

# Real-Time Water Quality Deployment Report

## Lower Churchill River Network

May 20 to June 23, 2010



Government of Newfoundland & Labrador Department of Environment and Conservation Water Resources Management Division



### General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This monthly deployment period illustrates and discusses water quality related events from May 20 to June 23, 2010; a period of 34 days.
- On May 20, 2010, real-time water quality monitoring instruments were deployed for the first time following winter 2009-10. Instruments were successfully deployed at three of the four Lower Churchill River Stations. An ice wall at the site below Grizzle Rapids prevented instrument deployment in May 2010.

## Maintenance and Calibration of Instrument

- As part of the Quality Assurance and Quality Control protocol (QAQC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
  - ► At deployment and removal, a QA/QC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the degree of difference between parameters recorded by the Field Sonde and QAQC Sonde at deployment, a qualitative statement is made on the data quality (Table 1).
  - ► At the end of a deployment period, readings are taken in the water body from the Field Sonde before and after a thorough cleaning in order to assess the degree of biofouling. During calibration in the laboratory, an assessment of calibration drift is made and the two error values are combined to give Total Error (T<sub>e</sub>). If T<sub>e</sub> exceeds a predetermined data correction criterion, a correction based on T<sub>e</sub> is applied to the dataset using linear interpolation.

	Rank						
Parameter	Excellent Good		Fair	Marginal	Poor		
Temperature (oC)	<=+/-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 $\mu$ S/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		

#### Table 1: Ranking classifications for deployment and removal

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.
- Deployment and removal comparison rankings for the Churchill River stations deployed between May 20 and June 23, 2010 are summarized in Table 2.

Station	Date	Action	Comparison Ranking					
Churchill River			Temperature	рН	Conductivity	Dissolved Oxygen	Turbidity	
Below	May 20, 2010	Deployment	Good	Good	Excellent	Poor	Good	
Muskrat Falls	June 23, 2010	Removal	Good	Good	Good	Marginal	Good	
Above	May 20, 2010	Deployment	Good	Good	Excellent	Fair	Excellent	
Muskrat Falls	June 23, 2010	Removal	n/a*	n/a*	n/a*	n/a*	n/a*	
Below	May 20, 2010	Deployment	Excellent	Good	Excellent	Poor	Excellent	
Metchin River	June 23, 2010	Removal	Excellent	Excellent	Excellent	Excellent	Excellent	

Table 2: Comparison rankings for Churchill River stations, May 20 – June 23, 2010

\* The instrument above Muskrat Falls became exposed to air as water levels dropped significantly throughout the deployment period. No QAQC measurement were taken upon removal therefore there are no rankings for this site on June 23.

On May 20, during the deployment of s/n 45700 at site below Muskrat Falls, the DO measurement was ranked as "Poor" in comparison to the QAQC sonde. The field sonde DO was recorded as 14.25mg/L while the QAQC sonde indicated 13.58mg/L, a difference of 1.17mg/L. At removal, the ranking was 'marginal' as, the field sonde read 12.72mg/L and the QAQC sonde was again slightly lower at 11.85mg/L, a 0.87mg/L difference. Similarly, on May 20 at the station below Metchin River, dissolved oxygen ranked 'poor' as well. The field sonde read 12.87mg/L and the QAQC sonde read 11.82mg/L, a difference of 1.05mg/L. It is likely that the QAQC sonde was reading low dissolved oxygen concentrations throughout the day as this is a consistent trend throughout the May 20 deployments.

## **Data Interpretation**

- The following graphs and discussion illustrate significant water quality-related events in the Lower Churchill River Network.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request. Where appropriate, corrected data for water quality parameters are indicated.

Churchill River below Muskrat Falls

- Due to significant stage level drop during the deployment period, the sonde was barely covered by water upon removal on June 23, 2010. Measurements taken in the final days of the deployment period may show some variability as the instrument would have been close to the shore, in shallow water and susceptible to wave action.
- Water temperature ranges from 2.3 to 12.8°C during this deployment period (Figure 1).
- Water temperature increases throughout the spring deployment period. This is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.
- A decrease in water temperature from June 6-9, 2010 corresponds with cold weather conditions and high precipitation (Appendix 1).



#### Water Temperature Churchill River below Muskrat Falls - May 20 - June 23, 2010

Figure 1: Water temperature at Churchill River below Muskrat Falls

- pH ranges between 6.42 and 7.00 pH units (Figure 2).
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 2).
- pH values are consistent throughout the deployment period, fluctuating slightly in the beginning of June.



pH Churchill River below Muskrat Falls - May 20 - June 23, 2010

Figure 2: pH at Churchill River below Muskrat Falls

- Specific conductivity ranged from 9.9 to 12.7µS/cm during the deployment period (Figure 3). Specific conductance remains stable, increasing slightly over the deployment period.
- There is a sharp increase in conductivity on June 20, 2010 however it is unknown what caused this spike to occur however could be a result of the shallow moving water where the sonde was deployed in the last part of the deployment period. The increase only lasts for 1-2 hours.



#### Specific Conductivity (with Stage) Churchill River below Muskrat Falls - May 20 - June 23, 2010

Figure 3: Specific conductivity at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 105.7 to 115.6% and a range of 11.55 to 15.34 mg/l was found in the concentration of dissolved oxygen with a median value of 13.95 mg/l (Figure 4).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 4
- Dissolved oxygen content decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 1, Appendix 1).
- There is some variability in dissolved oxygen during the final week in the deployment period which is likely caused by the shallow moving water where the sonde was deployed, after the river level dropped during late May and early June.



#### Dissolved Oxygen (mg/l and %Sat) Churchill River below Muskrat Falls - May 20 - June 23, 2010

Figure 4: Dissolved oxygen at Churchill River below Muskrat Falls

- A range of 4.1 to 544.0 NTU was recorded for turbidity for this deployment period (Figure 5). A median value of 10.75 NTU indicates there is a consistent natural background turbidity value at this station.
- Increasing number of spikes in turbidity near the end of the deployment indicate that the instrument was affected by the decrease in stage level that nearly left the sonde exposed to air. Turbidity values are also affected by the significant rainfall event from June 7-9.





Figure 5: Turbidity at Churchill River below Muskrat Falls

Churchill River above Muskrat Falls

- The instrument deployed at the site above Muskrat Falls became exposed to air on June 16, 2010 as water level in the river dropped over 1.8m from the beginning of the deployment period in late May. There is no data available between June 16-23.
- Water temperature ranges from 2.31 to 10.7°C during this deployment period (Figure 6).
- Water temperature continues to increase throughout the spring deployment (Figure 6). This trend is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.
- A decrease in water temperature from June 6-9, 2010 corresponds with cold weather conditions and high precipitation (Appendix 1).



#### Water Temperature Churchill River above Muskrat Falls - May 20 - June 23, 2010

Figure 6: Water temperature at Churchill River above Muskrat Falls

- pH ranges between 6.35 and 6.72 pH units (Figure 7).
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 7).
- pH values are consistent throughout the deployment period, fluctuating slightly in the beginning of June just before the instrument would have become exposed to air.



pH Churchill River above Muskrat Falls - May 20 - June 23, 2010

Figure 7: pH at Churchill River above Muskrat Falls

- Specific conductivity ranged from 11.6 to 13.7µS/cm during the deployment period (Figure 8). Specific conductance remains stable throughout the deployment period.
- Stage is included in Figure 8 to illustrate the relationship between conductivity and water level. Typically, as stage increases, specific conductivity decreases based on a dilution effect. Stage, although rapidly decreasing throughout the deployment period, also shows several increases. These increases correspond with decreases in specific conductance (indicated by red arrows on Figure 8).



#### Specific Conductivity (with Stage) Churchill River above Muskrat Falls - May 20 - June 23, 2010

Figure 8: Specific conductivity at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 93.1 to 98.9% and a range of 10.94 to 12.91 mg/l was found in the concentration of dissolved oxygen with a median value of 12.08 mg/l (Figure 9).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 9
- Dissolved Oxygen content decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 6, Appendix 1).



Dissolved Oxygen (mg/l and %Sat) Churchill River above Muskrat Falls - May 20 - June 23, 2010

Figure 9: Dissolved oxygen at Churchill River above Muskrat Falls

- A range of 3.0 to 162.0 NTU was recorded for turbidity during this deployment period (Figure 10). A median value of 8.0 NTU indicates there is a consistent natural background turbidity value at this station.
- Increasing number of spikes in turbidity near the end of the deployment indicate that the instrument was affected by the decrease in stage level that left the sonde exposed to air on June 16. Turbidity values are also affected by the significant rainfall event from June7-9.



Turbidity (with Stage) Churchill River above Muskrat Falls - May 20 - June 23, 2010

Figure 10: Turbidity at Churchill River above Muskrat Falls

Churchill River below Grizzle Rapids

• No instrument was deployed at this station between May and June due to a large ice wall that prohibited safe access to the river from the station hut (Figure 11).



Figure 11: Ice wall at station below Grizzle Rapids, May 20, 2010

Churchill River below Metchin River

- Water temperature ranges from 2.10 to 12.10°C during this deployment period (Figure 12).
- Water temperature continues to increase throughout the spring deployment (Figure 12). This trend is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.



Water Temperature Churchill River below Metchin River - May 20 - June 23, 2010

Figure 12: Water temperature at Churchill River below Metchin River

- pH ranges between 6.66 and 7.21 pH units (Figure 13). pH values are consistent throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 13).





Figure 13: pH at Churchill River below Metchin River

- Specific conductivity ranged from 14.6 to 31.2µS/cm during the deployment period (Figure 14). Specific conductance remains relatively stable throughout the deployment period with a few sharp increases lasting up to 7 hours.
- Variability in specific conductance most often can be related back to weather events. The nearest weather station to the site below Metchin River is located in Churchill Falls. However, for much of the time between May and November 2010, precipitation data is missing from the dataset. Stage can help determine some of the variability. Between May 29 and June 1, the conductivity varied considerably, fluctuating up and down. This event corresponds to a sudden decrease and increase in stage as seen on Figure 14 in red.
- Spikes in conductivity occur throughout the latter half of the deployment period reaching as high as  $31.2\mu$ S/cm and lasting for up to 7 hours. It is unknown what the cause of the spikes.



#### Specific Conductivity Churchill River below Metchin River - May 20 - June 23, 2010

Figure 14: Specific Conductivity at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 93.8 to 100.7% and a range of 10.56 to 13.06 mg/l was found in the concentration of dissolved oxygen with a median value of 11.54 mg/l (Figure 15).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 15.
- Dissolved Oxygen content decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 12, Appendix 1).



#### Dissolved Oxygen (mg/l and %Sat) Churchill River below Metchin River - May 20 - June 23, 2010

Figure 15: Dissolved oxygen at Churchill River below Metchin River

- A range of 0.0 to 204.6 NTU was recorded for turbidity for this deployment period (Figure 16). A median value of 0.0 NTU indicates this site is naturally clear with out significant turbidity values.
- Increasing number of spikes in turbidity, largely in the second half of the deployment, could indicate the instrument was affected by the rapidly decreasing water level. With no precipitation data to compare values with, it is unknown what exactly may have caused these increases.





Figure 16: Turbidity at Churchill River below Metchin River

## Conclusions

- Three of four water quality monitoring stations on the Lower Churchill River were deployed between May 20 and June 23. No instrument was deployed at the site below Grizzle Rapids due to a large ice wall that remained after the winter, prohibiting safe access to the site.
- The instrument at the site above Muskrat Falls became exposed to air on June 16 and remained on the shore until the site visit on June 23. No data is available for this station during this time. The instrument at the site below Muskrat Falls is nearly exposed to air at the end of the deployment period. Readings may have been affected due to the shallow water conditions.
- All pH and dissolved oxygen values for the three stations are within the CCME Guidelines for the Protection of Aquatic Life.

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## **Appendix 1**



#### Mean Daily Air Temperature and Total Precipitation Goose Bay, May 20 - June 23, 2010

20



#### Mean Daily Air Temperature and Total Precipitation Churchill Falls, May 20 - June 23