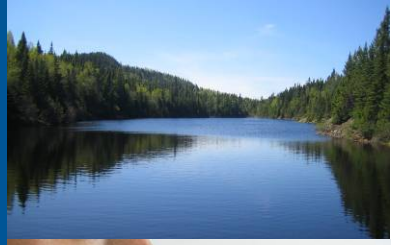




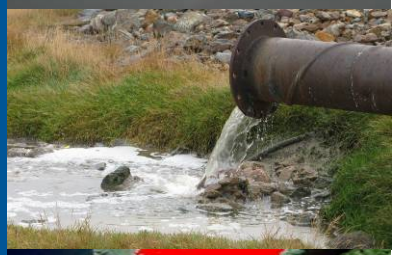


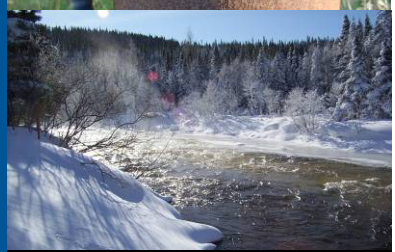

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2016-08-02 to 2016-09-07

Government of Newfoundland & Labrador
Department of Environment and Climate Change
Water Resources Management Division
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General

- During the 2016 field season the Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment and Climate Change Canada, maintained 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 August 2nd, 2016 to September 7th, 2016, which was the third deployment period for the 2016 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	2016-8-3	2016-9-7	2016-8-3	2016-9-7	2016-8-2	2016-9-6
Temperature	Excellent	Excellent	Excellent	Excellent	Good	Excellent
pH	Excellent	Fair	Marginal	Fair	Good	Fair
Specific Conductivity	Excellent	Good	Excellent	Excellent	Excellent	Excellent
Dissolved Oxygen	Excellent	Fair	Excellent	Fair	Excellent	Poor
Turbidity	Excellent	Good	Excellent	Good	Excellent	Excellent

- At Goodream Creek the performance of the pH sensor was marginal at the time of deployment due to the probe being very slow to stabilize in the very low conductivity water (Table 1).
- The performance of the oxygen sensor at Joan Brook was poor at the end of the deployment period as it was not reading due to low power (Table 1).
- 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 at Joan Brook on August 2nd, 2016 and at Elross and Goodream Creeks on August 3rd, 2016. Continuous real-time monitoring continued at Joan Brook until September 6th, and Elross and Goodream Creeks until September 7th, 2016. All three stations ran for the full deployment period with only minor operational issues. Due to operational issues there was a loss of dissolved oxygen data at Joan Brook resulting in missing data for more than half of the deployment period. Likewise the specific conductivity data for Joan Brook is missing from about August 12, 2016 until the end of the deployment period.

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 (□S/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 1.06 m to 1.26 m at Elross Creek, from 1.73 m to 2.05 m at Goodream Creek, and from 1.57 m to 1.72 m at Joan Brook (Figures 1, 2 and 3). Please note that stage height data for Elross Creek was missing for a brief period early in the deployment and for several days at the end of the deployment period. Likewise, stage height data at Joan Brook was not available for about 6 days during the middle of the deployment period. 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.

- For all three stations the stage height was typical for the summer season, when hydrological conditions are affected by significant rainfall events which cause spikes that are relatively short lived. The spikes in stage height generally correspond very well with significant rainfall events (Climate data located in Appendix B).

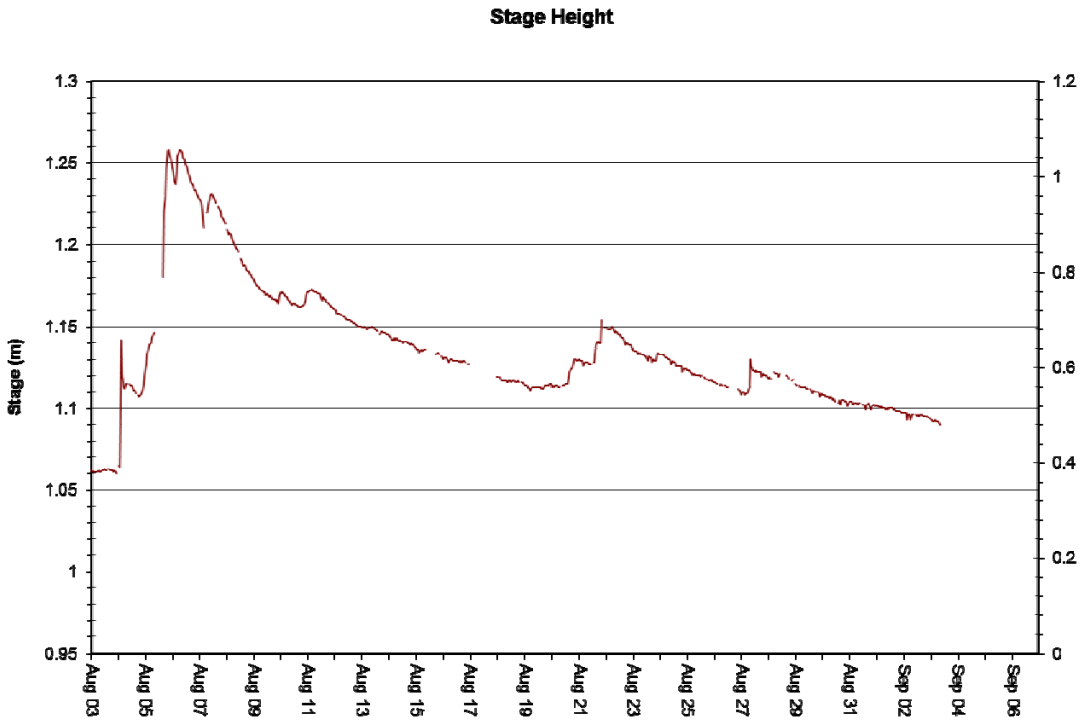

Figure 1: Stage Height (m) at Elross Creek – August 3, 2016 to September 7, 2016

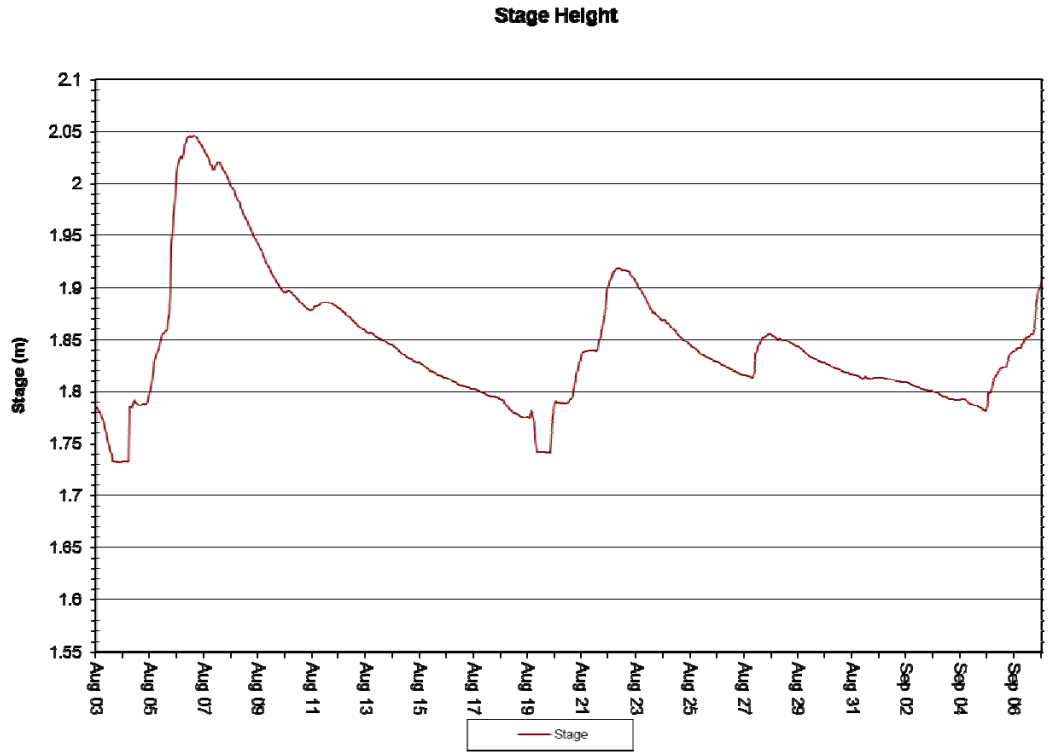

Figure 2: Stage Height (m) at Goodream Creek – August 3, 2016 to September 7, 2016

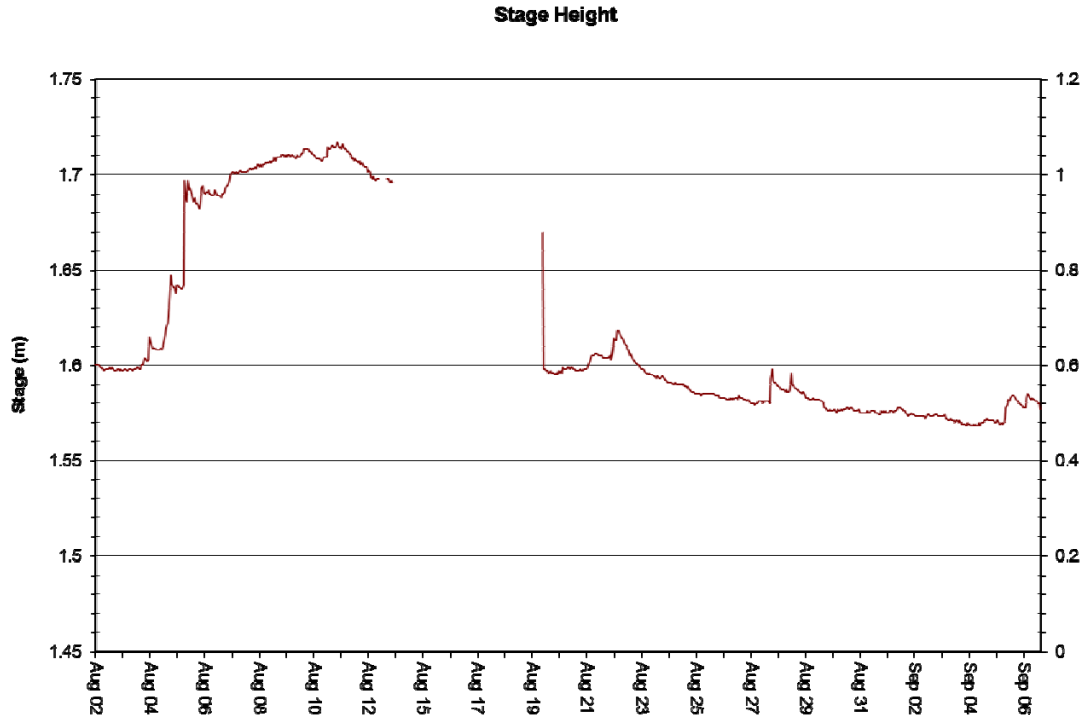

Figure 3: Stage Height (m) at Joan Brook – August 2, 2016 to September 6, 2016

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 5.95˚C to 15.10˚C at Elross Creek, from 4.80˚C to 16.00˚C at Goodream Creek, and from 4.45 to 16.20 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.
- For all three stations temperature begins a gentle declining trend over the second half of the deployment which is typical of the late summer climate of this northerly location.

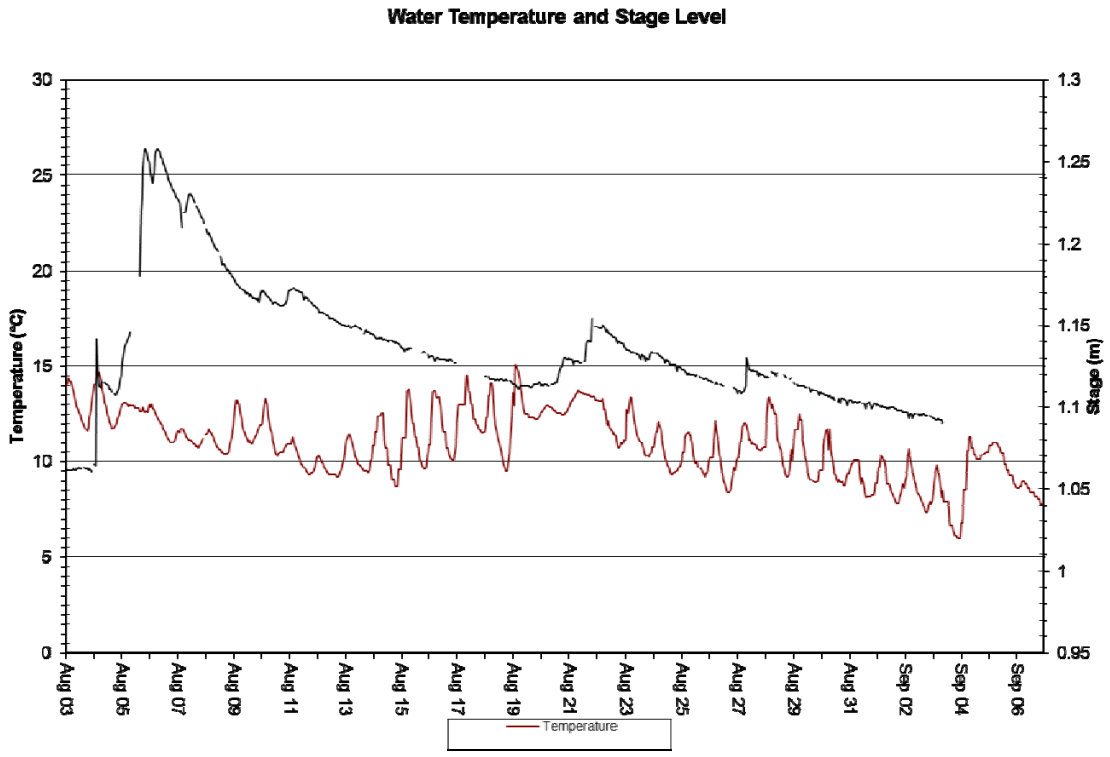

Figure 4: Temperature (°C) - Elross Creek – August 3, 2016 to September 7, 2016

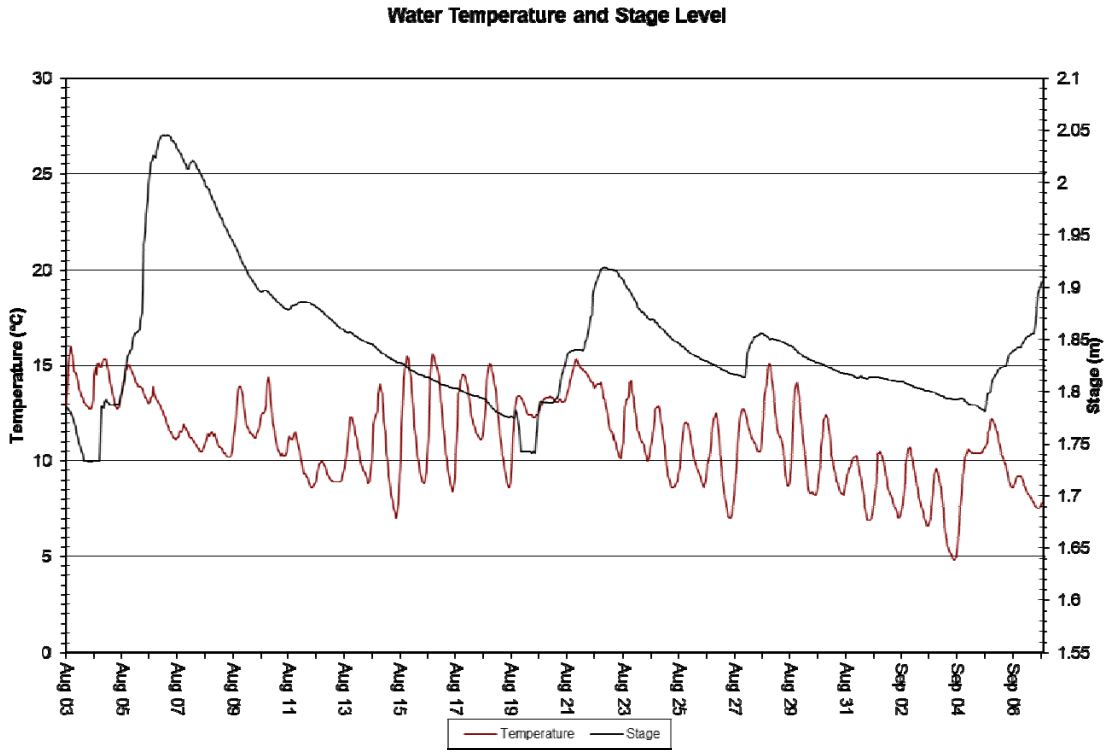

Figure 5: Temperature (°C) - Goodream Creek – August 3, 2016 to September 7, 2016

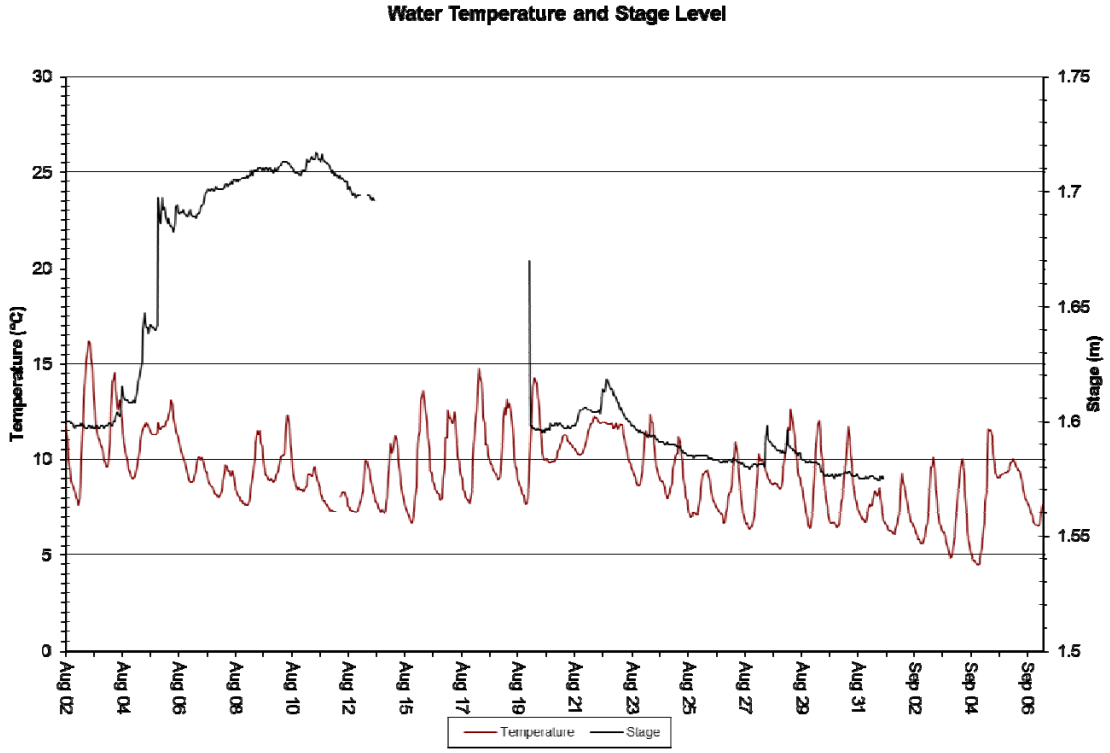

Figure 6: Temperature (°C) – Joan Brook – August 2, 2016 to September 6, 2016

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 5.97 units to 6.79 units at Elross Creek, from 4.87 units to 6.40 units at Goodream Creek, and from 6.71 units to 7.00 units at Joan Brook (Figures 7, 8 & 9). It should be noted that the low value of 4.87 units at Goodream Creek was not a typical value but was caused by a pH probe which was slow to stabilize in extremely low conductivity water.
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is clearly visible at all three stations.
- pH appears to be relatively stable at all three stations during this deployment period, however at both Elross and Goodream Creeks a noticeable dip in pH can be seen early in the deployment period (see inside red ovals, Figures 7 & 8). In both cases it appears that this dip in pH is related to a significant spike in flow caused by significant rainfall from August 5th to the 7th.
- With a median value of 6.63 units, pH at Elross Creek is 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 Goodream Creek the median pH value is 6.12 units which is just below this minimum guideline range. At Joan Brook the median pH value is 6.81 units which is within the 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.

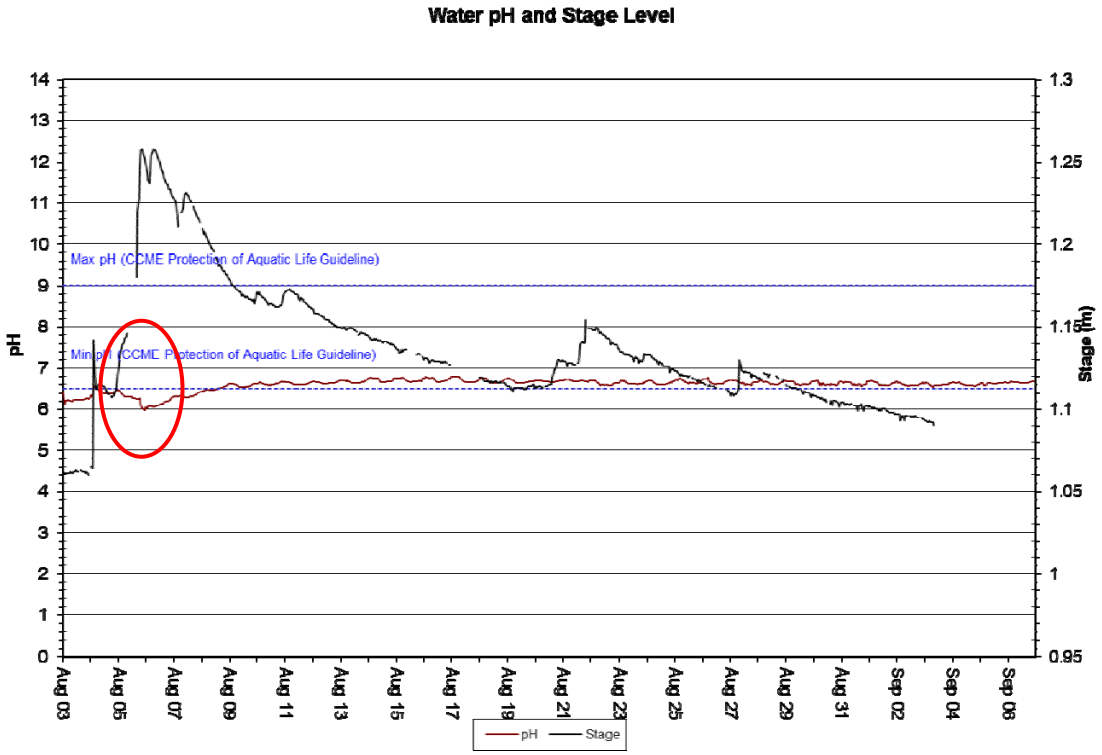

Figure 7: pH at Elross Creek – August 3, 2016 to September 7, 2016

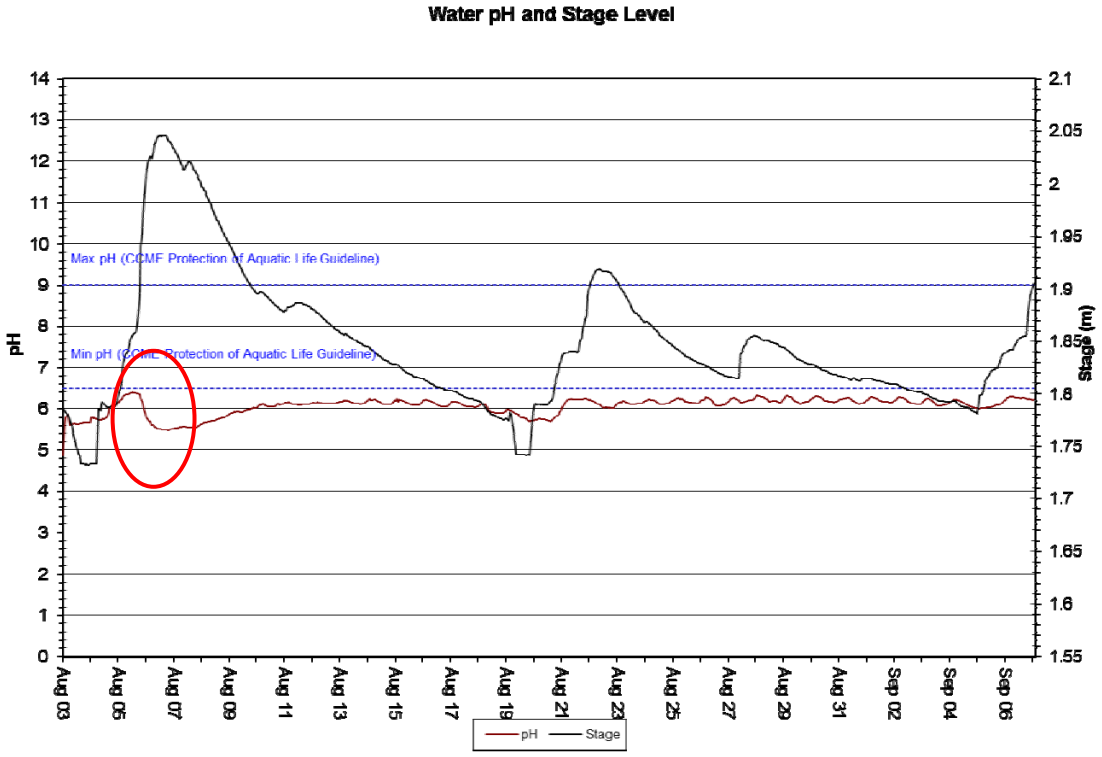

Figure 8: pH at Goodream Creek – August 3, 2016 to September 7, 2016

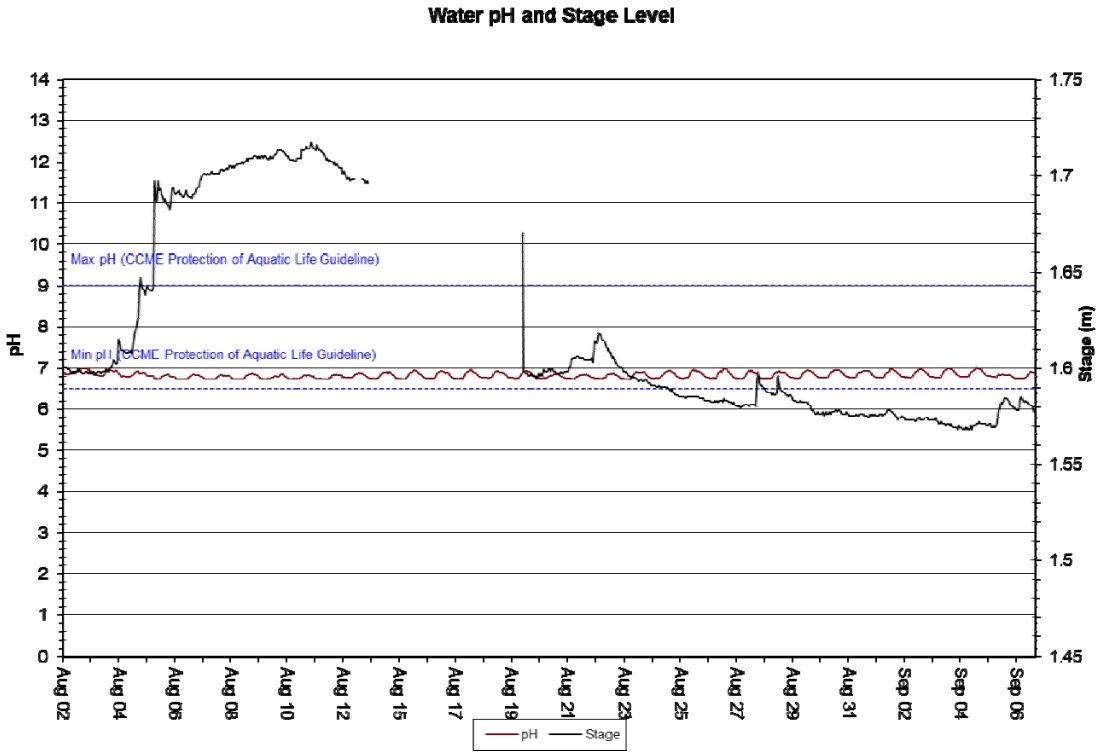

Figure 9: pH at Joan Brook – August 2, 2016 to September 6, 2016

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 10.1 µs/cm to 21.0 µs/cm at Elross Creek, from 3.9 µs/cm to 17.0 µs/cm at Goodream Creek, and from 5.7 µs/cm to 8.5 µs/cm at Joan Brook (Figures 10, 11 & 12).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend, however during this deployment these diurnal trends are somewhat obscured by other variables and can only be partially seen at Elross Creek and in the early part of the Joan Brook deployment.
- At Goodream Creek specific conductivity appears to be more variable than the other two stations. This variability may be related to low flow conditions when groundwater input is more significant to total flow.

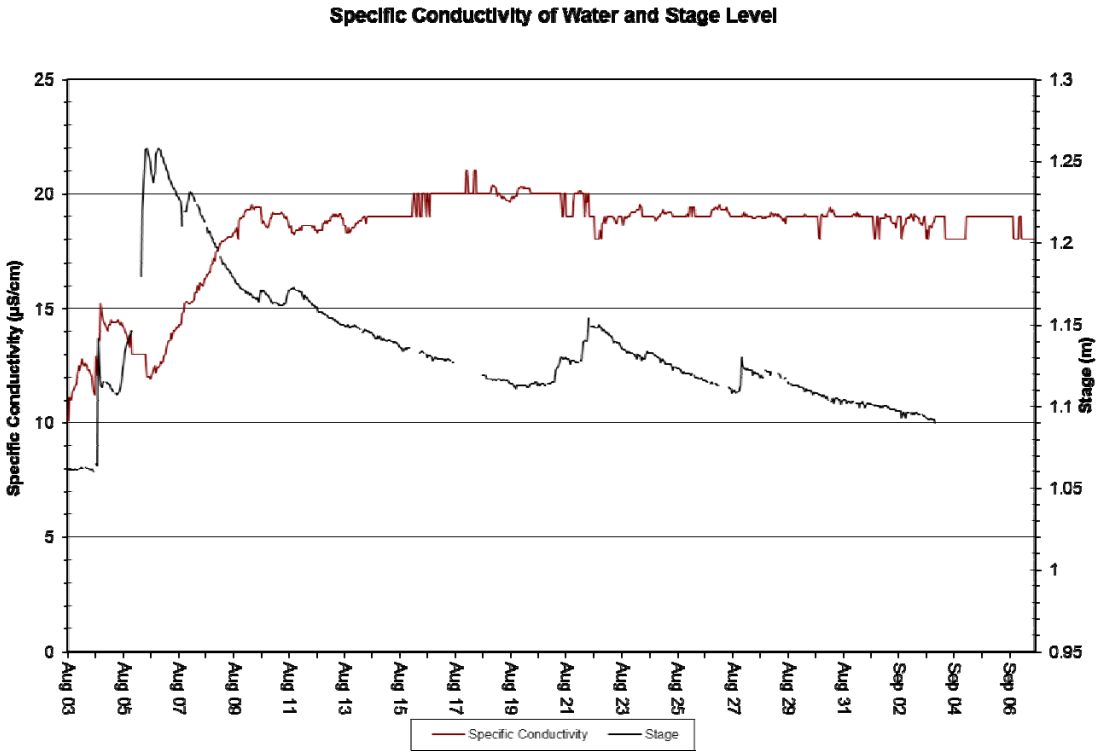

Figure 10: Specific conductivity - Elross Creek – August 3, 2016 to September 7, 2016

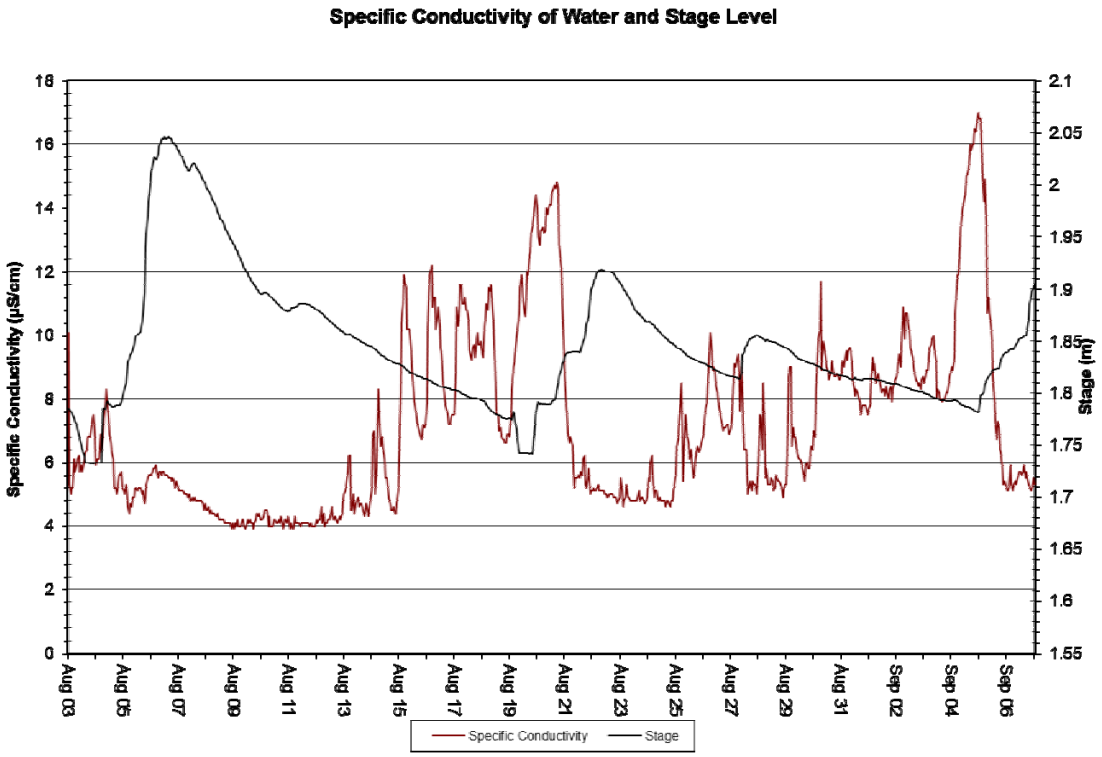

Figure 11: Specific conductivity - Goodream Creek – August 3, 2016 to September 7, 2016

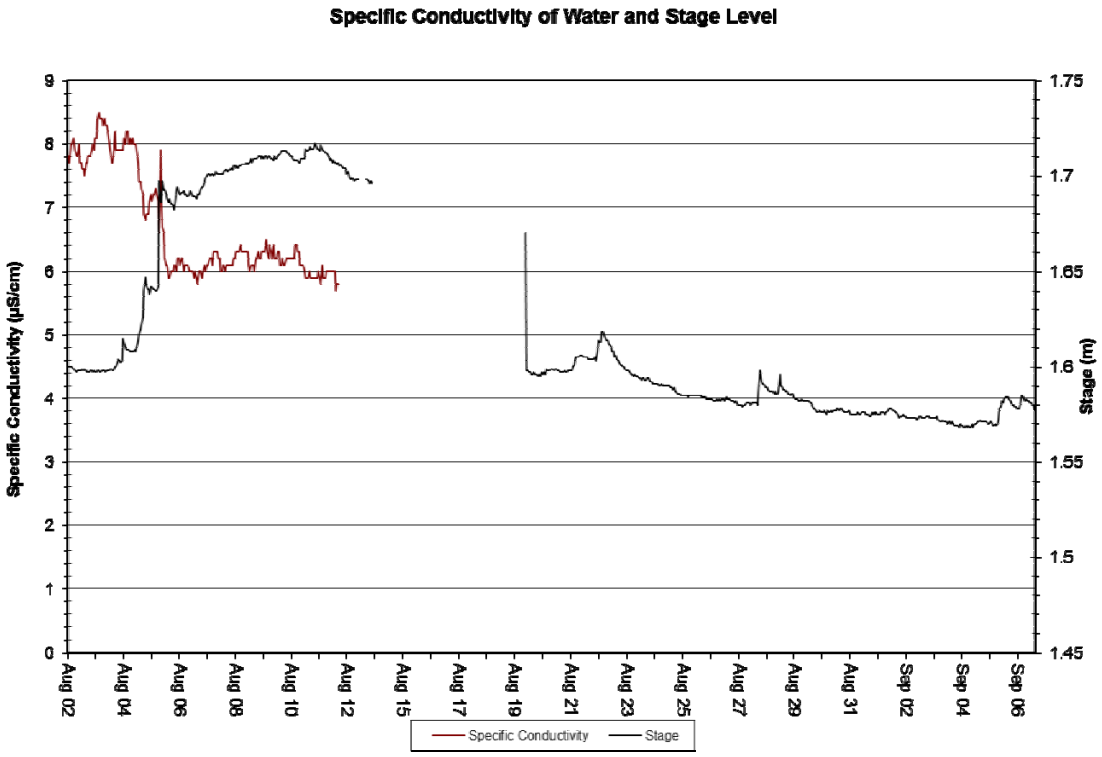

Figure 12: Specific conductivity – Joan Brook – August 2, 2016 to September 6, 2016

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.45 mg/l (83.5% saturation) to 10.68 mg/l (97.2% saturation) at Elross Creek, from 1.67 mg/l (16.6 % saturation) to 10.68 mg/l (101.4% saturation) at Goodream Creek, and from 9.13 mg/l (90.3% saturation) to 13.96 mg/l (140.5% saturation) at Joan Brook (Figures 13, 14 & 15).
- It appears that at Joan Brook there is significant missing DO data as well as potentially erroneous elevated DO levels for this second half of the deployment period which were removed from the dataset. The missing data and elevated DO levels are most likely related to power supply issues as batteries were quickly depleted when the instrument was disconnected from the RTWQ data transmission system part way through the deployment.
- DO was relatively stable over the deployment period for Elross Creek, however at Goodream Creek DO is highly variable due to low flow conditions when DO(mg/l & %saturation) takes several noticeable dips (See inside red ovals, Figure 14). During low flow conditions, less oxygen is introduced into the water. At Joan Brook missing data and potentially erroneous elevated data make it difficult to comment on the DO data for this deployment period.

- At all three stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- The DO values at Elross Creek were above minimum guidelines set for other life stages (6.5 mg/l) and at or slightly below 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). DO values at Goodream Creek dipped below both these guidelines due to low flow conditions. At Joan Brook missing and potentially erroneous elevated DO data make it difficult to make meaningful comparisons with these guidelines.

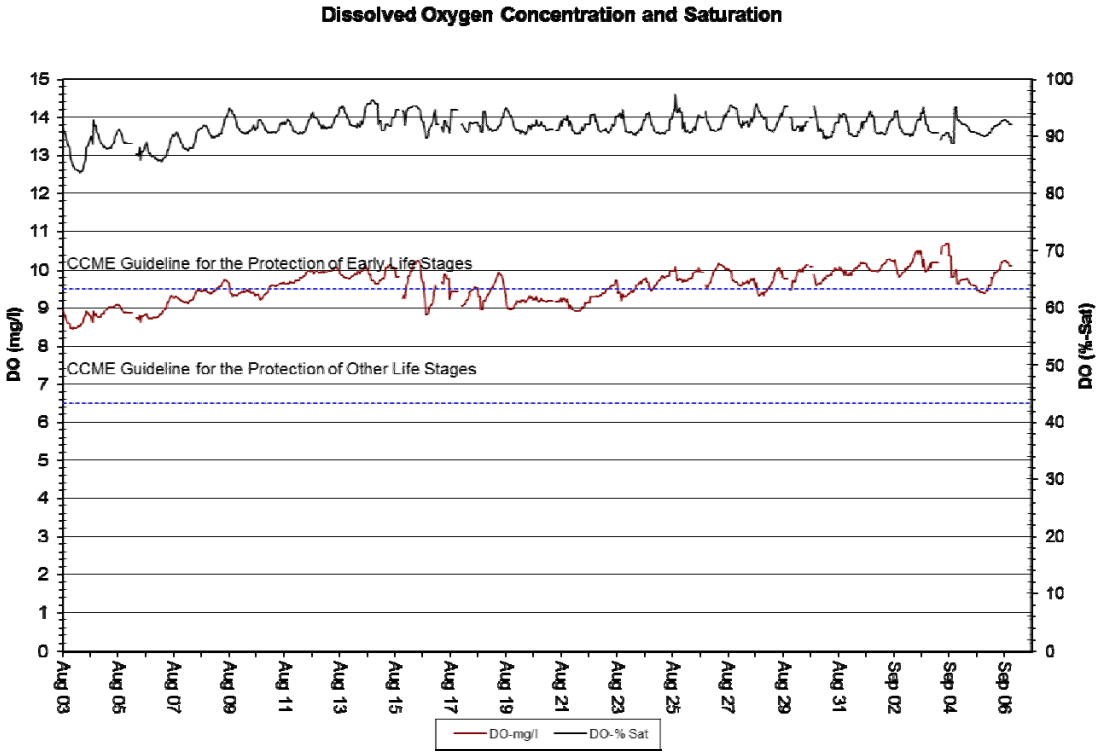

Figure 13: DO (mg/l & % saturation) at Elross Creek – August 3, 2016 to Sept. 7, 2016

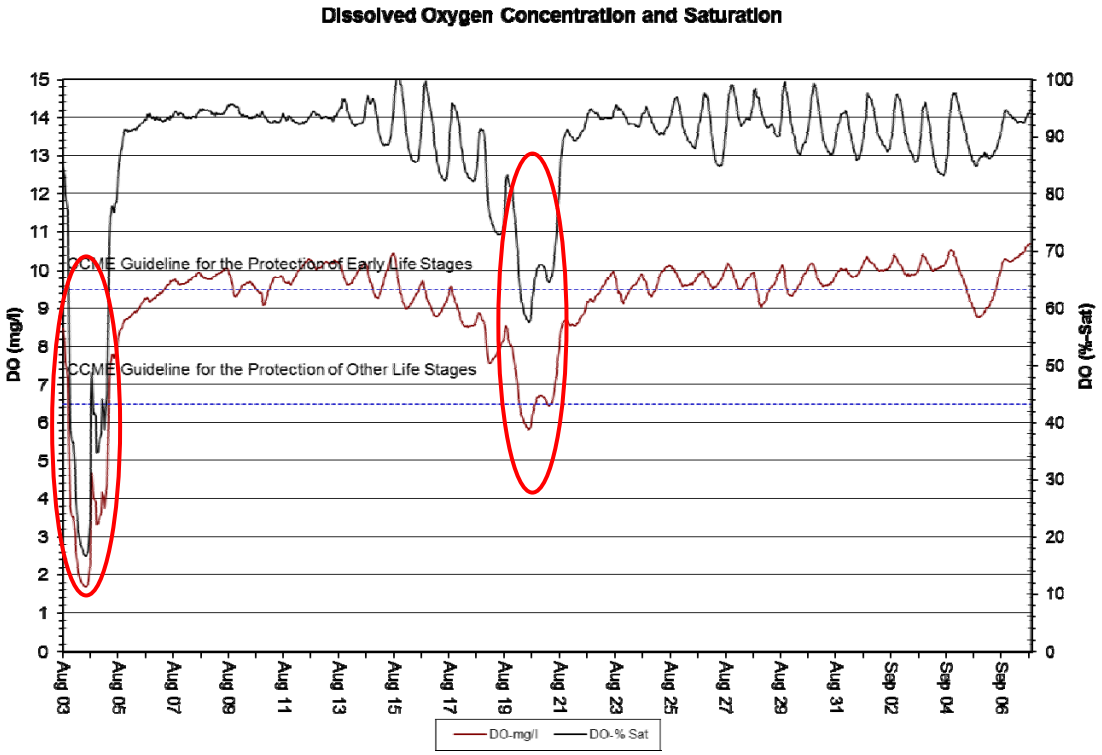

Figure 14: DO (mg/l & % saturation) at Goodream Creek – August 3, 2016 to Sept. 7, 2016

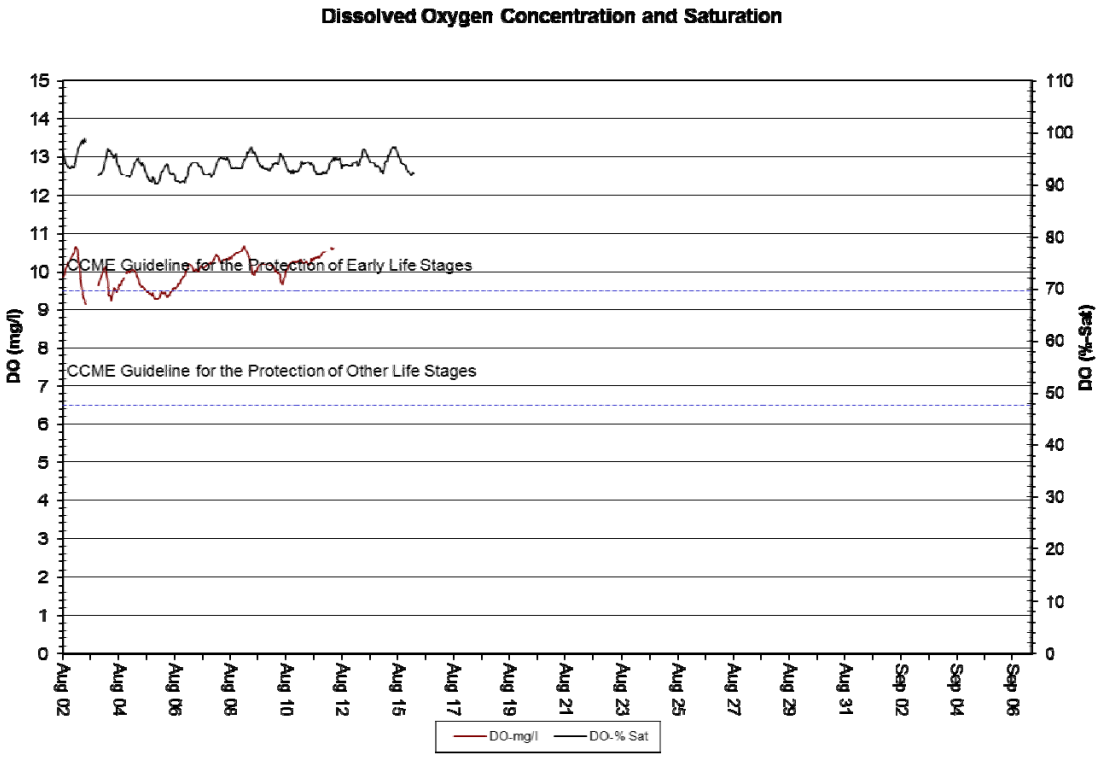

Figure 15: DO (mg/l & % saturation) at Joan Brook – August 2, 2016 to September 6, 2016

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 0.0 NTU to 1251.0 NTU at Elross Creek, from 0.0 NTU to 1674.0 NTU at Goodream Creek, and from 0.0 to 1097.0 at Joan Brook (Figures 16, 17 & 18).
- At Goodream Creek and Joan Brook there appears to be significant spikes in turbidity around August 6th which correspond with a significant increase in flow related to a rainfall event of over 50 mm on that date (see inside red ovals, Figures 17 &18).

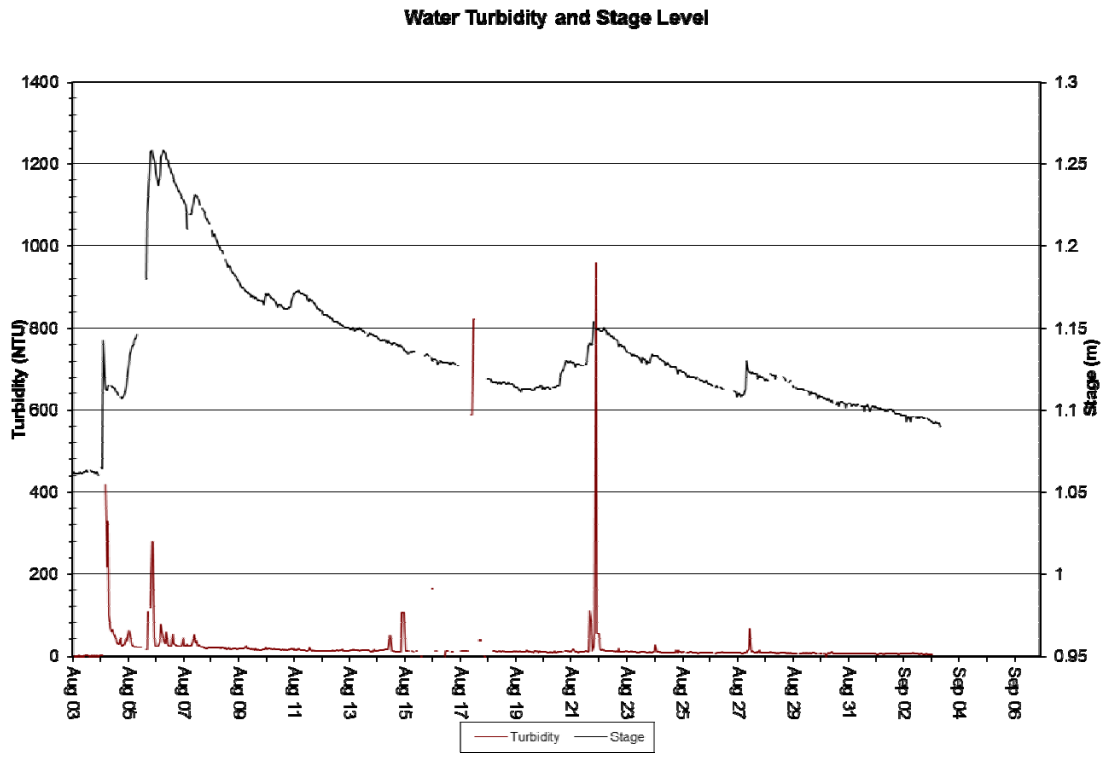

Figure 16: Turbidity (NTU) at Elross Creek – August 3, 2016 to Sept. 7, 2016

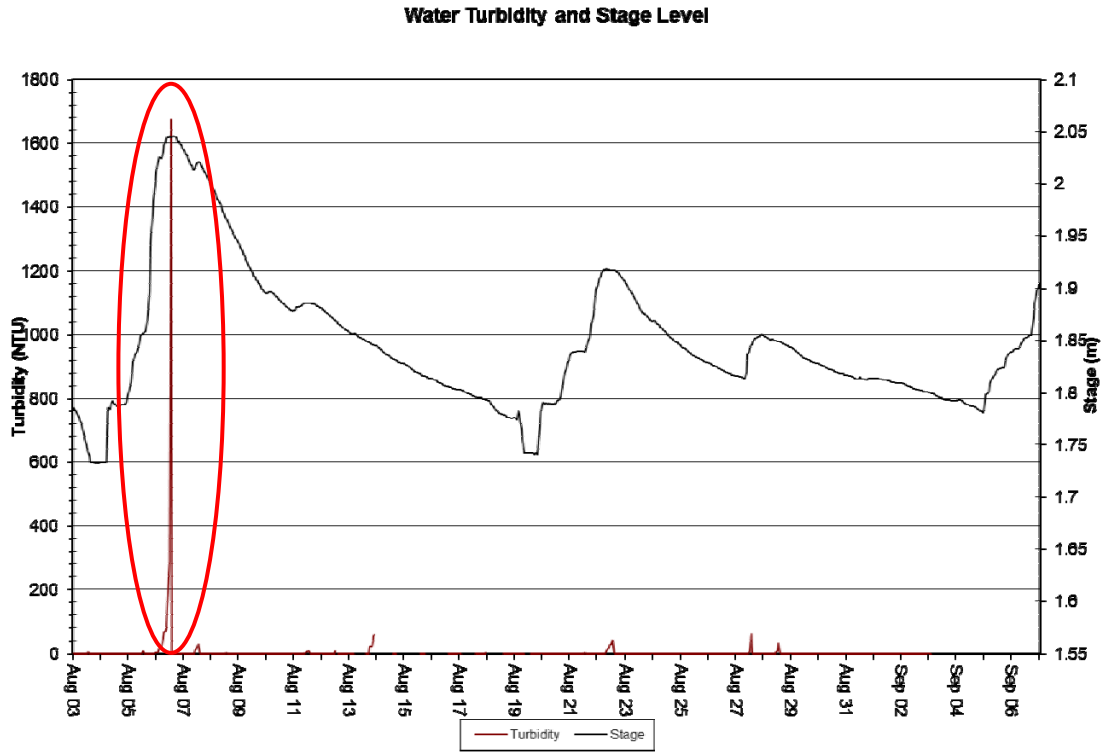

Figure 17: Turbidity (NTU) at Goodream Creek – August 3, 2016 to Sept. 7, 2016

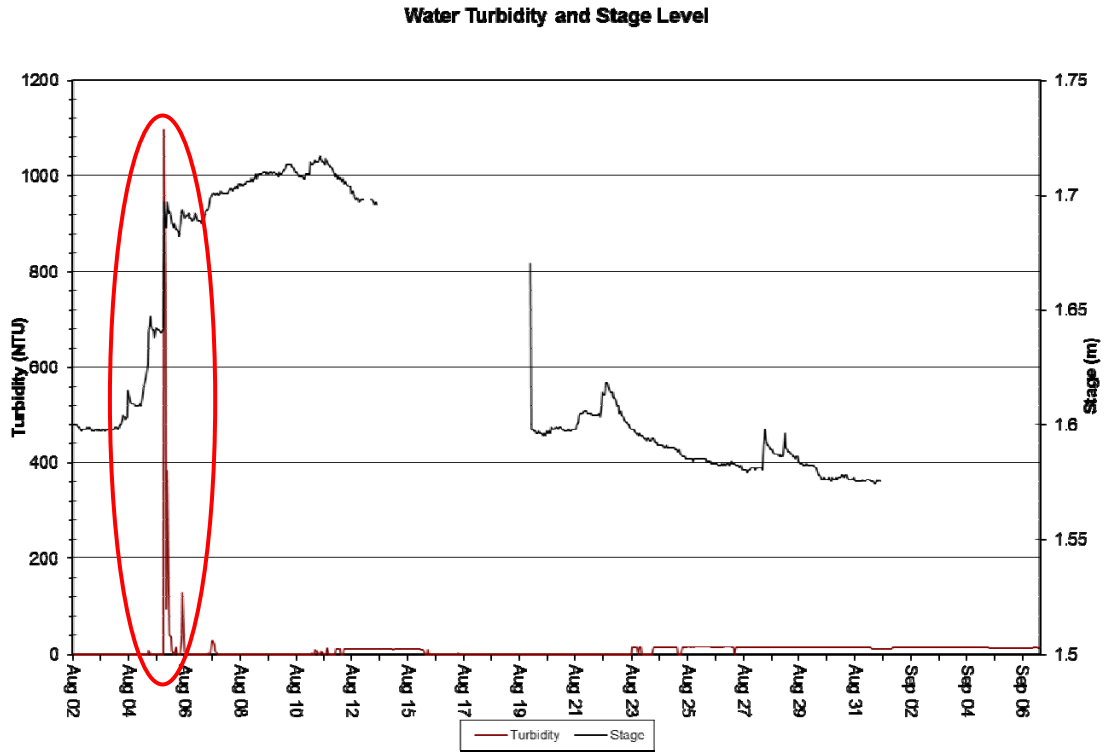

Figure 18: Turbidity (NTU) at Joan Brook – August 2, 2016 to September 6, 2016

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek, and Joan Brook stations from August 2nd, 2016 to September 7rd, 2016.
- Field instruments for all three stations performed reasonably well over the deployment period. However, due to operational issues there was a loss of dissolved oxygen data at Joan Brook resulting in missing data for more than half of the deployment period. Likewise the specific conductivity data for Joan Brook is missing from about August 12, 2016 until the end of the deployment period.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For all three stations the stage height was typical for the summer season, when hydrological conditions are affected by significant rainfall events which cause spikes that are relatively short lived.
    - For all three stations temperature begins a gentle declining trend over the second half of the deployment which is typical of the late summer climate of this northerly location.
    - During the deployment period covered by this report, pH values ranged from 5.97 units to 6.79 units at Elross Creek, from 4.87 units to 6.40 units at Goodream Creek, and from 6.71 units to 7.00 units at Joan Brook.
    - During the deployment period covered by this report, specific conductivity ranged from 10.1 µs/cm to 21.0 µs/cm at Elross Creek, from 3.9 µs/cm to 17.0 µs/cm at Goodream Creek, and from 5.7 µs/cm to 8.5 µs/cm at Joan Brook.
    - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.45 mg/l (83.5% saturation) to 10.68 mg/l (97.2% saturation) at Elross Creek, from 1.67 mg/l (16.6 % saturation) to 10.68 mg/l (101.4% saturation) at Goodream Creek, and from 9.13 mg/l (90.3% saturation) to 13.96 mg/l (140.5% saturation) at Joan Brook.
    - During the deployment period covered by this report, turbidity values ranged from 0.0 NTU to 1251.0 NTU at Elross Creek, from 0.0 NTU to 1674.0 NTU at Goodream Creek, and from 0.0 NTU to 1097.0 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 (August 2, 2016 to Sept. 7, 2016)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
8/2/2016	22.1	6.8	14.5	3.5	0	0
8/3/2016	24.8	7.6	16.2	1.8	0	0
8/4/2016	22.6	13	17.8	0.2	0	6
8/5/2016	16.3	12.6	14.5	3.5	0	17.2
8/6/2016	16	8.2	12.1	5.9	0	54.6
8/7/2016	9.2	6.8	8	10	0	10.7
8/8/2016	11.9	6.7	9.3	8.7	0	0
8/9/2016	18.6	7.8	13.2	4.8	0	0
8/10/2016	18.1	9.9	14	4	0	2
8/11/2016	11.6	5.3	8.5	9.5	0	5.1
8/12/2016	8.8	4.2	6.5	11.5	0	0.4
8/13/2016	14.1	7.4	10.8	7.2	0	0.3
8/14/2016	16.2	5.3	10.8	7.2	0	0.2
8/15/2016	20.1	3.7	11.9	6.1	0	0.4
8/16/2016	21.6	6.8	14.2	3.8	0	0
8/17/2016	22.7	6.1	14.4	3.6	0	0
8/18/2016	19.7	7.6	13.7	4.3	0	0
8/19/2016	22.2	6.1	14.2	3.8	0	0.5
8/20/2016	17	12.9	15	3	0	1.5
8/21/2016	21.3	14.3	17.8	0.2	0	16.2
8/22/2016	16.7	9.4	13.1	4.9	0	5.7
8/23/2016	17.4	8.1	12.8	5.2	0	0.2
8/24/2016	14.2	5.8	10	8	0	2
8/25/2016	11.5	6	8.8	9.2	0	0
8/26/2016	14.6	4.2	9.4	8.6	0	0.2
8/27/2016	15.9	3.5	9.7	8.3	0	3.9
8/28/2016	19.5	8.5	14	4	0	0.4
8/29/2016	12.9	4.3	8.6	9.4	0	0
8/30/2016	14.1	5.4	9.8	8.2	0	0.3
8/31/2016	8.8	4.4	6.6	11.4	0	0
9/1/2016	10.5	3.5	7	11	0	0.8
9/2/2016						
9/3/2016	9.2	0.3	4.8	13.2	0	0.5
9/4/2016	21.4	1.1	11.3	6.7	0	0
9/5/2016	18.4	7.9	13.2	4.8	0	5.7
9/6/2016	7.9	5.2	6.6	11.4	0	6
9/7/2016	6.6	3.3	5	13	0	11