

Real Time Water Quality Report VALE, Voisey's Bay Stations

Deployment Period 2010-08-17 to 2010-10-11

2010-10-30



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

Real Time Water Quality Monthly Report for VALE Newfoundland and Labrador Ltd. August, September & October 2010

General

- On August 17, 2010 WRMD staff deployed the 4 DataSondes[®] following the appropriate procedures.
- The real-time data (and subsequently the water quality graphs) logged, transmitted and graphed successfully for all four stations over the deployment period.
- Water Resources Management Division (WRMD) staff monitors the real-time web page on a daily basis.
- . This report interprets the real-time data collected over the deployment period from August 17 until the instruments were removed on October 11 for the winter season. The instruments will be redeployed in the spring 2011.

Maintenance and Calibration of Instrumentation

After being cleaned and freshly calibrated the DataSonde® were installed on August 17, 2010, and remained deployed continuously until October 11, 2010, a 52 day period. On October 11, 2010, the instrument was checked in situ against a freshly calibrated MiniSonde[®] to verify that it was functioning properly, and had no significant drift.

Quality Assurance / Quality Control (QAQC) Measures

As part of the QAQC (Quality Assurance, Quality Control) protocol, 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. See Table 1.

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	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 μ 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 limits for Parameters

- Upon deployment, a QAQC MiniSonde[®] is temporarily deployed along side the Field DataSonde[®]. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the difference between parameters recorded by the Field DataSonde[®], QAQC MiniSonde[®] a qualitative statement is made on the data quality upon deployment.
- At the end of a deployment period, readings are taken in the water body from the Field DataSonde[®] 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_e). If T_e exceeds a predetermined data correction criterion, a correction based on T_e is applied to the dataset using linear interpolation. Based on the value for T_e, a qualitative statement is also made on the data quality upon removal.
- The rankings at the beginning and end of the deployment period are shown in **Table 2** for the Voisey's Bay Stations.
- **Reid Brook at Outlet of Reid Pond** data was ranked at installation and removal. During installation all parameters ranked within the applicable ranges of *Excellent*, except for dissolved oxygen which ranked as *Poor*. This result may be a reflection of the performance of the Clark cell dissolved oxygen probe on the instrument. During removal most parameters ranked as *Good* and *Excellent*, turbidity ranked as *Fair* and due to a communication error there is no reading at removal for dissolved oxygen.
- Lower Reid below Tributary data was ranked at installation and removal. During installation all parameters ranked within the applicable ranges of *Good* and *Excellent*. During removal parameters only ranked as *Good* or *Marginal*, and due to a communication error there is no reading at removal for dissolved oxygen and turbidity.
- **Tributary to Lower Reid Brook** data was ranked at installation and removal. During installation all parameters ranked within the applicable ranges of *Excellent*, except for pH which ranked as *Fair*, this ranking can be a result of insufficient length of stabilization time for the sensor. During removal all parameters ranked as *Good*, however there was a connection issue for both dissolved oxygen and turbidity and the readings were not available from the QAQC instrument.
- Camp Pond Brook below Camp Pond data was ranked at installation and removal. During installation all parameters ranked within the applicable ranges of *Fair* and *Excellent*. During removal all parameters ranked slightly lower between *Good and Fair*, except for dissolved oxygen. This parameter was unable to be ranked due to a power issue with the instrument which prevented the instrument from giving a reading.
- 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.
- With the exception of water quantity data (stage & stream flow), 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.

Table 2: QAQC Data Comparison Rankings for deployment between August 17 and October 11,
2010

Station	Date	Action	Instrument Comparison Ranking				
Station			Temperature	pН	Conductivity	Dissolved Oxygen	Turbidity
Reid Brook	Aug 17/10	Installation	Excellent	Excellent	Excellent	Poor	Excellent
(40644)	Oct 11/10	Removal	Excellent	Good	Excellent	Error reading	Fair
Lower Reid	Aug 17/10	Installation	Excellent	Excellent	Excellent	Good	Excellent
вгоок (40643)	Oct 11/10	Removal	Marginal	Fair	Good	Error reading	Error reading
Tributary to Lower Reid	Aug 17/10	Installation	Excellent	Fair	Excellent	Excellent	Excellent
Brook (44175)	Oct 11/10	Removal	Good	Good	Good	Error reading	Error reading
Camp Pond Brook	Aug 17/10	Installation	Excellent	Fair	Excellent	Excellent	Excellent
(40642)	Oct 11/10	Removal	Fair	Good	Good	Error reading	Excellent

DATA INTERPRETATION

REID BROOK AT OUTLET OF REID POND (UPPER REID BROOK)

TEMPERATURE

- The water temperature (Figure 1) ranged from a minimum of 5.86 °C to a maximum of 20.59°C.
- The water temperature ranges depict the steady decrease in water temperature from August through to the end of summer.
- The water temperature graph indicates two events; on August 21, 2010 the temperature decreases to ~13.8°C and then again on September 6 to ~8°C.
- The decrease in water temperature may be explained by a drop in air temperature. On August 21, 2010 Nain recorded an average air temperature of 9.4°C, which was considerably lower than the days surrounding it. On September 5-6, 2010 the air temperature was within 6.4-7.9°C, which was on the lower scale for temperature during this month.
- It is likely that the decrease in air temperature directly influenced the water temperature during those days.



Reid Brook at Outlet of Reid Pond Temperature

Figure 1: Water Temperature at Reid Brook at Outlet of Reid Pond

pН

- Throughout the deployment period pH values (Figure 2) ranged from a minimum of 6.43 to a maximum of 6.95.
- The pH values can be compared to the CCME Protection for Aquatic Life Guideline. The values sit just above the recommended range (6.5) for the minimum CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life. This is not unusual as the background pH for Reid Brook Outlet is historically at the lower end of the CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life.
- A small drop in pH on September 6, 2010 could be explained by rainfall. There was a rainfall event in Nain on September 6, 2010 measuring ~7.5mm.



Reid Brook at Outlet of Reid Pond

Figure 2: pH values at Reid Brook at Outlet of Reid Pond

SPECIFIC CONDUCTIVITY

- The specific conductivity (Figure 3) ranged from a minimum of 7.8µS/cm to a maximum of 9.4µS/cm over the deployment period.
- Specific Conductivity remained constant during the deployment period; there were no significant changes in the data.
- There was one small peak in conductivity from ~8.5µS/cm to a high of ~9.5µS/cm. The reading dropped almost immediately back to ~8.5µS/cm.



Reid Brook at Outlet of Reid Pond Specific Conductivity

Figure 3: Specific Conductivity Values at Reid Brook at Outlet of Reid Pond

DISSOLVED OXYGEN

- The dissolved oxygen (DO), values ranged from a minimum of 5.91mg/L to a maximum of 10.77mg/L over the deployment period (**Figure 4**).
- Throughout the deployment period, majority of the DO values are above the CCME *Guideline for the Protection of Cold Water Other Life Stages* (>6.5mg/L).
- At installation of the instrument the DO probe ranked as *Poor* against the QA sonde. It is possible that the Clark cell DO sensor is reading incorrectly. This may be a reoccurring problem, as it was noted at removal during last month's deployment. This data should be used with caution.
- During removal, there were connection issues from the QAQC sonde to the handheld display instrument therefore there is no comparison between the field instrument and QAQC to determine the ranking of the data.
- The jump in DO values on September 21 to 25 may be a result of a rainfall event that occurred on September 18 to 21.



Reid Brook at Outlet of Reid Pond Dissolved Oxygen (mg/l and %Sat)

Figure 4: Dissolved Oxygen (mg/L & % Sat) at Reid Brook at Outlet of Reid Pond

TURBIDITY

- The turbidity values ranged from a minimum of 0.0NTU to a maximum of 243.6NTU over the deployment period (Figure 5).
- There is steady increase in turbidity from September 4, 2010 toward the end of deployment, with intermittent peaks reaching as high as ~245NTU.
- The field instrument values ranked as *Excellent* at deployment providing confidence in the data. At removal the field instrument was ranked as *Fair*; it can be assumed that there was interference on the sensor during the deployment period that caused the ranking to drop to *Fair*.
- It is likely that the turbidity sensor had become blocked by sand/silt or any type of floating debris, which may have been stirred up by several rainfall events that occurred from September 1 to September 9.
- This station is typically clear with very few turbidity events; therefore, the changes in turbidity from September 23 onwards is unusual for this station. This data is not accurate and should be used with caution.



Reid Brook at Outlet of Reid Pond Turbidity

Figure 5: Turbidity Values for Reid Brook at Outlet of Reid Pond

STAGE AND STREAM FLOW

- The stage (Figure 6) or water level ranged from a minimum of 1.424m to a maximum of 1.802 m.
- The stream flow ranged from minimum of 0.2m³/s to a maximum of 1.45m³/s.
- There is a gradual decrease in both stage and stream flow during the deployment period.
- The graph (Figure 6) displays the precipitation events that had effect on stream flow for this deployment period.

PRECIPITATION

- The closest recorded rainfall to Reid Brook at Outlet to Reid Pond is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at <u>http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID</u> =10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (Figure 6) ranged from a minimum of 0.0mm to a maximum of 7.4mm.
- Nain had one substantial rainfall event on September 6, 2010 at 7.4mm and several small ones throughout the deployment period.



Reid Brook at Outlet of Reid Pond

Figure 6: Reid Brook at Outlet of Reid Pond stream flow and stage

CONCLUSION

The water quality monitoring instrument was deployed at the station at Reid Brook at Outlet of Reid Pond between August 17 and October 11, 2010. During this deployment period, there were no significant influences to the parameters, although rainfall did influence increases in dissolved oxygen and potentially caused debris stir-up affecting the performance of the turbidity sensor. Water temperature depicted the natural drop as the warm summer temperatures start to decrease into the fall season. It also displayed two prominent drops in water temperature which may be related to a drop in air temperature at those dates. Typical seasonal patterns are still evident in temperature, pH, conductivity, stream flow and stage.

DATA INTERPRETATION

TRIBUTARY TO LOWER REID BROOK

TEMPERATURE

- The water temperature (**Figure 7**) ranged from a minimum of 1.40°C to a maximum of 17.80°C.
- The water temperature ranges depict a steady decrease in water temperature from August onward, as air temperature decreases toward the fall season.
- The diurnal cycling of temperature is a natural process and that will also have an effect on other parameters.



Tributary to Lower Reid Brook Water Temperature

Figure 7: Water Temperature at Tributary to Lower Reid Brook

pН

- Throughout the deployment period pH values (Figure 8) ranged from a minimum of 6.71 to a maximum of 7.23
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline*. For Tributary to Lower Reid Brook the pH values sit within the recommended range (6.5 9.0 for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*). This is not unusual as the background pH for Tributary to Lower Reid Brook, is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- At installation pH was ranked as *Fair* however it is important to note that it can take considerable time for this sensor to stabilize. At removal pH was ranked *Good*.
- It appears that pH had no significant events during the deployment period.



Tributary to Lower Reid Brook pH

Figure 8: pH values at Tributary to Lower Reid Brook

- The specific conductivity (Figure 9) ranged from a minimum of 33µS/cm to a maximum of 43.2µS/cm over the deployment period.
- Conductivity ranges were slightly higher than that of the previous deployment period from July to August 2010.
- As noted in previous reports, there does appear to be a correlation between specific conductivity and stage, there are two examples noted on the graph (Figure 9) where stage increases and conductivity responds by decreasing.
- The decreasing of conductivity values is not uncommon as rainfall dilutes the water body, saturating the dissolved substances (salts) in the water body and creating a lower reading.



Tributary to Lower Reid Brook Specific Conductivity

Figure 9: Specific Conductivity Values at Tributary to Lower Reid Brook

DISSOLVED OXYGEN

- The dissolved oxygen (DO), values ranged from a minimum of 8.88mg/L to a maximum of 12.95mg/L over the deployment period (Figure 10).
- Throughout the deployment period, the DO values are increasing. At deployment, values were just above the lower limit recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Cold Water/Early Life Stages above 9.5 mg/L). Within ~10 days of deployment, DO values rise above the lower recommended guideline. This rise corresponds with decreasing water temperatures.
- There was evidence of several increases DO (mg/L) on September 4, September 14 16 and October 6 7, 2010. Each one of these events correspond (within a couple days) to a rainfall event.
- At installation the dissolved oxygen probe ranked as *Excellent* against the QA sonde. It was not possible (due to a power issue) to collect the removal value for DO.



Tributary to Lower Reid Brook Dissolved Oxygen (mg/l and %Sat)

Figure 10: Dissolved Oxygen (mg/L & % Sat) at Tributary to Lower Reid Brook

TURBIDITY

- The turbidity values ranged from a minimum of 0.0NTU to a maximum of 26.3NTU over the deployment period (Figure 11).
- Rainfall and subsequent runoff can adjust the levels of suspended material in the water body, causing the sensor to read higher than normal. Generally within 24-48 hours after a rainfall event the turbidity levels will increase and over a period of days or even weeks (in high precipitation season). The turbidity levels should then return to normal.
- Isolated turbidity readings (such as those indicated on the left side of Figure 11) can be a result of debris momentarily passing over the sensor as the reading is being taken, this is most evident when all other readings before and after the high turbidity reading are very low (i.e. 0.0 5 NTU).



Tributary to Lower Reid Brook Turbidity

Figure 11: Turbidity Values for Tributary to Lower Reid Brook

STAGE AND STREAM FLOW

- The stage (Figure 12) or water level ranged from a minimum of 0.226m to a maximum of 0.541m.
- There is no data for stream flow at this station.
- Stage was influenced on several occasions by rainfall. Stage peaked on September 6, 2010 to 0.41m and on October 10 to 0.51m both events correspond with the higher rainfall events for the deployment period.

PRECIPITATION

- The closest recorded rainfall to Tributary to Lower Reid Brook is at a weather station in Nain, approximately 32.5km from Voisey's Bay. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID=10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (Figure 12) ranged from a minimum of 0.0mm to a maximum of 7.4mm.
- There were several small precipitation events under 5mm and one large rainfall on September 6, 2010 of 7.4mm.



Tributary to Lower Reid Brook Daily Averages

Figure 12: Tributary to Lower Reid Brook precipitation and stage

CONCLUSION

The water quality monitoring instrument was deployed at the station at Tributary to Lower Reid Brook from August 17 to October 11, 2010. There were no significant disturbances to any of the parameters at this station. While there is an indication of rainfall on several of the graphs, it was not considerable enough to affect the quality of the water.

Toward the end of the deployment period the turbidity graph does indicate an event. The turbidity readings correspond with rainfall in Nain, and by the display of the data it is likely that something was blocking the sensor preventing it from restabilising.

There is evidence of several jumps in DO(mg/L) that may be directly influenced by rainfall during the deployment period. During the deployment period the DO(mg/L) increases steadily, which corresponds with the water temperature decreases at the station.

DATA INTERPRETATION

LOWER REID BELOW TRIBUTARY

TEMPERATURE

- The water temperature (Figure 13) ranged from a minimum of 1.24 °C to a maximum of 19.96°C.
- The water temperature during this deployment period has a large range. It depicts the change from the warmer summer temperatures into the fall temperatures which are cooler.
- The graph also displays the diurnal pattern that is evident in water temperature, during each day (increase) and night (decrease).



Lower Reid below Tributary Water Temperature

Figure 13: Water Temperature at Lower Reid below Tributary

pН

- Throughout the deployment period pH values (Figure 14) ranged from a minimum of 6.76 to a maximum of 7.23.
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline*. For Lower Reid below Tributary, the pH values sit slightly above the lower recommended range (6.5) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. This is not unusual as the background pH for Lower Reid below Tributary is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- The graph indicates that on September 6, pH decreased slightly. It is also evident that stage increased on that same day. It can be assumed stage increased due to precipitation.



Lower Reid below Tributary

Figure 14: pH values at Lower Reid below Tributary

SPECIFIC CONDUCTIVITY

- The specific conductivity (Figure 15) ranged from a minimum of 28.0µS/cm to a maximum of 44.0µS/cm over the deployment period.
- As usual, the graph indicates the correlation between specific conductivity and stage, as stage decreases, conductivity responds by increasing.
- This relationship is not unusual as water levels lower (through evaporation, absorption) as it concentrates the presence of dissolved substances (salts) in the water body.



Lower Reid below Tributary Specific Conductivity

Figure 15: Specific Conductivity Values at Lower Reid below Tributary

DISSOLVED OXYGEN

- The dissolved oxygen (DO), values ranged from a minimum of 6.93mg/L to a maximum of 11.23mg/L over the deployment period (**Figure 16**).
- The DO values fluctuate throughout the deployment period. For the majority of the deployment period from August 17 to late September, the DO values are below the lower guideline as recommend by the *CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Cold Water/Early Life Stages above 9.5 mg/L).
- On August 21-24, September 12 -15 and October 6-10, the DO levels have increased slightly (circled in red on Figure 16). These events correspond with rainfall events recorded in the region.
- Values ranked *Good* during installation however there are no rankings available for DO at the time of removal due to a power connection problem with the QAQC instrument.
- DO levels are lower than expected for this time of year at this station. With decreasing temperatures, it would be expected that the DO concentrations would be at least higher than 9.5mg/L (lower guideline). It is not clear whether these generally low values are related to sensor performance.

Lower Reid Brook below Tributary Dissolved Oxygen (mg/l and %Sat)



Figure 16: Dissolved Oxygen (mg/L & % Sat) at Lower Reid below Tributary

TURBIDITY

- The turbidity values ranged from a minimum of 0.0NTU to a maximum of 37.8NTU over the deployment period (Figure 17).
- Several events are displayed on the graph. The higher turbidity readings are most likely a result of the stirred up sediment from rainfall. Additional sediment in the water column increases the scattering of light, hence increasing the turbidity values.



Lower Reid Brook below Tributary Turbidity

Figure 17: Turbidity Values for Lower Reid below Tributary

STAGE AND STREAM FLOW

- Stage can be defined as the height of the surface of a river or other fluctuating body of water above a set point. The set point is the bottom axis of this graph.
- The stage (Figure 18) or water level ranged from a minimum of 1.365m to a maximum of 1.509m.
- The stream flow ranged from minimum of 0.62m³/s to a maximum of 2.29m³/s.

PRECIPITATION

- The closest recorded rainfall to Lower Reid below Tributary is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID =10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (Figure 18) ranged from a minimum of 0.0mm to a maximum of 7.4mm.
- Nain had several rainfall events, the largest on September 6, 2010 to ~ 7.4mm. A rainfall event or increase in rainfall can adjust and alter the quality of the water body.



Lower Reid below Tributary Daily Averages

Figure 18: Lower Reid below Tributary stream flow and stage

CONCLUSION

The water quality monitoring instrument was deployed at the station at Lower Reid below Tributary between August 17 and October 11, 2010. During this deployment period, no significant water quality events were recorded at Lower Reid below Tributary station. There was rainfall occurrences throughout this deployment period. Precipitation may be the source of the smaller events on the graphs for pH, dissolved oxygen and turbidity.

DATA INTERPRETATION

CAMP POND BROOK BELOW CAMP POND

TEMPERATURE

- The water temperature (Figure 19) ranged from a minimum of 0.70°C to a maximum of 23.20°C.
- The water temperature values depict the highest readings in late August to the period at which the air temperature starts to decrease throughout the fall. This trend is reflected in the low water temperatures in October.
- The graph indicates the general decrease in water temperature over the deployment period, with small increases in water temperature that seem to correspond with fluctuations in the stage.
- The fluctuations in stage and water temperature may be a result of rainfall in that region.



Camp Pond Brook below Camp Pond Temperature

Figure 19: Water Temperature at Camp Pond Brook below Camp Pond

pН

- Throughout the deployment period pH values (Figure 20) ranged from a minimum of 6.39 to a maximum of 7.45.
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline*. For Camp Pond Brook below Camp Pond the pH values sit above the lower range (6.5) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. This is not unusual as the background pH for Camp Pond Brook below Camp Pond is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- The pH range is slightly higher than last deployment period, pH may be influenced by the increase in rainfall during this deployment period.
- Furthermore, when pH is coupled with a drop in stage and air temperature, the range will adjust to the natural surroundings.

Camp Pond Brook below Camp Pond



Figure 20: pH values at Camp Pond Brook below Camp Pond

- The specific conductivity (Figure 21) ranged from a minimum of 26.4µS/cm to a maximum of 60.6µS/cm over the deployment period.
- Specific Conductivity levels during this month increased over the deployment period. There is also evidence on the graph of several small peaks. On September 24 25 and October 6, 2010 conductivity increased in level and then returned, dropping back to a lower reading.
- The increases in conductivity coincide with a decrease in stage on those same dates.



Camp Pond Brook below Camp Pond Specific Conductivity

Figure 21: Specific Conductivity Values at Camp Pond Brook below Camp Pond

DISSOLVED OXYGEN

- The dissolved oxygen (DO mg/L), values ranged from a minimum of 7.25mg/L to a maximum of 12.27mg/L over the deployment period (**Figure 22**).
- During the deployment period the DO (mg/L and % Sat) values increase consistently.
- At installation the DO values ranked as *Excellent*, indicating that the instrument was functioning on form, however at the end of the deployment period (at removal) we were unable to take a DO reading due to a communication problem.
- The graph indicates steady DO(mg/L) readings over the deployment period. The steady increase in DO(mg/L) corresponds with the drop in water temperature. Cooler water holds more DO (mg/L) than warmer water.



Camp Pond Brook below Camp Pond Dissolved Oxygen (mg/l and %Sat)

Figure 22: Dissolved Oxygen (mg/L & % Sat) at Camp Pond Brook below Camp Pond

TURBIDITY

- The turbidity values ranged from a minimum of 0.8NTU to a maximum of 30.3NTU over the deployment period (Figure 23).
- Turbidity is jumpy and inconsistent during this deployment period. By the display of data on the graph one can assume that something is blocking the sensors ability to drop back down to a lower reading.
- The majority of the data is within 0-5NTU during the deployment period, with several peaks over 5 NTU.
- The peaks displayed on the graph also coincide with rainfall events for particular times, rainfall occurred on the following dates August 21 through to August 30, September 1-4, September 4-9 and September 18-21, 2010. With September 4-9 being the larger rainfall amount. Rainfall events can mix up the water body sediment and increase the particles in the water column.



Camp Pond Brook below Camp Pond Turbidity

Figure 23: Turbidity Values for Camp Pond Brook below Camp Pond

STAGE AND STREAM FLOW

- Stage can be defined as the height of the surface of a river or other fluctuating body of water above a set point. The set point is the bottom axis of this graph.
- The stage (Figure 24) or water level ranged from a minimum of 1.232m to a maximum of 1.412m.
- The stream flow ranged from minimum of 0.034m³/s to a maximum of 0.385m³/s.
- Due to a transmitting error there are gaps in the data for stream flow from, September 22 to 24 and again from September 30 to October 10, 2010.

PRECIPITATION

- The closest recorded rainfall to Camp Pond Brook below Camp Pond is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at <u>http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID</u> =10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (**Figure 24**) ranged from a minimum of 0.0 mm to a maximum of 5.2mm. While there were several more precipitation events than the previous deployment month, the rainfall recorded was lower than that of last deployment month.
- There were no significant differences in stage and stream flow after the rainfall. After the larger precipitation event on September 6 there were small increases in stream flow (on September 7-8, 2010).



Camp Pond Brook below Camp Pond Daily Averages

Figure 24: Camp Pond Brook below Camp Pond Tributary stream flow and stage.

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CONCLUSION

The water quality monitoring instrument was deployed at the station at Camp Pond Brook below Camp Pond Tributary from August 17 through to October 11, 2010. This deployment period covered the change from summer season to a fall season in which there were several rainfall occurrences. It is possible that precipitation is the source of the events displayed on the graphs for temperature and turbidity. Although there are peaks and dips in the graph for conductivity it is not clear if this is directly related to rainfall. Typical seasonal patterns are evident in the graphs for pH and stage.

COMPARISON BETWEEN STATIONS

Water Temperature

The water temperature readings for all four RTWQ stations at Voisey's Bay were within the ranges of 0.70°C and 23.20°C. At all stations, temperature shows a decreasing trend for the entirety of the deployment period. This trend is expected as the warm summer air temperatures begin to cool into the fall season. All stations also experience diurnal fluctuations in water temperature with decreasing cooler temperatures at night and warmer increasing temperatures throughout the day time. At each of the stations, there are instances that show slightly greater fluctuations. These instances for the most part correspond with precipitations events recorded in the area.

pН

pH values for all stations remain within the recommended range as stated by the CCME *Guidelines for the Protection of Aquatic Life*. pH values average between 6.4 and 7.4 at all stations throughout the deployment period. These are typical values for these stations as there are usually just slightly acidic (at the lower end of the range for the guidelines). Diurnal fluctuations are also evident from the graphs, most significantly at Camp Pond Brook. pH values will tend to increase during the day and decrease at night. A rainfall event occurring in early September (~September 4), caused an increase in stage and hence a slight decrease in pH. This event was noticeable at both the Upper and Lower Reid Brook Stations.

Specific Conductance

Specific conductivity at stations on Tributary to Reid Brook, Lower Reid Brook and Camp Pond Brook all range on average between 25μ S/cm and 45μ S/cm. Values at the station at Outlet to Reid Pond are significantly lower averaging around 8μ S/cm. Specific conductance is generally increasing at stations on Tributary to Reid Brook and Lower Reid below Tributary. Values at the Upper Reid brook station on average increase just slightly. These three stations show minimal fluctuations. Specific conductivity at Camp Pond Brook appears to increase as well throughout the deployment period but displays the most significant fluctuations. All of the fluctuations at all stations regardless of magnitude do correspond with rainfall events and increases in stage. However, the degree to how the water quality is affected is greater at the Camp Pond Brook station.

Dissolved Oxygen

Dissolved Oxygen concentrations tend to increase throughout the deployment period at all four stations. This trend is expected as water temperatures are decreasing and DO concentrations are inversely related to temperature. At stations at Outlet to Reid Pond, Lower Reid below Tributary and Camp Pond Brook, concentrations are a bit lower then expected. Values at these stations are below the minimum CCME *Guideline for the Protection of Aquatic Life for Early Life Stages* for a good portion of the deployment period. The Clark cell sensors on the instruments deployed at these stations are very sensitive and are easily thrown off. Due to a power connection issue with the QAQC instrument at the time of removal, a DO value was not able to be collected for the comparison. DO concentrations at the station on the Tributary to Lower Reid Brook are higher then the other stations and are more typical of what is expected for this time of year. The DO sensor on this instrument is of a different make (luminescent) and is more robust in this environment. DO values do fluctuate diurnally with the increases and decreases in water temperatures at all stations as well as feature some other more significant fluctuations which correspond with rainfall events and increases in stage.

Turbidity

Turbidity values range between 0.0NTU and 243.6NTU. Turbidity is variable at all of the stations and shows no distinct relationship between stations. Turbidity values at stations at Outlet to Reid Pond, Tributary to Reid Brook and Lower Reid below Tributary all experience long lasting turbidity events. Background values at Lower Reid Brook below Tributary and Camp Pond Brook average between 3NTU and 5NTU, while background values at Outlet to Reid Brook Pond are higher than expected and average between 5NTU and 10NTU, increasing throughout the deployment period. There is no background value for turbidity at the station on the Tributary to Lower Reid. Rainfall event and increases in stage level sometimes correspond with increase values however this relationship is not clear in all instances. Instruments will be examined carefully over the winter months in a controlled setting to help identify any sensor issues.

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