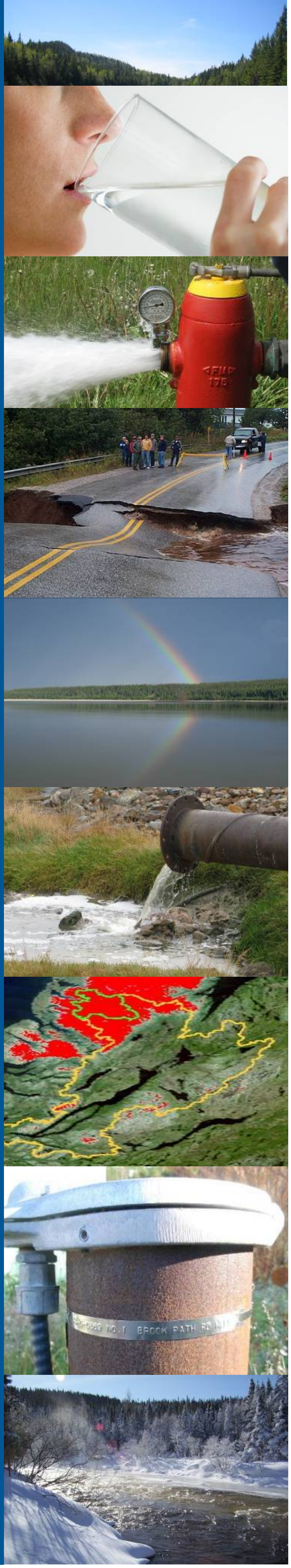

Teck Duck Pond Operations Real-Time Water Quality Monitoring Network Annual Report 2010

2011-03-21

Newfoundland Labrador

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

Acknowledgements

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations is successful in tracking emerging water quality issues due to the hard work and diligence of individuals from three different organizations. The management and staff of Teck Duck Pond Operations work in cooperation with the management and staff of the Department of Environment and Conservation (ENVC) as well as Environment Canada (EC) to ensure the protection of ambient water resources in the vicinity of the mine and mill.

At Teck Duck Pond Operations several staff members including General Manager Bob Kelly have assisted in ensuring that the real-time system is operating such that data are reliable and accurate. Boyd Gulliford, Jill Kelly, Carol-Ann Hayden, Gord Parsons and Robert Vaters have provided valuable assistance with the stations and feedback from time to time.

Various individuals from the Department of Environment and Conservation under the direction of Haseen Khan have been integral in ensuring the smooth operation of such a technologically advanced network. Robert Picco, Renée Paterson and Robert Wight played the lead roles in coordinating and liaising between the major agencies involved, thus, ensuring open lines of communication at all times. Robert was responsible for the data management/reporting, troubleshooting, along with ensuring the quality assurance/quality control measures are satisfactory. Throughout the year, Robert travelled to Teck Duck Pond Operations sometimes twice monthly to maintain and service the equipment and troubleshoot any technical problems as they arose. 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.

Staff of Environment Canada (Meteorological Service of Canada - Water Survey Canada) under the management of Howie Wills play an essential role in the data logging/communication aspect of the network. Brent Ruth and Roger Ellsworth, visit the site often to ensure the data logging equipment is operating properly and transmitting the data efficiently. They play the lead role in dealing with hydrological quantity and flow issues.

All individuals from each agency are fully committed to maintaining and 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 open communication and high level of cooperation of all three agencies involved.

Section 1.0 Introduction

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations began in 2006 when the property was being developed by Aur Resources Inc. This network forms part of a larger network of government run and government-industry partnership run real-time water quality stations throughout the Province. **Figure 1** depicts the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations in relation to the others on the island portion of the Province.

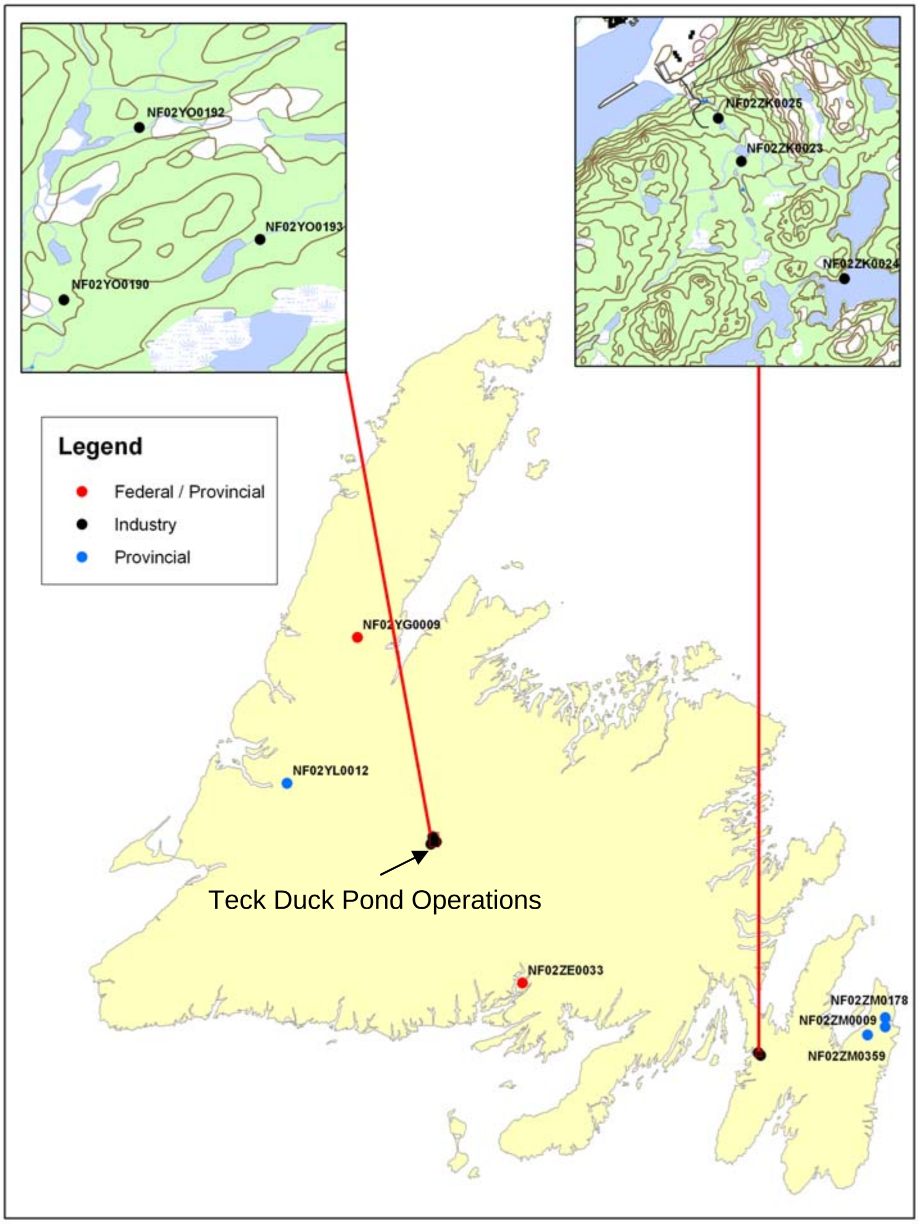

Figure 1: Real-Time Water Quality Monitoring Stations, Newfoundland

Three permanent stations (**Figure 2**) are established at Teck Duck Pond Operations; two in surface water streams and one in a ground water monitoring well:

- **Tributary to Gills Pond Brook Station (NF02YO0190**) is located 1700 m downstream of the final discharge point for the site's Tailings Management Area / Polishing Pond. This station is located such that any impacts from normal mine/mill discharge on receiving waters can be measured. This station has been fully operational since May 10, 2006 during the mine/mill construction phase.

- **East Pond Brook Station (NF02YO0192)** is located several kilometers downstream of the Tailings Management Area. This station is located such that any surface water impacts from the Tailing Management Area via seepage through Dam A may be measured. This station has been fully operational since September 7, 2006, during the mine/mill construction phase.

- **Monitoring Well After Tailings Dam Station (NF02YO0193)** is located approximately 100 meters below Tailings Dam A. This station is located such that any ground water impacts from the Tailing Management Area via seepage through Dam A may be measured. This station has also been fully operational since September 7, 2006.

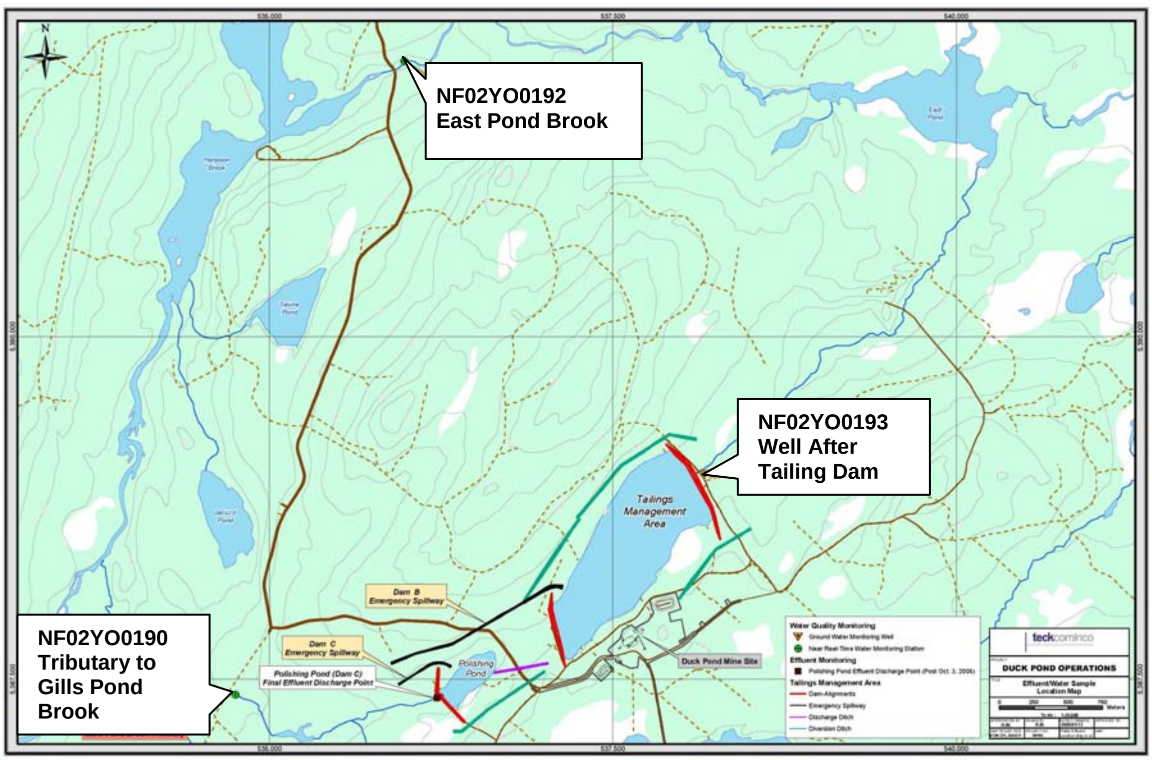

Figure 2: Real-Time Water Quality Monitoring Stations
Teck Duck Pond Operations

The two surface water stations (Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192)) are operated under a renewable cost-share agreement with Teck Duck Pond Operations. The operation of the ground water station (Monitoring Well After Tailings Dam Station (NF02YO0193)) is funded solely under the Canada-Newfoundland and Labrador Water Quality Agreement.

The objective of operating these stations is to provide an early warning of any potential or emerging water quality issues such that mitigative measures can be employed to ensure that discharge from Teck Duck Pond Operations meets all regulatory requirements and has minimal impact on the receiving waters and other water in proximity to the site.

It was initially intended to remove the instruments from the three stations during the winter months, as the instruments are prone to be damaged by freezing. Furthermore, initially, there was no discharge planned for the winter months. However, as the mine and mill have become operational, discharge from the site has been required outside the planned time frame of July through November. Accordingly, the instruments have been deployed continuously when ever possible throughout the year.

The instruments at Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192) were deployed nearly continuously throughout the year. During the winter months, they remained deployed for longer periods to minimize the risk of damage from freezing during deployment and removal. Up to this point in time no significant negative impacts on the instruments have been observed. During the remaining months, these instruments were removed approximately monthly for short periods, generally two days, to facilitate regular maintenance and calibration.

As Monitoring Well After Tailings Dam Station (NF02YO0193) freezes at surface, the instrument has sometimes remained deployed continuously over the winter. However due to required factory servicing and calibration it was removed on October 30, 2009, and could not be replaced until April 28, 2010 because the well was frozen at surface. The instrument remained deployed continuously until October 18, 2010 when it was removed for three days for regular cleaning and maintenance. It has been deployed since October 21, 2010 and will remain deployed until the spring of 2011. Past experience has indicated that this probe is very stable over the long term, thus deployments up to six months have been recommended by the vendor.

Presently, all instruments are **Hydrolab®** brand **DataSonde®** probes in the surface water stations and a **Quanta G®** probe in the ground water station. Normally, the same probe is deployed consistently at a given station. However, from time to time, an alternate probe, having the same technical specifications, may temporarily be substituted. Portable **Hydrolab®** brand **MiniSonde®** probes are used for QA/QC purposes.

Section 2.0 Maintenance and Calibration

All staff involved in the installation, deployment, maintenance and calibration of these probes have undergone the training and certification by **Hydrolab®.** Maintenance and calibration of these probes are undertaken in controlled conditions at the laboratory of the Department of Environment and Conservation in Grand Falls – Windsor. Maintenance and calibration procedures, specified by the equipment manufacturer are followed precisely, and all calibration values logged into a database. All replacement parts, reagents and calibration solutions used meet the manufacturer's specifications.

It is recommended that regular maintenance and calibration of the **DataSonde®** instruments take place on a monthly basis in order to ensure the accuracy of the data. Particularly during the warmer months, the sensors are prone to fouling from the accumulation of biofilm and other organic matter in the streams. **Quanta G®** instruments are intended for longer term deployments, with less frequent maintenance and calibration, as they may not be as subject to fouling in the well where temperatures are colder and more stable. **Table 1** details the dates the instruments were installed and removed for maintenance and calibration in 2010. It is important to note that during the winter months instruments remained deployed for periods longer than a month to minimize the risk of damage from freezing during installation and removal. It has also been demonstrated that during the winter months, due to the colder temperatures, there is less fouling of the sensors, thus allowing them to remain accurate for longer periods of time.

Tributary to Gills Pond Brook Station (NF02YO0190)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2009-11-25	2010-04-26	152	Winter deployment
2010-04-28	2010-07-05	68	
2010-07-07	2010-08-31	55	
2010-09-02	2010-10-18	46	
2010-10-21	2010-11-30	40	
2010-11-30			Ongoing winter deployment
East Pond Brook Station (NF02YO0192)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2009-11-25	2010-04-26	152	Winter deployment
2010-04-28	2010-07-05	68	
2010-07-07	2010-08-31	55	
2010-09-02	2010-09-09	7	Communications/Cable Issues
2010-09-09	2010-10-18	39	Communications/Cable Issues
2010-10-21	2010-11-30	40	
2010-12-02			Ongoing winter deployment
Monitoring Well After Tailings Dam Station (NF02YO0193)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2010-04-28	2010-10-18	173	
2010-10-21			Ongoing winter deployment

Table 1: Maintenance and Calibration Schedule

Section 3.0 Discharge from Polishing Pond

Under Provincial and Federal regulatory measurers, effluent from the mine's Tailings Management Area may be discharged through the Polishing Pond to receiving waters (Tributary to Gills Pond Brook) provided it meets stringent criteria. During 2010, there were 14 separate Discharge Periods as summarized in **Table 2** and depicted in **Figure 3**. It is important to note, that while meeting the discharge criteria, the physical and chemical characteristics of the discharge water will be different than the receiving water. This will be evident in some of the parameters reviewed in Section 4.1.

Discharge Period	Start Date (yyyy-mm-dd)	Stop Date (yyyy-mm-dd)	# of Days	Average Daily Discharge (m^3/day)
1	2010-01-01	2010-01-18	18	23,516
2	2010-02-02	2010-02-05	4	18,868
3	2010-02-16	2010-02-27	12	10,927
4	2010-03-17	2010-03-18	2	1,266
5	2010-04-19	2010-06-11	54	16,986
6	2010-06-14	2010-06-18	5	16,337
7	2010-07-08	2010-08-08	32	22,693
8	2010-08-10	2010-08-17	8	13,871
9	2010-08-20	2010-08-26	7	14,812
10	2010-08-28	2010-10-27	61	18,983
11	2010-10-29	2010-11-06	9	12,363
12	2010-11-12	2010-11-25	14	11,757
13	2010-12-06	2010-12-15	10	13,122
14	2010-12-19	2010-12-31	13	14,948

Note1: Discharge Period 1 began before the beginning of the Calendar Year
Note 2: Discharge Period 14 ended after the end of the Calendar Year

Table 2

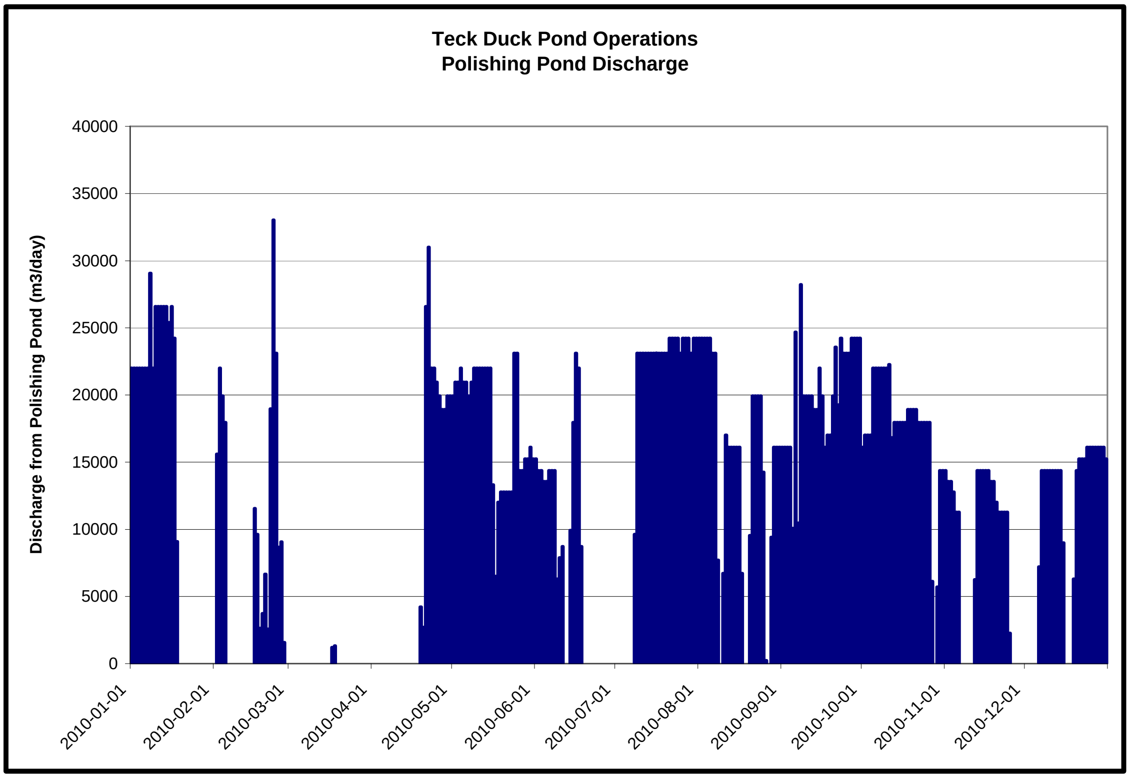
Teck Duck Pond Operations
Polishing Pond Discharge
Discharge from Polishing Pond (m3/day)
40000
35000
30000
25000
20000
15000
10000
5000
0
2010-01-01
2010-02-01
2010-03-01
2010-04-01
2010-05-01
2010-06-01
2010-07-01
2010-08-01
2010-09-01
2010-10-01
2010-11-01
2010-12-01

Figure 3

Section 4.0 Data Interpretation

Section 4.1 Tributary to Gills Pond Brook Station (NF02YO0190)

Tributary to Gills Pond Brook Station is located 1700 m downstream of the final discharge point for the mine's Tailings Management Area - Polishing Pond. This station is located such that any impacts from the mine discharge on receiving waters can be measured.

The water temperature (**Figure 4**) ranged from a minimum of -0.38 ^{o}C to a maximum of 25.31 ^{o}C. In the winter months, under the cover of ice in the stream, temperatures were generally at or slightly below the freezing point. The highest temperatures were measured in July. The temperature profile for this stream is very similar to that of East Pond Brook (**Figure 10**). There are no obvious changes in temperature during discharge periods (**Figure 3**). Accordingly discharge from the Polishing Pond does not appear to have any significant impact on the water temperature at this station.

There is no recommended limit or range for water temperature.

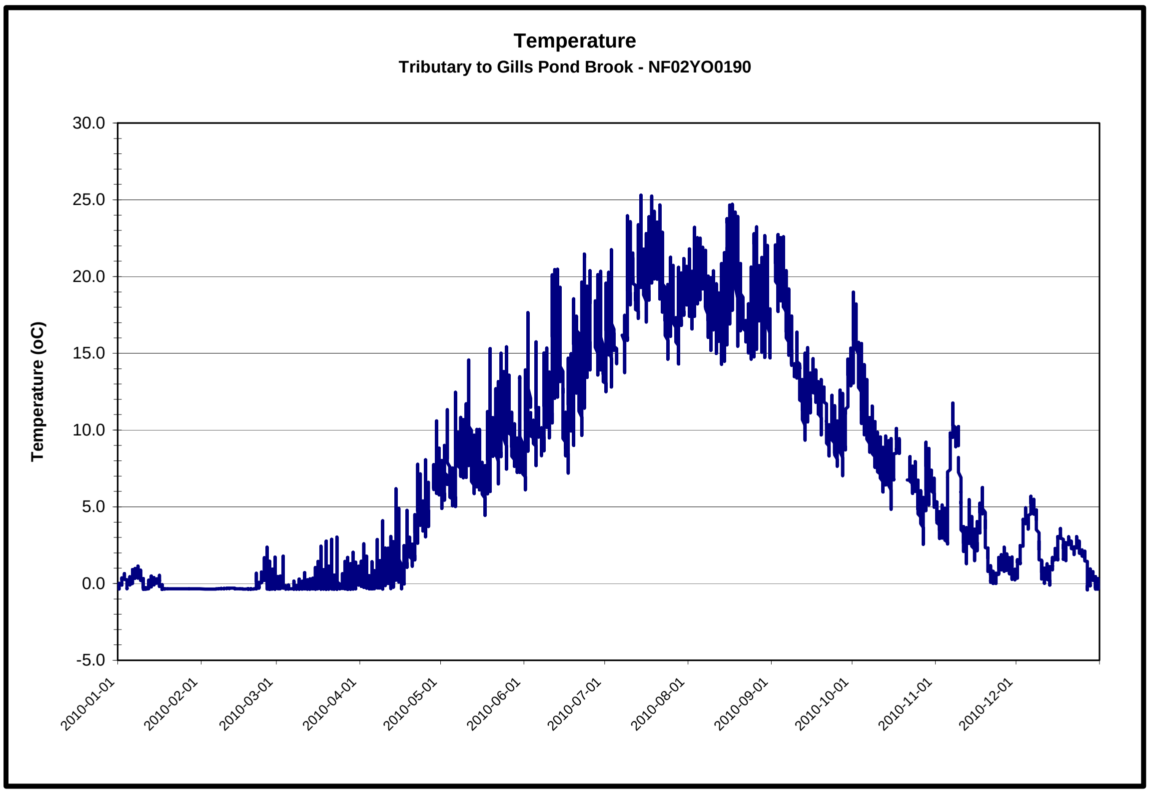

Figure 4

The pH (**Figure 5**) ranged from a minimum of 5.74 to a maximum of 7.38. The pH of this stream is naturally quite low, often being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines on **Figure 5**) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [(1)]. It should be noted however, that discharge from Polishing Pond often has a pH higher than the natural background pH of the receiving waters. Thus, when there is discharge from Polishing Pond (**Figure 3**), there is generally an increased pH in the stream at this station, which often brings the water within the pH range recommended by CCME. The pH profile throughout the year is similar to East Pond Brook (**Figure 11**), except for the influences of the discharge periods.

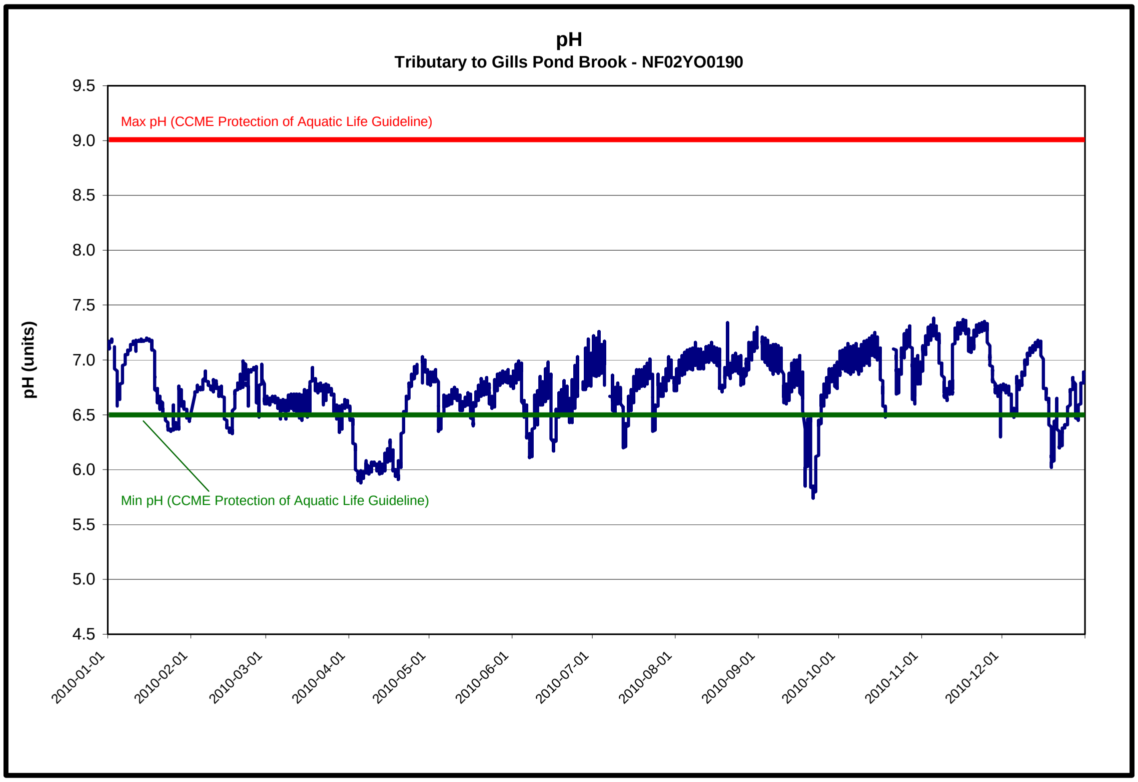

Figure 5

The specific conductivity (**Figure 6**) is affected by the amount of dissolved metals and salts in the water. Pristine waters in this part of the island generally have a specific conductance of less than 50 µmS/cm. Outside the periods when there is discharge from Polishing Pond (**Table 2**), the specific conductivity in this stream would generally be quite low. During the past year, the minimum specific conductivity was measured to be 17.0 µS/cm. When there is discharge from the Polishing Pond, conductivity increases significantly, the highest value being measured to be 1029.9 µS/cm. The significant increases and decreases in specific conductivity correspond closely with the beginning and end of the discharge periods from polishing pond (**Figure 3**).

It is interesting to note, that specific conductivity dips, sometimes significantly, following periods of snowmelt or rainfall. Snowmelt and rainfall contributions to the stream's discharge would generally have an extremely low (approaching zero) background specific conductively and would effectively 'dilute' water in stream. This is particularly more evident when there is discharge from the Polishing Pond.

There is no recommended limit or range for specific conductance, although it is a key indicator to the potential effects of the discharge from Polishing Pond.

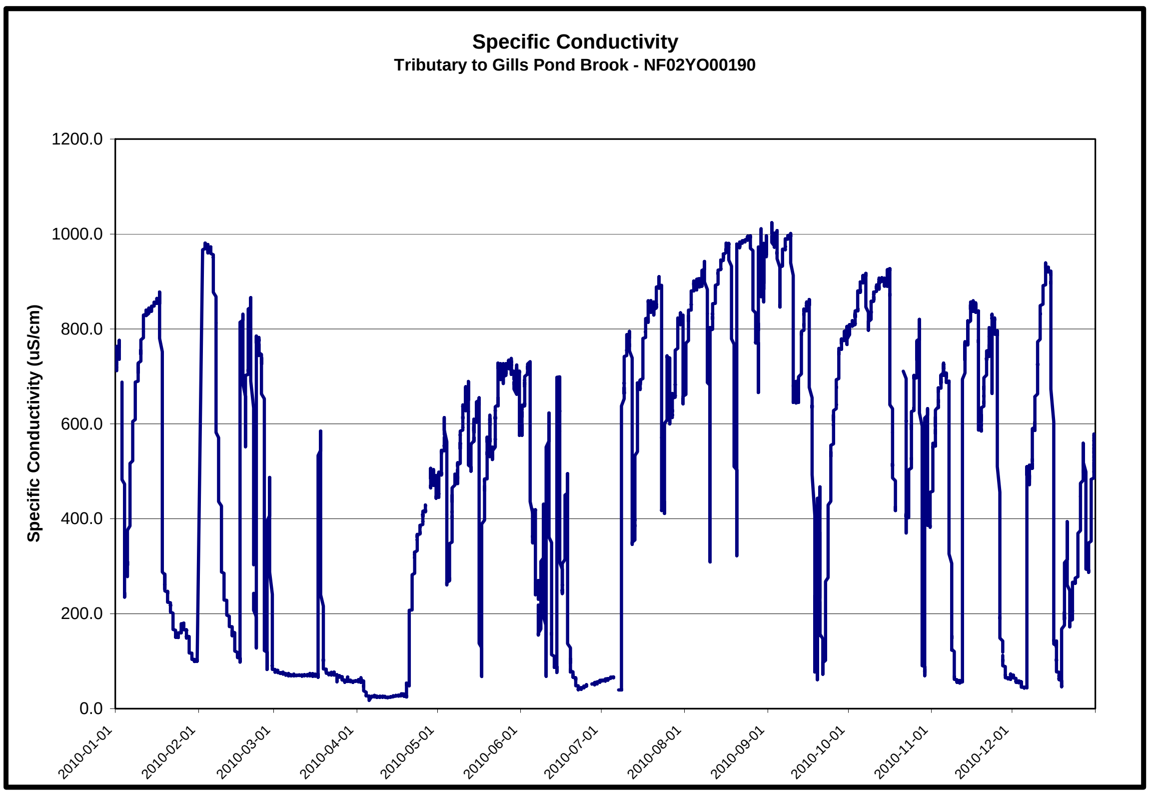

Figure 6

Dissolved oxygen (**Figure 7**) ranged from a minimum of 7.21 mg/L to a maximum of 13.76 mg/L. Generally, dissolved oxygen is inversely proportional to water temperature; this being evident in comparison to **Figure 4**.

The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (1) for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen consistently remained above 6.5 mg/L, in the warmer months, it did not remain above 9.5 mg/L, the recommended lower limit for early life stage cold water biota. This is a function of the inverse relationship to the warmer water temperatures. During the period when dissolved oxygen was below 9.5 mg/L, the percent saturation (DO % Sat) remained in the normal range between 80 % and 100 %, indicating that the water was fully saturated with oxygen. In fact, the dissolved oxygen in waters in East Pond Brook (**Figure 13**) has a very similar profile. There does not appear to be any appreciable change in dissolved oxygen resultant from discharge from Polishing Pond.

There were two brief periods during the year, when the DO Sensor failed and no data could be recorded.

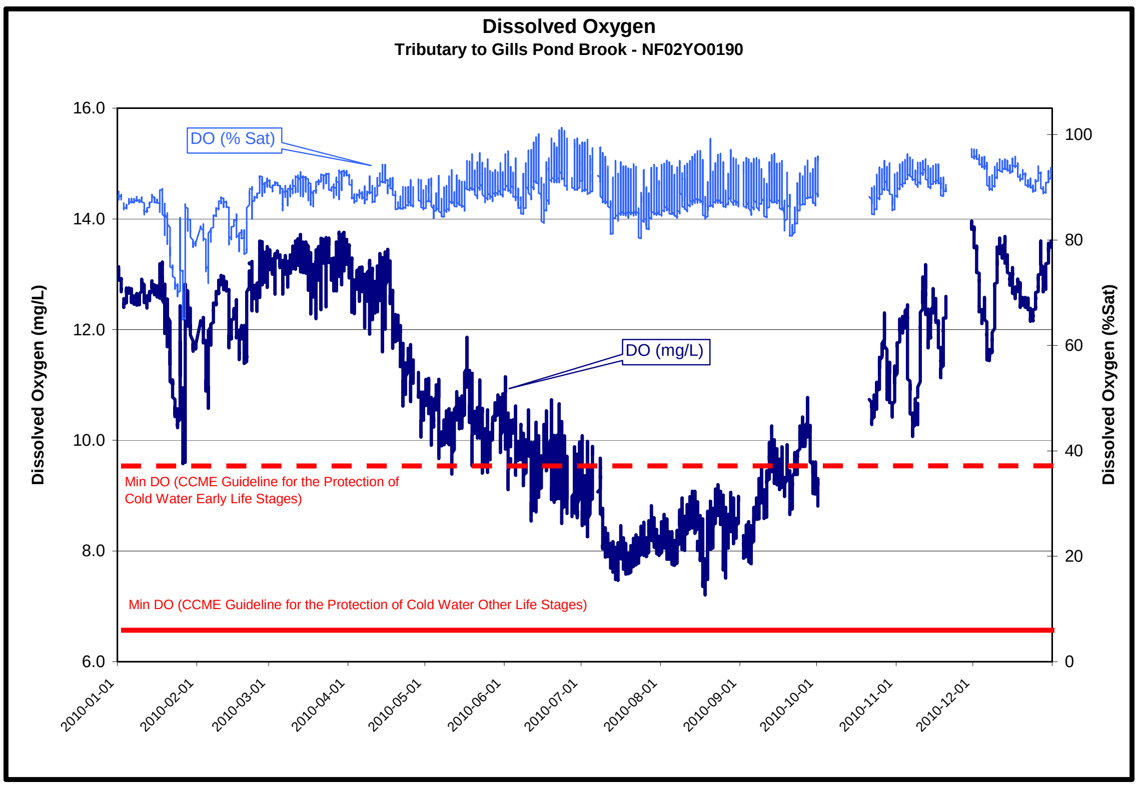

Figure 7

Turbidity (**Figure 8**) ranged from a minimum of 0.0 NTU to a maximum of 1635.0 NTU. Minor and un-sustained spikes are the usually the result of natural debris passing over the sensor.

On occasion on-line transmitted turbidity values were reported to be 3000 NTU. This number represents a system error in data transmission. Accordingly, these values have been removed and internally (**DataSonde®**) logged turbidity values substituted. During periods when there was no discharge from Polishing Pond, turbidity values were generally at or close to zero. The frequency and intensity of turbidity spikes was generally greater during discharge periods (**Figure 3**).

It has also been documented in the *Real Time Water Quality Report Duck Pond Operations (Teck Cominco Limited) Deployment Period 2008-10-16 to 2008-11-12* [(2)] that at this location, air entrainment due to higher water velocities, and turbulent flow at higher stream discharges results in false-positive turbidity values. Accordingly, the on-line real time turbidity graph is annotated with the following comment: '*Turbidity values may be exaggerated due to air entrainment (turbulent flow)'*. Efforts are made to place the probe in a location in the stream which is least impacted by turbulent flow. Other solutions continue to be investigated.

Throughout the year, high turbidity was not visible in the stream nor documented in any *in situ* measurements or water sample results. Accordingly, the higher turbidity values (frequency and intensity) during the periods of discharge from Polishing Pond are attributed to air entrainment due to high flows or the result of natural debris passing over the sensor, as opposed to actual water quality impairment. Any unusual turbidity measurements will continue to be investigated by staff of the Department of Environment and Conservation and/or Teck Duck Pond Operations.

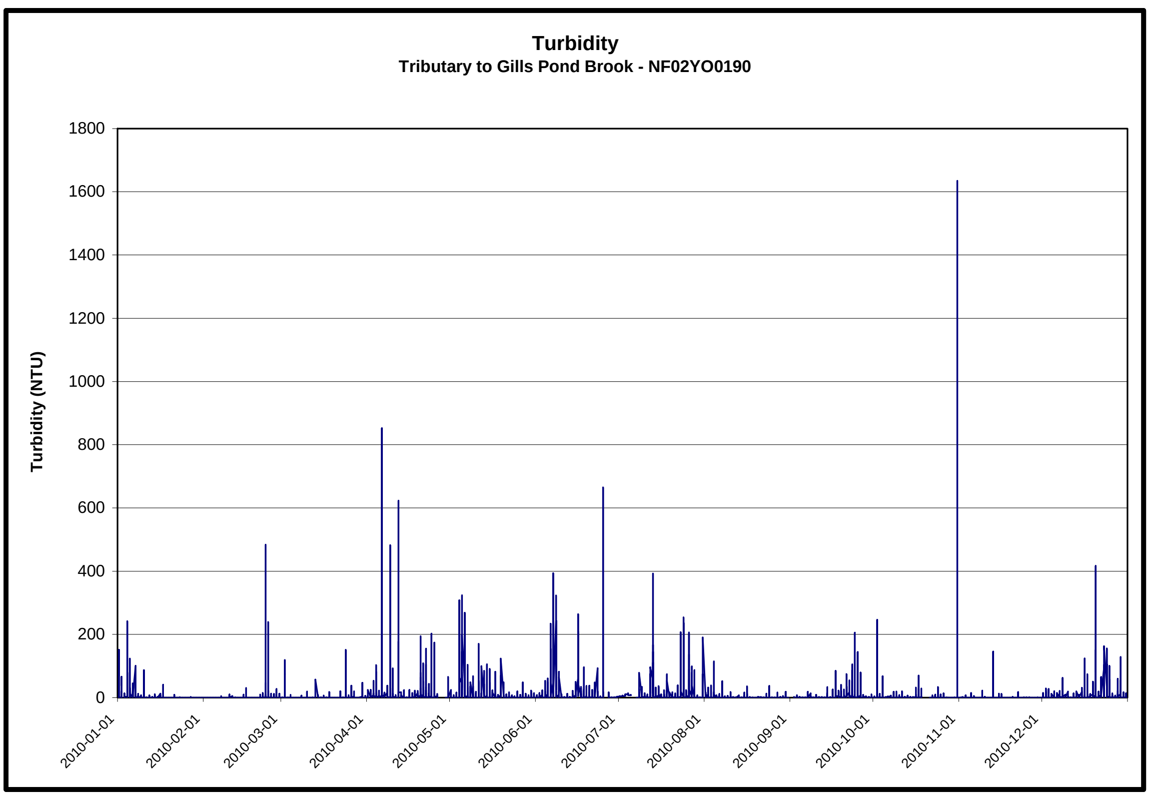

Figure 8

The stage or water level (**Figure 9**) was recorded to be between 1.21 m and 1.92 m. At this location, stage is referenced to an arbitrary bench mark. The highest stage was recorded in February, presumably due to the backwater effect from ice formation.

For the remainder of the year, however, stage varied between 1.21 m and 1.70 m, with the higher levels corresponding to periods of discharge from Polishing Pond (**Figure 3**) and following snow melt and rainfall events.

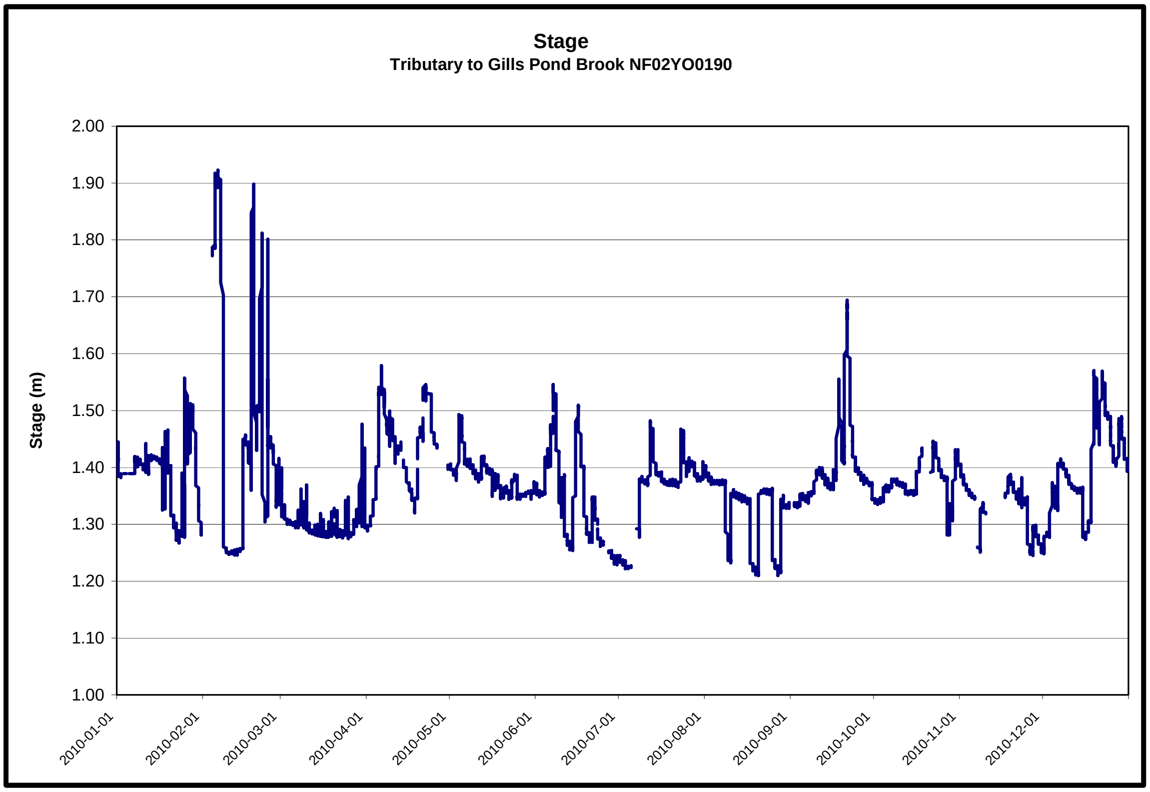

Figure 9

Section 4.2 East Pond Brook Station (NF02YO0192)

East Pond Brook Station is located several kilometres downstream of the Tailings Management Area. This station is located such that any surface water impacts from the Tailing Management Area via seepage through Dam A may be measured.

The water temperature (**Figure 10**) ranged from a minimum of -0.14 ^{o}C to a maximum of 26.34 ^{o}C. In the winter months, under the cover of ice in the stream, temperatures were generally at or slightly below the freezing point. The highest temperatures were measured in July and August. The temperature profile for this stream is very similar to that of Tributary to Gills Pond Brook (**Figure 4**).

There is no recommended limit or range for water temperature.

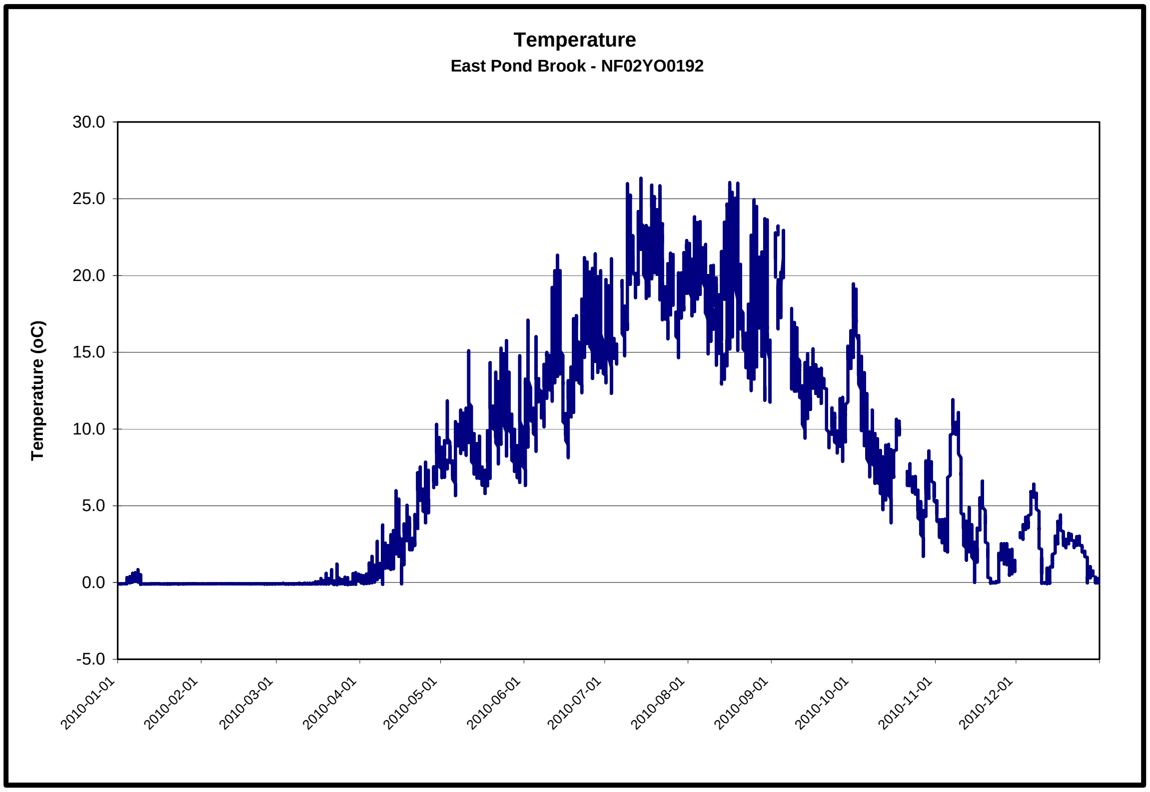

Figure 10

The pH (**Figure 11**) ranged from a minimum of 5.04 to a maximum of 7.36. The pH of this stream is naturally quite low, often being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines on **Figure 11**) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [1].

Variation in pH is influenced by a number of factors. For example, there is an inverse relationship with stage (**Figure 15**) which is influenced by snowmelt and precipitation, and a positive relationship with specific conductivity (**Figure 12**). All variations in pH appear to be due to natural influences.

The significant dip in pH in late September follows a major precipitation event related to Hurricane Igor.

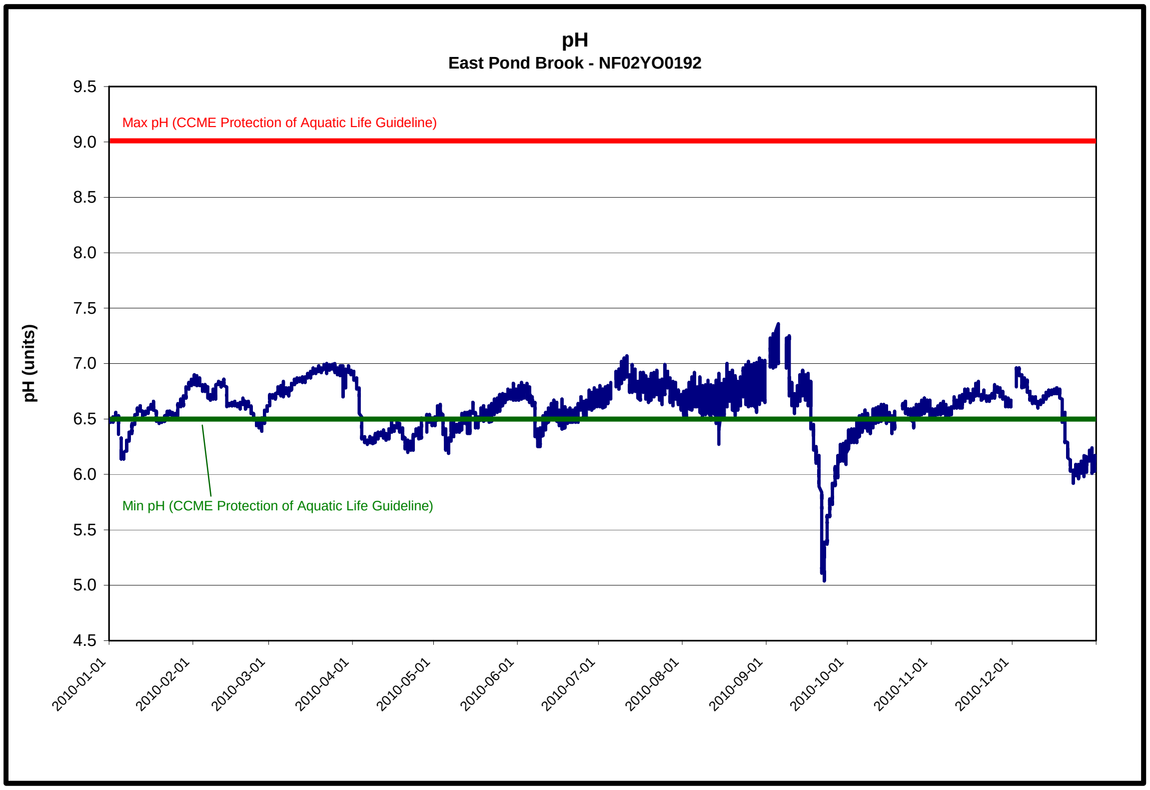

Figure 11

The specific conductivity (**Figure 12**) is affected by the amount of dissolved metals and salts in the water. Pristine waters in this part of the island generally have a specific conductance of less than 50 µS/cm.

During the past year, the specific conductivity ranged between 12.4 µS/cm and 57.0 µS/cm. Specific conductivity shows a similar profile to pH (**Figure 11**) and an inverse relation to stage (**Figure 15**).

The significant increase in specific conductivity in mid September corresponds to a particularly dry period, when flows in this stream were minimal. The sudden drop corresponds to the onset of precipitation related to Hurricane Igor.

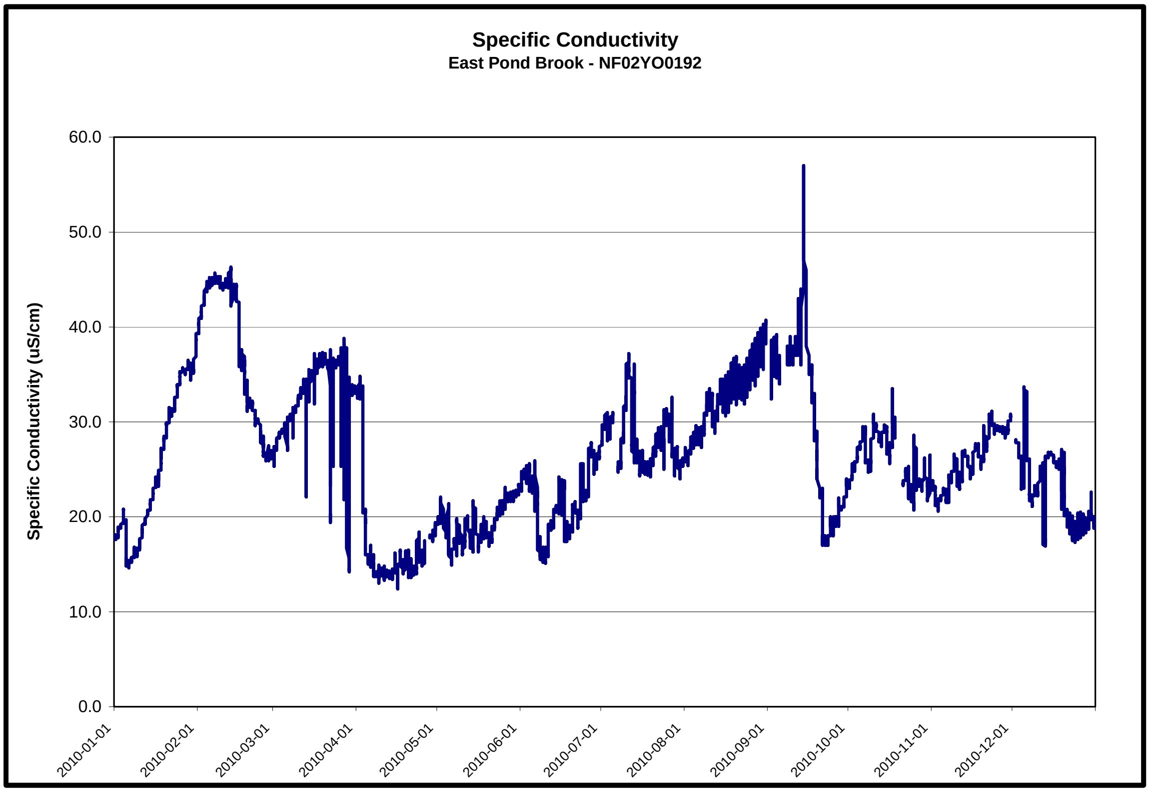

Figure 12

Dissolved oxygen (**Figure 13**) ranged from a minimum of 7.72 mg/L to a maximum of 14.44 mg/L. Generally, dissolved oxygen is inversely proportional to water temperature; this being evident in comparison to **Figure 10**.

The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (1) for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen consistently remained above 6.5 mg/L, in the warmer months, it did not remain above 9.5 mg/L, the recommended lower limit for early life stage cold water biota. This is a natural function of the inverse relationship to the warmer water temperatures. During the period when dissolved oxygen was below 9.5 mg/L, the percent saturation (DO % Sat) remained in the normal range between 80 % and 100 %, indicating that the water was fully saturated with oxygen.

There were three brief periods during the year, when the DO Sensor failed and no data could be recorded.

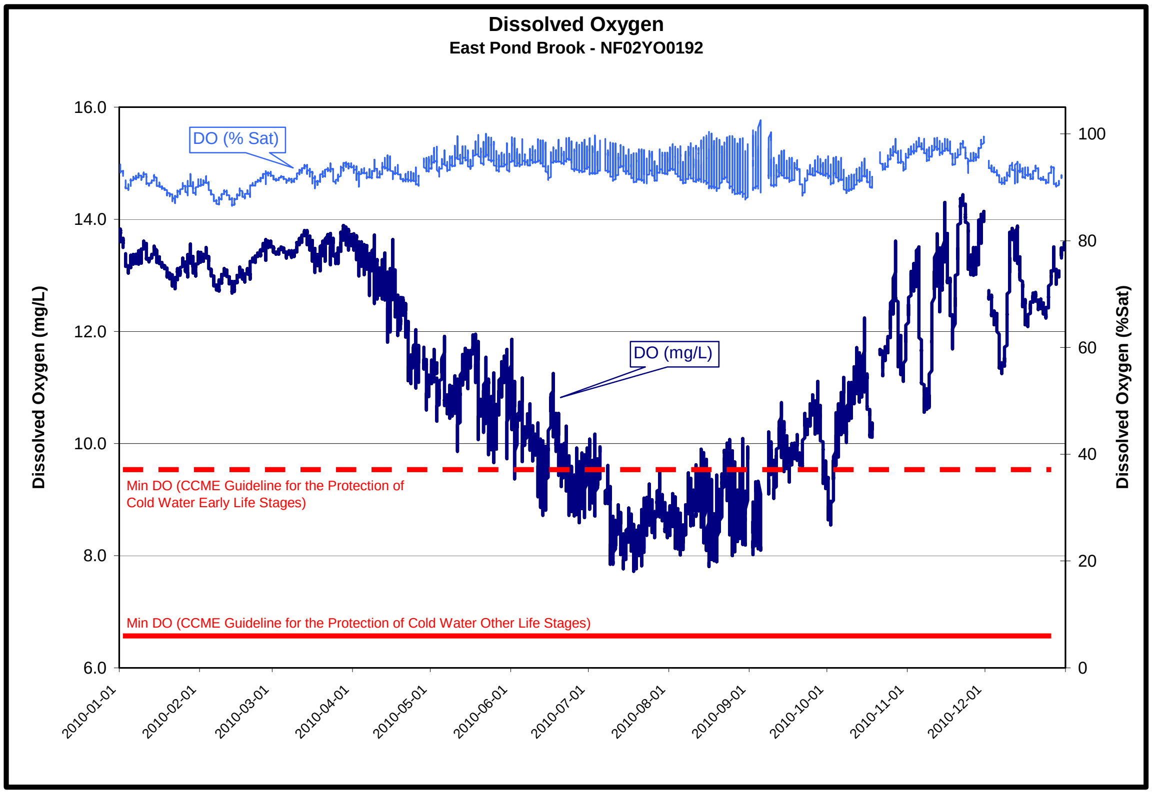

Figure 13

Turbidity (**Figure 14**) ranged from a minimum of 0.0 NTU to a maximum of 331.1 NTU. Generally, turbidity values in this stream are at or close to zero. Minor and un-sustained spikes are the result of natural debris passing over the sensor. There was a sustained period of higher than normal turbidity in late June / early July, at the end of a deployment period when it was noted that leaves were caught on the sensor. Turbidity values returned to normal values following maintenance and calibration of the instrument.

On occasion on-line transmitted turbidity values were reported to be 3000 NTU. This number represents a system error in data transmission. Accordingly, these values have been removed and internally (**DataSonde®**) logged turbidity values were substituted.

Throughout the year, high turbidity was not visible in the stream nor documented in any water sample results.

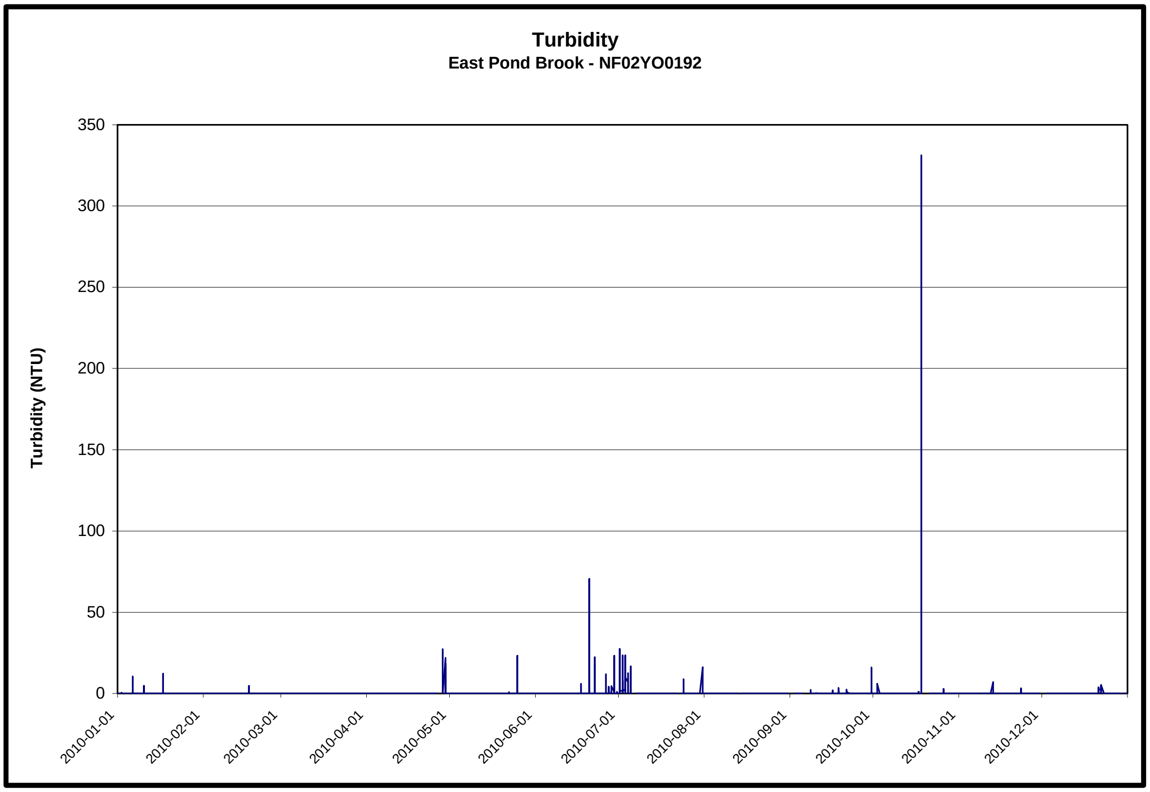

Figure 14

The stage or water level (**Figure 15**) was recorded to be between 0.88 m and 7.83 m. At this location, stage is referenced to an arbitrary bench mark. The highest stage was recorded in January. High values are attributed to the backwater effect caused by ice in the stream as it would be highly unlikely that stage would ever go that high.

For the remainder of the year, however, stage varied between 0.88 m and 2.28 m, with the higher levels following snow melt and rainfall events.

The peak on September 21, 2010 was the result of a significant precipitation event associated with Hurricane Igor. Following that event, there was evidence (erosion and detritus) that the stream had topped its banks in the vicinity of this station.

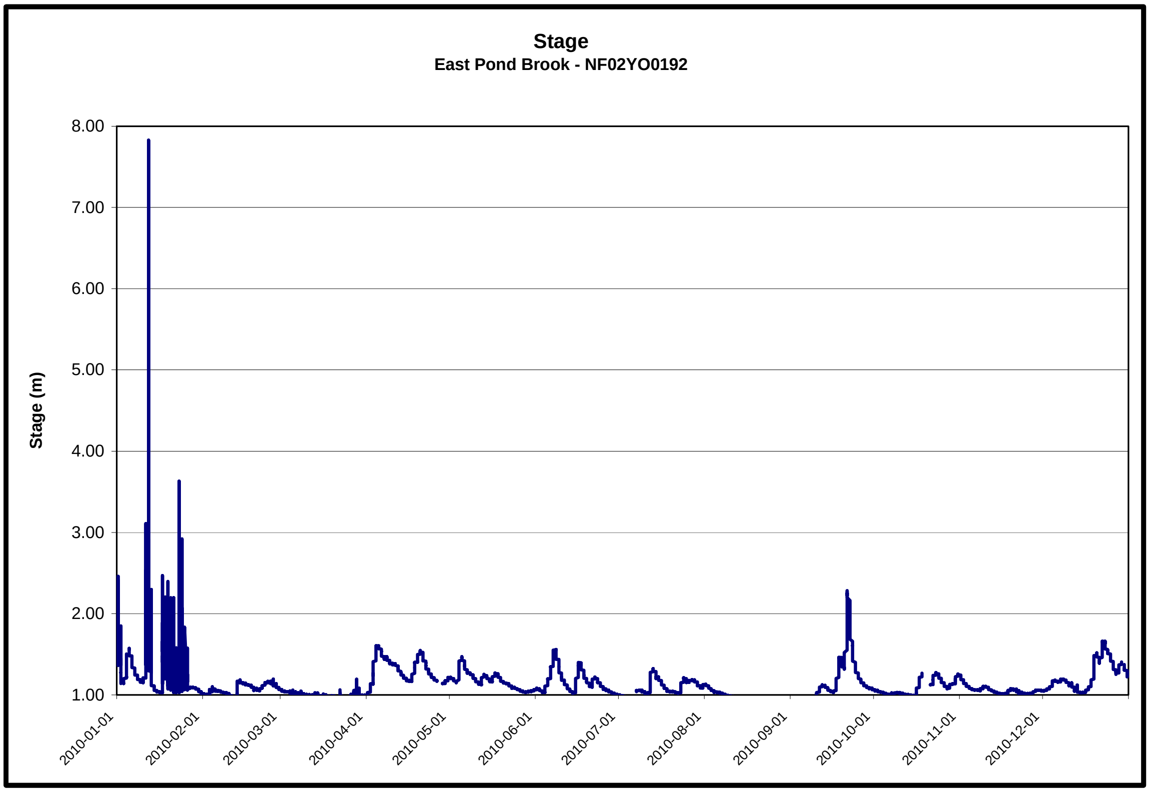

Figure 15

Section 4.3 Monitoring Well After Tailings Dam Station (NF02YO0193)

Monitoring Well After Tailings Dam Station is located near Tailings Dam A. This station is located such that any ground water impacts from the Tailing Management Area via seepage through Dam A may be measured.

There is continuous data from April 28, 2010 through the end of the year, apart from a 3 day period in October when the instrument was removed for cleaning and calibration. It should be noted as well that the well was purged of at least one volume on April 28, 2010. Water samples were collected on October 18, 2010 and October, 21, 2010, necessitating the purging of some water from the well.

Water temperature (**Figure 16**) ranged from a minimum of 4.80 ^{o}C to a maximum of 5.80 ^{o}C. Lower temperatures were recorded in the summer months, while the higher temperatures were recorded in late December. The temperature profile is very similar to previous years.

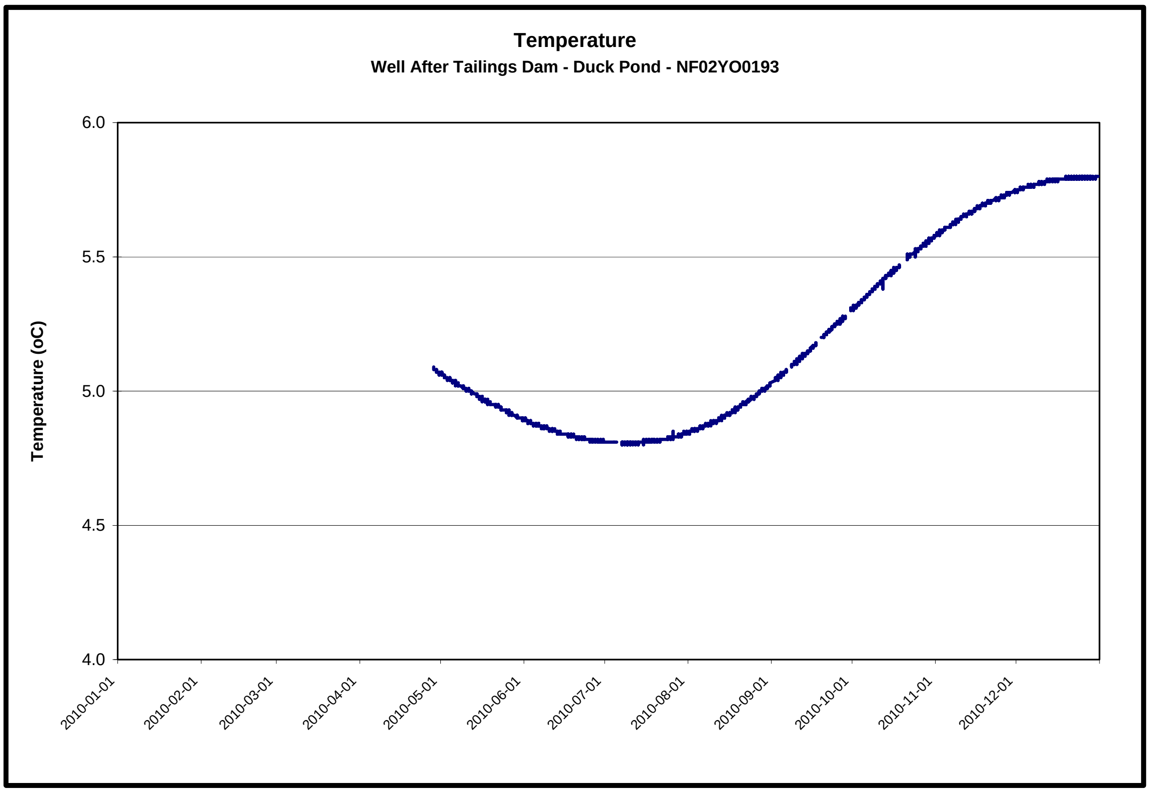

Figure 16

The pH measurements for this well are depicted in **Figure 17**. Values ranged from a minimum of 7.34 to maximum of 8.92.

At the beginning of each deployment period, there is a significant increase in pH which essentially 'levels off' for the remainder of that period. This response in pH is typical of previous deployments. It is believed that this is a function of the well being purged.

pH values tend to be lower than in previous years. The long term variation in pH in this well is being investigated further, and may be the subject of a separate report.

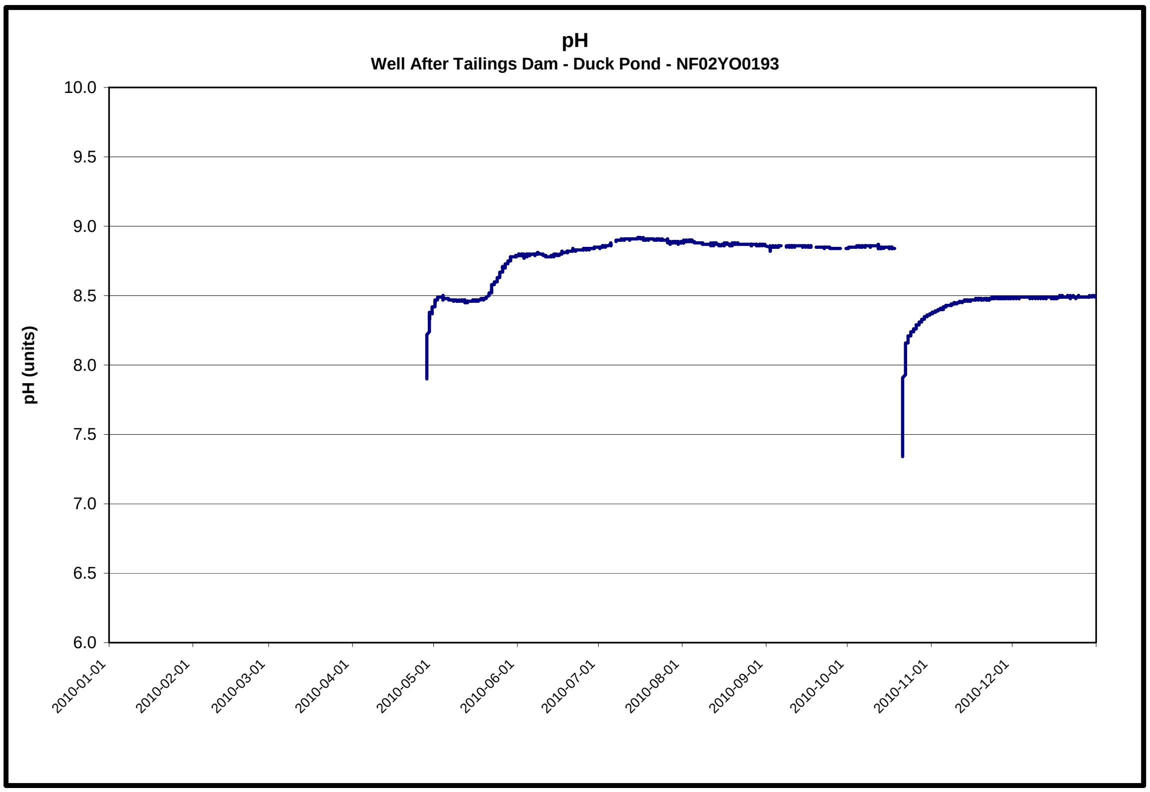

Figure 17

Specific conductance in this well (**Figure 18**) ranged from a minimum of 0.517 mS/cm to a maximum of 0.599 mS/cm. The range is higher than measured in previous years. Specific conductivity in this well is higher than surrounding surface waters due to the highly mineralized nature of the material through which it is drilled. The well is also located such that it could be used to measures changes in ground water resultant from seepage from Tailing Dam A.

Specific conductivity is increasing significantly over this year, confirming a trend that began to be only subtly apparent previously. The long term variation in specific conductivity in this well is being investigated further, and may be the subject of a separate report.

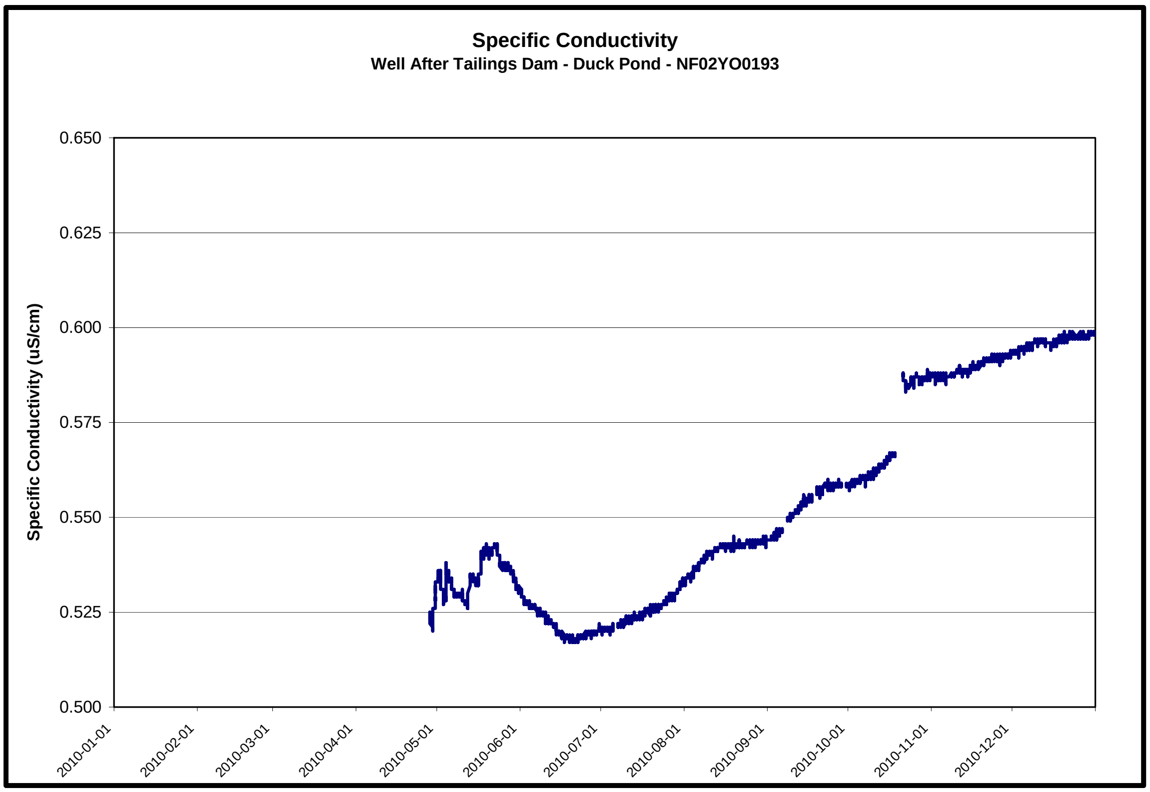

Figure 18

The water elevation (**Figure 19**) ranged between a minimum of 270.89 m and maximum of 271.16 m. This shallow well is located in a glacial till, less than 50 meters from a small stream (Trout Brook). The water elevation in this well is influenced by periods of snow melt and precipitation, showing elevation peaks which correspond closely with monitored streams in the area (Tributary to Gills Pond Brook and East Pond Brook). This is not surprising given its proximity to the stream.

There is excellent agreement between recorded and measured water elevations throughout the year, with the maximum differential being measured to be 0.005 m. This indicates that the water elevation being logged is extremely accurate.

There appears to be a slight decrease in water elevation throughout the year. However, having no data for the winter months, we are unable to determine the profile for the first part of the year.

The long term variation in water elevation in this well is being investigated further to determine if changes are correlated with changes in the Tailings Management Area, or simply a seasonal fluctuation. This may be the subject of a separate report.

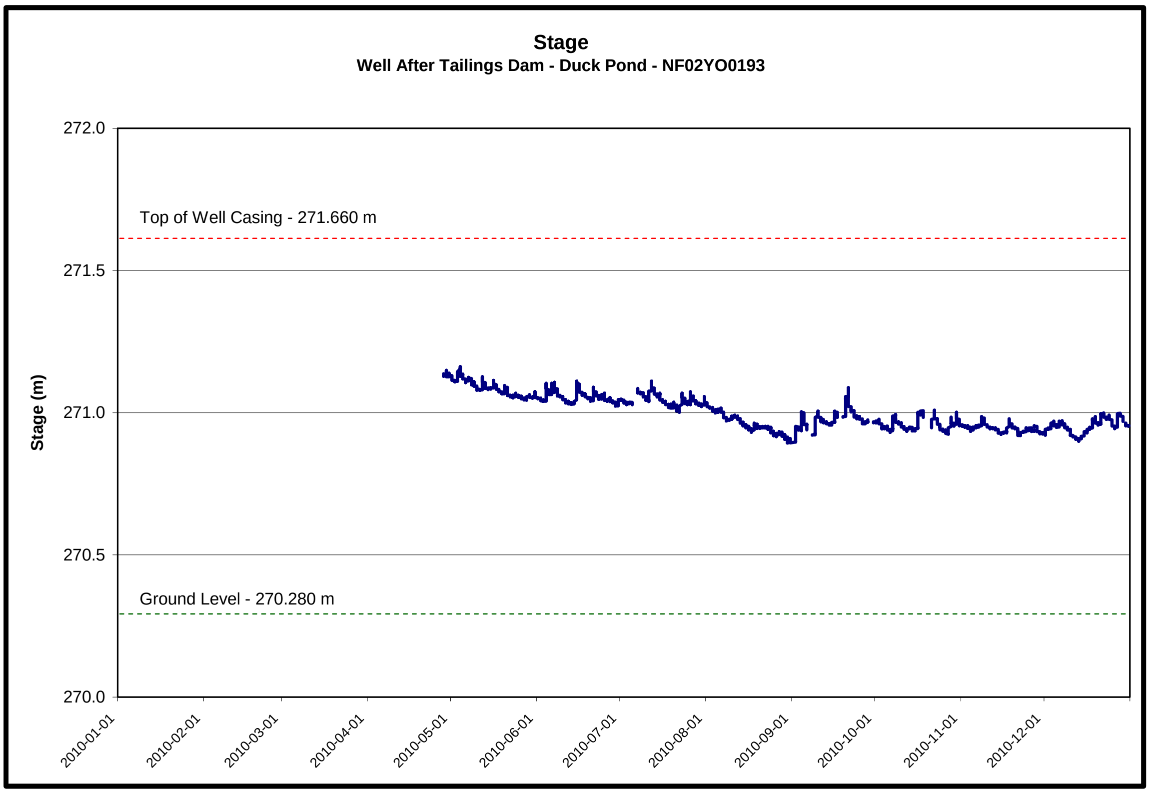

Figure 19

Section 5 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 at Teck Duck Pond Operations. These measures are put in place to ensure that the instruments are reading data accurately, and the numbers that are reported are representative of the actual environmental conditions. During 2010 new QA/QC processes were implemented on a trial basis by ENVC, which were able to quantify drift (fouling and instrument) over individual deployment periods. In individual deployment reports prepared after each deployment period we documented this drift numerically and graphically.

- As part of the QA/QC protocol, an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The ranking system is based upon methodology developed by the U.S. Geological Survey [3], and uses the formulae in **Table 3** to qualify or rank the accuracy of the instruments.

	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 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

Table 3

- Upon deployment, a QA/QC **MiniSonde®** is temporarily deployed along side the Field **DataSonde®**. Values for temperature and dissolved oxygen are compared between the two instruments. A grab sample is taken to compare with the Field **DataSonde®** for specific conductivity, pH and turbidity parameters. Based on the difference between parameters recorded by the Field **DataSonde®**, QAQC **MiniSonde®** and grab sample 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 ranking at the beginning and end of the deployment period are shown in **Table 4** for Tributary to Gill's Pond Brook and **Table 5** for East Pond Brook. Any corrections to the data sets were discussed and graphed in the individual deployment reports.
- Because the deployment set-up for Well After Tailings Dam (MW1) is different, comparison with another instrument is not possible, thus Total Error cannot be calculated. In this case, a grab sample was collected at the end of the first deployment period, and at the beginning of the second deployment period, and the deployment ranking was calculated for pH and Specific Conductance based upon live data and laboratory data. See **Table 6**.

- With the exception of water quantity data (Stage), all data used in the preparation of the graphs above and subsequent discussion below adhere to this stringent Quality Assurance and Quality Control (QA/QC) protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Tributary to Gills Pond Brook Station (NF02YO0190)				
Parameter	**Installation Date (yyyy-mm-dd)**	**Ranking**	**Removal Date (yyyy-mm-dd)**	**Ranking**
Temp (°C)	2009-11-25	Good	2010-04-26	Excellent
pH (units)		Good		Excellent
Sp. Conductivity (uS/cm)		Fair		Excellent
Dissolved Oxygen (mg/L)		Excellent		Good
Turbidity (NTU)		Excellent		Excellent
Temp (°C)	2010-04-28	Good	2010-07-05	Excellent
pH (units)		n/a		Excellent
Sp. Conductivity (uS/cm)		n/a		Excellent
Dissolved Oxygen (mg/L)		Excellent		Excellent
Turbidity (NTU)		n/a		Excellent
Temp (°C)	2010-07-07	Excellent	2010-08-31	Excellent
pH (units)		Good		Excellent
Sp. Conductivity (uS/cm)		Good		Poor
Dissolved Oxygen (mg/L)		Excellent		Excellent
Turbidity (NTU)		Excellent		Excellent
Temp (°C)	2010-09-02	Excellent	2010-10-18	Excellent
pH (units)		Good		Excellent
Sp. Conductivity (uS/cm)		Excellent		Good
Dissolved Oxygen (mg/L)		Fair		n/a
Turbidity (NTU)		Excellent		Excellent
Temp (°C)	2010-10-21	Excellent	2010-11-30	Excellent
pH (units)		Good		Good
Sp. Conductivity (uS/cm)		Excellent		Excellent
Dissolved Oxygen (mg/L)		Fair		n/a
Turbidity (NTU)		Excellent		Excellent
Temp (°C)	2010-11-30	Good	Spring 2011	n/a
pH (units)		Good		n/a
Sp. Conductivity (uS/cm)		Good		n/a
Dissolved Oxygen (mg/L)		Good		n/a
Turbidity (NTU)		Excellent		n/a

Table 4

East Pond Brook Station (NF02YO0192)				
Parameter	**Installation Date (yyyy-mm-dd)**	**Ranking**	**Removal Date (yyyy-mm-dd)**	**Ranking**
Temp (^oC)	2009-11-25	Excellent	2010-04-26	Excellent
pH (units)		Excellent		Excellent
Sp. Conductivity (uS/cm)		Good		Excellent
Dissolved Oxygen (mg/L)		Excellent		Excellent
Turbidity (NTU)		Excellent		Excellent
Temp (^oC)	2010-04-28	Excellent	2010-07-05	Excellent
pH (units)		n/a		Excellent
Sp. Conductivity (uS/cm)		n/a		Good
Dissolved Oxygen (mg/L)		Excellent		Excellent
Turbidity (NTU)		n/a		Excellent
Temp (^oC)	2010-07-07	Excellent	2010-08-31	Excellent
pH (units)		Excellent		Excellent
Sp. Conductivity (uS/cm)		Excellent		Excellent
Dissolved Oxygen (mg/L)		Excellent		Excellent
Turbidity (NTU)		Excellent		Excellent
Temp (^oC)	2010-09-02	Excellent	2010-10-18	n/a
pH (units)		Excellent		n/a
Sp. Conductivity (uS/cm)		Excellent		n/a
Dissolved Oxygen (mg/L)		Fair		n/a
Turbidity (NTU)		Excellent		n/a
Temp (^oC)	2010-10-21	Excellent	2010-11-30	Excellent
pH (units)		Good		Excellent
Sp. Conductivity (uS/cm)		Good		Excellent
Dissolved Oxygen (mg/L)		Poor		Good
Turbidity (NTU)		Excellent		Excellent
Temp (^oC)	2010-12-02	Excellent	Spring 2011	n/a
pH (units)		Excellent		n/a
Sp. Conductivity (uS/cm)		Excellent		n/a
Dissolved Oxygen (mg/L)		Excellent		n/a
Turbidity (NTU)		Excellent		n/a

Table 5

Well After Tailings Dam (MW1) Station (NF02YO0193)				
Parameter	**Installation Date (yyyy-mm-dd)**	**Ranking**	**Removal Date (yyyy-mm-dd)**	**Ranking**
pH (units)	2009-04-28	n/a	2010-10-18	Good
Sp. Conductivity (uS/cm)		n/a		Excellent
pH (units)	2010-10-21	Marginal	Spring 2011	n/a
Sp. Conductivity (uS/cm)		Excellent		n/a

Table 6

For Tributary to Gills Pond Brook Station (NF02YO0190) the monitoring instrument performed very well. The *in situ* **DataSonde®** ranked 'Excellent' or 'Good' compared to a portable **MiniSonde®** or laboratory results in 41 of 45 measurements.

For East Pond Brook Station (NF02YO0192) the monitoring instrument performed very well. The *in situ* **DataSonde®** ranked 'Excellent' or 'Good' compared to a portable **MiniSonde®** or laboratory results in 45 of 47 measurements.

For the two surface water stations, the occasional ranking below good could not be attributed to any one particular event or parameter. They are considered to be random errors within the tolerances and limitations of the equipment and procedures.

For Well After Tailings Dam (MW1) Station (NF02YO0193), the monitoring instrument performed very well. The *in situ* **Quanta G®** ranked 'Excellent' or 'Good' compared to laboratory results in 3 of 4 measurements. A 'Marginal' ranking for pH is the subject of further investigation, related to the depressed pH values at the beginning of each deployment period.

The new QA/QC processes implemented by ENVC during this past year, were able to quantify drift (fouling and instrument) over individual deployment periods. Analysis of this drift over the five completed deployment periods has revealed that drift, when quantifiable is negligible, with the average drift being less than 5%. The sum of any positive variation is essentially equal to the sum of any negative variation, and is within the tolerances and limitations of the equipment and procedures. Accordingly, it has been determined that future data corrections for drift are not required.

This confirms that the measurements recorded by each of these instruments and transmitted to our web site in real-time are very accurate. However, it is understood drift may increase over time, particularly in the warmer months when bio-fouling is more likely to occur. Accordingly, when conditions and accessibility permit, the instruments will continue to be maintained and calibrated at the intervals recommended by the manufacturer.

Maintenance and calibration are always undertaken by trained staff in accordance with protocols prescribed by the manufacturer. All replaceable parts, reagents and calibration solutions used meet the specifications of the manufacturer. All work is undertaken in a controlled laboratory environment.

In order to ensure long term accuracy for the instruments, they are returned to the vendor periodically (approximately every two years, or when problems or issues are observed) for replacement of sensors (if required) and factory maintenance and calibration.

Section 6.0 Conclusions

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations has again this year proven to be quite useful. The data derived from this network has been used by Teck management and staff to monitor their performance. Government has reviewed the data daily to ensure that equipment is functioning properly, and that discharge from the site remains within the regulated discharge criteria. The public, who have access to this data through the web, have undoubtedly been diligent in monitoring the water quality data as well.

In the two surface water stations (Tributary to Gills Pond Brook and East Pond Brook), while changes to water quality have been observed throughout the year, not one incident has been identified which has raised any cause for concern. No mitigative measures have needed to be employed to address any problems or issues resultant from this monitoring.

In Monitoring Well After Tailings Dam (MW1), it is becoming apparent that there are some long term changes, particularly in pH, specific conductance and water elevation. These changes are presently being investigated by staff of both Water Resources Management Division and Pollution Prevention Division of ENVC, will be reviewed with management at Teck Duck Pond Operations, and may be the subject of an additional report.

Continued operation of the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations is planned for the life of the operation.

Section 7.0 Path Forward

In order for this program to remain successful, it is essential to continually evaluate, improve and move forward. The following is a list of initiatives and activities to be carried out in the upcoming year:

1) The **DataSonde®** instruments owned by Teck Duck Pond Operations will be monitored closely to ensure their accuracy and reliability. Should any issues be identified, they will be returned to the vendor for factory servicing and calibration. Instruments owned by the province will be used during this period.
2) The **DataSonde®** instruments owned by Teck Duck Pond Operations are nearing their projected lifespan of 5 to 10 years. Teck should plan/budget for replacement of these instruments.
3) As planning work proceeds on Boundary Deposit, consideration needs to be given early in 2011, as to whether or not additional surface-based real-time water quality monitoring stations need to be installed. If new stations are warranted, planning, budgeting, purchasing and installation must take place in ample time to allow for 12 months baseline monitoring before the project starts.
4) Work will continue to overcome challenges with false-positive turbidity measurements at Tributary to Gills Pond Brook Station (NF02YO0190).
5) In addition to the work that has been done thus far, efforts will continue to monitor and evaluate water elevation and changes in water quality at Monitoring Well After Tailings Dam Station (NF02YO0193) and the possible relationship with Tailings Management Area.
6) Evaluation of pH in Monitoring Well After Tailings Dam will continue to determine a standardized well purging / sampling protocol to be used ENVC and Teck staff/
7) Work will continue to obtain weather data from on-site weather station operated by Teck Duck Pond Operations, and possibly incorporate it into the real-time reporting systems. Weather data can be used to more precisely assess the changes in water quality/quantity, as presently there is no automatic weather station nearby.
8) Considerable improvements were made to the pathways leading to the Real-Time Water Quality Monitoring stations in 2010. These areas will be reviewed again in 2011 to determine if any additional work needs to be done.
9) Work will continue to optimize sensor performance, data transmission, and information transfer. Any emerging issues will be addressed in a timely manner.
10) Work will continue to enhance and automate the data handling and reporting processes. ENVC is working on extrapolation of other water quality parameters using regression analysis.

Section 8.0 References

1. *Canadian Water Quality Guidelines for the Protection of Aquatic Life,* Canadian Council of Environment Ministers, 1999, Update 7.1, December 2007.

2. *Real Time Water Quality Report, Duck Pond Operations (Teck Cominco Limited), Deployment Period 2008-10-16 to 2008-11-12*, Department of Environment and Conservation, 2009.

3. *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*, U.S Geological Survey, 2006.