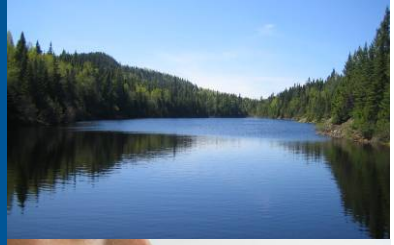
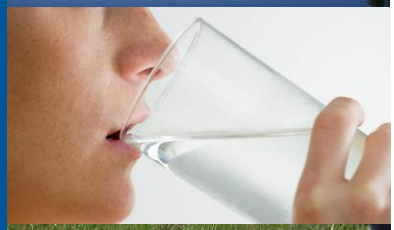



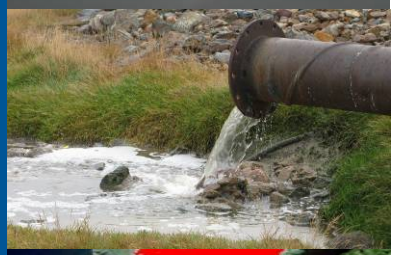


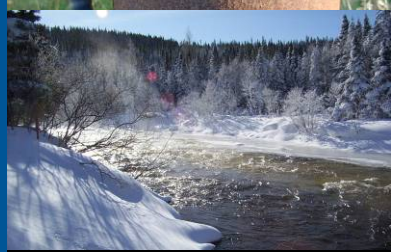

Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2012-11-14 to 2012-12-31

2013-01-22

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

General

- Water Resources Management Division (WRMD) staff monitors the real-time web page on a daily basis. Any unusual observations are investigated, with site visits being carried out as warranted.
- Management at Teck Duck Pond Operations are informed of any significant water quality events or instrumentation problems by WRMD.
- There was planned discharge of effluent from Polishing Pond into the receiving waters (Tributary to Gills Pond Brook) for most of the deployment period, with brief periods without discharge from December 3, 2012 to December 7, 2012, December 14, 2012 to December 15, 2012, and December 20, 2012 to December 27, 2012. There were small batch discharges for part of each day from December 27, 2012 to December 31, 2012.

Maintenance and Calibration of Instrumentation

- Following a maintenance overhaul and software upgrade, and after being cleaned and freshly calibrated the regular **DataSondes®**(s/n 43245) for Tributary to Gills Pond Brook and (s/n 43794) for East Pond Brook were installed on November 14, 2012, and remained deployed continuously until December 31, 2012; a 47 day period. Due to icing conditions, these instruments will remain deployed throughout the winter and until spring break-up.
- The regular **MiniSonde®** (s/n 47591) was used for QA/QC purposes during the installation of the instruments. It too, was cleaned and freshly calibrated prior to each use.
- The regular **Quanta G®** (s/n 00035) was deployed on October 3, 2012 after being cleaned and freshly calibrated. It remains deployed continuously in Monitoring Well After Tailings Dam Station (MW1) until some time in the spring of 2013. The reporting period for this instrument is from November 14, 2012 to December 31, 2012; a 47 day period.

Quality Assurance / Quality Control (QA/QC) Measures

- 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 procedure is based on the approach used by the United States Geological Survey. See **Table 1**.

	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 1

- For the Surface Water Stations, upon deployment and removal, a QA/QC **MiniSonde®** is usually temporarily deployed along side 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.
- The ranking at the beginning of the deployment period is shown in **Table 2** for Tributary to Gill's Pond Brook and **Table 3** for East Pond Brook. No ranking can be calculated for the end of the reporting period as the instruments remain deployed.
- Because the deployment set-up for Well After Tailings Dam (MW1) is different, comparison with another instrument is not possible. In this case, a grab sample is usually collected at the beginning and end of the deployment period, and the ranking is calculated for pH and Specific Conductance based upon live data and laboratory data. The ranking for the beginning of the deployment period is documented in a previous report. No ranking can be determined for the end of the deployment period, as the unit remains deployed.
- From November 23, 2102 to November 30, 2012 there was some interference (leafy debris) with the turbidity sensor at Tributary to Gills Pond Brook. Accordingly, all turbidity data have been removed from the data set for this period.
- With the exception of water quantity data (Stage and Flow), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent 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)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2012-11-14 Deployment	Temp (^{o}C)	Good
	pH (units)	Good
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2012-11-14 Deployment	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Good
	Turbidity (NTU)	Excellent

Table 3

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of -0.45 ˚C to a maximum of 6.35 ˚C.
- Temperature tended to decline throughout the deployment period, with the last 10 days of the reporting period remaining constant near freezing.
- There appears to be little correlation with stage.

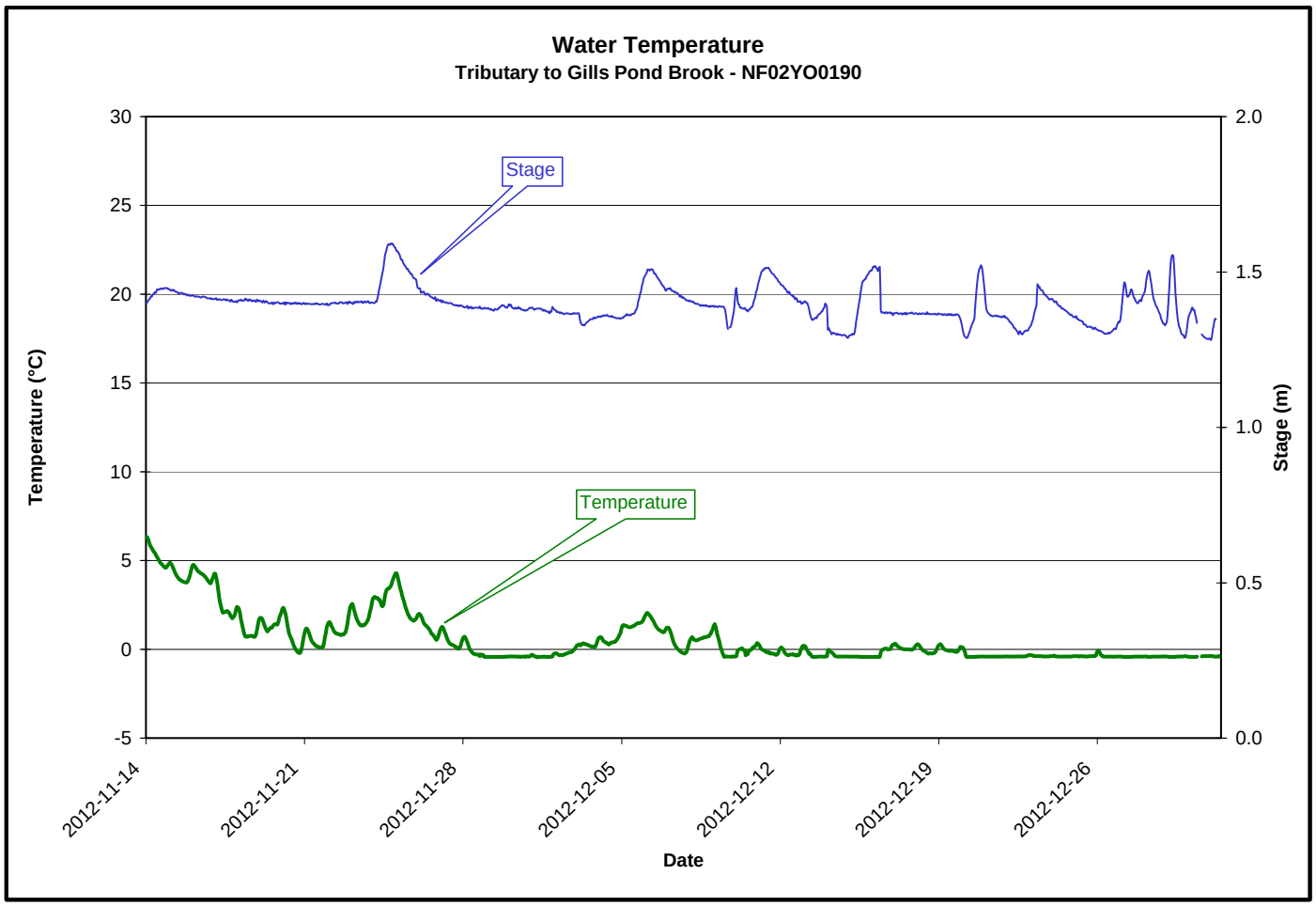

Figure 1

- Throughout the deployment period pH values (**Figure 2**) ranged from a minimum of 6.38 to a maximum of 7.58 with the majority of values falling just above the lower limit of the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- An inverse relationship with stage is obvious during some events throughout the deployment period.
- The three periods indicated by the solid red ellipses correspond with periods when there was a cessation of discharge from the Polishing Pond. pH in the stream dropped markedly, bringing the levels to near normal (background) levels. pH of discharged water is generally higher than the background pH of the stream.
- The period indicated by the dashed red ellipse is when there were short batch discharges from Polishing Pond into the stream, causing daily fluctuations in pH.
- Other times, pH fell as stage increased, the inverse relationship being in response to rainfall/runoff events.
- The background pH of this stream is normally around the lower limit of the recommended range.

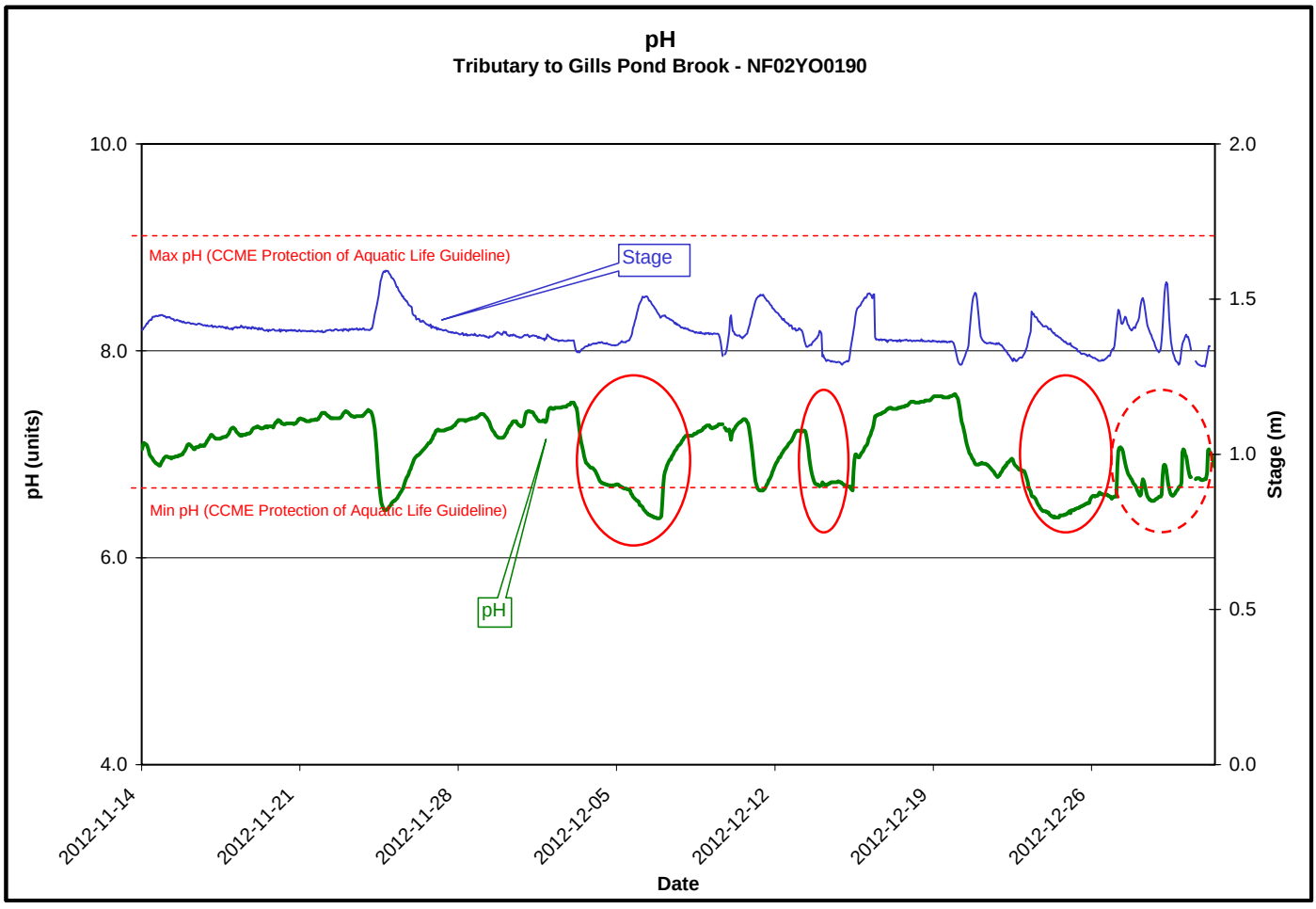

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 40.3 µS/cm to a maximum of 1168.0 µS/cm over the deployment period.
- An inverse relationship with stage is obvious during some events throughout the deployment period.
- The three periods indicated by the solid red ellipses correspond with periods when there was a cessation of discharge from the Polishing Pond. Specific conductance in the stream dropped markedly, bringing the levels to near normal (background) levels. Specific conductance of discharged water is generally higher than the background specific conductance of the stream.
- The period indicated by the dashed red ellipse is when there were short batch discharges from Polishing Pond into the stream, causing daily fluctuations in specific conductance.
- Other times, specific conductance fell as stage increased, the inverse relationship being in response to rainfall/runoff events.
- Precipitation effectively has a dilution effect on this stream which is the receiving water from the Polishing Pond.

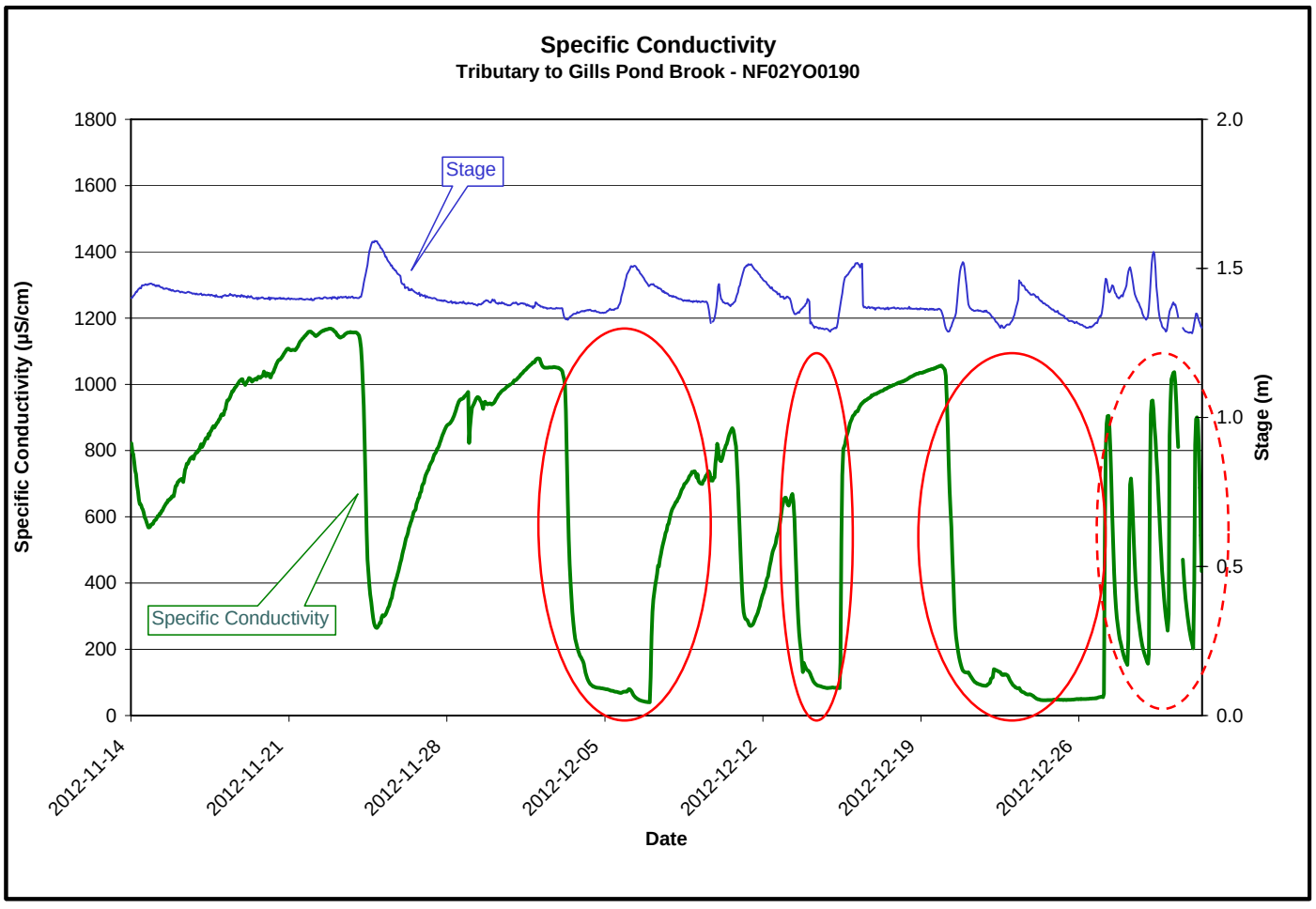

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 11.30 mg/L to a maximum of 13.55 mg/L over the deployment period, with the percent saturation ranging between 78.4 and 95.2.
- Dissolved oxygen is generally inversely proportional to water temperature.
- All of the dissolved oxygen values fell above the upper limit recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (cold water/other life stages – above 6.5 mg/L; cold water/early life stages – above 9.5 mg/L).
- Based upon the fact that Dissolved Oxygen % saturation had minimal change over the deployment period, we can be confident that the Dissolved Oxygen mg/L values are accurate.

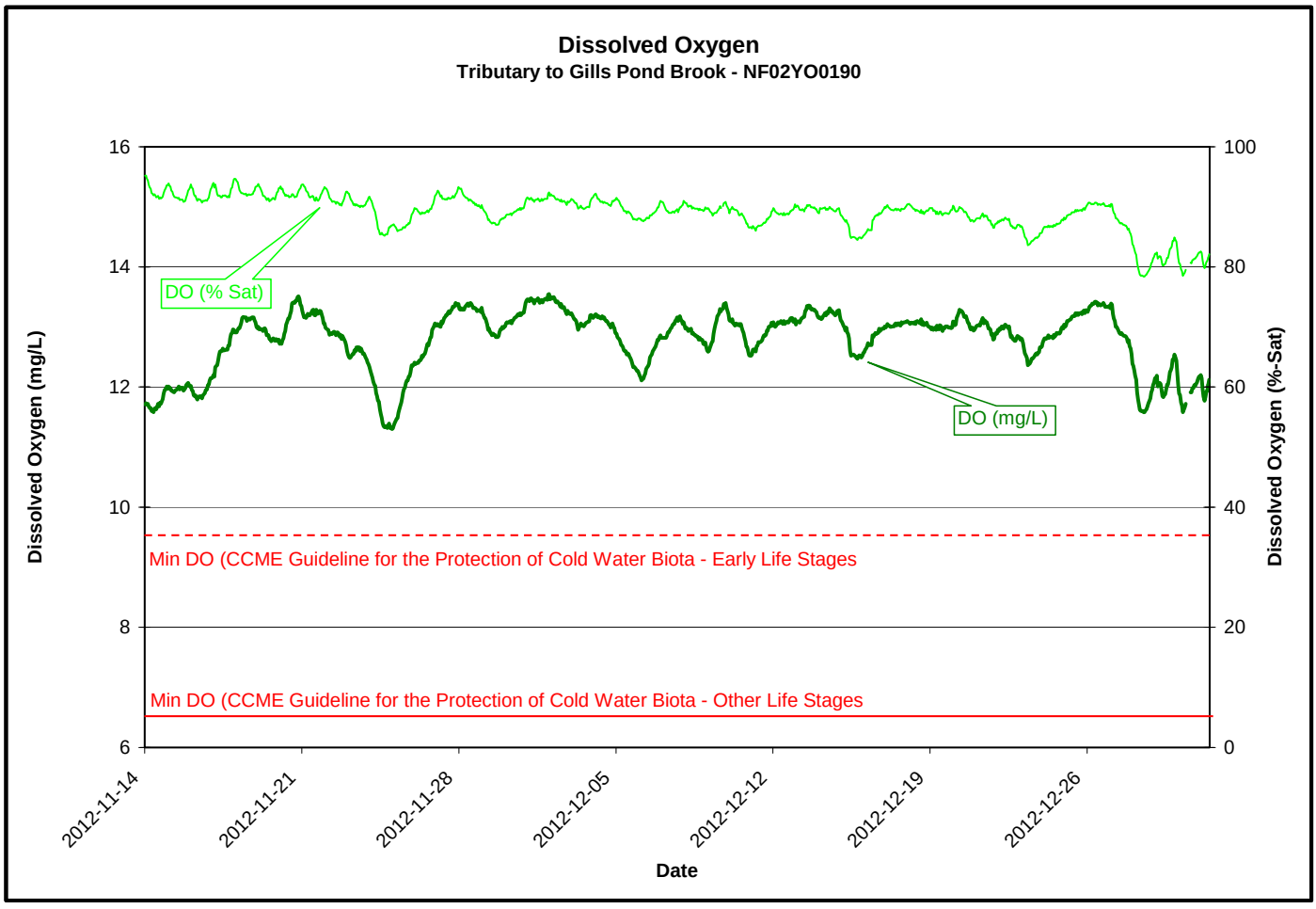

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 434.0 NTU.
- Based upon previous investigation, it has been determined that turbidity values may be artificially increased due to air entrainment during higher flows.
- From November 23, 2102 to November 30, 2012 there was some interference (leafy debris) with the turbidity sensor at Tributary to Gills Pond Brook. Accordingly, all turbidity data have been removed from the data set for this period.
- There was a significant peak in turbidity on December 11, 2012 during a precipitation/runoff event. As this peak was short lived (only 1 hourly measurement), it is considered insignificant, similar to the other minor individual turbidity spikes which are likely due to air bubbles or natural in-stream debris passing over the sensor.
- Neither in-situ nor grab sample measurements nor visual observation indicated turbidity issues.

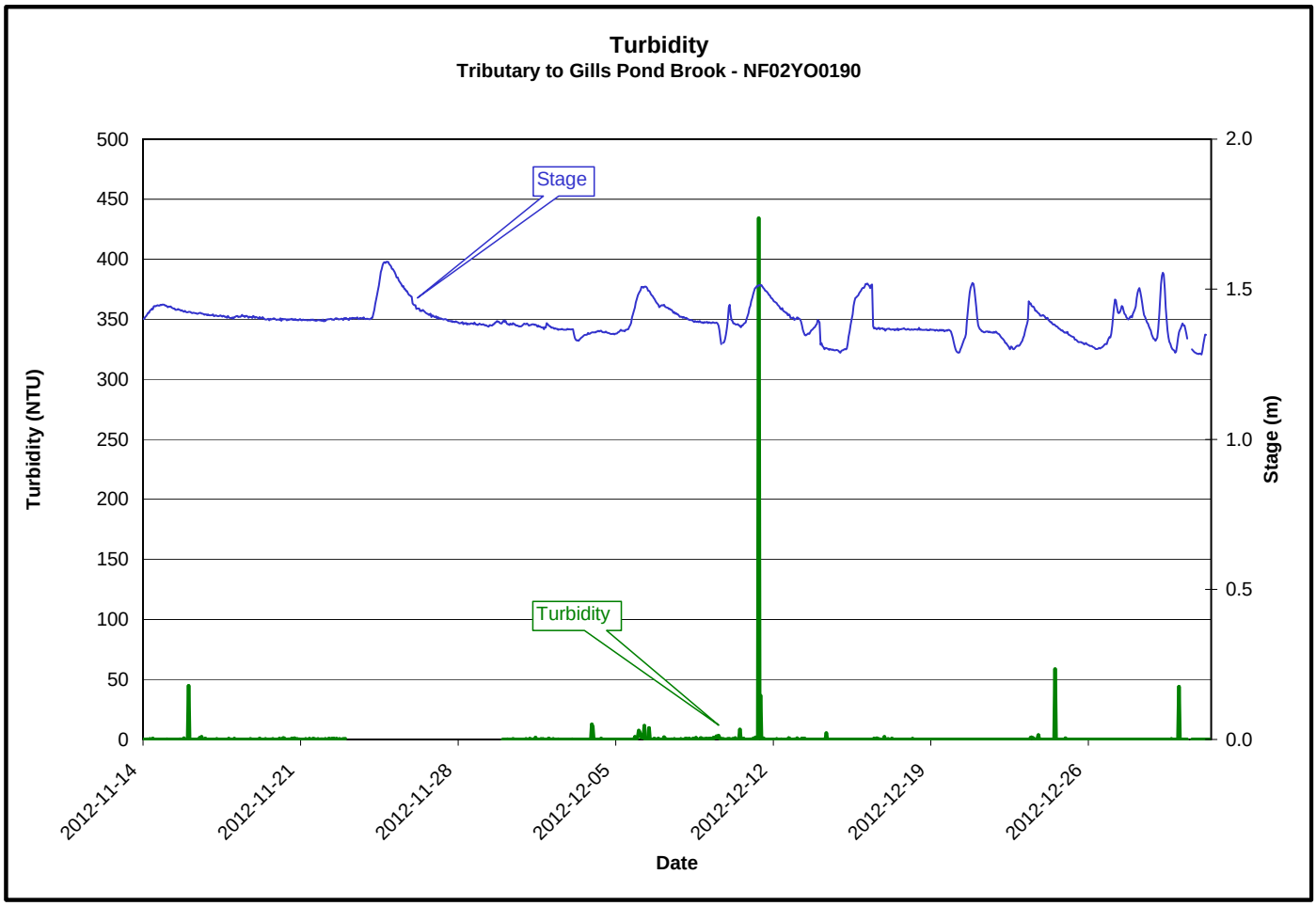

Figure 5

- The stage or water level ranged from a minimum of 1.28 m to a maximum of 1.59 m. The flow or discharge ranged from a minimum of 0.07 m^3/s to a maximum of 1.66 m^3/s (**Figure 6)**.
- The changes in stage and flow are not entirely evident or correspond to the cessation of discharge from the Polishing Pond from December 3, 2012 to December 7, 2012, December 14, 2012 to December 15, 2012 and December 20, 2012 to December 27, 2012. A number of precipitation/runoff event affect the stage and flow more significantly.
- However from December 27, 2012 to December 31, 2012 the small batch discharges for part of each day are quite evident.
- All values are within the normal range.

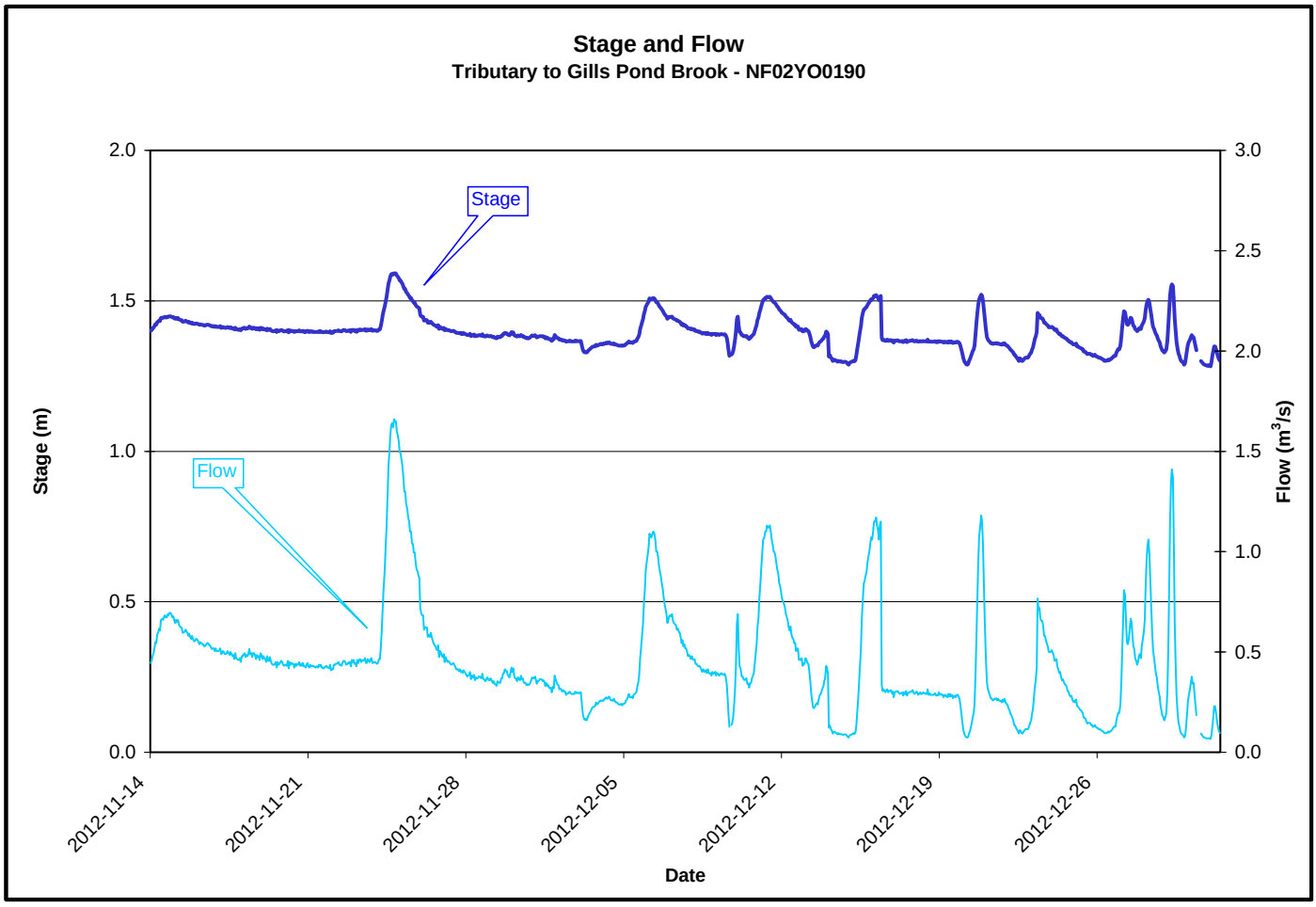

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 0.05 ˚C to a maximum of 6.89 ˚C.
- Temperatures generally decreased throughout the deployment period, with temperatures remaining near freezing from December 12, 2012 through December 31, 2012.
- There appears to be little correlation with stage

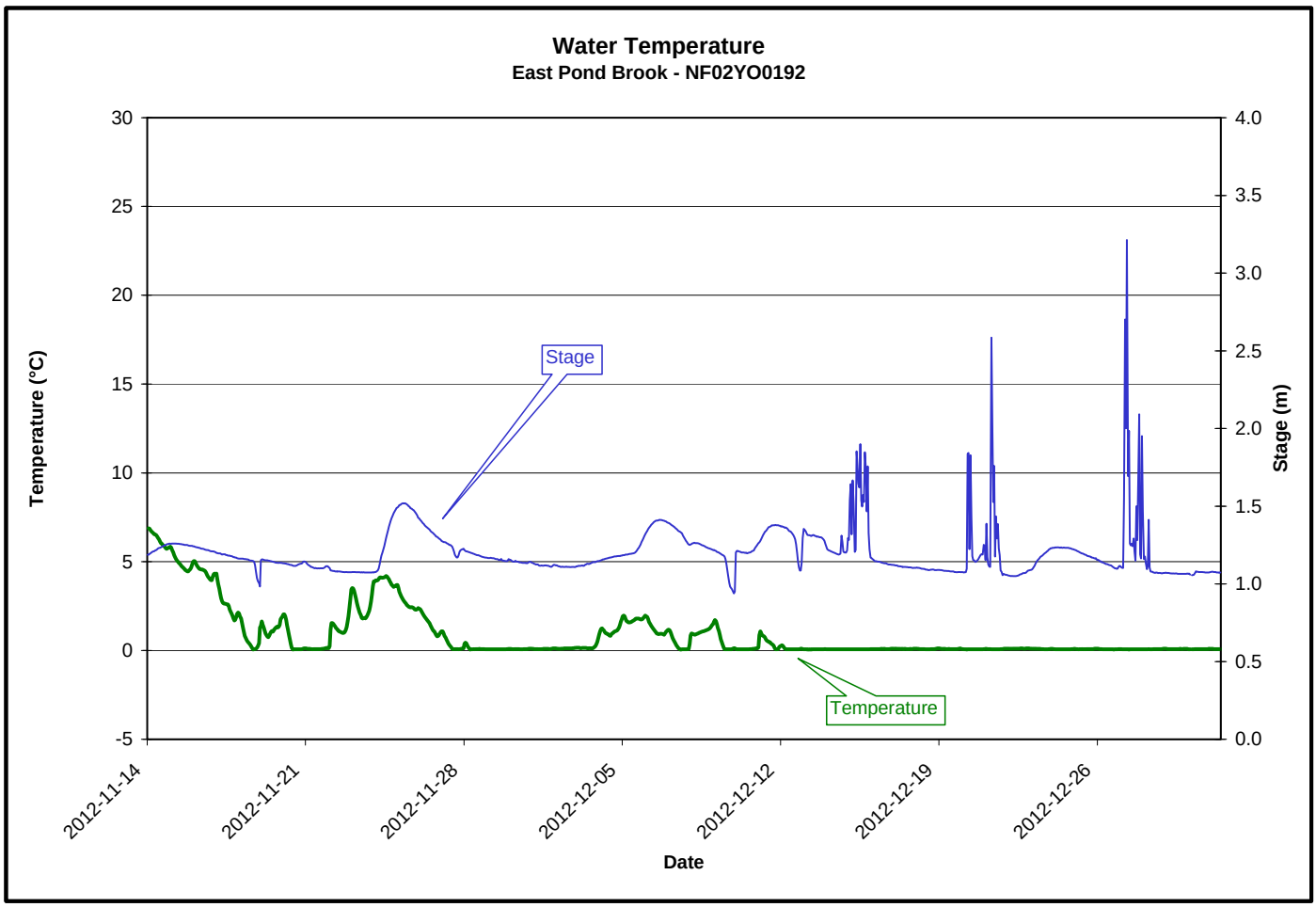

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.01 to a maximum of 6.59 with very little variation over the deployment period.
- pH values fell just below the lower limit of the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- The background pH of this stream is normally quite low, and values near and below the lower limit are not unusual.

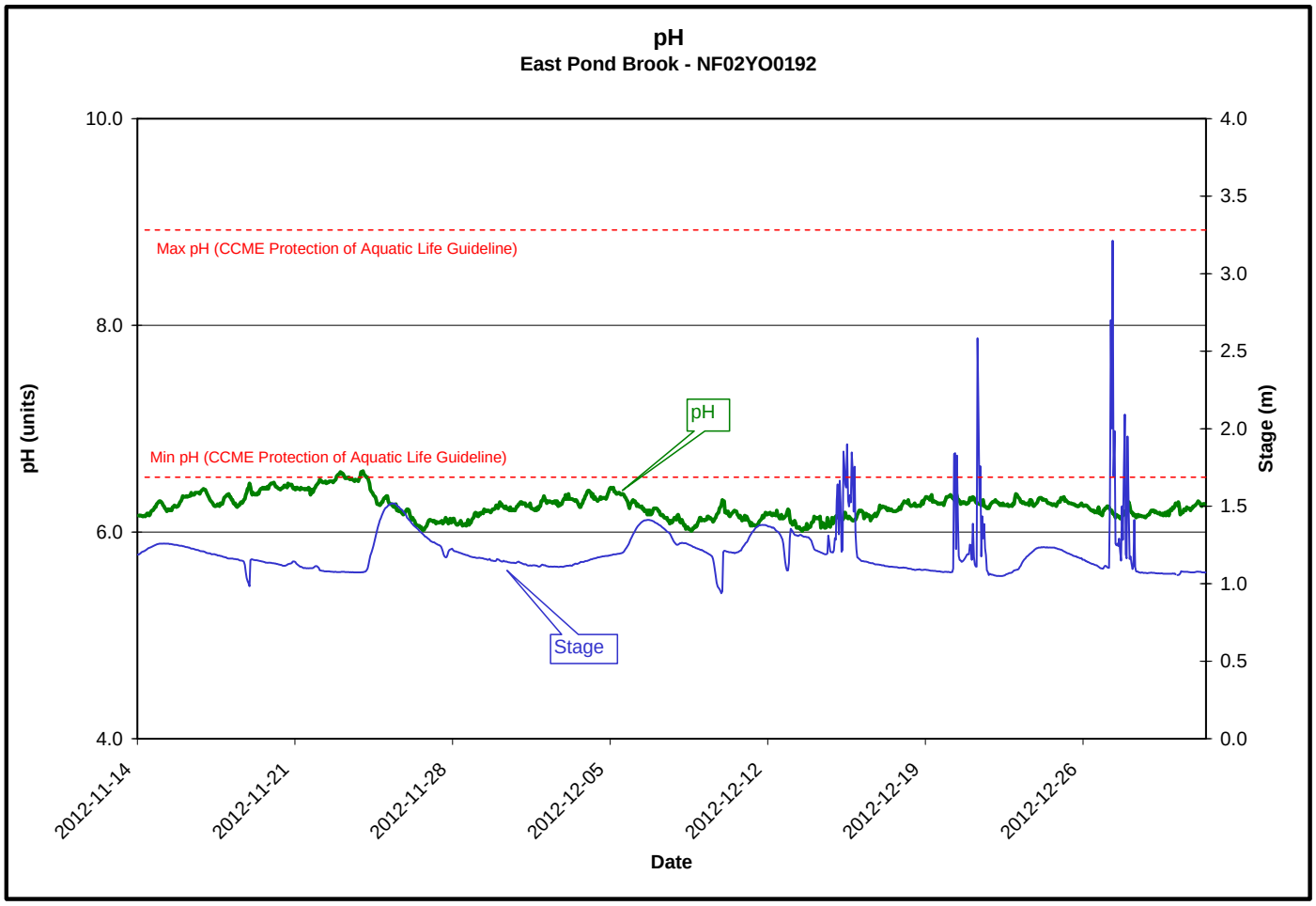

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 17.2 µS/cm to a maximum of 29.5 µS/cm, with very little variation over the deployment period.
- All values are within the normal range.

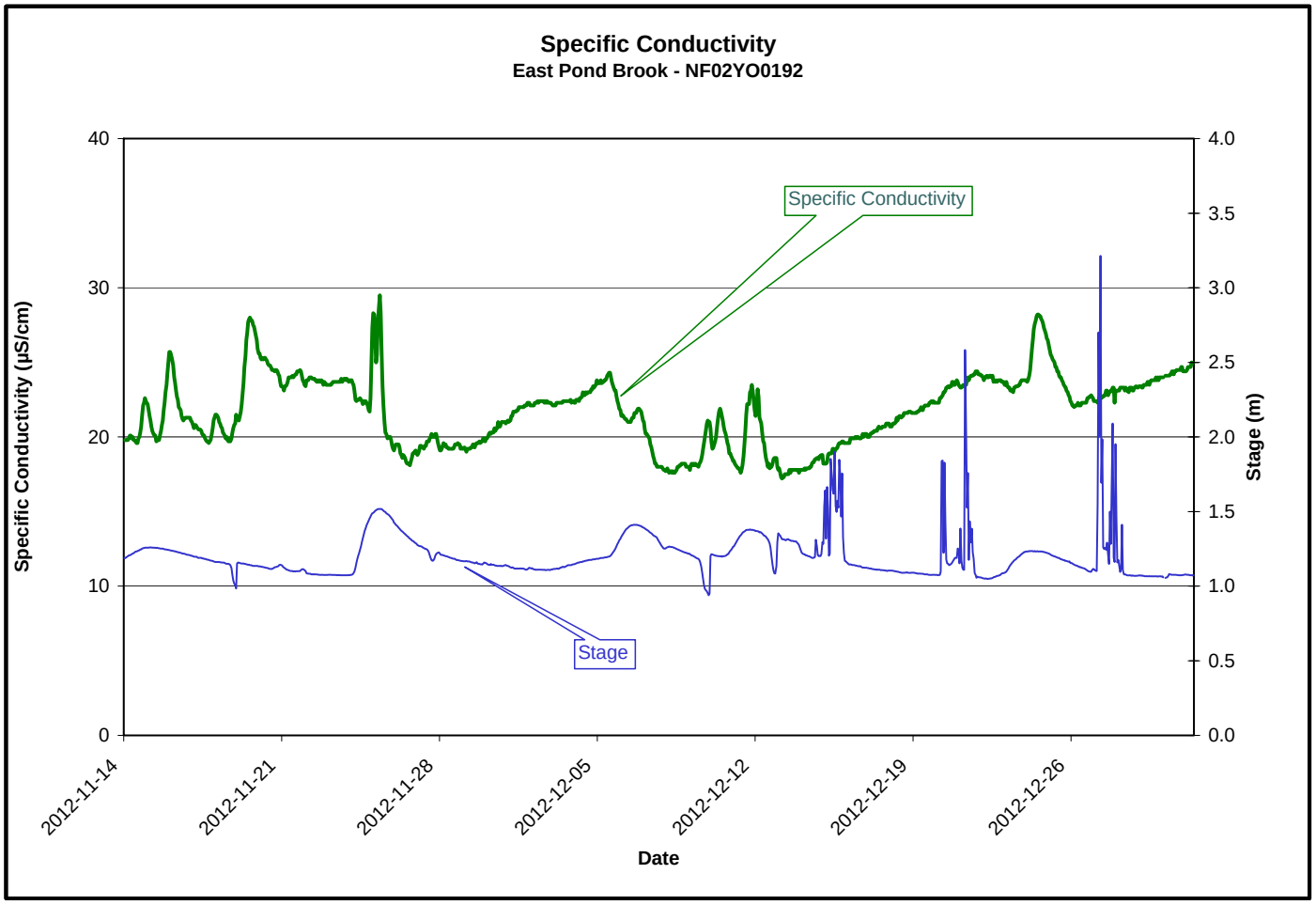

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 11.40 mg/L to a maximum of 13.39 mg/L over the deployment period, with the percent saturation ranging between 83.6 and 94.9.
- Dissolved oxygen is generally inversely proportional to water temperature.
- Throughout the deployment period, all dissolved oxygen values fell above the upper limit recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (cold water/other life stages – above 6.5 mg/L; cold water/early life stages – above 9.5 mg/L).
- Based upon the fact that Dissolved Oxygen % Saturation had limited drift, we can be confident that the Dissolved Oxygen mg/L values are accurate.

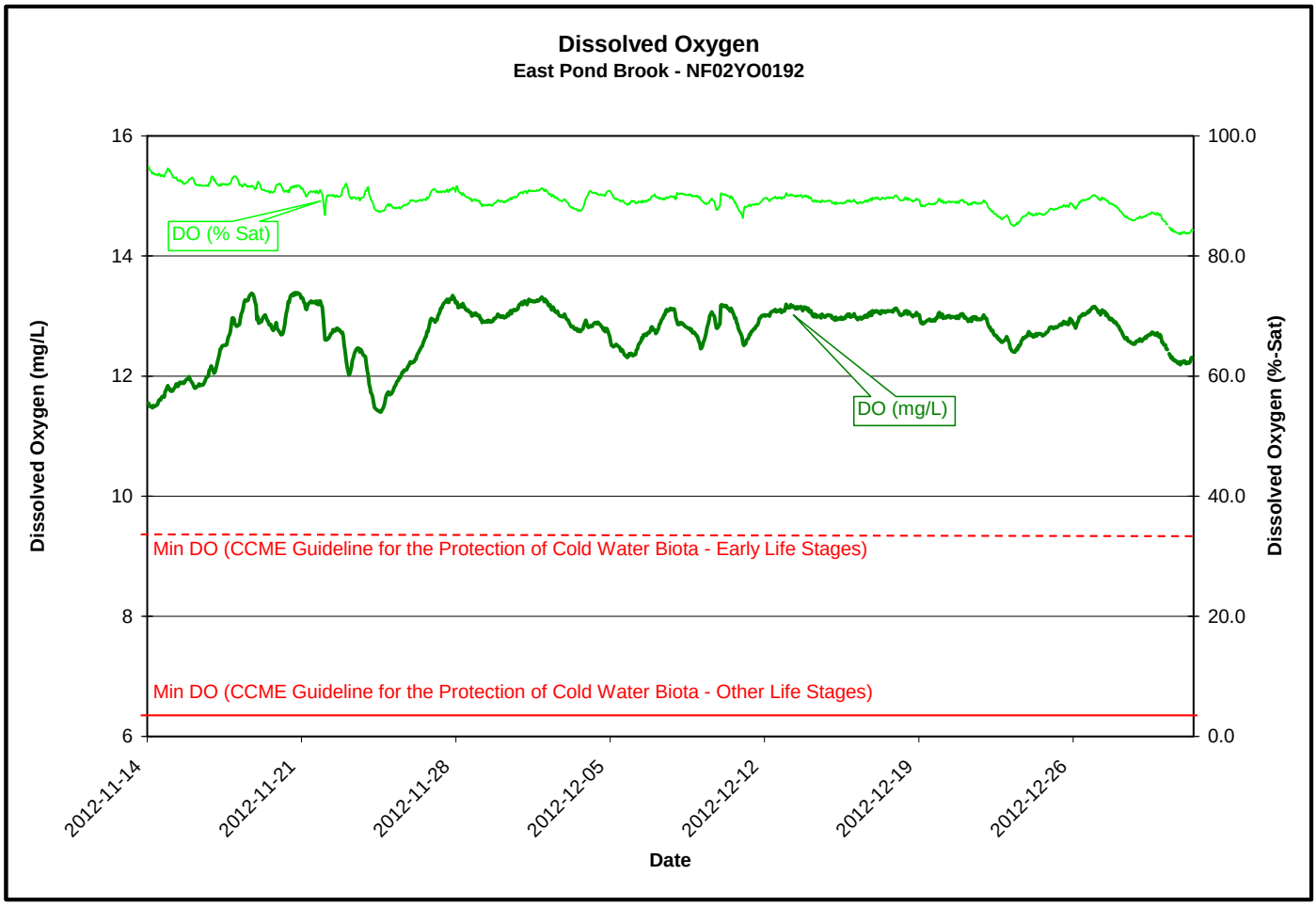

Figure 10

- The turbidity values (**Figure 11**) ranged from a minimum of 0.0 NTU to a maximum of 27.3 NTU.
- There were five brief periods when turbidity was above zero. There periods correspond to higher flows and are likely attributed to natural in-stream debris, episodic accumulation of leafy debris on the sensor, and/or icing conditions.
- Neither in-situ nor grab sample measurements nor visual observation indicated turbidity issues.

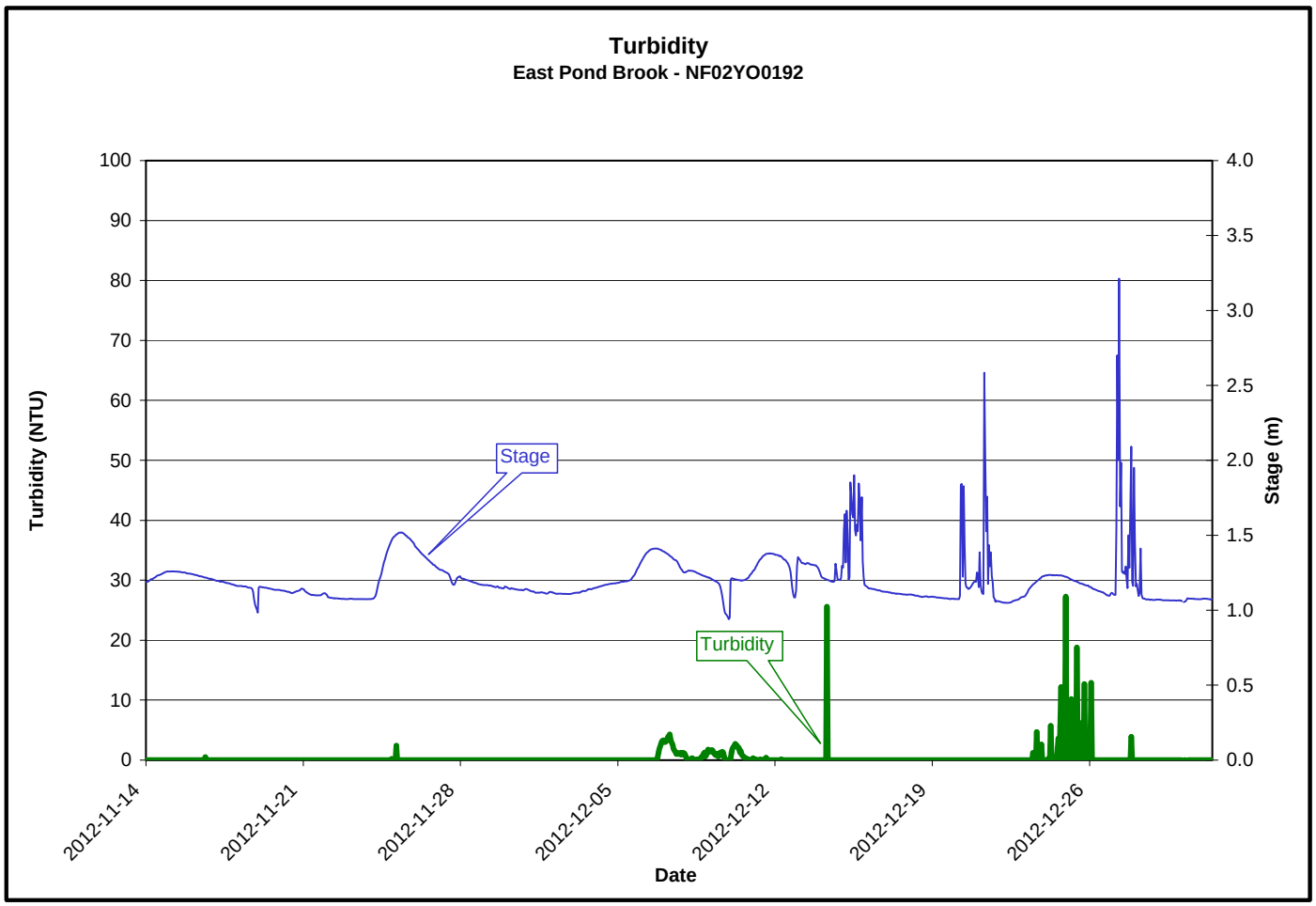

Figure 11

- The stage or water level ranged from a minimum of 0.94 m to a maximum of 3.21 m. The flow or discharge ranged from a minimum of 0.21 m^3/s to a maximum of 12.60 m^3/s **(Figure 12)**.
- From December 15, 2012 to December 28, 2012, there was a marked increase in stage and flow over three distinct periods. This increase is attributed to the backwater effect as the ice accumulated in this stream.
- All values for stage and flow are within the normal range.

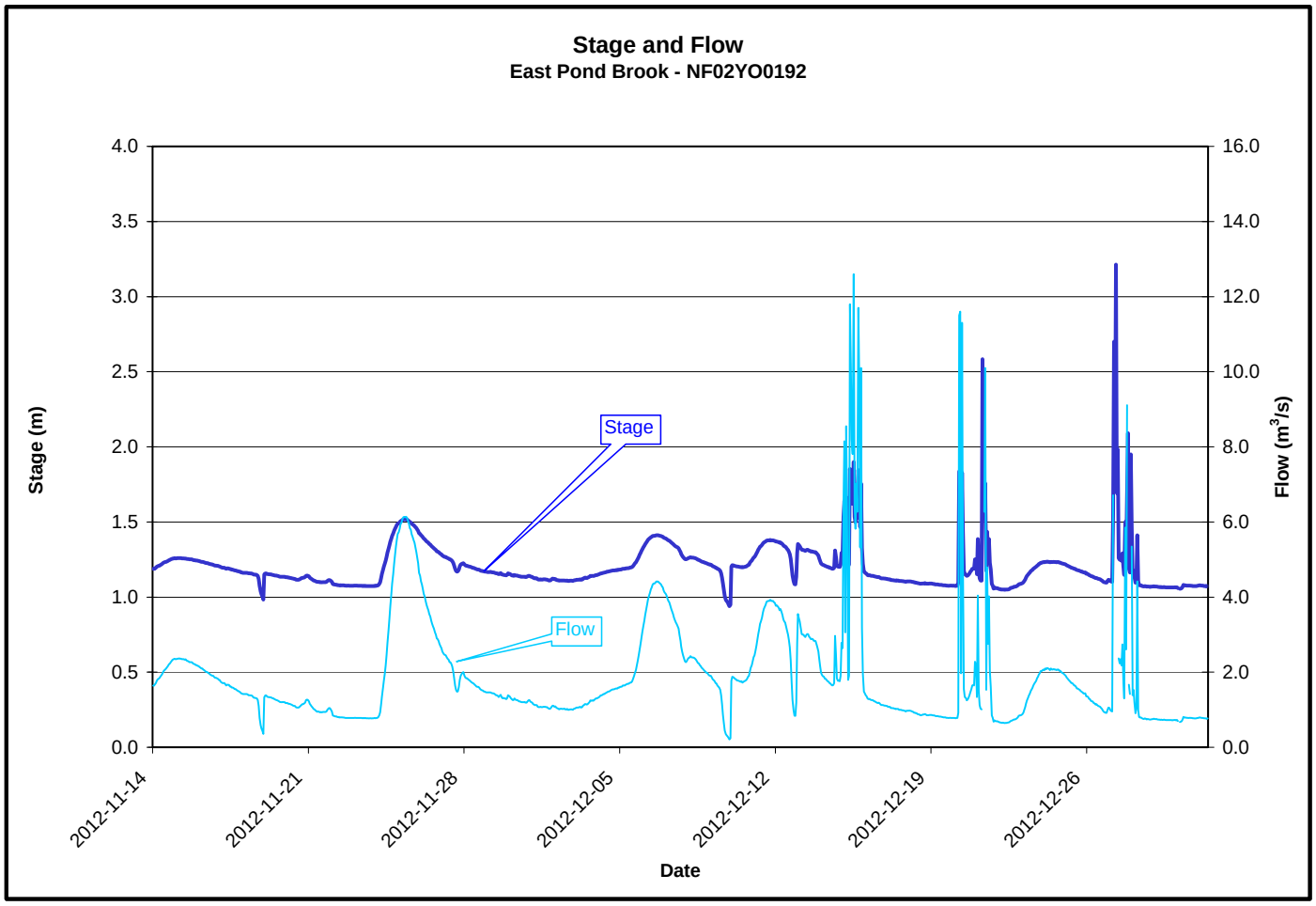

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.86 ˚C to a maximum of 6.03 ˚C with a slight increase over deployment period.
- There appears to be no correlation with water elevation.

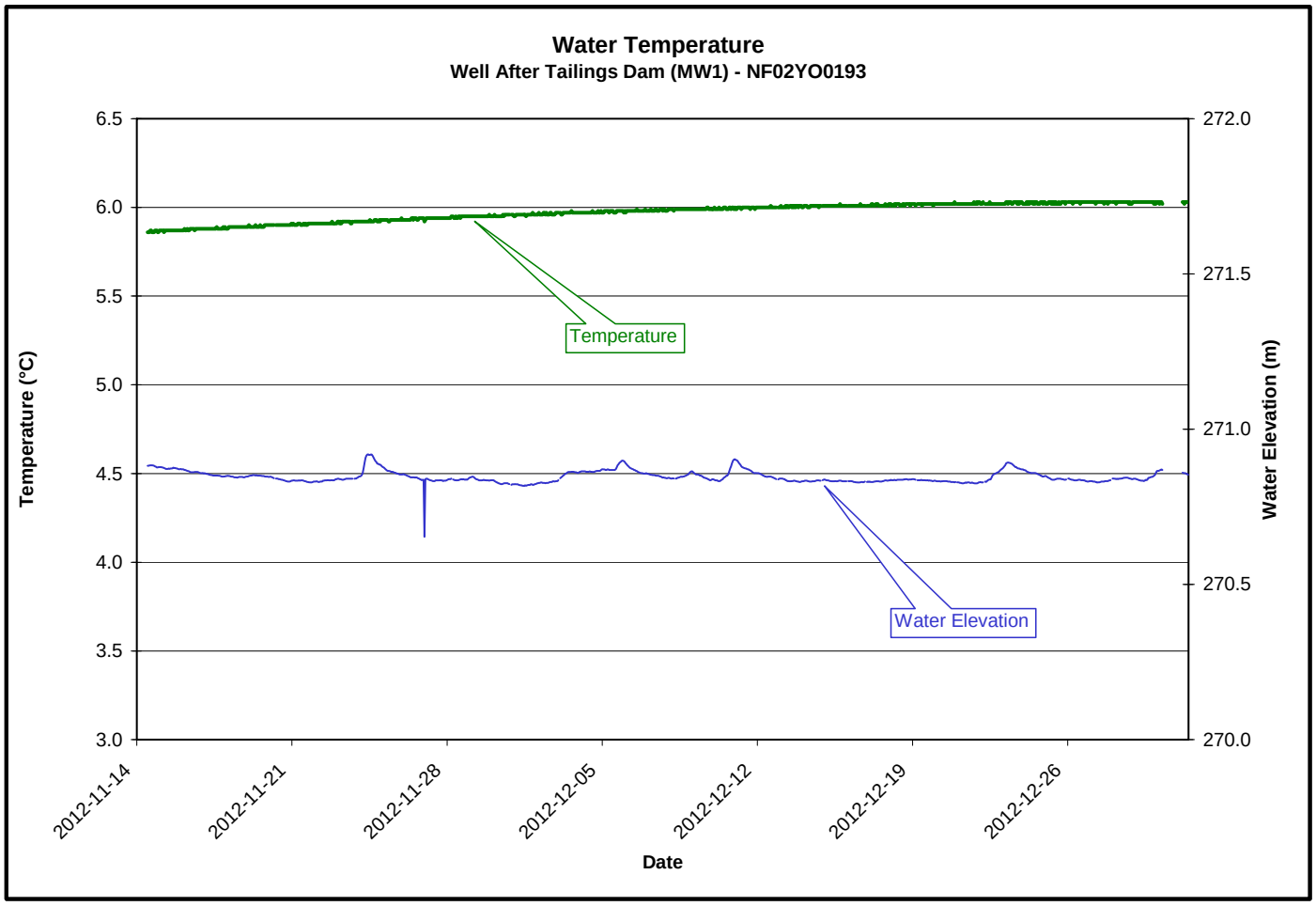

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 8.17 to a maximum of 8.20 with very little change over the deployment period.
- There does not appear to be any correlation with water elevation.

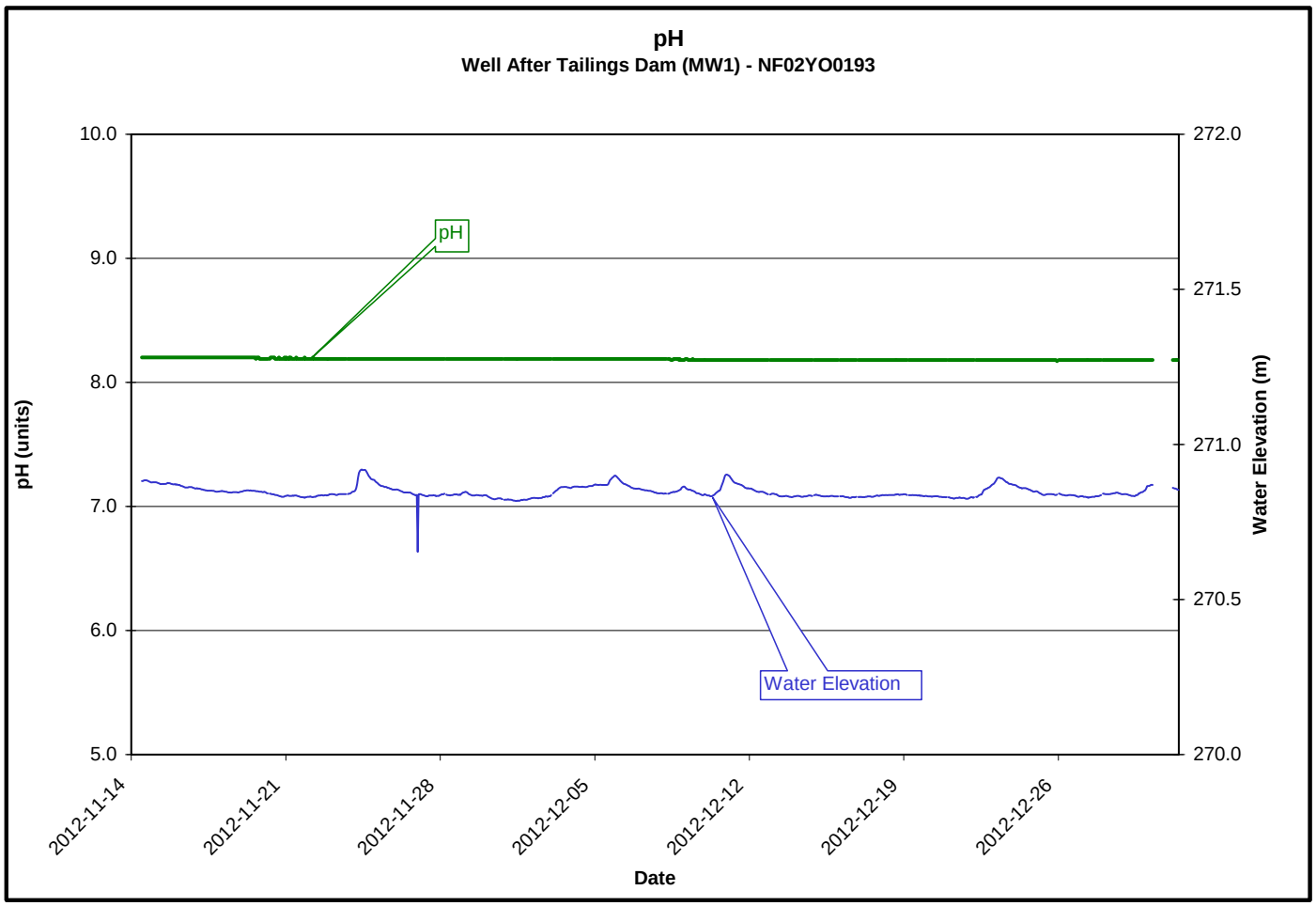

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.727 mS/cm to a maximum of 0.742 mS/cm.
- There was a slight increase over the deployment period.
- There does not seem to be any correlation with water elevation.

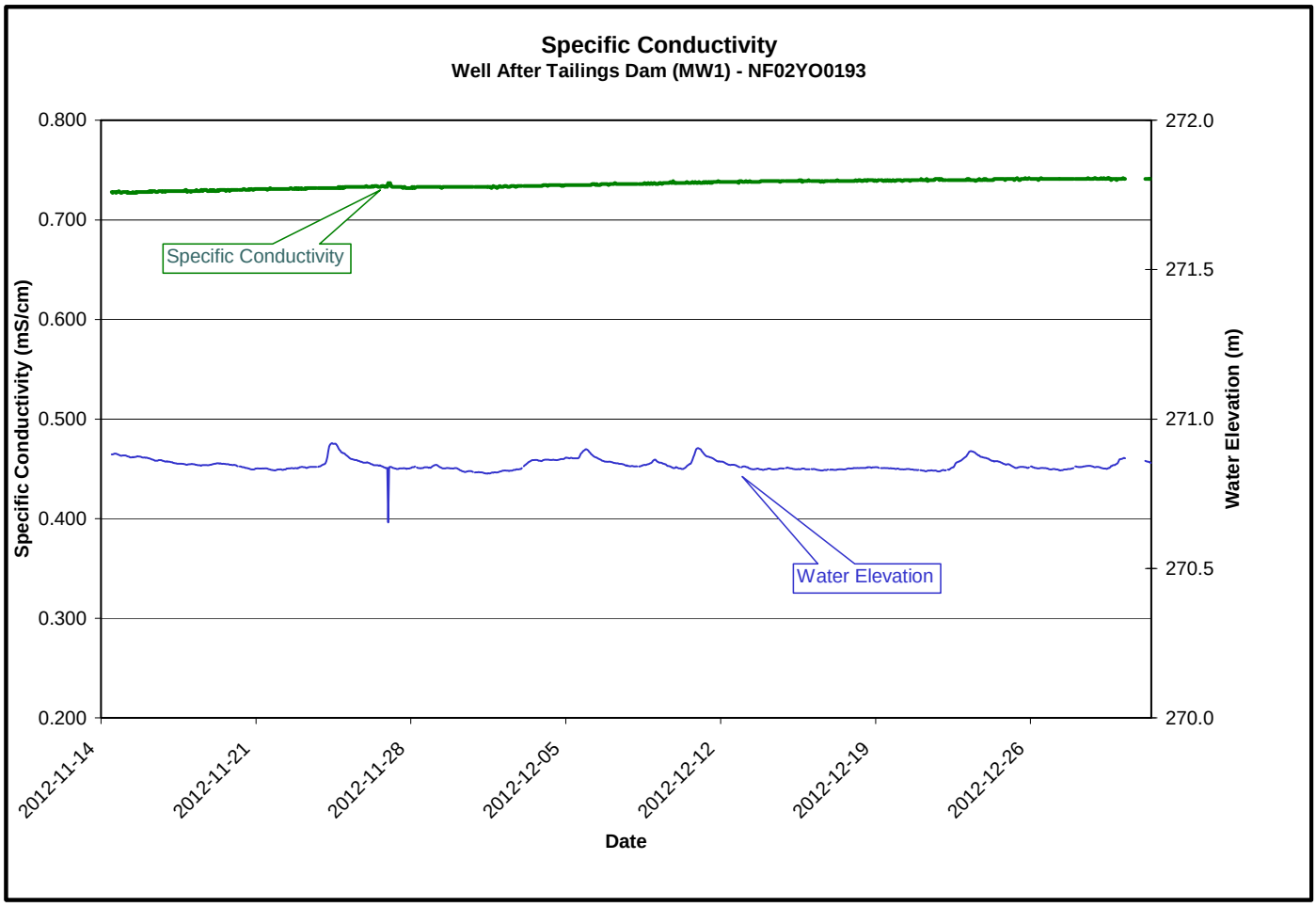

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.65 m to a maximum of 270.92 m. with little variation over the deployment period, apart from one short term event on November 27, 2012.
- The decrease in water elevation indicated by the red ellipse corresponds to a regular purging and water sampling event undertaken by Teck Duck Pond staff.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by runoff from precipitation.

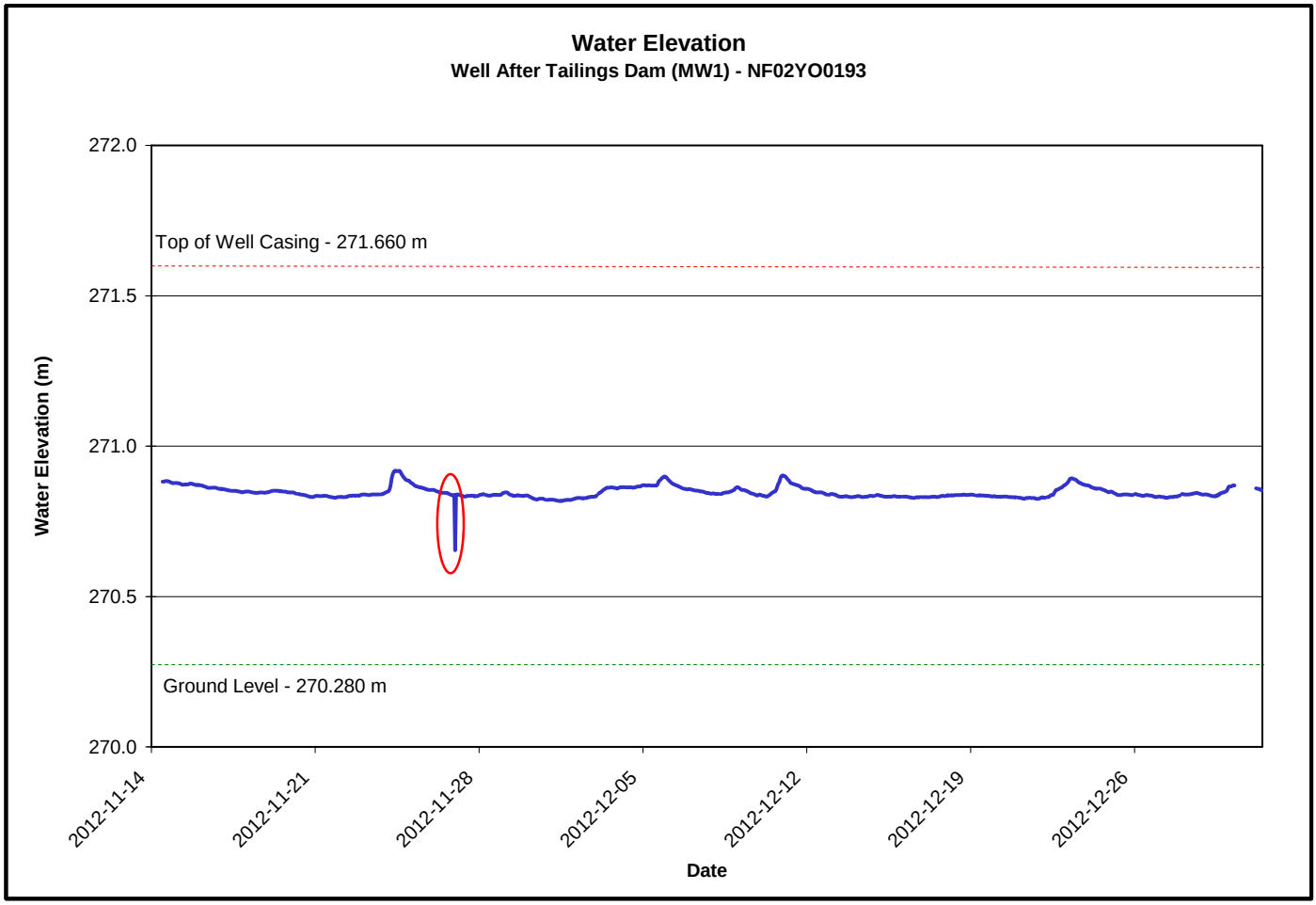

Figure 16

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