Real Time Water Quality Report

Labrador Iron Mines
Schefferville Network

Deployment Period
2015-06-02 to 2015-07-07

Newfoundland Labrador

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

Prepared by:

Ian Bell
Environmental Scientist

Department of Environment & Conservation
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 Labrador Iron Mines Ltd. and Environment Canada, maintain two real-time water quality/quantity stations in close proximity to the James Property deposits, near Schefferville, QC, and one real-time water quality/quantity station in close proximity to the Houston Property deposits.
- The official name of each station is *James Creek Above Bridge*, *Unnamed Tributary Below Settling Pond*, and *Houston Creek above Road Culvert,* hereafter referred to as the James Creek station, the Unnamed Tributary station, and the Houston Creek station respectively.
- The Unnamed Tributary station was idled at the end of 2013 when dewatering operations ceased and the brook ran dry.
- The Houston Creek station was idled at the end of 2014 as plans for developing the ore body in that area were delayed and there was to be no activity in the area during 2015.
- James Creek station monitors water outflow from the multi-cell retention and settling pond system as well as from Ruth Pit. The retention and settling pond system was designed with four smaller man-made ponds that received water primarily from groundwater wells constructed along the periphery of the James Property, in addition to storm water from the beneficiation area, flush water from the reject rock pipeline, and in case of pump failure, reject rock inside the pipeline that was destine to Ruth Pit. At present none of these pumping systems are operational and outflow from the retention and settling pond system is directed into James Creek
- Ruth Pit was used as a settling pond for reject rock originating from the beneficiation area at the Silver Yard, and also received water from pit dewatering pumps. The outflow from Ruth Pit is the start of James Creek.
- The Water Resources Management Division will inform Labrador Iron Mines Ltd. 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 James Creek from June 2, 2015, to July 7, 2015.
- It should be noted that during the 2015 field season there were technical issues with the power supply at the James Creek station which affected data logging and data transmissions. As a result there is missing data.

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.
- **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 shows the performance ratings of five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) measured by the instrument deployed at the water monitoring station.

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

	James Creek	
Stage of deployment	**Beginning**	**End**
Date	2015-06-02	2015-07-07
Temperature	Excellent	NA
pH	Excellent	NA
Specific Conductivity	Excellent	NA
Dissolved Oxygen	Excellent	NA
Turbidity	Excellent	NA

- The performance of all sensors at James Creek was rated excellent at the beginning of the deployment period (Table 1). Unfortunately, due to technical issues with the power supply, there was no field data available for comparison at the time of removal of the instrument from James Creek.

Deployment Notes

- Water quality monitoring for this deployment period started at James Creek on June 2, 2015 at 5:00 pm. Continuous real-time monitoring continued without any significant operational issues until June 28, 2015, when some data for several parameters was lost, and then continued with partial data collection until July 6th at 10:30 pm. The instrument was removed for calibration and maintenance on July 7, 2015 at 10:00 am.

Data Interpretation

- Data records were interpreted for the 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

- Stage values ranged from 515.75 m to 515.78 m at James Creek (Figure 1) from June 2, 2015 to June 28, 2015, while the corresponding flow for the same period ranged from 0.47 m^3/sec to 0.54 m^3/sec. Due to technical issues no stage or flow data was available from June 29, 2015 until the end 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 James Creek there appears to be an overall gentle declining trend throughout the deployment period which is consistent with the transition from late spring to summer.
- Daily fluctuations in stage height and flow observed at James Creek are related to variations in the local climate. One of the more noticeable peaks at around June 24 (see inside red oval) corresponds with a rainfall event at that time (see climate data in appendix B).
- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.

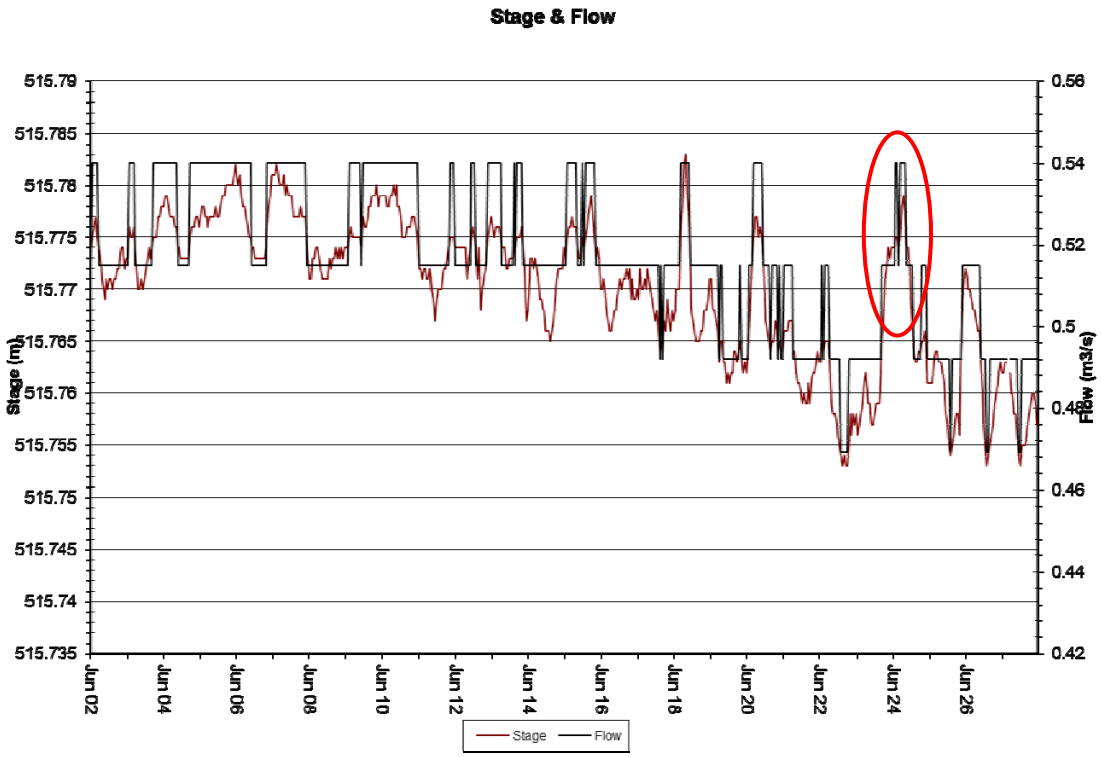

Figure 1: Stage Height (m) at James Creek from June 2, 2015 to June 28, 2015

Temperature

- Water temperature ranged from 3.70˚C to 15.78˚C at James Creek (Figure 2) from June 2, 2015 to July 6, 2015.
- Water temperature at James Creek shows significant diurnal variations. This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- There was a gentle increasing temperature trend at James Creek over the deployment period which is consistent with the transition from late spring to early summer.

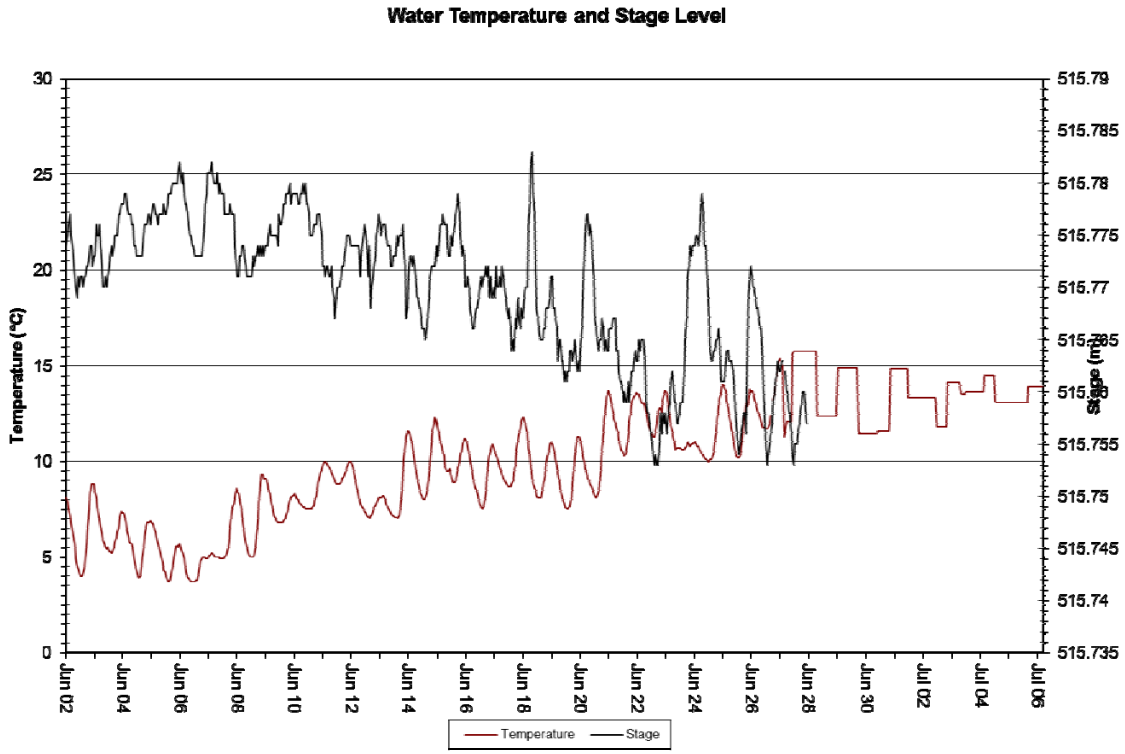

Figure 2: Temperature (^{o}C) at James Creek from June 2, 2015 to July 6, 2015

pH

- pH values ranged from 7.73 units to 8.61 units at James Creek (Figure 3) from June 2, 2015 to July 6, 2015.
- pH values at James Creek station shows regular diurnal fluctuations which are related to the diurnal temperature fluctuations.
- pH at James Creek was relatively stable throughout the deployment period and with a median value of 8.12, all data were within the guidelines for pH for the protection of aquatic life (i.e., 6.5 to 9.0 units), as defined by the Canadian Council of Ministers of the Environment (2007).

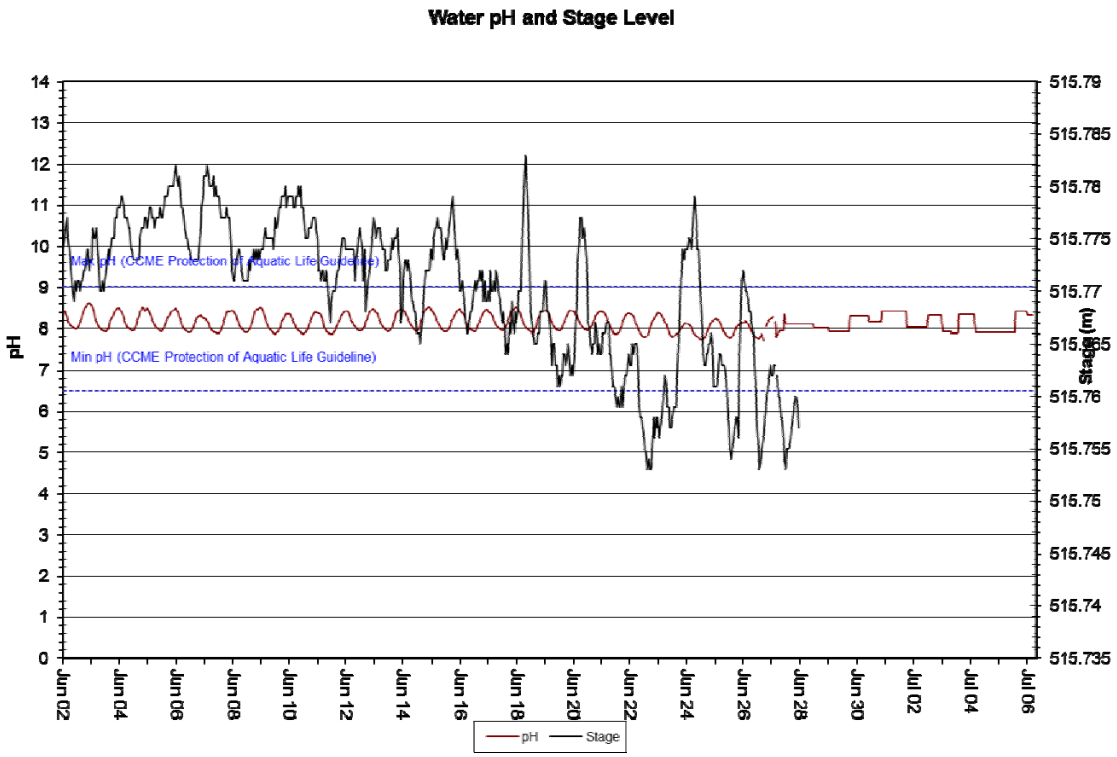

Figure 3: pH values recorded at James Creek from June 2, 2015 to July 6, 2015

Specific Conductivity

- Specific Conductivity ranged from118.7 µS/cm to 140.0 µS/cm at James Creek (Figure 4) from June 2, 2015 to July 6, 2015.
- Specific conductivity readings show a noticeable drop early in the deployment around June 4, 2015 (see inside red oval), which corresponds with an increase in flow due to snowmelt in the upstream watershed.
- Over the deployment period there is a gentle increasing trend in the specific conductivity at James Creek which is related to the increasing temperature trend for the same period.
- There are noticeable diurnal fluctuations in the specific conductivity at James Creek which are related to the diurnal temperature fluctuations.

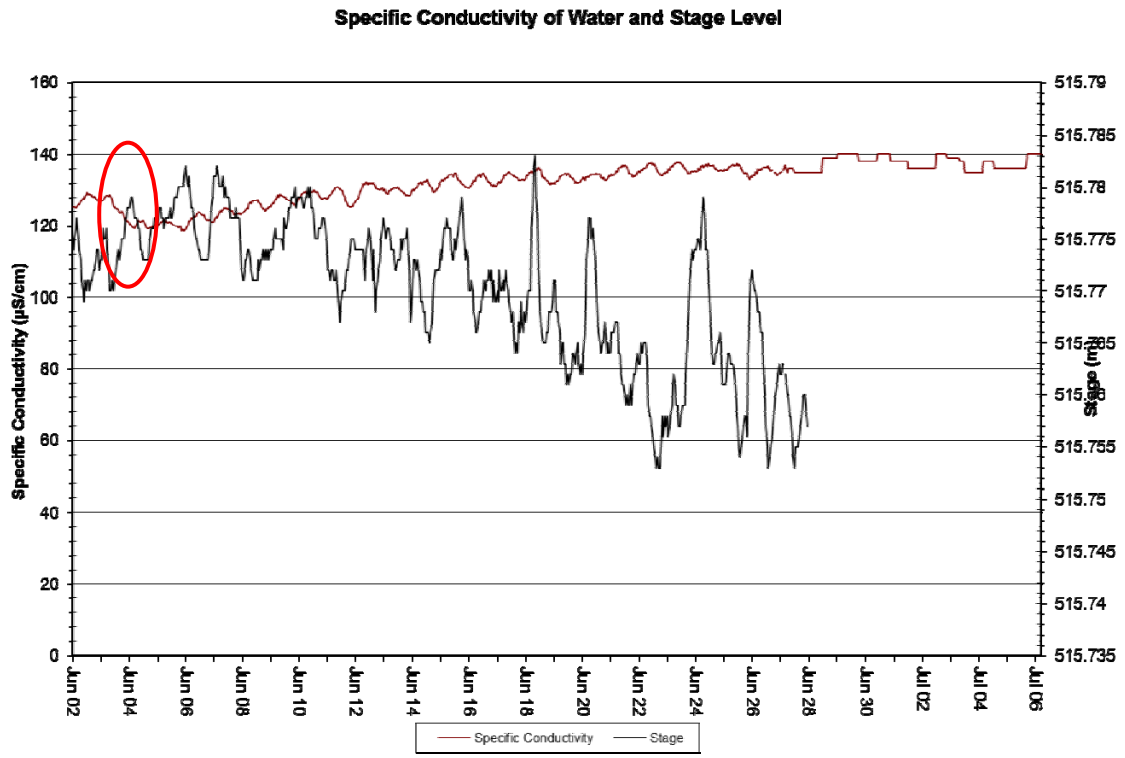

Figure 4: Specific conductivity (µs/cm) at James Creek from June 2, 2015 to July 6, 2015

Dissolved Oxygen

- Dissolved Oxygen [DO] values ranged from 9.25 mg/l (86.0% saturation) to 12.87 mg/l (106.1% saturation) at James Creek (Figure 5) from June 2, 2015 to July 6, 2015. Due to technical issues there is a gap with missing data on June 29th and 30th.
- DO (mg/l & % saturation) shows clear diurnal fluctuations which can be attributed to the diurnal temperature fluctuations.
- DO (mg/l) shows a gentle declining trend over the deployment period which is related to the increasing temperature trend for the same period.
- The DO values were near or above the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and well above minimum guideline set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).

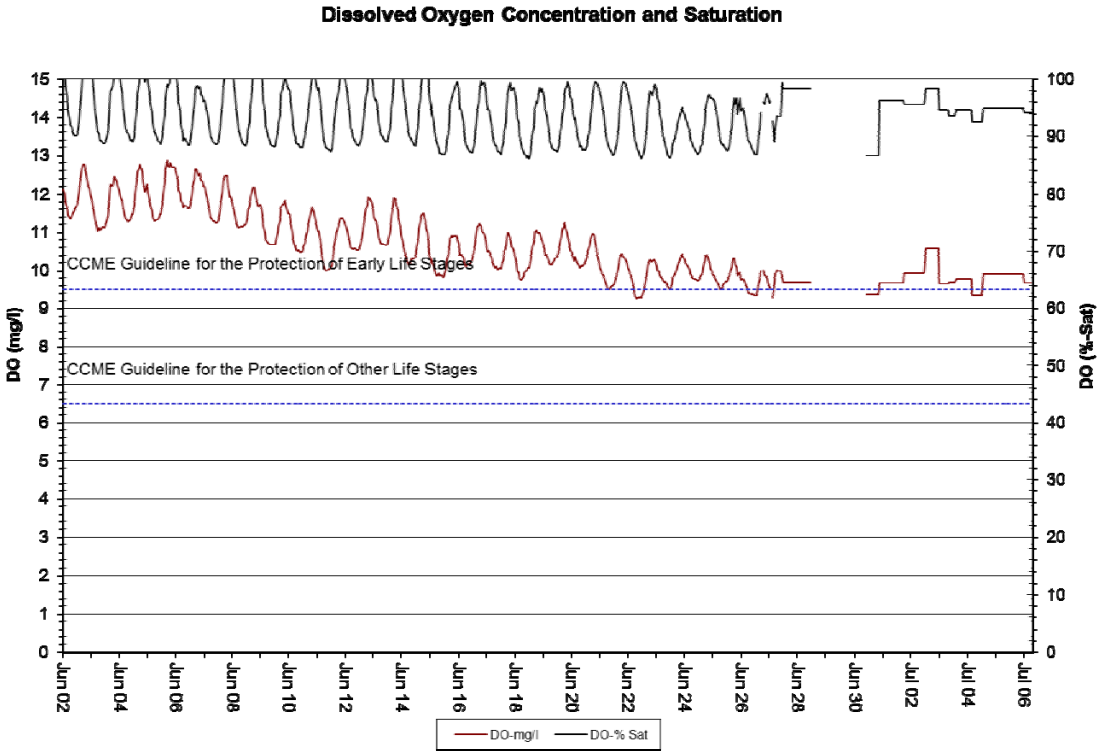

Figure 5: DO (mg/l & % saturation) at James Creek from June 2, 2015 to July 6, 2015

Turbidity

- Turbidity values ranged from 0.0 NTU to 59.6 NTU at James Creek (Figure 6) from June 2, 2015 to June 29, 2015.
- Due to technical issues at the James Creek station, turbidity readings were only available up until early in the day on June 29th and there was no turbidity data available for the last 8 days of the deployment period.

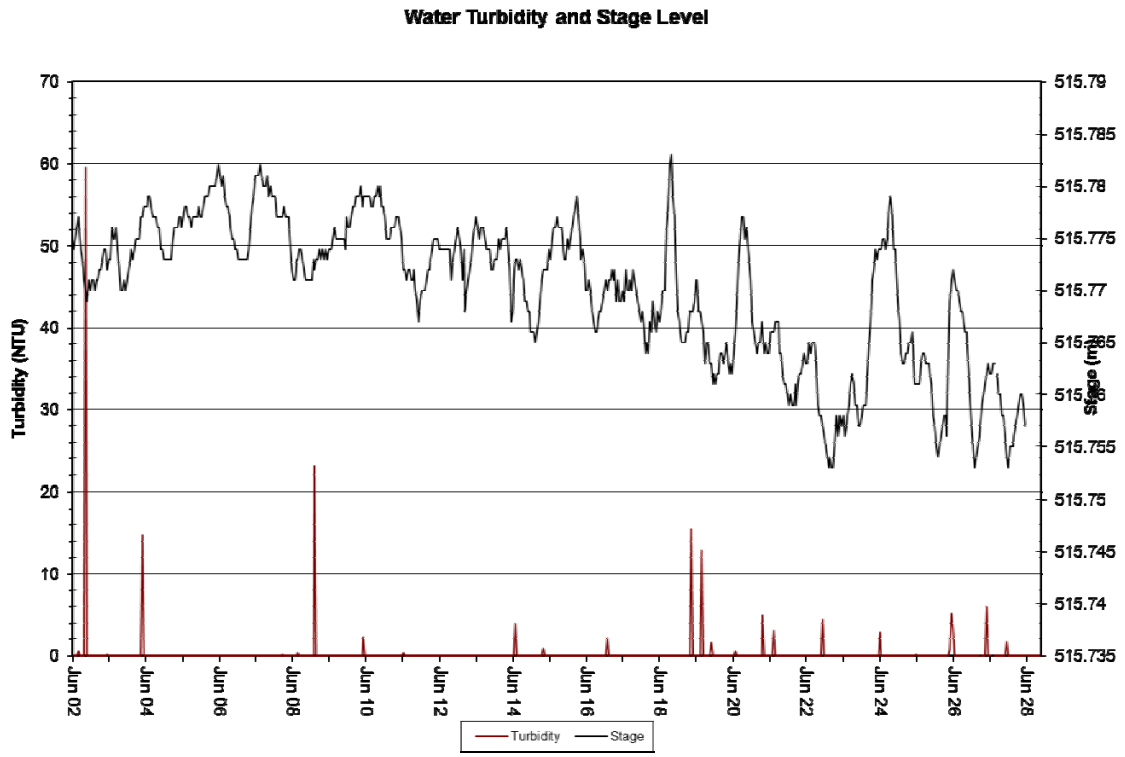

Figure 6: Turbidity (NTU) at James Creek from June 2, 2015 to June 29, 2015

Conclusion

- This monthly deployment report presents water quality and water quantity data recorded at the James Creek station from June 2, 2015 to July 6, 2015.
- The performances of all sensors were rated excellent at the beginning of the deployment period. Unfortunately, due to technical issues with the power supply, there was no field data available for comparison at the time of removal of the instrument from James Creek.
- Variations in water quality/quantity values recorded at each station are summarized below:

- With the exception of water quantity data (stage height), all data used in the preparation of the graphs and subsequent discussion adhere to a 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.
- For James Creek flow values ranged from 0.47 m^3/sec to 0.54 m^3/sec over the deployment period and there appears to be an overall gentle declining trend, which is consistent with the transition from late spring to summer.
- Water temperature at James Creek shows significant diurnal variations. This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- There was a gentle increasing temperature trend at James Creek over the deployment period which is consistent with the transition from late spring to early summer.
- pH values at James Creek station shows regular diurnal fluctuations which are related to the diurnal temperature fluctuations.
- pH at James Creek was relatively stable throughout the deployment period and with a median value of 8.12, pH values recorded at James Creek were within the guidelines for pH for the protection of aquatic life (i.e., 6.5 to 9.0 units), as defined by the Canadian Council of Ministers of the Environment (2007).
- Over the deployment period there is a gentle increasing trend in the specific conductivity at James Creek which is related to the increasing temperature trend for the same period.
- There are noticeable diurnal fluctuations in the specific conductivity at James Creek which are related to the diurnal temperature fluctuations.
- DO (mg/l & % saturation) shows clear diurnal fluctuations which can be attributed to the diurnal temperature fluctuations.
- DO (mg/l) shows a gentle declining trend over the deployment period which is related to the increasing temperature trend for the same period.
- The DO values were near or above the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and well above minimum guideline set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).
- Turbidity values ranged from 0.0 NTU to 59.6 NTU at James Creek (Figure 6) from June 2, 2015 to June 29, 2015. Unfortunately due to technical issues at the James Creek station, turbidity readings were not available for the last 8 days of the 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

[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*

APPENDIX B
Environment Canada Weather Data – Schefferville (June 2, 2015 to July 7, 2015)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
6/2/2015	17.9	6.5	12.2	5.8	0	0
6/3/2015	19.4	8.5	14	4	0	0
6/4/2015	12.9	0.7	6.8	11.2	0	0.3
6/5/2015	11.1	-1.1	5	13	0	0
6/6/2015	6.8	-0.3	3.3	14.7	0	1.5
6/7/2015	8.9	0.4	4.7	13.3	0	9.8
6/8/2015	19.5	6.3	12.9	5.1	0	0
6/9/2015	14.8	5.5	10.2	7.8	0	0.3
6/10/2015	12.7	7	9.9	8.1	0	5.8
6/11/2015	14.6	7.3	11	7	0	0.6
6/12/2015	9.3	4.9	7.1	10.9	0	7.8
6/13/2015	5.7	2.2	4	14	0	3.8
6/14/2015	14	1.1	7.6	10.4	0	0
6/15/2015	22.6	1.6	12.1	5.9	0	1.5
6/16/2015	12.3	2.2	7.3	10.7	0	0.8
6/17/2015	10.9	0.7	5.8	12.2	0	0
6/18/2015	21.6	1.2	11.4	6.6	0	4.6
6/19/2015	8.7	0.8	4.8	13.2	0	0.8
6/20/2015	16.1	0.7	8.4	9.6	0	5.8
6/21/2015	18.5	2	10.3	7.7	0	0
6/22/2015	23.7	7.5	15.6	2.4	0	0
6/23/2015	25.4	10.3	17.9	0.1	0	0
6/24/2015	14.2	8	11.1	6.9	0	9.1
6/25/2015	19.4	5.8	12.6	5.4	0	
6/26/2015	17.4	4.9	11.2	6.8	0	6.1
6/27/2015	21.2	5.5	13.4	4.6	0	0.3
6/28/2015	23.8	5.2	14.5	3.5	0	0
6/29/2015	24.2	11.9	18.1	0	0.1	0
6/30/2015	23.6	7.4	15.5	2.5	0	5
7/1/2015	18	6.3	12.2	5.8	0	0.3
7/2/2015	14.4	10.4	12.4	5.6	0	18.8
7/3/2015	17.8	10	13.9	4.1	0	8.1
7/4/2015	13.9	9.1	11.5	6.5	0	2.9
7/5/2015	15.9	10.2	13.1	4.9	0	6.1
7/6/2015	22.6	9.2	15.9	2.1	0	0.5
7/7/2015	20.4	14.5	17.5	0.5	0	24.6