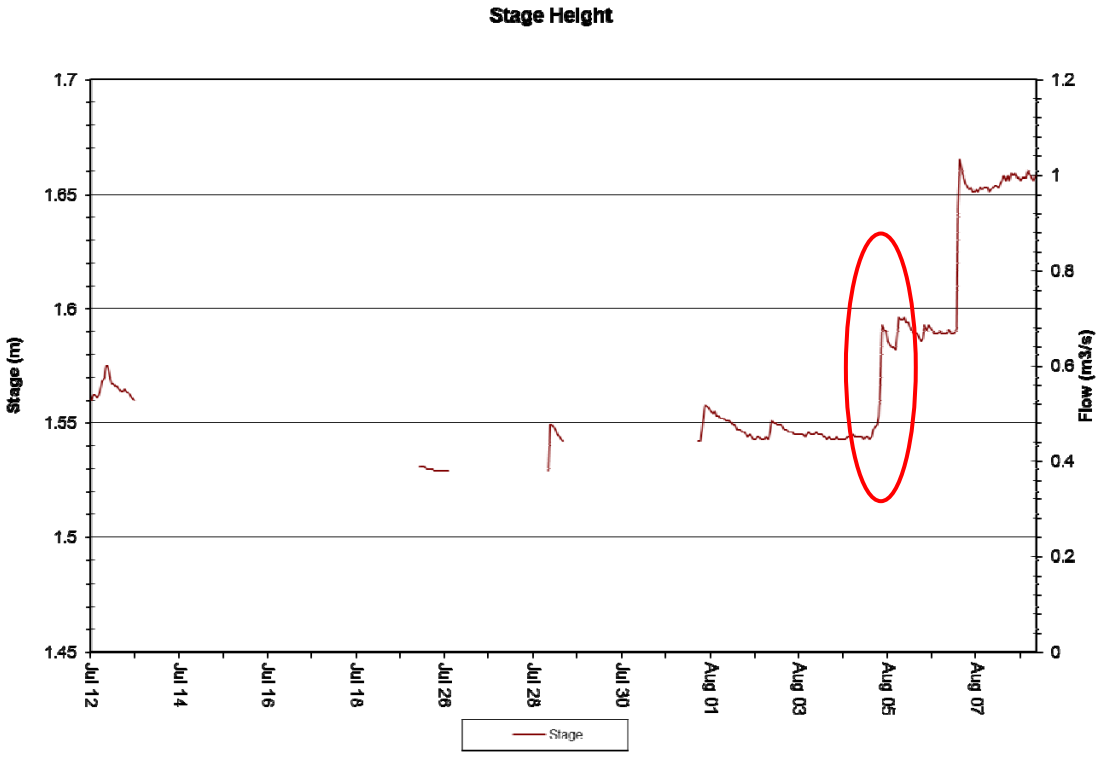

Figure 3: Stage Height (m) at Joan Brook – July 12, 2017 to August 8, 2017

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 6.90˚C to 14.20˚C at Elross Creek, from 6.60˚C to 17.70˚C at Goodream Creek, and from 5.89 ˚C to 14.20 ˚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.

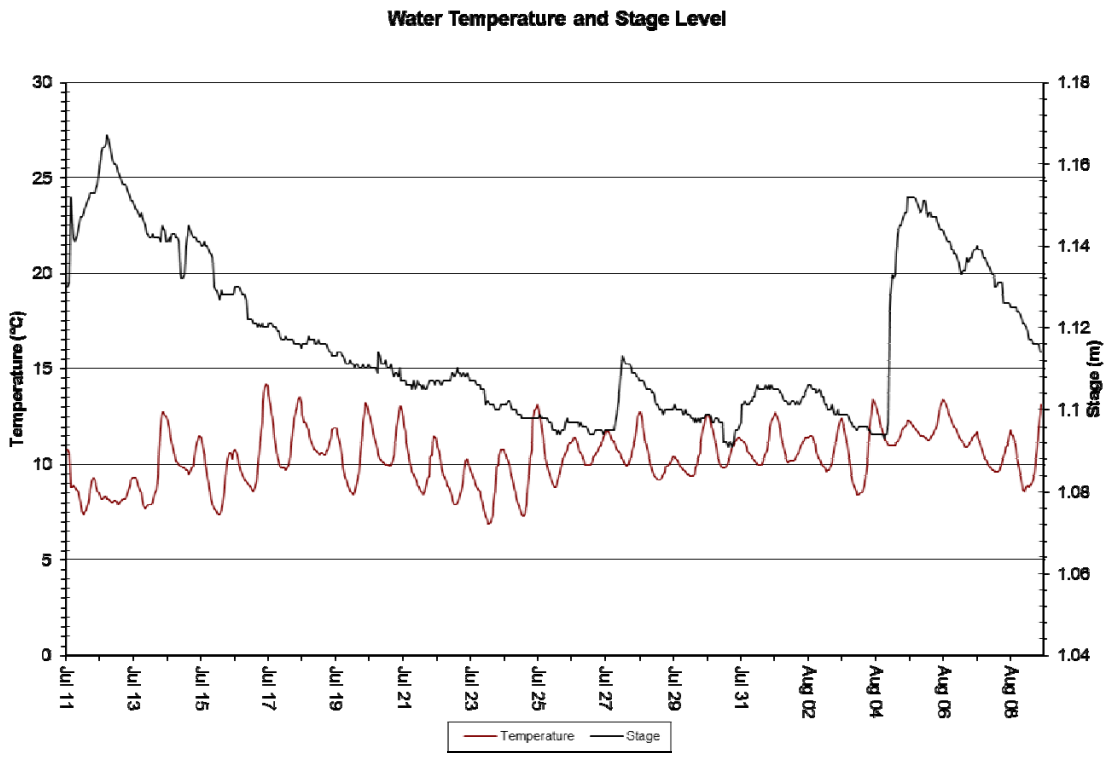

Figure 4: Temperature (°C) - Elross Creek – July 11, 2017 to August 9, 2017

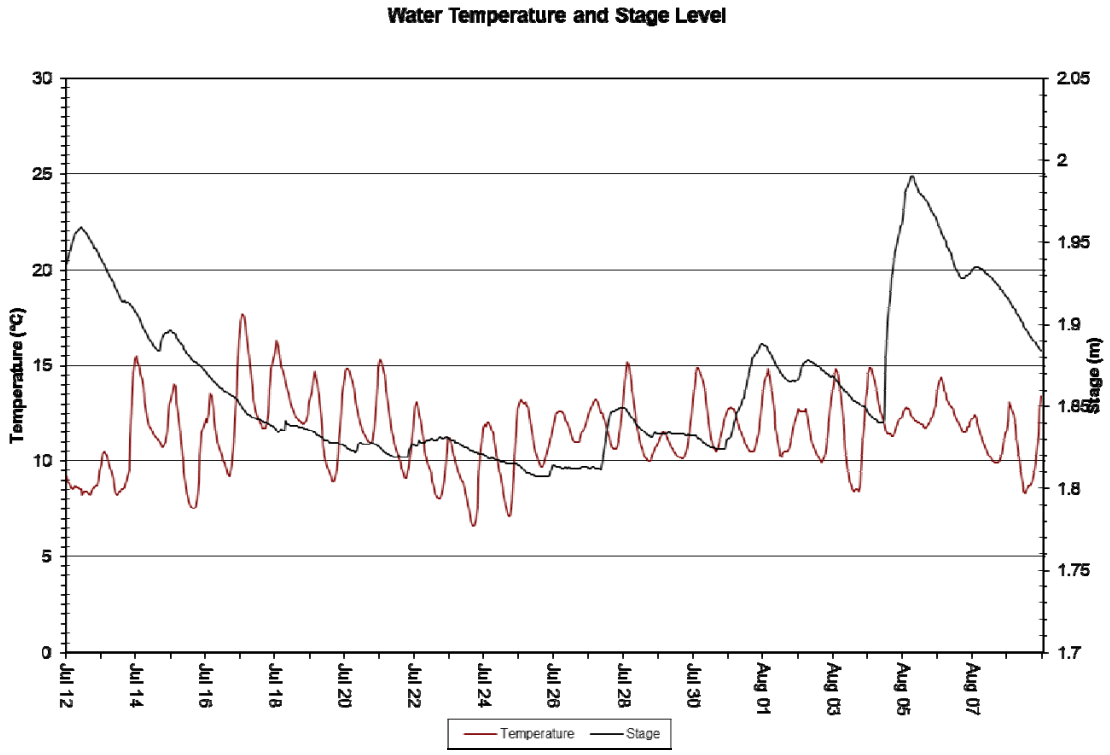

Figure 5: Temperature (°C) - Goodream Creek – July 12, 2017 to August 9, 2017

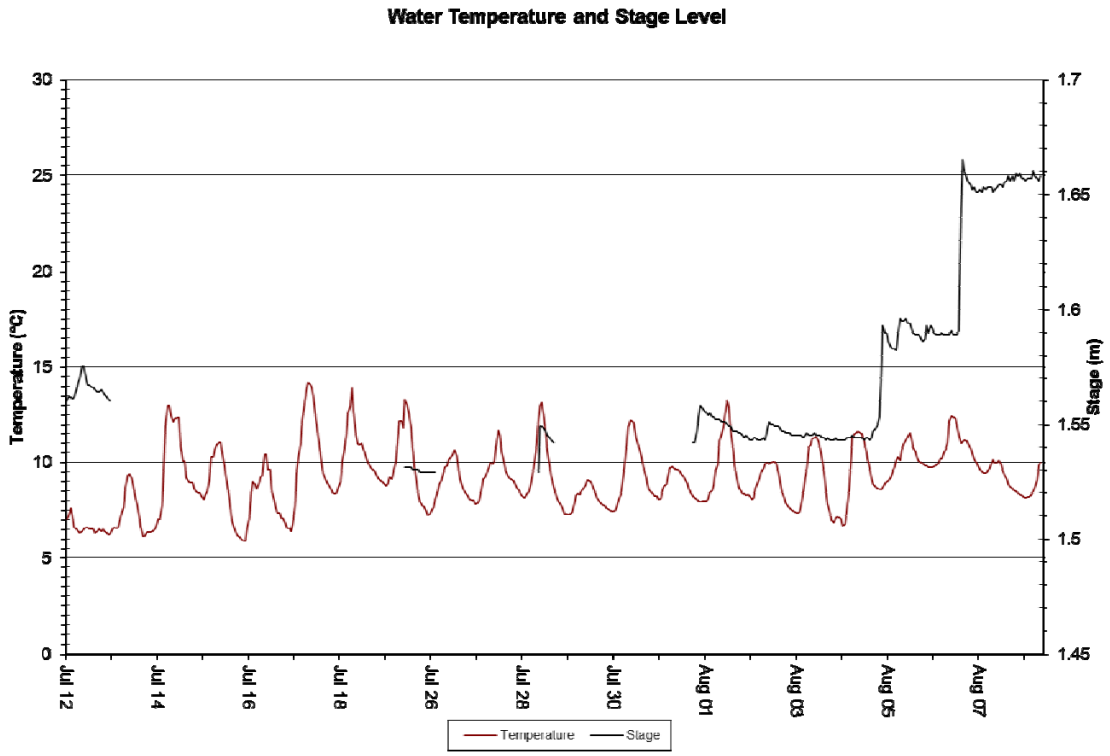

Figure 6: Temperature (°C) – Joan Brook – July 12, 2017 to August 8, 2017

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 6.18 units to 6.59 units at Elross Creek, from 5.61 units to 6.27 units at Goodream Creek, and from 6.27 units to 6.79 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.
- With a median value of 6.45 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 6.04 units with all pH values below this minimum guideline range. At Joan Brook the median pH value is 6.63 units with almost all values 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.

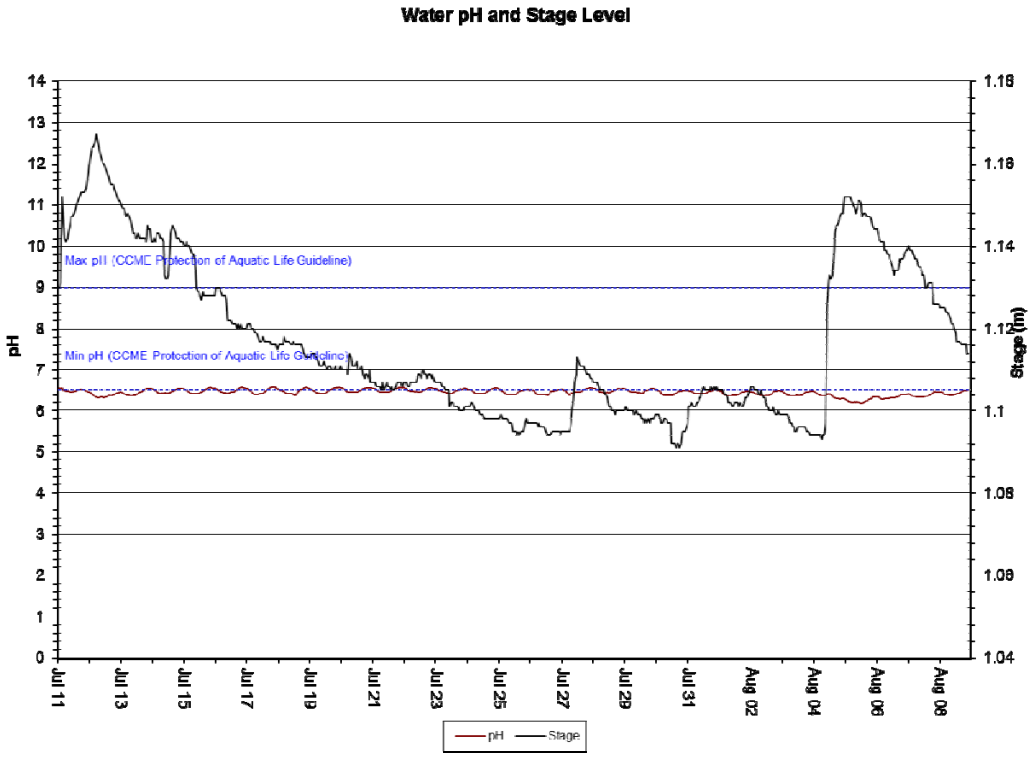

Figure 7: pH at Elross Creek – July 11, 2017 to August 9, 2017

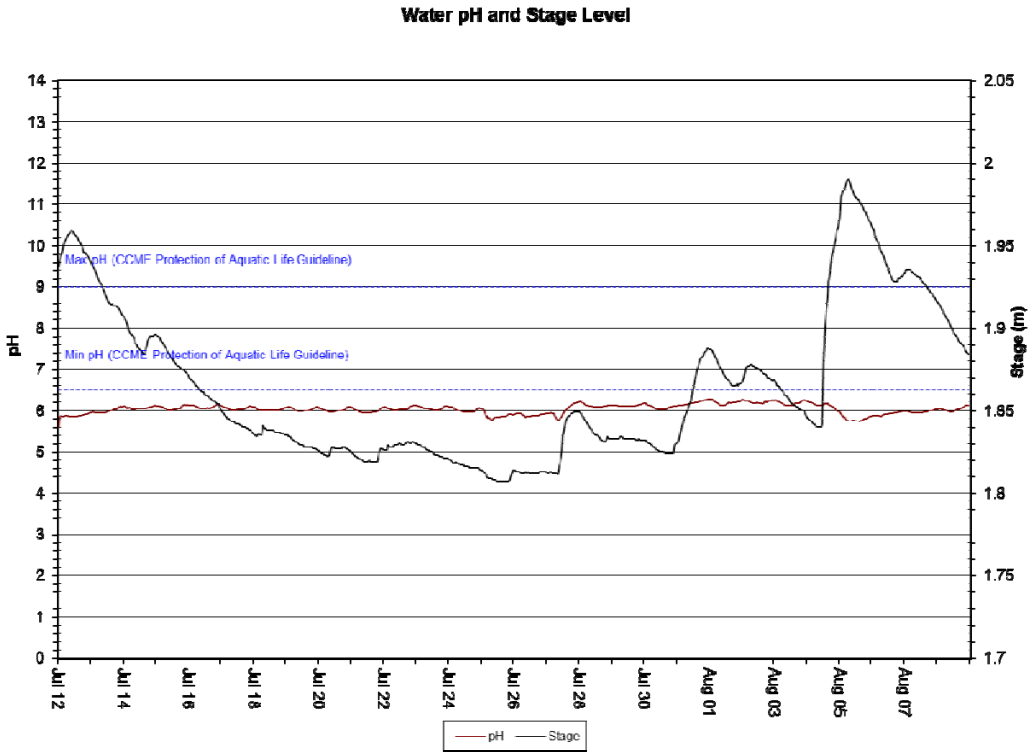

Figure 8: pH at Goodream Creek – July 12, 2017 to August 9, 2017

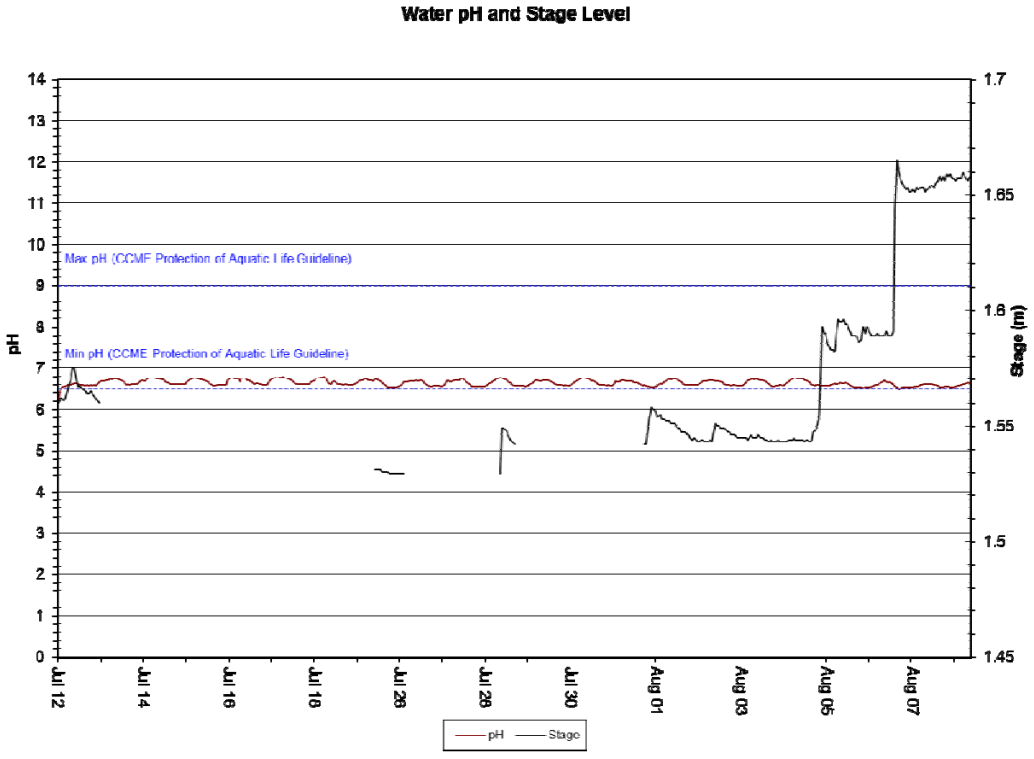

Figure 9: pH at Joan Brook – July 12, 2017 to August 8, 2017

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 12.2 µs/cm to 19.2 µs/cm at Elross Creek, from 3.3 µs/cm to 7.1 µs/cm at Goodream Creek, and from 5.0 µs/cm to 7.0 µs/cm at Joan Brook (Figures 10, 11 & 12).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend.
- The step-like graph for Figure 12 (Specific Conductivity at Joan Brook) is due to a programming issue with not enough decimal places being recorded.
- At Elross Creek there is a significant dip in specific conductivity around July 10th (see inside red oval) which corresponds with a significant spike in flow for the same time period.

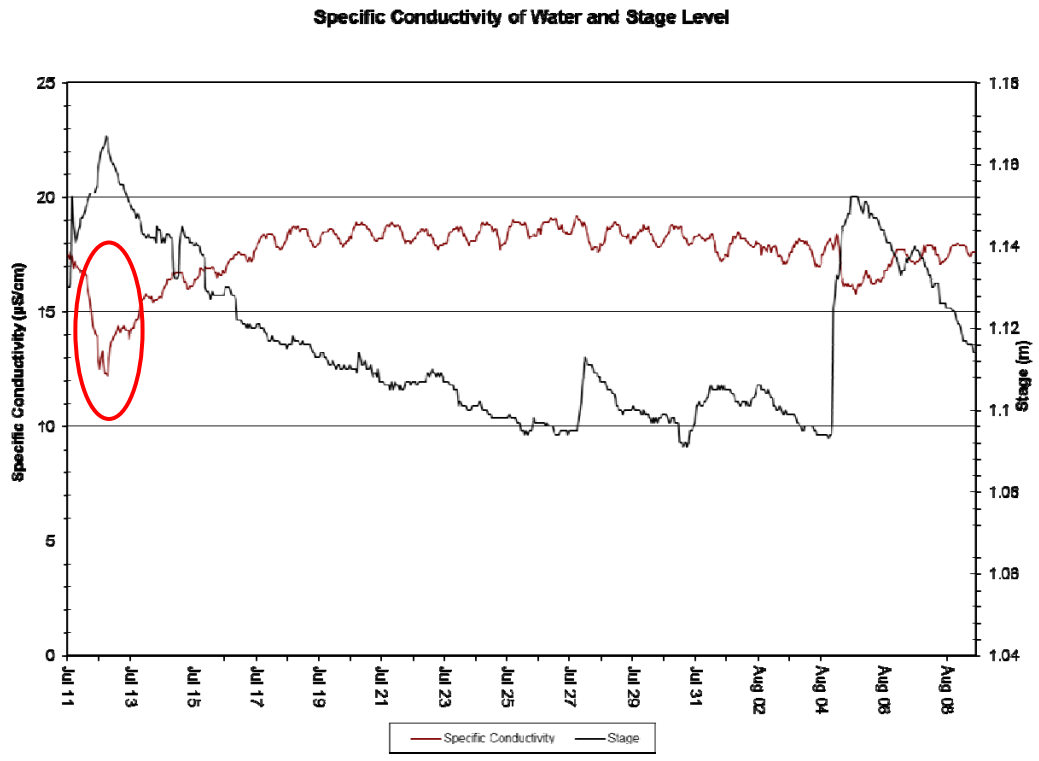

Figure 10: Specific Conductivity at Elross Creek – July 11, 2017 to August 9, 2017

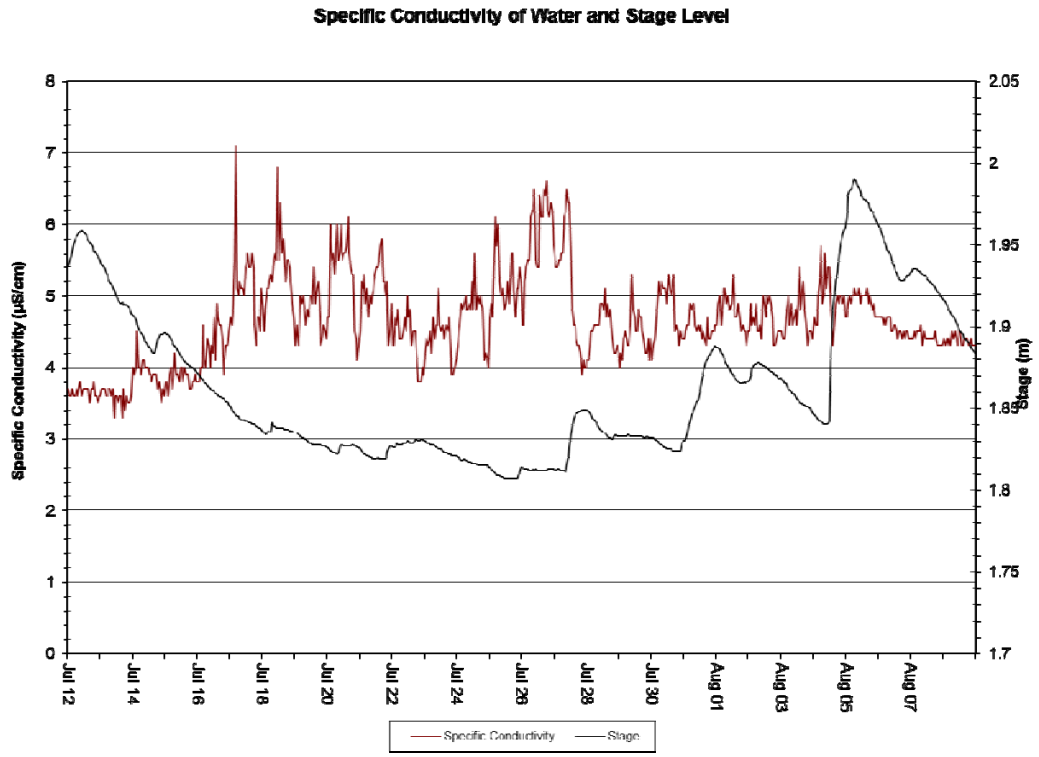

Figure 11: Specific Conductivity at Goodream Creek - July 12, 2017 to August 9, 2017

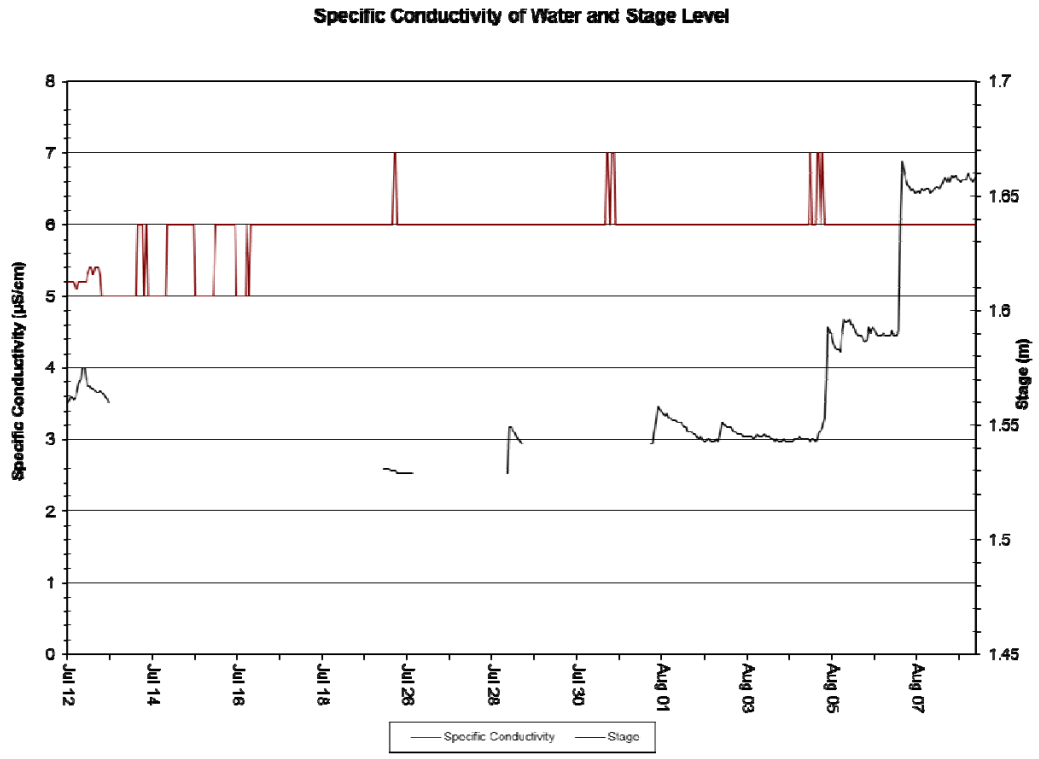

Figure 12: Specific Conductivity at Joan Brook – July 12, 2017 to August 8, 2017

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.86 mg/l (88.9% saturation) to 10.45 mg/l (98.7% saturation) at Elross Creek, from 7.03 mg/l (71.2 % saturation) to 10.47 mg/l (100.9% saturation) at Goodream Creek, and from 9.49 mg/l (93.4% saturation) to 11.58 mg/l (102.8% saturation) at Joan Brook (Figures 13, 14 & 15).
- DO was relatively stable over the deployment period at Elross Creek and Joan Brook, however at Goodream Creek there was a period of lower dissolved oxygen (see inside red oval) which corresponds with a low flow period.
- At all three stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- The DO values at all three stations are above the minimum guideline set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007). At Elross Creek and Joan Brook the DO values were at or just above the minimum guidelines set for the protection of early life stages(9.5 mg/l) while at Goodream Creek most of the values were below this guideline as Goodream tends to have lower dissolved oxygen levels during low flow conditions.

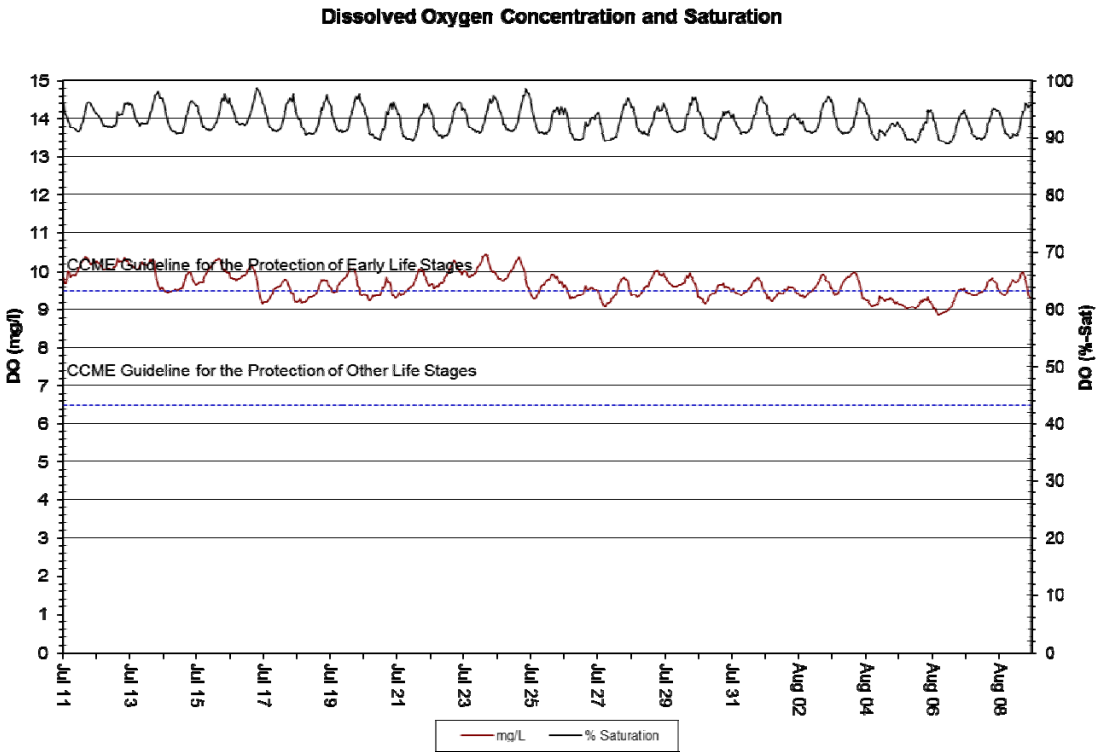

Figure 13: DO (mg/l & % Sat.) at Elross Creek – July 11, 2017 to August 9, 2017

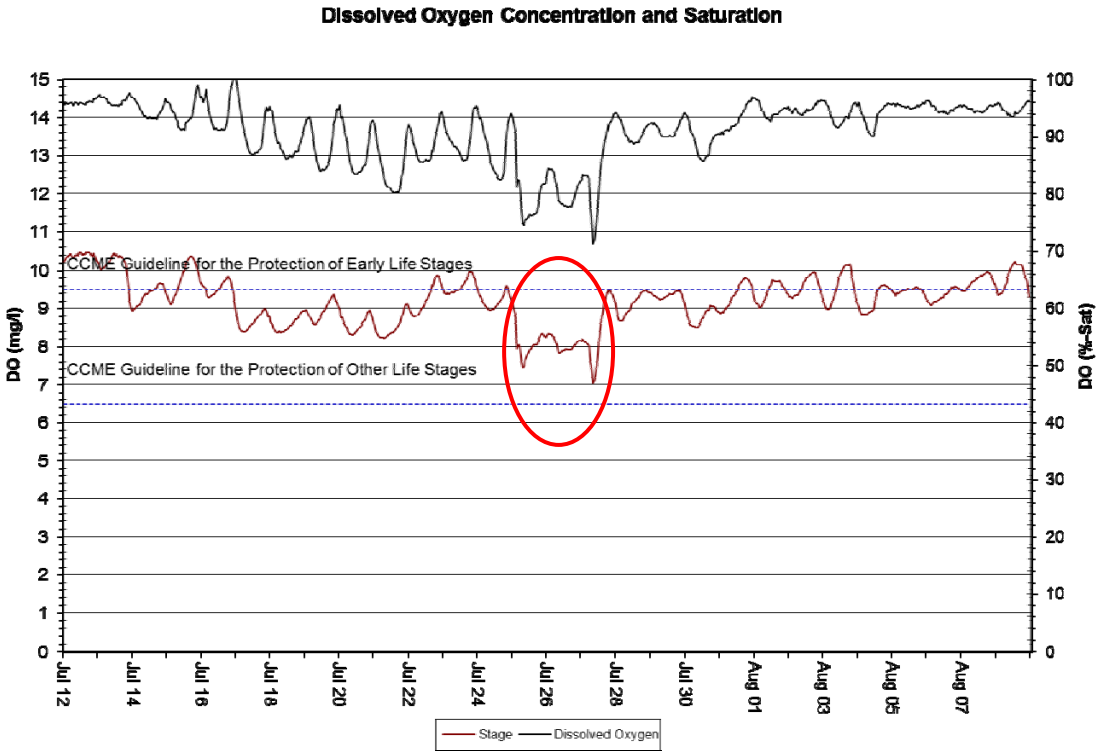

Figure 14: DO (mg/l & % Sat.) at Goodream Creek – July 12, 2017 to August 9, 2017

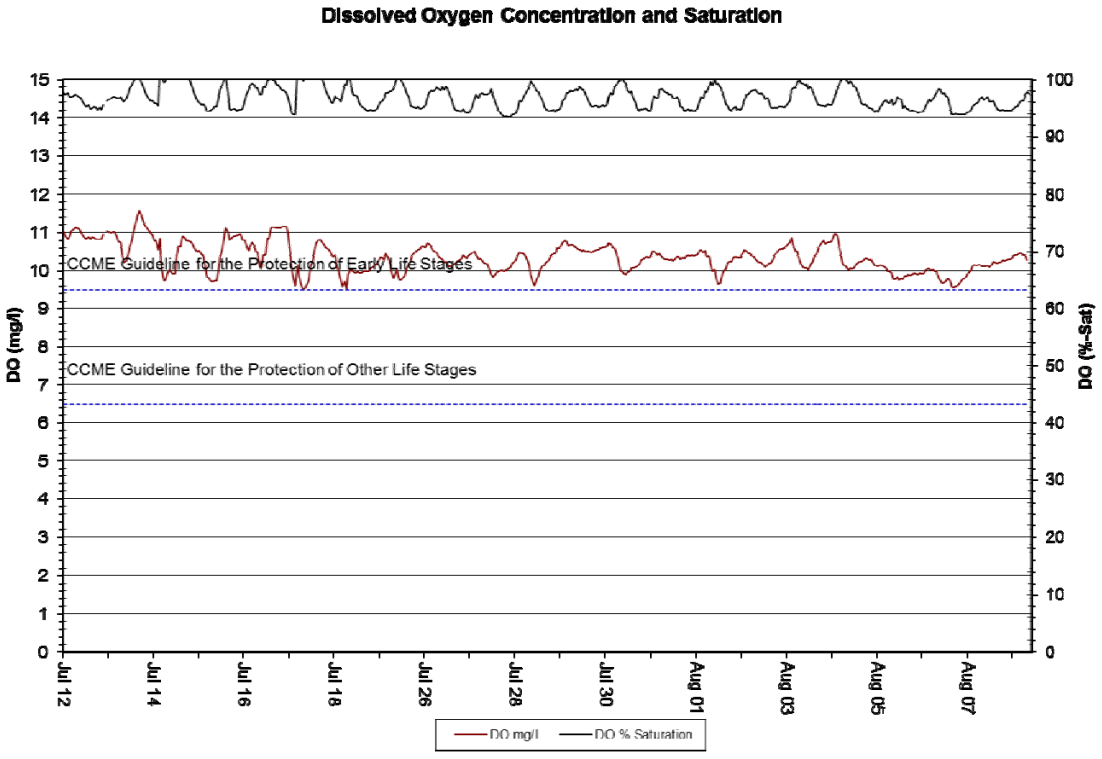

Figure 15: DO (mg/l & % Sat.) at Joan Brook – July 12, 2017 to August 8, 2017

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 7.2 NTU to 199.7 NTU at Elross Creek, from 0.0 NTU to 660.0 NTU at Joan Brook (Figures 16 & 17).
- At Joan Brook there was a significant spike in turbidity at around July 28th (see inside red oval) which is most likely related to a precipitation event.
- At Goodream Creek the turbidity values remained at 0.0 NTU for the entire deployment period which is an indication of either an issue with the turbidity sensor or with the calibration procedures. These data have been flagged as erroneous and removed from the dataset.
- At Elross Creek there is a significant spike in turbidity on two occasions (see inside red ovals) which both seem to correspond with increases in Stage Height and corresponding flow.

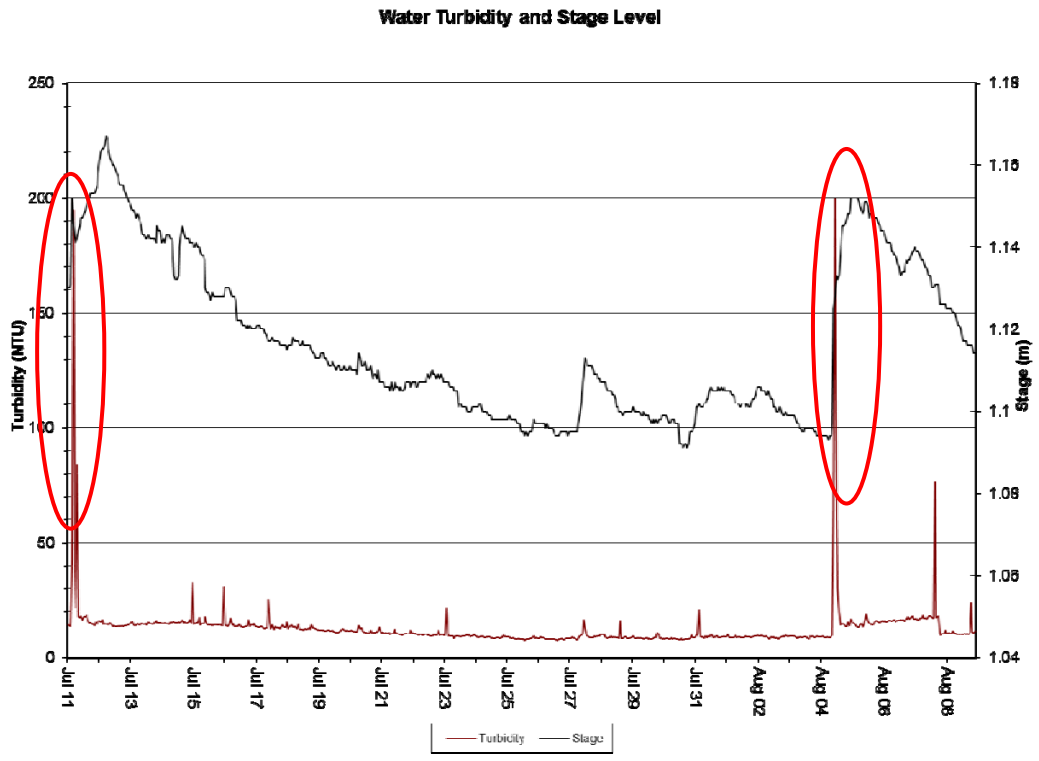

Figure 16: Turbidity (NTU) at Elross Creek – July 11, 2017 to August 9, 2017

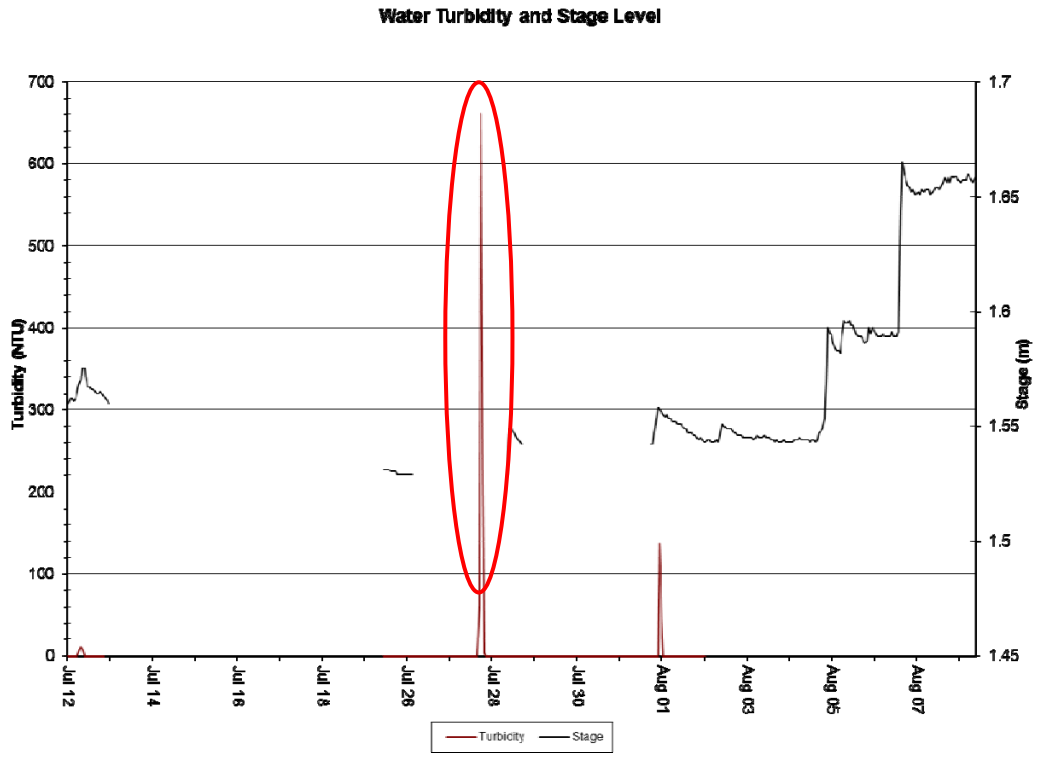

Figure 17: Turbidity (NTU) at Joan Brook – July 12, 2017 to August 8, 2017

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek, and Joan Brook stations from July 11th, 2017 to August 9th, 2017.
- Field instruments for all three stations performed well over the deployment period with only minor operational issues; including interruptions in data transmissions from Joan Brook station.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For all three stations the stage height was typical for the early to mid-summer 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 early to mid-summer season in this northerly location.

- During the deployment period covered by this report, pH values ranged from 6.18 units to 6.59 units at Elross Creek, from 5.61 units to 6.27 units at Goodream Creek, and from 6.27 units to 6.79 units at Joan Brook.
- During the deployment period covered by this report, specific conductivity ranged from 12.2 µs/cm to 19.2 µs/cm at Elross Creek, from 3.3 µs/cm to 7.1 µs/cm at Goodream Creek, and from 5.0 µs/cm to 7.0 µs/cm at Joan Brook.
- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.86 mg/l (88.9% saturation) to 10.45 mg/l (98.7% saturation) at Elross Creek, from 7.03 mg/l (71.2 % saturation) to 10.47 mg/l (100.9% saturation) at Goodream Creek, and from 9.49 mg/l (93.4% saturation) to 11.58 mg/l (102.8% saturation) at Joan Brook.
- During the deployment period covered by this report, turbidity values ranged from 7.2 NTU to 199.7 NTU at Elross Creek, from 0.0 NTU to 660.0 NTU at Joan Brook and they remained at 0.0 NTU at Goodream Creek for the entire deployment period.

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 (°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

APENDIX B

[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*

Environment Canada Weather Data – Schefferville (July 11, 2017 to August 9, 2017)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
7/11/2017	14.1	3.1	8.6	9.4	0	6.4
7/12/2017	10.2	0.3	5.3	12.7	0	8
7/13/2017	13.6	7	10.3	7.7	0	0.3
7/14/2017	22	8.8	15.4	2.6	0	0.6
7/15/2017	17.5	3.8	10.7	7.3	0	3.4
7/16/2017	15.7	3.2	9.5	8.5	0	1.1
7/17/2017	23.5	12.1	17.8	0.2	0	0
7/18/2017	25.4	12.3	18.9	0	0.9	1.2
7/19/2017	14.6	4.1	9.4	8.6	0	0.2
7/20/2017	17.7	4.2	11	7	0	8.1
7/21/2017	14.5	6.4	10.5	7.5	0	0.2
7/22/2017	10.7	3.3	7	11	0	8
7/23/2017	8.7	3	5.9	12.1	0	1.9
7/24/2017	15.3	3	9.2	8.8	0	1.6
7/25/2017	21.6	4.8	13.2	4.8	0	1.2
7/26/2017	20.8	12	16.4	1.6	0	1.6
7/27/2017	17.7	10.7	14.2	3.8	0	6.8
7/28/2017	14.4	6.7	10.6	7.4	0	2.2
7/29/2017	10.3	6.8	8.6	9.4	0	1.7
7/30/2017	17.9	9	13.5	4.5	0	0
7/31/2017	16.1	9.5	12.8	5.2	0	24
8/1/2017	17.6	9.3	13.5	4.5	0	3.7
8/2/2017	15.7	9	12.4	5.6	0	3.3
8/3/2017	15.5	5.4	10.5	7.5	0	0
8/4/2017	19.3	4.8	12.1	5.9	0	4.9
8/5/2017	19.4	11.9	15.7	2.3	0	23.5
8/6/2017	19.7	12.2	16	2	0	1.9
8/7/2017	12.2	6.6	9.4	8.6	0	6.5
8/8/2017	14.6	4.7	9.7	8.3	0	0.2
8/9/2017	16.8	5	10.9	7.1	0	1.8