Teck Duck Pond Operations Real-Time Water Quality Monitoring Network 10 Year Report 2006 - 2015

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Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division
Grand Falls - Windsor, NL, A2A 1W9

Prepared by: Robert Wight

Executive Summary

The Newfoundland and Labrador Department of Environment and Conservation operated a Real-Time Water Quality Monitoring Program in partnership with Teck Duck Pond Operations and Environment Canada since 2006 under a Memorandum of Agreement.

The monitoring instrumentation provides timely and continuous water quantity and quality information at select stations in proximity to the mine and mill site. Key indicator parameters are measured to ensure that any emerging issues are identified and addressed in a timely manner.

This technical report documents the real-time water data that has been collected at Teck Duck Pond Operations over the past 10 years during production, and into the closure, and remediation phases. The extensive high quality long-term data set collected has provided both the regulator and industry with valuable information to allow evidence-based decision making regarding the management of the water resources both on and off site. Over the years, the continuous on-line data has been used by many stakeholders to ensure that the mining and milling operation is regulatory compliant. Real-Time Water Quality Monitoring at Teck Duck Pond Operations has demonstrated that this operation has remained responsible, accountable and transparent!

As the project continues into its closure and remediation phases, continuation of the Real-Time Water Quality Monitoring Program is anticipated to further demonstrate the efficacy and applicability of this technology. Furthermore, it will demonstrate the effectiveness of Teck Duck Pond Operation's Closure Plan, and an opportunity to adjust this plan if necessary.

Based on the 10 year history of this project, this model for real-time water monitoring can justifiably be applied to other mining and industry projects.

Acknowledgements

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations has been very successful in tracking water quality and quantity due to the hard work and diligence of individuals from three different organizations. The management and staff of Teck Duck Pond Operations worked in cooperation with the management and staff of the Department of Environment and Conservation as well as Environment Canada 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 Larry Bartlett and his predecessors, assisted in ensuring that the real-time system was operating such that data were reliable and accurate, and that resources were available to purchase and maintain the necessary equipment. Adam Miller, Darren Hennessey, and Robert Vaters, along with other staff over the years provided valuable assistance with the stations and feedback from time to time. Special recognition goes to Terry Brace and Guy Belleau, Aur Resources Inc., for having the foresight and recognizing the potential benefits of this program, and committing to this program during the development and construction phase of Duck Pond Operations. The site map of Duck Pond Operations was prepared by Bernard McNeil.

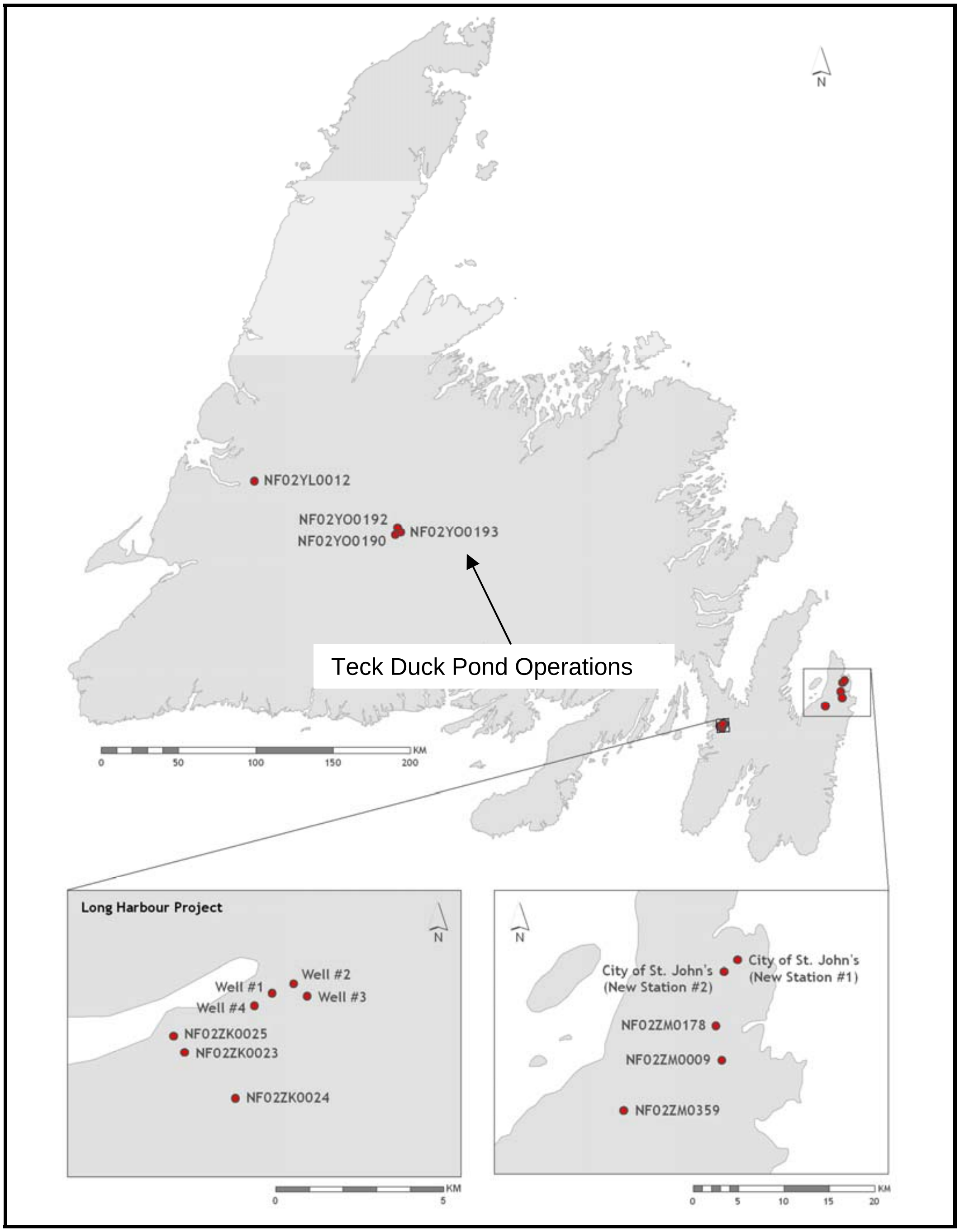
Various individuals from the Department of Environment and Conservation under the direction of Haseen Khan were integral in ensuring the smooth operation of such a technologically advanced network. Renée Paterson was the Project Lead for most of the 10 year period. Joanne Sweeney and Robert Wight played the key roles in coordinating and liaising between the major agencies involved, thus, ensuring open lines of communication at all times. In recent years Robert Wight was responsible for the data management/reporting, troubleshooting, along with ensuring the quality assurance/quality control measures are satisfactory. Throughout the years, Robert travelled to Teck Duck Pond Operations sometimes multiple times monthly to maintain and service the equipment and troubleshoot any technical problems as they arose. Leona Hyde worked on the communication aspects of the network ensuring the data was being provided to the general public on a near real-time basis through the departmental web page. Shibly Rahman provided invaluable assistance and guidance with the statistical analyses and discussion. Keith Abbott provided the mapping and spatial analysis. Robert Wight assembled the complete data set, employed the final quality assurance/quality control measures, and completed the final report.

Staff of Environment Canada (Water Survey Canada) under the management of Howie Wills played an essential role in the data logging/communication aspect of the network. Brent Ruth, Roger Ellsworth, Perry Pretty, Dwayne Ackerman, Taylor Krupa and Mike Ludwicki visited the site several times throughout each year to ensure the data logging equipment was operating properly and transmitting the data efficiently. They played the lead role in dealing with hydrological quantity and flow issues.

All individuals from each agency were fully committed to maintaining and improving this network and ensuring it provided meaningful and accurate water quality/quantity data that could be used in the decision-making process. This network was only successful due to the open communication and high level of cooperation of all three agencies involved.

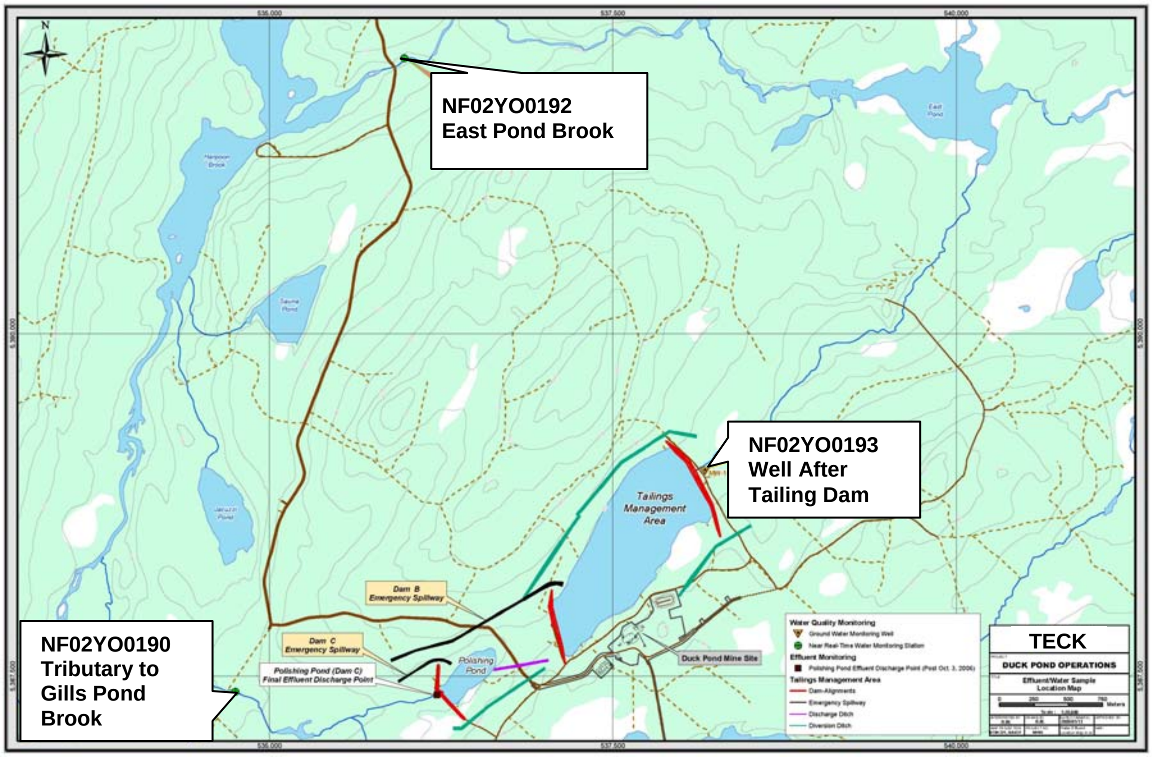
Section 1 - Introduction

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. The map below 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.



Real-Time Water Quality Monitoring Stations, Newfoundland

Three permanent stations are established at Teck Duck Pond Operations; two in surface water streams and one in a ground water monitoring well.

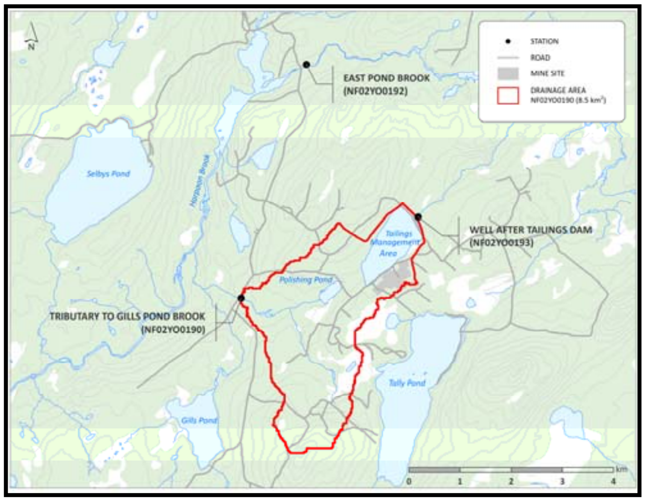


Real-Time Water Quality Monitoring Stations at Teck Duck Pond Operations

Tributary to Gills Pond Brook Station (NF02YO0190) is located 1700 meters 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 when it was installed during the mine / mill development / construction phase.

Tributary to Gills Pond Brook Station

The watershed for this station has an area of 8.5 square kilometers. The natural drainage basin was modified slightly (increased in area) during the construction of the Tailings Management Area, and presently includes the Tailings Pond, which previously was part of the East Pond Brook Watershed. Eventually, it is planned to redirect water from the Tailings Pond northeast, out its original course, Trout Brook, to East Pond and East Pond Brook. The watershed is comprised of 3% developed area (mostly the mine and mill site), 12 % water, 2 % barren, 2 % scrub, 7 % wetland, and 74 % forest. There is approximately 14.2 kilometers of roads in this watershed, most of which were built for forest resource extraction, some are related to mine development.

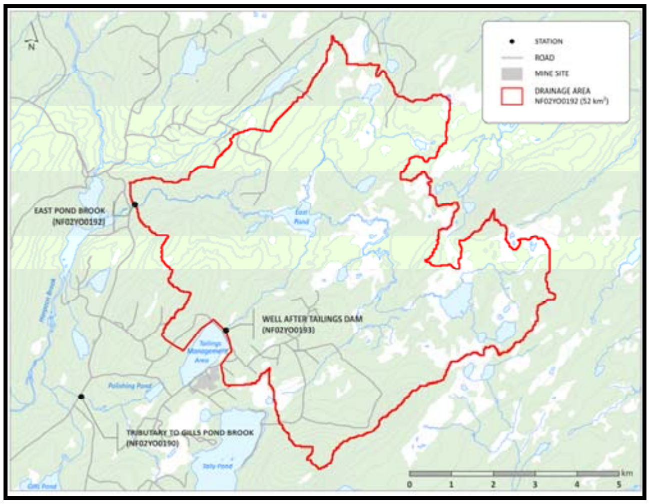


Tributary to Gills Pond Brook Watershed

East Pond Brook Station (NF02YO0192) is located 8.6 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, when it was installed during the mine / mill development / construction phase.

East Pond Brook Station

The watershed for this station has an area of 52 square kilometers. The natural drainage basin was modified slightly (decreased in area) during the construction of the Tailings Management Area, and presently does not include what is now the Tailings Pond. Eventually, it is planned to redirect water from the Tailings Pond northeast, out its original course, Trout Brook, to East Pond and East Pond Brook. The watershed is comprised of less than 1% developed area (includes Boundary Deposit), 3 % water, 3 % barren, 3 % scrub, 8 % wetland, and 82 % forest. There is approximately 21.5 kilometers of roads in this watershed, most of which were built for forest resource extraction; some are related to mine development. Monitoring Well after Tailings Dam Station (NF02YO0193) is located inside the East Pond Brook watershed.



East Pond Brook Watershed

Monitoring Well After Tailings Dam Station (NF02YO0193) is located approximately 100 meters northeast 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, when it too was installed during the mine / mill development / construction phase.

This station does not have an associated watershed, as it is a point (well), which measures groundwater from its zone of influence; primarily shallow subsurface drainage from the Tailings Pond. Regardless of the drainage basin modifications, this station remains located within the East Pond Brook watershed.

Monitoring Well After Tailings Dam Station

The two surface water stations (Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192) are operated under a renewable cost-shared 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 was to provide an early warning of any potential or emerging water quality issues such that mitigative measures could 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, which are the headwaters of the Exploits River.

It was initially intended during the planning phase of this project 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, and subsequently closed, discharge from the site has been required outside the originally-planned time frame of May through November. Accordingly, the instruments have been deployed continuously whenever possible throughout the year. The need for year-round instrument deployment will be re-evaluated on a go-forward basis, as the site continues through its closure and remediation phases.

The instruments at Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192) were deployed nearly continuously since May 10, 2006 and September 7, 2006 respectively, right through to December 31, 2015. 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 changed out approximately monthly, to facilitate regular maintenance and calibration.

At Monitoring Well After Tailings Dam Station (NF02YO0193) every effort has been made to have an instrument deployed nearly continuously since September 7, 2006. As this well freezes at surface, an instrument has usually been deployed continuously over the winter months. However, there were some data communication errors throughout parts of the colder winter months. This reoccurring problem has been thoroughly investigated, with multiple system components being changed out from time to time. 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.

Throughout the life of this project, all instruments are **Hydrolab®** brand **DataSonde®** probes in the surface water stations and **Quanta G®** probes in the ground water station. To allow for continuous monitoring without extended periods of missing data, and to augment the older fleet of instruments, in 2012 Teck Duck Pond Operations purchased two additional **DataSonde®** probes and one additional **Quanta G®** probe so that replacement units having the same technical specifications, are usually available when one or all three instruments are out of service for an extended period of time. Unfortunately, there are brief periods throughout the year, when one or more instruments are out of service, and no alternate instrument is available to allow for continuous uninterrupted service. Every effort is made to minimize the frequency and duration of these incidents. Portable **Hydrolab®** brand **MiniSonde®** probes having the same technical specifications are used for QA/QC purposes.

From time to time there are transmission errors resulting in a loss of data through our satellite-based communications system. For the surface water-based **DataSonde®** instruments we have the ability to log the water quality data internally, and augment any missing data, particularly for periods of more than a few hours. This feature is not available on the ground water-based **Quanta G®** instrument. Any significant periods of missing satellite-based data which are augmented with internally logged data are noted in specific Deployment Period reports. See http://www.env.gov.nl.ca/env/waterres/rti/rtwq/index.html

Section 2 - Maintenance and Calibration

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

There have been times, when there has been critical instrument failure, or a warranty repair, when the instruments have been shipped back to the vendor or manufacturer, or factory servicing and/or calibration.

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 water chemistry more stable. Individual Deployment Reports and the Annual Reports detail the dates the instruments were installed and removed for maintenance and calibration from the beginning of this project through to the end of 2015. 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.

Throughout the project period there were a number of instrumentation issues. As expected, several individual sensors have failed and needed to be replaced. The Department of Environment and Conservation has worked with the vendor's representative to identify problems and issues causing the failures, with the aim to mitigate future failures. As costs for these repairs were significant, the vendor has worked with the manufacturer to minimize costs to the Department and Teck by covering some of the repairs outside of the normal warranty period. In fact, one of the **Quanta G®** instruments that has failed repeatedly and had numerous warranty repairs, has been totally replaced by the manufacturer with a new out-of-the-box instrument having exactly the same technical specifications.

In order to ensure long term accuracy for the instruments, they are returned to the vendor and/or our in-house factory-trained staff periodically (approximately every two years, or when problems or issues are observed) for Performance Testing and Evaluations (PTE). At this time, sensors are replaced if required, and the instruments are maintained and calibrated to factory specifications.

Section 3 - 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.

As part of the QA/QC protocol, an assessment of the reliability of data recorded by an instrument was made at the beginning and end of the deployment period, beginning in January of 2007. The ranking system is based upon methodology developed by the U.S. Geological Survey [(1)], and uses the formulae in the table below 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

For the Surface Water Stations, upon deployment and removal, a QA/QC **MiniSonde®** is temporarily deployed alongside the Field **DataSonde®**. Values for each recorded parameter are compared between the two instruments. Based upon the difference between the parameters recorded by the Field **DataSonde®** and QA/QC **MiniSonde®** a qualitative statement (Ranking) is usually made on the data. In nearly all cases, a grab sample was also collected from the stream and analysed at a commercial laboratory. Instrument values were compared with laboratory values to ensure the integrity of the instruments' measurements. Results were consistently determined to be within the expected range of values.

Because the deployment set-up for Well After Tailings Dam (MW1) is different, comparison with another instrument is not always possible. In most cases, a grab sample is usually collected at the beginning and end of the deployment period, and the ranking was calculated for the relevant parameters based upon live data and laboratory data. In some cases, early in the study period a second instrument was deployed in the well, and rankings were calculated between the two instruments. This practice was discontinued due to the vertical separation of the instruments, and the potential for getting the second instrument caught in the narrow well casing.

The table below highlights the QA/QC rankings for all three stations from 2007 through 2015. For Tributary to Gill's Pond Brook, rankings were Excellent or Good in 91.2 % of the instances, for East Pond Brook, rankings were Excellent or Good in 94.0 % of the instances, and for Monitoring Well After Tailings Dam, rankings were Excellent or Good in 76.4 % of the instances.

	Tributary to Gills Pond Brook			East Pond Brook			Monitoring Well After Tailings Dam		
	Ranking Excellent/Good	Total Rankings	% Excellent/Good	Ranking Excellent/Good	Total Rankings	% Excellent/Good	Ranking Excellent/Good	Total Rankings	% Excellent/Good
2007	55	76	72.4%	37	52	71.2%	9	12	75.0%
2008	28	36	77.8%	25	27	92.6%	6	6	100.0%
2009	24	25	96.0%	25	25	100.0%	2	4	50.0%
2010	41	45	91.1%	45	47	95.7%	3	4	75.0%
2011	53	55	96.4%	54	55	98.2%	5	6	83.3%
2012	49	51	96.1%	52	53	98.1%	6	8	75.0%
2013	64	64	100.0%	72	73	98.6%	9	13	69.2%
2014	62	65	95.4%	62	65	95.4%	9	14	64.3%
2015	70	73	95.9%	70	73	95.9%	70	73	95.9%
Average			**91.2%**			**94.0%**			**76.4%**

For Tributary to Gills Pond Brook Station and East Pond Brook Station the **DataSonde®** and **MiniSonde®** monitoring instruments performed extremely well. Many of those rankings that fell below the Excellent or Good categories were at the end of the deployment periods, when bio-fouling and expected instrument drift, were noted as the most common cause of the disparity in the numbers. This was particularly evident with the summer deployments (bio-fouling) and over-winter deployments (instrument drift).

For Monitoring Well After Tailings Dam Station the **Quanta G®** monitoring instruments also performed very well. Although there were some sensor and instrument failures, the vendor and manufacturer were prompt and fair in facilitating repairs and/or replacements. When the instruments were working, many of those rankings that fell below the Excellent or Good categories were at the beginning of the deployment periods, when there were significant changes in the water quality (particularly pH) in the well following the deployment of the instruments. This will be discussed further in Section 9.

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, and with the longer over-winter deployments. Accordingly, when conditions and accessibility permit, the instruments will continue to be maintained and calibrated at the intervals recommended by the manufacturer.

With the exception of water quantity data (Stage), all data used in the preparation of the previous Deployment Reports, Annual Reports and this report adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected water quantity data can be obtained upon request.

Section 4 - Mine and Mill Production

In many of the graphs below, the Production Phase of Mine and Mill (April 1, 2007 through June 30, 2015) is highlighted as a light blue background. While construction and development of the site began in January 2005, the official start of commercial production did not begin until April 1, 2007. During the intervening period, the site was cleared, a camp and office were built, the mine was developed, the mill was built, and the Tailings Management Area and associated dams and drainage alterations was constructed. Much of this work was completed prior to the establishment of either of the Real Time Water Quality Stations.

Tributary to Gills Pond Brook Station became operational on May 10, 2006, while East Pond Brook Station and Well After Tailing Dam Station became operational on September 7, 2006.

While production at the Mill ceased officially on June 30, 2015, there continues to be some operations at the site. The Tailings Management Area will continue to be managed, with periodic discharges to the environment. The site will be closed, all buildings and structures being removed, waste rock will be placed in the Tailings Management Area, and the area will be rehabilitated in accordance with a pre-approved closure plan. All this work will take several more years. Accordingly, an extension to the Memorandum of Agreement, with Teck Duck Pond Operations ensures that this Real-Time Water Quality Monitoring Program will continue until at least March 31, 2020.

Section 5 - Statistical Analysis and Interpretation

Throughout the life of this project, all reporting in the form of Deployment Reports and Annual Reports have been descriptive in nature using plain-language text. By design, these reports have not been written to include anything other than basic descriptive statistics.

However, over the longer term it was necessary to step back and assess any changes measured via the Real-Time Water Quality Monitoring Program over the course of the project to determine if there were any long-term changes or trends on the receiving waters around the operation.

Due to the non-normal distribution of the data and the presence of outliers, medians are more appropriate for data condensation since medians are not affected by outliers. The presence of voluminous data makes it difficult to perform proper trend interpretation since trend analysis is always affected by large datasets which makes anything significant. Therefore, it was required to condense the data in way such that it would provide a meaningful trend result but at the same time reflective on any changes in the original data. Accordingly, careful consideration was given to the most appropriate ways to analyse the data for any long-term changes or trends, determine if this change or trend was statistically significant, and then graphically represent any changes or trends in the long term data. Daily, monthly and yearly median values were determined to be the most appropriate breakdown analysis of each specific data set. Monthly median values were used in the Trend Analysis calculations. Yearly median values were used to depict the trend line on the respective graphs.

In excess of 2 million individual data points were reviewed, verified and determined to be valid and accurate, in order to perform this data analysis. Any erroneous or questionable data were removed from the data set prior to the preparation of the respective Deployment Reports.

A trend is tested for water temperature, pH, specific conductance, dissolved oxygen, turbidity and stage for the surface water stations, and water temperature, pH, specific conductivity, and water elevation for the ground water station, to identify whether there was any increase, decrease or no change in trend. Rank Spearman Correlation Coefficient functionality using R programming is used to perform the trend test. The p-values obtained for each of the parameters identifies whether or not a trend exists. If a trend exists it would be indicated by the obtained p-value which would be less than the significance level of 0.05. A P-value closer to 0.00, is more statistically significant than a P-value closer to 0.05. A positive value of Spearman's rho indicates a parameter showing upward trend while a negative rho indicates a downward trend. Upward trend is indicated by the keyword "Up" in the "Trend Result", downward trend by the keyword "Down" while no trend is indicated by the keyword "No".

The specific details of each trend test are presented in tables in the respective sections below. Plan-language text in the discussion will highlight the significance and potential implications of any trends.

To help visualize these trends (if any), it was decided that Box Plot graphs would be most appropriate. Box plots are used to quickly compare distributions, view the central tendency of the data, and highlight the variability of the data. Box plots can determine whether a sample distribution is symmetric or skewed. Box plots can show outliers (unusually large or small observations, which can have a disproportionate influence on statistical results), which can result in misleading interpretations.

For each graph, vertical blue boxes represent approximately 50% of the observations, or the 25th to 75th percentiles. Lines extending above and below the boxes (called "whiskers") roughly represent the lower and upper 25% of the distribution, or zero to 25th and 75th to 100th percentiles respectively. Asterisks beyond the whiskers represent the outliers. Outliers are determined to be all those individual measurements that are greater than 1.5 times the interquartile range (blue boxes) or the 25th to 75th percentiles. Where multiple outliers lie near or on top of one another, they form a 'snowflake' pattern, so as not to obscure their numbers. Given that there are up to 8760 measurements of each parameter, per station, per year, there are surprisingly few outliers. While outliers are included in the data analysis, because medians are used to assess the trends, the outliers do not skew the trend analysis.

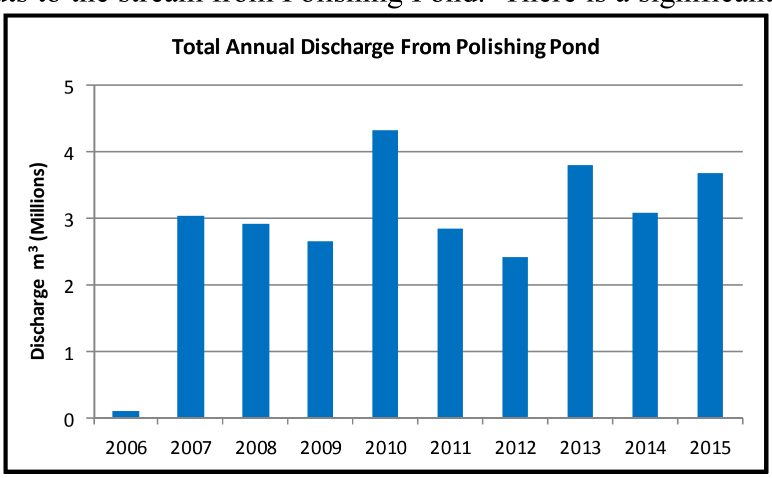
As noted above, trends are depicted by lighter blue lines that connect the yearly median values.

Section 6 - Discharge from Polishing Pond

Under Provincial and Federal regulatory measures, effluent from the mine's Tailings Management Area may be discharged (controlled release) through the Polishing Pond (Dam C) to receiving waters (Tributary to Gills Pond Brook) provided it meets stringent criteria. Throughout the life of the project, several discharge periods were recorded each year, as Duck Pond staff monitored and controlled discharge to ensure they worked within the design capacity of the Tailing Management Area, and met the established discharge criteria. The Total Annual Discharge, the Number of Days Discharging, and the Average Daily Discharge (when discharging) are summarized for each year in the table below.

Year	Total Annual Discharge (m^3)	# of Days Discharging	Average Daily Discharge (m^3/day)
2006	105,041	16	6,565
2007	3,042,249	200	15,211
2008	2,930,749	176	16,652
2009	2,659,805	139	19,135
2010	4,331,532	249	17,396
2011	2,855,627	193	14,796
2012	2,431,468	206	11,803
2013	3,800,676	233	16,312
2014	3,093,449	225	13,749
2015	3,673,397	256	14,349

The graph below illustrates the Total Annual Discharge from Polishing Pond over the study period. The Stage graph in the next section depicts the water level at Tributary to Gills Pond Brook; the receiving waters. It is possible to see some of the individual discharge events, when stage increased as a result of the inputs to the stream from Polishing Pond. There is a significant relationship (P-value of 0.00) between the two locations. However, the impact on Tributary to Gills Pond Brook is mild (Pearson Correlation = 0.13), as the data are considered over the entire period, not just the times when there was a discharge from Polishing Pond. Furthermore, there are other natural influences in the watershed which would mitigate the impacts from the discharge from Polishing Pond.



There is no significant increase or decrease in the Total Annual Discharge from Polishing Pond over the course of the project.

Discharge from Polishing Pond is measured through a V-Notch Weir which was built, and is calibrated regularly in accordance with the applicable ASTM standards. This V-Notch Weir is considered to be the Final Discharge Point.

V-Notch Weir and Rock-Lined Channel

Discharge from the weir flows through a rock-lined channel for several hundred meters, until the gradient levels out to the point where water velocities are minimal and can be mitigated by the natural wetlands and vegetation. This way, the potential effects of erosion from the input of the discharge waters on the receiving watershed was minimized.

It is important to note, that while meeting the discharge criteria, the physical and chemical characteristics of the discharge water were different from, and altered the physical and chemical properties of the receiving water at Tributary to Gills Pond Brook. This is evident in some of the parameters reviewed in the next section.

Section 7 - Data Interpretation - Tributary to Gills Pond Brook Station

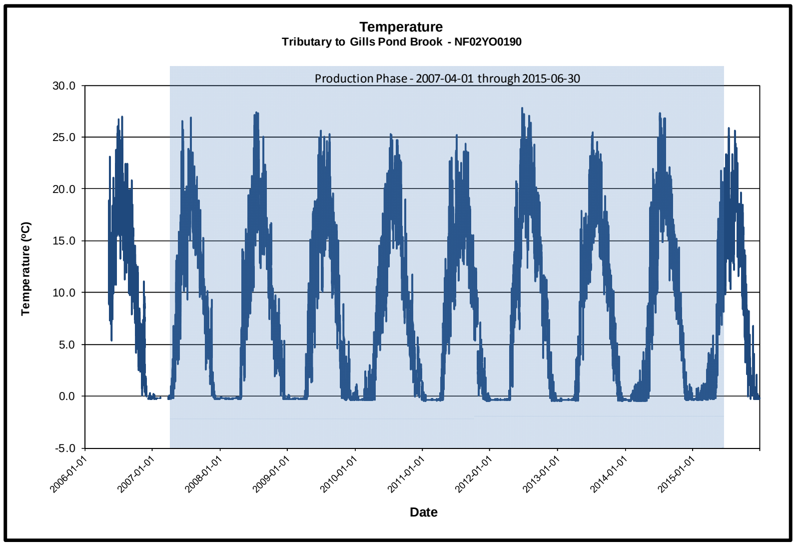
Trend Analysis

Station	Temp (°C)	pH	Specific Conductivity (µS/cm)	DO (mg/l)	Turbidity (NTU)	Stage (m)
P-Value	0.75	0.03	0.00	0.23	0.05	0.00
Spearman's rho	-0.03	0.20	0.55	-0.11	-0.18	0.29
Parameter Count	116	116	116	116	114	116
Significance Level	0.05	0.05	0.05	0.05	0.05	0.05
Trend Result	No	Up	Up	No	No	Up

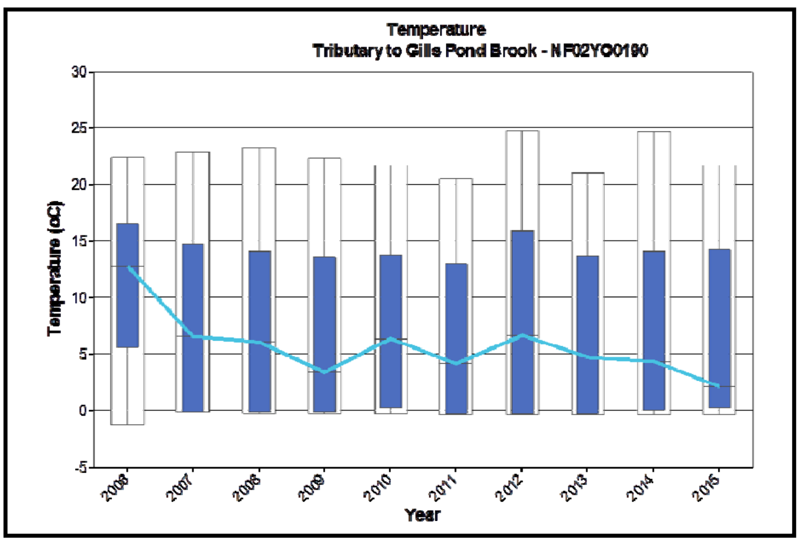
There is no statistically significant trend for temperature, dissolved oxygen (mg/L) or turbidity. Specific conductance, pH, and stage have a statistically significant upward or increasing trend. Yearly Median Values are depicted in the table below.

Yearly Median Values						
Year	Temp (°C)	pH	Specific Conductivity (µS/cm)	DO (mg/l)	Turbidity (NTU)	Stage (m)
2006	12.19	6.49	24.8	10.27	0.0	1.28
2007	6.92	6.78	64.3	11.60	0.6	1.34
2008	5.69	6.80	63.2	11.53	0.0	1.36
2009	3.00	6.72	79.5	12.12	0.0	1.32
2010	5.99	6.77	529.0	11.00	0.0	1.37
2011	4.02	6.73	251.0	11.88	0.0	1.36
2012	6.24	6.78	318.0	11.41	0.0	1.35
2013	4.75	6.81	601.0	11.33	0.0	1.37
2014	4.01	6.60	338.5	11.87	0.0	1.36
2015	2.93	6.90	590.0	11.79	0.0	1.36

The water temperature profile over the 10 year period is remarkably similar for each year. Temperatures ranged from a minimum of -1.36 ^{o} C in the winter months to as high as 27.8 ^{o} C in the summer. As expected, the highest temperatures were recorded in July and August. Under the cover of ice, temperatures remained fairly constant near zero over the winter months.

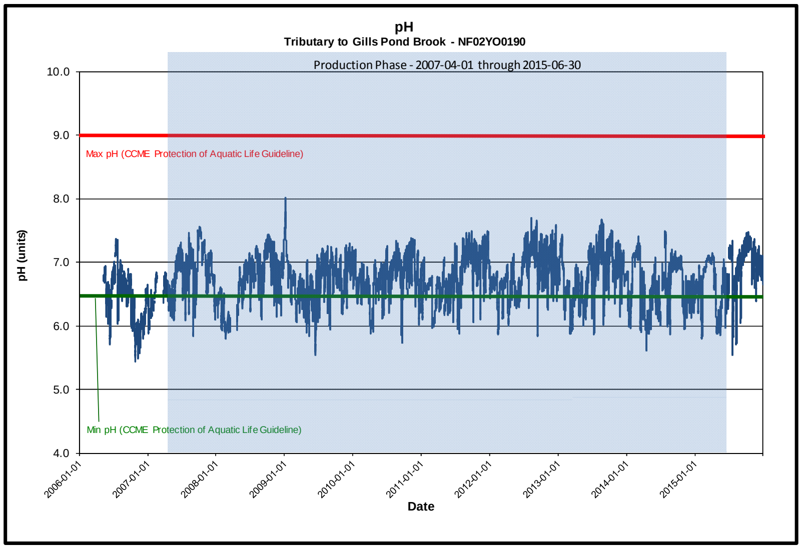


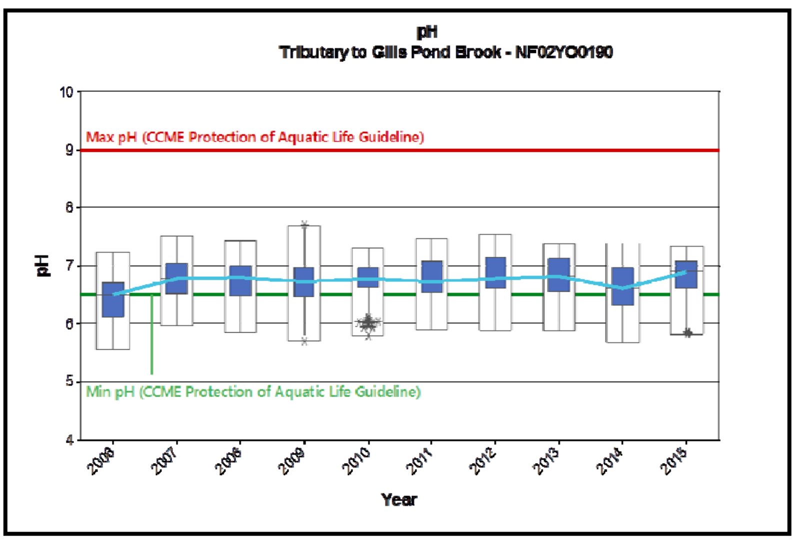
The temperature profile for this stream is very similar to that of East Pond Brook (Section 8). Any difference would likely be the result of the different stream order. There are no obvious changes in temperature outside the Production Phase. There is no recommended limit or range for water temperature.



There is no statistically significant change or trend in water temperature at this station. The most obvious change in the trend line is from 2006 to 2007. As this station was installed part way through 2006, no data from those colder winter months would have skewed the median values upwards for that year.

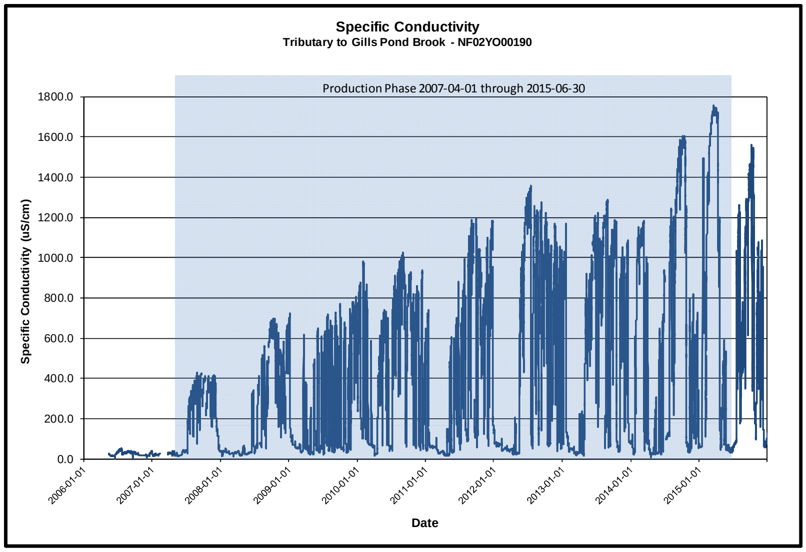
The pH ranged between a minimum of 5.44 and a maximum of 8.02. The pH of this stream is naturally quite low, being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (2). It should be noted however, that water discharged 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, there is generally an increased pH in the stream at this station, which often brings the water within the pH range recommended by CCME. When discharge ceases, the pH values generally decrease to near their normal background levels. This behaviour is more obvious over shorter intervals when individual discharge periods are obvious.





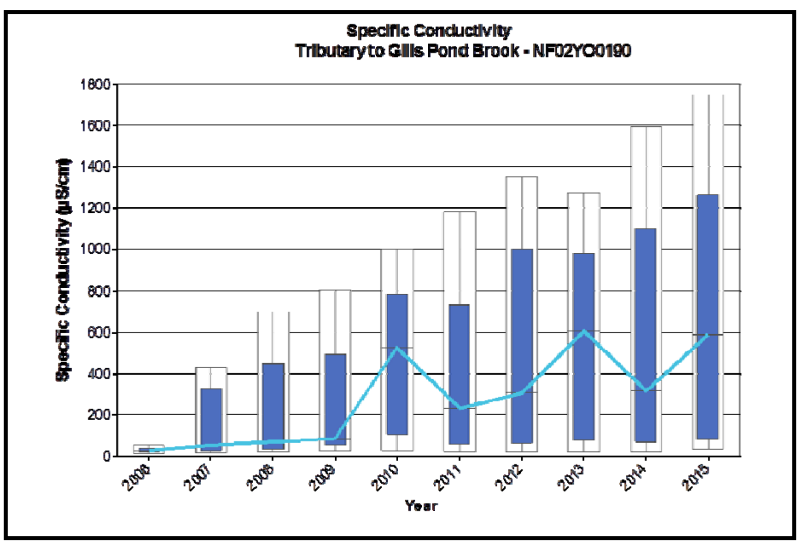
pH has a statistically significant upward or increasing trend accordingly to the calculations. A P-value of 0.03 indicated that the significance is not very strong. Graphically, there does not appear to be that much variability either. There is, however, a notable increase between 2006 and 2007, when discharges from the Polishing Pond began. There were discharges from the Polishing Pond in all subsequent years. The Yearly Median pH ranged from a low of 6.49 in 2006 to a high of 6.90 in 2015, a difference of 0.41.

The specific conductivity 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. Specific conductance ranged from a minimum of 1.8 µS/cm to a maximum of 1755 µS/cm. Outside the periods when there is discharge from Polishing Pond, the specific conductivity in this stream would generally be quite low, in that normal range.



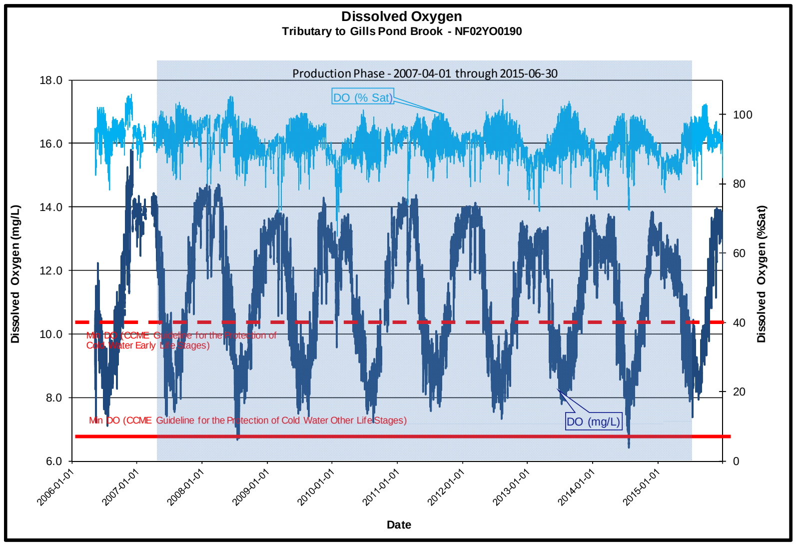
Beginning with the first discharge to the environment following the start-up of the mill on July 11, 2007, the dramatic change in the specific conductivity is quite obvious. Prior to this date, any discharges to the environment did not contain treated effluent.

The significant increases and decreases in specific conductivity correspond closely with the beginning and end of the discharge periods from Polishing Pond, with specific conductivity returning to near background levels within hours of the cessation of discharge. While not obvious over the longer period of this report, this relationship is obvious in the individual Deployment Reports, and Annual Reports. There is no recommended limit or range for specific conductance, although it is a key indicator of the concentration of other parameters of interest which may be regulated in the discharge from Polishing Pond.

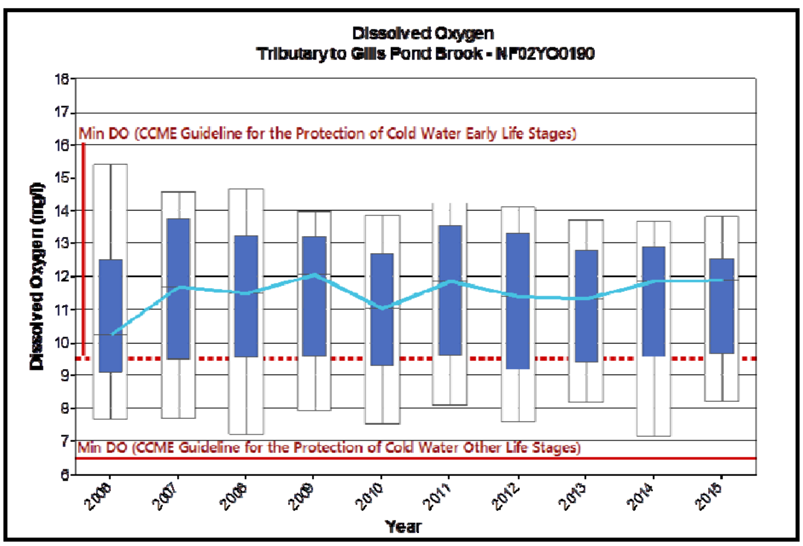


Specific conductivity has a statistically significant upward or increasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. This is obvious graphically as well. Similar to the graph above, there is, a notable increase between 2006 and 2007, when discharges from the Polishing Pond began. There were discharges from the Polishing Pond in all subsequent years, and the specific conductance tended to increase nearly every subsequent year. Yearly median values ranged from a low of 24.8 in 2006 to a high of 590.0 in 2015, a difference of 565.2.

Over the course of the past 10 years, dissolved oxygen (the darker blue data points) ranged from a minimum of 6.41 mg/L to a maximum of nearly 15.8 mg/L, a range which would typically be expected.



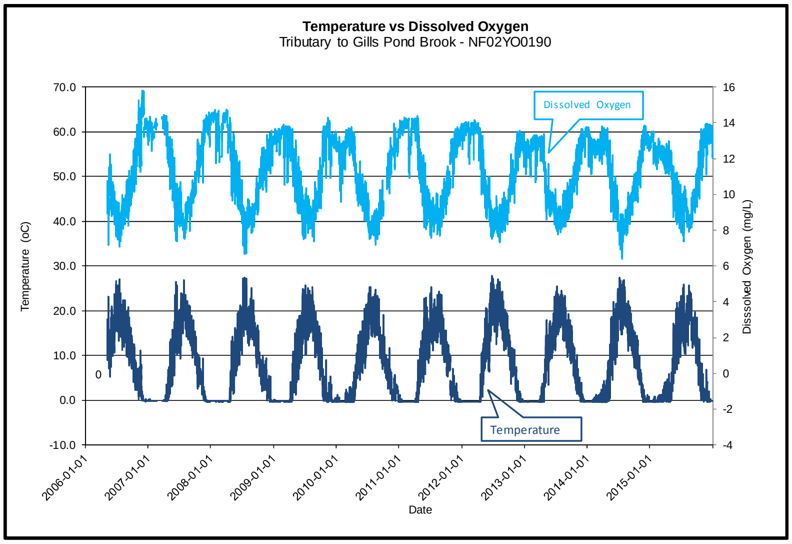
The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (2) for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen usually remained above 6.5 mg/L, in the 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 (see below). The percent saturation (the lighter blue data points) usually 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 (Section 8) has a very similar profile. Over the course of the past 10 years, there did not appear to be any appreciable change in dissolved oxygen resultant from discharge from Polishing Pond, as dissolved oxygen values were typical of other locations in the province.



Dissolved oxygen (mg/L) does not have a statistically significant trend. There is a marked visual increase on the box plot from 2006 to 2007, however, this is likely a result of only a partial year's worth of data for 2006.

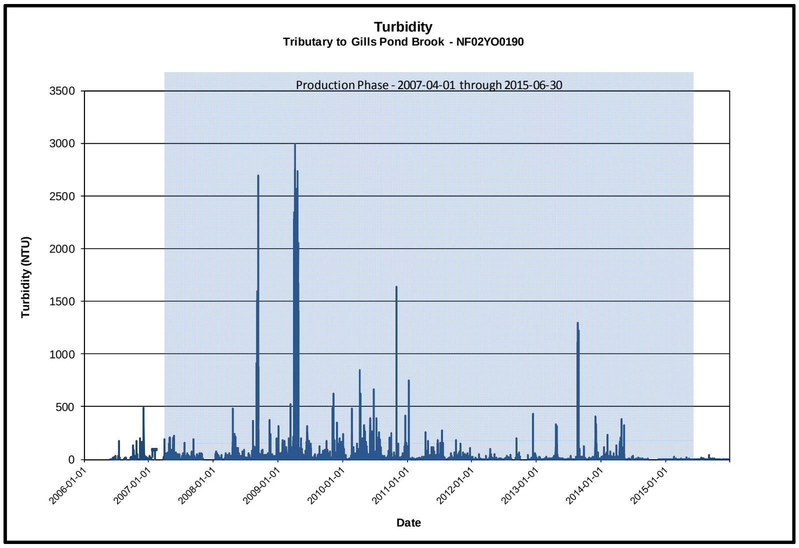
It is generally understood that dissolved oxygen (mg/L) is inversely proportional to water temperature. This is particularly evident in the graph to the right.

Statistically, it has been determined that there is an almost perfect inverse relationship between temperature and dissolved oxygen at this site, with a Pearson Correlation Coefficient of -0.954 and a significance (P-value) of 0.00.

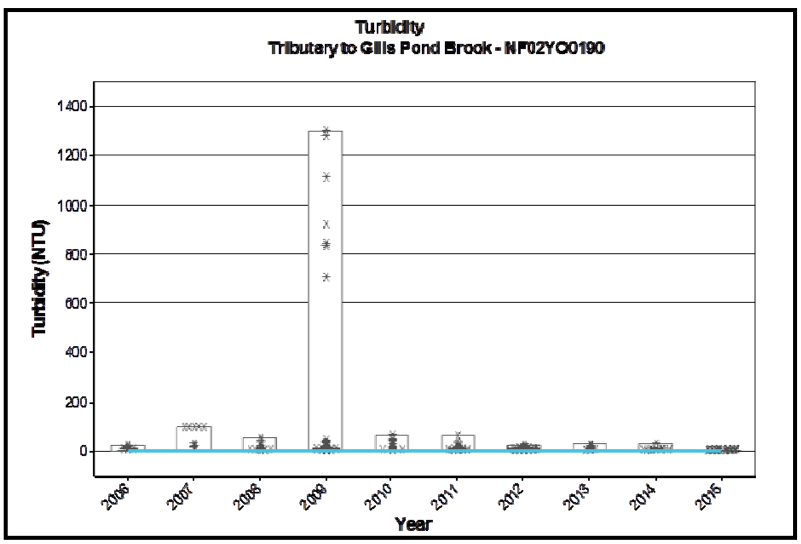


This confirms that the dissolved oxygen values over the life of the project, which were lower than the recommended CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life, were solely a function of the water temperature, and not a result of the discharge from Polishing Pond. Similar findings were made over the shorter term as documented in the individual Deployment Reports, and Annual Reports.

Turbidity at Tributary to Gills Pond Brook Station was of particular interest because of the proximity to the mine's Final Discharge Point. Turbidity values ranged from zero to 2993 NTU. 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 periods of discharge from Polishing Pond or following runoff from precipitation and snowmelt events. The highest spikes in turbidity often coincided with the onset of, or increase to, the discharge rate from Polishing Pond.

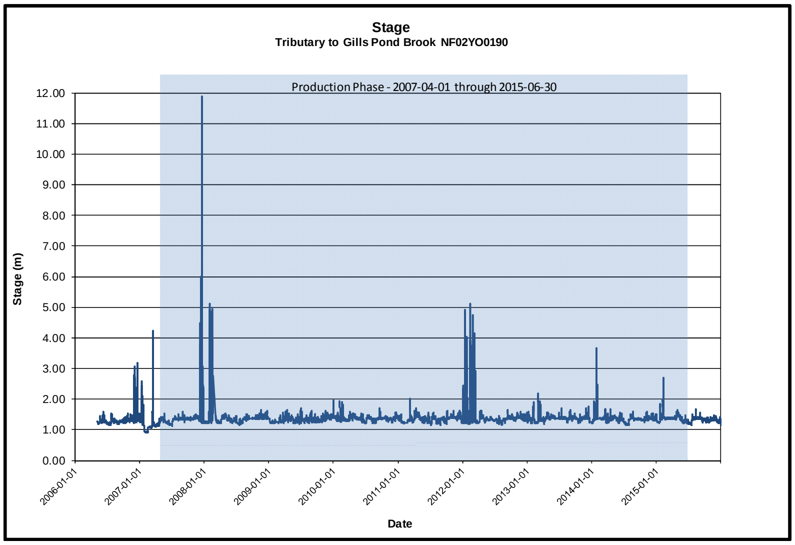


From time to time, leaves, algae and other natural in-stream debris became caught on the turbidity sensor, causing interference and false-positive readings. Data for these periods has been removed. In 2008 and 2009 there were brief periods when there were some extremely high turbidity recordings. Similar peaks noted in other Real Time water Quality Monitoring Stations on the island. While no solid explanation has been documented, it is suspected that widespread airborne deposition and major precipitation events may have contributed to the turbidity spikes.



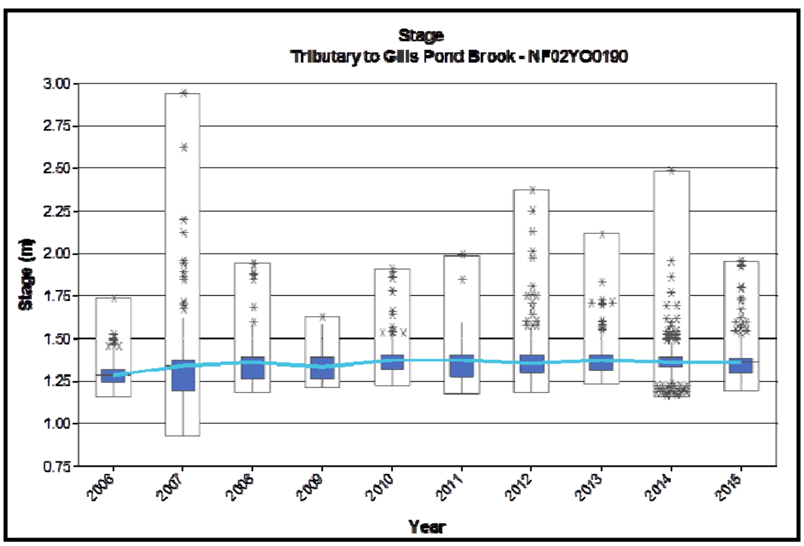
Turbidity at Tributary to Gills Pond Brook does not have a statistically significant trend. Most of the spikes in the graph above are calculated to be outliers, and do not have any impact on skewing the trend results.

The stage or water level was recorded from an arbitrary benchmark to be from a low of 0.91 meters, to a peak near 11.9 meters. It is important to consider from the outset that many of the highest peaks occur in the winter months under freezing conditions, and are considered to be due to the backwater effect from ice formation.



For the remainder of the year, however, stage was within normal ranges, with the higher levels corresponding to periods of controlled release from Polishing Pond and following snow melt and rainfall events. In fact, throughout the 10 year period, it is possible to see the brief increases in stage during the Polishing Pond discharge periods. This relationship is much easier to see over shorter timer periods, as described in the Deployment Period and Annual Reports.

Stage has a statistically significant upward or increasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. However, this trend is not so obvious from the yearly median line on the Box Plots. There are however, enough outliers and higher stage values in the later years to cause this upward trend. The only obvious change is again in the yearly median from 2006 to 2007. Once discharge from Polishing Pond began in 2007, there were repeated discharge events each year. As noted in Section 6 above, there is a significant relationship (P-value of 0.00) between the two locations. However, the impact on Tributary to Gills Pond Brook is mild (Pearson Correlation = 0.13), as the data are considered over the entire period, not just the times when there was a discharge from Polishing Pond. Yearly Median Stage ranged from a low of 1.28 m in 2006 to 1.37 meters in 2010 and 2013. This difference (0.09 m) is the result of the volumes input from Polishing Pond.



Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Section 8 - Data Interpretation - East Pond Brook Station

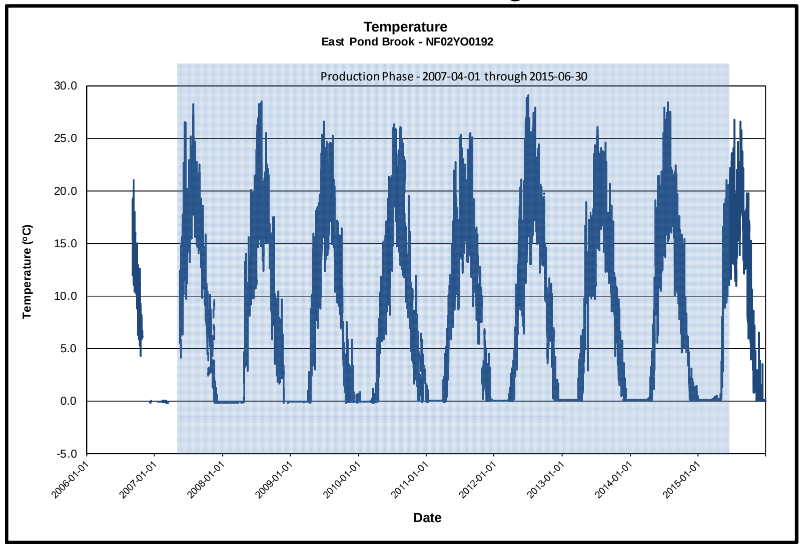
Trend Analysis

Station	Temp (^{o}C)	pH	Specific Conductivity (µS/cm)	DO (mg/l)	Turbidity (NTU)	Stage (m)
P-Value	**0.13**	**0.27**	**0.01**	**0.06**	**0.00**	**0.82**
Spearman's rho	**0.14**	**-0.11**	**0.26**	**-0.18**	**0.34**	**-0.02**
Parameter Count	**110**	**109**	**110**	**110**	**103**	**110**
Significance Level	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
Trend Result	**No**	**No**	**Up**	**No**	**Up**	**No**

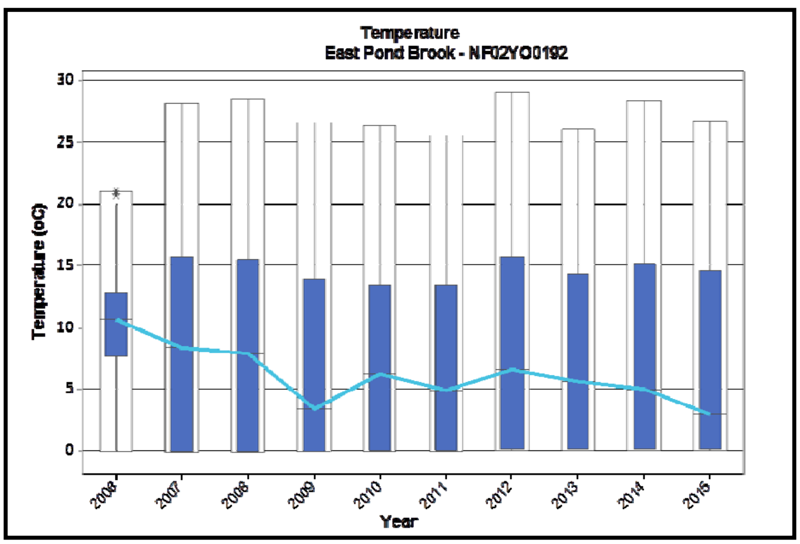
There is no statistically significant trend for temperature, pH, dissolved oxygen (mg/L) or stage. Specific conductance and turbidity have a statistically significant upward or increasing trend. Yearly Median Values are depicted in the table below.

Yearly Median Values						
Year	Temp (oC)	pH	Specific Conductivity (µS/cm)	DO (mg/L)	Turbidity (NTU)	Stage (m)
2006	10.57	6.52	28.6	10.85	0.00	1.12
2007	8.32	6.52	22.4	11.31	0.00	1.01
2008	7.88	6.58	25.1	11.24	0.00	1.12
2009	3.35	6.55	24.7	12.52	0.00	1.12
2010	6.15	6.63	25.9	11.62	0.00	1.08
2011	4.81	6.35	23.8	11.75	0.00	1.13
2012	6.55	6.33	25.8	11.46	0.00	1.07
2013	5.60	6.38	25.7	11.54	0.00	1.14
2014	4.97	6.40	25.4	11.75	0.00	0.98
2015	2.93	6.54	30.2	12.17	0.00	1.07

The water temperature profile over the 10 year period is remarkably similar for each year. Temperatures ranged from a low of -0.16 ^{o} C in the winter months to a high of 29.05 ^{o} C in the summer of 2012. As expected, the highest temperatures were recorded in July and August. Under the cover of ice, temperatures remained fairly constant near zero over the winter months.

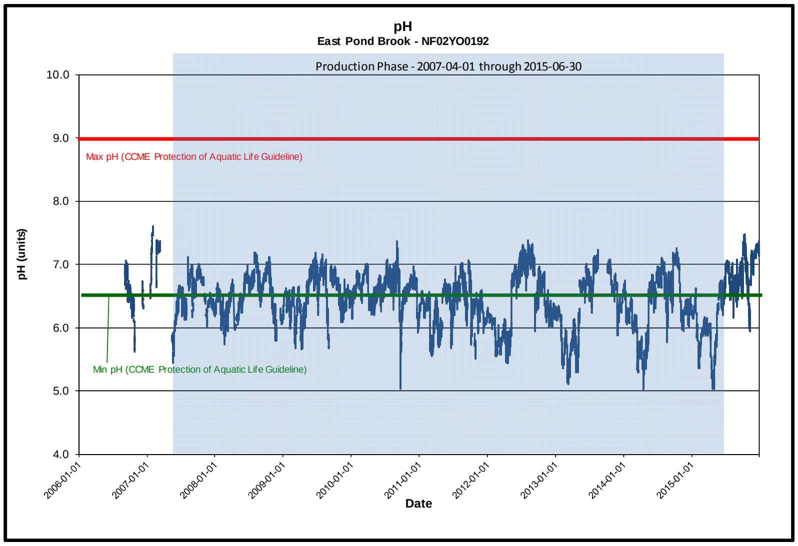


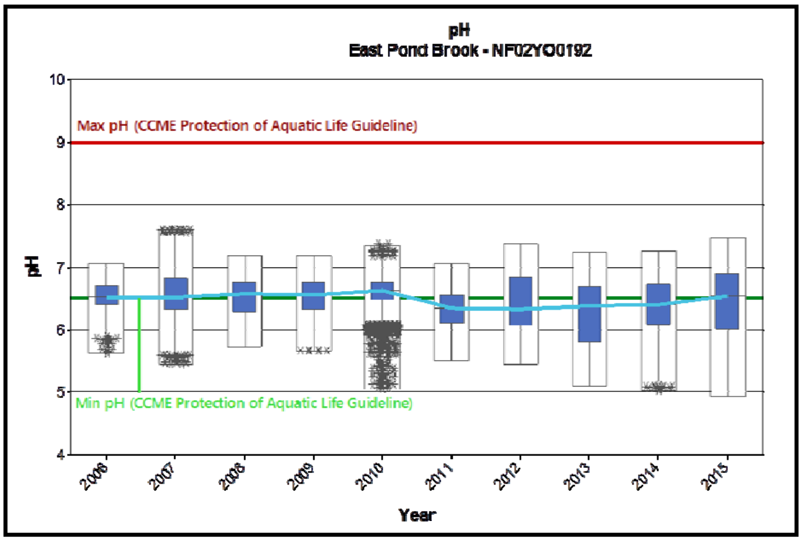
The temperature profile for this stream is very similar to that of Tributary to Gills Pond Brook (Section 7). Any difference would likely be the result of the different stream order. There is no recommended limit or range for water temperature.



There is no statistically significant change or trend in water temperature at this station. The most obvious change in the box plot is from 2006 to 2007. As this station was installed late in 2006, no data from much of the year would have skewed the median values upwards for that year.

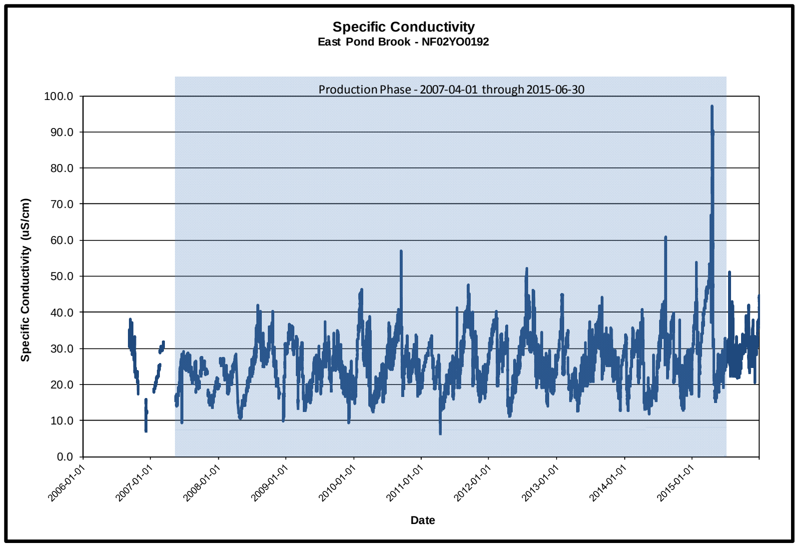
The pH ranged between a minimum of 4.94 and a maximum of 7.60. The pH of this stream is naturally quite low, being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (2). It should be noted however, that unlike Tributary to Gills Pond Brook, this stream does not receive any direct inputs from Polishing Pond. Any change in pH would only be potentially evident over the longer term, as a result of seepage through the dams that for the Tailings Management Area.



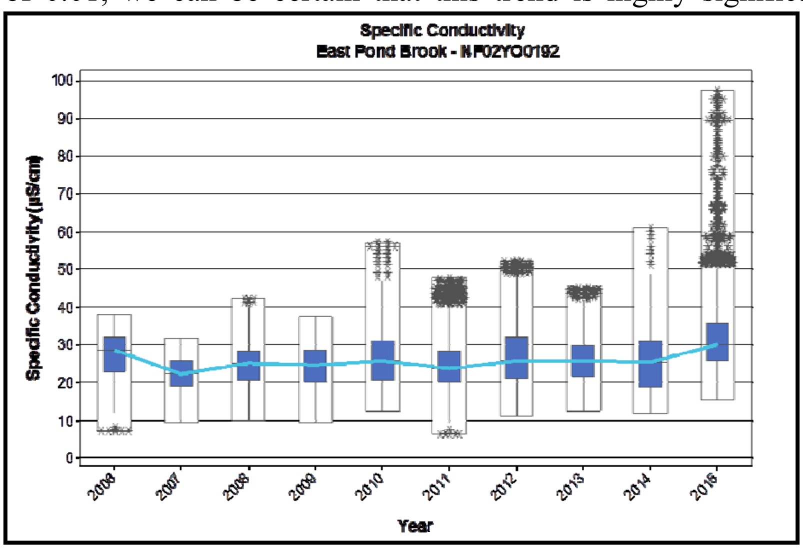


pH does not have a statistically significant trend. Any minor changes in pH would likely be the result of natural influences.

The specific conductivity 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. The specific conductivity in this stream ranged from a minimum of 6.30 µS/cm to a maximum of 97.3 µS/cm. There is no recommended limit or range for specific conductance, although it is a key indicator of the concentration of other parameters.

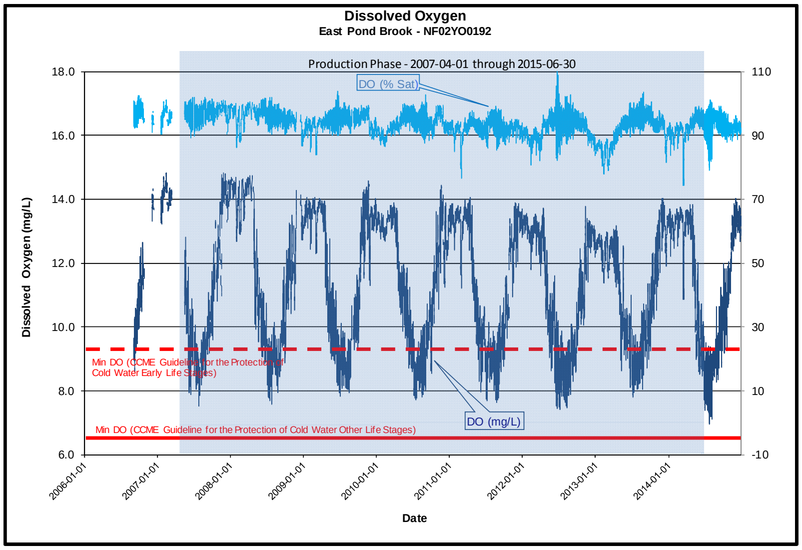


Specific conductivity has a statistically significant upward or increasing trend. Having a P-value of 0.01, we can be certain that this trend is highly significant. However, this trend is not so obvious from the yearly median line on the Box Plots. There are however, enough outliers and higher specific conductance values in the later years, to cause this upward trend. Yearly median values ranged from 22.4 µS/cm in 2007 to 30.2 µS/cm in 2015.

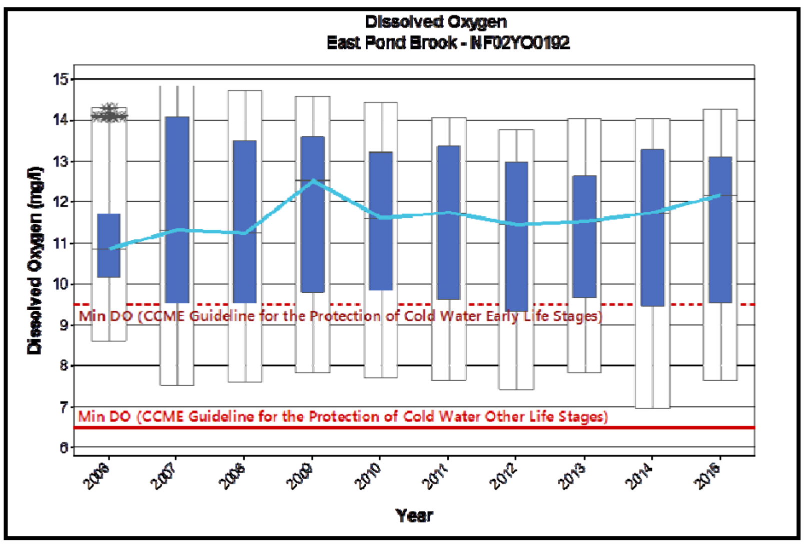


Similar to the highest peak in the graph above, in 2015, there were a considerable number of outliers, and a higher yearly median value. Care must be exercised not to assume that this increase is directly linked to Duck Pond Operations. There are other land uses in the watershed which may account for or contribute to the change in specific conductance.

Over the course of the past 10 years, dissolved oxygen (the darker blue data points) ranged from a minimum of 6.95 mg/L to a maximum of 14.83 mg/L, a range which would typically be expected.

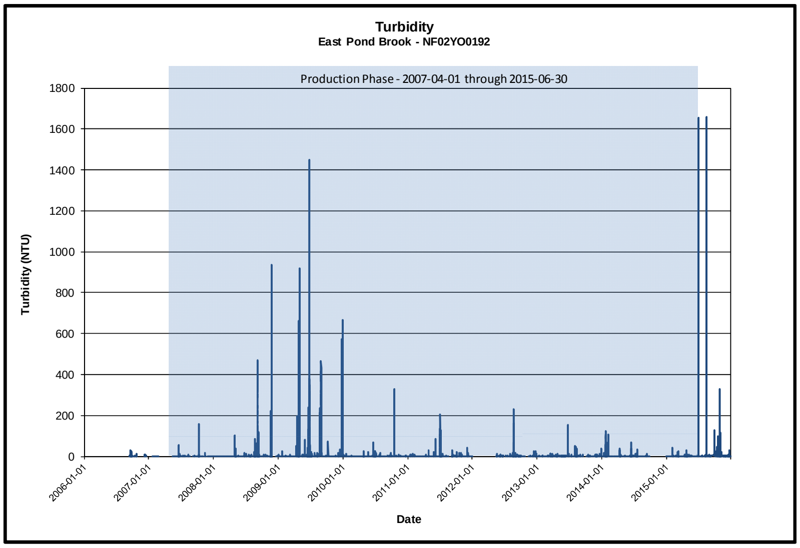


The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (2) for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen usually remained above 6.5 mg/L, in the 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 (Section 7). The percent saturation (the lighter blue data points) usually 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 Tributary to Gills Pond Brook (Section 7) has a very similar profile. Any differences would likely be the result of the different orders of the streams, and the moderating effect of the larger stream on the water temperature.

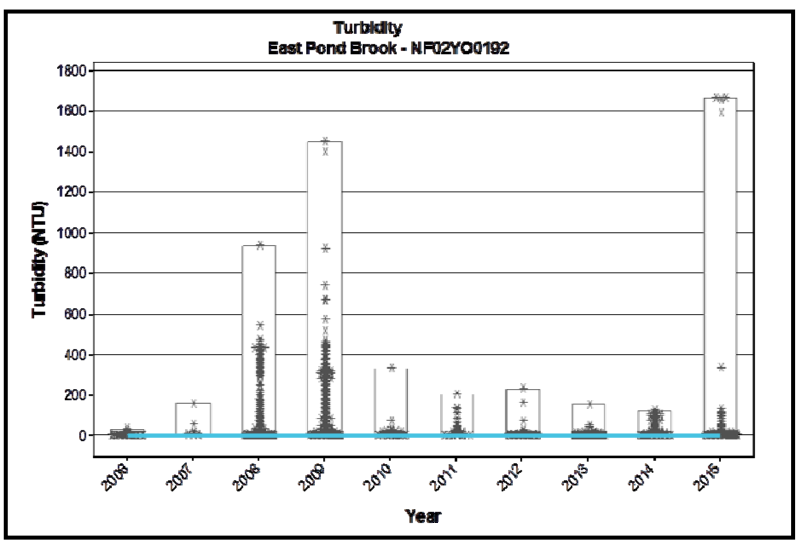


Dissolved oxygen (mg/L) does not have a statistically significant trend. There is a much smaller range in the box plot for 2006. This is a result of only a partial year's worth of data for 2006. Other changes although appearing significant from a visual perspective, must be considered natural variation.

Turbidity at East Pond Brook Station generally ranged from a minimum of zero to a maximum of 1660 NTU. Generally, turbidity values in this stream are at or close to zero.

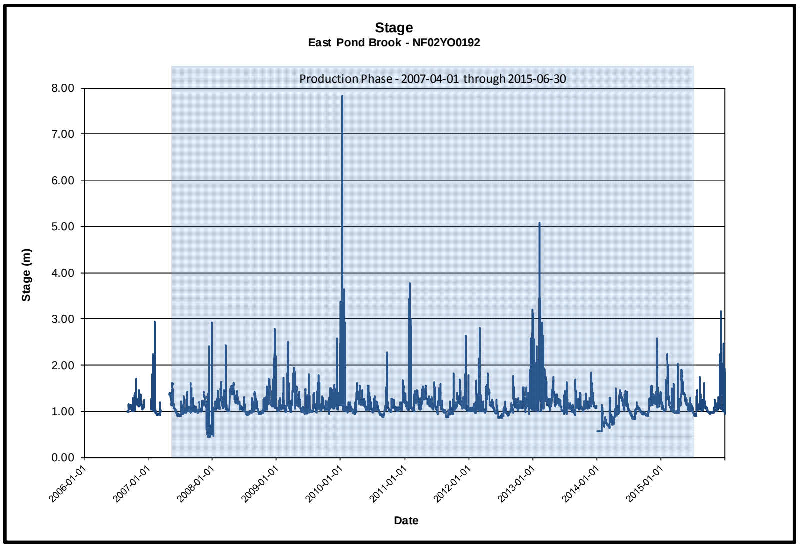


From time to time, leaves, algae and other natural in-stream debris became caught on the turbidity sensor, causing interference and false-positive readings. Data for these periods has been removed. In 2008 and 2009 there were brief periods when there were some extremely high turbidity recordings. Similar peaks noted in other Real Time water Quality Monitoring Stations on the island. While no solid explanation has been documented, it is suspected that widespread airborne deposition and major precipitation events may have contributed to the turbidity spikes. Also, in 2015, there were two individual turbidity spikes in July and August which were atypical. From October 2015 through to the end of the year, there were higher-than-usual turbidity values recorded in this steam. On occasion, the stream was visibly turbid, and grab sample results analysed at commercial laboratories confirmed these higher values. Investigation could not determine the source of the turbidity, despite there being other ongoing activities in this watershed. There is certainly no indication that it was the result of anything related to the mine's activities.

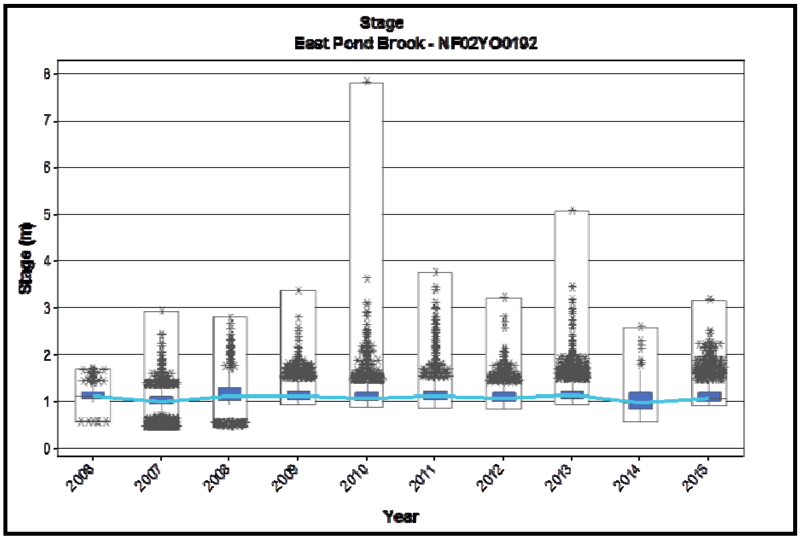


Turbidity has a statistically significant upward or increasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. However, this trend is not at all obvious from the yearly median line on the Box Plots. There are however, enough outliers and higher turbidity values in later years to cause this upward trend. The P-values are calculated using the Monthly median values, and the line on the box plot connects the Yearly median values, which happen to be 0.00 NTU for each year from 2006 through 2015. Due to the massive volume of data used in calculating the yearly median, the subtle trend calculated via the Monthly median becomes obscured on the graph.

The stage or water level was recorded from an arbitrary benchmark to be from a low of 0.45 meters, to a peak 7.83 meters. It is important to consider from the outset that many of the highest peaks occur in the winter months under freezing conditions, and are considered to be due to the backwater effect from ice formation.



For the remainder of the year, however, stage was within normal ranges, with the higher levels following snow melt and rainfall events.



Stage at East Pond Brook does not have a statistically significant trend. Many of the peaks in stage, as noted above are considered as outliers. Despite their visual appearance on the box plots, these outliers and higher stage values are not numerous enough to cause a statistically significant trend.

Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Section 9 - Data Interpretation - Monitoring Well After Tailings Dam Station

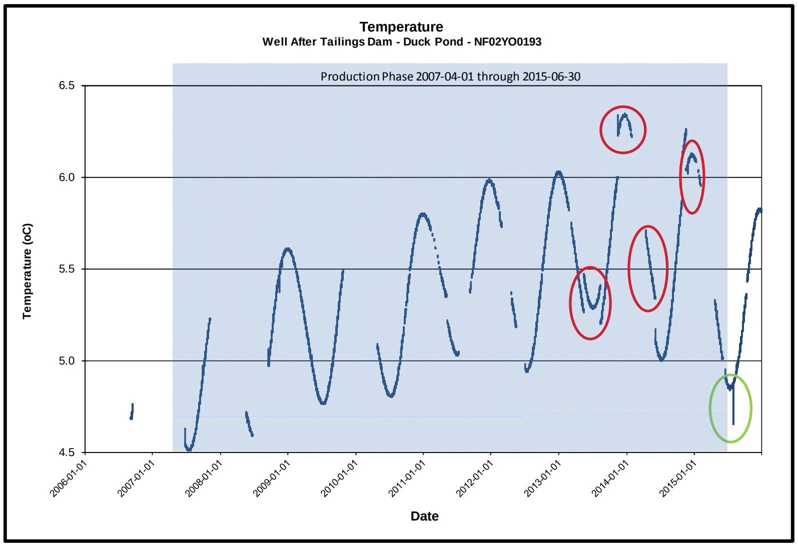
Trend Analysis

Station	pH	Specific Conductance (mS/cm)	Temp (^oC)	Water Elevation (m)
P-Value	0.00	0.00	0.00	0.00
Spearman's rho	-0.602	0.9745	0.4195	-0.5384
Parameter Count	84	86	86	86
Significance Level	0.05	0.05	0.05	0.05
Trend Result	Down	Up	Up	Down

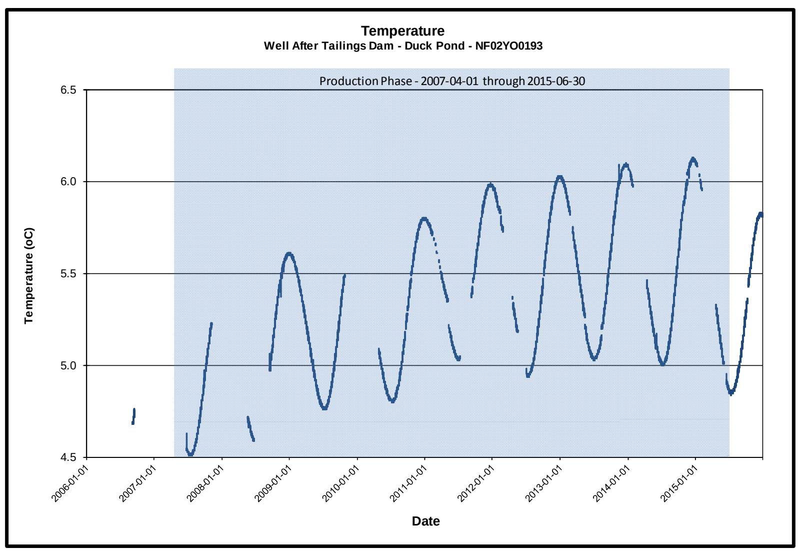
There is a statistically significant upward or increasing trend for temperature, and specific conductance. pH and water elevation have a statistically significant downward or decreasing trend. Yearly Median Values are depicted in the table below.

Yearly Median Values				
Year	pH	Specific Conductivity (mS/cm)	Temp (^{o} C)	Water Elevation (m)
2006	9.34	0.175	4.71	270.97
2007	9.09	0.255	4.69	270.78
2008	8.83	0.415	5.15	270.95
2009	8.88	0.430	5.14	271.02
2010	8.80	0.542	5.07	270.97
2011	8.54	0.621	5.53	270.98
2012	8.19	0.674	5.47	270.86
2013	8.20	0.747	5.57	270.83
2014	8.51	0.791	5.42	270.79
2015	8.48	0.791	5.29	270.78

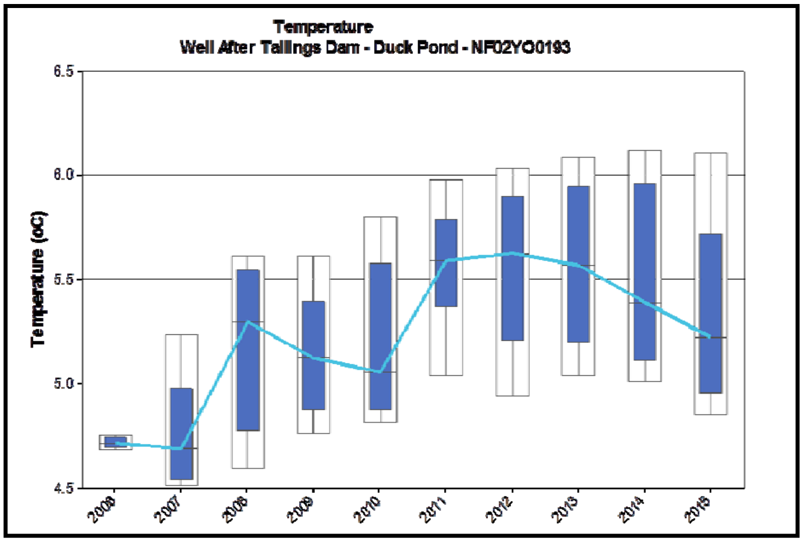
Water temperatures when plotted over the longer term, showed some interesting artifacts, which are highlighted by the red and green ellipses in the graph below. In all instances highlighted in red, a different **Quanta G®** probe was used. Although it had the same technical specifications, and all measurements were within these technical specifications, this particular unit consistently recorded temperature at 0.25 °C higher than the **Quanta G®** probe that was used for most of the study period. As highlighted by the green ellipse, there was a short-term drop in temperature on July 27, 2015. This corresponded with the well being purged by Teck Staff as part of their ongoing monitoring program. Although these are real and valid numbers, they have been adjusted (in the case of the red ellipses) and deleted (green ellipse) so as not to skew the results, nor impact the visual interpretation. These adjusted values are used in the graph below and for the statistical analyses.



Water temperature in the well ranged from a minimum of 4.51 °C to a maximum of 6.35 °C. Lower temperatures were recorded in the summer months, while the higher temperatures were recorded in winter months.

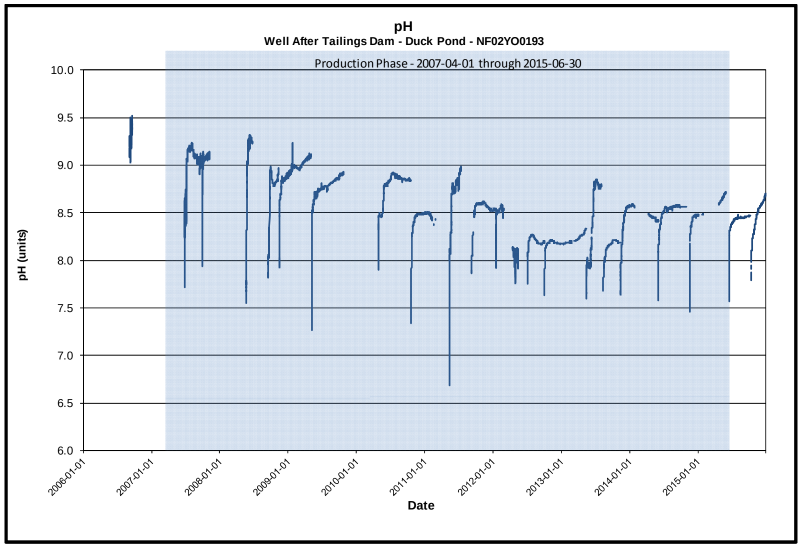


Water temperature has a statistically significant upward or increasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. This is obvious graphically as well.

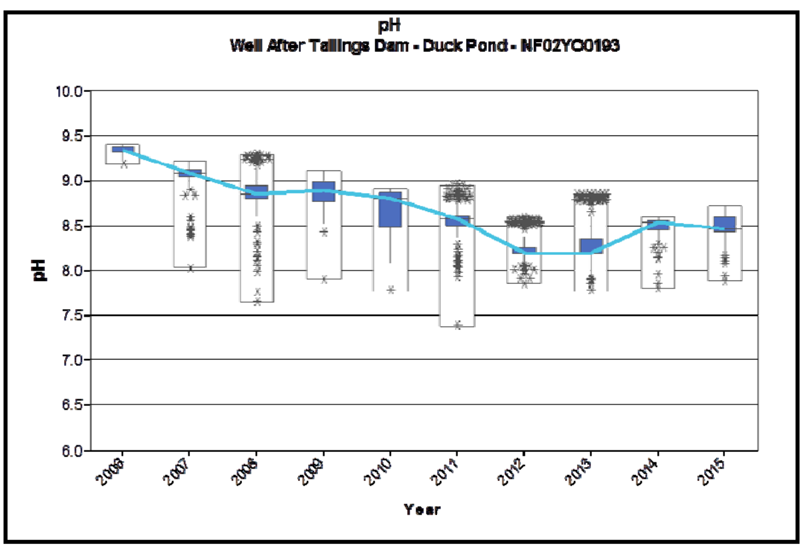


Similar to several of the graphs above, there is, a notable difference in 2006, when the range of the box plot is far less, due to the fact that there are only four months (or less) of data. Yearly median values ranged from a low of 4.69 ^{o}C in 2007 to a high of 5.57 ^{o}C in 2013, a difference of 0.86.

The pH measurements for this well ranged from a minimum of 6.69 to maximum of 9.52.

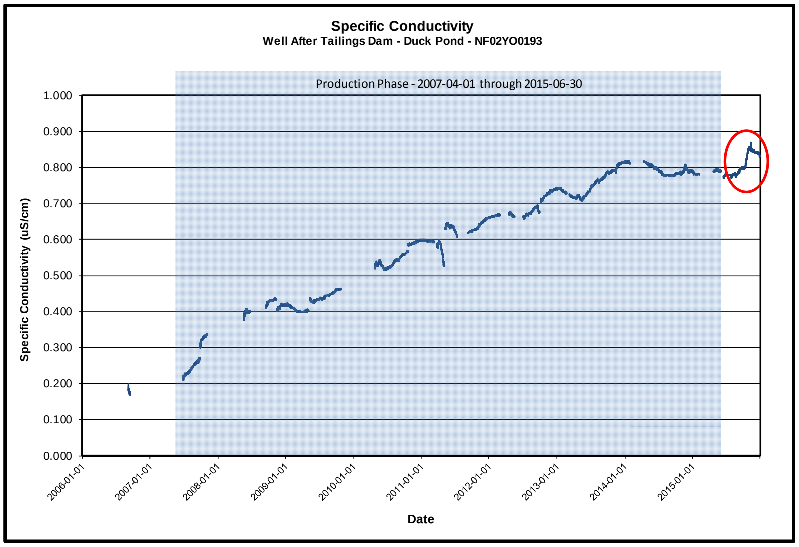


At the beginning of each deployment period, there is a significant increase in pH which essentially 'levels off' for the remainder of that period. This response in pH is typical for every single deployment in this well. Prior to an investigation of this feature in 2011, it was believed that this was a function of the well being purged. However, it has been determined that the rapid change in pH at the beginning of each deployment is simply a function of the water in the small diameter well being displaced, as the instrument is deployed in the well[3], thus temporarily disturbing the relatively 'static' nature of the well. Accordingly, it has been decided to minimize the number of deployments of the instrument in this well, and maximize the length of the deployment periods (approximately 6 months). Furthermore, it has also been demonstrated that purging the well has no long term (i.e. less than 60 minutes) effect on the water quality, including pH, in the well[3]. The effects of purging the well at the beginning of deployment, and during deployment continue to be monitored, as it is necessary to sample this well from time to time while the instrument is deployed. A draft Standardized Purging and Sampling Protocol [4] has been developed for this particular well.



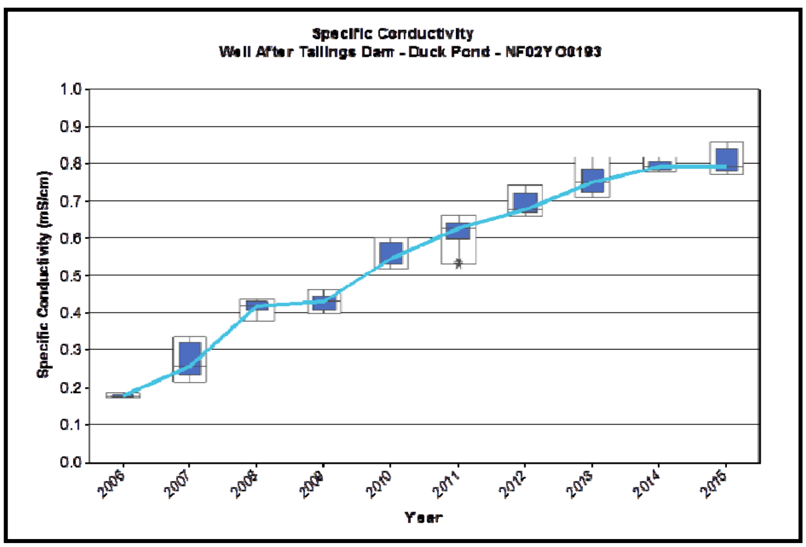
pH has a statistically significant downward or decreasing trend accordingly to the calculations. A P-value of 0.00 indicates that the significance is very strong. The trend is quite evident graphically as well. The Yearly Median pH ranged from a low of 8.19 in 2012 to a high of 9.34 in 2006, a difference of 1.15.

Specific conductivity in this shallow well is higher than surrounding surface waters due to the highly mineralized nature of the glacial till material through which it is drilled. The well is also located such that it can be used to measures changes in ground water resultant from seepage from Tailing Dam A.

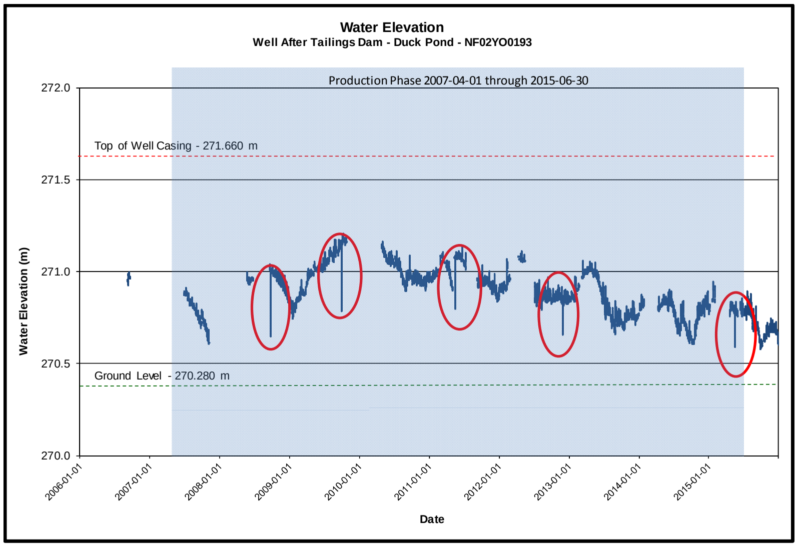


Specific conductance in this well ranged from a minimum of 0.175 mS/cm to a maximum of 0.870 mS/cm.

There was a fairly rapid increase (see red ellipse) in specific conductance beginning on October 14, 2015, followed by a steady decrease until the end of the year. This change corresponds with Teck's actions to place waste rock in the Tailings Pond for the period from October 16, 2015 to November 18, 2015. Prior to this, water levels in the Tailings Pond were reduced to minimum levels. This work was completed in accordance with the mine closure plan.



Specific conductivity in this well has a statistically significant upward or increasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. This is obvious graphically as well. Yearly median values ranged from a low of 0.175 mS/cm in 2006 to a high of 0.791 mS/cm in 2014 and 2015. Over the period of this study, the specific conductance in this well increased by 0.616 mS/cm.

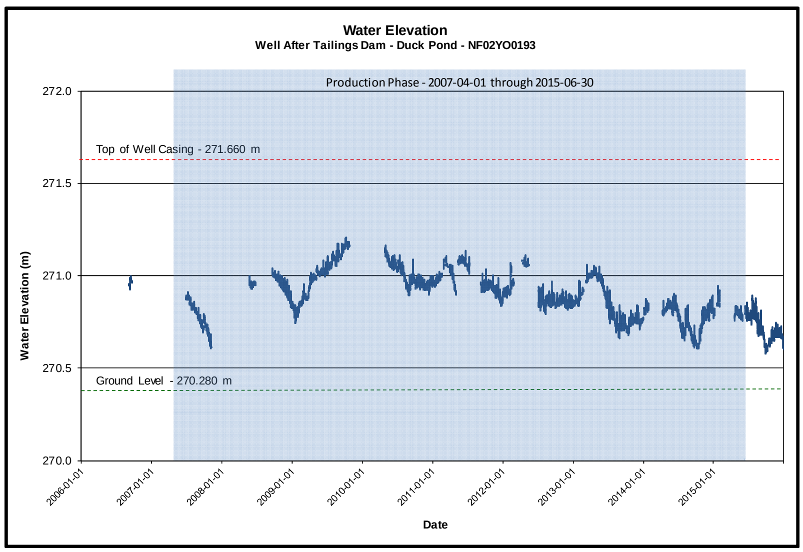


Similar to the example with water temperature above, a number of data artifacts are evident in the long term water elevation measurements as well. Highlighted by the red ellipses in the graph to the left, it has been determined that each of these artifacts corresponded to when the well was being purged by Teck Staff or Department of Environment and Conservation Staff as part of ongoing monitoring programs.

Again, although real and valid numbers, these five (5) individual measurements have been deleted from the data set so as not impact the visual interpretation. It is unlikely that these five (5) data points would skew the data however, other than possibly giving an unrealistically low minimum value.

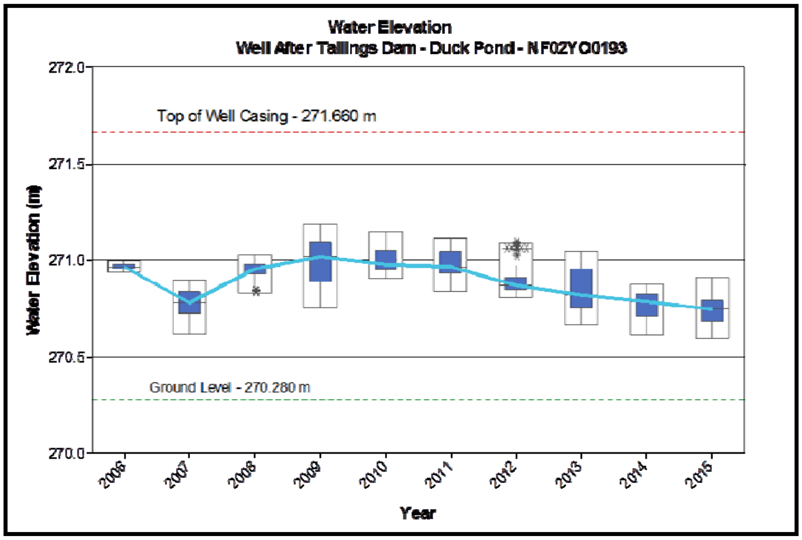
The water elevation in this well ranged between a minimum of 270.58 m and maximum of 271.21 m.

There is excellent agreement between recorded and measured water elevations throughout the 10 year period, each time a probe is installed or removed. The maximum differential measured was 0.017 m. This indicates that the water elevation being logged is extremely accurate.



An analysis of the long term water elevation of this well, shows a significant correlation (Pearson Correlation Coefficient = 0.84) with the water level in the Tailings Management Area (TMA). Thus as water levels in the TMA rise and fall, so does the water elevation in this well, suggesting as we would expect, a hydraulic connection between the two. During particular seasons, a weak correlation (Pearson Correlation Coefficient = 0.19) exists between the water elevation in this well and the water level in East Pond Brook, suggesting that, over shorter periods, changes in the well's water elevation are influenced to some degree by the nearby stream.

Water elevation in this well has a statistically significant downward or decreasing trend. Having a P-value of 0.00, we can be certain that this trend is highly significant. This is obvious graphically as well. Yearly median values ranged from a low of 270.78 m in 2007 and 2015 to a high of 271.02 in 2009. As noted above these water level changes are linked directly to the water level changes in the Tailings Management Area.



Section 10 - Conclusions

1. The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations has proven to be quite useful. The data derived from this network have been documented to be accurate representations of the true environmental conditions. The data have 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 and quantity data as well.

2. In all three water quality monitoring stations (the two surface water stations; Tributary to Gills Pond Brook and East Pond Brook, and in Monitoring Well After Tailings Dam), some changes to water quality have been observed throughout the life of the project. While changes to water quality were anticipated, no serious incidents have been identified which have raised any cause for concern.

3. Data from the Real-Time Water Quality Monitoring Network was useful in that it consistently and conveniently provided timely observations, in an easy-to-understand visual format (scrolling 30 day on-line graphs), and 7-day, 30-day and 365-day data summaries. This allowed Teck management and staff, and government officials to implement mitigative measures quickly when necessary to avoid exceedance of the regulated discharge criteria or unwanted environmental impacts.

4. The statistical significance of any long terms trends has now been documented. However, no commentary has been provided on the potential implications on the environment as a result of any trends, as this determination is beyond the scope and mandate of this project. The situation will continue to be monitored and reviewed from time to time in collaboration with Pollution Prevention Division of the Department of Environment and Conversation

5. Continued operation of the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations is planned for the life of the operation, and throughout the ongoing planned closure, rehabilitative and subsequent monitoring phases.

Section 11 - Path Forward

1. Based on the success of the past 10 years, we are confident that we are on the right path. As the project has moved from conception and planning, though implementation, we have made a number of adjustments and modifications in order for this program to remain successful. The present analysis is confirmation that based on the last 10 years our path forward is justified and evidence-based.

2. It is essential to continually evaluate and potentially improve the program. Consideration must be given to implementation of new technologies, better instrumentation, and new or adaptive analytical techniques. It is recommended that long term data continue to be graphed annually, such that any emerging trends or changes can be visualized. At least 12 months before the expiry of the current Memorandum of Agreement, trend analyses should be completed again, to assess any changes during the present closure and remediation phases, and determine the need for any continuation of the Memorandum.

3. Currently, four **DataSonde®** instruments owned by Teck Duck Pond Operations are available for service in the surface water - based stations. The two older units are at the end of their projected lifecycle of 10 years. These units will continue to be updated with some new sensor tips and software. However, at some point in time, they will become obsolete and will need to be replaced. The two newer instruments have been put into regular service on a rotating basis. Hopefully, they will remain functional and reliable for the life of the remaining phases of the project.

4. Currently two **Quanta G®** instruments (one owned by Teck Duck Pond Operations and one owned by the Department of Environment and Conversation) are deployed alternately in Monitoring Well After Tailings Dam on a rotating basis. The older of the two units functions quite well, but is at the end of its projected lifecycle (10 years). The newer unit, was replaced by the manufacturer in 2015, and has yet to be deployed. It is anticipated that this unit will remain functional and reliable for the life of the remaining phases of the project.

5. An evaluation of the most recent Closure Plan for the site was completed in 2015. Even though the mine and mill have ceased operation, real time water quality monitoring is planned to continue throughout the planned closure, rehabilitative and subsequent monitoring phases. A new station potentially at Trout Brook can be considered if surface water is re-routed back to its original course in the East Pond watershed

6. Some minor maintenance work may be needed on the pathways leading to the Real-Time Water Quality Monitoring stations in subsequent years.

7. In 2015 the Department of Environment and Conservation and Teck met to discuss the real time program's success to date, and any ongoing or emerging issues, and negotiated an extension to the present Memorandum of Agreement to continue the Real-Time Water Quality Monitoring Network at Teck Duck Pond. This Memorandum of Agreement has been extended until March 31, 2020, and may potentially be extended for another period beyond that date.

Section 12 - References

1. *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.

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

3. *Accuracy and Precision in Real-Time Water Quality Monitoring - How good is my data?* Proceedings of Real Time Water Quality Workshop, Department of Environment and Conservation, June 7, 2011. http://www.env.gov.nl.ca/env/waterres/rti/rtwq/workshops.html#2011

4. *Draft Standardized Purging and Sampling Protocol for MW1@ Teck Duck Pond Operations*, Department of Environment and Conservation, June 15, 2011.