

# Real Time Water Quality Report

## Tata Steel Minerals Canada

### Elross Lake/Joan Brook Network

Deployment Period  
2019-08-20 to 2019-10-9



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](mailto: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.
- **Please note that the Goodream Creek Station has been temporarily shut down to allow for moving the station to a new location further downstream near Triangle Lake. However, for the third deployment period of 2019 a Hydrolab was deployed independently and logged internally at the new location. This temporary deployment did not include the collection of any stage or flow data.**
- 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 original Goodream Creek Station served to monitor potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek. The new Goodream Station will monitor impacts from the development of the Howse deposit. 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, Joan Brook and Goodream Creek stations from August 20th, 2019 to October 9th, 2019, which was the third and final deployment period for the 2019 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. The 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**

Stage of deployment	Elross Creek		Joan Brook	
	Beginning	End	Beginning	End
Date	2019-8-20	2019-10-8	2019-8-21	2019-10-9
Temperature	Excellent	Excellent	Excellent	Excellent
pH	Good	Good	Excellent	Good
Specific Conductivity	Excellent	Excellent	Excellent	Excellent
Dissolved Oxygen	Excellent	Good	Fair	Marginal
Turbidity	Good	Good	Excellent	Excellent

*\*Goodream Creek was a temporary deployment and comparisons between the field and QA/QC instruments were not available.*

- The performance of all sensors at both stations was within acceptable limits during this deployment period (Table 1) with the exception of dissolved oxygen at Joan Brook which was marginal at the time of removal. The marginal reading at Joan Brook at the time of removal was most likely related to a slightly longer than normal deployment (49 days) and the oxygen sensor drifting off calibration.

### Deployment Notes

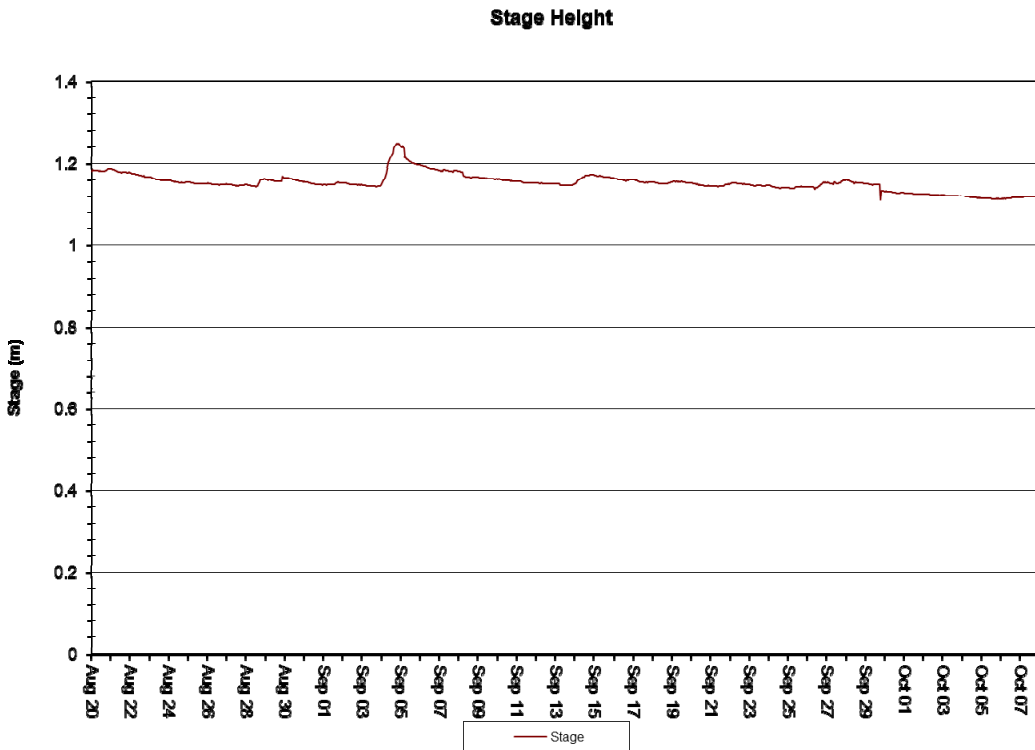
- Water quality monitoring for this deployment period started on August 20<sup>th</sup>, 2019, at Elross Creek and August 21<sup>st</sup>, 2019, Joan Brook. Continuous real-time monitoring continued at Elross Creek until October 8<sup>th</sup>, 2019, and at Joan Brook until October 9<sup>th</sup>, 2019. Both stations ran for the full deployment period with no significant operational issues; however it should be noted that there were numerous data gaps at Joan Brook due to data transmission issues.
- The temporary deployment at the new Goodream Creek location ran from August 21<sup>st</sup>, 2019, to October 9<sup>th</sup>, 2019.

## Data Interpretation

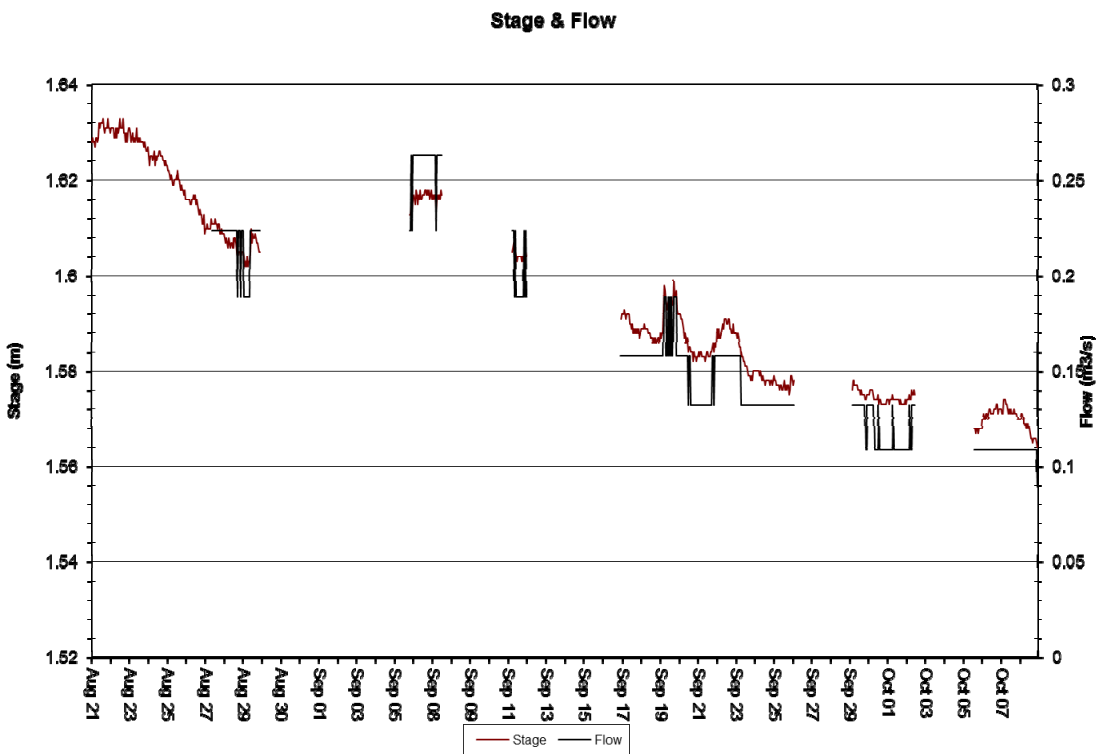
- Data records were interpreted for each station during the deployment period for the following six parameters:
  - (i.) Stage (m)
  - (ii.) Temperature (°C)
  - (iii.) pH
  - (iv.) Specific conductivity ( $\mu\text{S}/\text{cm}$ )
  - (v.) Dissolved oxygen (mg/l)
  - (vi.) Turbidity (NTU)

## 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. The 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 values ranged from 1.11 m to 1.25 m at Elross Creek, and from 1.60 m to 1.63 m at Joan Brook (Figures 1 & 2). Stage is directly related to the volume of flow in a stream, as defined by a rating curve which is unique for every site.
- There was no stage data available for the new Goodream Creek station as it was only a temporary deployment with the Hydrolab independently deployed and recording internally.
- Due to data transmission issues, there are numerous data gaps for stage and all other parameters at Joan Brook.



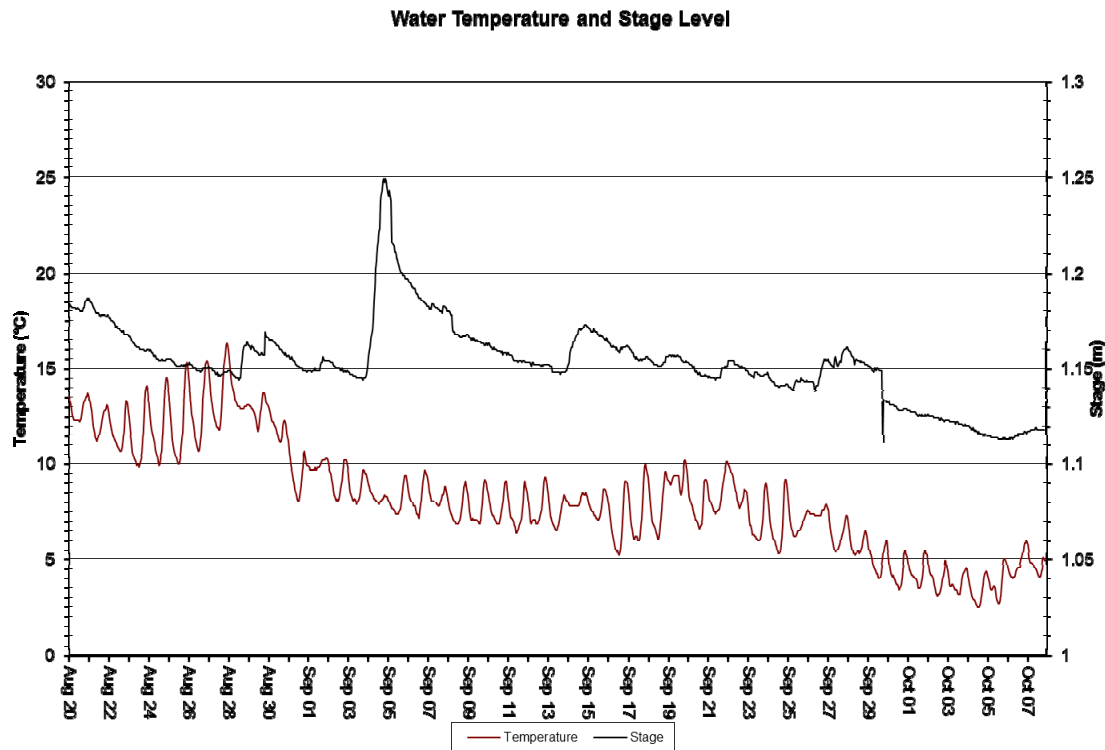
**Figure 1: Stage (m) at Elross Creek – August 20, 2019 to October 8, 2019**



**Figure 2: Stage (m) at Joan Brook – August 21, 2019 to October 9, 2019**

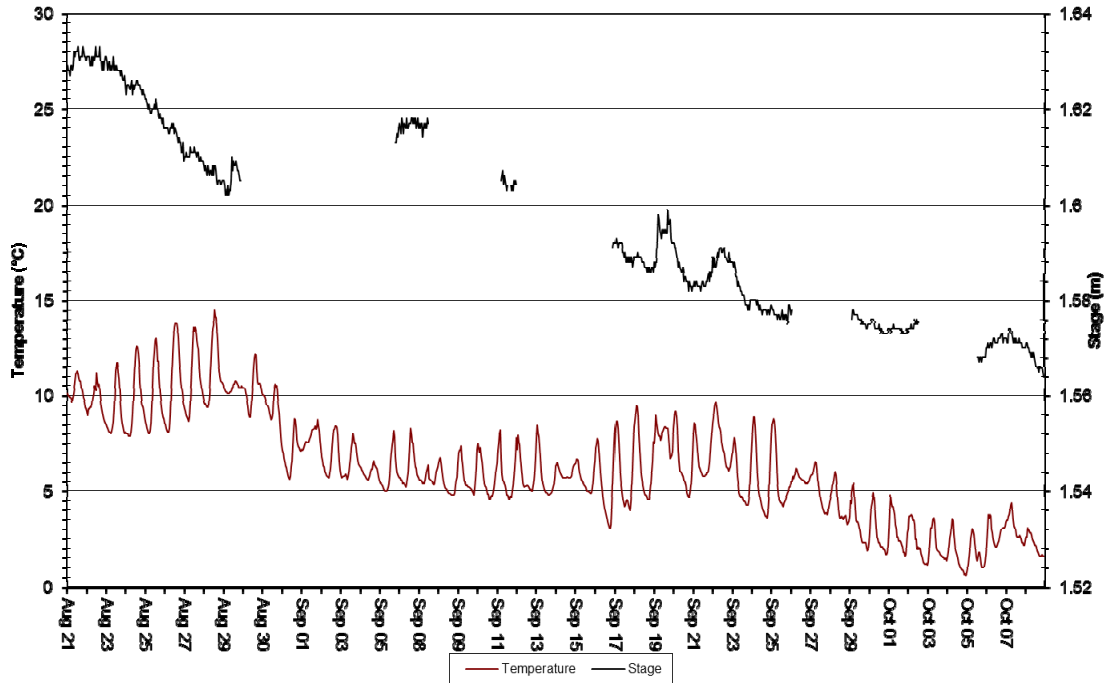
## Temperature

- 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. The 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 2.50°C to 16.30°C at Elross Creek, from 0.64 °C to 14.50 °C at Joan Brook, and from 1.17 to 9.32 at Goodream Creek (Figures 3, 4 & 5).
- 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.
- At all three station's temperature values showed a declining trend over the deployment which is typical of the transition from late summer to early fall.



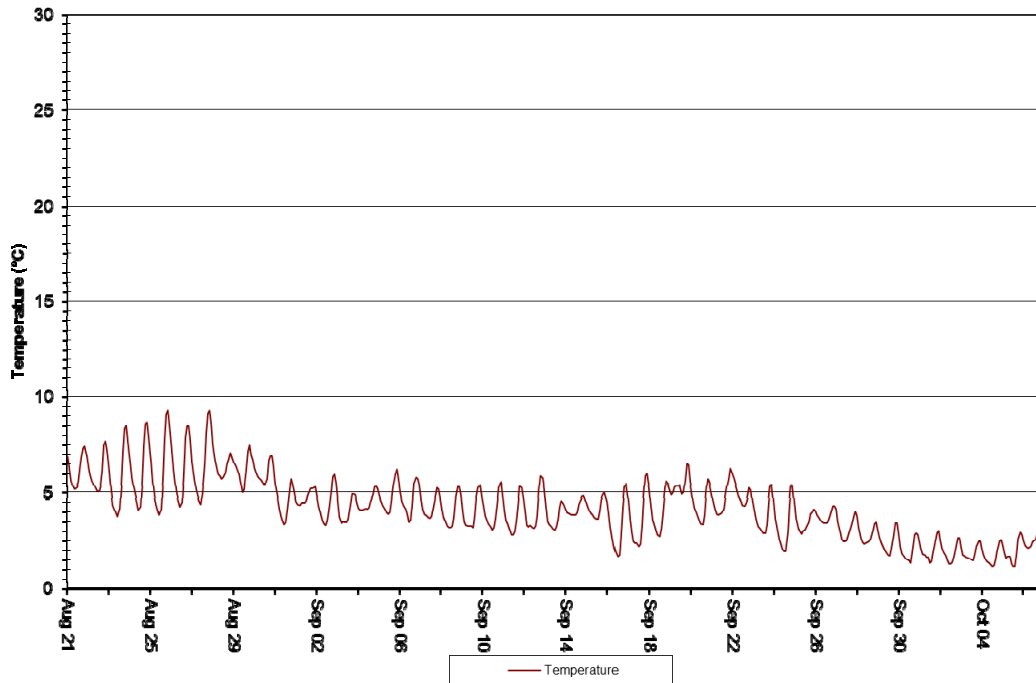
**Figure 3: Temperature (°C) - Elross Creek – August 20, 2019 to October 8, 2019**

**Water Temperature and Stage Level**



**Figure 4: Temperature (°C) – Joan Brook – August 21, 2019 to October 9, 2019**

**Water Temperature**

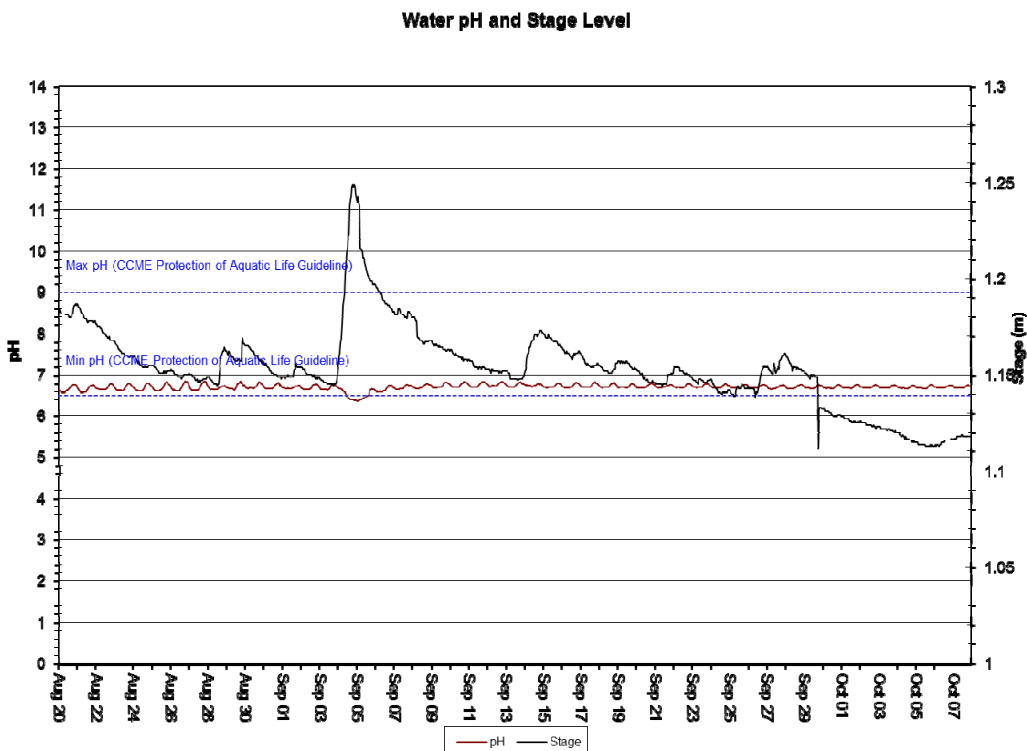


**Figure 5: Temperature (°C) – Goodream Creek – August 21, 2019 to October 9, 2019**

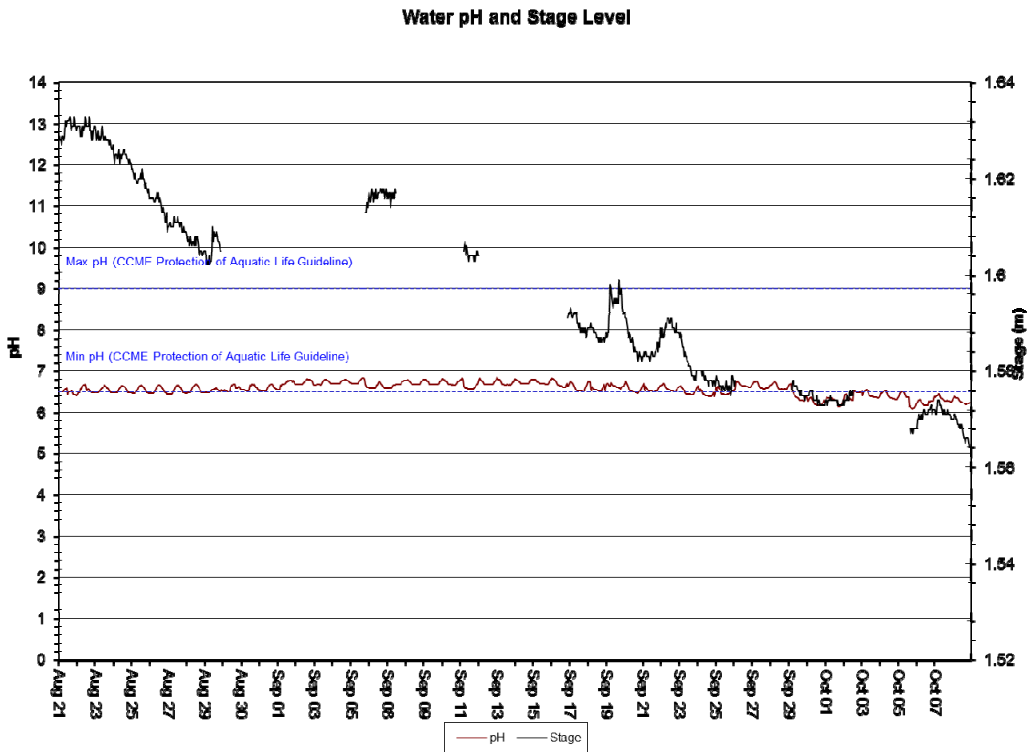


## pH

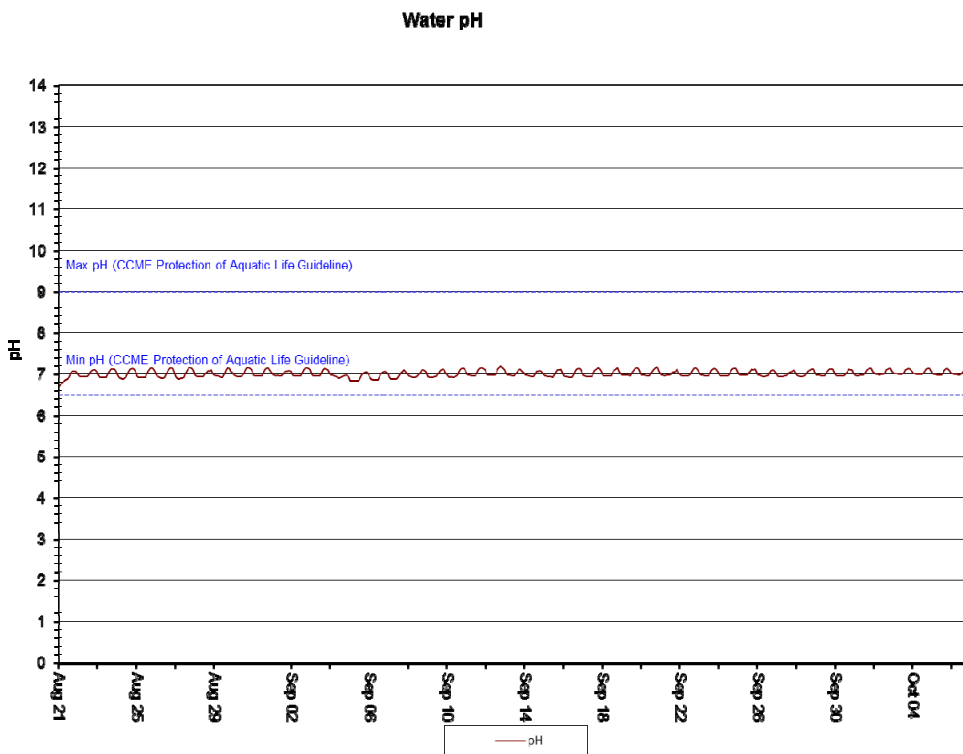
- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, pH values ranged from 6.36 units to 6.84 units at Elross Creek, from 6.09 units to 6.84 units at Joan Brook, and 6.72 units to 7.18 units at Goodream Creek (Figures 6, 7 & 8).
- 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 6.70 units, almost all pH values at Elross Creek are just above 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 Joan Brook, the median pH value is 6.59 units with the majority of values at, or very near to, the minimum guideline. At Goodream Creek, with a median pH value of 6.99, the majority of values are above the minimum guideline. 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 6: pH at Elross Creek – August 20, 2019 to October 8, 2019**



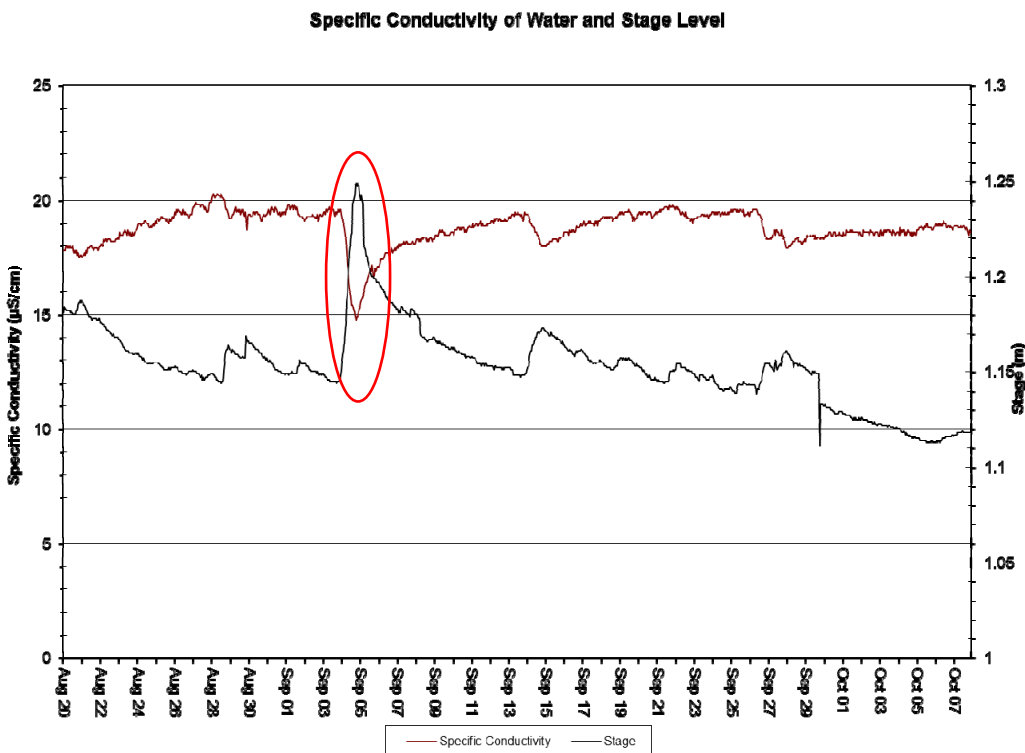
**Figure 7: pH at Joan Brook – August 21, 2019 to October 9, 2019**



**Figure 8: pH at Goodream Creek – August 21, 2019 to October 9, 2019**

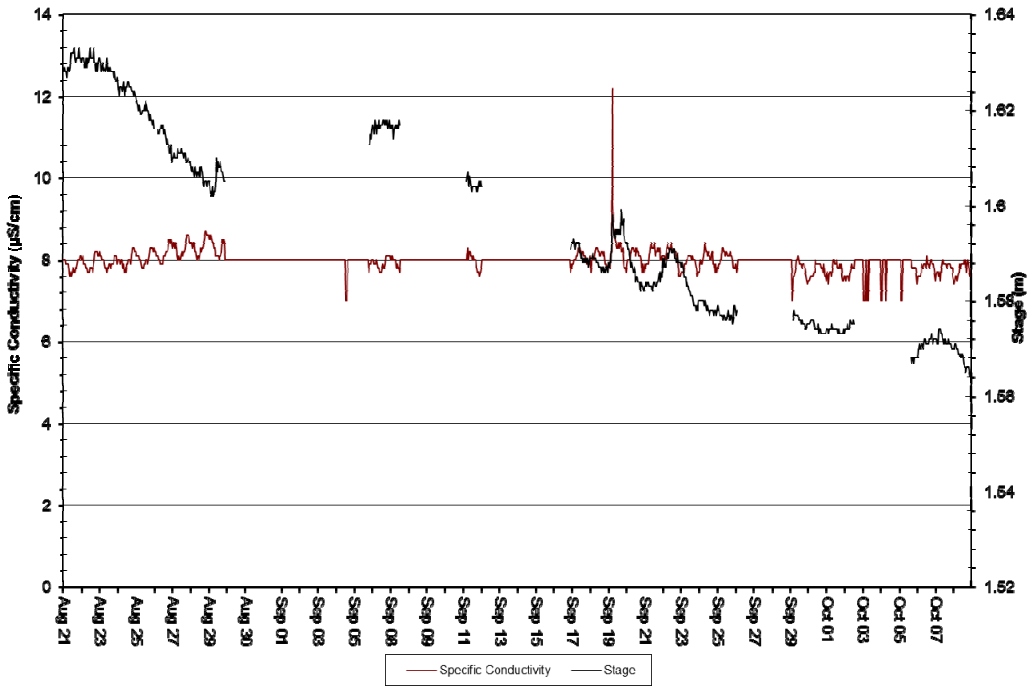
## Specific Conductivity

- 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. The 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 14.8  $\mu\text{s}/\text{cm}$  to 20.3  $\mu\text{s}/\text{cm}$  at Elross Creek, from 7.0  $\mu\text{s}/\text{cm}$  to 12.2  $\mu\text{s}/\text{cm}$  at Joan Brook, and from 29.0  $\mu\text{s}/\text{cm}$  to 41.0  $\mu\text{s}/\text{cm}$  at Goodream Creek (Figures 9, 10 & 11).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend.
- At Elross Creek there is a significant dip in specific conductivity which corresponds to a sharp peak in stage height (see inside red oval).



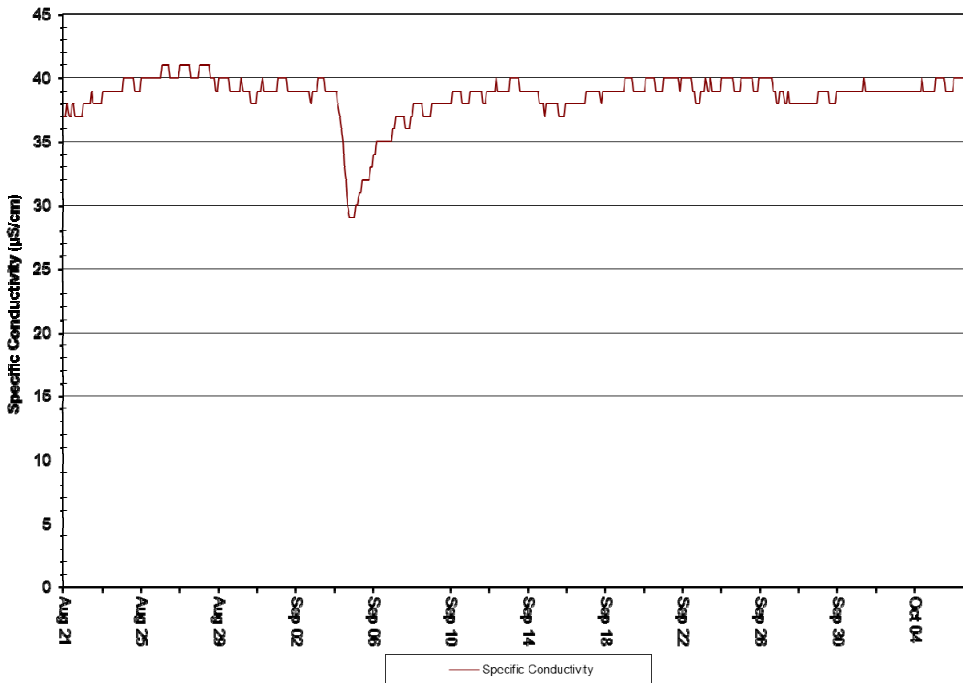
**Figure 9: Specific Conductivity at Elross Creek – August 20, 2019 to October 8, 2019**

**Specific Conductivity of Water and Stage Level**



**Figure 10: Specific Conductivity at Joan Brook – August 21, 2019 to October 9, 2019**

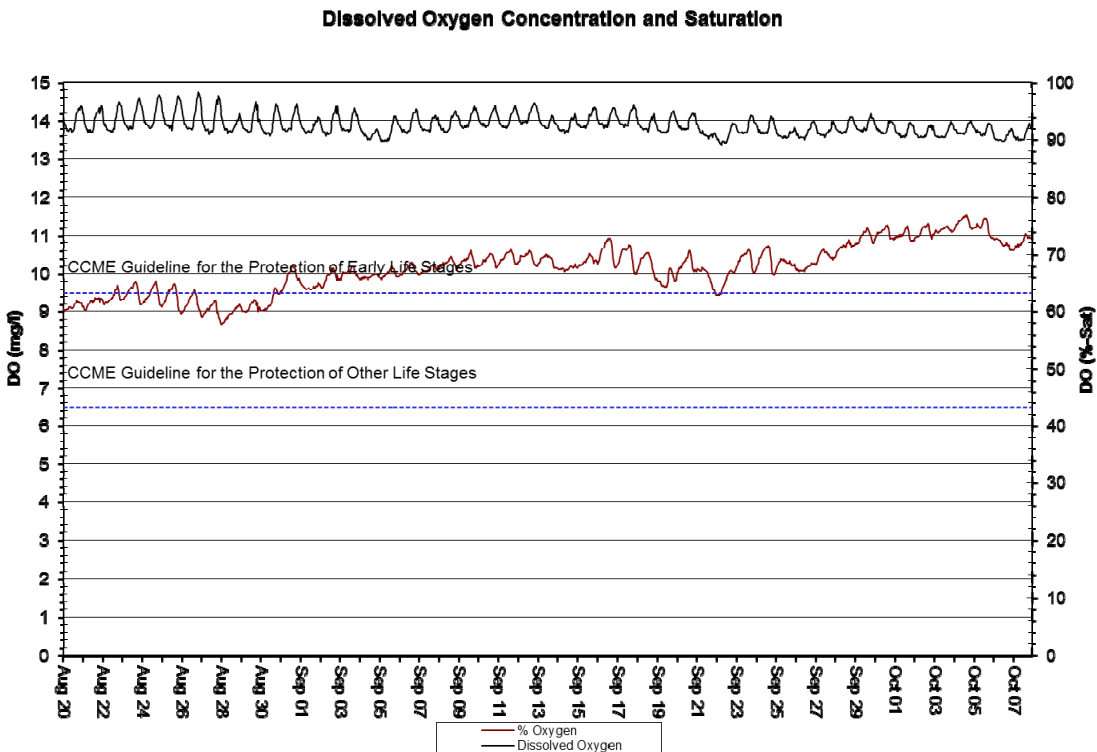
**Specific Conductivity of Water and Stage Level**



**Figure 11: Specific Conductivity at Goodream Creek – August 21, 2019 to October 9, 2019**

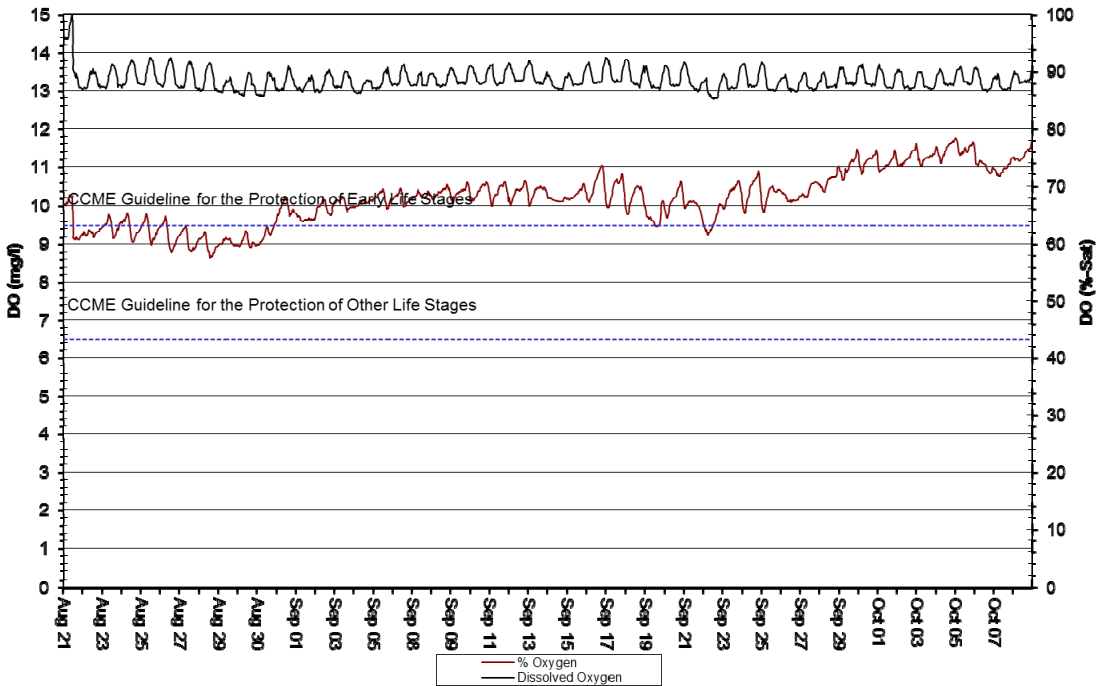
## Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.65 mg/l (89.1% saturation) to 11.55 mg/l (98.4% saturation) at Elross Creek, from 8.64 mg/l (85.2% saturation) to 11.76 mg/l (100.4% saturation) at Joan Brook, and from 9.70 mg/l (83.9% saturation) to 11.69 mg/l (95.2% saturation) at Goodream Creek (Figures 12, 13 & 14).
- DO was relatively stable over the deployment period for all three stations.
- At all three stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- The DO values at Elross Creek and Joan Brook are above the minimum guidelines set for other life stages (6.5 mg/l) and near or above the minimum guideline set for cold-water biota during early life stages (9.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007). At Goodream Creek DO values are above both guidelines.



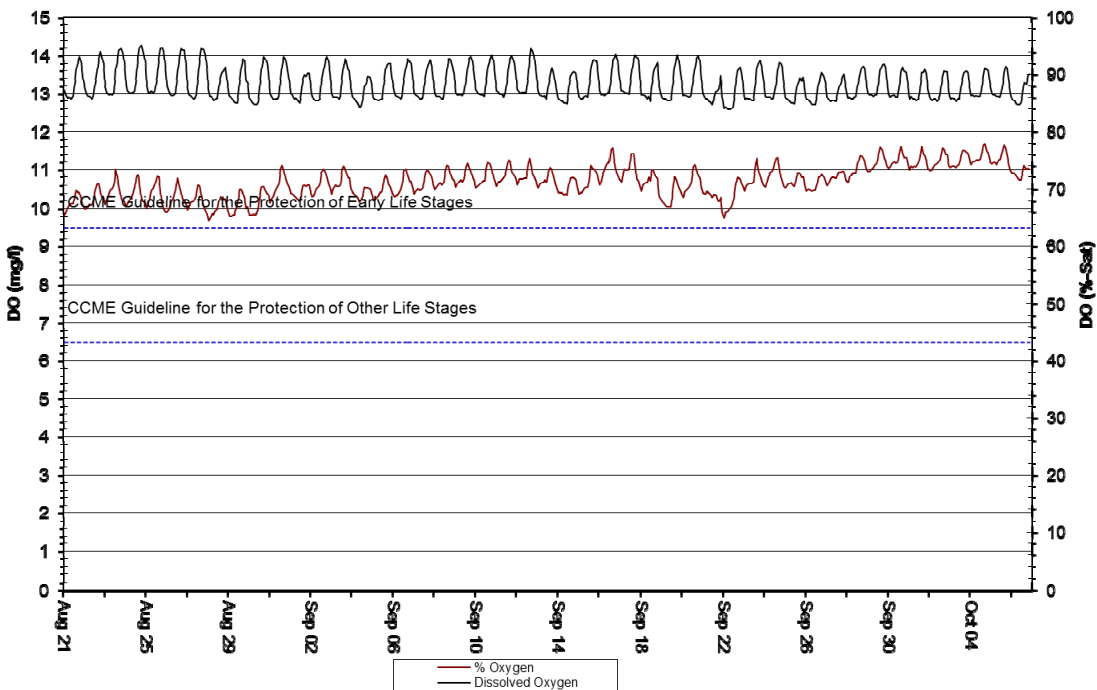
**Figure 12: DO (mg/l & % Sat.) at Elross Creek – August 20, 2019 to October 8, 2019**

**Dissolved Oxygen Concentration and Saturation**



**Figure 13: DO (mg/l & % Sat.) at Joan Brook – August 21, 2019 to October 9, 2019**

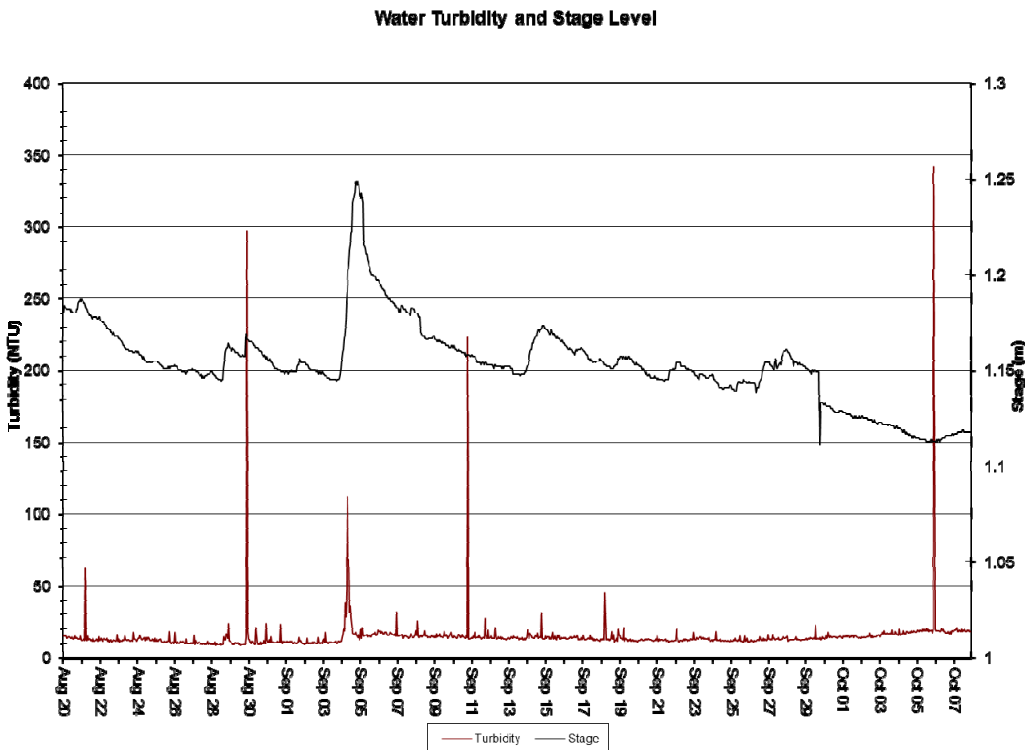
**Dissolved Oxygen Concentration and Saturation**



**Figure 14: DO (mg/l & % Sat.) at Goodream Creek – August 21, 2019 to October 9, 2019**

## 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. The 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 8.8 NTU to 342.0 NTU at Elross Creek, from 0.0 NTU to 62.3 NTU at Joan Brook, and from 0.0 NTU to 1.1 NTU at Goodream Creek (Figures 15, 16 & 17).



**Figure 15: Turbidity (NTU) at Elross Creek – August 20, 2019 to October 8, 2019**

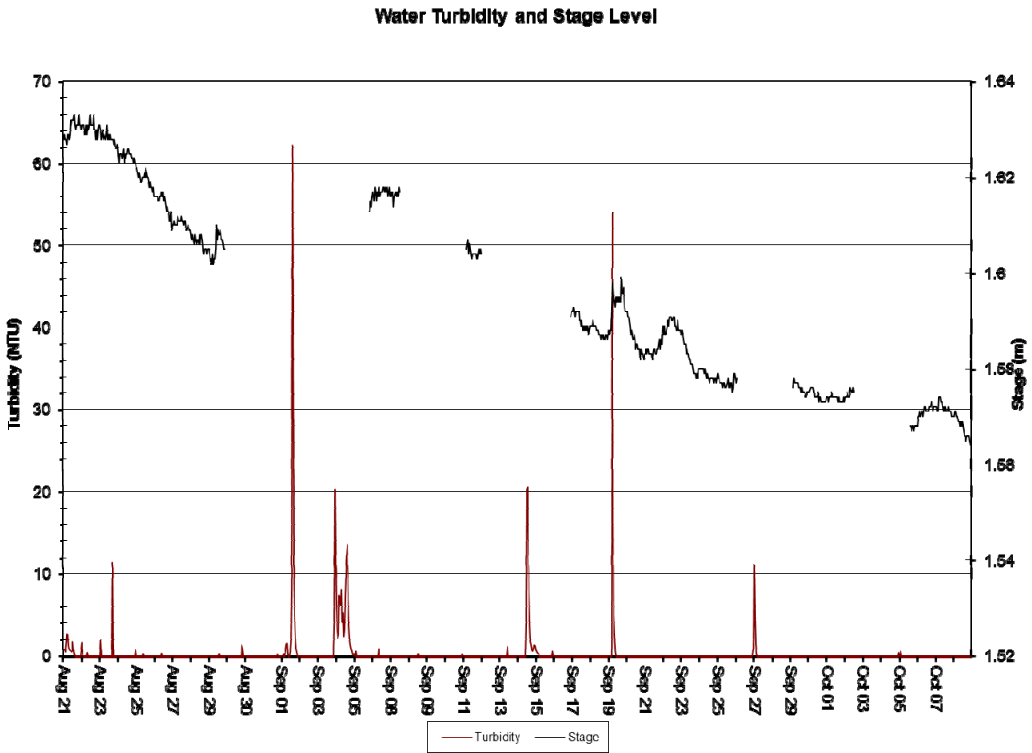


Figure 16: Turbidity (NTU) at Joan Brook – August 21, 2019 to October 9, 2019

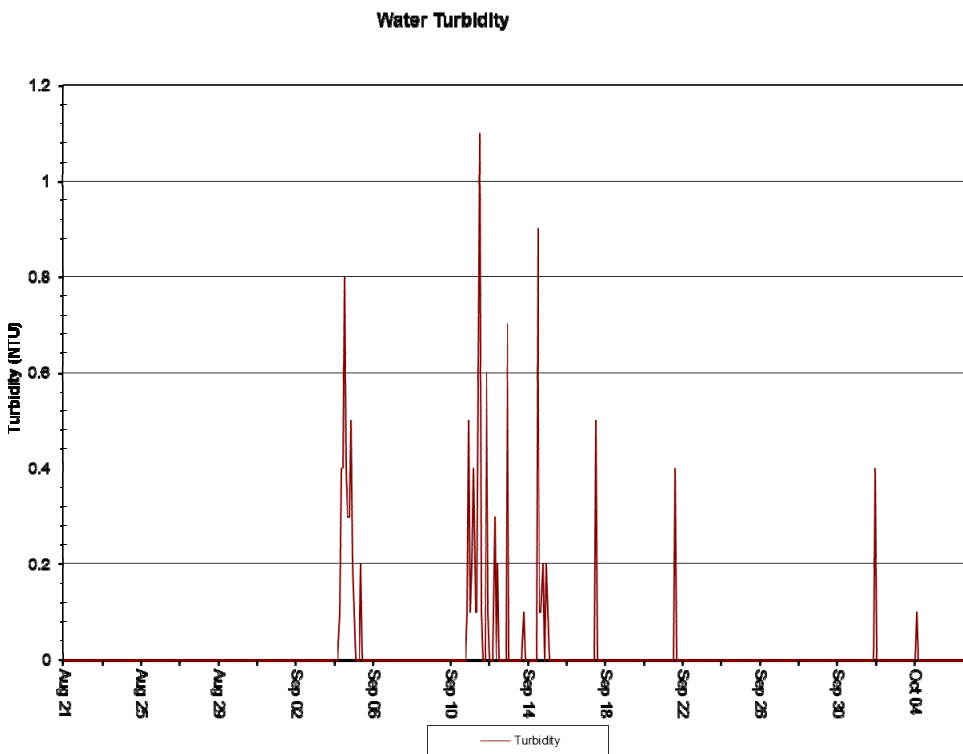


Figure 17: Turbidity (NTU) at Goodream Creek – August 21, 2019 to October 9, 2019



## Conclusions

- This monthly deployment report presents water quality and water quantity data recorded at the Elross Creek, Joan Brook, and Goodream Creek stations from August 20th, 2019 to October 9th, 2019.
- Field instruments for all three stations performed well over the deployment period with only minor operational issues.
- Variations in water quality/quantity values recorded at each station are summarized below:
  - For all three stations, stage was typical for the late summer to early fall season when hydrological conditions are affected by significant rainfall events which cause spikes that are relatively short lived.
  - For all three stations, temperature showed a declining trend over the deployment which is typical of the transition from late summer to early fall.
  - During the deployment period covered by this report, pH values ranged from 6.36 units to 6.84 units at Elross Creek, from 6.09 units to 6.84 units at Joan Brook, and 6.72 units to 7.18 units at Goodream Creek.
  - During the deployment period covered by this report, specific conductivity ranged from 14.8  $\mu\text{s}/\text{cm}$  to 20.3  $\mu\text{s}/\text{cm}$  at Elross Creek, from 7.0  $\mu\text{s}/\text{cm}$  to 12.2  $\mu\text{s}/\text{cm}$  at Joan Brook, and from 29.0  $\mu\text{s}/\text{cm}$  to 41.0  $\mu\text{s}/\text{cm}$  at Goodream Creek.
  - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 88.65 mg/l (89.1% saturation) to 11.55 mg/l (98.4% saturation) at Elross Creek, from 8.64 mg/l (85.2% saturation) to 11.76 mg/l (100.4% saturation) at Joan Brook, and from 9.70 mg/l (83.9% saturation) to 11.69 mg/l (95.2.0% saturation) at Goodream Creek.
  - During the deployment period covered by this report, turbidity values ranged from 8.8 NTU to 342.0 NTU at Elross Creek, from 0.0 NTU to 62.3 NTU at Joan Brook , and from 0.0 NTU to 1.1 NTU at Goodream Creek.

## 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.

## 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)<sup>1</sup>.

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.

Parameter	Rating				
	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

<sup>1</sup> 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 (August 20, 2019 to October 9, 2019)**

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
8/20/2019	17	10.5	13.8	4.2	0	1.6
8/21/2019	14.2	6.1	10.2	7.8	0	8
8/22/2019	14.5	7	10.8	7.2	0	0.4
8/23/2019	14.4	5.2	9.8	8.2	0	0
8/24/2019	18.9	5.3	12.1	5.9	0	0
8/25/2019	21.7	7.4	14.6	3.4	0	0
8/28/2019	26.4	10.9	18.7	0	0.7	0
8/29/2019	15.6	12.2	13.9	4.1	0	10.8
8/30/2019	18.1	10.9	14.5	3.5	0	1.8
8/31/2019	11.3	2.1	6.7	11.3	0	0.6
9/1/2019	11.4	1.7	6.6	11.4	0	0.7
9/2/2019	11.2	1.6	6.4	11.6	0	6.5
9/3/2019	9.7	2.6	6.2	11.8	0	1.6
9/4/2019	9.6	2.9	6.3	11.7	0	16.8
9/5/2019	5.5	3.1	4.3	13.7	0	
9/6/2019	10	2.4	6.2	11.8	0	2.4
9/7/2019	10.3	3.6	7	11	0	0
9/8/2019	7.7	2	4.9	13.1	0	0
9/9/2019	10.2	1.7	6	12	0	1.2
9/10/2019	9.4	1.1	5.3	12.7	0	
9/11/2019	8.7	2.4	5.6	12.4	0	0
9/12/2019	10.2	1.2	5.7	12.3	0	0
9/13/2019	11.4	3.6	7.5	10.5	0	0
9/14/2019	10.7	3.5	7.1	10.9	0	7.9
9/15/2019	9.1	5.4	7.3	10.7	0	4.9
9/16/2019	7.9	-1.8	3.1	14.9	0	0.2
9/17/2019	10.2	-2.7	3.8	14.2	0	0
9/18/2019	15.7	1.5	8.6	9.4	0	0
9/19/2019	20.3	5.7	13	5	0	2.7
9/20/2019	15.6	6	10.8	7.2	0	0.5
9/21/2019	11.9	2.4	7.2	10.8	0	0
9/22/2019	17.7	8	12.9	5.1	0	
9/23/2019	9.6	0.8	5.2	12.8	0	0.6
9/24/2019	10.3	0.7	5.5	12.5	0	0
9/25/2019	12.8	0.2	6.5	11.5	0	0
9/26/2019	8.7	6.1	7.4	10.6	0	2
9/27/2019	8.2	1.7	5	13	0	11.8
9/28/2019	9.4	0.3	4.9	13.1	0	6.1

<b>Date/Time</b>	<b>Max Temp (°C)</b>	<b>Min Temp (°C)</b>	<b>Mean Temp (°C)</b>	<b>Heat Deg Days (°C)</b>	<b>Cool Deg Days (°C)</b>	<b>Total Precip (mm)</b>
9/30/2019	3.9	-2.1	0.9	17.1	0	0
10/4/2019	2.4	-1.9	0.3	17.7	0	0
10/5/2019	3.5	-1.2	1.2	16.8	0	0
10/6/2019	7.2	-0.8	3.2	14.8	0	0.7
10/7/2019	9.6	3.6	6.6	11.4	0	5.3
10/8/2019	4.7	1.5	3.1	14.9	0	0.8
10/9/2019	11.1	0.6	5.9	12.1	0	0