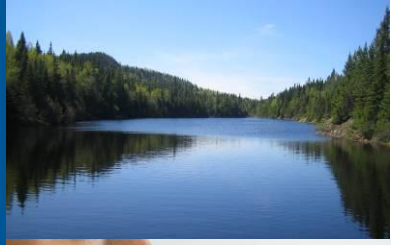




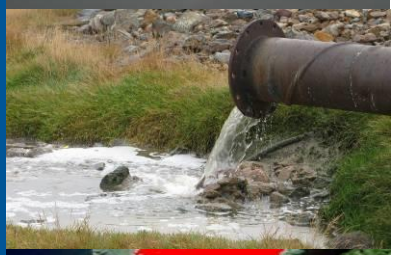


Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2014-05-13 to 2014-06-25

2014-07-03

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) for 4 separate events over the deployment period:
    - From Beginning to 2014-05-16
    - 2014-06-02 to 2014-06-07
    - 2014-06-14 to 2014-06-20
    - 2014-06-24 to the end of the deployment period

Maintenance and Calibration of Instrumentation

- **DataSonde®**(s/n 62268) was deployed in Tributary to Gills Pond Brook on May 13, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until June 25, 2014; a 42 day period.
- **DataSonde®**(s/n 62267) was deployed in East Pond Brook on May 13, 2014 after being cleaned and freshly calibrated, and remained deployed continuously until June 25, 2014; a 42 day period.
- **MiniSonde®** (s/n 44998) was used for QA/QC purposes during the installation of the instruments, and **MiniSonde®** (s/n 47591), was used during removal. Both instruments, having the same technical specifications as the **DataSondes®**, were cleaned and freshly calibrated prior to each use.
- **Quanta G®** (s/n 00653) was deployed on November 13, 2013 and remained deployed continuously in Monitoring Well After Tailings Dam Station (MW1), until June 3, 2014 when it was switched out with **Quanta G®** (s/n 00035). This report covers the period from May 13, 2014 through June 25, 2014, a 42 day period, which covers the deployment of the two 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 and **Table 3** for East Pond Brook.
- A 'Fair' ranking was determined for Turbidity for East Pond Brook upon installation. The Field **DataSonde®** read 5.5 NTU while the QA/QC **MiniSonde®** read 0.0 NTU.
- 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. See **Table 4**.
- A 'Fair' ranking was determined for pH for Well After Tailings Dam (MW1) upon installation. This is typical of new deployments in this well. Refer to discussion on page 18
- 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**
2014-05-13 Installation	Temp (^{o}C)	Good
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Good
2014-06-25 Removal	Temp (^{o}C)	Excellent
	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**
2014-05-13 Installation	Temp (^{o}C)	Good
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Good
	Turbidity (NTU)	Fair
2014-06-25 Removal	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent

Table 3

Well After Tailings Dam (MW1) Station (NF02YO0193)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2014-06-03 Removal	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
2014-06-03 Installation	pH (units)	Fair
	Sp. Conductivity (µS/cm)	Excellent

Table 4

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of 3.54˚C to a maximum of 21.89˚C.
- The temperatures throughout the deployment period are typical for this time of year.
- As expected there is an inverse relationship with dissolved oxygen (mg/L) (See **Figure 4**).
- There does not appear to be any correlation with stage.

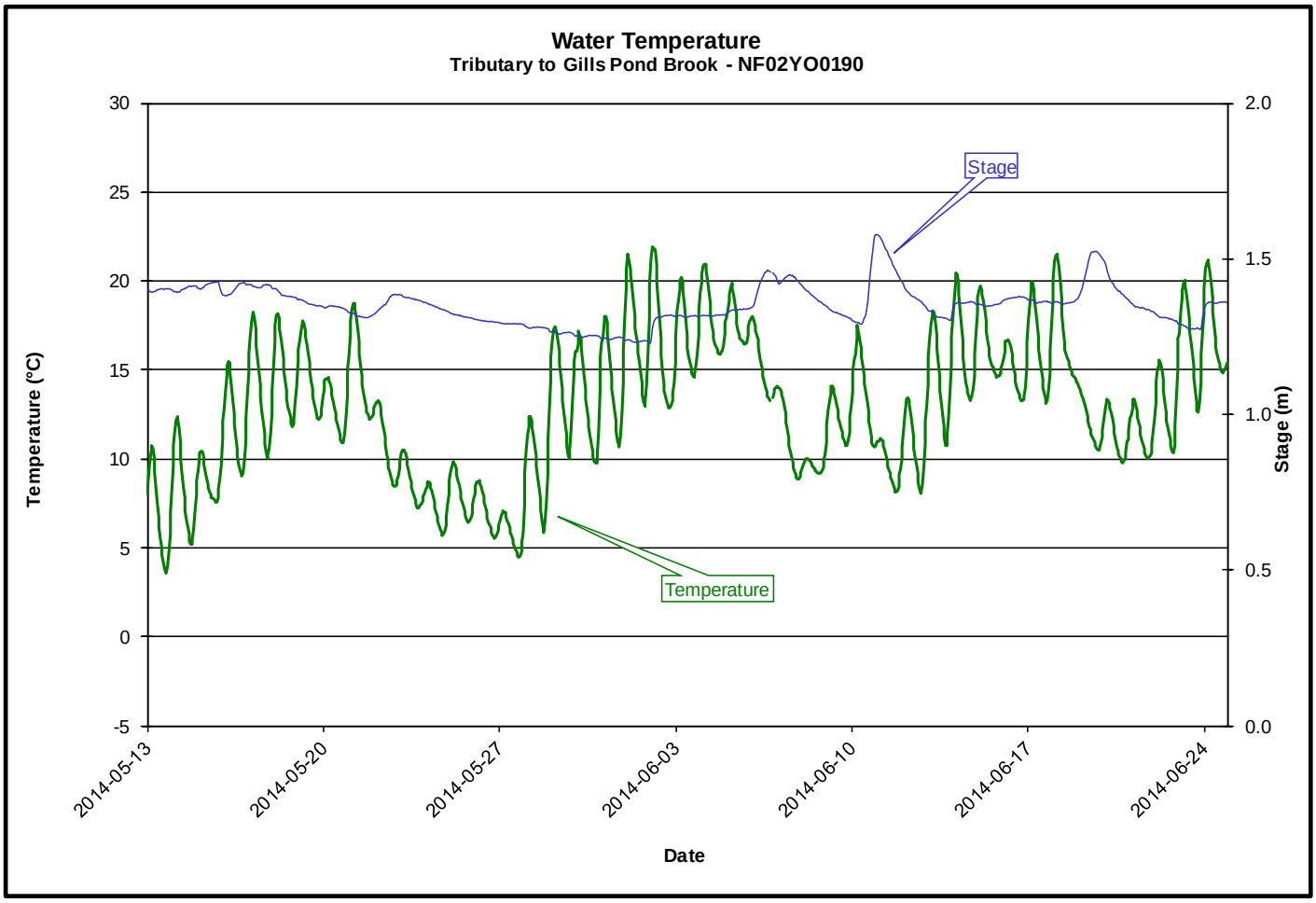

Figure 1

- Throughout the deployment period, pH values (**Figure 2**) ranged from a minimum of 6.07 to a maximum of 7.07 with most values lower than 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 over several events during the deployment period.
- The background pH of this stream is normally around the lower limit of the recommended range, and is usually higher during periods of discharge from Polishing Pond. During this deployment period, however, pH dropped notably at the beginning of the June 2, 2014, June 14, 2014 and June 24, 2014 releases from Polishing Pond.

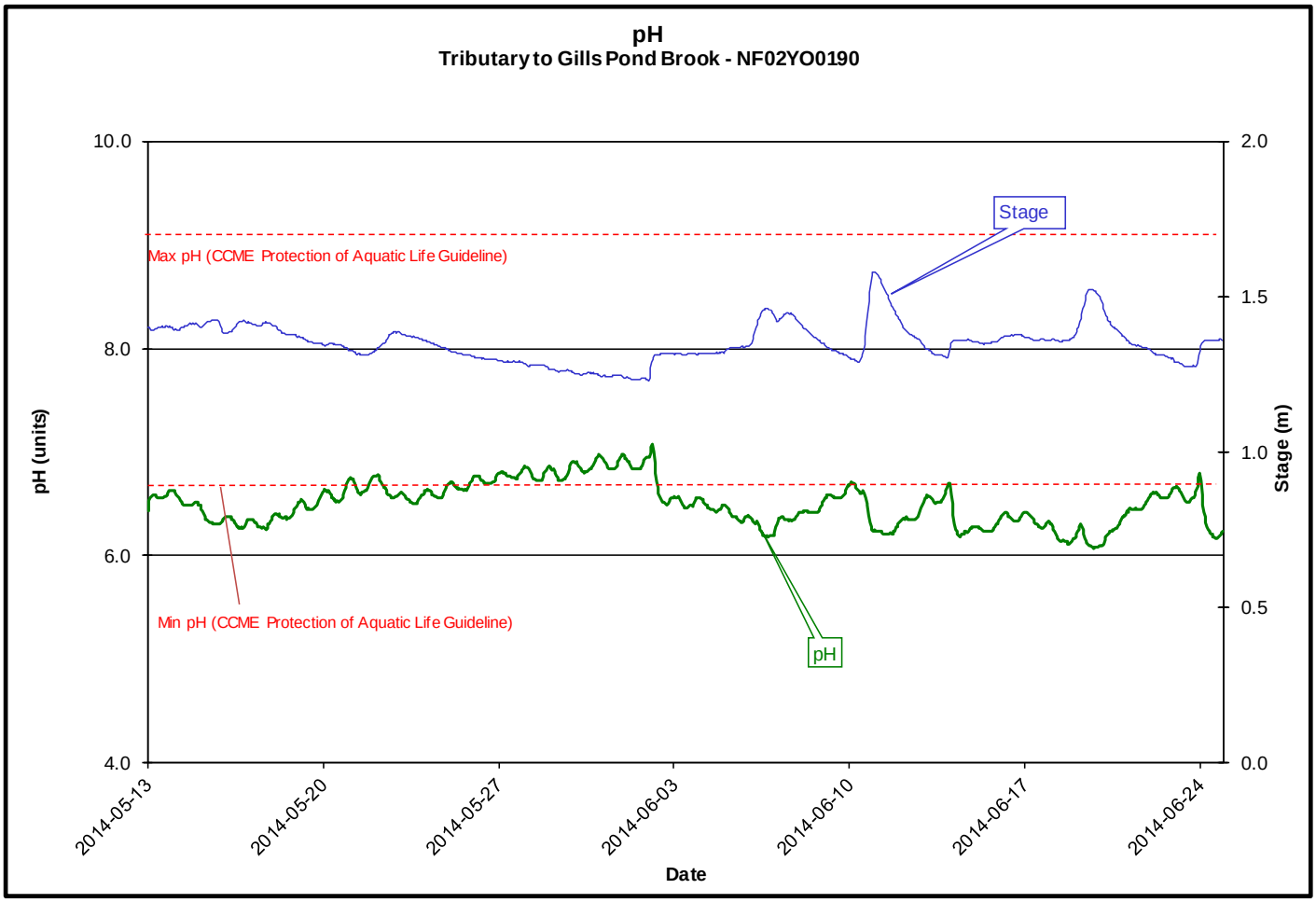

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 21.6 µS/cm to a maximum of 704.00 µS/cm over the deployment period.
- Specific conductance increased significantly during periods when there was discharge from Polishing Pond.

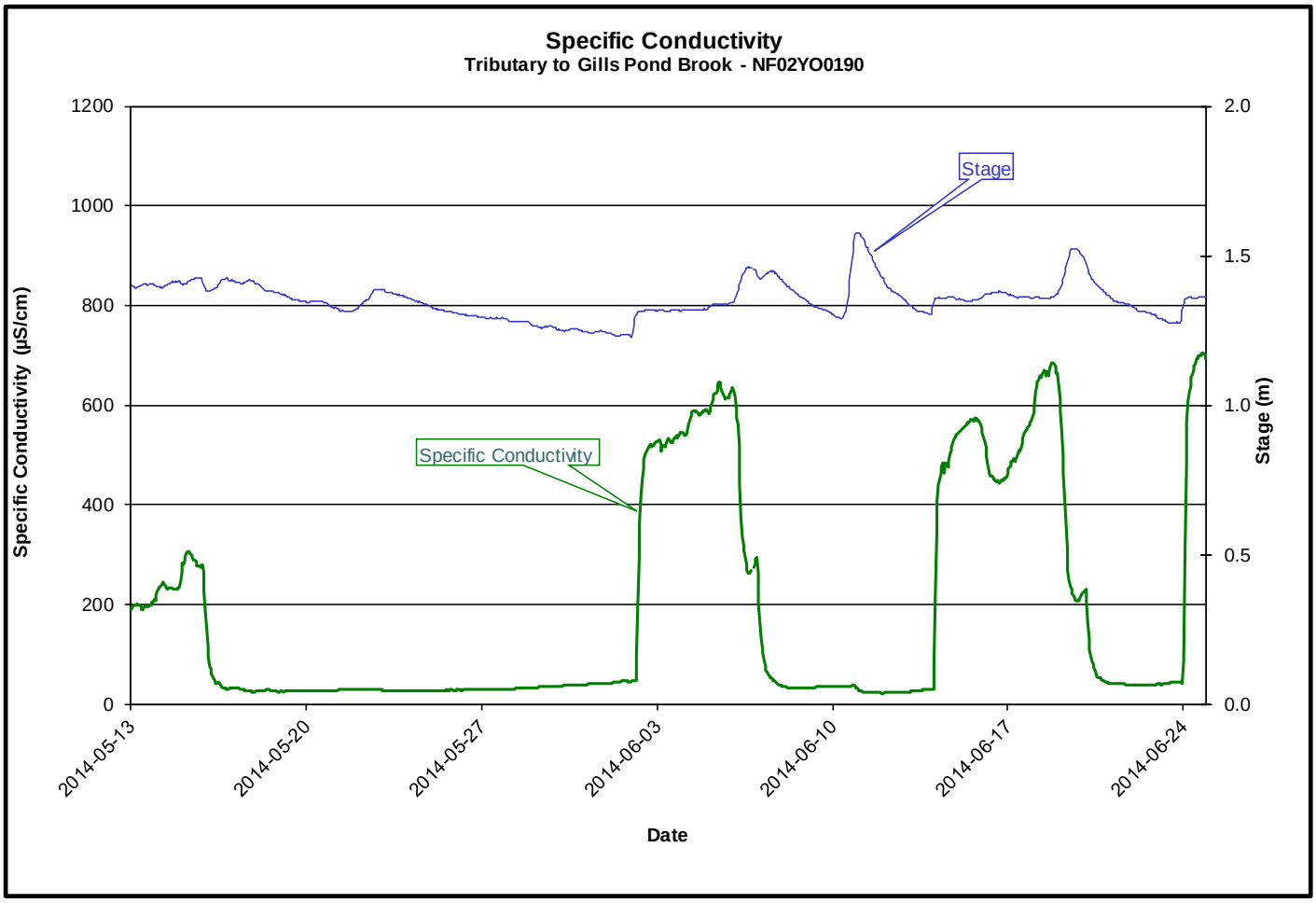

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 8.56 mg/L to a maximum of 12.22 mg/L over the deployment period, with the percent saturation ranging between 82.9 and 100.4.
- Dissolved oxygen (mg/L) decreased slightly over the deployment period.
- As expected there is an inverse relationship between dissolved oxygen (mg/L) and water temperature (see **Figure 1**).
- All of the dissolved oxygen values fell above the minimum for Other 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 change over the deployment period, we can be confident that the Dissolved Oxygen mg/L values are accurate.

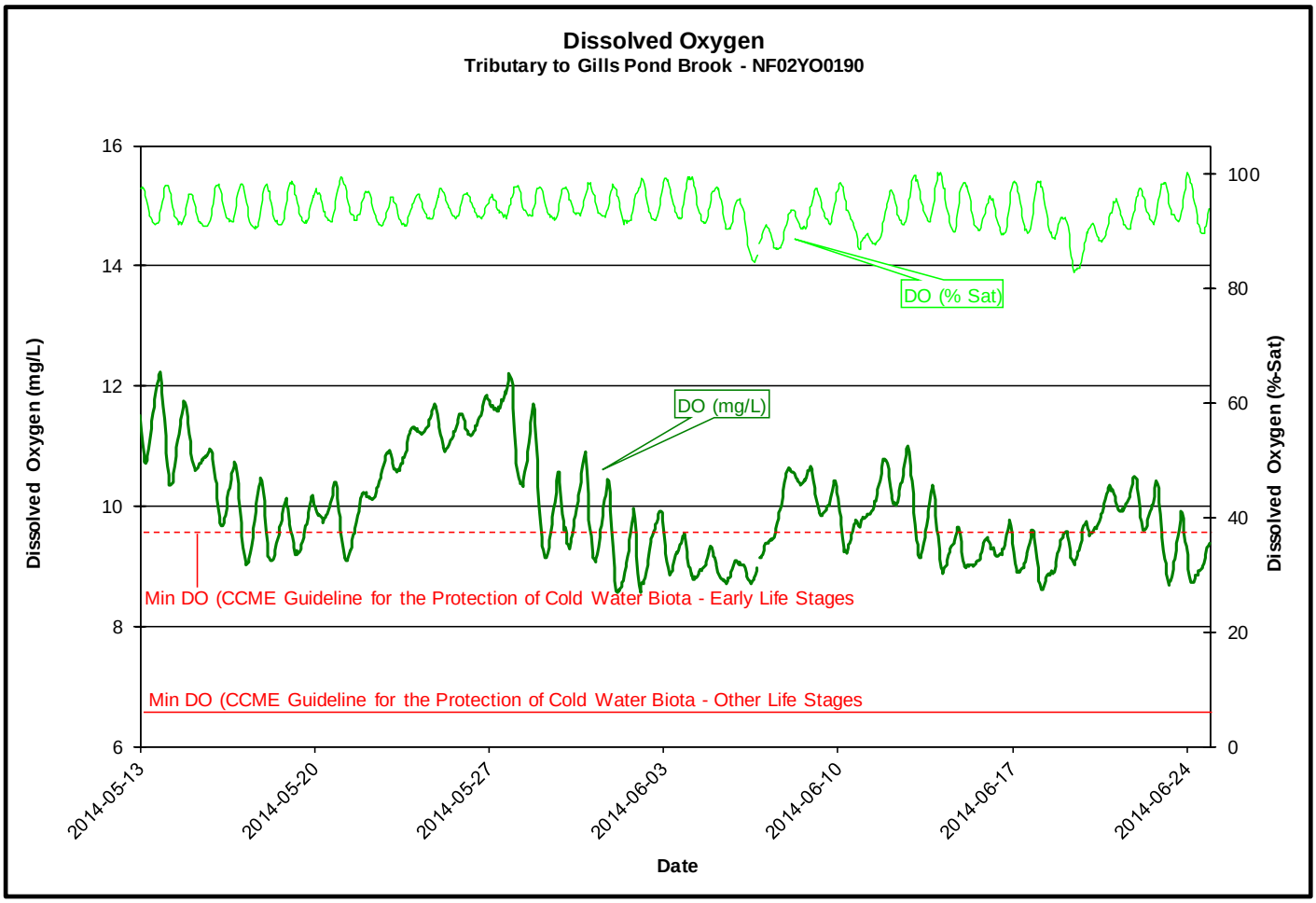

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 9.8 NTU.
- Some of the highest peaks in turbidity were recorded during increased stage.

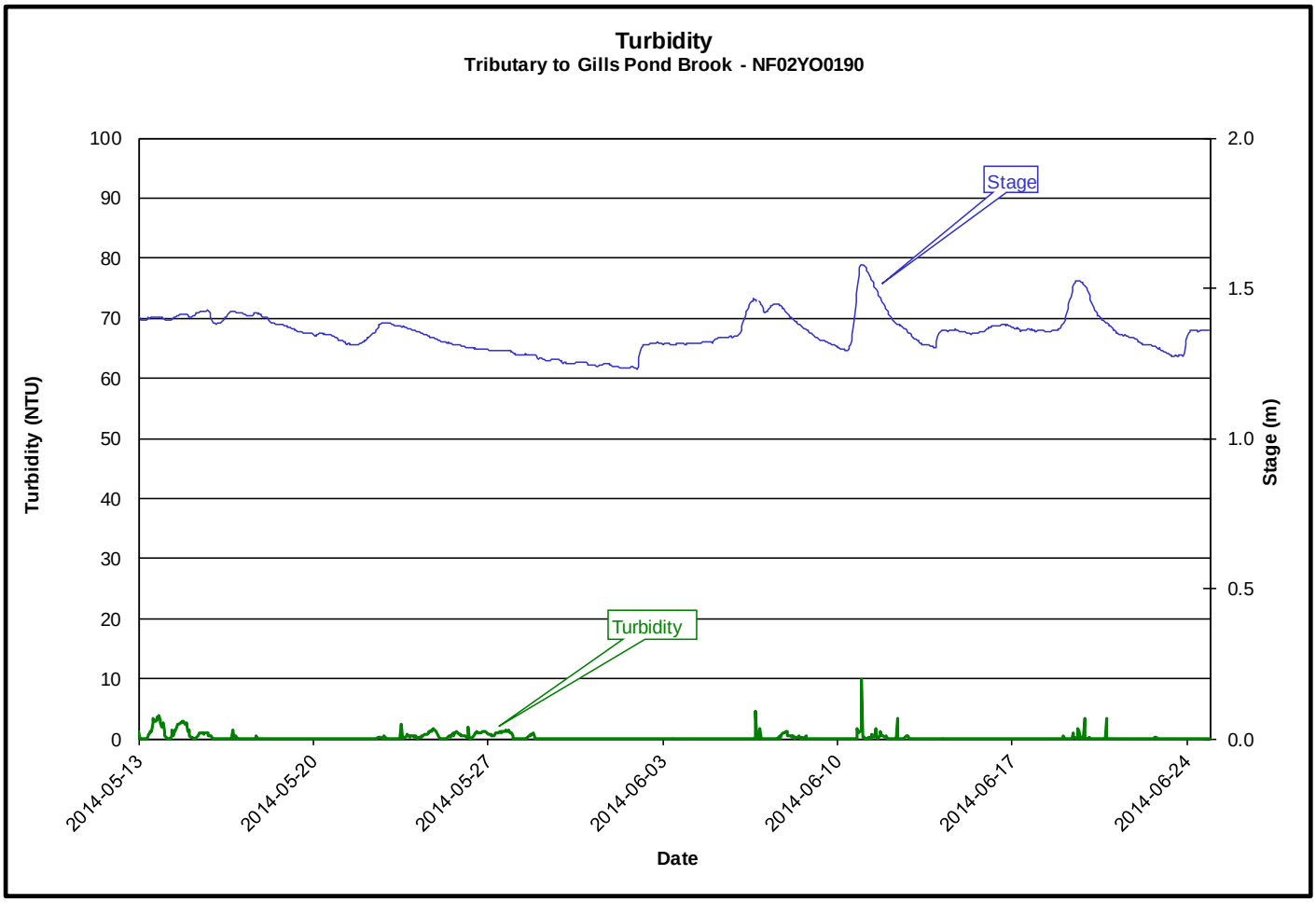

Figure 5

- The stage or water level ranged from a minimum of 1.23 m to a maximum of 1.58 m. The flow or discharge ranged from a minimum of 0.02 m^3/s to a maximum of 1.56 m^3/s (**Figure 6)**.
- The increase in stage and flow during the periods of discharge from Polishing Pond is obvious. The highest peaks are resultant from precipitation/runoff events.
- All values are within the normal range.

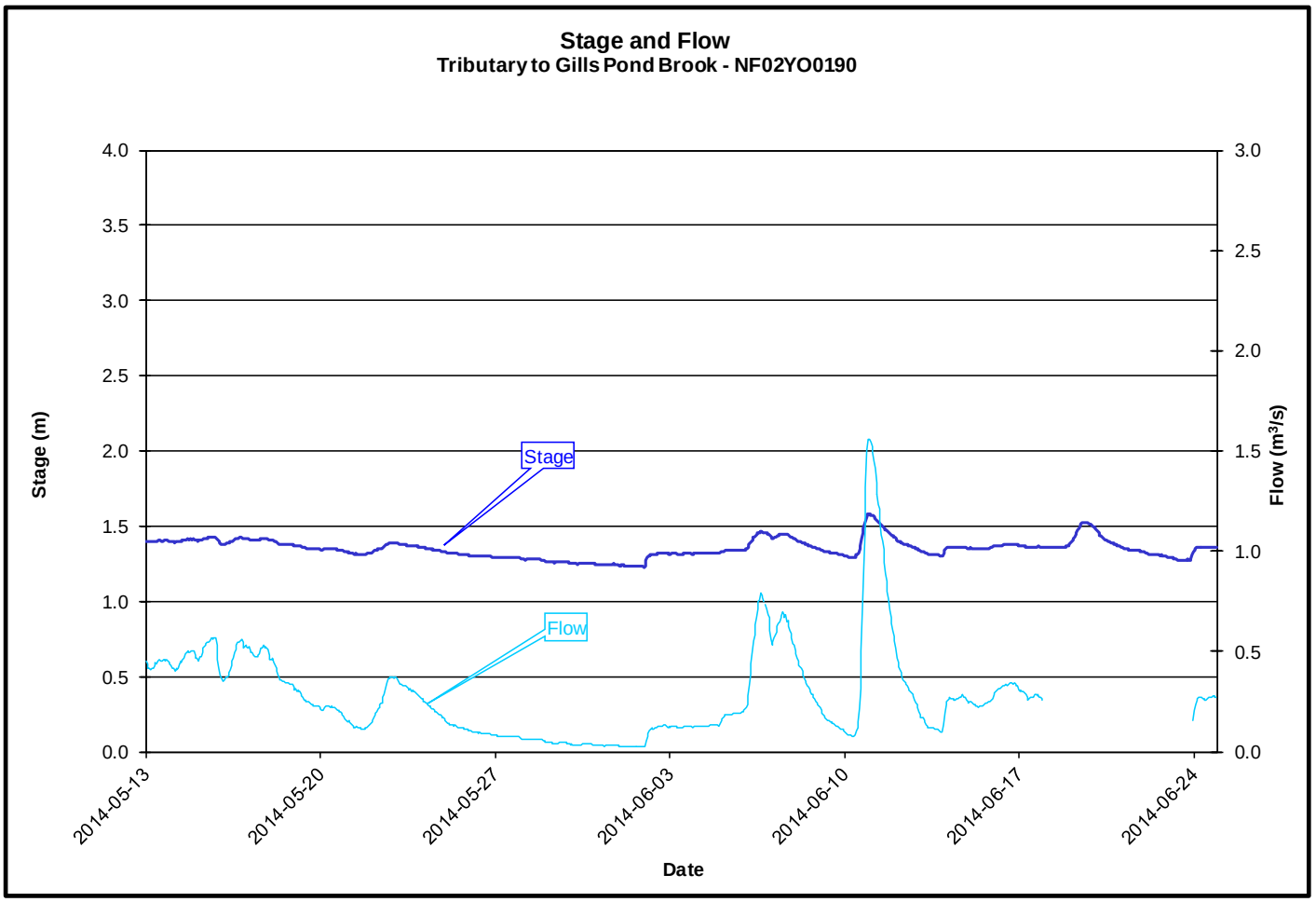

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 5.54 ˚C to a maximum of 21.86 ˚C.
- The temperatures throughout the deployment period are typical for this time of year.
- As expected there is an inverse relationship with dissolved oxygen (mg/L)(see **Figure 10**).
- There does not appear to be any correlation with stage during this reporting period, although during some events, there is less diurnal variation during periods of increased stage.

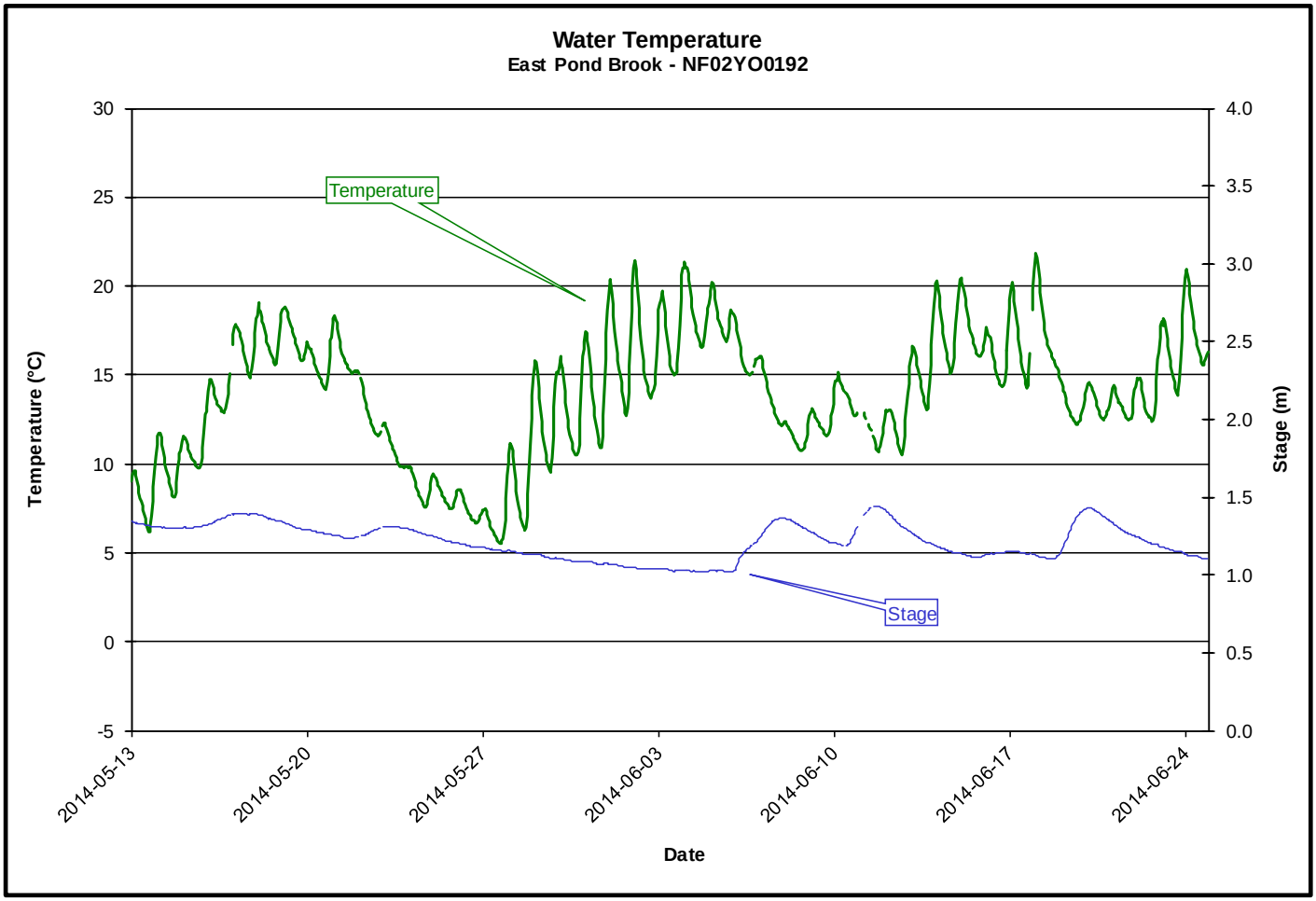

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.24 to a maximum of 6.84, and remained very constant over the deployment period.
- For the entire 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.

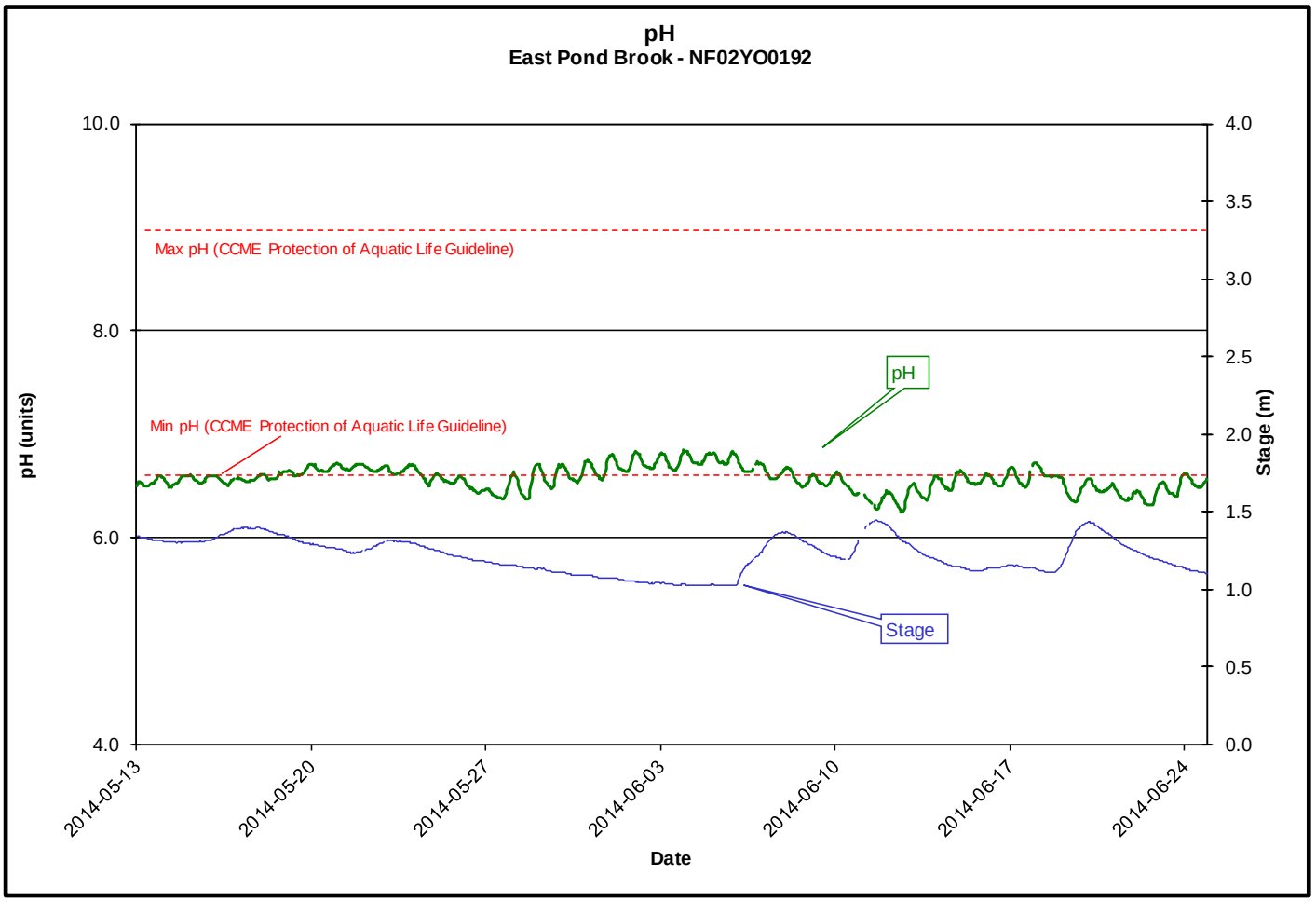

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 11.8 µS/cm to a maximum of 28.1 µS/cm.
- There was little variation throughout the deployment period, however, there is a positive correlation with increases in stage over a couple of events.
- All values are within the normal range.

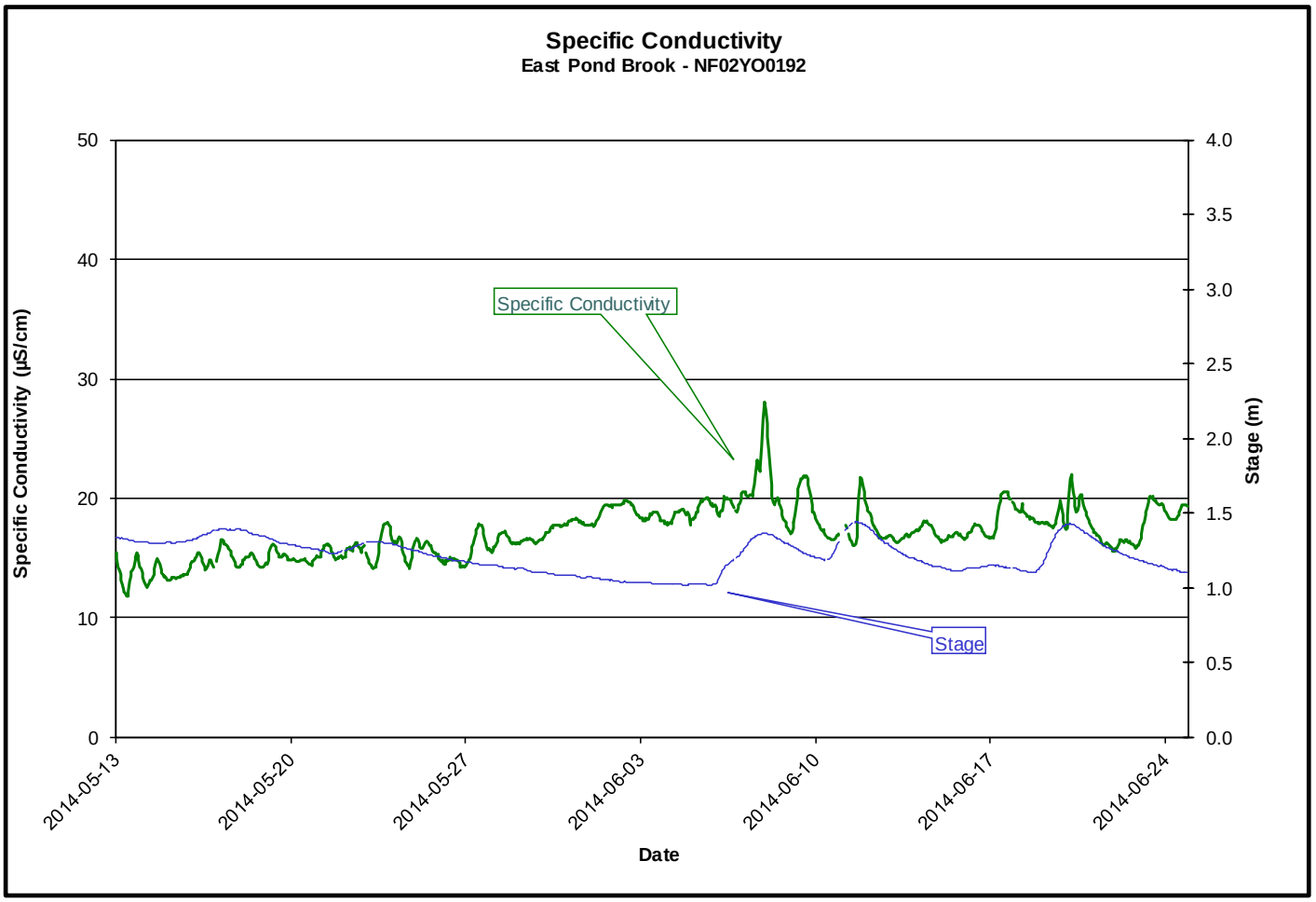

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 8.47 mg/L to a maximum of 12.02 mg/L over the deployment period, with the percent saturation ranging between 92.0 and 99.2.
- Dissolved oxygen (mg/L) tended to decrease toward the end of the deployment period.
- As expected there is an inverse relationship between dissolved oxygen (mg/L) and water temperature (see **Figure 7**).
- All of the dissolved oxygen values fell above the minimum for Other 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 limited drift, we can be confident that the Dissolved Oxygen mg/L values are accurate.

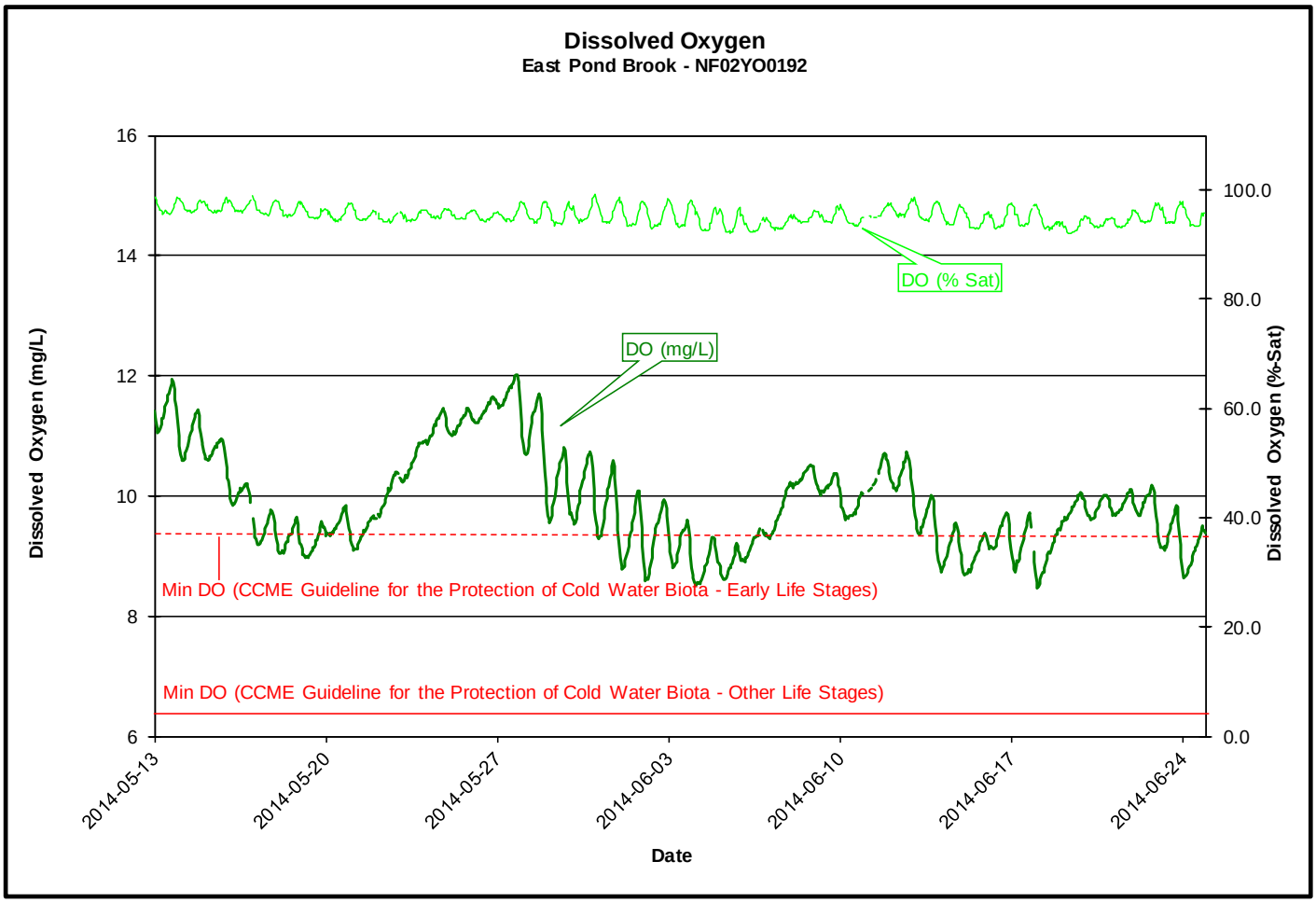

Figure 10

- The turbidity values (**Figure 11**) ranged from a minimum of 0.0 NTU to a maximum of 69.1 NTU.
- There is no obvious explanation for the peaks on June 14, 2014.
- All other turbidity values are typical.

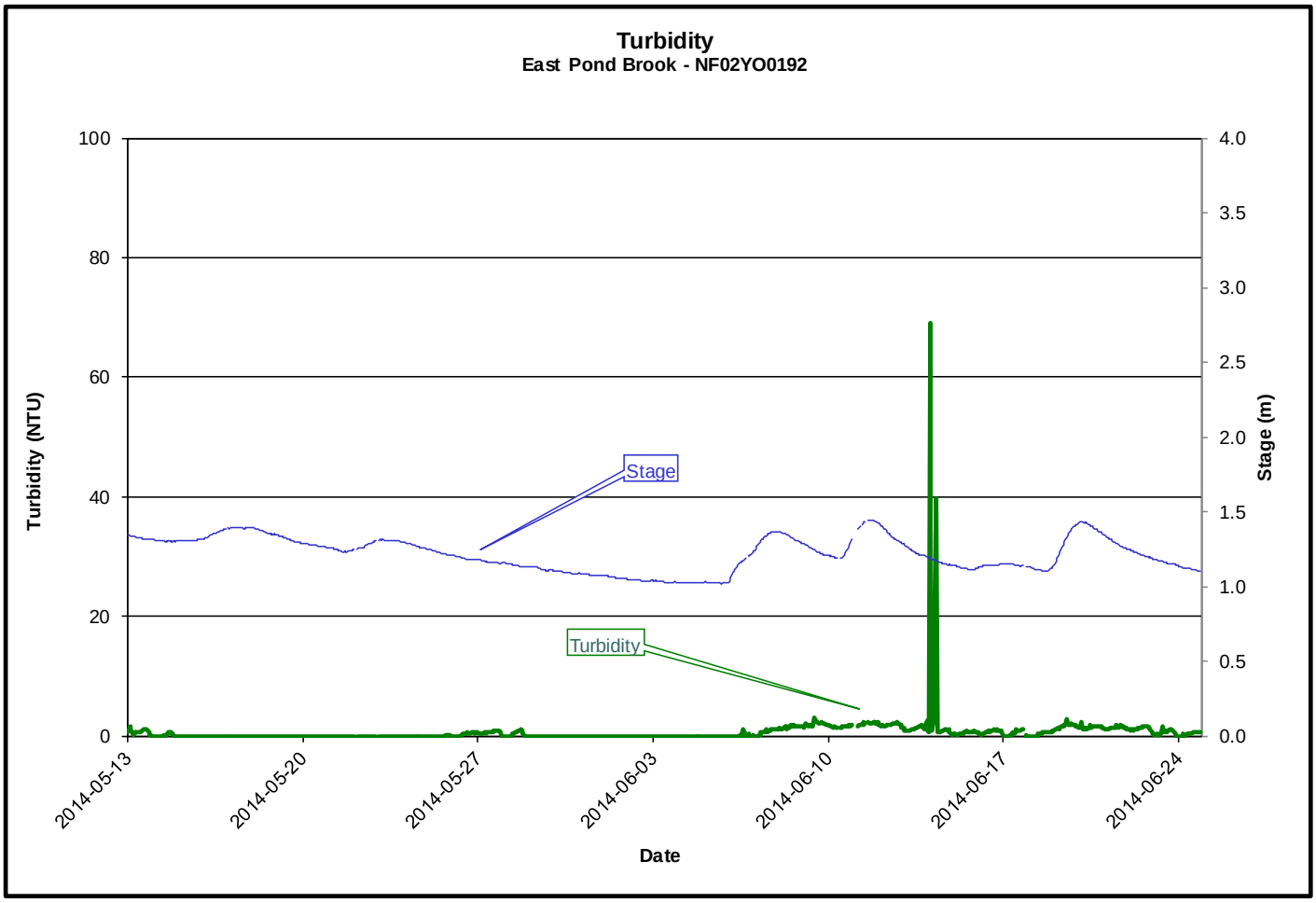

Figure 11

- The stage or water level ranged from a minimum of 1.02 m to a maximum of 1.44 m. The flow or discharge ranged from a minimum of 0.50 m^3/s to a maximum of 4.91 m^3/s **(Figure 12)**.
- Increases in stage and flow are attributed to precipitation/runoff events.
- All values for stage and flow are within the normal range.

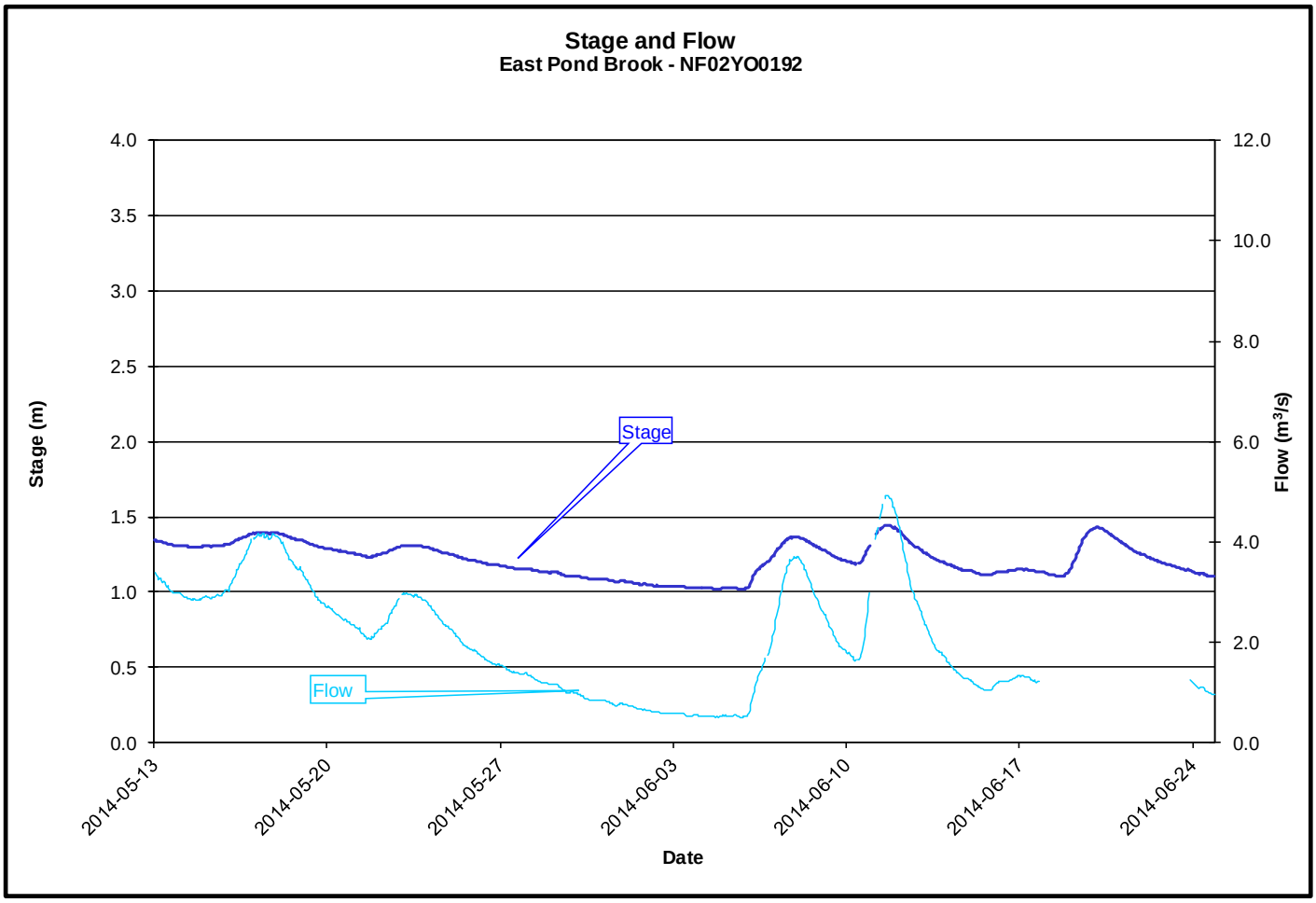

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.02 ˚C to a maximum of 5.48 ˚C with a decrease over the deployment period.
- There is a difference on approximately 0.25 ˚C noted on June 3, 2014. This is presumed to be the difference between the two different instruments, and is well within the technical specifications for the instrument.
- There appears to be no correlation with water elevation.

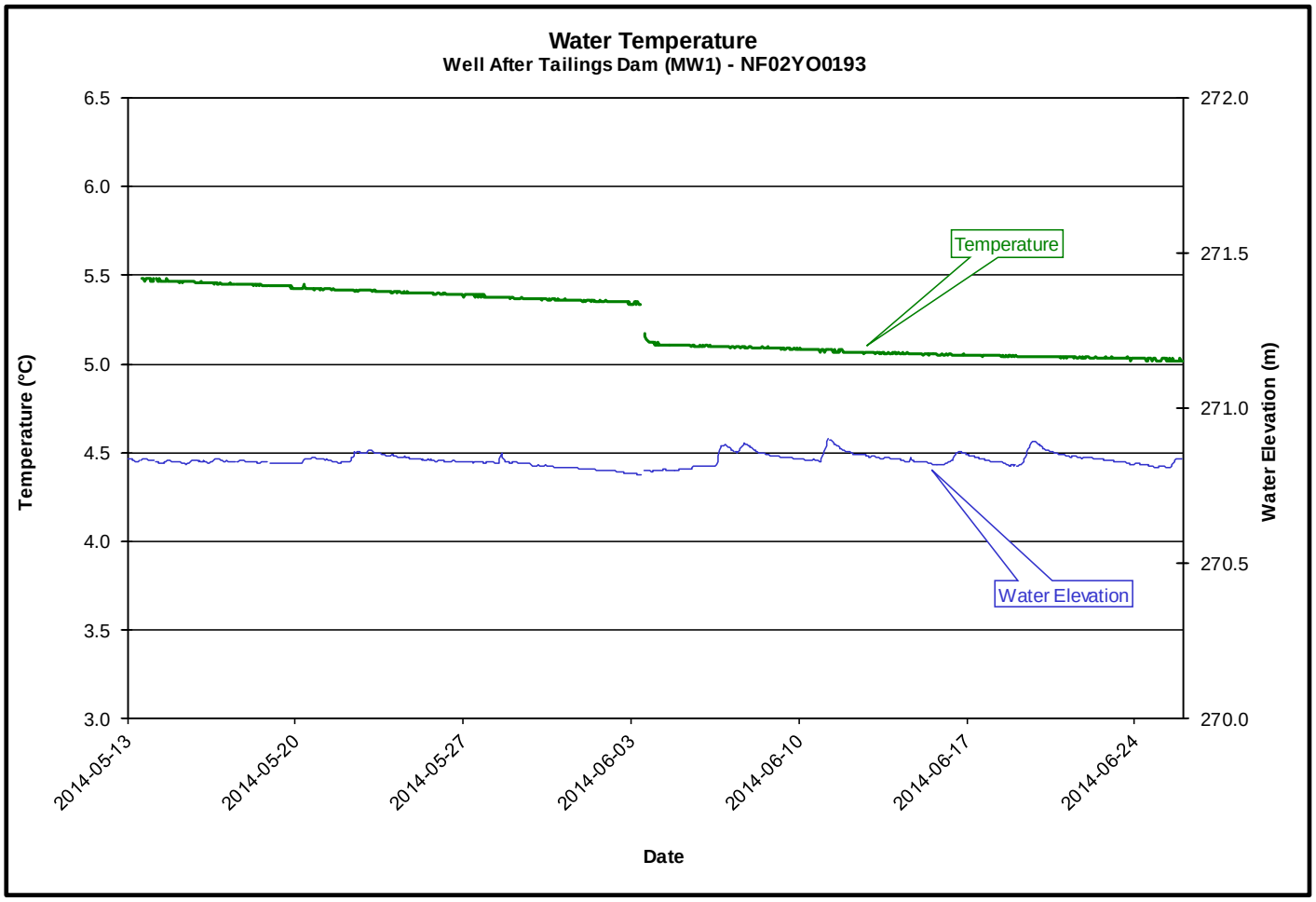

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 7.58 to a maximum of 8.49.
- The difference in pH on June 3, 2104 is typical each time a Quanta G instrument is deployed in this well. It is assumed that this is due to the displacement of water in the well as the Sonde is deployed in the small diameter casing.
- The subsequent rapid increase in pH, followed by gradual increase is also typical. By the end of the deployment period, levels were very similar to those at the beginning.
- There does not appear to be any correlation with water elevation.

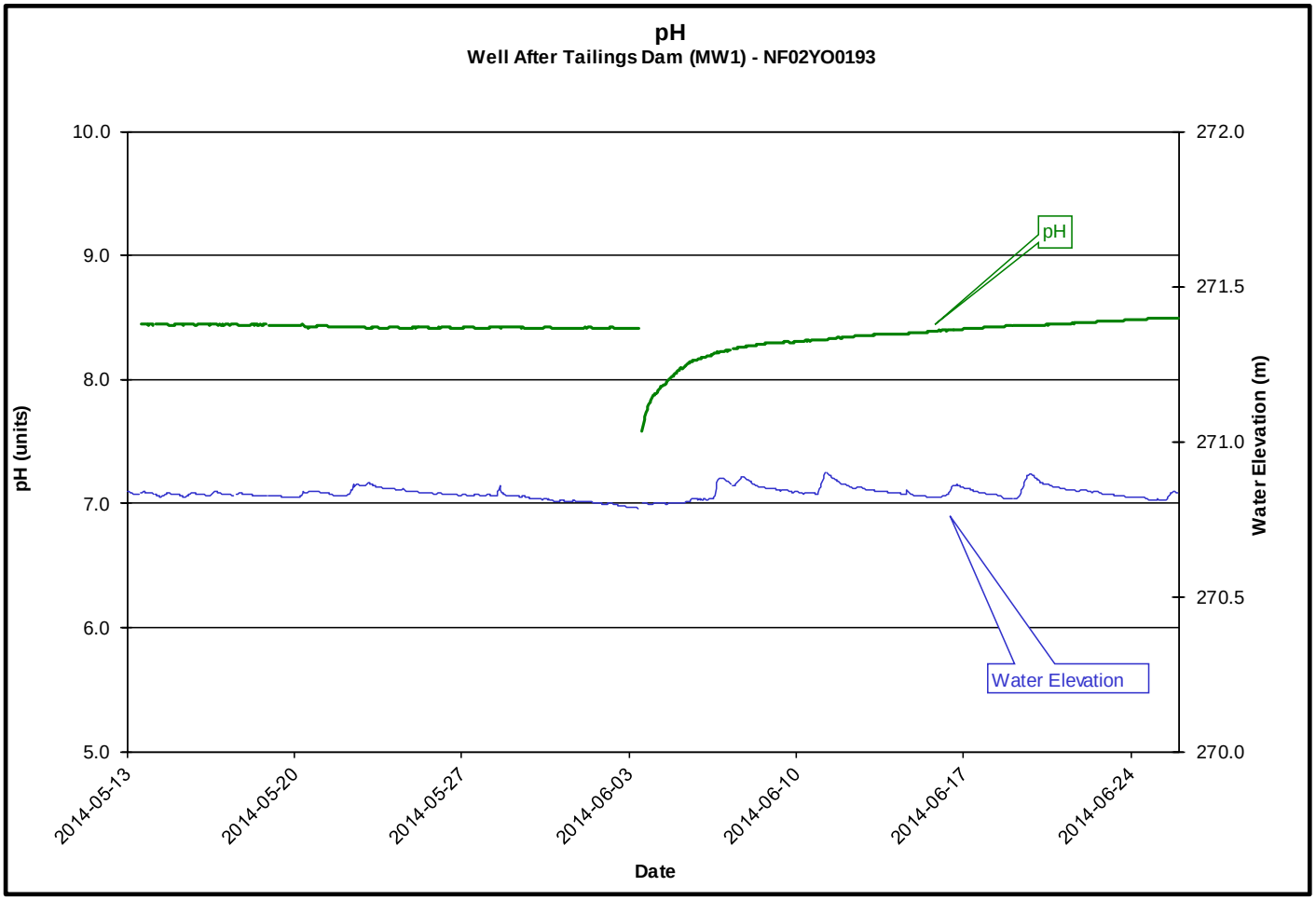

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.794 mS/cm to a maximum of 0.810 mS/cm.
- There was little change over the deployment period, and very close agreement between the two instruments when switched out on June 3, 2014.
- There does not seem to be any correlation with water elevation.

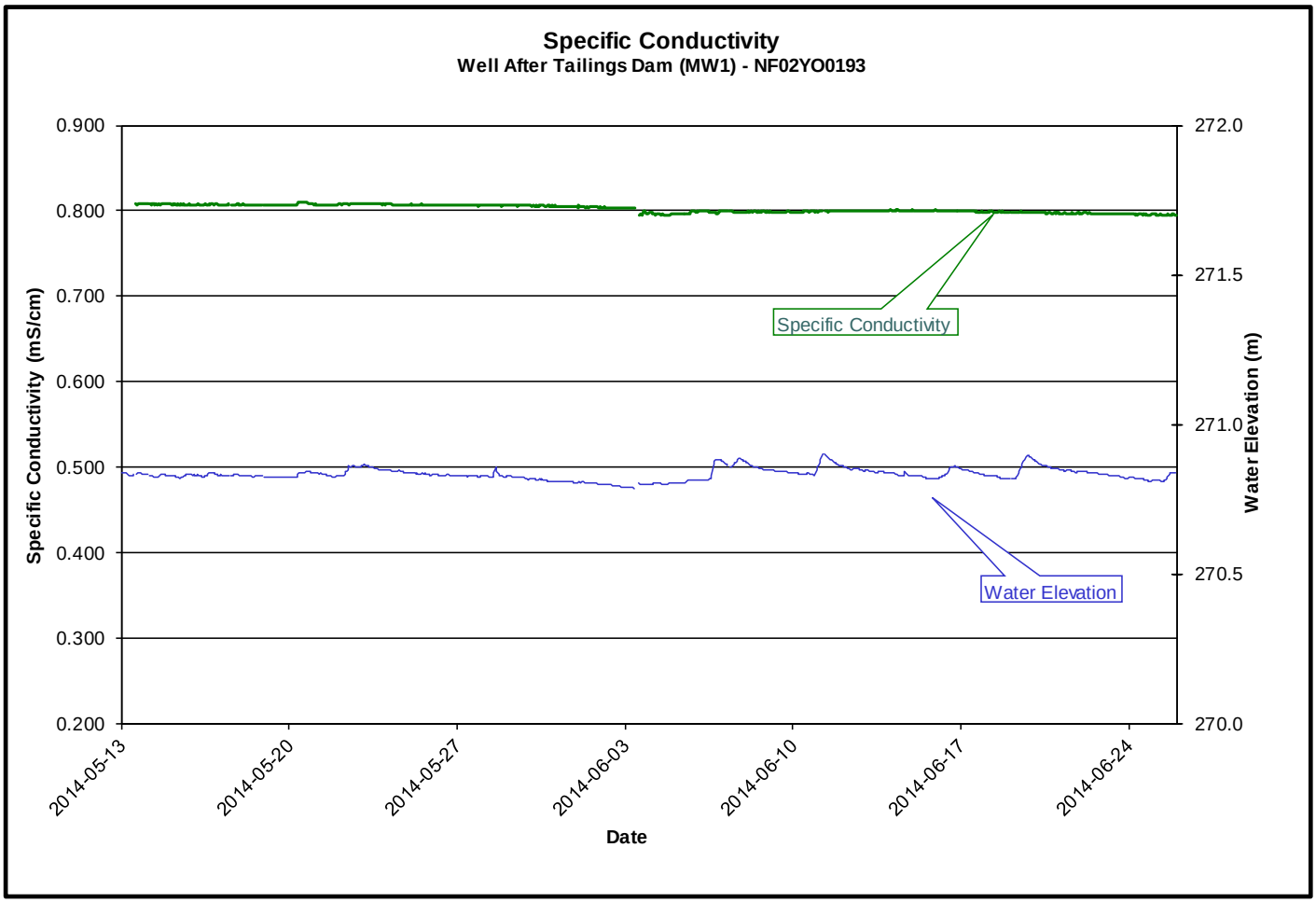

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.86 m to a maximum of 270.90 m, remaining fairly constant over the deployment period.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by runoff from precipitation.

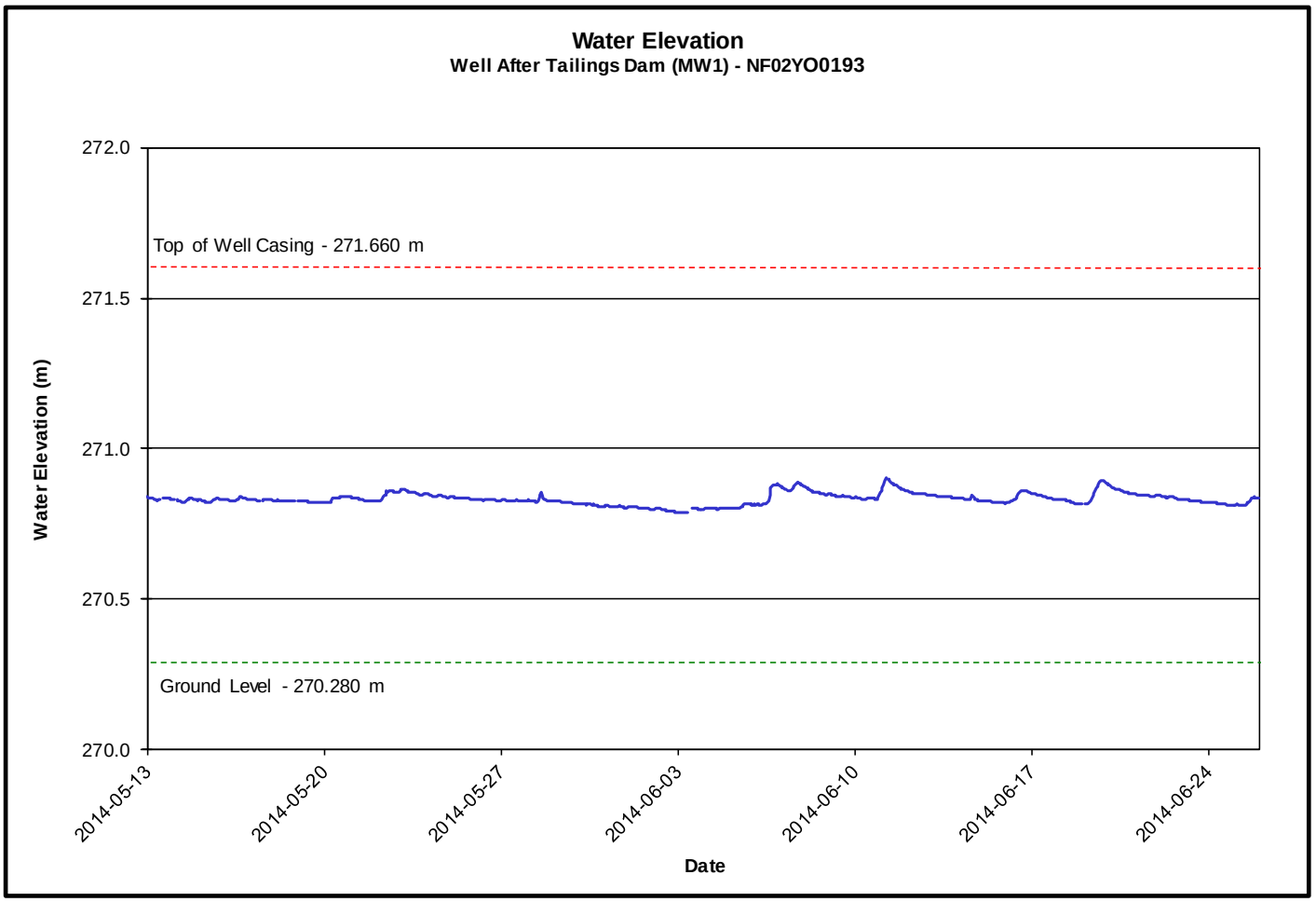

Figure 16

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