# Real Time Water Quality Report

# Labrador Iron Mines
# Schefferville Network

## Deployment Period
## 2011-06-04 to 2011-07-15

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

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## General

- The Water Resources Management Division, in partnership with Labrador Iron Mines Ltd. and Environment Canada, maintain two real-time water quality and water quantity stations in close proximity to the James Property deposits, near Schefferville, QC.
- The official name of each station is *James Creek Above Bridge* and *Unnamed Tributary Below Settling Pond*, hereafter referred to as the James Creek station and the Unnamed Tributary station, respectively.
- James Creek station monitors water outflow from Ruth Pit and a series of multi-cell retention and settling ponds.
- The Unnamed Tributary station monitors water outflow from the retention and settling pond system mentioned above.
- The retention and settling pond system is comprised of four smaller man-made ponds that receive 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. Outflow from the retention and settling pond system is directed into Unnamed Tributary and James Creek. Priority is given to the outflow leading into the Unnamed Tributary, with surplus water directed into James Creek.
- Ruth Pit is used as a settling pond for reject rock originating from the beneficiation area at the Silver Yard, as well as receives 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 and Unnamed Tributary stations from June 4, 2011 to July 15, 2011.

## 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, conductivity, dissolved oxygen and turbidity) measured by instruments deployed at the water monitoring stations.

Table 1. Water quality instrument performance at the beginning and end of deployment at the James Creek and Unnamed Tributary stations.

| | James Creek (Sonde 49199) | | Unnamed Tributary (Sonde 49200) | |
|---|---|---|---|---|
| Stage of deployment | Beginning | End | Beginning | End |
| Date | 2011-06-04 | 2011-07-15 | 2011-06-04 | 2011-07-15 |
| Temperature | Good | Excellent | Good | Excellent |
| pH | Good | Good | Excellent | Excellent |
| Conductivity | Excellent | Good | Excellent | Excellent |
| Dissolved Oxygen | Fair | Excellent | Good | Excellent |
| Turbidity | Excellent | Good | Excellent | Poor |

- With the exception of Dissolved Oxygen (DO) and turbidity, the performances of all sensors were rated good to excellent during the deployment period (Table 1).
- The performance of the James Creek DO sensor was rated fair at the beginning of deployment (Table 1). Based on QA/QC protocol, it was determined that the sensor was underestimating DO by 0.53 mg/l. It is worth noting that the QA/QC Sonde, used to test the performance of the Field Sonde, was recording abnormally high DO values (i.e., 13.04 mg/l) at the beginning of deployment, and it is quite possible that the QA/QC Sonde was the problem, providing incorrect DO measurements. Furthermore, Field Sonde DO sensor performance was rated excellent at the end of the deployment period (Table 1).
- The turbidity sensor at Unnamed Tributary was given a poor performance rating at the end of the deployment period. Based on QA/QC protocol, the Field Sonde was underestimating turbidity by 12.0 NTU. This was considered an inaccurate assessment, based on a poor reading provided by the QA/QC Sonde. A laboratory analyzed grab sample indicated that turbidity was 1.9 NTU at Unnamed Tributary. This result aligned more with the Field Sonde reading (0.0 NTU) versus the QA/QC Sonde reading (12.0 NTU) and the Field Sonde was given an excellent performance rating based on this grab sample result.

## Data Interpretation

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

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

## Stage

- Stage values ranged from 0.77 m to 0.85 m at James Creek and from 1.12 m to 1.17 m at Unnamed Tributary from June 4, 2011 to July 15, 2011.
- As the spring thaw was ending, there was a small decrease in level at the James Creek station during the first half of the deployment period (Figure 1).
- As a regulated stream, stage levels were consistent at the Unnamed Tributary station during the deployment period.
- Daily fluctuations were observed at both stations with increases occurring in the afternoon and decreases occurring at night.
- 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.

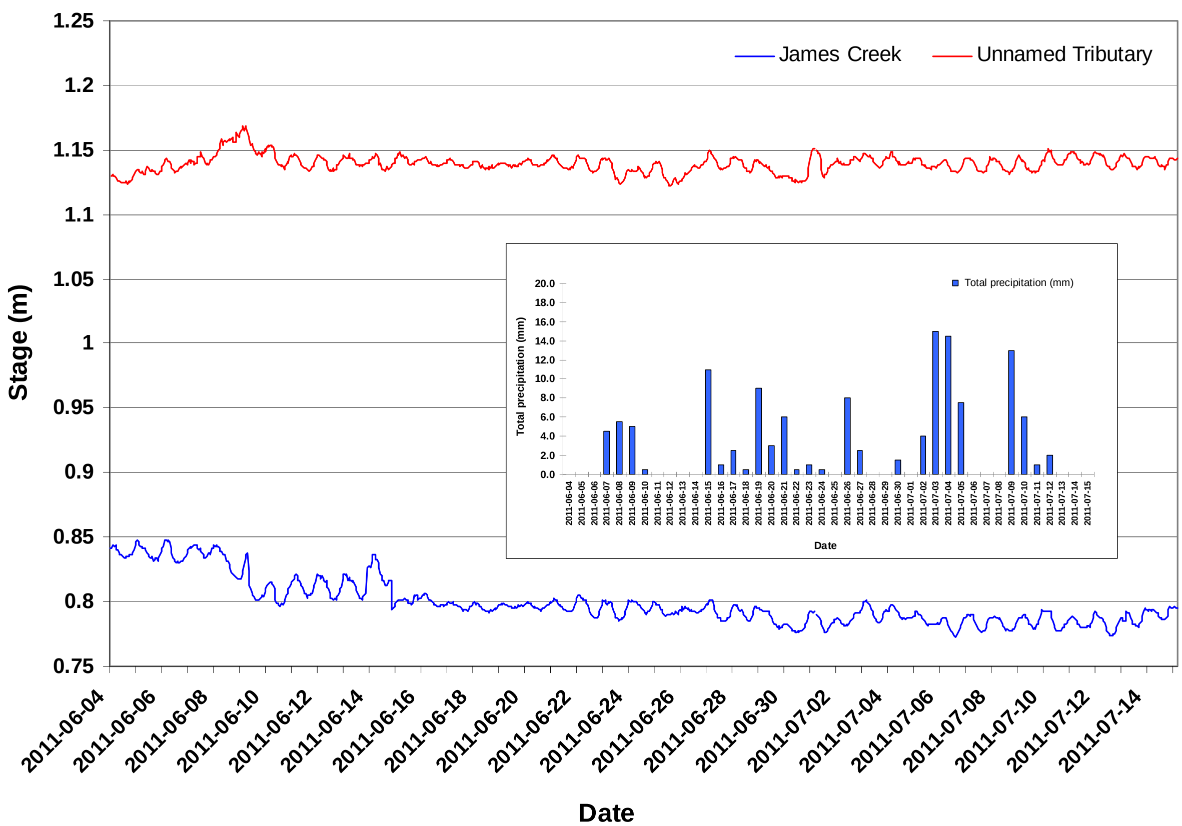


Figure 1. Hourly stage (m) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011. The inset chart shows total precipitation (mm) recorded at the Schefferville weather station during the same time period. All data was provided by Environment Canada.

## Temperature

- Water temperature ranged from 3.3˚C to 15.2˚C at James Creek and from 1.7˚C to 10.9˚C at Unnamed Tributary (Figure 2).
- Water temperatures at both stations display large diurnal variations (Figure 2). This is typical of shallow water streams that have high exposure to diurnal variations in ambient air temperatures.
- Water temperature increased at both stations during the deployment period, with weekly trends corresponding well with ambient air temperatures recorded by Environment Canada at the Schefferville weather station (Figure 2, inset).
- The overall increase in water temperature during the deployment period was smaller for Unnamed Tributary compared to James Creek. Indeed, the Unnamed Tributary station is close to its groundwater source, and groundwater generally maintains a consistent temperature year round and is less influenced by ambient air temperatures.

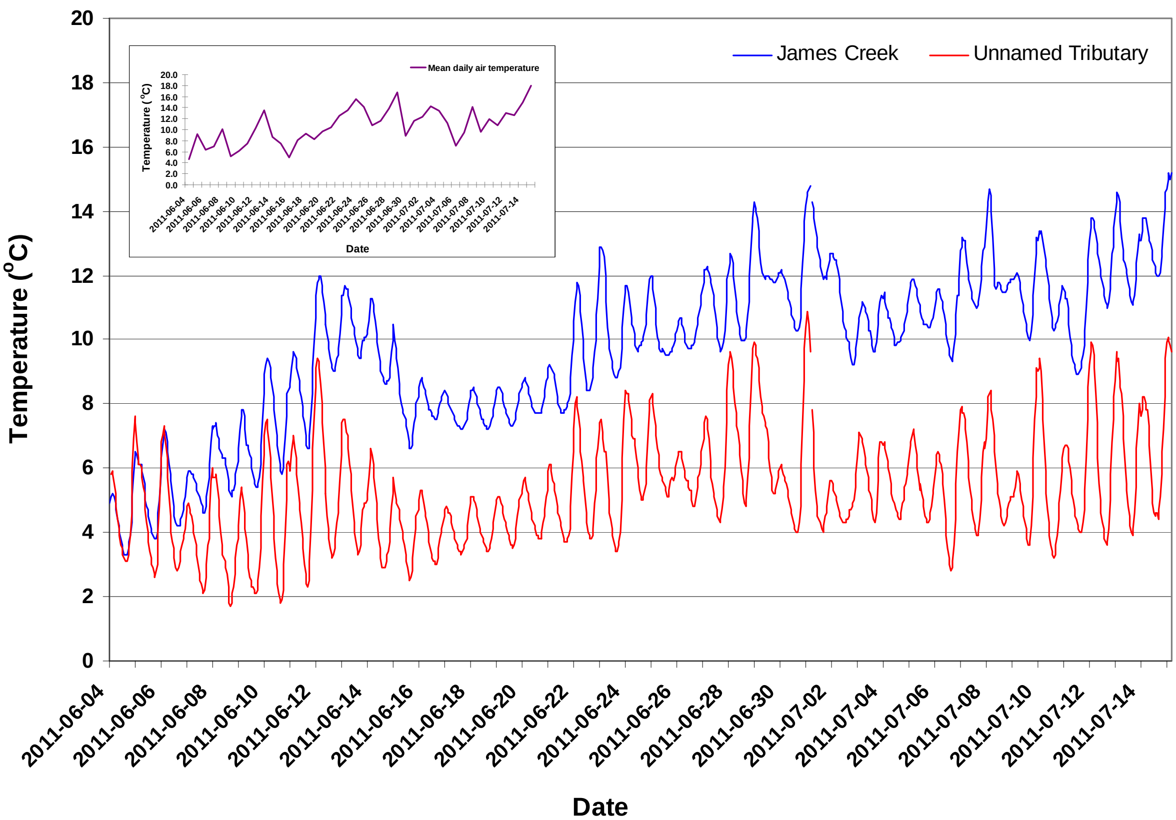


Figure 2. Hourly water temperature (°C) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011. The inset chart shows air temperature during the same period, as recorded by Environment Canada at the Schefferville weather station.

## pH

- pH values ranged from 7.70 units to 8.28 units at James Creek and from 6.99 units to 7.50 units at Unnamed Tributary from June 4, 2011 to July 15, 2011 (Figure 3).
- pH at both stations fluctuated daily with peaks typically occurring in the late afternoon/ early evening; coinciding with the photosynthetic cycling of $CO_2$ by aquatic organisms.
- Weekly trends in pH were observed during the second half of the deployment period, where James Creek saw a slight decrease in pH and the Unnamed Tributary saw a slight increase in pH. It is unclear at this time what influenced these changes in pH.
- On average, pH was 0.87 units higher at James Creek than at Unnamed Tributary. This difference could be attributed to the mining effluent discharged into Ruth Pit and detected at the James Creek station.
- All pH values were within the acceptable range 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).

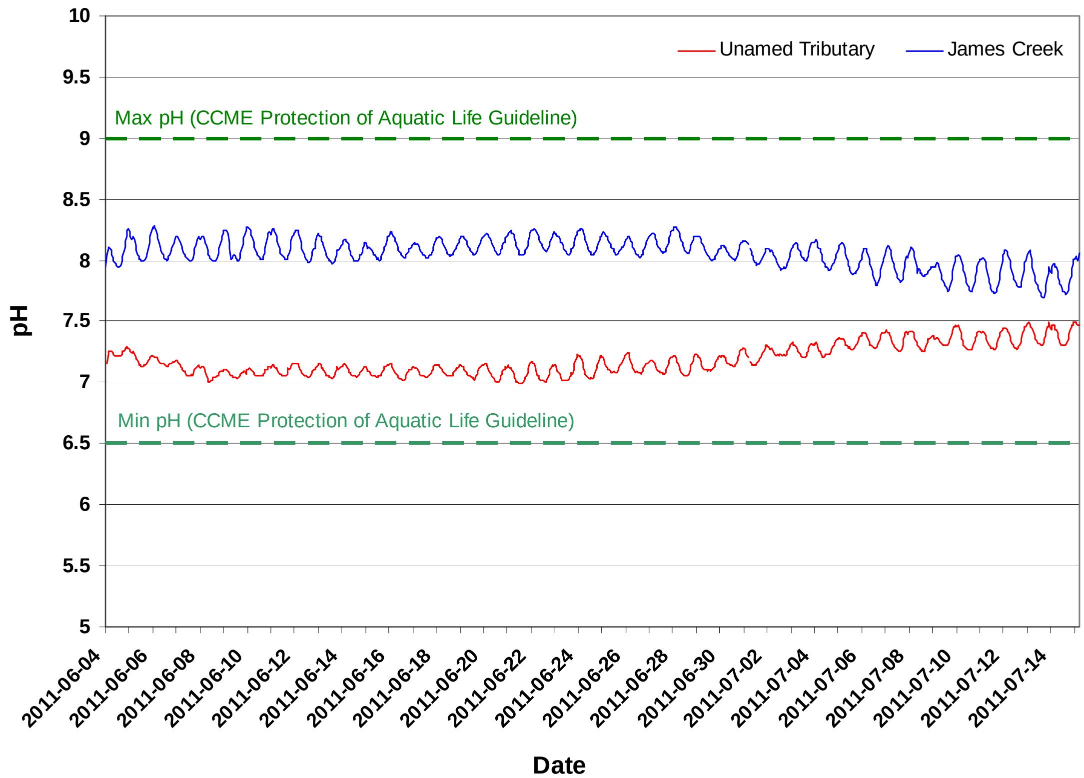


Figure 3. Hourly pH values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011.

## Specific Conductivity

- Specific Conductivity ranged from 126.3 μs/cm  to 161.3 μs/cm at James Creek and from 30.4 μs/cm to 63.1 μs/cm at Unnamed Tributary (Figure 4).
- On average, specific conductivity was 105.7 μS/cm higher at James Creek than at Unnamed Tributary.  This difference can be attributed to the increased concentration of dissolved solids from the iron ore tailings deposited into Ruth Pit, which feeds into James Creek.
- There was a small increase in specific conductivity at James Creek during the deployment period.  This increase could be attributed to an increased concentration of dissolved solids, resulting from a decrease in stage (Figure 4 inset).
- There was a sudden increase in specific conductivity at Unnamed Tributary on July 1, 2011.  This date coincident with Labrador Iron Mines commencement of full mining operations in the area (Appendix D).

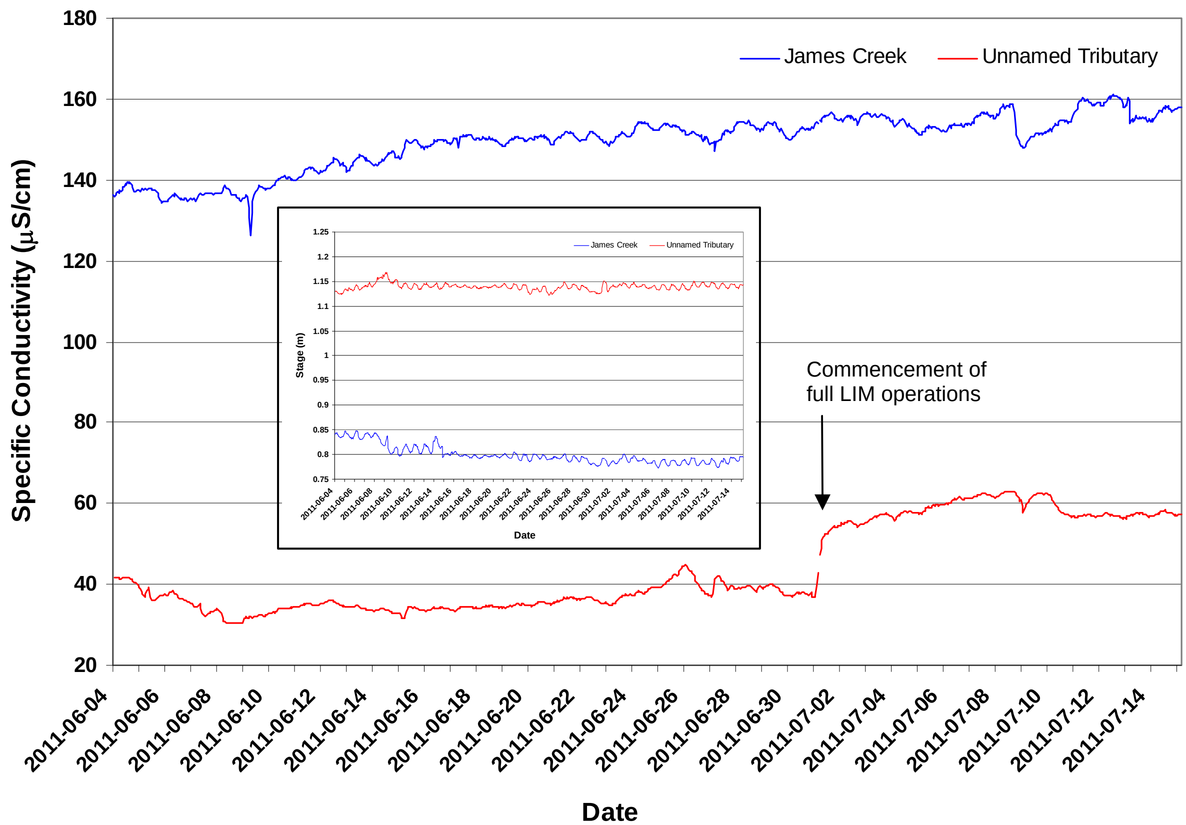


Figure 4. Hourly specific conductivity (μs/cm) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011.  The inset chart shows stage (m) recorded at both stations during the same time period.

## Total Dissolved Solids

- Total Dissolved Solids (TDS) values ranged from 0.0808 g/l to 0.1032 g/l at James Creek and from 0.0194 g/l to 0.0404 g/l at Unnamed Tributary (Figure 5).
- TDS is calculated directly from specific conductance and temperature, and as a result TDS values (Figure 5) show a similar trend to specific conductance (Figure 4).
- TDS values were on average 0.0676 g/l higher at James Creek compared to Unnamed Tributary. This difference can be attributed to the past and present deposit of iron ore tailings into Ruth Pit, upstream of James Creek.

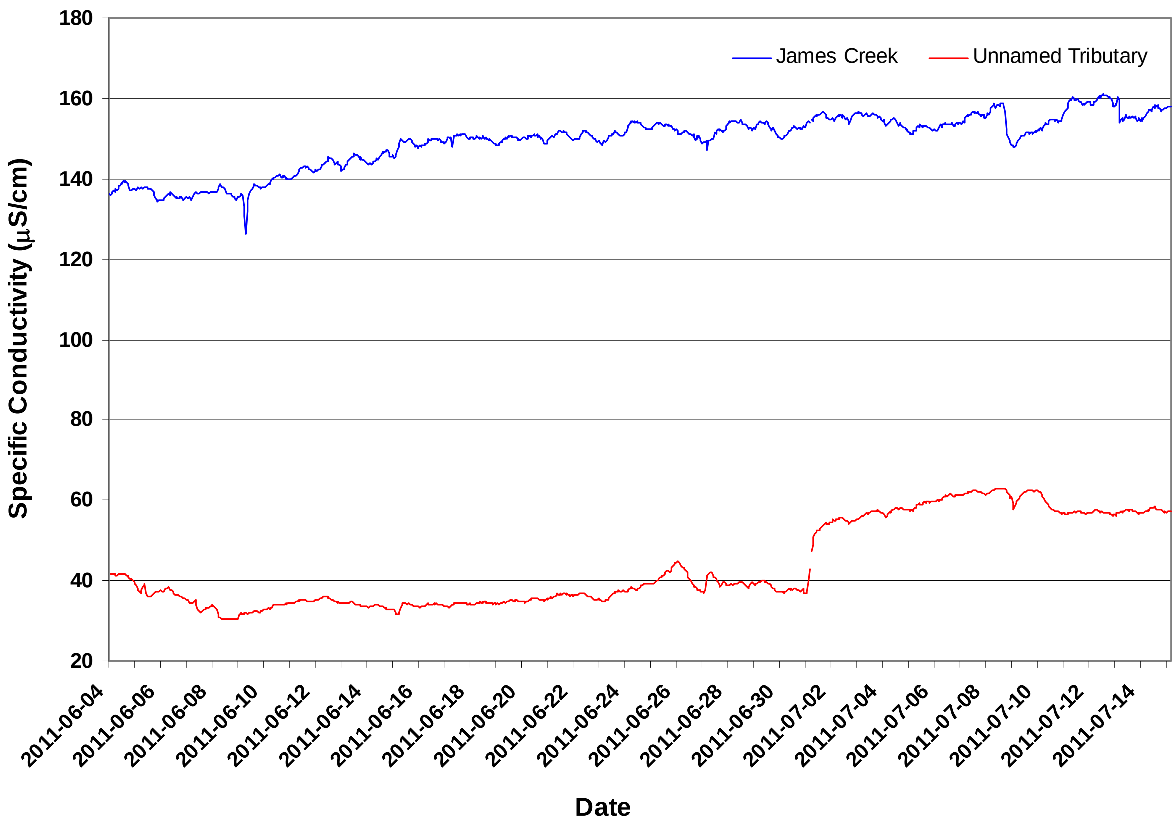


Figure 5. Hourly TDS (g/l) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011.

## Dissolved Oxygen

- Dissolved Oxygen [DO] values ranged from 9.46 mg/l to 12.54 mg/l at James Creek and from 10.69 mg/l to 12.51 mg/l at Unnamed Tributary (Figure 6).

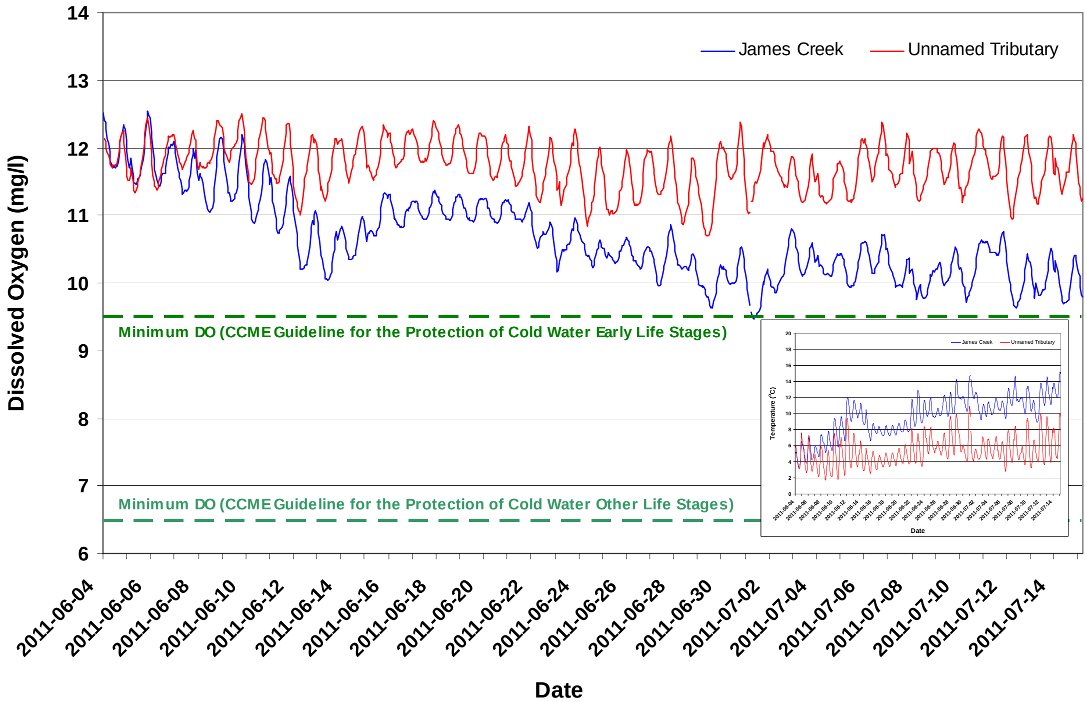


Figure 6. Hourly dissolved oxygen (mg/l) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011. The inset chart shows water temperature ($^{o}$C) recorded at each station during the same period.

- DO (mg/l) fluctuated daily, with increases in DO observed in the afternoon and decreases observed at night. These diurnal variations can be attributed to the photosynthetic activity of aquatic organisms, increasing DO during daylight hours, and decreasing DO during the night.
- Weekly trends in DO (mg/l) corresponded well with the inverse of water temperature (Figure 2, Figure 6 inset), since colder water has a greater potential to dissolve oxygen compared to warmer water.
- On average, DO values were 1.06 mg/l higher at Unnamed Tributary compared to James Creek. This difference can be largely attributed to colder water temperatures at Unnamed Tributary than at James Creek (Figure 2, Figure 6 inset).
- DO values at both stations were, for the majority of time, above cold water minimum guidelines set for aquatic life during early life stages (9.5 mg/l) period, and above minimum guidelines set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).

## Turbidity

- Turbidity values ranged from 2.1 NTU to 690.0 NTU at James Creek and from 0.0 NTU to 97.8 NTU at Unnamed Tributary (Figure 7).
- Turbidity events were numerous at both stations, resulting from various noted sources (Appendix D). These sources include: (i) increased flow rates during the spring freshet; (ii) rainfall events (Figure 7 inset); (iii) spawning fish; (iv) dewatering test discharges; and (v) debris caught in sensor probes (e.g., algae, leaves, etc.). Compounding the effects of these events is the presence of historical silt sediment in both streams that easily gets re-suspended, resulting in turbidity spikes. The historical silt sediment in the watercourses originated from past mining activities in the area.

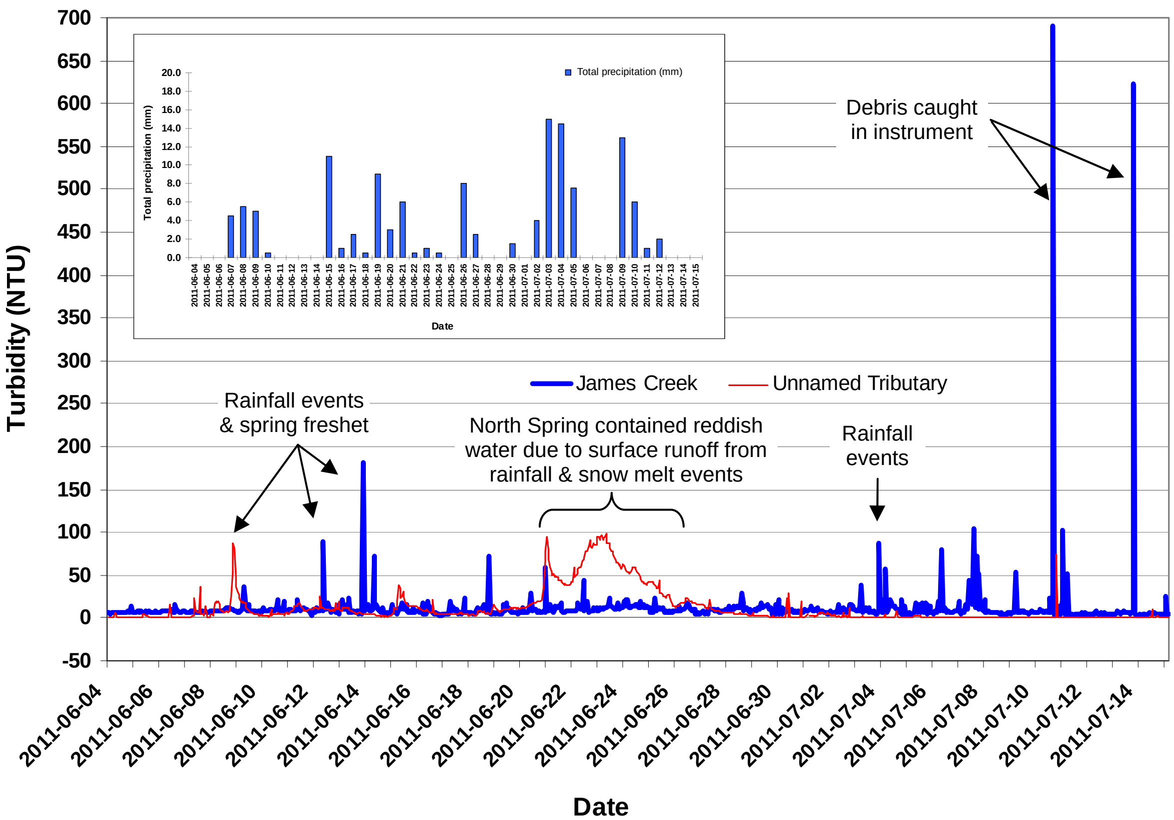


Figure 7. Hourly turbidity (NTU) values recorded at James Creek and Unnamed Tributary from June 4, 2011 to July 15, 2011.

## Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the James Creek and Unnamed Tributary stations from June 4, 2011 to July 15, 2011.
- With the exception of DO and turbidity, water quality sensor performance was rated good-to-excellent for all parameters at both stations. Based on QA/QC protocol, DO sensor performance at James Creek was rated fair at the beginning of deployment and turbidity sensor performance at Unnamed Tributary was rated poor at the end of deployment. These performance ratings were considered inaccurate, due to erroneous QA/QC instrument readings.
- Water quality/quantity values recorded at each station were considered normal:

  Changes in stage were attributed to the end of spring freshet, precipitation events, and changes in air pressure and temperature.

  Fluctuations in water temperature corresponded with fluctuations in air temperature. Differences in water temperature between stations were attributed to water source: groundwater versus surface water.

  Weekly trends in pH were unexplained; however, daily variations were attributed to the photosynthetic cycling of $CO_2$ by aquatic organisms. Differences in pH between stations was attributed to the water source, where groundwater is the primary source of water for the Unnamed Tributary and surface water from Ruth Pit, which receives mining effluent, is the primary source of water for James Creek.

  Specific conductivity and TDS were influenced by varying concentrations of mining effluent entering each stream system, as well as varying concentrations caused by changes in stage.

  DO (mg/l and % saturation) variations were related to changes in water temperature and the photosynthetic activity and aerobic respiration of aquatic organisms.

  Turbidity events were thought to be caused by a variety of sources, including: (i) increased flow rates during the spring freshet; (ii) rainfall events; (iii) spawning fish; (iv) dewatering test discharges; (v) debris caught in sensor probes (e.g., algae, leaves, etc.); and (vi) the re-suspension of historical silt sediment found on the bottom of the streams.
- The Water Resources Management Division in partnership with Labrador Iron Mines Ltd. and Environment Canada will continue monitoring the water quality and water quantity of James Creek and Unnamed Tributary.

## References

Allan, D. (2010). Advanced Water Quality Instrumentation Training Manual. Edmonton, AB: Allan Environmental Services Inc. (pp. 160).

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/)

Hach (2006) Important water quality factors - H2O University. Hach Company. Online: http://www.h2ou.com/index.htm (accessed August 24, 2010).

Swanson, H.A., and Baldwin, H.L., 1965. A Primer on Water Quality, U.S. Geological Survey. Online: http://ga.water.usgs.gov/edu/characteristics.html (accessed August 24, 2010)

# 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*

# APPENDIX B
# Water Parameter Description

***Dissolved Oxygen*** - The amount of Dissolved Oxygen (DO) (mg/l or % saturation) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (Allan 2010).

***Flow*** – Flow (m3/s) is a measure of how quickly a volume of water is displaced in streams, rivers, and other channels.

***pH*** - pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluence, saline inflows or aquatic organisms involved in the photosynthetic cycling of $CO_2$ (Allan 2010).

***Specific conductivity*** - Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25ºC. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

***Stage*** – Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

***Temperature*** - Essential to the measurement of most water quality parameters, temperature (oC) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (Allan 2010; Hach 2006).

***Total Dissolved Solids*** - Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

***Turbidity*** - Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Allan 2010; Hach 2006; Swanson and Baldwin 1965).

# APPENDIX C
## Environment Canada Weather Data – Schefferville (June 4, 2011 to July 15, 2011)

| Date yyyy-mm-dd | Max Temp °C | Min Temp °C | Mean Temp °C | Heat Deg Days °C | Cool Deg Days °C | Total Rain mm | Total Snow cm | Total Precip mm | Snow on Grnd cm | Avg Wind Spd Km/hr | Avg Wind Dir deg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2011-06-04 | 8.3 | 0.8 | 4.6 | 13.4 | 0.0 | M | M | 0.0 | 0.0 | 11.2 | 114.2 |
| 2011-06-05 | 16.3 | 2.1 | 9.2 | 8.8 | 0.0 | M | M | 0.0 | 0.0 | 18.6 | 200.0 |
| 2011-06-06 | 11.8 | 0.9 | 6.4 | 11.6 | 0.0 | M | M | 0.0 | 0.0 | 10.6 | 248.8 |
| 2011-06-07 | 12.0 | 1.9 | 7.0 | 11.0 | 0.0 | M | M | 4.5 | 0.0 | 13.5 | 174.2 |
| 2011-06-08 | 16.3 | 3.8 | 10.1 | 7.9 | 0.0 | M | M | 5.5 | 0.0 | 9.3 | 179.6 |
| 2011-06-09 | 10.3 | 0.1 | 5.2 | 12.8 | 0.0 | M | M | 5.0 | 0.0 | 19.3 | 341.7 |
| 2011-06-10 | 13.0 | -0.7 | 6.2 | 11.8 | 0.0 | M | M | 0.5 | 0.0 | 13.9 | 285.4 |
| 2011-06-11 | 15.7 | -0.7 | 7.5 | 10.5 | 0.0 | M | M | 0.0 | 0.0 | 10.8 | 202.9 |
| 2011-06-12 | 17.9 | 2.6 | 10.3 | 7.7 | 0.0 | M | M | 0.0 | 0.0 | 9.6 | 202.5 |
| 2011-06-13 | 21.9 | 5.1 | 13.5 | 4.5 | 0.0 | M | M | 0.0 | 0.0 | 9.3 | 226.7 |
| 2011-06-14 | 14.0 | 3.4 | 8.7 | 9.3 | 0.0 | M | M | 0.0 | 0.0 | 11.2 | 262.9 |
| 2011-06-15 | 12.8 | 2.1 | 7.5 | 10.5 | 0.0 | M | M | 11.0 | 0.0 | 12.1 | 166.7 |
| 2011-06-16 | 8.9 | 0.9 | 4.9 | 13.1 | 0.0 | M | M | 1.0 | 0.0 | 11.4 | 194.6 |
| 2011-06-17 | 10.5 | 5.6 | 8.1 | 9.9 | 0.0 | M | M | 2.5 | 0.0 | 12.5 | 153.8 |
| 2011-06-18 | 11.5 | 7.0 | 9.3 | 8.7 | 0.0 | M | M | 0.5 | 0.0 | 16.2 | 114.6 |
| 2011-06-19 | 10.0 | 6.5 | 8.3 | 9.7 | 0.0 | M | M | 9.0 | 0.0 | 15.4 | 87.9 |
| 2011-06-20 | 11.7 | 7.7 | 9.7 | 8.3 | 0.0 | M | M | 3.0 | 0.0 | 9.0 | 146.3 |
| 2011-06-21 | 12.2 | 8.6 | 10.4 | 7.6 | 0.0 | M | M | 6.0 | 0.0 | 6.4 | 119.6 |
| 2011-06-22 | 17.5 | 7.4 | 12.5 | 5.5 | 0.0 | M | M | 0.5 | 0.0 | 5.3 | 156.7 |
| 2011-06-23 | 19.7 | 7.2 | 13.5 | 4.5 | 0.0 | M | M | 1.0 | 0.0 | 6.2 | 84.6 |
| 2011-06-24 | 23.3 | 7.8 | 15.6 | 2.4 | 0.0 | M | M | 0.5 | 0.0 | 13.1 | 172.5 |
| 2011-06-25 | 18.3 | 9.9 | 14.1 | 3.9 | 0.0 | M | M | 0.0 | 0.0 | 14.4 | 187.9 |
| 2011-06-26 | 12.7 | 8.8 | 10.8 | 7.2 | 0.0 | M | M | 8.0 | 0.0 | 9.3 | 141.7 |
| 2011-06-27 | 14.7 | 8.5 | 11.6 | 6.4 | 0.0 | M | M | 2.5 | 0.0 | 10.0 | 132.9 |
| 2011-06-28 | 19.4 | 8.2 | 13.8 | 4.2 | 0.0 | M | M | 0.0 | 0.0 | 12.1 | 152.1 |
| 2011-06-29 | 23.0 | 10.6 | 16.8 | 1.2 | 0.0 | M | M | 0.0 | 0.0 | 9.8 | 180.4 |
| 2011-06-30 | 12.1 | 5.6 | 8.9 | 9.1 | 0.0 | M | M | 1.5 | 0.0 | 17.7 | 303.3 |
| 2011-07-01 | 17.7 | 5.4 | 11.6 | 6.4 | 0.0 | M | M | 0.0 | 0.0 | 10.7 | 163.3 |
| 2011-07-02 | 14.7 | 9.8 | 12.3 | 5.7 | 0.0 | M | M | 4.0 | 0.0 | 10.2 | 197.9 |
| 2011-07-03 | 18.0 | 10.3 | 14.2 | 3.8 | 0.0 | M | M | 15.0 | 0.0 | 16.0 | 135.8 |
| 2011-07-04 | 17.5 | 9.2 | 13.4 | 4.6 | 0.0 | M | M | 14.5 | 0.0 | 10.0 | 162.9 |
| 2011-07-05 | 13.5 | 8.8 | 11.2 | 6.8 | 0.0 | M | M | 7.5 | 0.0 | 16.9 | 262.1 |
| 2011-07-06 | 10.4 | 3.7 | 7.1 | 10.9 | 0.0 | M | M | 0.0 | 0.0 | 11.3 | 272.9 |
| 2011-07-07 | 16.2 | 2.7 | 9.5 | 8.5 | 0.0 | M | M | 0.0 | 0.0 | 5.7 | 164.2 |
| 2011-07-08 | 18.6 | 9.5 | 14.1 | 3.9 | 0.0 | M | M | 0.0 | 0.0 | 4.3 | 110.4 |
| 2011-07-09 | 12.1 | 7.1 | 9.6 | 8.4 | 0.0 | M | M | 13.0 | 0.0 | 11.8 | 236.3 |
| 2011-07-10 | 17.6 | 6.1 | 11.9 | 6.1 | 0.0 | M | M | 6.0 | 0.0 | 7.9 | 181.7 |
| 2011-07-11 | 15.4 | 6.1 | 10.8 | 7.2 | 0.0 | M | M | 1.0 | 0.0 | 11.6 | 144.6 |
| 2011-07-12 | 17.0 | 9.0 | 13.0 | 5.0 | 0.0 | M | M | 2.0 | 0.0 | 13.0 | 101.3 |
| 2011-07-13 | 18.0 | 7.2 | 12.6 | 5.4 | 0.0 | M | M | 0.0 | 0.0 | 12.8 | 320.8 |
| 2011-07-14 | 21.5 | 8.3 | 14.9 | 3.1 | 0.0 | M | M | 0.0 | 0.0 | 11.5 | 252.5 |
| 2011-07-15 | 23.7 | 12.3 | 18.0 | 0.0 | 0.0 | M | M | 0.0 | 0.0 | 10.1 | 248.8 |

- = No data available
M = Missing
E = Estimated
A = Accumulated
C = Precipitation occurred, amount uncertain
L = Precipitation may or may not have occurred
F = Accumulated and estimated
N = Temperature missing but known to be > 0
Y = Temperature missing but known to be < 0
S = More than one occurrence
T = Trace
* = The value displayed is based on incomplete data
† = Data for this day has undergone only preliminary quality checking

# APPENDIX C (continued...)

## Environment Canada Weather Data – Schefferville (June 4, 2011 to July 15, 2011)

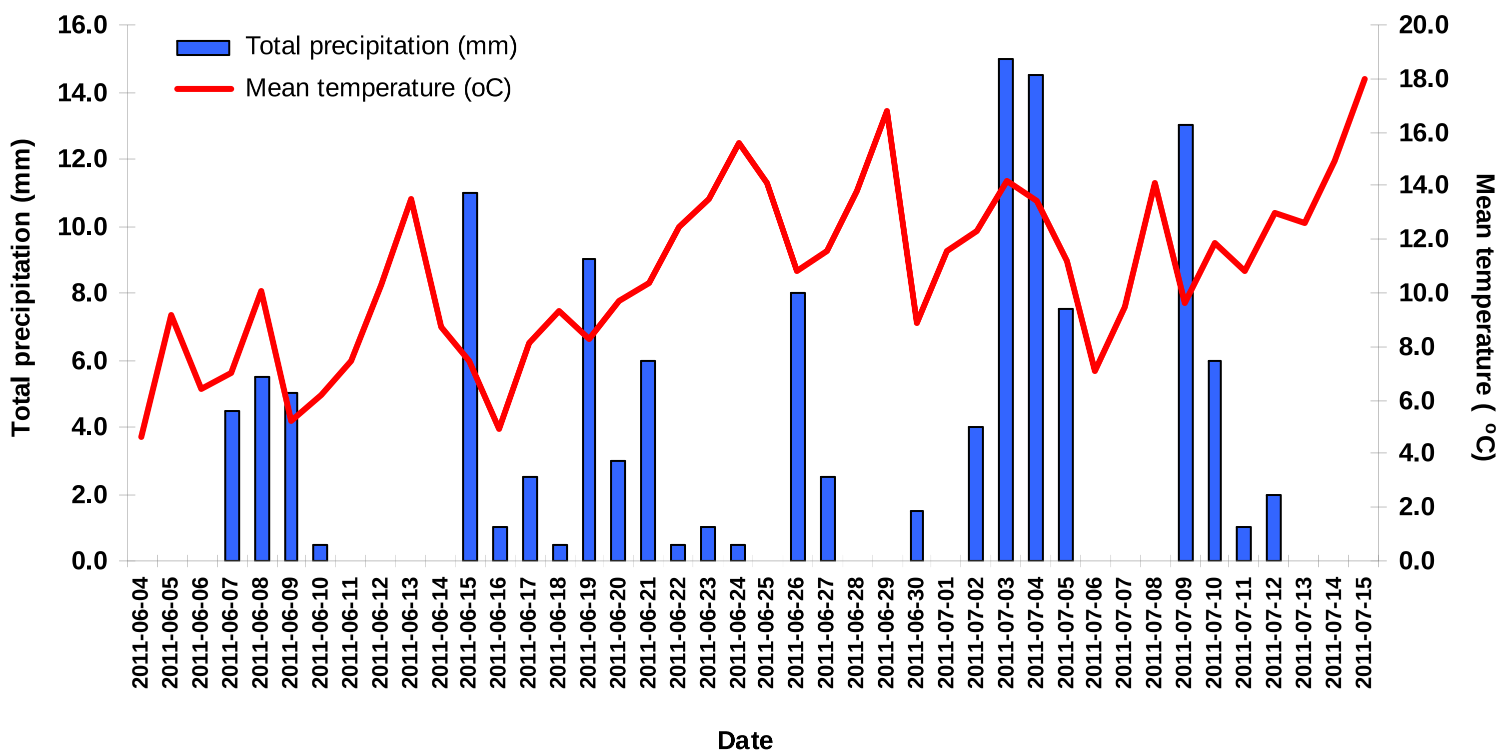


Figure 1. Daily precipitation and mean temperature recorded at the Schefferville Weather Station by Environment Canada from June 4, 2011 to July 15, 2011.

## APPENDIX C (continued...)

## Environment Canada Weather Data - Schefferville (June 4, 2011 to July 15, 2011)

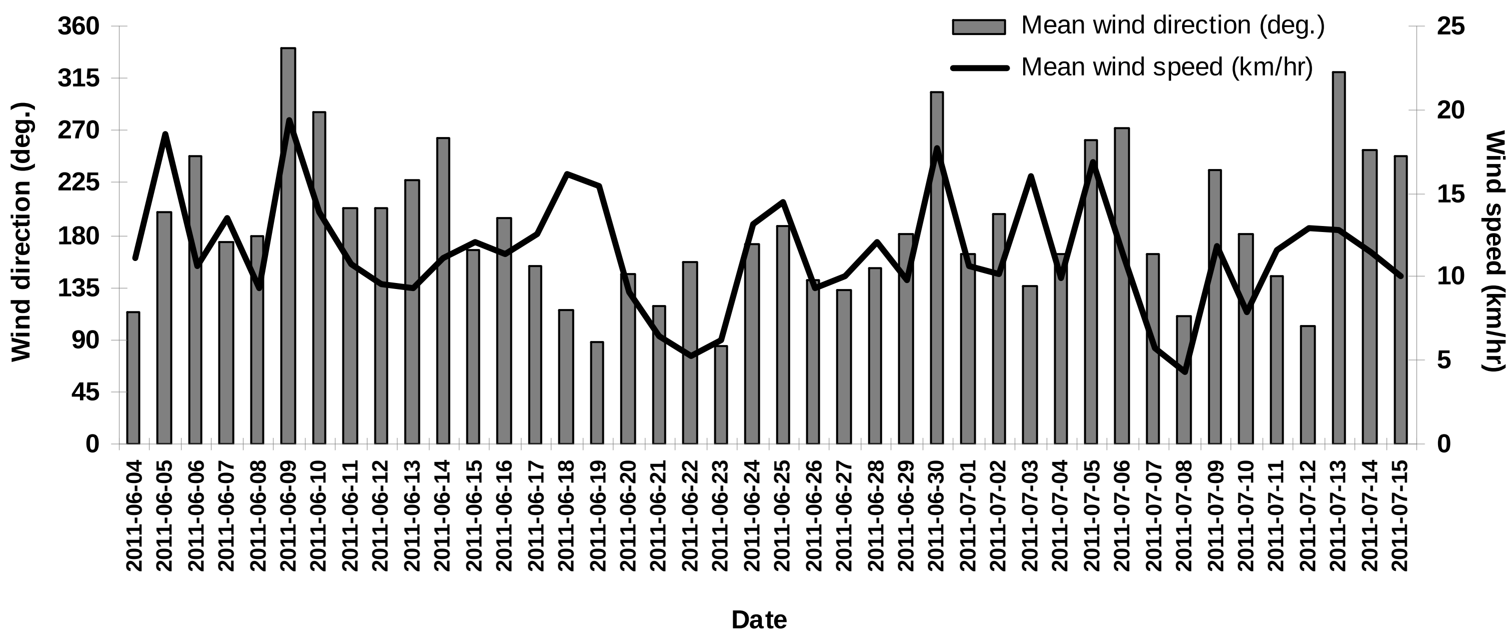


Figure 2. Mean daily wind direction and wind speed recorded at the Schefferville Weather Station by Environment Canada from June 4, 2011 to July 15, 2011.

# APPENDIX D

## Labrador Iron Mines Limited – Report

7 October 2011

Mr. Keith Abbot,
Government of Newfoundland and Labrador
Department of Environment and Conservation
Water Resources Management Division
P.O. Box 8700, 4th Floor, West Block,
Confederation Building
St. John's, NL, A1B 4J6
E-mail: keithnabbott@gov.nl.ca

Dear Keith:

Re: Background Information for Real Time Water Quality Monitoring Stations; James Creek and the Unnamed Tributary.

This report has been generated to summarize events that caused changes in water quality as seen at the Real Time Water Quality Stations between the dates of June 4th and July 15th, 2011.

**Quick Events or Anomalous Spikes**

Labrador Iron Mines' Environmental Department, along with additional environmental support from consultant companies WESA and Parks Environmental, diligently inspect the waters when a spike is observed. It has been found that, with the exception of the events described below, the turbidity spikes cannot be attributed to Labrador Iron Mines' mining or construction activities and are sudden events. Visual observations recorded at the time of these follow-up inspections typically note clear water conditions. Conditions observed to cause many of the spikes recorded include the following:

- Presence of spawning fish stirring up the sediment near the hydrolabs;
- Naturally-occurring materials such as sediment, algae or branches that pass, or become trapped in, the hydrolab.

The following sections present a summary of observations recorded during the following dates of interest:

- June 14-15 – James Creek – increased Turbidity
- June 21-27 – Unnamed Tributary – prolonged increase in Turbidity
- July 1 – Unnamed Tributary – increase in conductivity and TDS
- July 4-5 – James Creek – increased Turbidity
- July 11 – James Creek – increased Turbidity

**June 14th – June 15th, 2011**

In the LIM Project Area, June and early July is the time of spring thaw and, as the project is located in an historic mining area that contributed to pre-LIM elevated levels of sediment in the substrates of area water



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courses, this sediment becomes re-suspended during any periods of increased precipitation. There was precipitation every day during this time period. A total of 33.5 mm of rain fell and caused a slight increase in turbidity, both in James Creek and in the Unnamed Tributary during this time frame.

**June 21st – June 27th, 2011 – Unnamed Tributary**

During this time period, high springtime precipitation combined with snow melt contributed to the management of large amounts of water at the site, which is also located in an area of high groundwater and previous historical development. On June 21, 2011 it was found that the North Spring, located between the two pits (and now dry because of dewatering) contained reddish water. The North Spring was the former headwater of the Unnamed Tributary; however, this water is now being intercepted by groundwater dewatering wells and discharged directly into the Unnamed Tributary. At the time of the noted spike, the water had been previously clear but had turned red turbid overnight on the evening of June 21, 2011. After extensive investigation, it was found that there were several underground channels, pre-existing LIM's activities onsite, and turbid water was found to be entering into the spring area through these pre-existing channels. Control measures were increased at these historic locations, including the use of Geotextiles and increase in groundwater pumping, and this was found to clear up the problem. The construction of water management features, such as diversion ditches, ponds and the dewatering program are now in place and will reduce the potential for surface water run-off in the future.

**July 1st, 2011 – Unnamed Tributary**

During the 2010 deployment of the hydrolab, it was found that the conductance value had an approximate average of 43 µS/cm. The average conductance was similar in the 2011 deployment prior to July 1st, i.e. prior to the commencement of full LIM operations. The conductivity of our discharge to the Unnamed Tributary averages at 54.4 µS/cm, which slightly raised the conductivity of the stream system. This groundwater discharge also initially had a higher TDS, however, this stabilized once the dewatering program was in full operation.

**July 4th -5th, 2011 – James Creek**

This spike was attributable to an elevated period of precipitation during this time and the associated re-suspension of historical sediments in the substrate.

**July 11th – James Creek**

The spike on this date was a quick event most likely due to material flowing downstream getting trapped on the hydrolab. The event could not be attributed to a discharge from our mine site.

The spikes observed are not exhibiting an actual trend, as seen in the recorded observations, and not attributed to any release associated to our mining activity. There has also been a small shift in the overall conductivity and TDS in the Unnamed Tributary due to commencing the dewatering program at the James Mine, however, this has now stabilized.



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We appreciate the opportunity to share this information with you. Please contact Linda Wrong, P. Geo., VP of Environment and Permitting, or Corey McLister, Environmental Manager if you have any questions or concerns.

Yours truly,

Linda Wrong,
Vice President, Environment and Permitting

cc: Mr. Bill Hooley, LIM, President and COO
Mr. Corey McLister, LIM, Environmental Manager
Ms. Leah Butler, LIM, Environmental Scientist