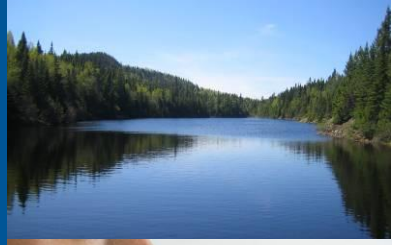




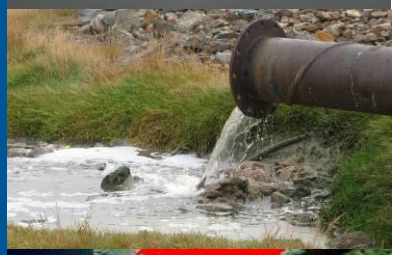


Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2014-09-24 to 2014-11-21

2014-12-17

Newfoundland Labrador

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 October 23, 2014 and again from November 12, 2014 through the end of the reporting period.

Maintenance and Calibration of Instrumentation

- **DataSonde®**(s/n 62268) was deployed in Tributary to Gills Pond Brook on September 24, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until November 21, 2014; a 57 day period.
- **DataSonde®**(s/n 62267) was deployed in East Pond Brook on September 24, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until November 21, 2014; a 57 day period.
- **MiniSonde®** (s/n 47591) was used for QA/QC purposes during the installation and removal 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 June 3, 2014 and remained deployed continuously in Monitoring Well After Tailings Dam Station (MW1) until October 29, 2014 when it was changed out with (s/n 000653). Following issues with the pH/ORP sensor unit s/n 00653, was removed and replaced on November 19, 2014 with the freshly cleaned and calibrated unit s/n 00035. This report covers the period from September 24, 2014 through November 21, 2014 which covers the three separate deployments of **Quanta G®** instruments.

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 and at the end of the deployment period is shown in **Table 2** for Tributary to Gill's Pond Brook, **Table 3** for East Pond Brook, and **Table 4** for Well After Tailings Dam (MW1).
- The turbidity sensor failed on the **DataSonde®** in Tributary to Gills Pond Brook after 7 hours of deployment, resulting in potentially inaccurate turbidity readings for most of the deployment period. This resulted in a 'Fair' ranking upon removal of the instrument. All questionable turbidity data have been removed from the dataset.
- A 'Fair' ranking for dissolved oxygen was also calculated. However, DO readings were all within normal ranges and the variance between the two probes was 0.53 mg/L.
- The turbidity sensor also failed on the **DataSonde®** in East Pond Brook after 5 days of deployment, resulting in potentially inaccurate turbidity readings for most of the deployment period. Despite a 'Good' ranking upon removal of the instrument, all questionable turbidity data have been removed from the dataset.
- There was a significant difference (12.9 µS/cm) in specific conductivity between the field **DataSonde®** and the QA/QC **MiniSonde®** upon deployment in East Pond Brook, resulting in a 'Fair' ranking. Based upon historical data for this time of year, and a grab sample collected at the time, it is suspected that the field Sonde calibrated slightly lower than the standard. The data for this period have been kept, as they are within the normal range.
- 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.
- 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. This resulted in an expected 'Fair' ranking during installations on October 29, 2014 and November 19, 2014. Unfortunately, the pH sensor failed shortly after deployment on October 29, 2014 resulting in a 'Poor' ranking upon removal on November 19, 2014. All unreliable pH data for this period have been removed from the dataset.
- 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**
2014-09-24 Installation	Temp (°C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2014-11-21 Removal	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Fair
	Turbidity (NTU)	Fair

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2014-09-24 Installation	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Fair
	Dissolved Oxygen (mg/L)	Good
	Turbidity (NTU)	Excellent
2014-11-21 Removal	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Good
	Dissolved Oxygen (mg/L)	Good
	Turbidity (NTU)	Good

Table 3

Well After Tailings Dam (MW1) Station (NF02YO0193)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2014-10-29 Removal	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
2014-10-29 Installation	pH (units)	Fair
	Sp. Conductivity (µS/cm)	Excellent
2014-11-19 Removal	pH (units)	Poor
	Sp. Conductivity (µS/cm)	Excellent
2014-11-19 Installation	pH (units)	Fair
	Sp. Conductivity (µS/cm)	Good

Table 4

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of 0.14˚C to a maximum of 15.59˚C.
- There was a significant decrease in water temperatures over the deployment period as winter set in.
- There does not appear to be any correlation with stage during this reporting period.

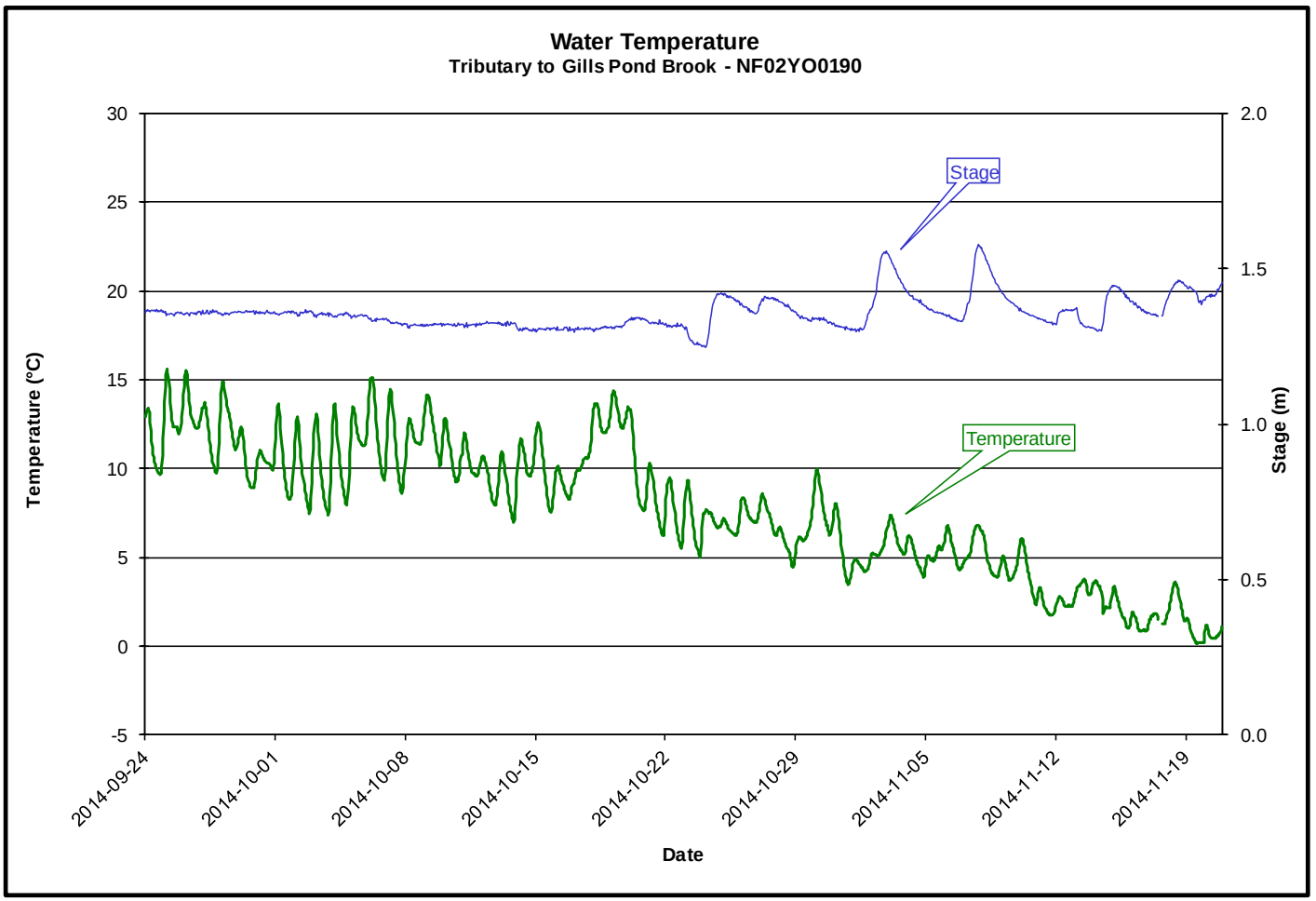

Figure 1

- Throughout the deployment period, pH values (**Figure 2**) ranged from a minimum of 5.94 to a maximum of 7.10.
- All pH values were stable and within the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* until October 25, 2015. During most of this period (up to October 23, 2014), there was discharge of treated mine effluent from Polishing Pond, and weather conditions were dry and stable. Following October 25, 2015, weather conditions changed, with several precipitation events. pH became more variable and remained below the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* despite the resumption of discharge of treated mine effluent on November 12, 2014.
- Following October 25, 2014 an inverse relationship with stage is obvious, indication that the lower pH values are a result of the precipitation/runoff events.

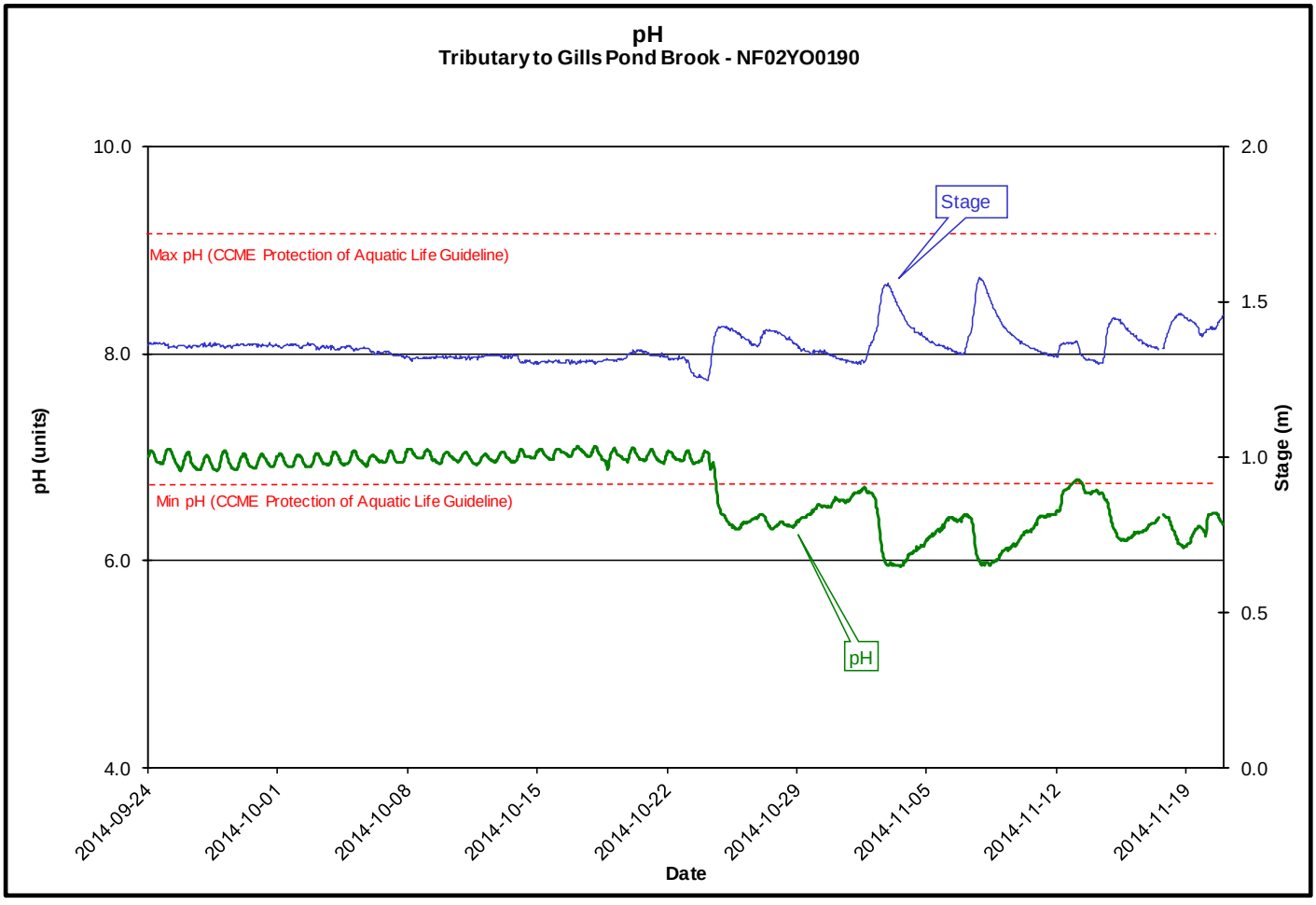

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 30.1µS/cm to a maximum of 1603.0 µS/cm over the deployment period.
- Specific conductance dropped off significantly following the cessation of treated mine effluent on October 23, 2014.
- A less dramatic increase in specific conductance is obvious following the resumption of discharge on November 12, 2014.

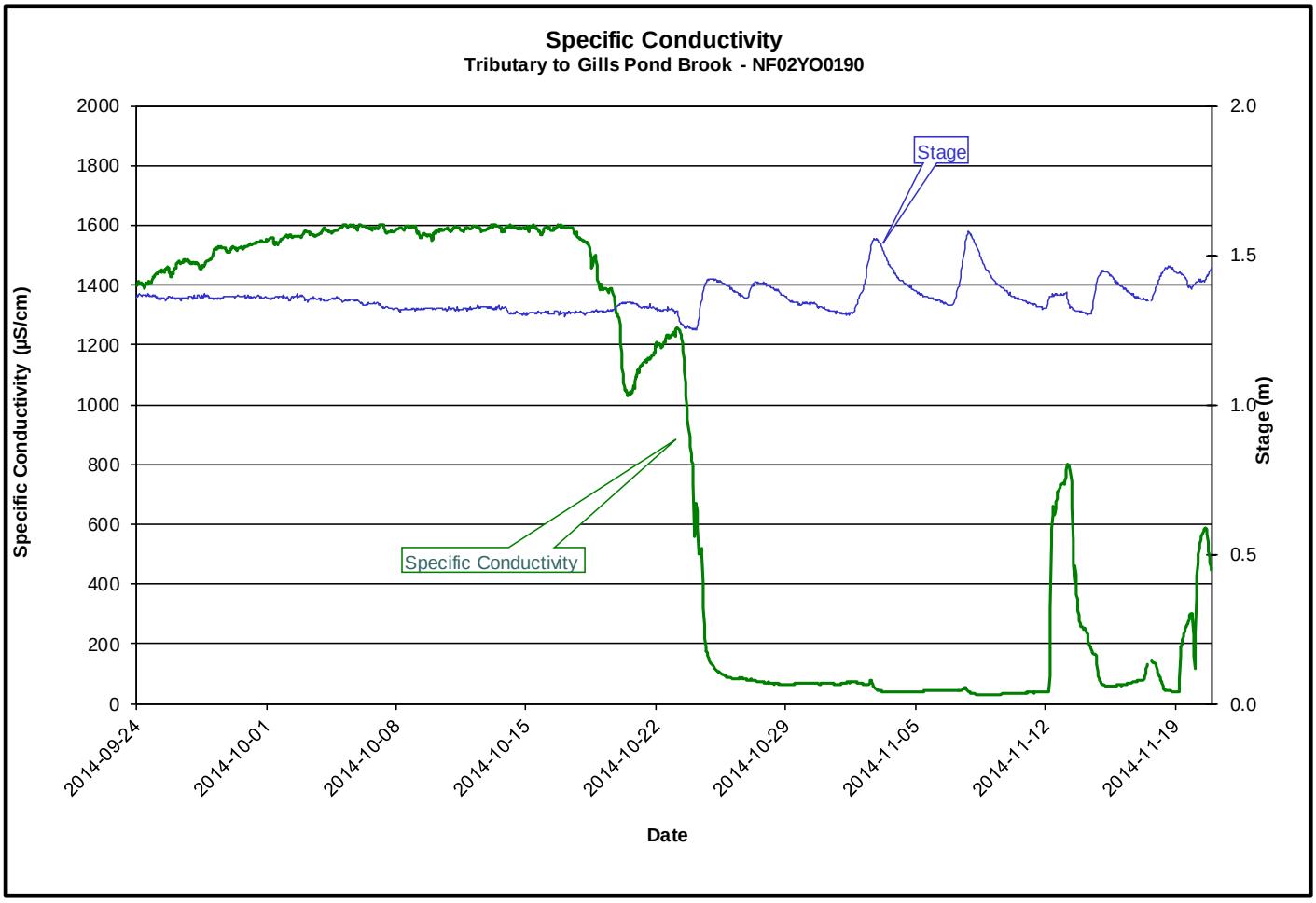

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 9.59 mg/L to a maximum of 13.32 mg/L over the deployment period, with the percent saturation ranging between 85.5 and 99.5.
- Dissolved oxygen (mg/L) increased slightly over the deployment period, which corresponds with the decrease in temperature (**Figure 1**)
- 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.

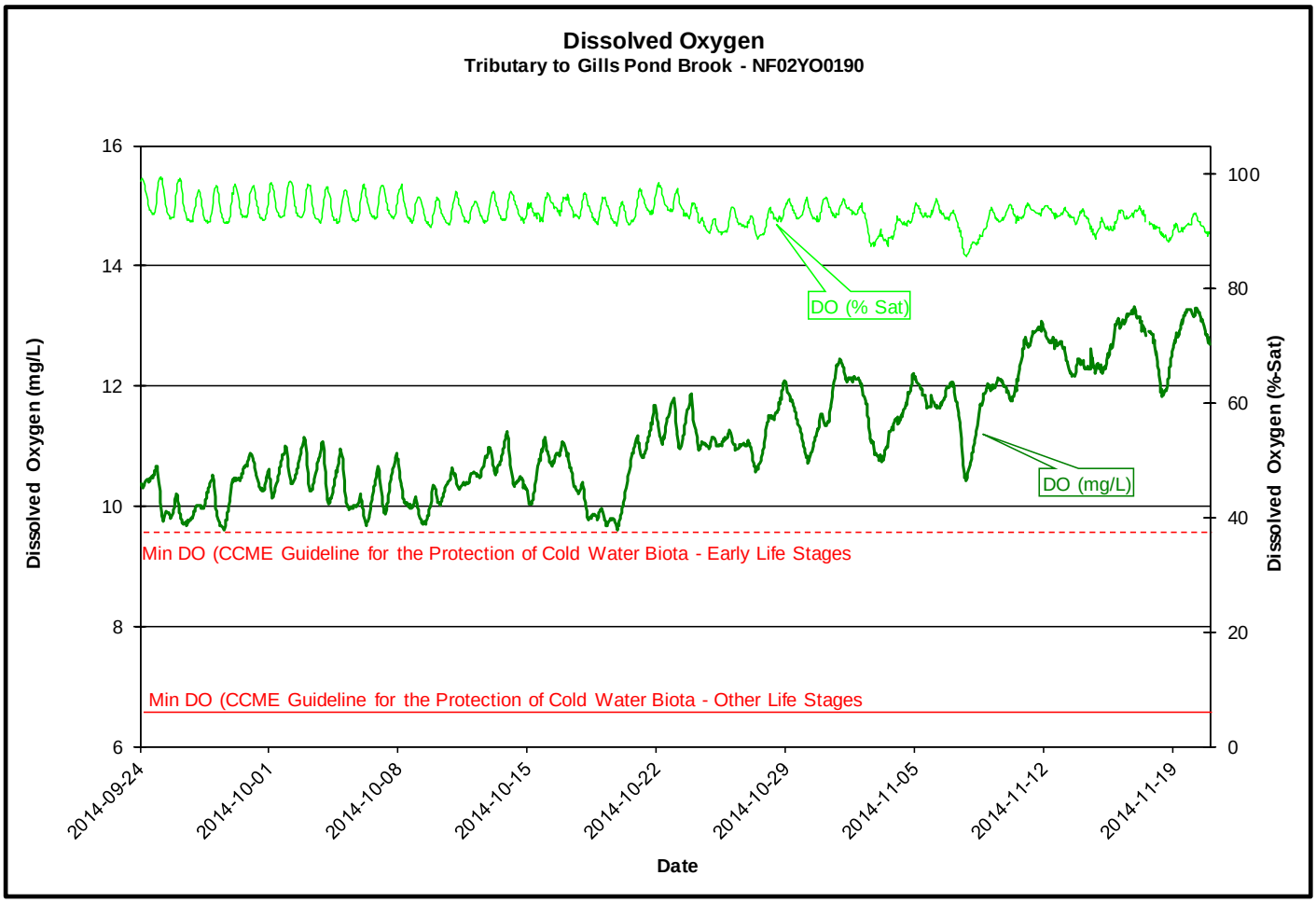

Figure 4

- The turbidity values **(Figure 5)** were all recorded at 0.0 NTU.

- The turbidity sensor failed after 7 hours of deployment, resulting in potentially inaccurate turbidity readings for most of the deployment period. All questionable turbidity data have been removed from the dataset.

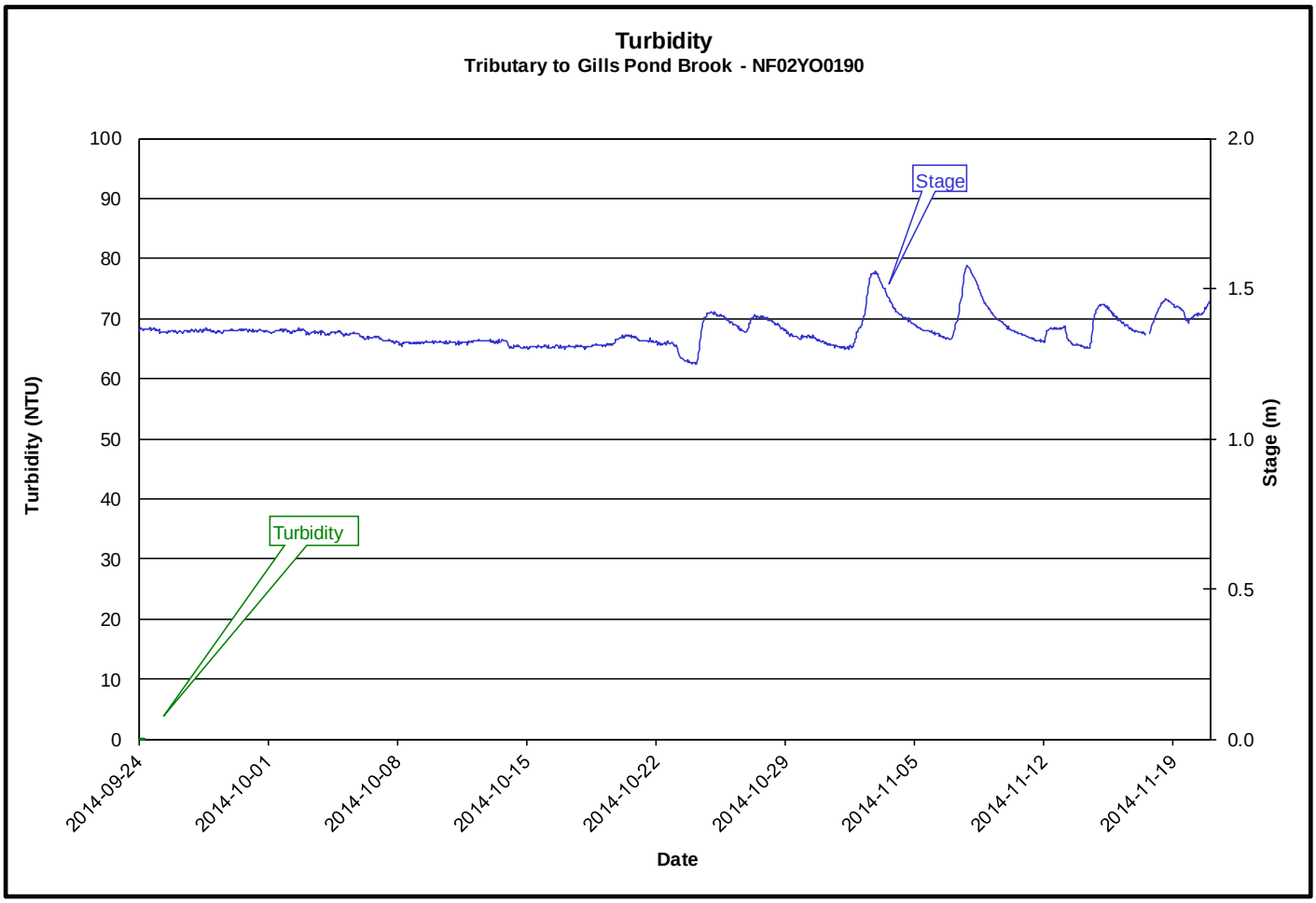

Figure 5

- The stage or water level ranged from a minimum of 1.25 m to a maximum of 1.58 m. The flow or discharge ranged from a minimum of 0.04 m^3/s to a maximum of 1.30 m^3/s (**Figure 6)**.
- There was little change in stage or flow until the cessation of discharge from Polishing Pond on October 23, 2014. The reduction was minor and then overshadowed by the onset of precipitation on October 25, 2014.
- Stage and flow are all within normal ranges.

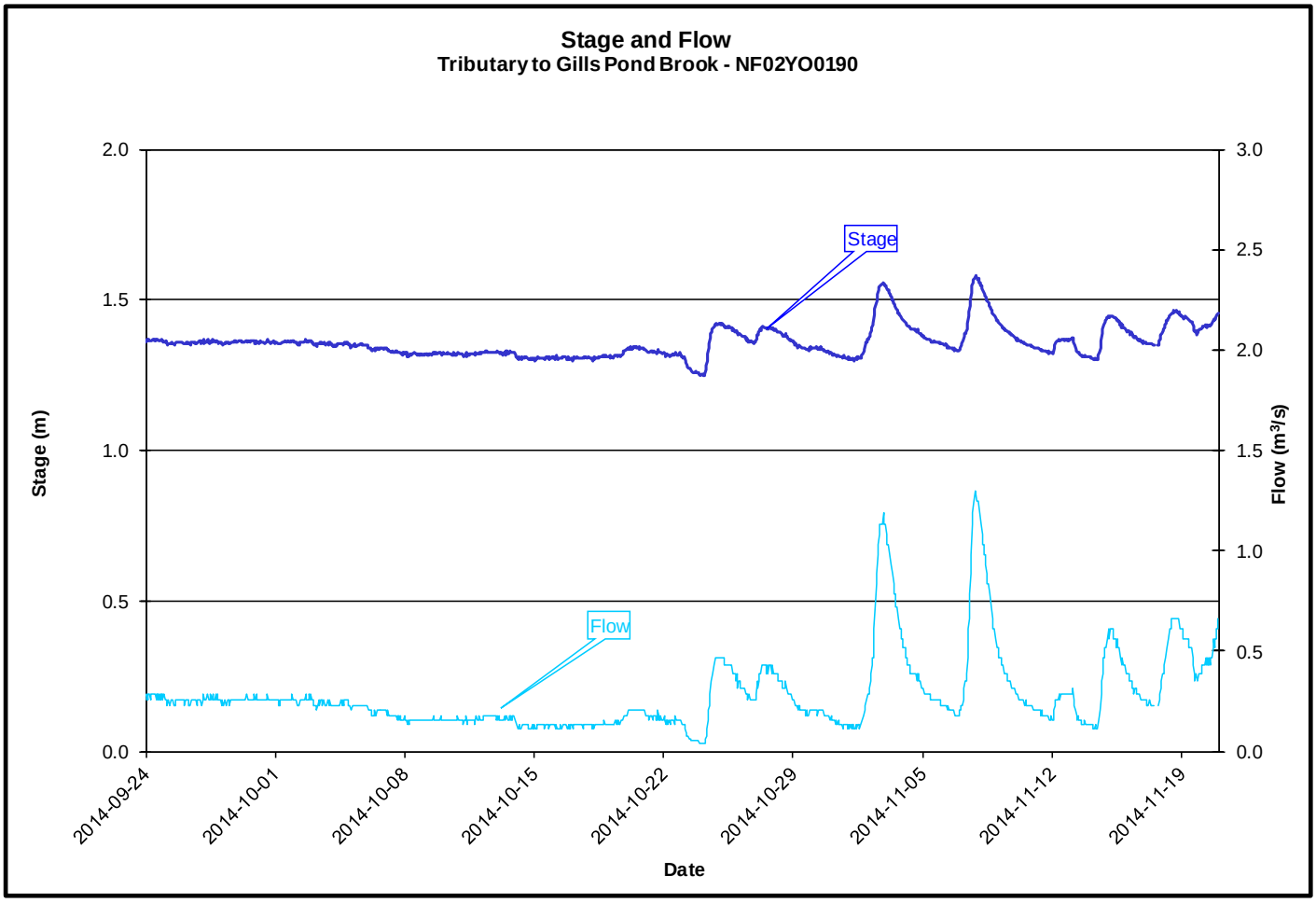

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 0.14 ˚C to a maximum of 16.24 ˚C.
- There was a decrease in water temperatures over the deployment period as winter set in.
- There does not appear to be any correlation with stage during this reporting period, however there was less diurnal variation after stage increased on October 25, 2014.

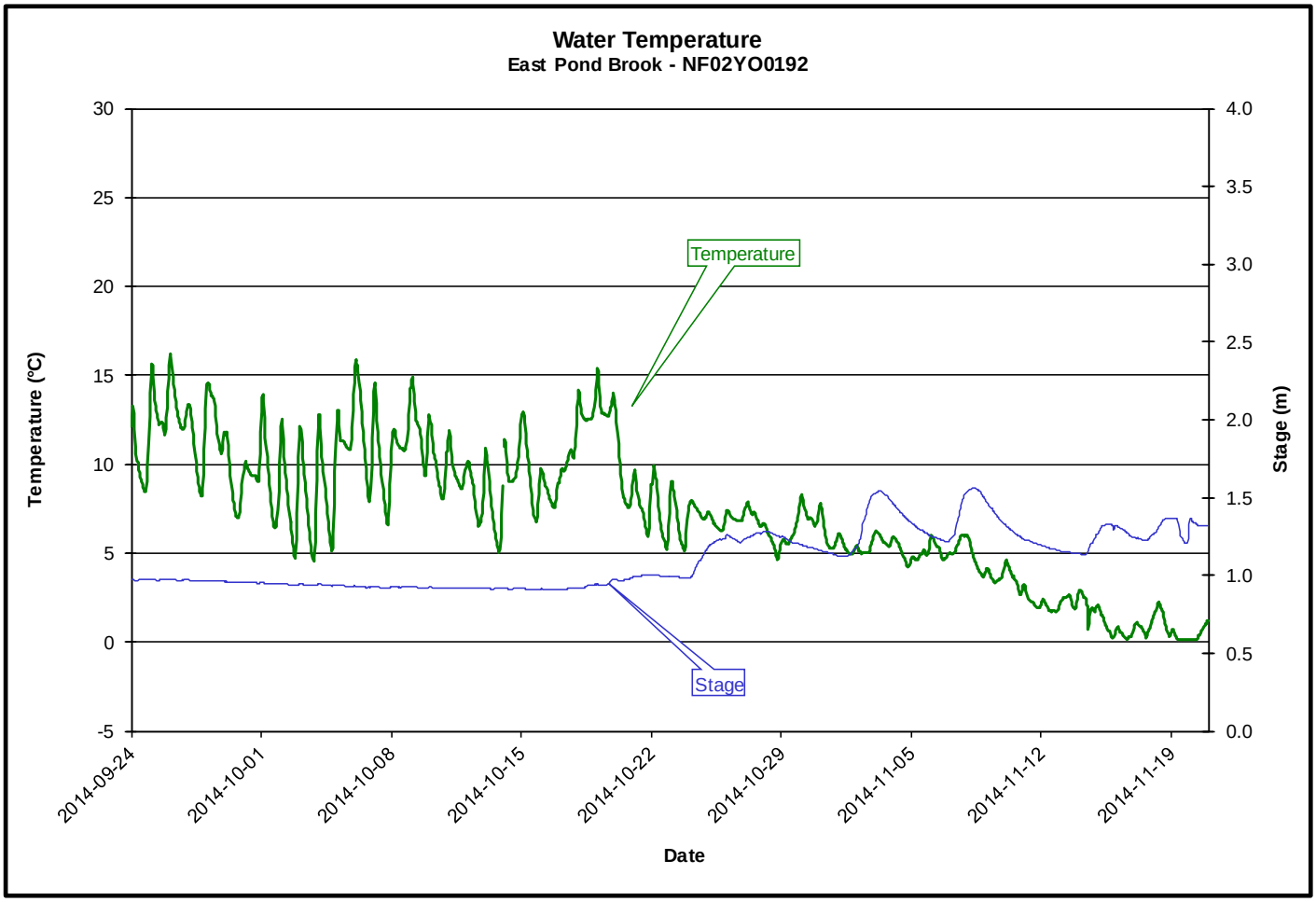

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 5.95 to a maximum of 7.26, with pH decreasing in the last half of the deployment period once stream stage began to increase.
- 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*.
- The background pH of this stream is normally quite low, and values near and below the lower limit are not unusual.

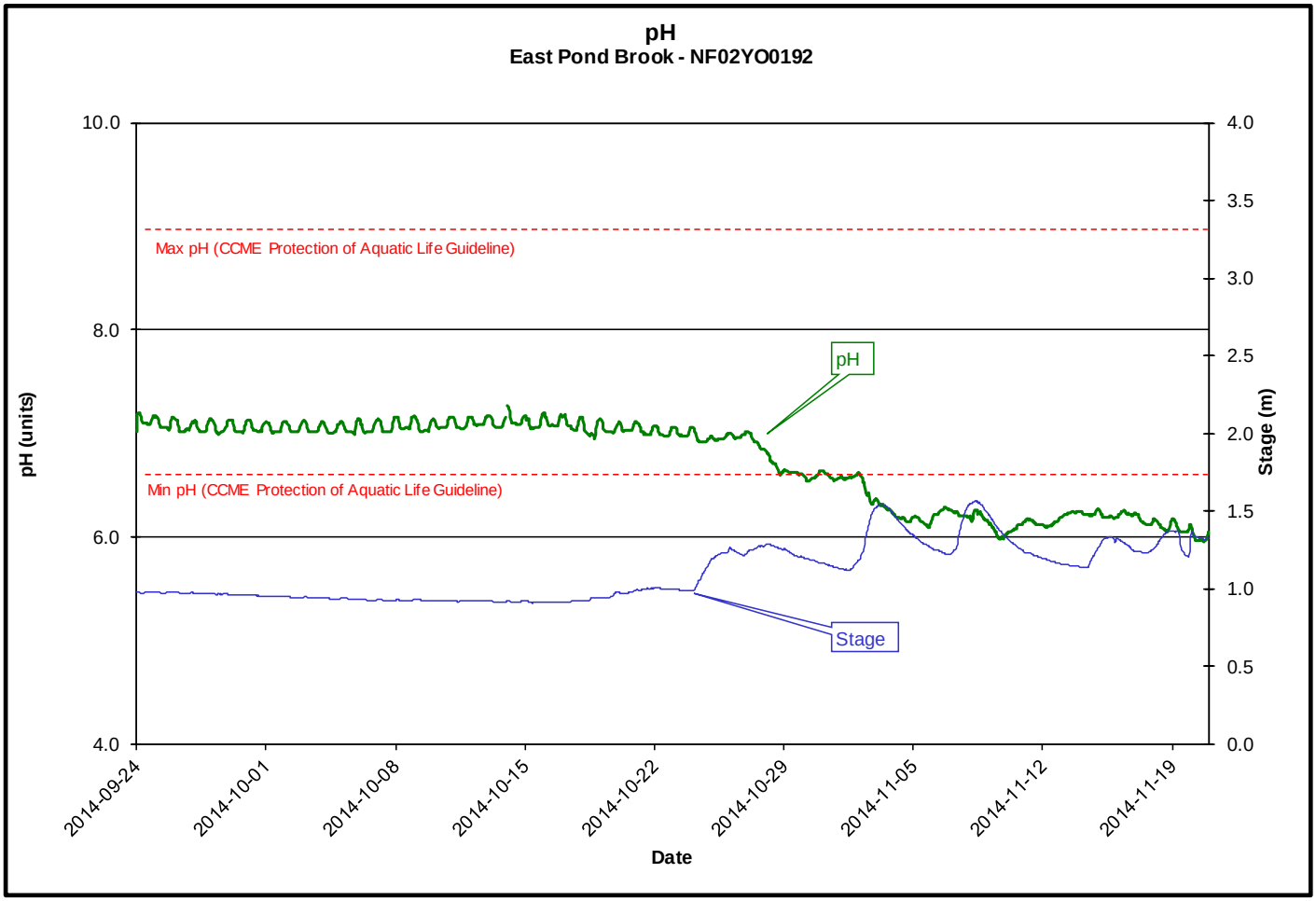

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 13.0 µS/cm to a maximum of 38.0 µS/cm.
- There was a slight decrease in specific conductance over the deployment period.
- There was a positive correlation between specific conductivity and stage particularly evident after the precipitation/runoff events after October 25, 2014.
- All values are within the normal range.

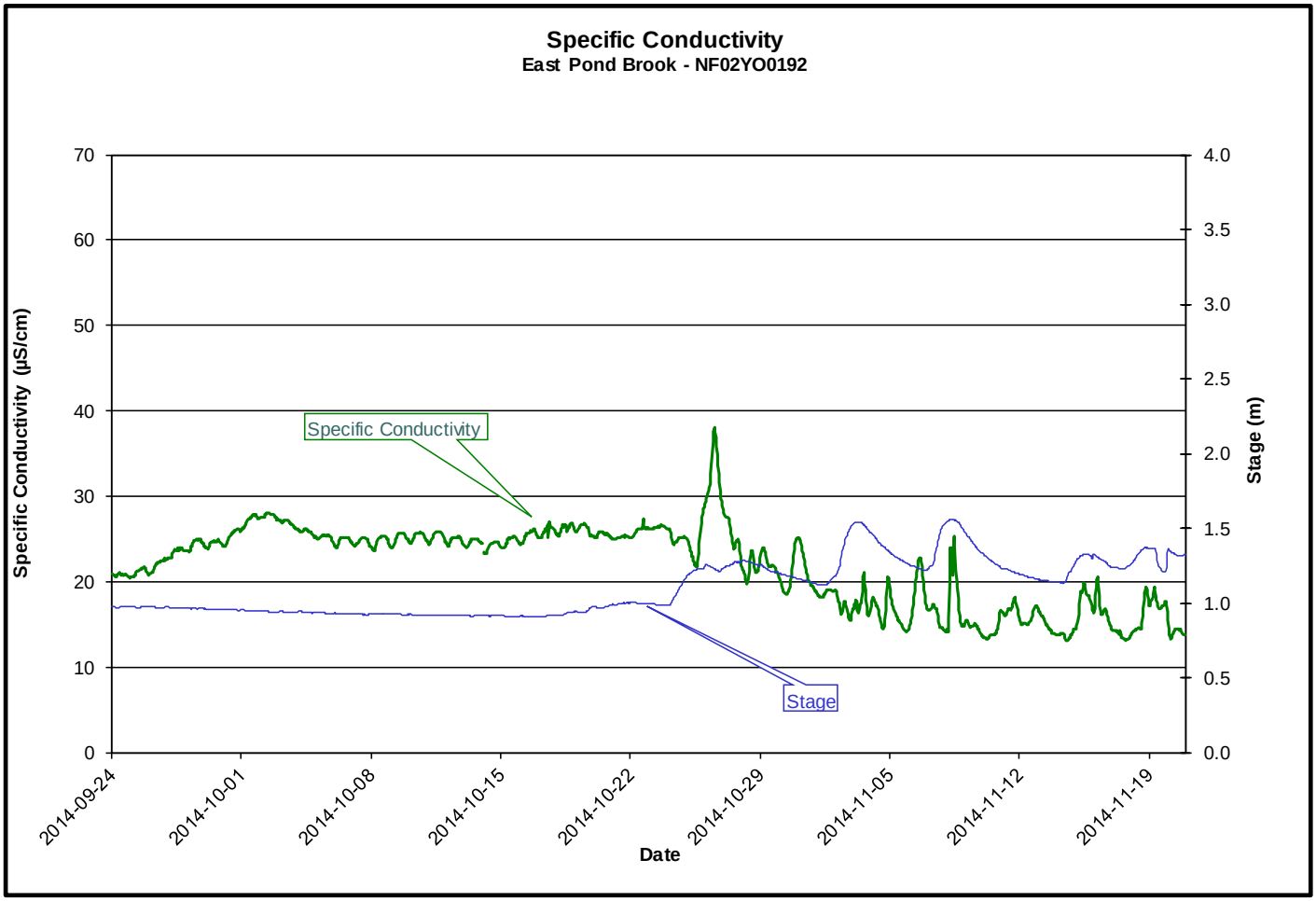

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 9.17 mg/L to a maximum of 13.51 mg/L over the deployment period, with the percent saturation ranging between 87.9 and 97.5.
- Dissolved oxygen (mg/L) tended to increase over the deployment period, which corresponds with the decrease in temperature (**Figure 7**)
- Nearly 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.

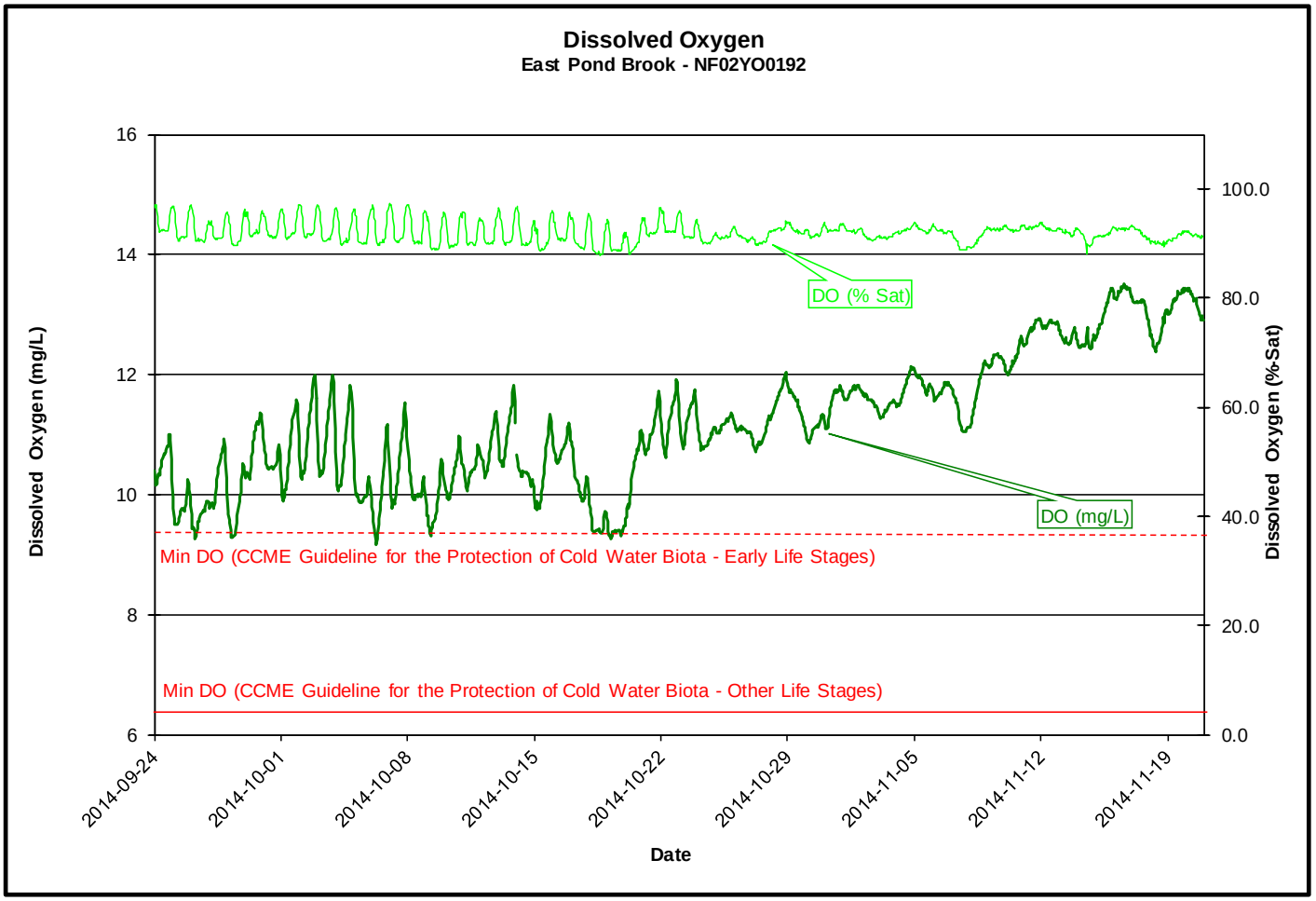

Figure 10

- The turbidity values (**Figure 11**) were all recorded at 0.0 NTU.

- The turbidity sensor failed after 5 days of deployment, resulting in potentially inaccurate turbidity readings for most of the deployment period. All questionable turbidity data have been removed from the dataset.

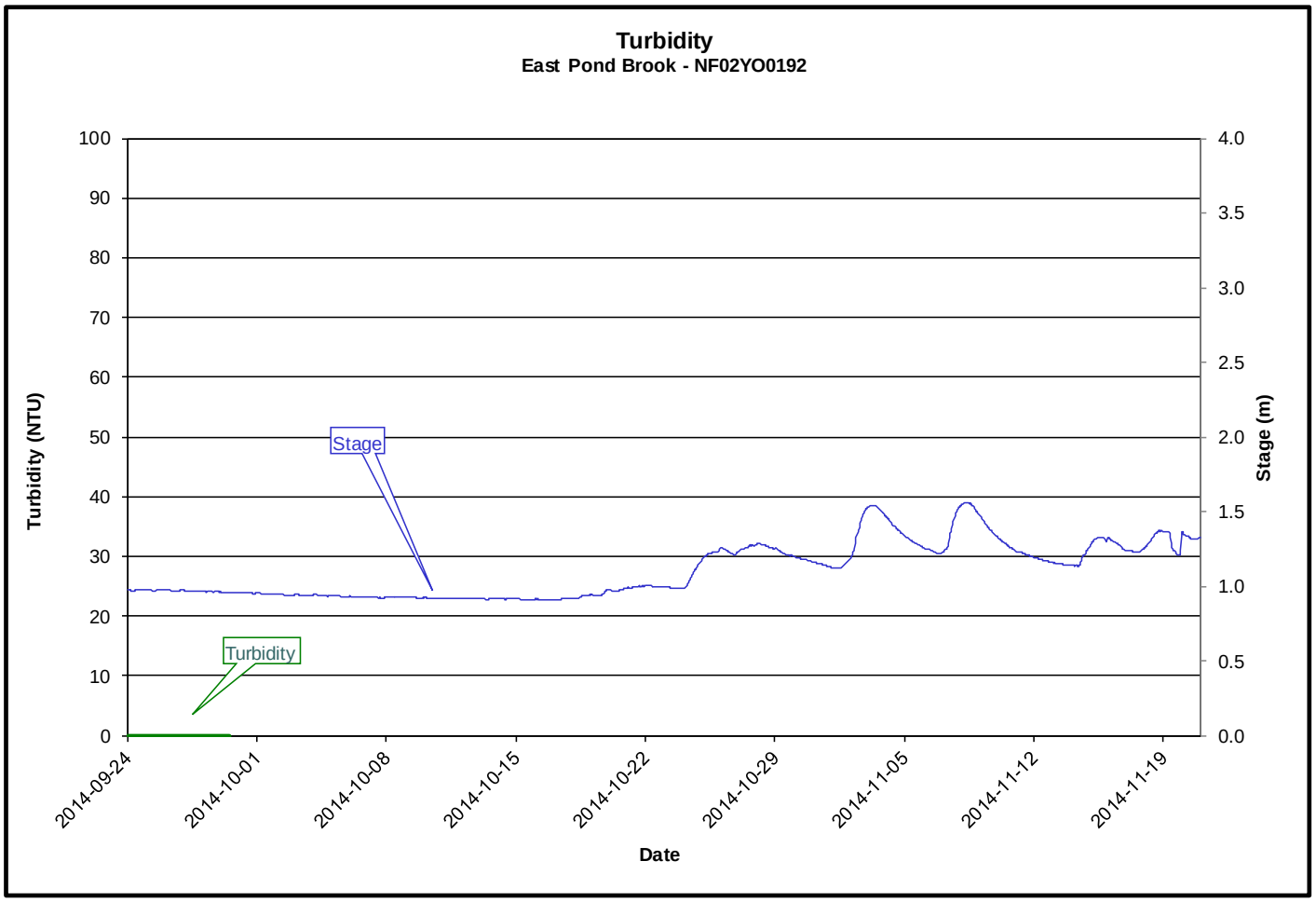

Figure 11

- The stage or water level ranged from a minimum of 0.91 m to a maximum of 1.56 m. The flow or discharge ranged from a minimum of 0.11 m^3/s to a maximum of 6.94 m^3/s **(Figure 12)**.
- Stage and flow remained fairly constant until the onset of precipitation/runoff events beginning on October 25, 2014.
- All values are within normal ranges.

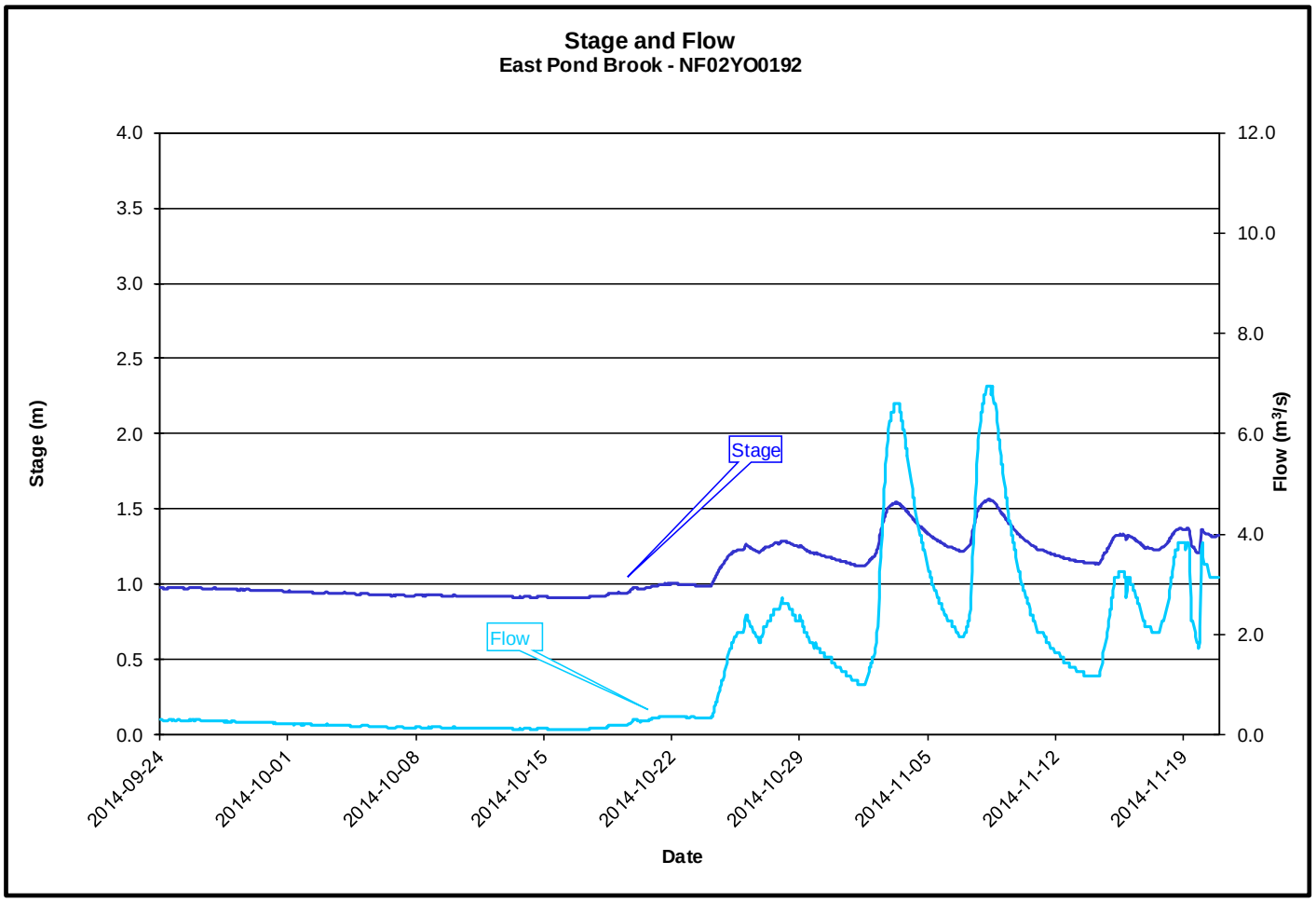

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.54 ˚C to a maximum of 6.26 ˚C with a slight increase over the deployment period.
- During the period highlighted by the red ellipse, a different instrument was used with which temperature measurements are typically recorded approximately 0.25 ˚C higher. This difference is well within the technical specifications for the instrument.
- There appears to be no correlation with water elevation.

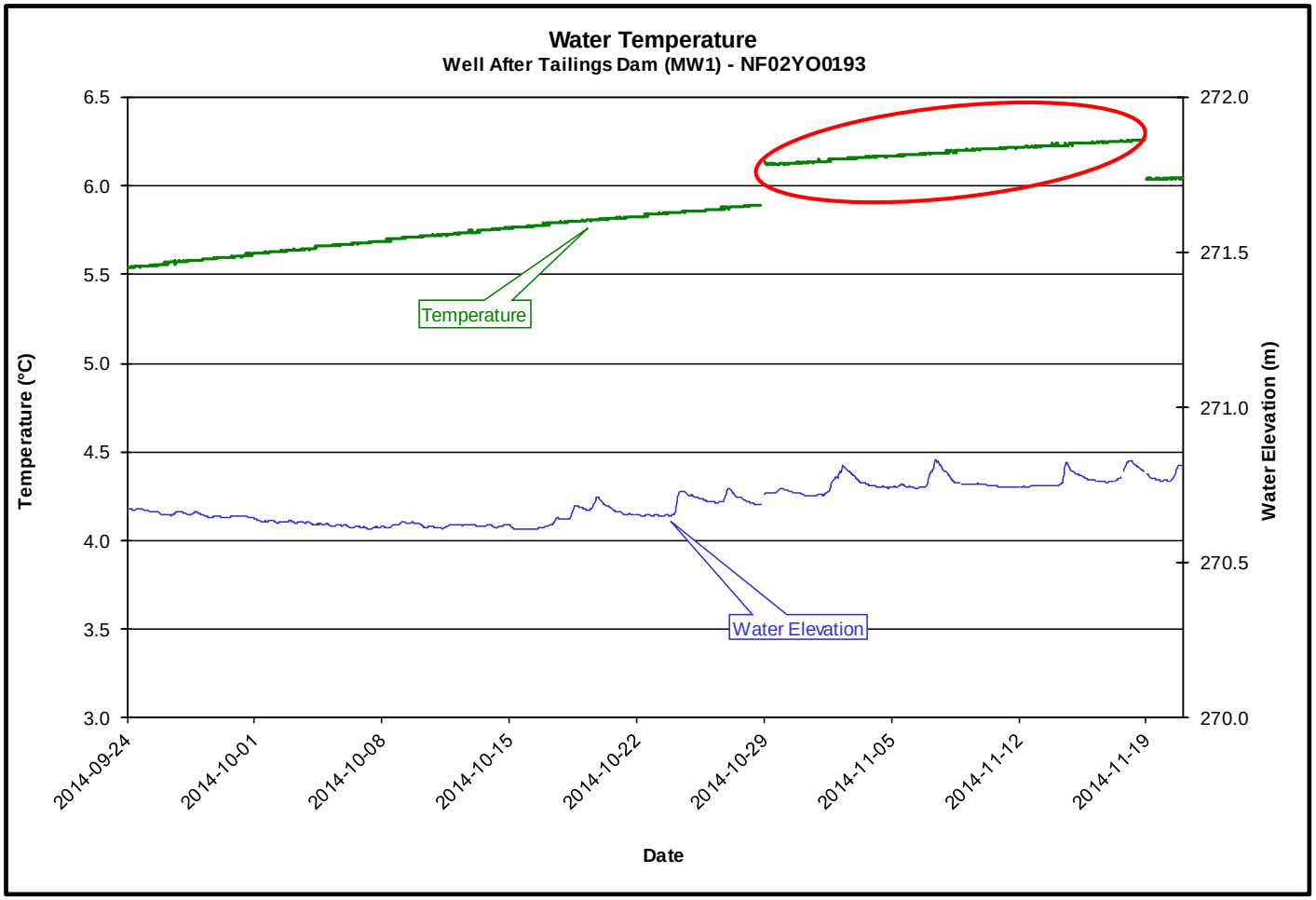

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 7.46 to a maximum of 8.57.
- Unfortunately, the pH sensor failed shortly after deployment on October 29, 2014. All unreliable pH data from that date to November 19, 2014 have been removed from the dataset.
- 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. This is highlighted by the red ellipse.
- There does not appear to be any correlation with water elevation.

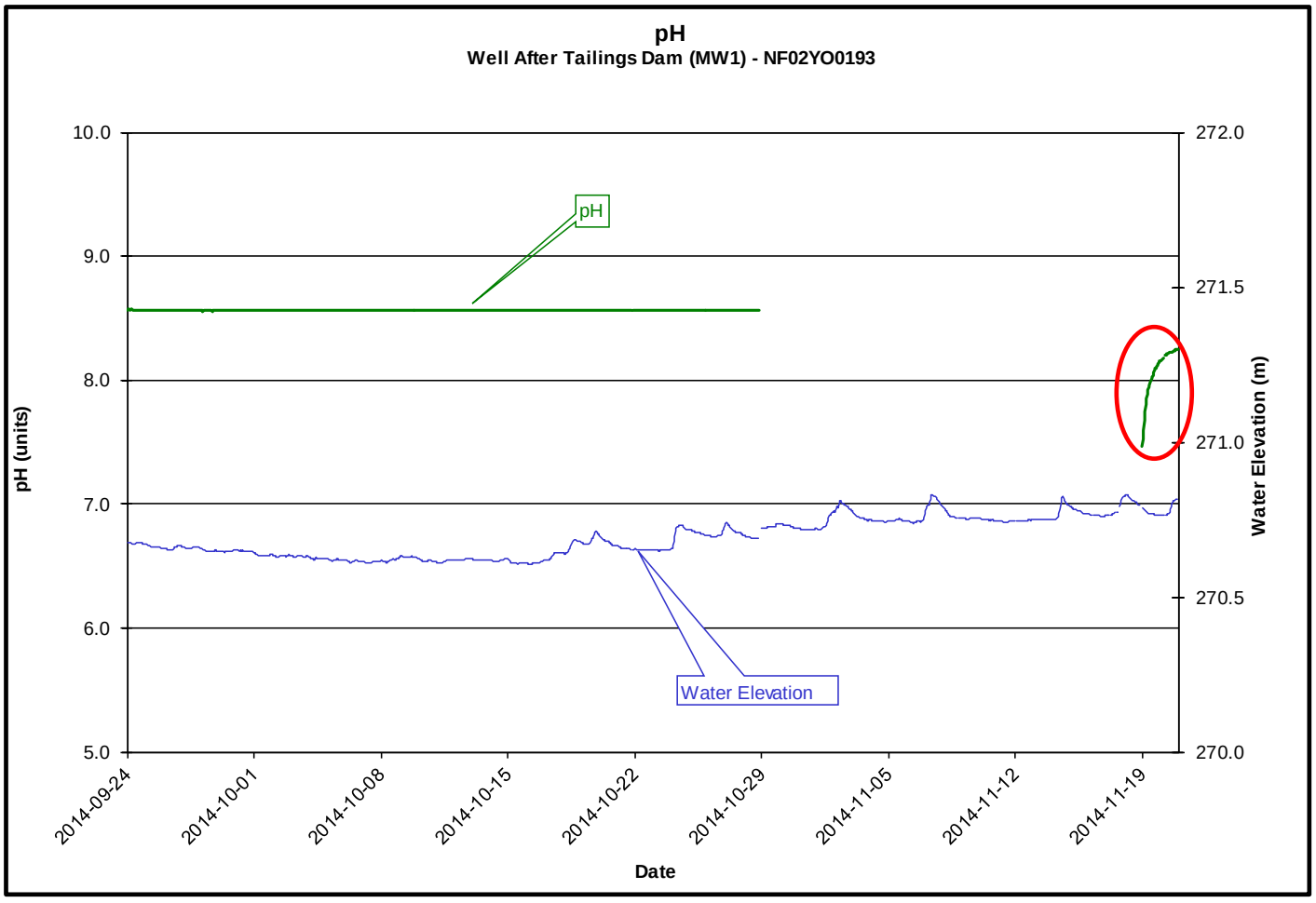

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.777 mS/cm to a maximum of 0.807 mS/cm.
- During the period highlighted by the red ellipse, a different instrument was used with which specific conductance measurements were slightly lower than the instrument used before and after this period.. This difference is well within the technical specifications for the instrument.
- There was a slight increase over the deployment period.

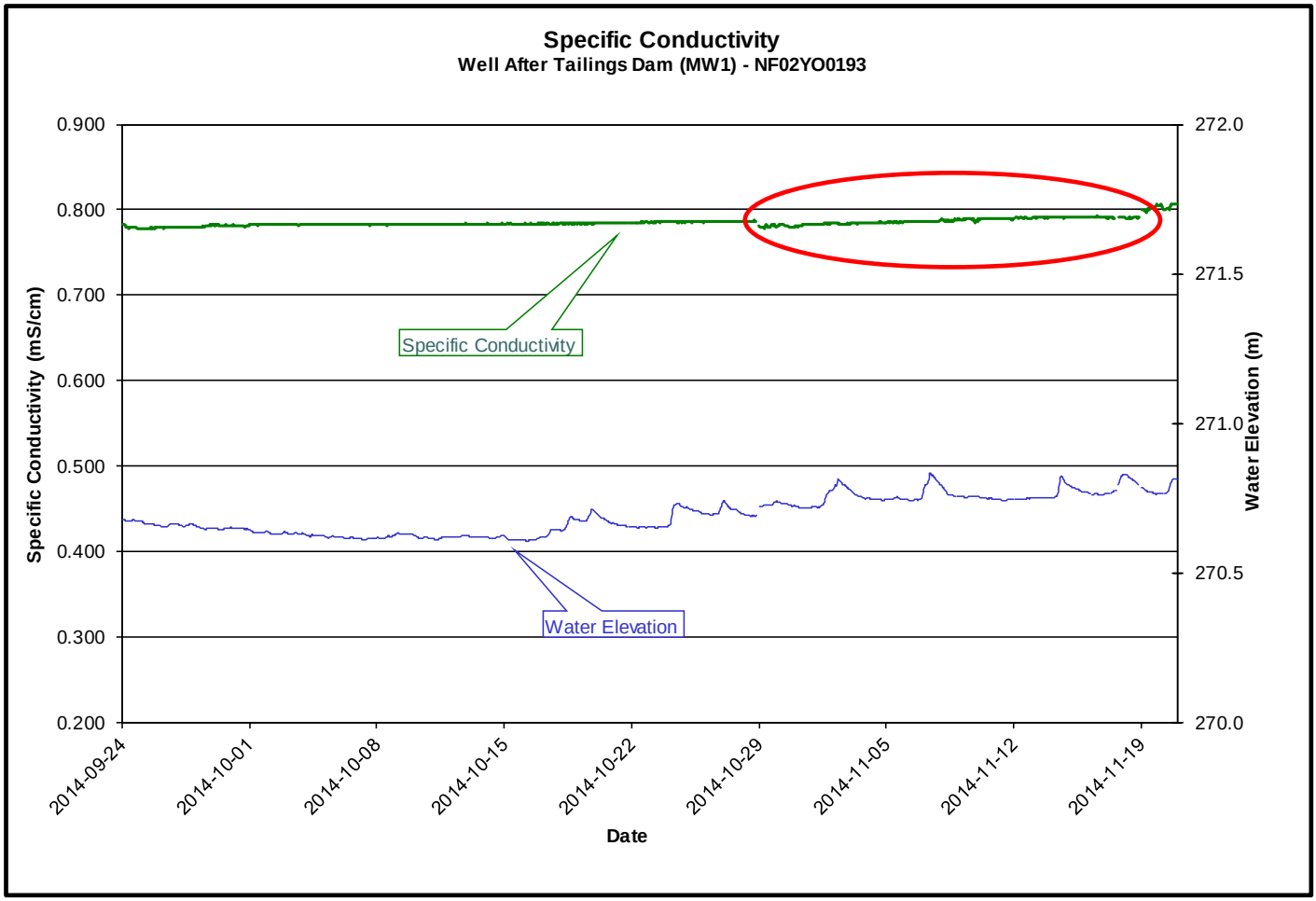

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.61 m to a maximum of 270.83 m.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by precipitation/runoff events.

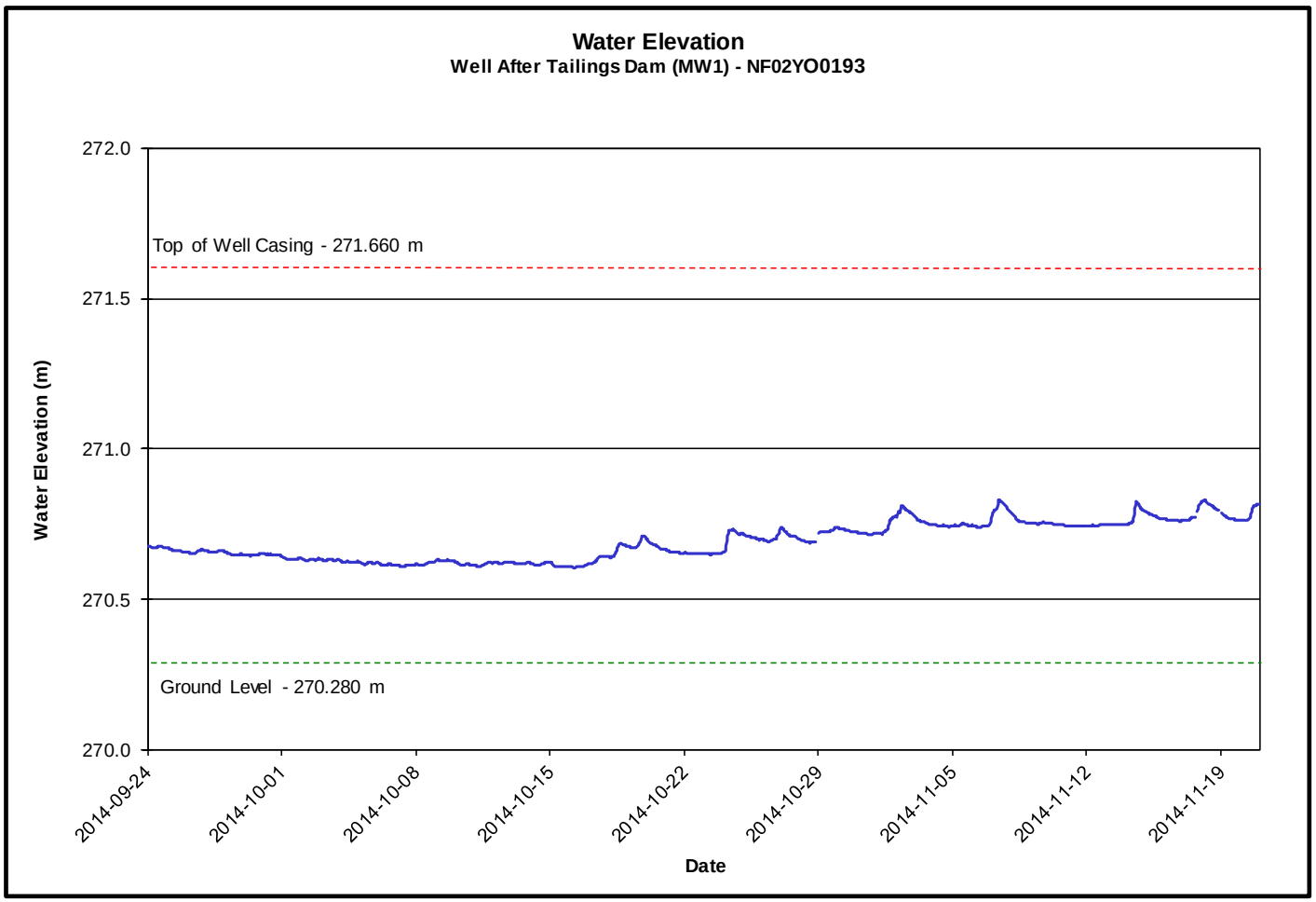

Figure 16

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