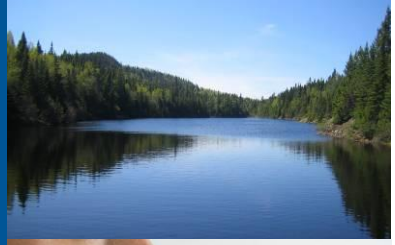




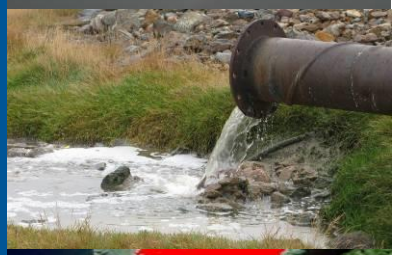


Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2014-11-21 to 2014-12-31

2015-01-23

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) from the beginning of the reporting period until December 29, 2014.

Maintenance and Calibration of Instrumentation

- **DataSonde®**(s/n 43245) was deployed in Tributary to Gills Pond Brook on November 21, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until December 31, 2014, the end of this reporting period; 40 days.
- **DataSonde®**(s/n 43794) was deployed in East Pond Brook on November 21, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until December 31, 2014, the end of this reporting period; 40 days.
- **MiniSonde®** (s/n 47591) was used for QA/QC purposes during the installation of the instruments. This unit, having the same technical specifications as the **DataSondes®**, was cleaned and freshly calibrated prior to each use.
- **Quanta G®** (s/n 00035) was deployed on November 19, 2014 after being freshly cleaned and calibrated and remained deployed continuously in Monitoring Well After Tailings Dam Station (MW1) This reporting period covers from November 231, 2014 until December 31, 2014; 40 days.

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, **Table 3** for East Pond Brook. No ranking could be calculated at the end of this reporting period, as the units remain deployed until after spring break-up.
- Due to issues with data logging and transmission, satellite transmitted data for Tributary to Gills Pond Brook was not available from the beginning of the deployment period through December 2, 2014. For this period, the final data set was supplemented with data logged internally in the **DataSonde®**.
- Similarly, stage and flow data are unavailable for Tributary to Gills Pond Brook from the beginning of the deployment period until November 25, 2014. Unfortunately, this data cannot be recovered.
- Due to issues with data logging and transmission, satellite transmitted data for East Pond Brook was not available for the periods:
    - December 24, 2014 08:30 through December 24, 2014 19:30
    - December 25, 2014 20:30 through December 26, 2014 16:30
    - December 28, 2014 07:30 through December 29, 2014 17:30

  For these periods, the final data set was supplemented with data logged internally in the **DataSonde®**.
- The turbidity sensor was reporting unusual measurements on the **DataSonde®** in East Pond Brook from the beginning of the deployment period until December 29, 2014. Upon deployment there was immediate icing on the instrument, and it was believed that frazzle ice near the sensor was causing the problem. Accordingly, erroneous data for this period has been removed from the final dataset.
- 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 Conductivity based upon live data and laboratory data.
- No ranking is available for this reporting period, as the **Quanta G®** was deployed in the well prior to the beginning of this period, and will remain deployed until after spring break-up.
- 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**
2014-11-21 Installation	Temp (^{o}C)	Good
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2014-11-21 Installation	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent

Table 3

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of -0.40˚C to a maximum of 2.30˚C.
- There was little change in water temperatures over the deployment period.
- There does not appear to be any correlation with stage during this reporting period.

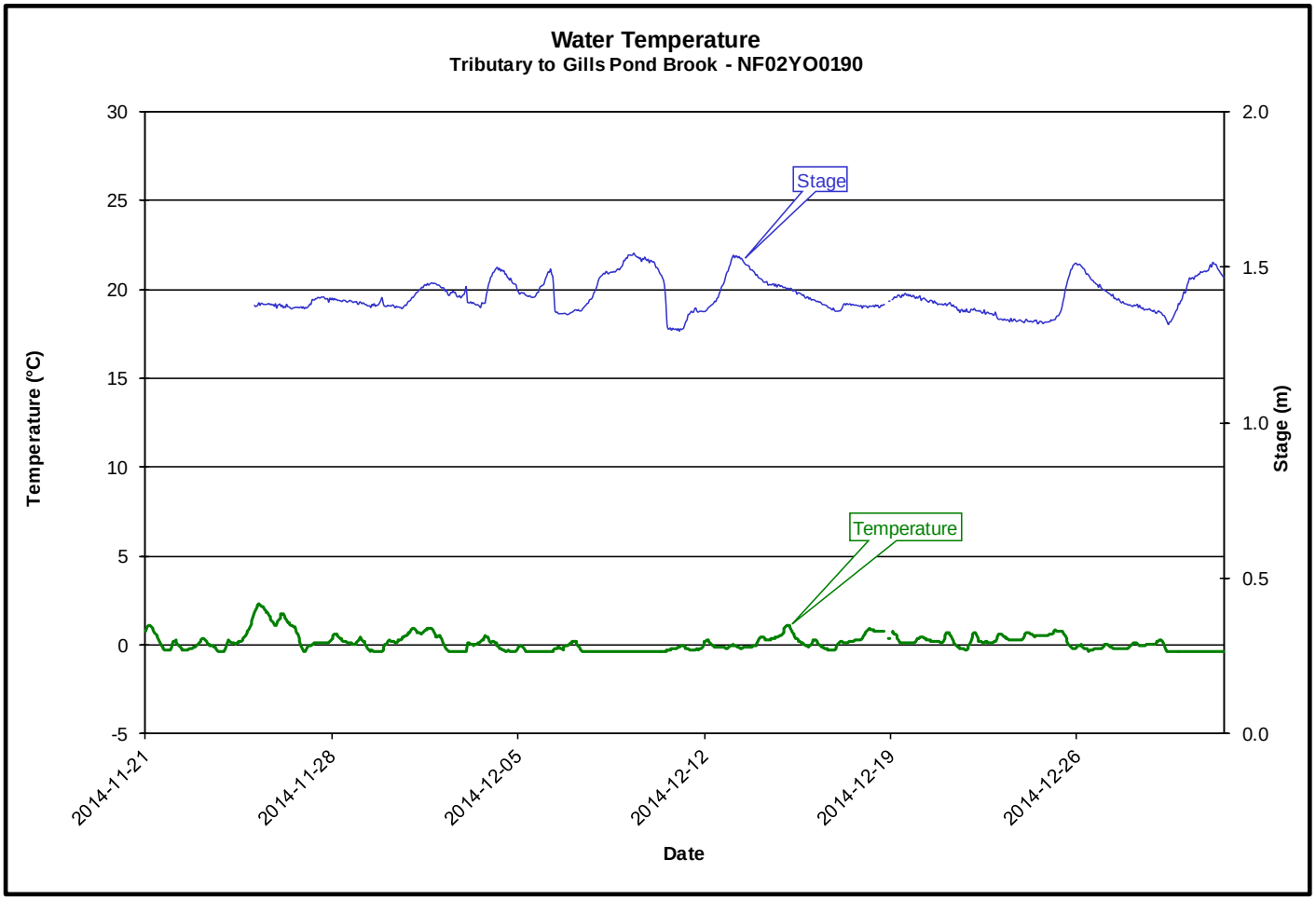

Figure 1

- Throughout the deployment period, pH values (**Figure 2**) ranged from a minimum of 6.12 to a maximum of 6.82.
- During this deployment period pH remained near or below the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. There was discharge of treated effluent from Polishing Pond for nearly all of the deployment period, up until December 29, 2014.
- An inverse relationship with stage is obvious throughout the deployment period.

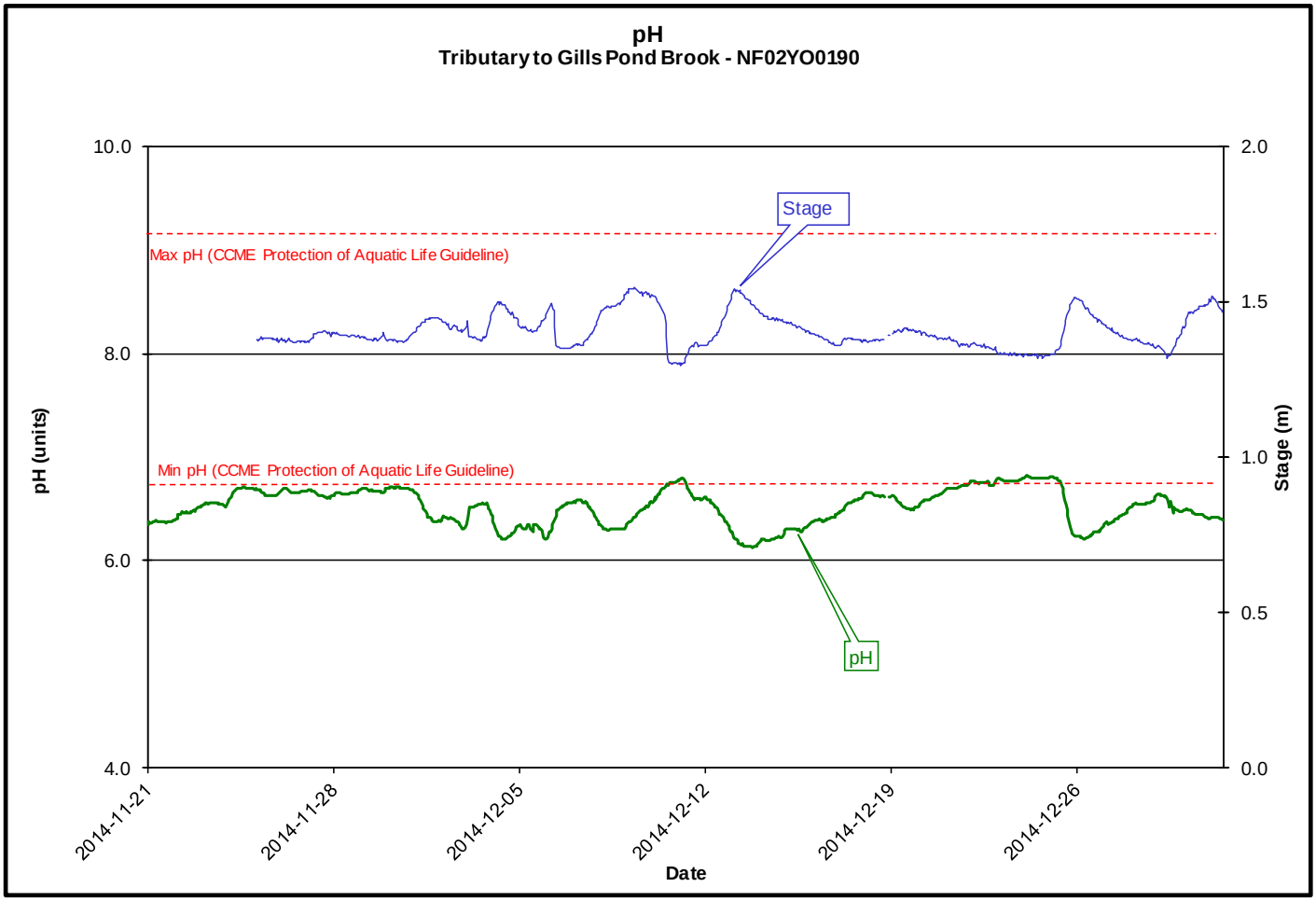

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 51.0 µS/cm to a maximum of 817.0 µS/cm over the deployment period.
- There was discharge of treated effluent from Polishing Pond for nearly all of the deployment period, up until December 29, 2014.

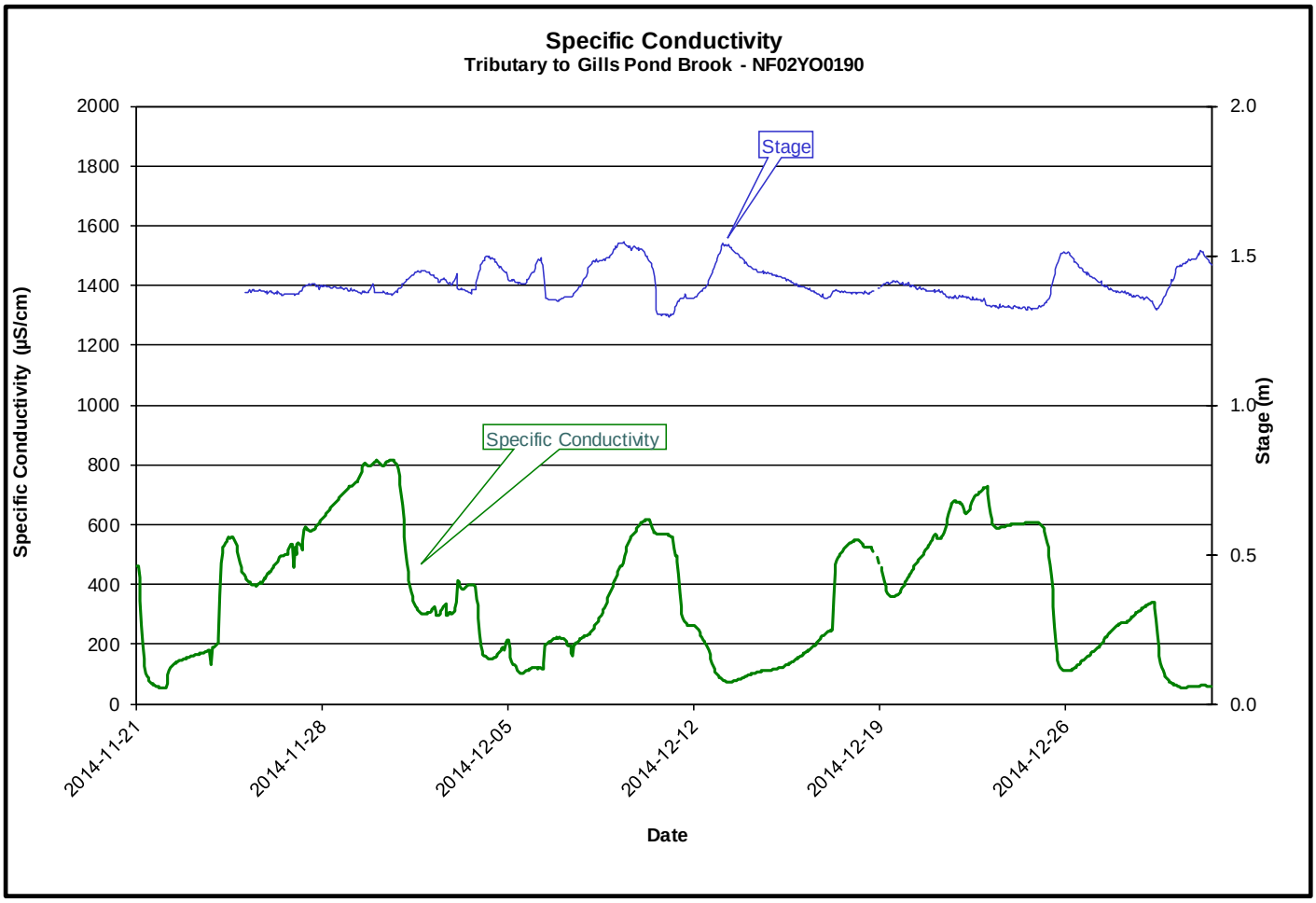

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 12.46 mg/L to a maximum of 13.84 mg/L over the deployment period, with the percent saturation ranging between 85.7 and 94.3.
- Dissolved oxygen (both % Sat and mg/L) remained fairly constant over the deployment period
- All of the dissolved oxygen values fell above the minimum for Early Life Stages (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). This range is typical based upon water temperatures.
- Based upon the fact that dissolved oxygen % saturation had minimal and predictable change over the deployment period, we can be confident that the dissolved oxygen mg/L values are accurate.

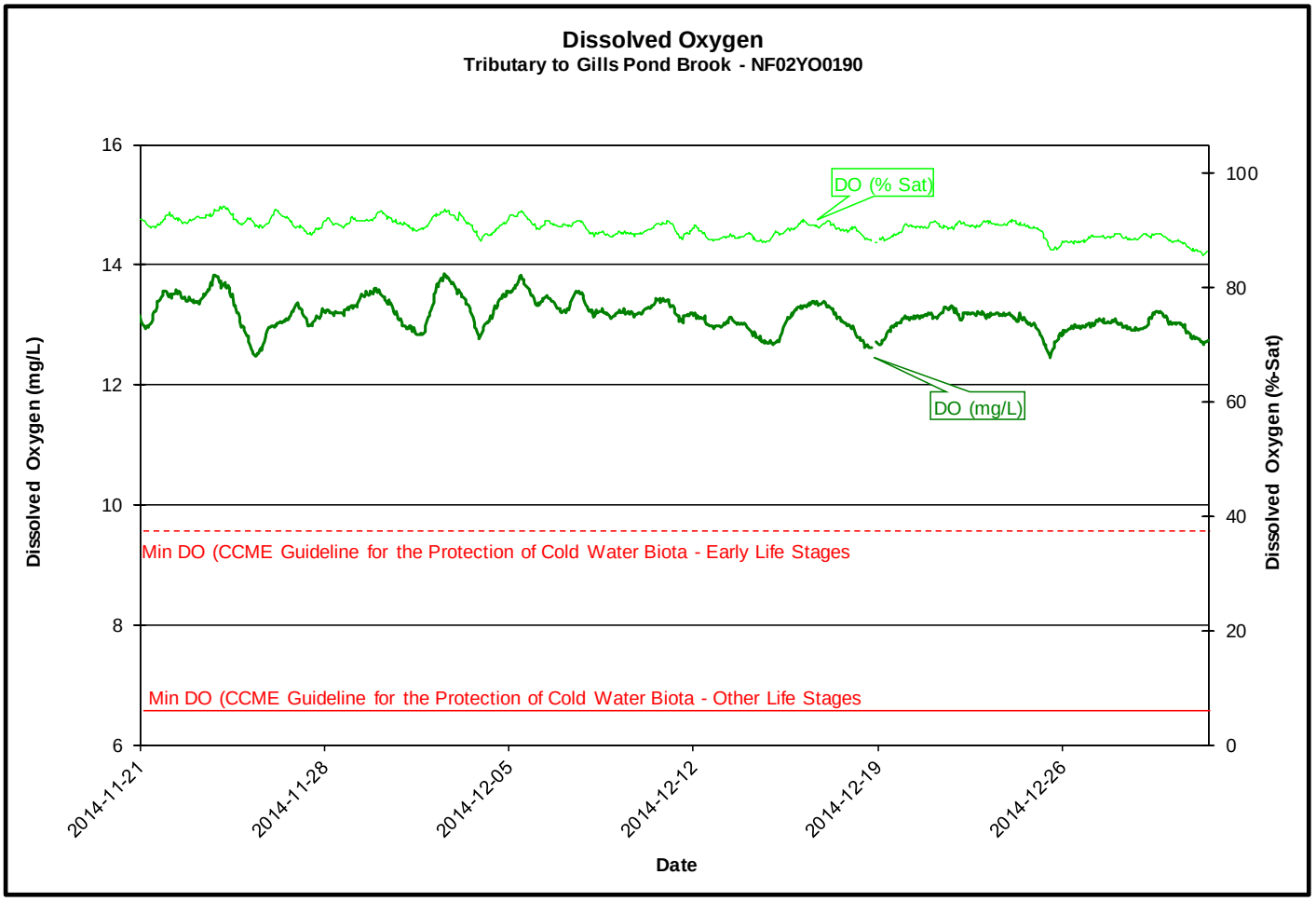

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 2.7 NTU.
- The minor spikes in turbidity each happened during the rising leg of the hydrograph (stage).

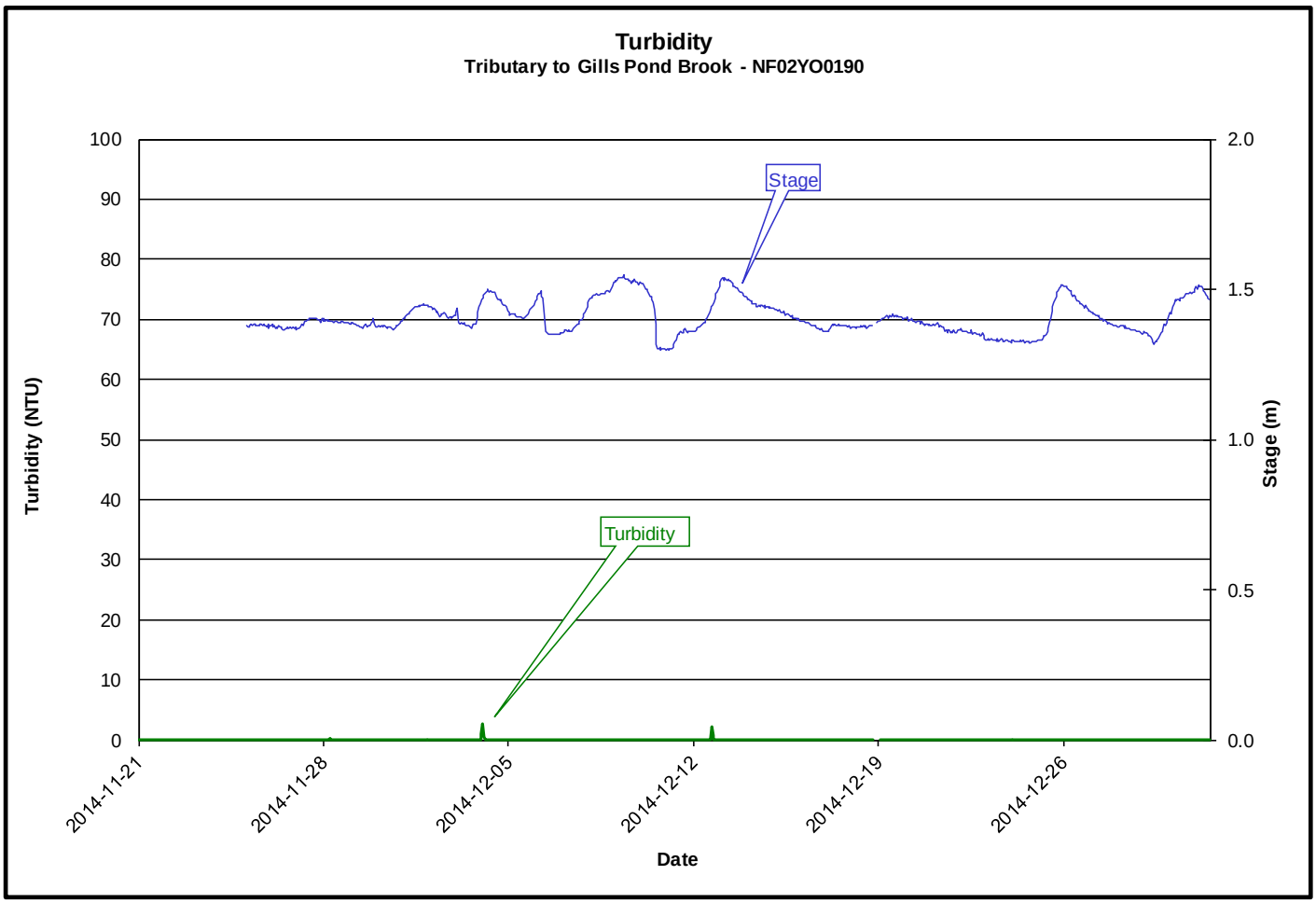

Figure 5

- The stage or water level ranged from a minimum of 1.30 m to a maximum of 1.55 m. The flow or discharge ranged from a minimum of 0.11 m^3/s to a maximum of 1.13 m^3/s (**Figure 6)**.
- Stage and flow are all within normal ranges.

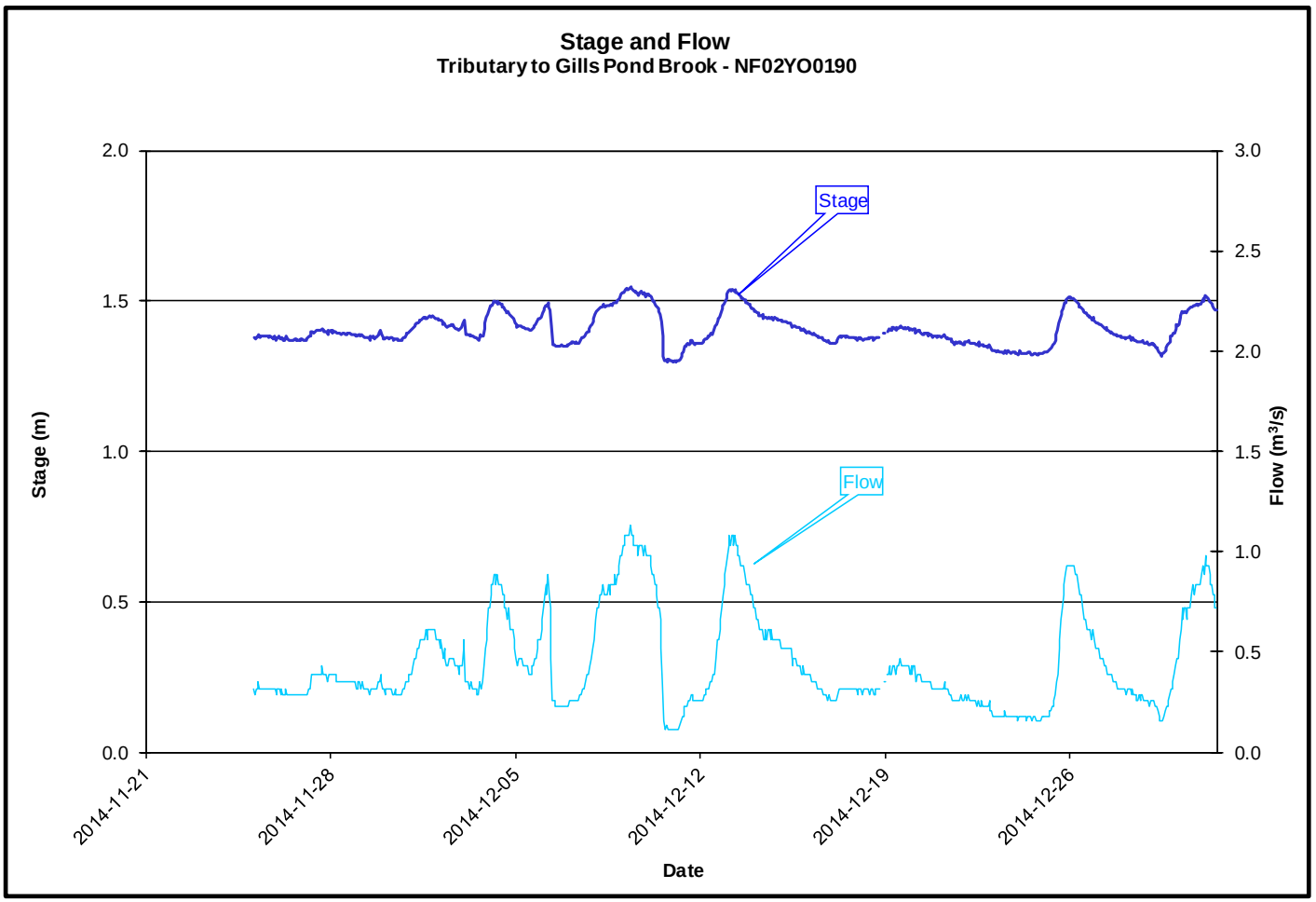

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 0.01 ˚C to a maximum of 3.09 ˚C.
- Water temperatures remained fairly consistent over the deployment period.
- There is some correlation with stage during some precipitation/runoff events.

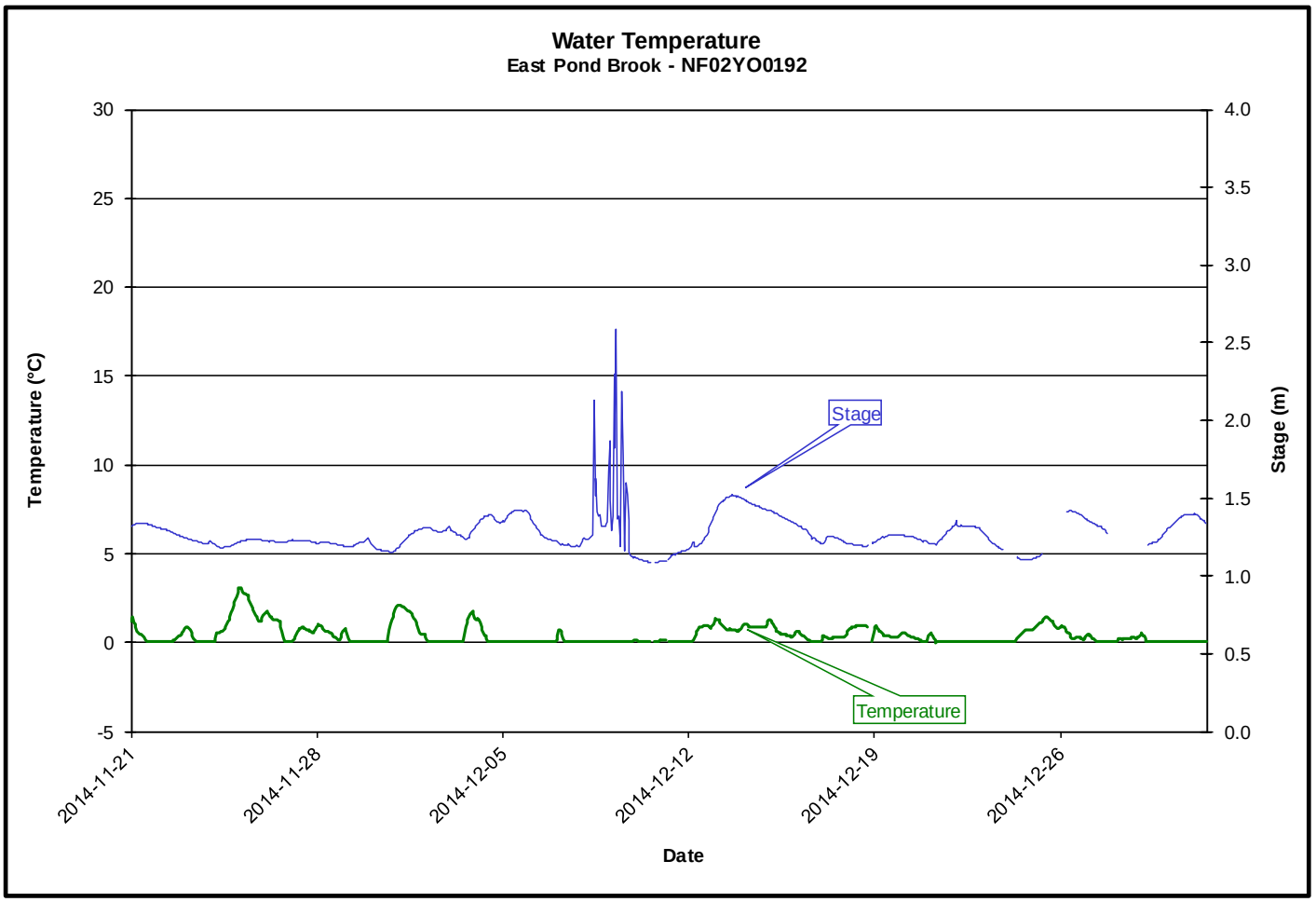

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.00 to a maximum of 6.49, with pH remaining fairly constant.
- Throughout the deployment period, pH values were near the lower limit of the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- There is an inverse relationship between pH and stage throughout most of the period.
- The background pH of this stream is normally quite low, and values near and below the lower limit are not unusual.

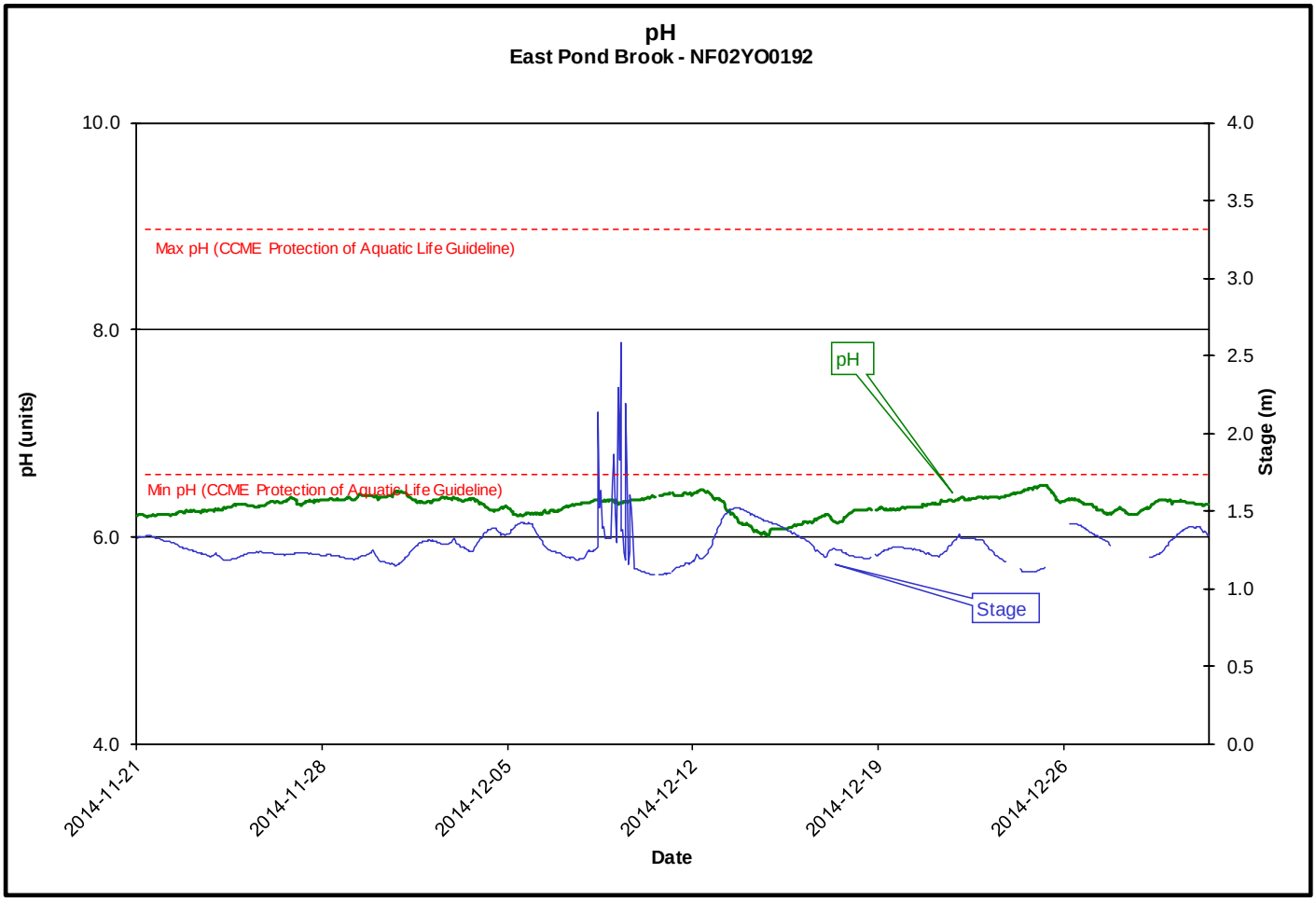

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 17.0 µS/cm to a maximum of 29.8 µS/cm.
- There was no significant change in specific conductance over the deployment period.
- There was a negative correlation between specific conductivity and stage evident during some precipitation/runoff events.
- All values are within the normal range.

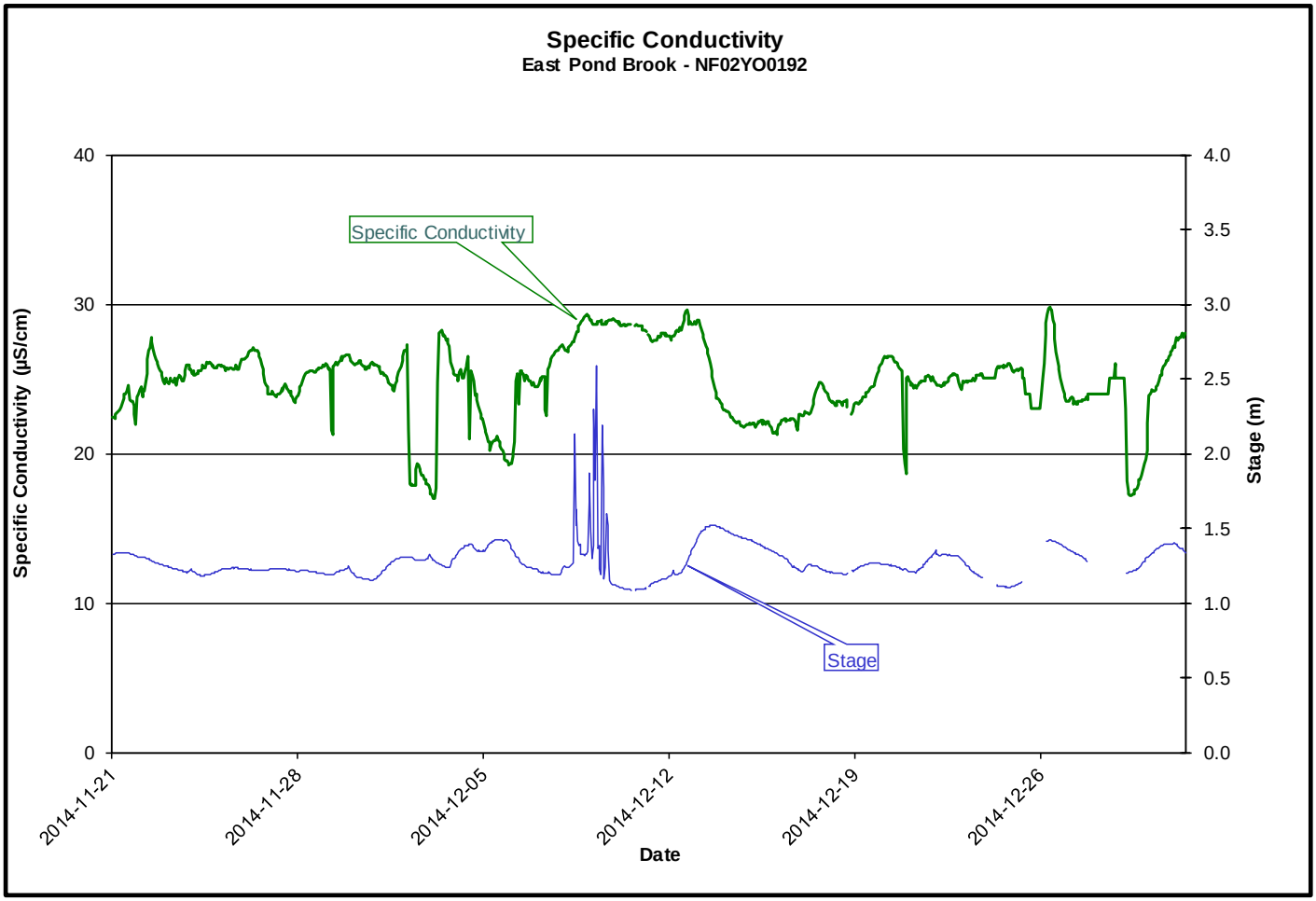

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 12.55 mg/L to a maximum of 14.03 mg/L over the deployment period, with the percent saturation ranging between 88.8 and 96.1.
- Dissolved oxygen (both % Sat and mg/L) remained fairly constant over the deployment period.
- All of the dissolved oxygen values fell above the minimum for Early Life Stages (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). This range is typical based upon water temperatures.
- Based upon the fact that dissolved oxygen % saturation had minimal and predictable change over the deployment period, we can be confident that the dissolved oxygen mg/L values are accurate.

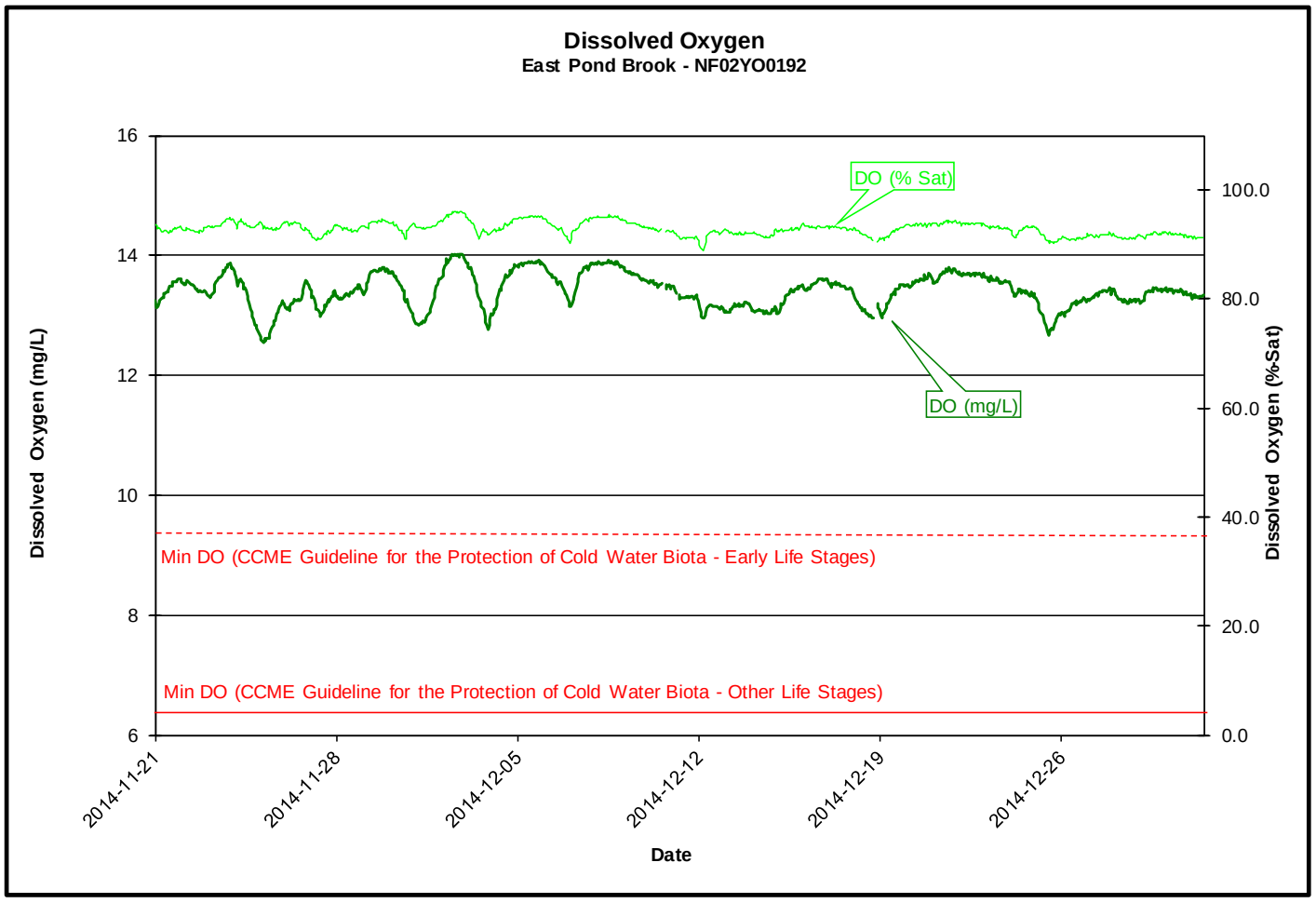

Figure 10

- The turbidity sensor was reporting unusual measurements from the beginning of the deployment period until December 29, 2014. Upon deployment there was immediate icing on the instrument, and it was believed that frazzle ice near the sensor was causing the problem. Accordingly, erroneous data for this period has been removed from the final dataset.
- The turbidity values for the last few days of the reporting period (**Figure 11**) were all recorded at 0.0 NTU.

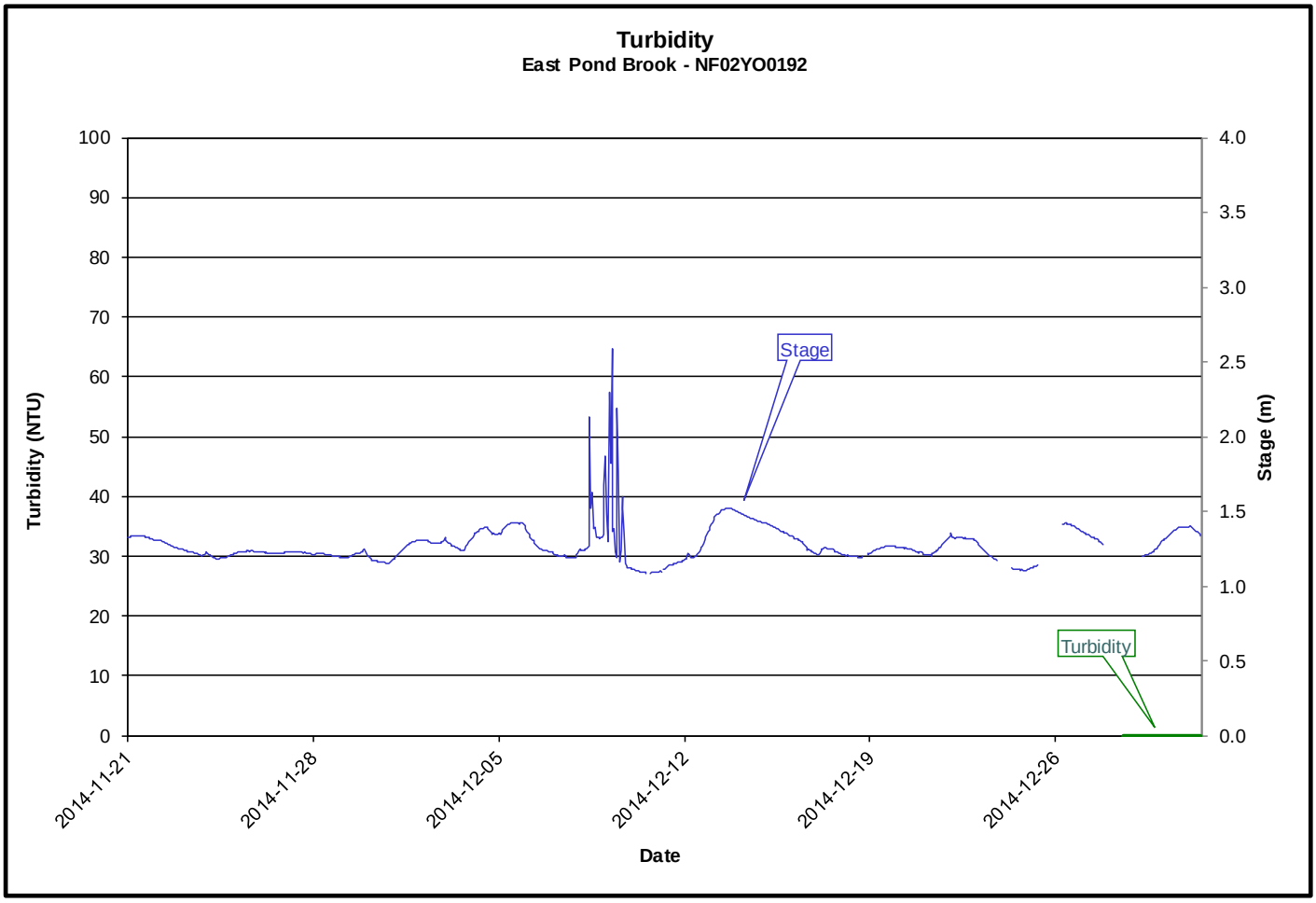

Figure 11

- The stage or water level ranged from a minimum of 1.09 m to a maximum of 2.59 m. The flow or discharge ranged from a minimum of 0.81 m^3/s to a maximum of 21.13 m^3/s **(Figure 12)**.
- During the period highlighted in the red ellipse, stage and flow are shown to be abnormally high. This is due to the backwater effect as continuous ice cover formed in the stream
- All other values are within normal ranges.

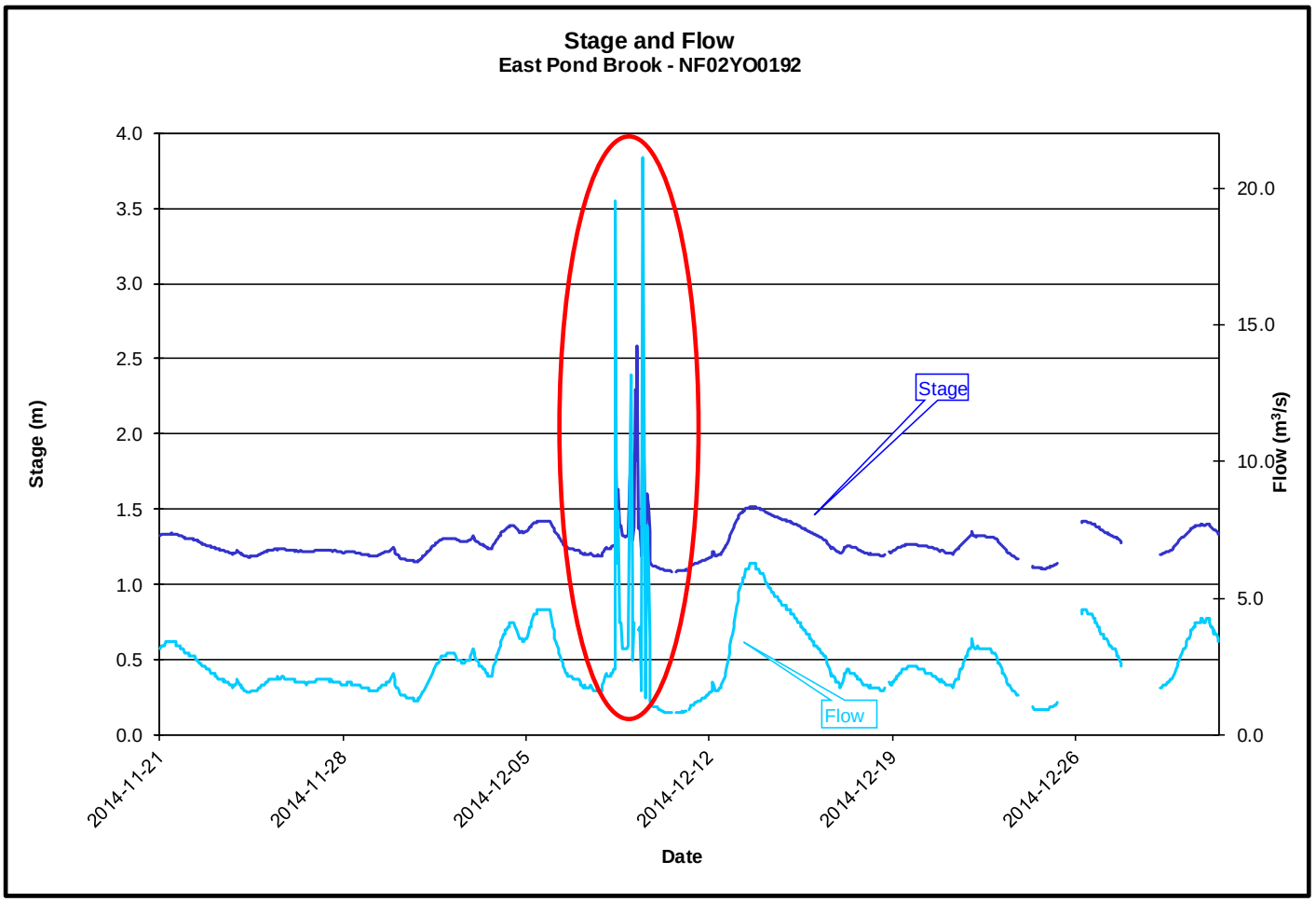

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 6.02 ˚C to a maximum of 6.13 ˚C with a slight increase over the deployment period.

- There appears to be no correlation with water elevation.

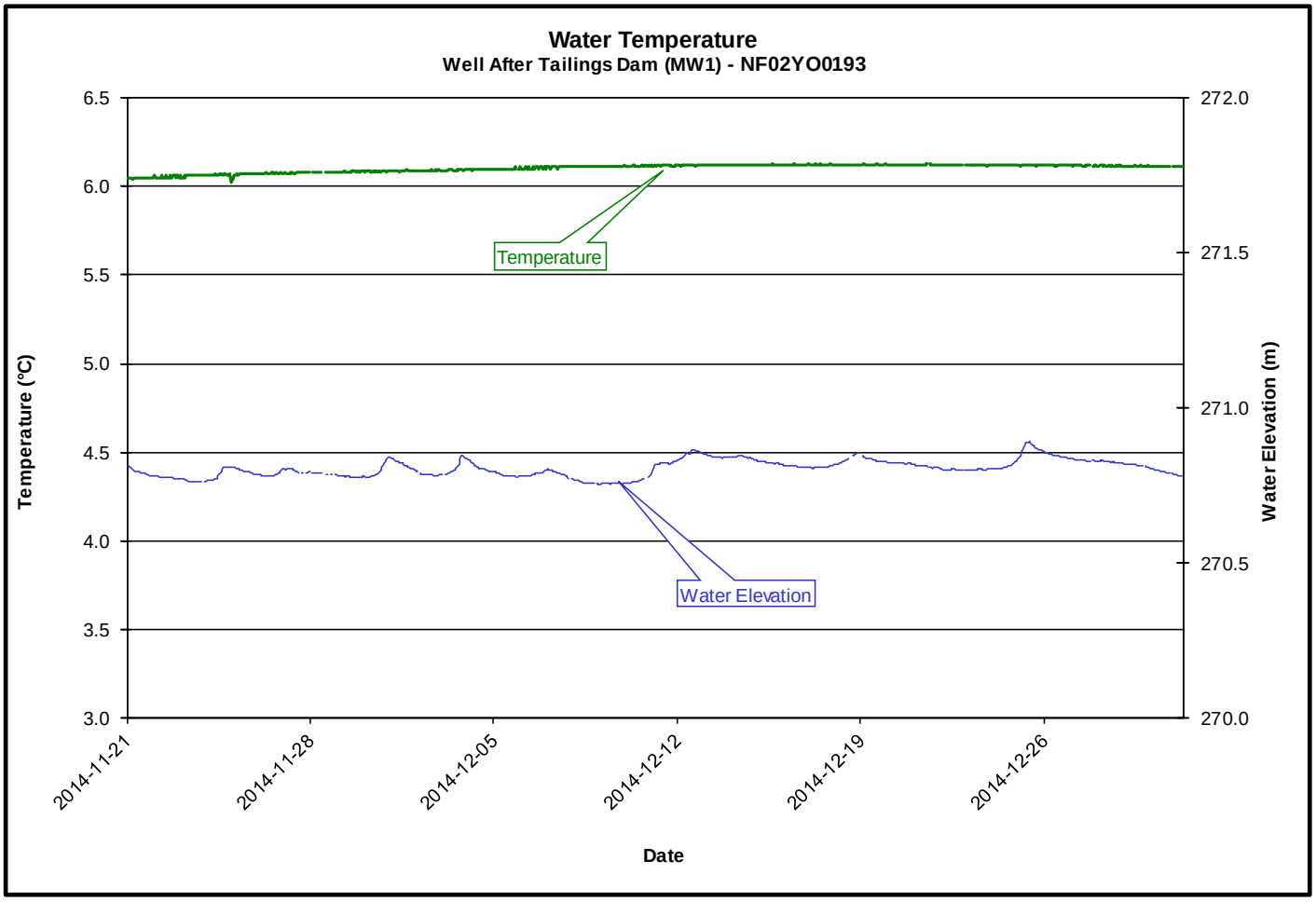

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 8.26 to a maximum of 8.48.
- Typical of every instrument deployment in this well, there was a significant drop and subsequent recovery of pH, resultant from disturbance of the water column in the well when the instruments were removed and replaced on November 19, 2014 (two days prior to the beginning of the reporting period). During the first several days of this reporting period, the pH continued to recover, then remained stable to the end of the reporting period.
- There does not appear to be any correlation with water elevation.

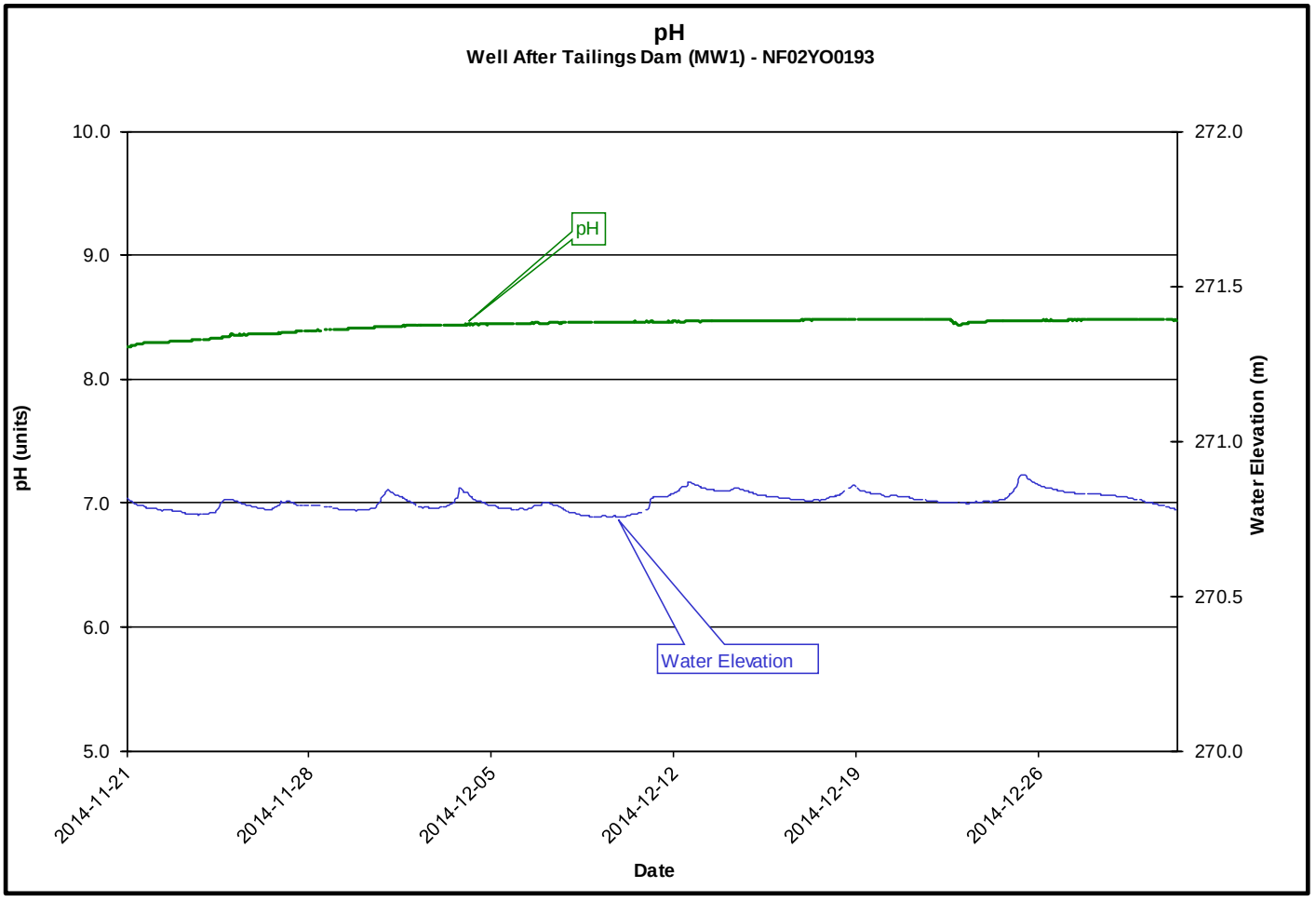

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.785 mS/cm to a maximum of 0.808 mS/cm.
- There was a slight decrease over the deployment period.

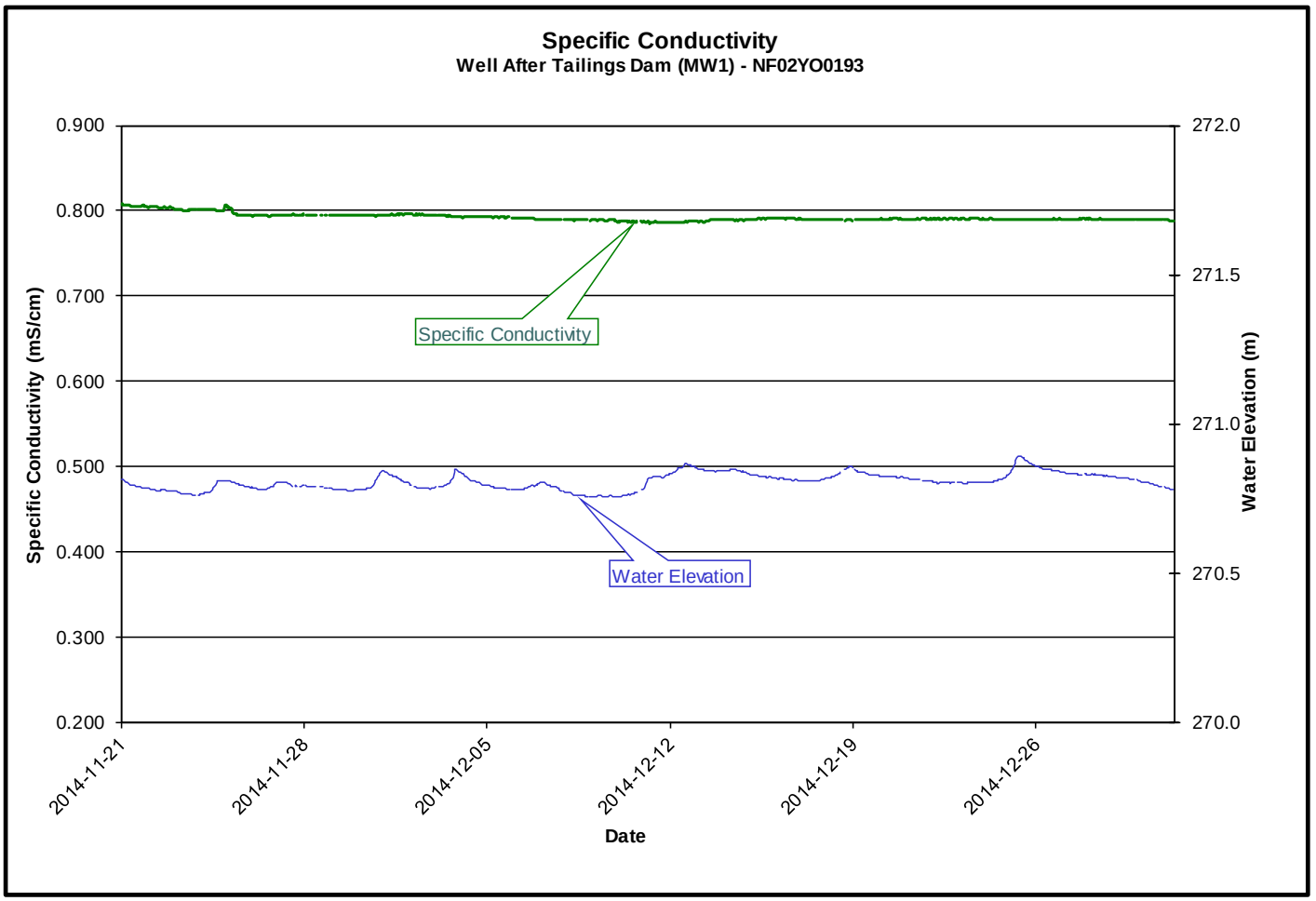

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.75 m to a maximum of 270.89 m.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by precipitation/runoff events, as well as the water elevation in the nearby Tailings Management Area.

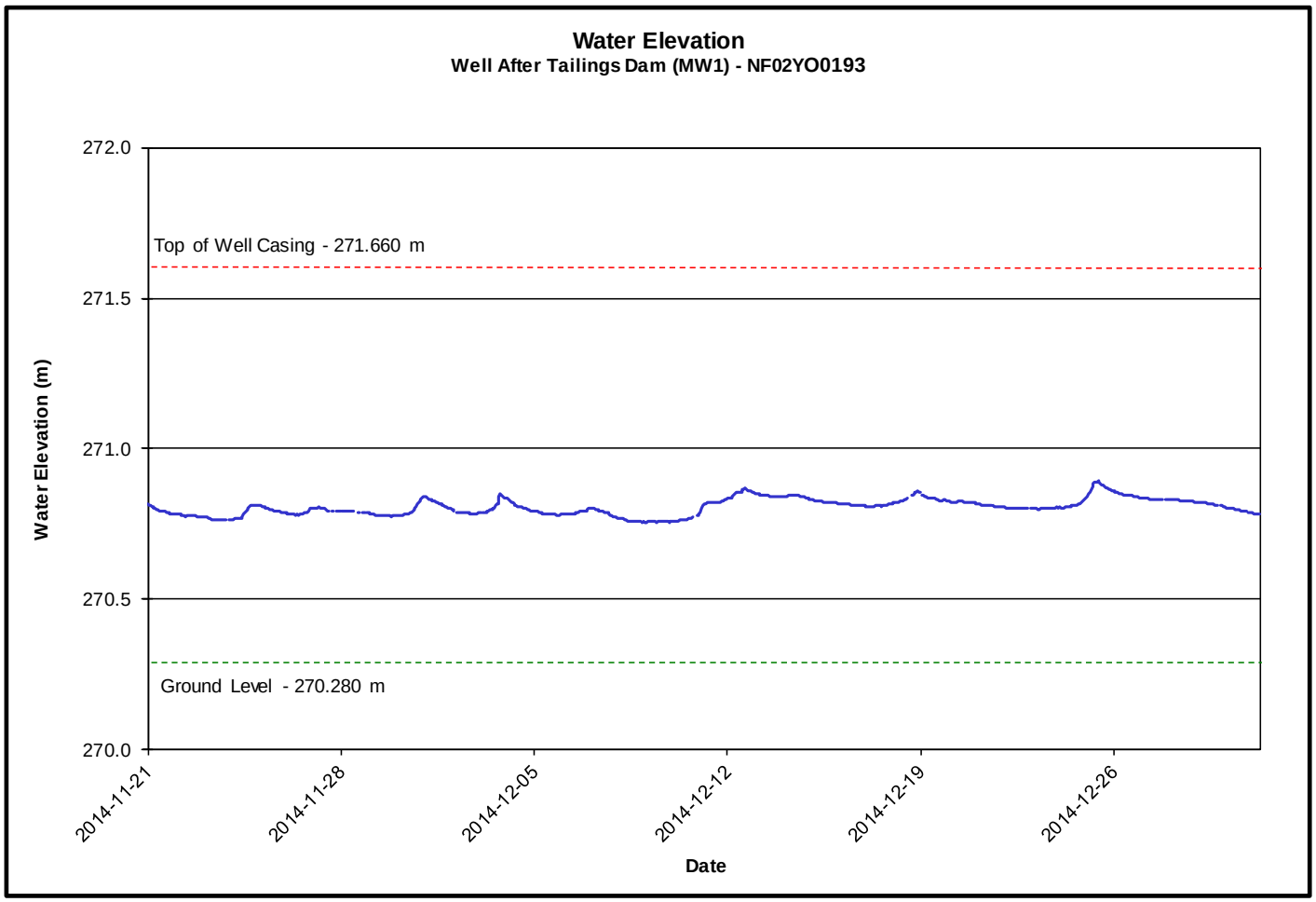

Figure 16

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