Voisey's Bay Real-Time Water Quality Monitoring Network Annual Report 2008

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Acknowledgements

The Real-Time Water Quality Monitoring Network in Voisey's Bay is successful in tracking emerging water quality issues due to the hard work and diligence of certain individuals. The management and staff of Vale Inco work in cooperation with the management and staff of the Department of Environment and Conservation (DOEC) as well as Environment Canada (EC) to ensure the protection of ambient water resources in Voisey's Bay, Labrador.

The Vale Inco Environmental Coordinators on-site, Perry Blanchard and Paul Hounsell, work to ensure the Real-Time Water Quality Monitoring Network is operating to the standards set by DOEC. During the 2008 sampling season, Erin Cullen played an integral role in the month-to-month maintenance and calibration of the instruments. It is only through their dedication to properly maintain and calibrate the equipment and perform acceptable quality control measures that the data can be viewed as reliable and accurate.

Various individuals from DOEC have been integral in ensuring the smooth operation of such a technologically advanced network. Renée Paterson plays the lead role in coordinating and liaising between the major agencies involved, thus, ensuring open communication lines at all times. In addition, Renée is responsible for the data management/reporting, troubleshooting, along with ensuring the quality assurance/quality control measures are satisfactory. Annette Tobin was involved in the real-time water quality program until mid-summer at which point she changed positions when Renée returned from maternity leave in August and resumed her assigned duties. Throughout the deployment season of 2008, Annette travelled to the Voisey's Bay Mine Site in early summer and Renée visited the mine site in the fall to ensure all procedures were being followed and to provide technical assistance. Paul Neary, Leona Hyde and Amir Ali Khan have worked on the communication aspects of the network ensuring the data is being provided to the general public on a near real-time basis through the departmental web page.

The staff of EC under Meteorological Service of Canada Water Survey Canada (Percy Roberts, Perry Pretty, Bill Mullins and Brent Ruth) play an essential role in the data logging/communication aspect of the network. These individuals visit the site often to ensure the data logging equipment is operating properly and transmitting the data efficiently. Finally, they play the lead role in dealing with hydrological quantity and flow issues.

The managers from each agency (Earl Dwyer – Vale Inco; Haseen Khan – DOEC; Howie Wills – EC) are fully committed to improving this network and ensuring it provides meaningful and accurate water quality/quantity data that can be used in the decision-making process. This network is only successful due to the cooperation of all three agencies involved.

Section 1.0 Introduction

The Real-Time Water Quality Monitoring Network began in Voisey's Bay during the summer of 2003 with the establishment of three surface water stations (**Upper Reid Brook – NF03NE0009**; **Camp Pond Brook – NF03NE0010**; **Lower Reid Brook – NF03NE0011**). These three stations have been operational (for summer/fall months) on an annual basis since 2003 acting as an early warning system to capture water quality related events. The three above-noted surface water stations have been providing valuable water quality information and therefore an additional surface water station on the **Tributary to Lower Reid Brook – NF03NE0012** was installed in 2006. This station is located in fairly close proximity to the ovoid and thus it was chosen in particular to capture any water quality events that may result from the actual open-pit mining activities. The groundwater monitoring station at Headwater Pond was not installed again this year due to complications with the location of the well and damage that occurred over the 2007 winter months. An alternative set-up for this station will be considered in the winter of 2009 for the 2009 deployment year. All five real-time water quality stations can be seen in **Figure 1**.

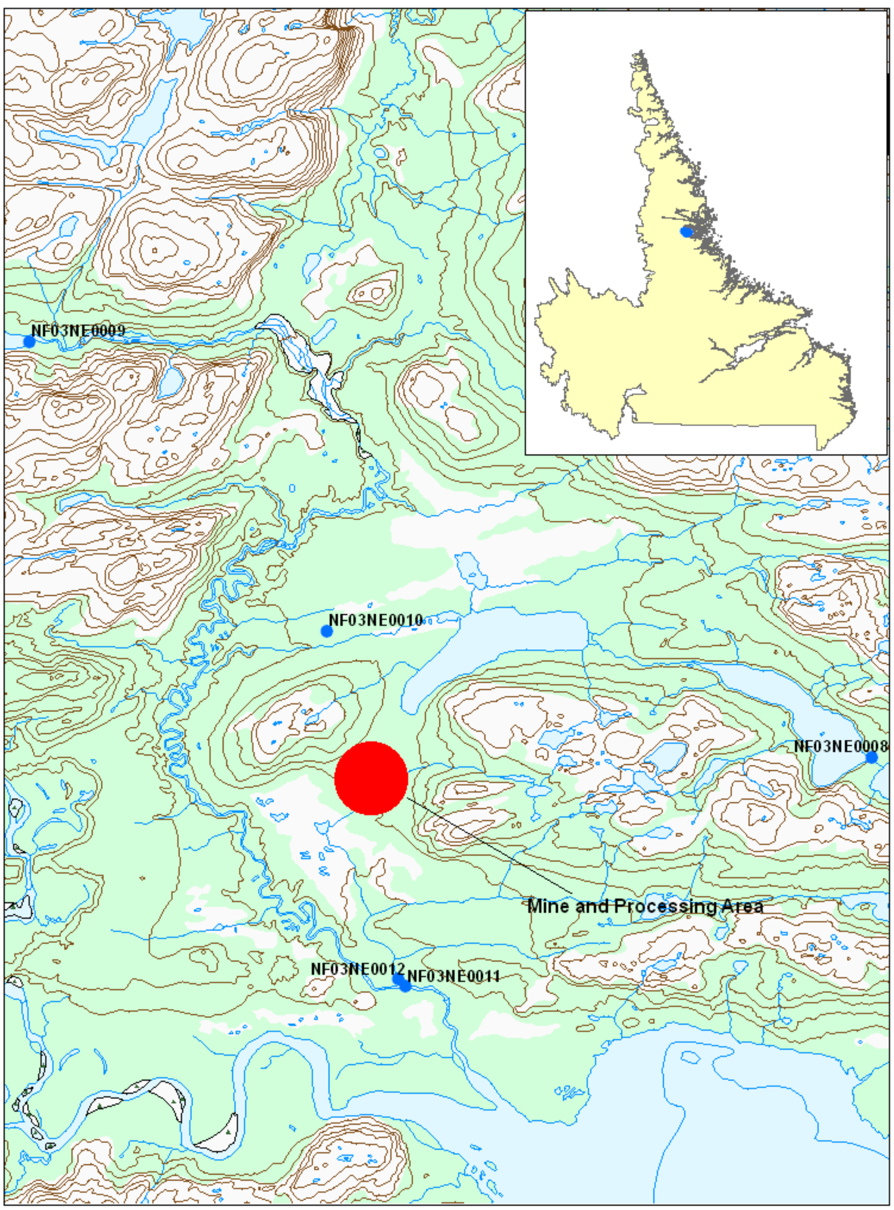


Figure 1: Location of Real-Time Water Quality Monitoring Stations in Voisey's Bay, Labrador

The water quality instruments were removed for the winter months in the fall of 2007. Vale Inco staff sent the instruments directly to Campbell Scientific Canada Corporation in the winter for the annual servicing of the Hydrolabs. The instruments were then returned directly to Vale Inco. Unlike previous years, the instruments were not sent to DOEC for departmental check by DOEC staff and storage over the winter months. This posed a slight problem in that the instruments were not checked properly for important defaults such as parameter order and SDI address after being returned from the manufacturer. Often times, some of the instrument defaults are inadvertently changed during the servicing process in Edmonton. This was the case with the instrument deployed at the Tributary to Reid Brook station, where an error with the SDI address results in a small data gap at the beginning of deployment.

In the spring of 2008, when the ice began to break apart, it was decided that the instruments should be returned to the water. On June 7th, the EC staff arrived for a site visit with a helicopter available to travel to the remote sites. Vale Inco staff accompanied the EC staff and successfully deployed the instruments at the Camp Pond Brook station, Lower Reid Brook station, Upper Reid station and Tributary to Reid Brook station.

In July 2008, both DOEC and EC staff travelled to the mine site for a site visit to ensure that proper maintenance/calibration procedures were being followed and at the same time provide technical assistance to the Vale Inco staff.

In August 2008, the Vale Inco staff performed the regular monthly maintenance/calibration procedures when a helicopter was available to retrieve the instruments.

In September 2008, the EC staff travelled to Voisey's Bay to check the communication of all stations. They completed their work quickly and were not on site long enough for the Vale Inco staff to coordinate retrieval of instruments.

In late October 2008, the Vale Inco staff retrieved the instruments and prepared the stations for the winter months. DOEC staff travelled again to Voisey's Bay on October 27th to meet with the Vale Inco staff to discuss the real-time water quality monitoring program and any issues/challenges encountered over the 2008 sampling season.

In December 2008, the Vale Inco staff shipped all instruments to DOEC for winter storage. DOEC will arrange to have all instruments serviced and tested prior to the start of the 2009 sampling season.

Section 2.0 Maintenance/Calibration

It is recommended by DOEC that regular maintenance/calibration take place on a monthly basis in order to ensure accuracy of the data from the real-time water quality monitoring stations. While this is ideal, due to the location and availability of transportation, this recommendation was often exceeded. Even with sensor drift, the Datasondes would still work successfully to capture any significant water quality event which is why extended deployment periods were made justifiable at these sites. **Table 1** identifies the dates that the instruments were removed/reinstalled for regular maintenance and calibration in 2008. It is important to note that some deployment periods were longer than thirty days due to such issues as availability of helicopters to get to remote locations; allowing for additional monitoring time before winter removal; etc.

Table 1: Dates of Maintenance/Calibration of Instruments

Station	Installation	Removal	Total # of Days	Remarks
Upper Reid Brook	June 7, 2008	July 7, 2008	31	
	July 8, 2008	August 17, 2008	41	Extended deployment due to lack of access to remote sites; removed stations when helicopter was available
	August 20, 2008	October 24, 2008	66	Extended deployment to allow more data collection before removal for winter months
Camp Pond Brook	June 7, 2008	July 7, 2008	31	
	July 8, 2008	August 17, 2008	41	Extended deployment due to lack of access to remote sites; removed stations when helicopter was available
	August 20, 2008	October 26, 2008	68	Extended deployment to allow more data collection before removal for winter months
Lower Reid Brook	June 7, 2008	July 7, 2008	31	
	July 8, 2008	August 17, 2008	41	Extended deployment due to lack of access to remote sites; removed stations when helicopter was available
	August 20, 2008	October 24, 2008	66	Extended deployment to allow more data collection before removal for winter months
Trib Lower Reid Brook	June 7, 2008	July 7, 2008	31	
	July 8, 2008	August 17, 2008	41	Extended deployment due to lack of access to remote sites; removed stations when helicopter was available
	August 20, 2008	October 24, 2008	66	Extended deployment to allow more data collection before removal for winter months

Section 3.0 Data Interpretation

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

The Upper Reid Brook site is a control station that is not directly impacted by development. Throughout the majority of the deployment period from June to October 2008, the water quality remained pristine.

The water temperature (**Figure 2**) increased until mid August and then began to decrease for the remainder of the deployment period. The temperature ranged from 1.929 to 18.4°C over the deployment period. This increasing/decreasing pattern is expected as the summer months progress into the fall. The dissolved oxygen values (**Figure 3**) decreased until mid-August and increased for the remainder of the deployment period corresponding inversely to the pattern seen in temperature. All dissolved oxygen values (9.38 to 12.86 mg/L) remained just at or above the CCME Water Quality Guidelines for the Protection of Aquatic Life. The points in the graph where the values drop to zero indicate the periods when the instrument was out of the water for maintenance/calibration purposes.

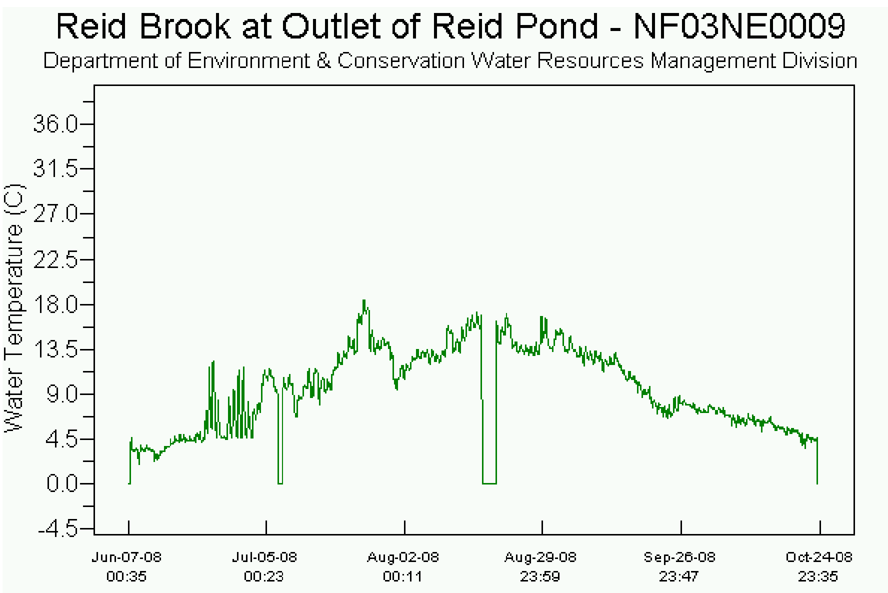


Figure 2: Water Temperature at Reid Brook at Outlet of Reid Pond

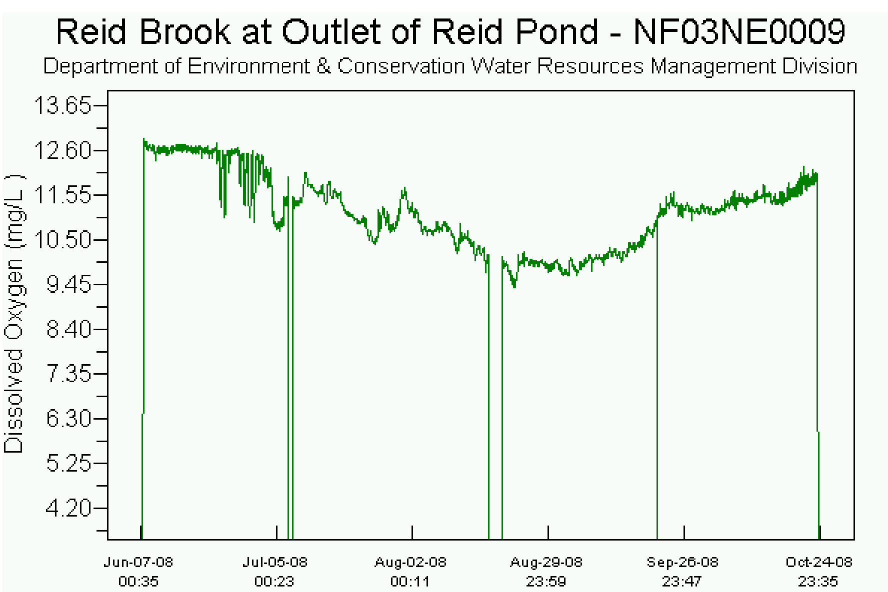


Figure 3: Dissolved Oxygen at Reid Brook at Outlet of Reid Pond

The pH values (**Figure 4**) at the Upper Reid Brook site remained consistent throughout the majority of the deployment period with a noticeable decrease in values towards the end. The pH values ranged from 6.079 to 7.11. The final deployment period (Aug 20th – Oct 24th) was extended significantly therefore the pH values decreased as expected. The sensor drifted causing the pH values to fall just slightly outside the CCME Water Quality Guidelines for the Protection of Aquatic Life recommended range (as seen on the graph as the blue and red lines). There was a noticeable decrease in the pH values around Oct. 18th which corresponded to a period of significant precipitation which can later be viewed in the stage graph.

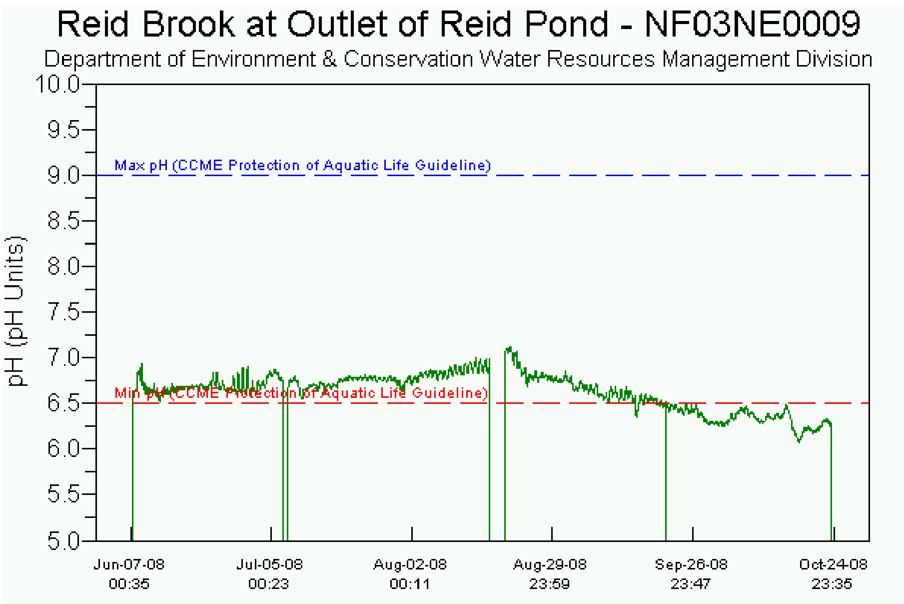


Figure 4: pH at Reid Brook at Outlet of Reid Pond

The conductivity values (**Figure 5**) remained very low at this fairly pristine station only ranging from 7.199 uS/cm to 9.399 uS/cm over the deployment period. The conductivity values from July 8th to August 17th are incorrect values due to a technical problem with the conductivity sensor. This problem will be looked at when the instruments are returned to the manufacturer for servicing over the winter months.

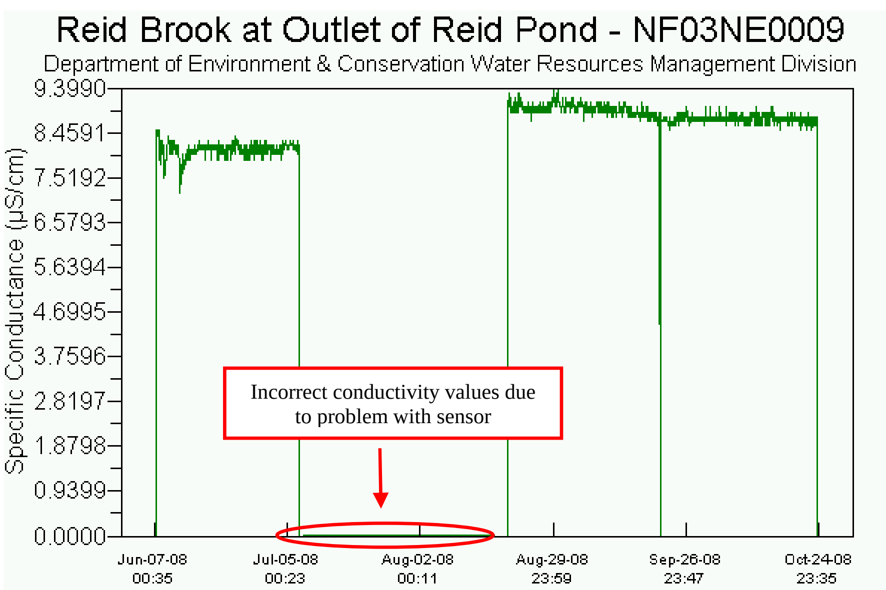


Figure 5: Specific Conductivity at Reid Brook at Outlet of Reid Pond

The turbidity values (**Figure 6a & 6b**) remained relatively stable at a very low background level for the duration of the deployment period. The outlier value (794.9 NTU) seen on August 24th for a one hour period was likely caused by some debris affecting the sensor measurement. This reading was not sustained for a long timeframe and is therefore not a water quality event. In **Figure 6b**, the outlier value was removed and the turbidity values fluctuated slightly with the majority of values below 10 NTU. There were some small spikes in turbidity which can be attributed to increased precipitation at these times as seen on the stage graph (**Figure 7**).

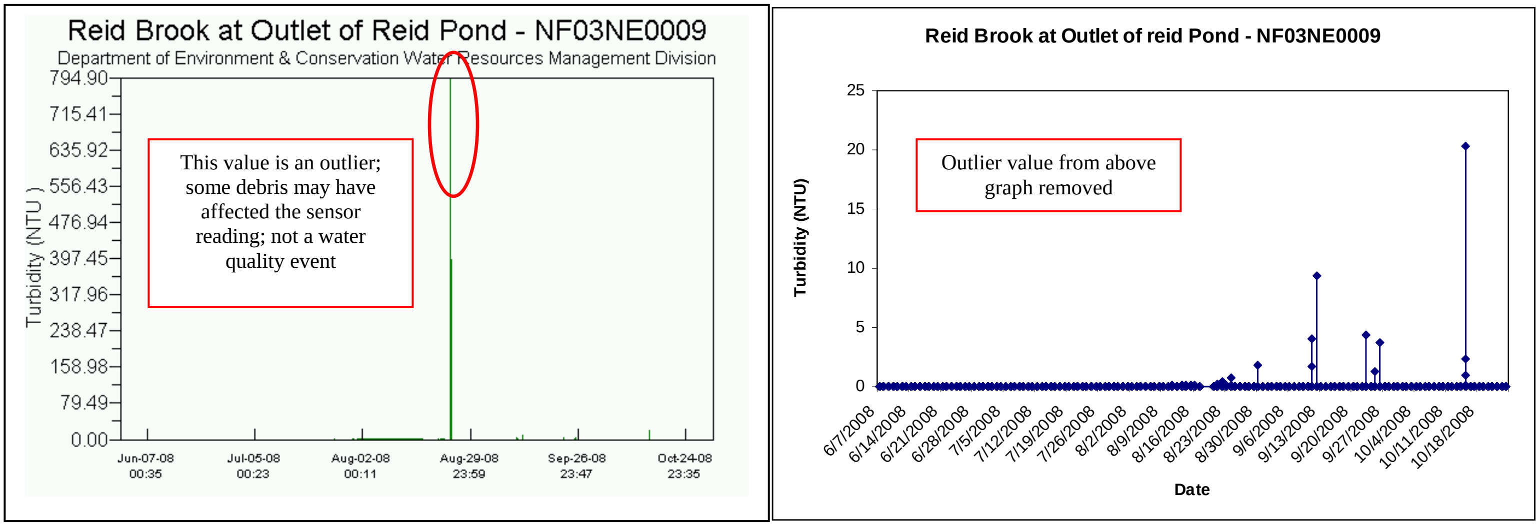


Figure 6a & 6b: Turbidity at Reid Brook at Outlet of Reid Pond

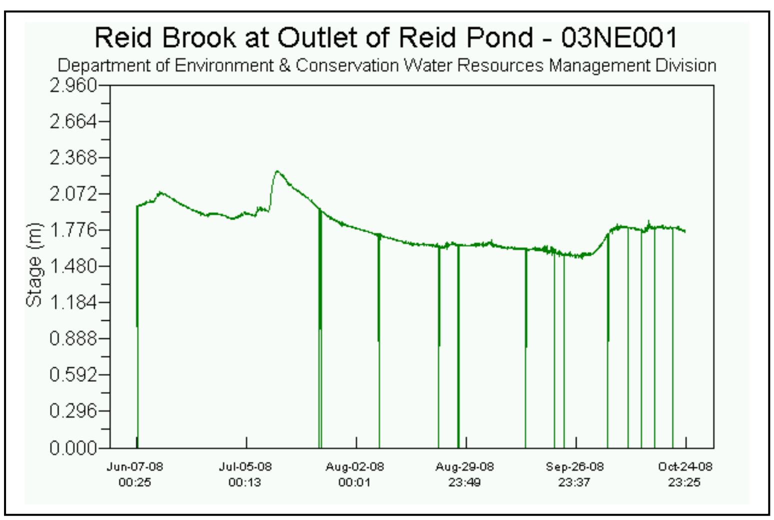


Figure 7: Stage at Reid Brook at Outlet of Reid Pond

Overall, the Upper Reid Brook station displayed very consistent values for all major parameters over the deployment period. Upper Reid Brook is a pristine water body that can be used successfully as a control station to determine the natural background levels expected in the Voisey's Bay area.

CAMP POND BROOK BELOW CAMP POND

The Camp Pond Brook site was chosen to capture any emerging water quality events due to the nearby development of the mine/mill site. Throughout the majority of the deployment period from June to October 2008 the water quality remained fairly consistent for most parameters monitored.

The water temperatures and dissolved oxygen (**Figures 8 & 9** respectively) values followed the expected pattern with water temperatures slightly increasing over the summer months and dissolved oxygen values subsequently decreasing. Then as the fall approached, the water temperatures began to decrease as the dissolved oxygen values increased. The temperature values ranged from -0.08 to 23.12°C. The dissolved oxygen values ranged from 7.44 to 13.29 mg/L. The points in the graph where the values drop to zero indicate the periods when the instrument was out of the water for maintenance/calibration purposes.

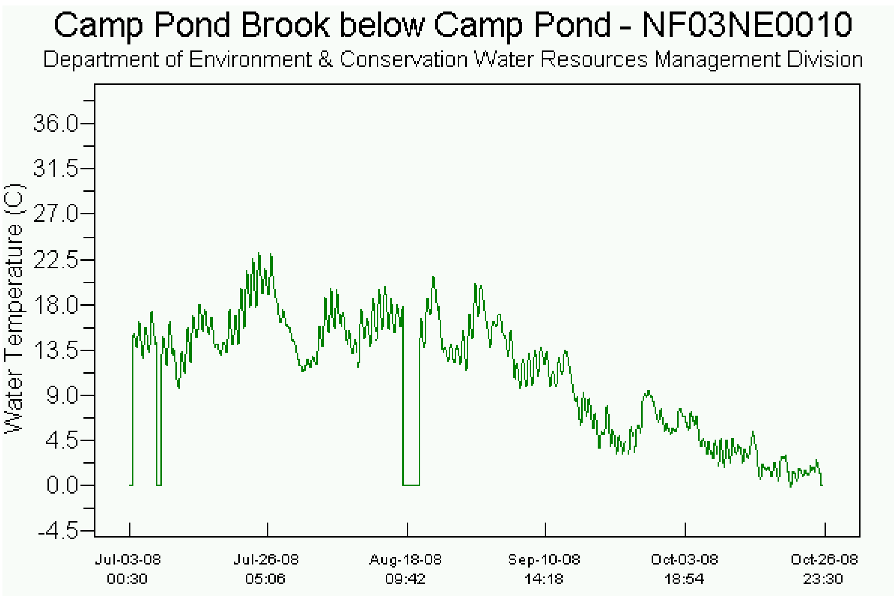


Figure 8: Water Temperature at Camp Pond Brook below Camp Pond

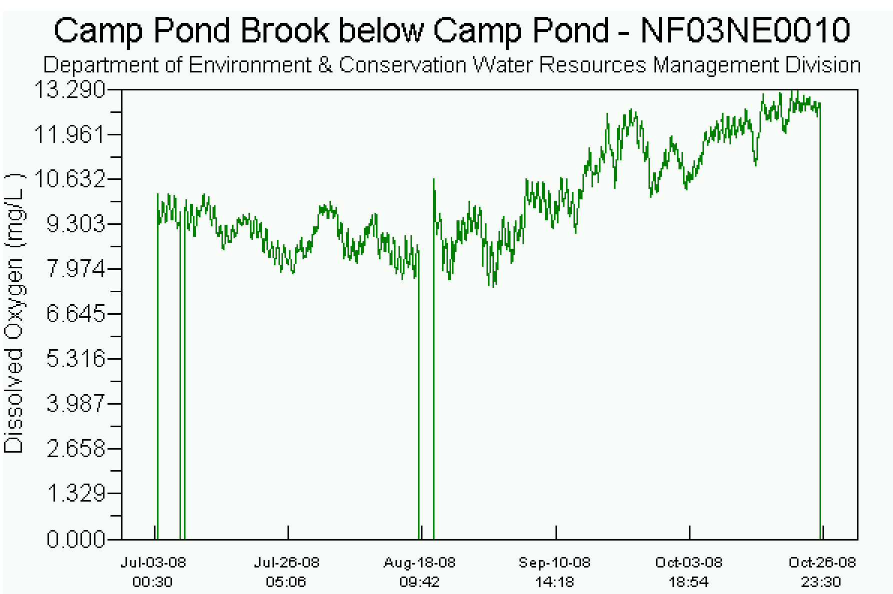


Figure 9: Dissolved Oxygen at Camp Pond Brook below Camp Pond

The pH values (**Figure 10**) at the Camp Pond Brook station remained fairly consistent over the entire deployment period (ranging from 6.63 to 7.49) with no major water quality events being captured. All the pH values remained in the recommended range (6.5 to 9.0) for the CCME Water Quality Guidelines for the Protection of Aquatic Life. There was a slight drift upward in the July deployment period. After cleaning and calibration in August, the pH values remained very consistent.

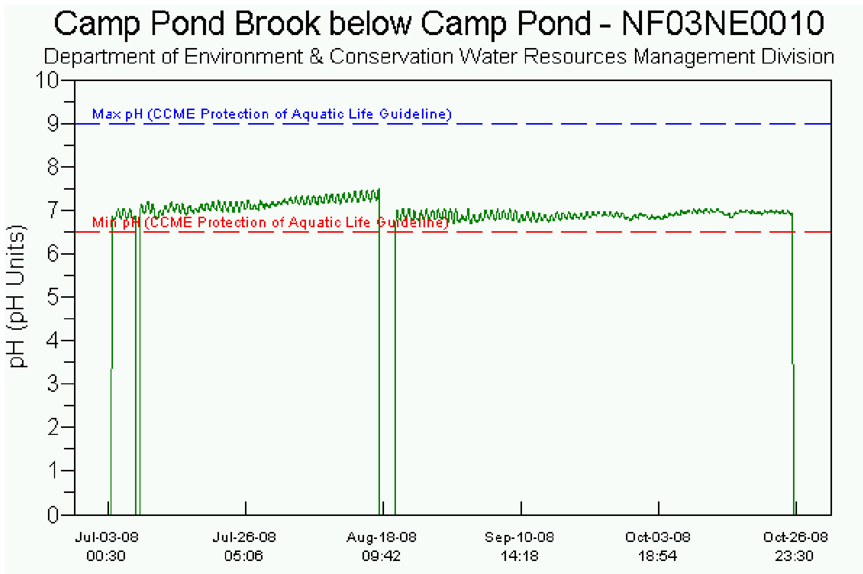


Figure 10: pH at Camp Pond Brook below Camp Pond

The conductivity values (**Figure 11**) remained fairly consistent throughout the deployment period. The conductivity values ranged from 27.4uS/cm to 47.3uS/cm which corresponds to values seen in previous years. There were two more significant spikes in conductivity in early July (43.4 uS/cm) and early October (47.3uS/cm). Both of these increases correspond to changes in the stage graph (**Figure 13**). Values are higher than that of the control station (Upper Reid Brook) but are expected due to the level of development surrounding Camp Pond Brook.

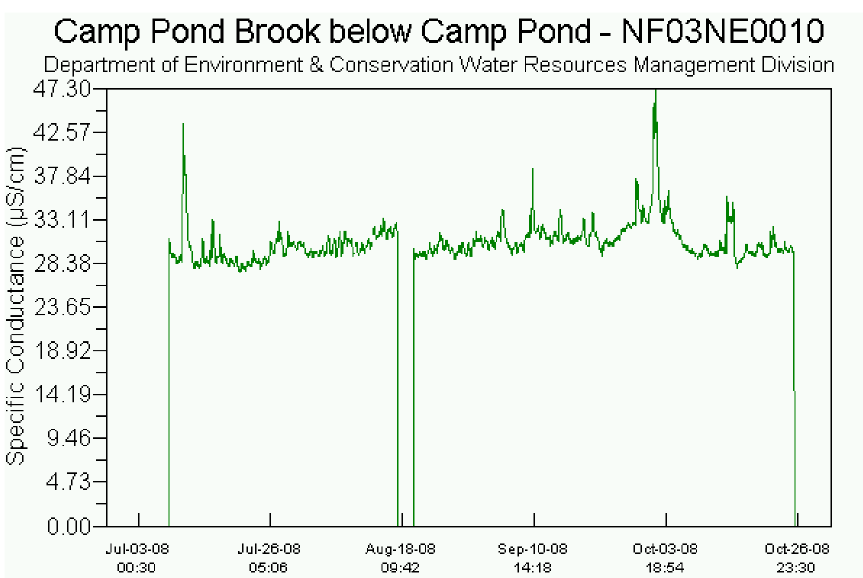
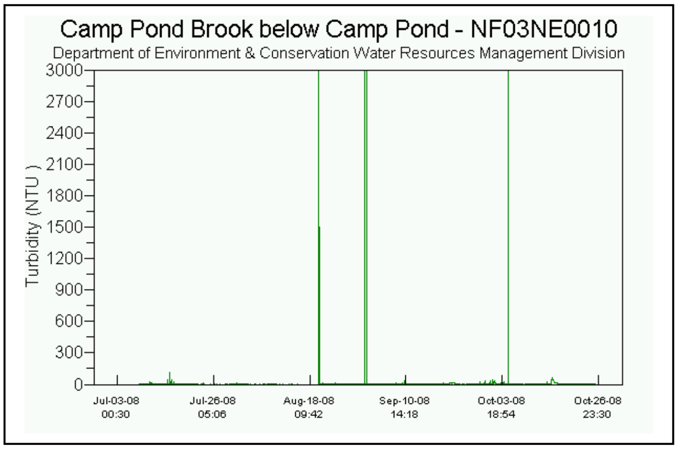


Figure 11: Specific Conductivity at Camp Pond Brook below Camp Pond

Turbidity values (**Figure 12a & 12b**) fluctuated at the Camp Pond Brook site over the deployment period (June – October). As can be seen in **Figure 12a**, there were three instances whereby the turbidity values spiked to 3000 NTU (error reading for instrument) most likely due to debris interfering with the measurement. These error readings are removed in **Figure 12b** to allow the user to view the results in more detail. There were some increases in turbidity in early July that were likely a result of increased rainfall as seen on the stage graph (**Figure 13**). Around September 21st and 22nd, the turbidity values were slightly increased so the Environmental staff on-site visually investigated and determined that the high winds were causing tremendous wave action along the shorelines in Camp Pond and was likely the cause of the slightly turbid water. There was a noticeable increase in the stage graph in early October thus explaining the likely cause of the increased turbidity values at that time.



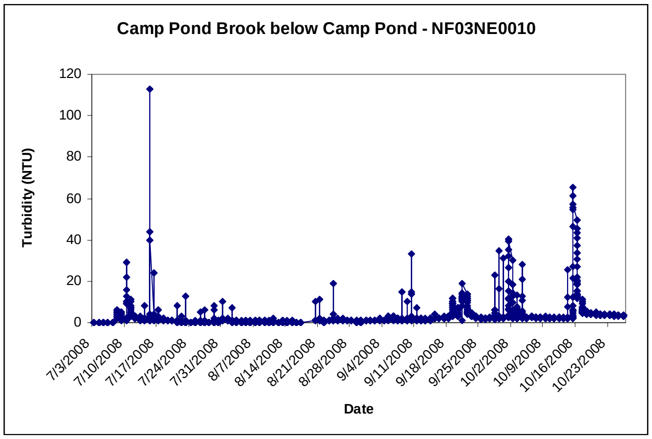


Figure 12a & 12b: Turbidity at Camp Pond Brook below Camp Pond

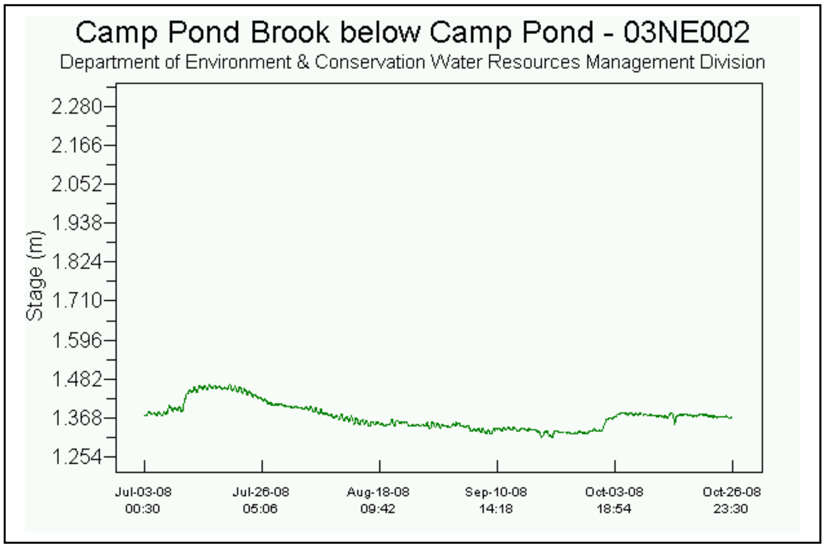


Figure 13: Stage at Camp Pond Brook below Camp Pond

Overall, the Camp Pond Brook station displayed consistent values for all major parameters over the deployment period. In most cases, the variation in both specific conductivity and turbidity values can be attributed to increased stage height from rainfall events.

LOWER REID BROOK

The Lower Reid Brook site was chosen as a downstream location that could be used to determine if water quality events from the upstream development area were still having an impact downstream just before the stream runs into the ocean.

The water temperatures and dissolved oxygen (**Figures 14 & 15** respectively) values followed the expected pattern with water temperatures slightly increasing over the summer months and dissolved oxygen values subsequently decreasing. Then as the fall approached, the water temperatures began to decrease as the dissolved oxygen values increased. The temperature values ranged from -0.2 to 19.09°C. The dissolved oxygen values ranged from 7.03 to 14.21 mg/L. The points in the graph where the values drop to zero indicate the periods when the instrument was out of the water for maintenance/calibration purposes.

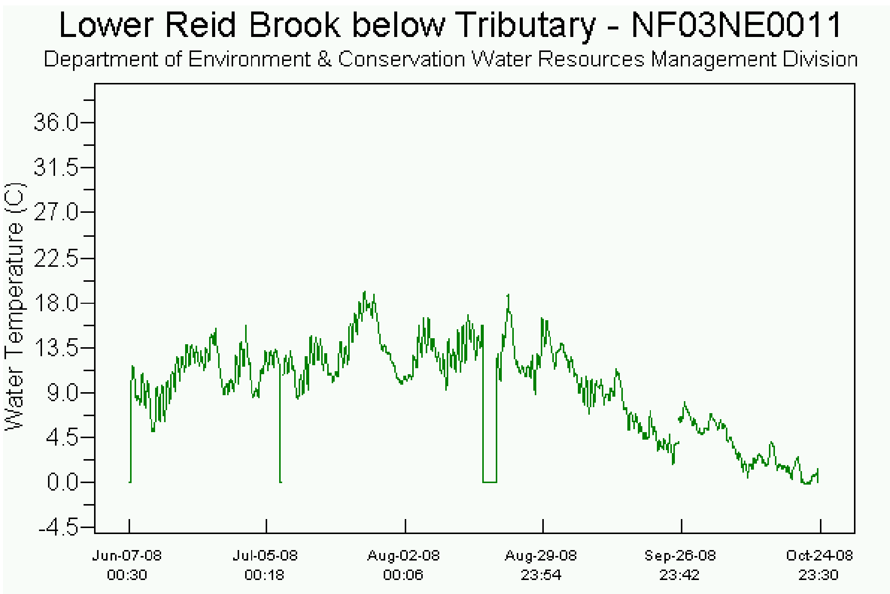


Figure 14: Water Temperature at Lower Reid Brook

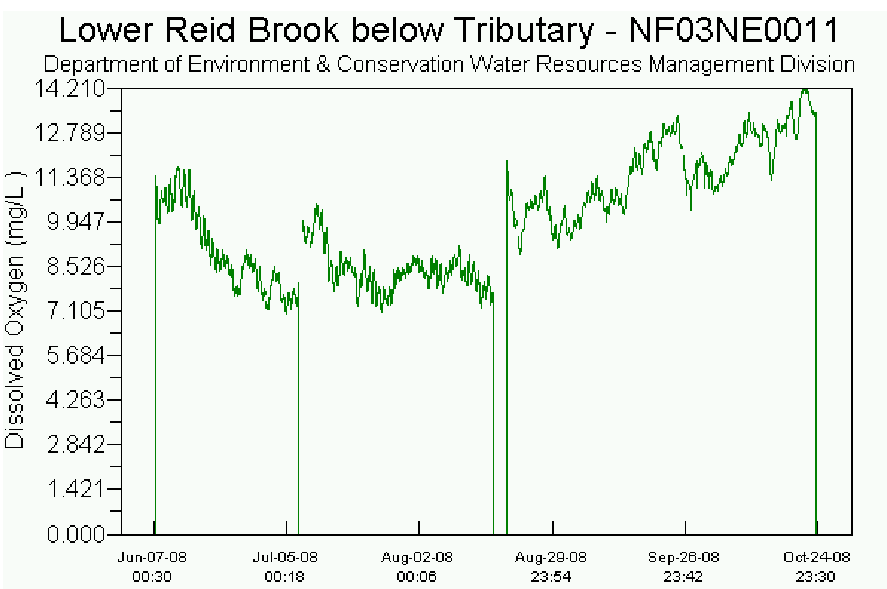


Figure 15: Dissolved Oxygen at Lower Reid Brook

The pH values (**Figure 16**) at the Lower Reid Brook station remained very consistent over the entire deployment period (ranging from 6.64 to 7.51) with no major water quality events being captured (only small drops in pH values resulting from times of increased precipitation). All the pH values remained in the recommended range (6.5 to 9.0) for the CCME Water Quality Guidelines for the Protection of Aquatic Life.

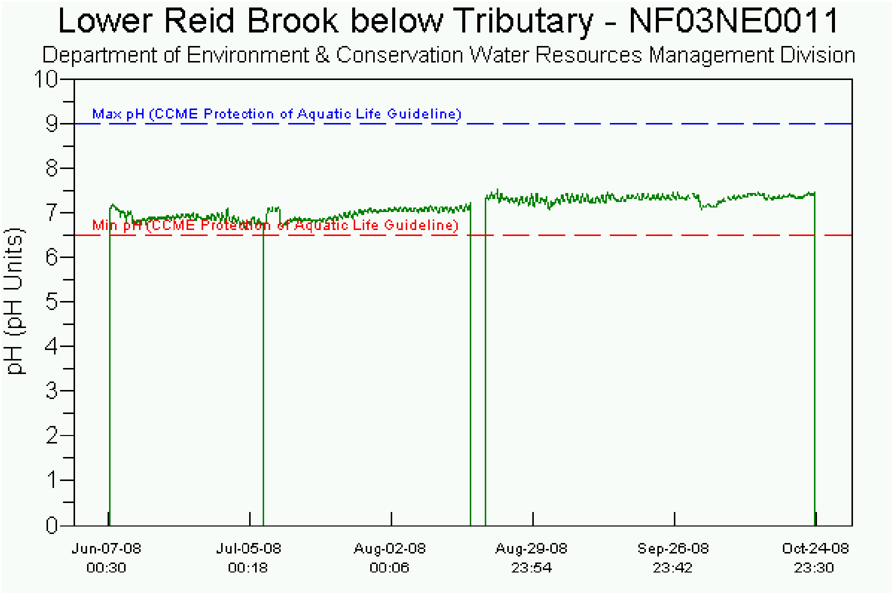


Figure 16: pH at Lower Reid Brook

The conductivity values (**Figure 17**) during the deployment period between June and October ranged from 15 uS/cm to 37 uS/cm for the Lower Reid Brook station. It is obvious that the times when the conductivity values decreased can be attributed to increases in the stage graph (**Figure 18**). It appears as though the increased rainfall amounts work to dilute the river system, resulting in a noticeable drop before an increase in conductivity. As the stage decreases back to a normal level after the increase, the specific conductivity values gradually increase.

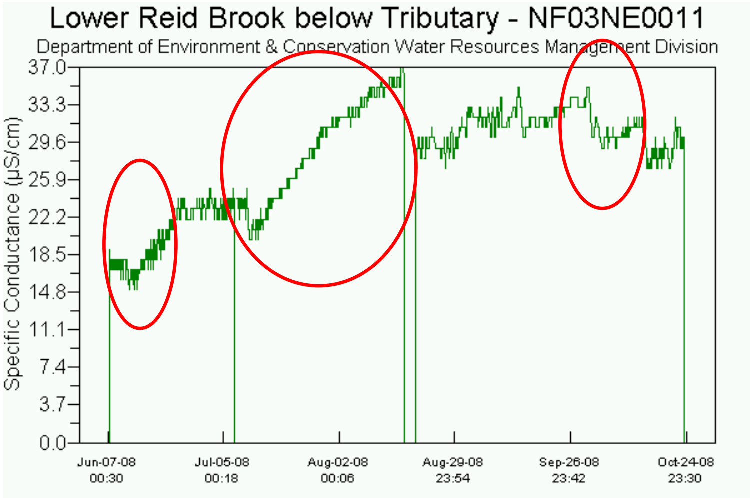


Figure 17: Specific Conductivity at Lower Reid Brook

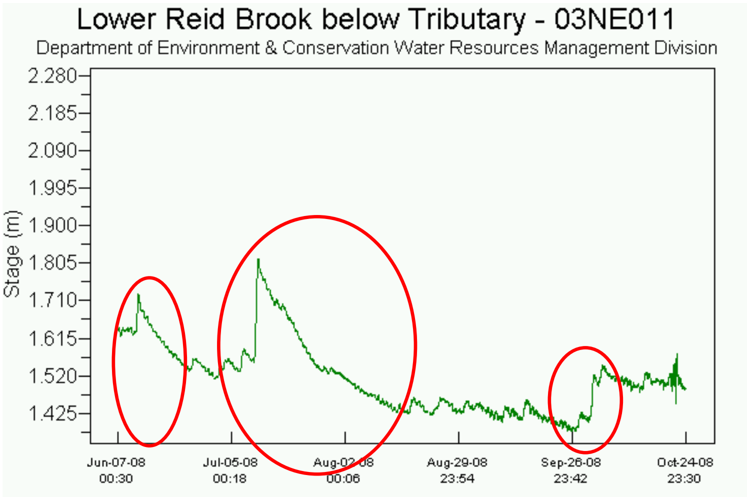


Figure 18: Stage at Lower Reid Brook

The turbidity (**Figure 19**) of the water at the Lower Reid Brook station is typically more variable than the other three stations at Voisey's Bay. The turbidity spikes seen in early July and early October correspond to increases in stage (**Figure 18).** Upon removal of the instrument on July 7th, there was significant sediment collected on the sonde thus affecting the turbidity readings. It is unlikely that the increased turbidity readings in early August are due to precipitation events since there are no increases visible on the stage graph. The data itself indicates that the spikes are random whereby very low readings are recorded followed by one very high reading and then back down again to low readings. The causes of these spikes remain unknown but may be due to sensor interference due to the silty nature of this particular site.

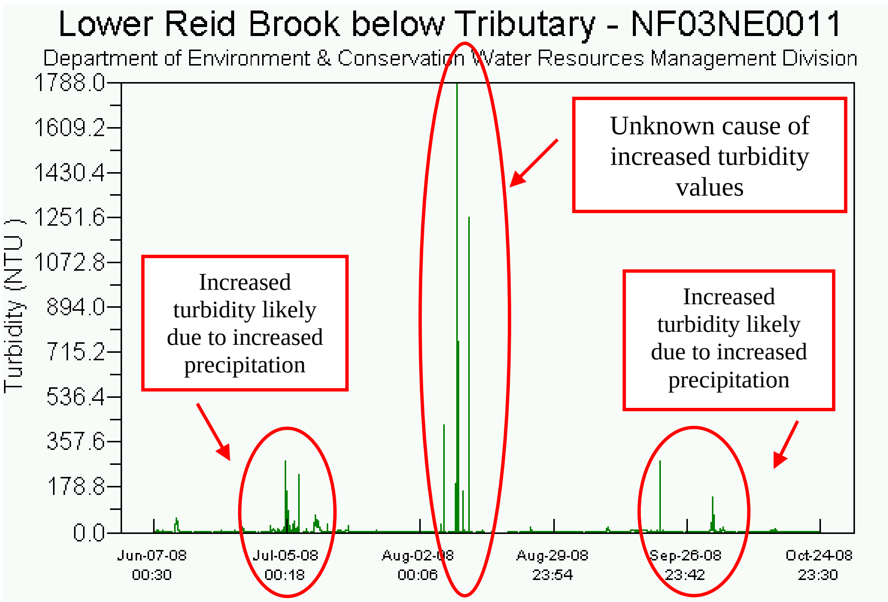


Figure 19: Turbidity at Lower Reid Brook

Overall, the Lower Reid Brook station displayed fairly consistent values for all major parameters during the deployment period. It is evident from the graphs that many of the parameters at this station are dependent on the changes in stage (pH, conductivity and turbidity).

TRIBUTARY TO LOWER REID BROOK

The tributary to Lower Reid Brook station is located in fairly close proximity to the ovoid and thus it was chosen in particular to capture any water quality events that may result from the actual open-pit mining activities. The deployment period extended from June – October 2008.

The water temperature (**Figure 20**) slightly increased until mid August and then began to decrease for the remainder of the deployment period. The temperature ranged from -0.13 to 18.15°C over the deployment period. This increasing/decreasing pattern is expected as the summer months progress into the fall. The dissolved oxygen values (**Figure 21**) decreased until mid-August and increased for the remainder of the deployment period corresponding inversely to the pattern seen in temperature. The dissolved oxygen values ranged from 7.76 to 14.96 mg/L. The points in the graph where the values drop to zero indicate the periods when the instrument was out of the water for maintenance/calibration purposes.

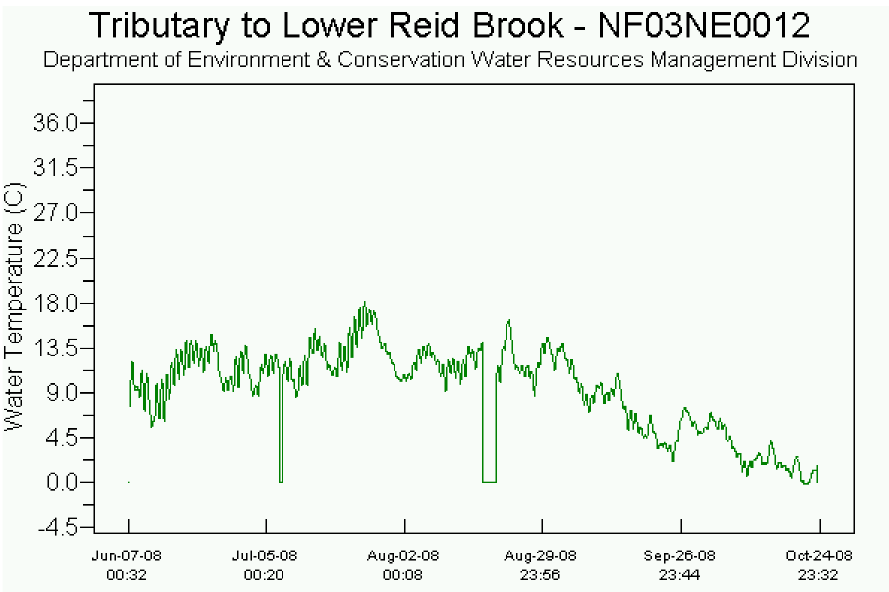


Figure 20: Water Temperature at Tributary to Lower Reid Brook

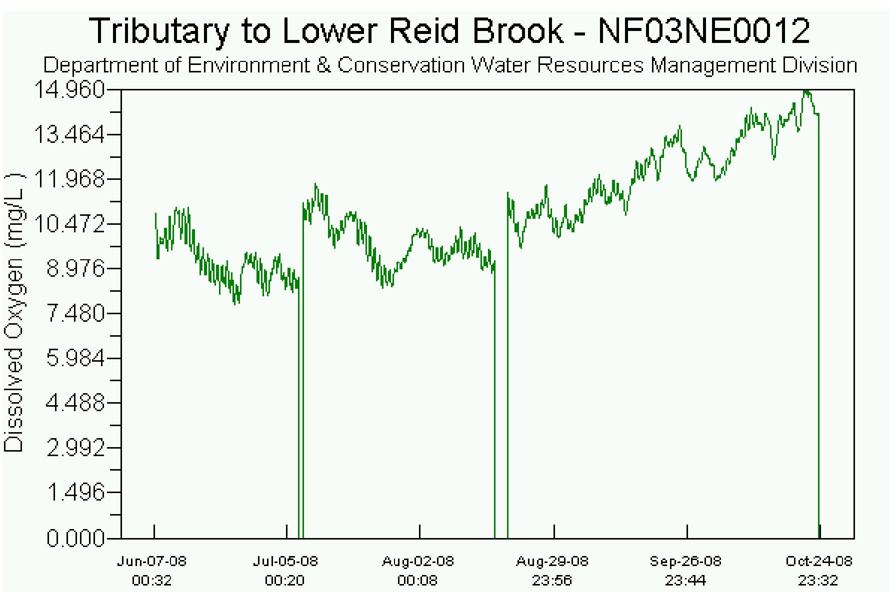


Figure 21: Dissolved Oxygen at Tributary to Lower Reid Brook

The pH (**Figure 22**) of the water at the Tributary to Lower Reid Brook station remained fairly consistent throughout the deployment period (ranging from 6.52 to 7.22) with no major water quality events being captured (only small drops in pH values resulting from times of increased precipitation). All the pH values remained in the recommended range (6.5 to 9.0) for the CCME Water Quality Guidelines for the Protection of Aquatic Life.

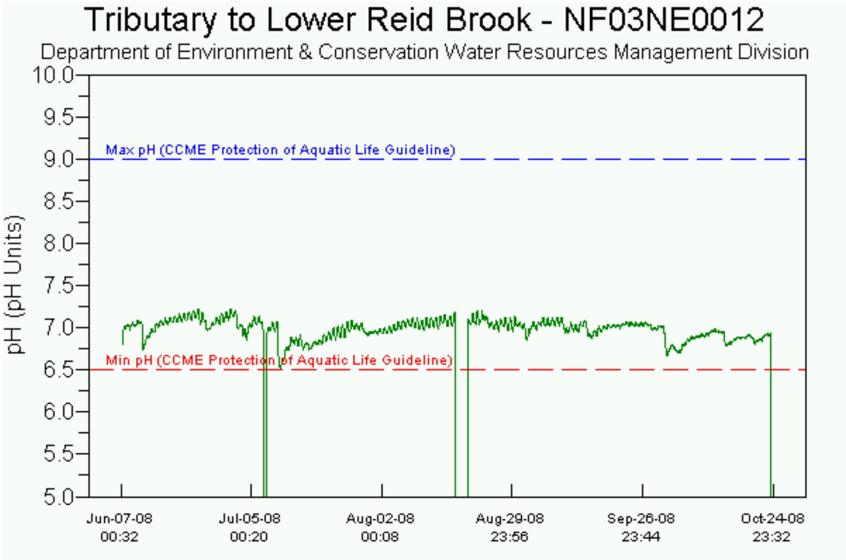


Figure 22: pH at Tributary to Lower Reid Brook

Conductivity values (**Figure 23**) at the Tributary to Lower Reid Brook station fluctuated over the deployment period from June to October. The conductivity values ranged from 15.8 uS/cm to 39.1 uS/cm. This range is comparable to that of the Lower Reid Brook station. As was the case with the Lower Reid Brook station, during times of increased precipitation, the specific conductivity values generally decreased and then gradually increased at the Tributary station as well (**Figure 23**). These fluctuations correspond with sharp increases and gradual decreases in the stage levels as indicated by the areas circled on **Figure 24**.

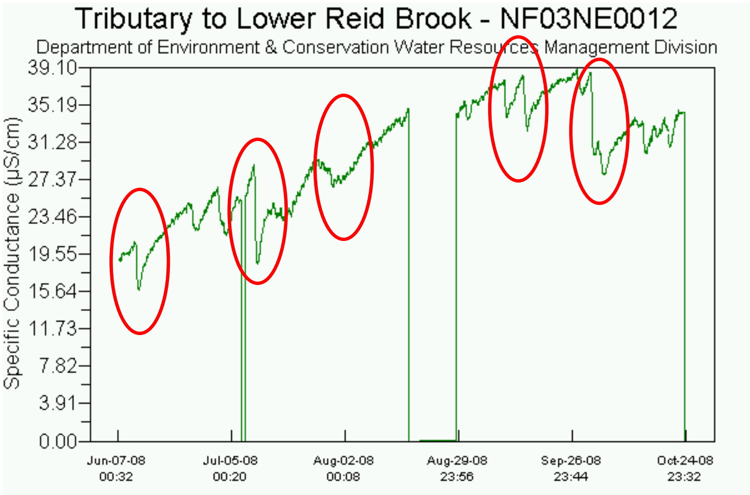


Figure 23: Specific Conductivity at Tributary to Lower Reid Brook

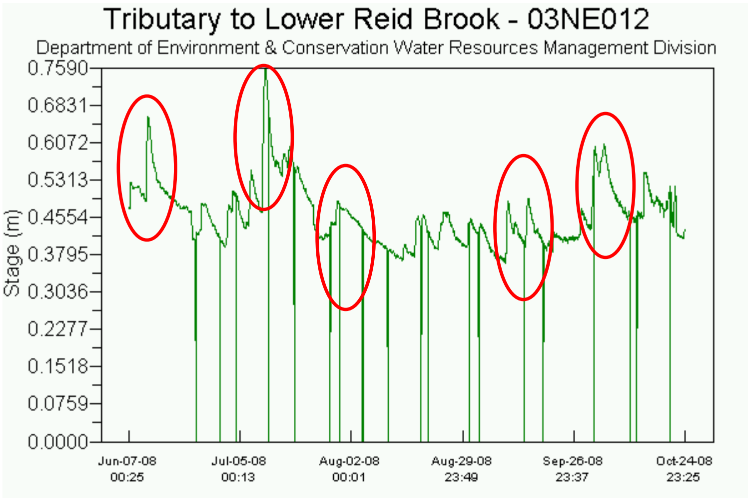


Figure 24: Stage at Tributary to Lower Reid Brook

As can be seen in **Figure 25,** the turbidity values during the first two deployment periods (June-August) are somewhat variable and fluctuating with values ranging from 0 to 91.9 NTU. The majority of the increases in turbidity values correspond to increases in the stage graph (**Figure 24**). The spikes in turbidity values in early August are likely a result of built up debris (cobblestone/silt) inside the instrument casing as noted by the Vale Inco staff upon removal of this instrument. There was an instrumentation issue during the last deployment period (from August 20th until October 24th) whereby the turbidity values are inaccurate. The instrument will be sent for servicing during the winter months to rectify this problem.

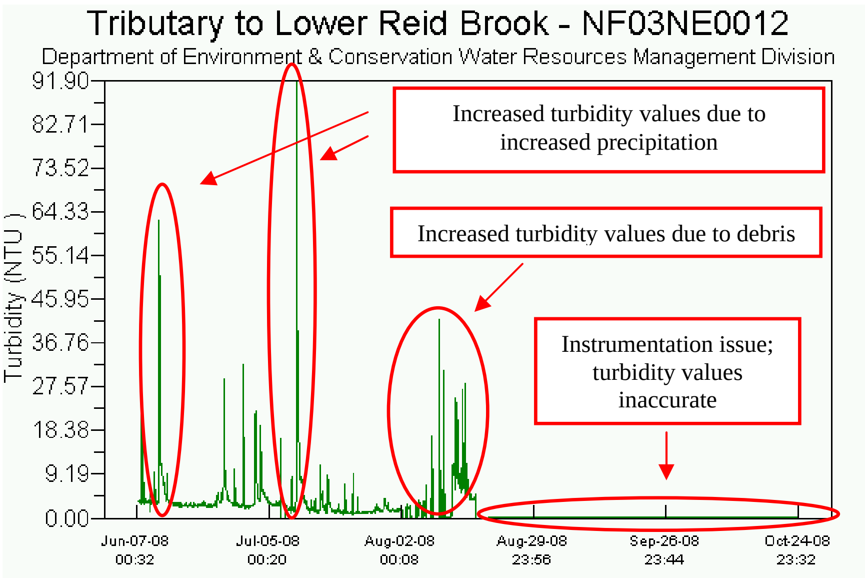


Figure 25: Turbidity at Tributary to Lower Reid Brook

Overall, the Tributary to the Lower Reid Brook station parameter values remained in expected ranges for all major parameters during the deployment period. Parameters are typically slightly higher than the control site (Upper Reid Brook), but similar to the Lower Reid Brook station.

Section 4.0 Quality Assurance/Quality Control (QA/QC) Measures

Quality Assurance/Quality Control (QA/QC) measures are a very important aspect of the Real-Time Water Quality Monitoring Network in Voisey's Bay. These measures are put in place to ensure that the instruments are reading data accurately. The QA/QC procedures established by DOEC are two-fold:

1) Data from the water quality monitoring instrument in-situ (Field sonde) are compared to data from a portable instrument in-situ (QA sonde) at the time of redeployment after maintenance/calibration procedures have been performed; data must fall within a specified range. **Table 2** summarizes the QA/QC results comparing the Datasonde readings against the Minisonde readings for each real-time water quality station.

2) Grab water samples are taken from each station at the time of redeployment and sent to a laboratory for analysis; the results are then compared to those of the water quality monitoring instrument in-situ (Datasonde); data must fall within a specified range. **Table 3** summarizes the QA/QC results comparing the Datasonde readings against the laboratory readings (only three readings available from the lab for comparison – pH; conductivity; turbidity).

As can be seen in **Table 2**, a number of the QA/QC comparisons between the Datasondes and the Minisonde at the time of redeployment could not be recorded. For the initial deployment in June and then the first removal/redeployment in July, the charger cable (used to charge the Surveyor) was not working properly therefore the Surveyor was not available to display the Minisonde values (shown as NA*) in Table 2. The charger cable (in turn, the Surveyor) was working for the removal/redeployment in August for all stations. As seen in Table 2, at all stations (with the exception of Lower Reid Brook station), the rankings are "Good" and "Excellent" for all parameters. However, at the Lower Reid Brook station, the rankings range from "Good" to "Poor". It appears as though the silty nature of this particular site influences some of the readings thus leading to lower rankings.

It should be noted that the conductivity values from the Minisonde were not recorded due to a malfunction in the sensor leading to erroneous values. The Minisonde was sent for manufacturer servicing during the 2008 sampling season. DOEC provided Vale Inco with an alternative Minisonde for use as a QA sonde for the last part of the season.

It is imperative that all equipment be maintained and checked before the start of the 2009 sampling season in order to ensure there is no loss of field or QA data during the short sampling season due to malfunctioning equipment.

As can be seen in **Table 3**, the QA/QC comparison between the Datasondes and laboratory data fell into the "Excellent" and "Good" Categories for all parameters. There was only one set of grab samples taken at each station on July 8th that could be used for comparison purposes. There was no grab sample taken upon initial deployment on June 7th at any of the stations. Additionally, the grab samples that were collected in August were mistakenly taken on the day of removal (not redeployment) as is necessary for QA/QC purposes therefore this data could not be used.

During the upcoming 2009 sampling season, it is imperative that grab samples be taken upon initial deployment and then upon each redeployment throughout the sampling season; protocols will be outlined clearly at the start of the season.

Table 2: QA/QC Results (Field sonde vs. QA sonde)

Station	Reinstallation Date	Parameters	Field Sonde Data	QA Sonde Data	Rating
Upper Reid Brook	June 7, 2008	Temp (°C)	3.66	NA *	NA *
		pH (units)	6.53	NA *	NA *
		Conductivity (µS/cm)	8.399	NA *	NA *
		Dissolved Oxygen (mg/L)	12.86	NA *	NA *
	July 8, 2008	Temp (°C)	9.51	NA *	NA *
		pH (units)	6.55	NA *	NA *
		Conductivity (µS/cm)	11	NA *	NA *
		Dissolved Oxygen (mg/L)	11.51	NA *	NA *
	August 20, 2008	Temp (°C)	14.52	14.25	Good
		pH (units)	6.909	6.46	Good
		Conductivity (µS/cm)	9.1	NA**	NA**
		Dissolved Oxygen (mg/L)	10.1	10.57	Good
Camp Pond Brook	July 3, 2008	Temp (°C)	13.87	NA *	NA *
		pH (units)	6.69	NA *	NA *
		Conductivity (µS/cm)	0.0	NA *	NA *
		Dissolved Oxygen (mg/L)	10.17	NA *	NA *
	July 8, 2008	Temp (°C)	12.3	NA *	NA *
		pH (units)	6.71	NA *	NA *
		Conductivity (µS/cm)	31.1	NA *	NA *
		Dissolved Oxygen (mg/L)	9.7	NA *	NA *
	August 20, 2008	Temp (°C)	12.07	11.83	Good
		pH (units)	6.63	6.80	Excellent
		Conductivity (µS/cm)	29.9	NA**	NA**
		Dissolved Oxygen (mg/L)	10.62	10.67	Excellent
Lower Reid Brook	June 7, 2008	Temp (°C)	7.99	NA *	NA *
		pH (units)	7.1	NA *	NA *
		Conductivity (µS/cm)	18	NA *	NA *
		Dissolved Oxygen (mg/L)	11.37	NA *	NA *
	July 8, 2008	Temp (°C)	10.74	NA *	NA *
		pH (units)	6.79	NA *	NA *
		Conductivity (µS/cm)	24	NA *	NA *
		Dissolved Oxygen (mg/L)	9.66	NA *	NA *
	August 20, 2008	Temp (°C)	10.52	11.46	Marginal
		pH (units)	7.14	6.90	Good
		Conductivity (µS/cm)	29	NA**	NA**
		Dissolved Oxygen (mg/L)	11.88	7.56	Poor
Trib. to Lower Reid Brook	June 7, 2008	Temp (°C)	7.67	NA *	NA *
		pH (units)	6.8	NA *	NA *
		Conductivity (µS/cm)	19	NA *	NA *
		Dissolved Oxygen (mg/L)	10.82	NA *	NA *
	July 8, 2008	Temp (°C)	10.82	NA *	NA *
		pH (units)	6.9	NA *	NA *
		Conductivity (µS/cm)	25.4	NA *	NA *
		Dissolved Oxygen (mg/L)	11.16	NA *	NA *
	August 20, 2008	Temp (°C)	9.73	9.55	Excellent
		pH (units)	6.93	6.91	Excellent
		Conductivity (µS/cm)	32.2	NA**	NA**
		Dissolved Oxygen (mg/L)	11.49	11.20	Excellent

* - There was no QA data taken with the Minisonde because the charger cable was not working therefore the Surveyor (hand-held display) could not be charged and used to get the QA data from the Minisonde
** - The conductivity sensor on the Minisonde was not functioning properly; Minisonde will be sent to Campbell Scientific for repairs; DOEC sent up an alternate Minisonde for use for the last retrieval.

Table 3: QA/QC Results (Datasonde Data vs. Laboratory Data)

Station	Reinstallation Date	Parameters	Datasonde Data	Laboratory Data	Rating
Upper Reid Brook	July 8, 2008	Temp (°C)	9.51		
		pH (units)	6.55	6.64	Excellent
		Conductivity (µS/cm)	11	12	Excellent
		Dissolved Oxygen (mg/L)	11.51		
		Turbidity (NTU)	0.0	0.3	Excellent
	August 20, 2008	Temp (°C)	14.52		
		pH (units)	6.909	NA*	NA*
		Conductivity (µS/cm)	9.1	NA*	NA*
		Dissolved Oxygen (mg/L)	10.1		
		Turbidity (NTU)	0.0	NA*	NA*
Camp Pond Brook	July 8, 2008	Temp (°C)	12.3		
		pH (units)	6.71	7.06	Good
		Conductivity (µS/cm)	31.1	34	Excellent
		Dissolved Oxygen (mg/L)	9.7		
		Turbidity (NTU)	2.0	1.7	Excellent
	August 20, 2008	Temp (°C)	12.07		
		pH (units)	6.63	NA*	NA*
		Conductivity (µS/cm)	29.9	NA*	NA*
		Dissolved Oxygen (mg/L)	10.62		
		Turbidity (NTU)	1.0	NA*	NA*
Lower Reid Brook	July 8, 2008	Temp (°C)	10.74		
		pH (units)	6.79	7.08	Good
		Conductivity (µS/cm)	24	27	Excellent
		Dissolved Oxygen (mg/L)	9.66		
		Turbidity (NTU)	2.0	1.8	Excellent
	August 20, 2008	Temp (°C)	10.52		
		pH (units)	7.14	NA*	NA*
		Conductivity (µS/cm)	29.0	NA*	NA*
		Dissolved Oxygen (mg/L)	11.88		
		Turbidity (NTU)	3.0	NA*	NA*
Trib. to Lower Reid Brook	July 8, 2008	Temp (°C)	10.82		
		pH (units)	6.9	7.10	Excellent
		Conductivity (µS/cm)	25.4	28	Excellent
		Dissolved Oxygen (mg/L)	11.16		
		Turbidity (NTU)	2.9	1.1	Excellent
	August 20, 2008	Temp (°C)	9.73		
		pH (units)	6.93	NA*	NA*
		Conductivity (µS/cm)	32.2	NA*	NA*
		Dissolved Oxygen (mg/L)	11.49		
		Turbidity (NTU)	--	NA*	NA*

*NA – There was no grab sample taken for comparison purposes upon redeployment on August 20th therefore no rankings available.

Section 5.0 Conclusions

The Voisey's Bay real-time water quality monitoring network has been very successful as a regulatory tool throughout the past year. The near-real time water quality data allows the Vale Inco staff to act immediately on emerging water quality events. It has clearly shown that the ambient water quality surrounding the development area is being protected. Since Vale Inco has transitioned from construction to operations, the number of recorded water quality events has reduced significantly (ie: number/extent of turbidity spikes as observed in the data has greatly reduced). The majority of increase/decrease in water quality parameters can usually be attributed to precipitation events.

Upper Reid Brook is a pristine area that can effectively be used as a control station that provides reliable natural background water quality data for comparison purposes. Most importantly, the water quality of Camp Pond Brook, Lower Reid Brook and the Tributary to Lower Reid Brook did not change drastically from the natural background concentrations even though there is a significant amount of development occurring in the watersheds. It is evident that the mitigation measures established by Vale Inco have significantly reduced the effect of development on the overall ambient water quality.

Section 6.0 Path Forward

In order for a program to be successful, it is essential to continually evaluate and move forward. The following is a list of planned activities to be carried out in the upcoming year. The list also includes some multi-year activities planned in the previous year that are still in progress.

- shipment of instruments for servicing work during the winter months to minimize loss of data over a short sampling season due to malfunctioning equipment
- testing/preparation of instruments in St. John's office prior to spring deployment to ensure all instruments are functioning properly
- Vale Inco staff will be invited to participate in a Hydrolab Training Course to refresh maintenance/calibration procedures (to be held in January 2009)
- spring site visitation to install all instruments and continue to standardize all data logger programming
- continued monitoring of water quality from late spring to late fall 2009 with continued data analysis in the form of monthly deployment reports; annual report will be prepared at end of 2009 calendar year
- continued direct communication between DOEC and Vale Inco staff to respond to emerging issues on a proactive basis
- continued site visitation and training by DOEC staff throughout the summer and fall
- plans are underway to relocate the groundwater monitoring station so that it will not be damaged by snow; reinstallation to take place in spring 2009
- Vale Inco staff will be invited to attend/present at the 2nd Real-Time Water Quality Monitoring Workshop to be held in June 2009 in St. John's NL
- continued work on Automatic Data Retrieval System to incorporate new capabilities
- continued transfer of data from DOEC to Vale Inco staff through the departmental web page
- provide on-line statistical analysis of data; work on extrapolation of other water quality parameters using regression analysis
- evaluation and upgrading of QA/QC procedures through the production of a Real-Time Water Quality Monitoring manual; this product will be disseminated before the start of the 2009 sampling season