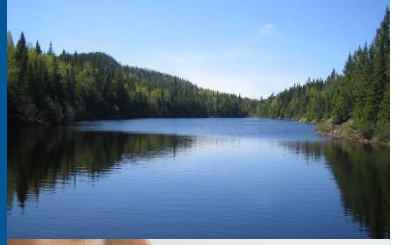
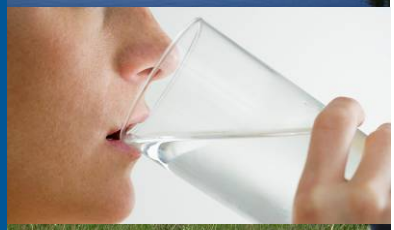



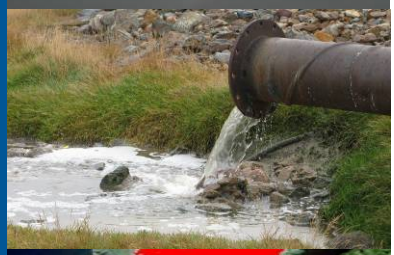


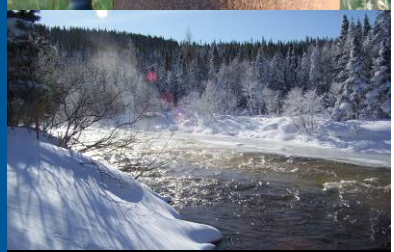

Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2010-09-02 to 2010-10-18

2010-12-13

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.
- The graphs below may sometimes show vertical lines from the data string to zero or the bottom of the graph. These lines should be ignored, as they are an artefact of individual missing data points. We are working to resolve this issue.
- There was effluent from Polishing Pond into the receiving waters (Tributary to Gills Pond Brook) throughout the entire deployment period,

Maintenance and Calibration of Instrumentation

- After being cleaned and freshly calibrated the regular **DataSonde®** (s/n 43245) for Tributary to Gills Pond Brook was installed on September 2, 2010, and remained deployed continuously until October 18, 2010, a 46 day period.
- After being cleaned and freshly calibrated the regular **DataSonde®** (s/n 43794) for East Pond Brook was installed on September 2, 2010. Within days, there was loss of data, so a spare **DataSonde®** (s/n 43323) was installed on September 9, 2010 and remained deployed continuously until October 18, 2010. As that did not resolve the issue, a new cable was ordered in and replaced on September 28, 2010. Total deployment with the two instruments was a 46 day period, with intermittent periods of lost data.
- For East Pond Brook, due to the cabling issues, there were intermittent losses of data through satellite transmission. However, as this instrument was set up to record internally, we were able to rely on this dataset to supplement some of the missing remotely transmitted data usually used to prepare these reports.
- The **Quanta G®** (s/n 00035) remained deployed in Monitoring Well After Tailings Dam Station (MW1) since April 28, 2010 and remained in service until October 18, 2010, at which time it was removed for semi-annual cleaning and calibration.
- There were three brief periods when there was a loss of data from the well site, due to communications issues with satellite data transmission.

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

- Upon deployment, a QA/QC **MiniSonde®** is temporarily deployed along side the Field **DataSonde®**. Values for temperature and dissolved oxygen are compared between the two instruments. A grab sample is taken to compare with the Field **DataSonde®** for specific conductivity, pH and turbidity parameters. Based on the difference between parameters recorded by the Field **DataSonde®**, QAQC **MiniSonde®** and grab sample a qualitative statement is made on the data quality upon deployment.
- At the end of a deployment period, readings are taken in the water body from the Field **DataSonde®** before and after a thorough cleaning in order to assess the degree of biofouling. During calibration in the laboratory, an assessment of calibration drift is made and the two error values are combined to give Total Error (T_e). If T_e exceeds a predetermined data correction criterion, a correction based on T_e is applied to the dataset using linear interpolation. Based on the value for T_e, a qualitative statement is also made on the data quality upon removal.
- The ranking at the beginning and end of the deployment period are shown in **Table 2** for Tributary to Gill's Pond Brook and **Table 3** for East Pond Brook.

- The removal ranking for Dissolved Oxygen at Tributary to Gills Pond Brook could not be calculated as the sensor failed prior to the end of the Deployment period. The removal rankings for all parameters at East Pond Brook could not be calculated due to the fact that the instruments where changed out during the deployment period. Accordingly, Total Error cannot be calculated nor shown on the graphs for Dissolved Oxygen at Tributary to Gills Pond Brook and all parameters at East Pond Brook.

- Because the deployment set-up for Well After Tailings Dam (MW1) is different, comparison with another instrument is not possible, thus Total Error cannot be calculated. In this case, a grab sample was collected at the end of the deployment period, and the removal ranking was calculated for pH and Specific Conductance based upon live data and laboratory data. See **Table 4**.

- With the exception of water quantity data (Stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent Quality Assurance and Quality Control (QA/QC) protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request. Where appropriate, corrected data for water quality parameters are indicated.

Tributary to Gills Pond Brook Station (NF02YO0190)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2009-09-02 Deployment	Temp (^oC)	Excellent
	pH (units)	Good
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Fair
	Turbidity (NTU)	Excellent
2010-10-18 Removal	Temp (^oC)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Good
	Dissolved Oxygen (%)	NA
	Turbidity (NTU)	Excellent

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2009-09-02 Deployment	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Fair
	Turbidity (NTU)	Excellent
2010-10-18 Removal	Temp (°C)	NA
	pH (units)	NA
	Sp. Conductivity (uS/cm)	NA
	Dissolved Oxygen (%)	NA
	Turbidity (NTU)	NA

Table 3

Well After Tailings Dam (MW1) Station (NF02YO0193)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2009-09-02 Deployment	pH (units)	NA
	Sp. Conductivity (mS/cm)	NA
2010-10-18 Removal	pH (units)	Good
	Sp. Conductivity (mS/cm)	Excellent

Table 4

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of 4.48 ˚C to a maximum of 22.74 ˚C, with temperatures generally decreasing throughout the deployment period.
- There appears to be little correlation with stage.
- As fouling and instrument drift were negligible, no data corrections were required for temperature.

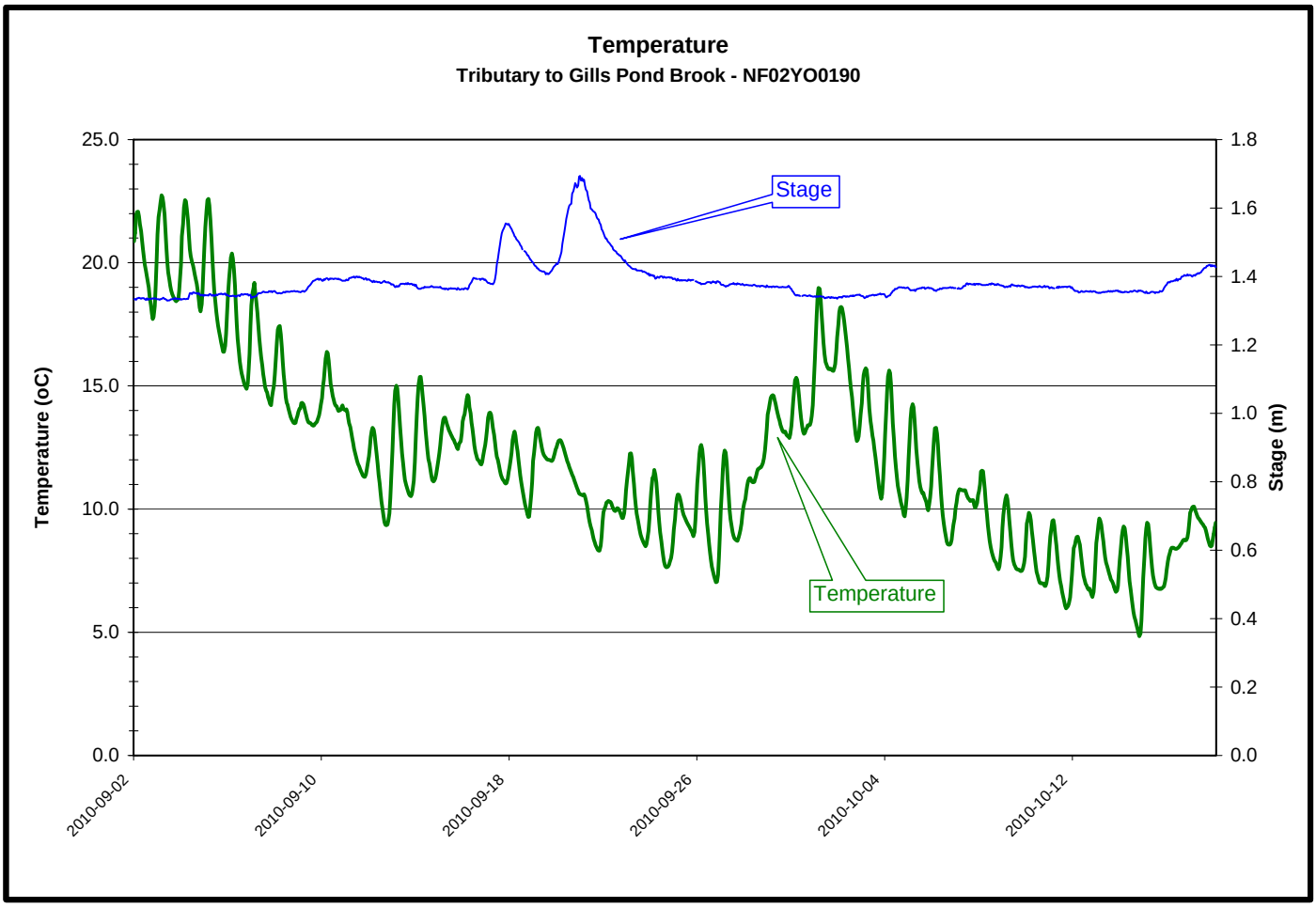

Figure 1

- Throughout the deployment period pH values (**Figure 2**) ranged from a minimum of 5.74 to a maximum of 7.25 with some of the values falling below 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 around the lower limit of the recommended range. pH is somewhat higher during discharge from Polishing Pond, as discharge water has a slightly higher pH than the background water quality.
- An inverse correlation with discharge is obvious particularly during increases in stage on September 18, 2010, September 21, 2010 and October 15, 2010, when there is a noticeable decrease in pH. Presumably, this is due to the onset of precipitation events.
- As fouling and instrument drift were negligible, no data corrections were required for pH.

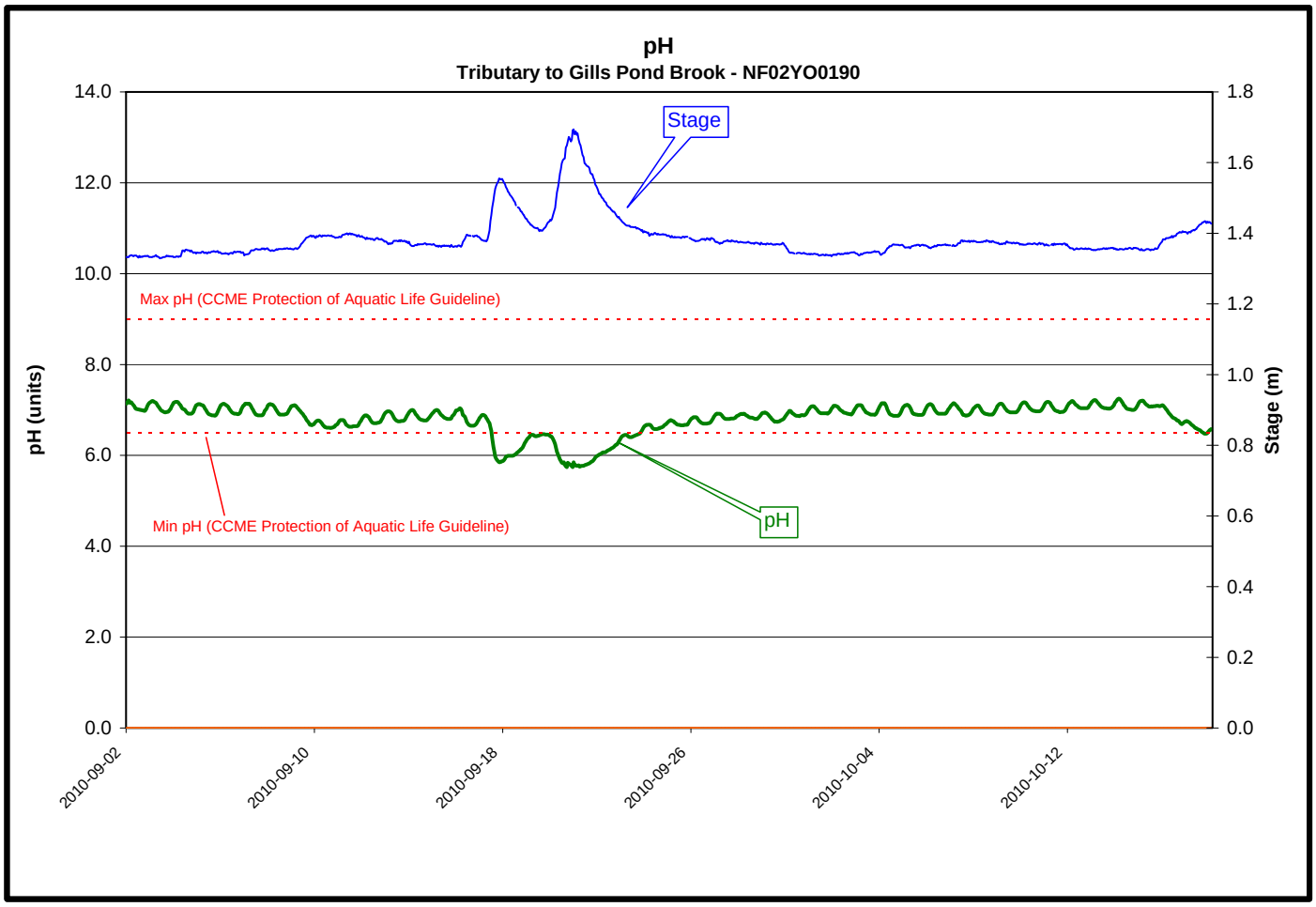

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 73.6 µS/cm to a maximum of 1024.0 µS/cm over the deployment period.
- Specific Conductance decreased markedly and an inverse correlation with stage is obvious particularly on September 18, 2010, September 21, 2010 and October 15, 2010. The several 'V' shaped dips are the result of dilution caused by precipitation events
- The QA/QC protocol revealed a net increase of 35.3 µS/cm (2.4 %) over the 46 day deployment period. This increase was due in part to fouling and instrument drift. Accordingly the correction factor has been applied to the raw data.

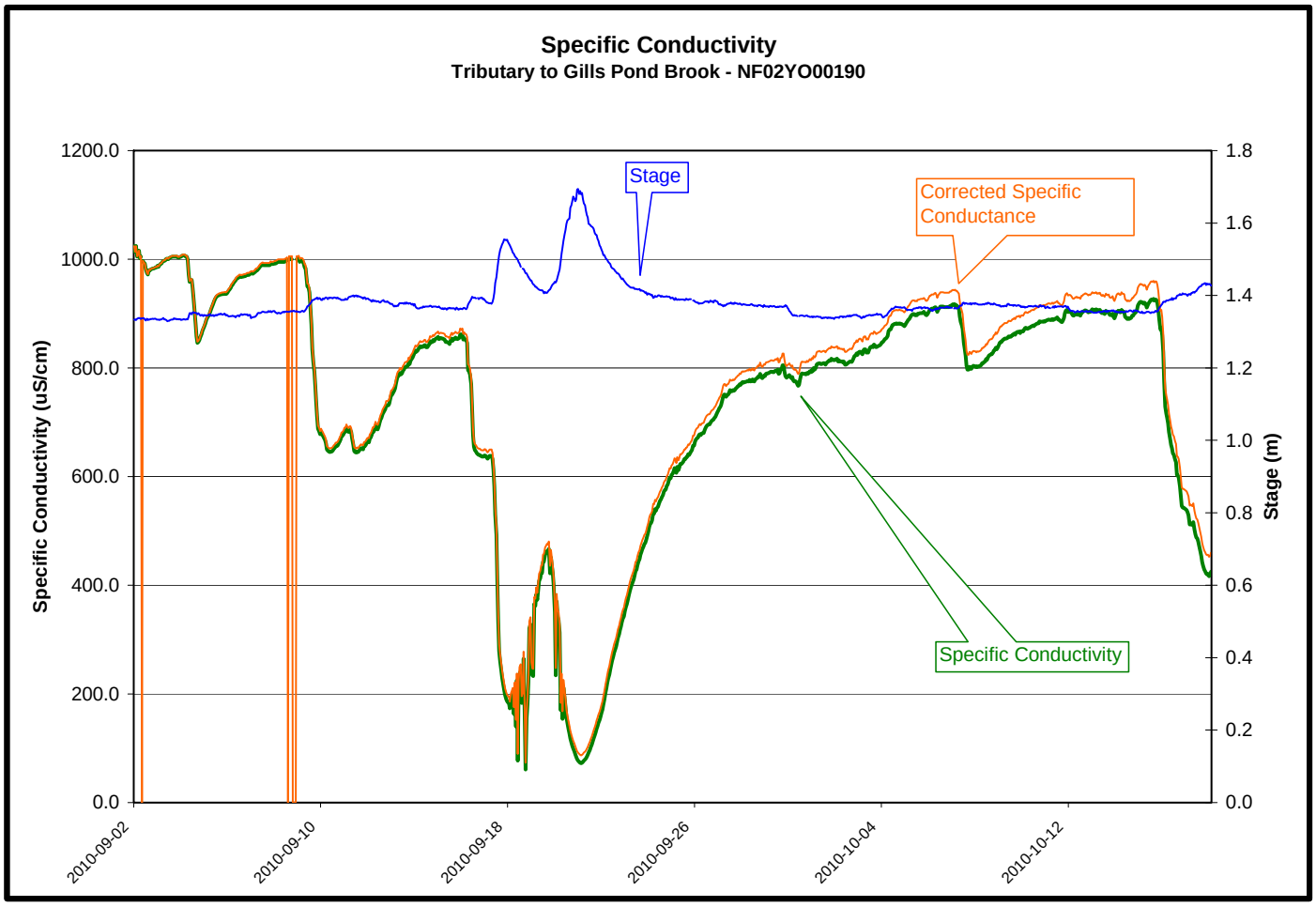

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 0.00 mg/L to a maximum of 10.77 mg/L over the deployment period.
- On October 1, 2010 the DO sensor failed, resulting in unreliable or no data to the end of the deployment period.
- Dissolved oxygen is inversely proportional to water temperature.
- From the beginning of the deployment period until the sensor failed, more than half of the dissolved oxygen values fell below 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). Lower dissolved oxygen values are considered to be solely a function of the warmer water temperatures during this period.
- As the sensor failed, the QA/QC protocol could not be employed to calculate a correction factor for this data.

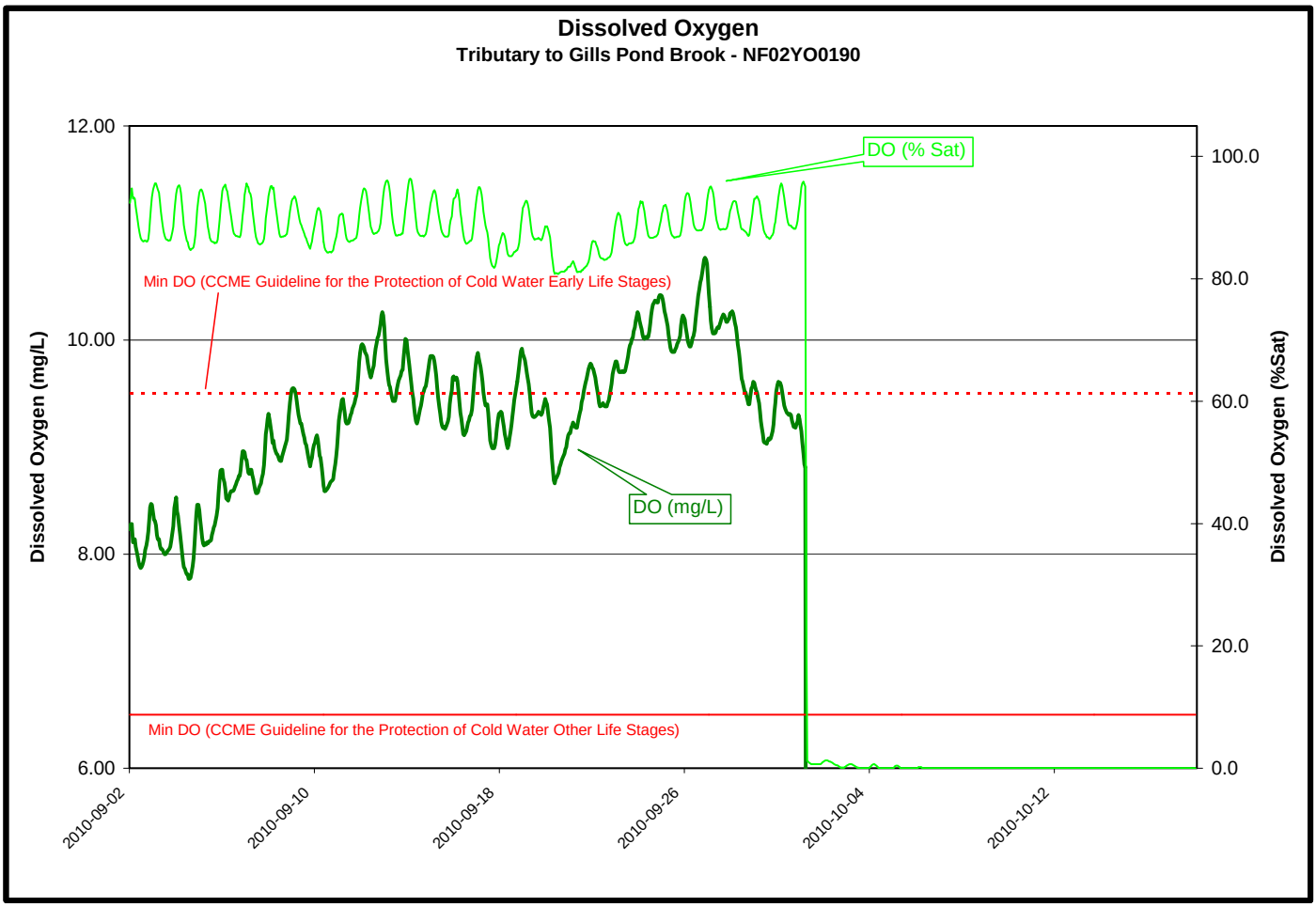

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 244.8 NTU.
- Sustained peaks in turbidity correspond to high stage, presumably the result of precipitation events. Other peaks are likely the result of leaves and other natural in-stream debris.
- Based upon previous investigation, it has been determined that turbidity values may be artificially increased due to air entrainment during high flows.
- Neither *in situ* nor grab sample measurements nor visual observations indicated turbidity issues.
- As fouling and instrument drift were negligible, no data corrections were required for turbidity.

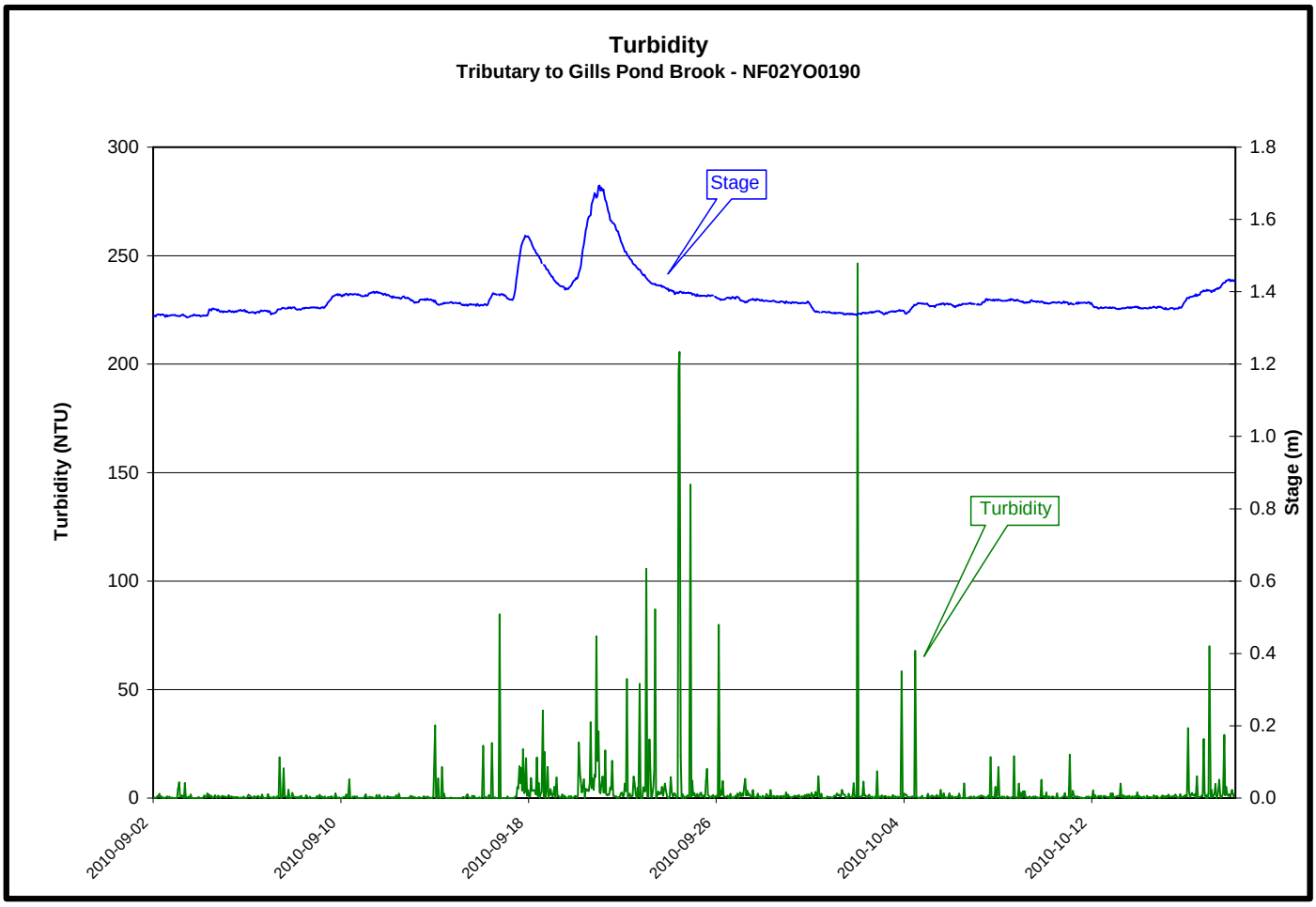

Figure 5

- The stage (**Figure 6)** or water level ranged from a minimum of 1.33 m to a maximum of 1.69 m with the peaks on September 18, 2010 and September 21, 2010 corresponding to precipitation events associated with Hurricane Igor.
- All values are within the normal range.

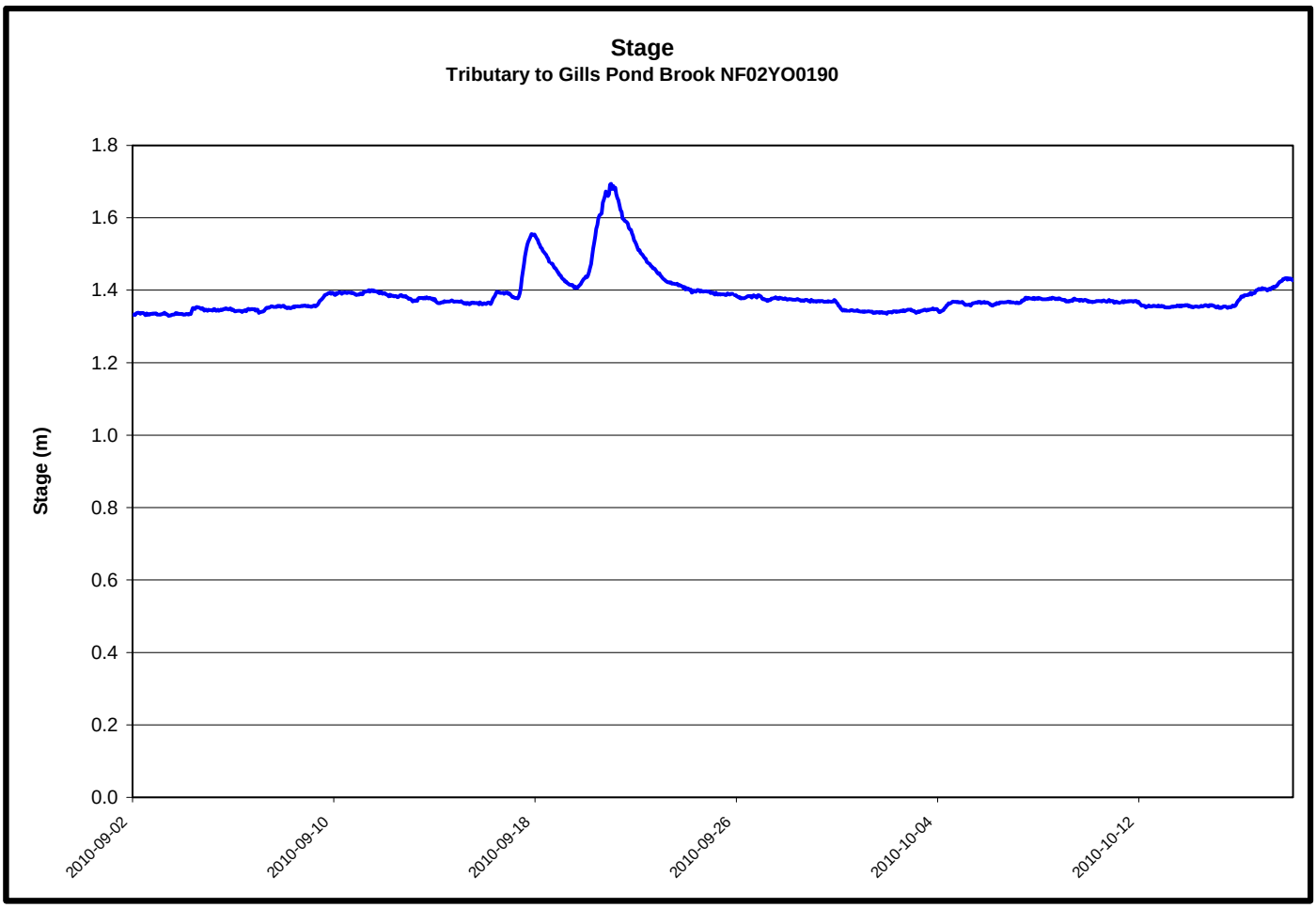

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 3.89 ˚C to a maximum of 23.23 ˚C, with a general decrease over the deployment period.
- There appears to be little correlation with stage for the most part, although when stage increased on September 21, 2010, there is a noticeable decrease in water temperature. Presumably, this is due to the onset of precipitation events, and subsequent runoff.
- The QA/QC protocol could not be employed to calculate a correction factor for this data.

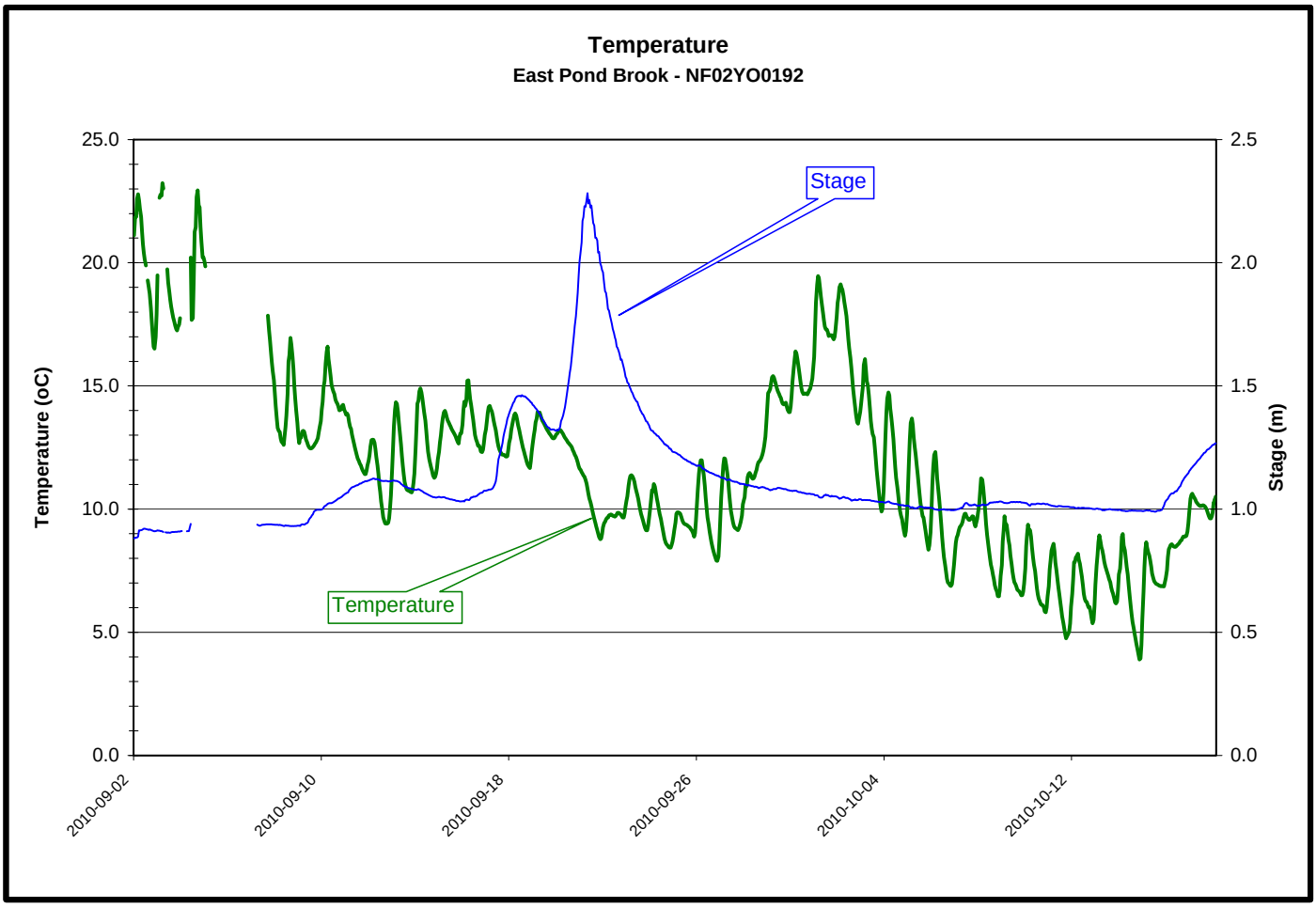

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 5.04 to a maximum of 7.36 with some of the values falling below the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- An inverse correlation between pH and stage is obvious.
- The background pH of this stream is normally quite low, and values near and below the limit are not unusual.
- The QA/QC protocol could not be employed to calculate a correction factor for this data.

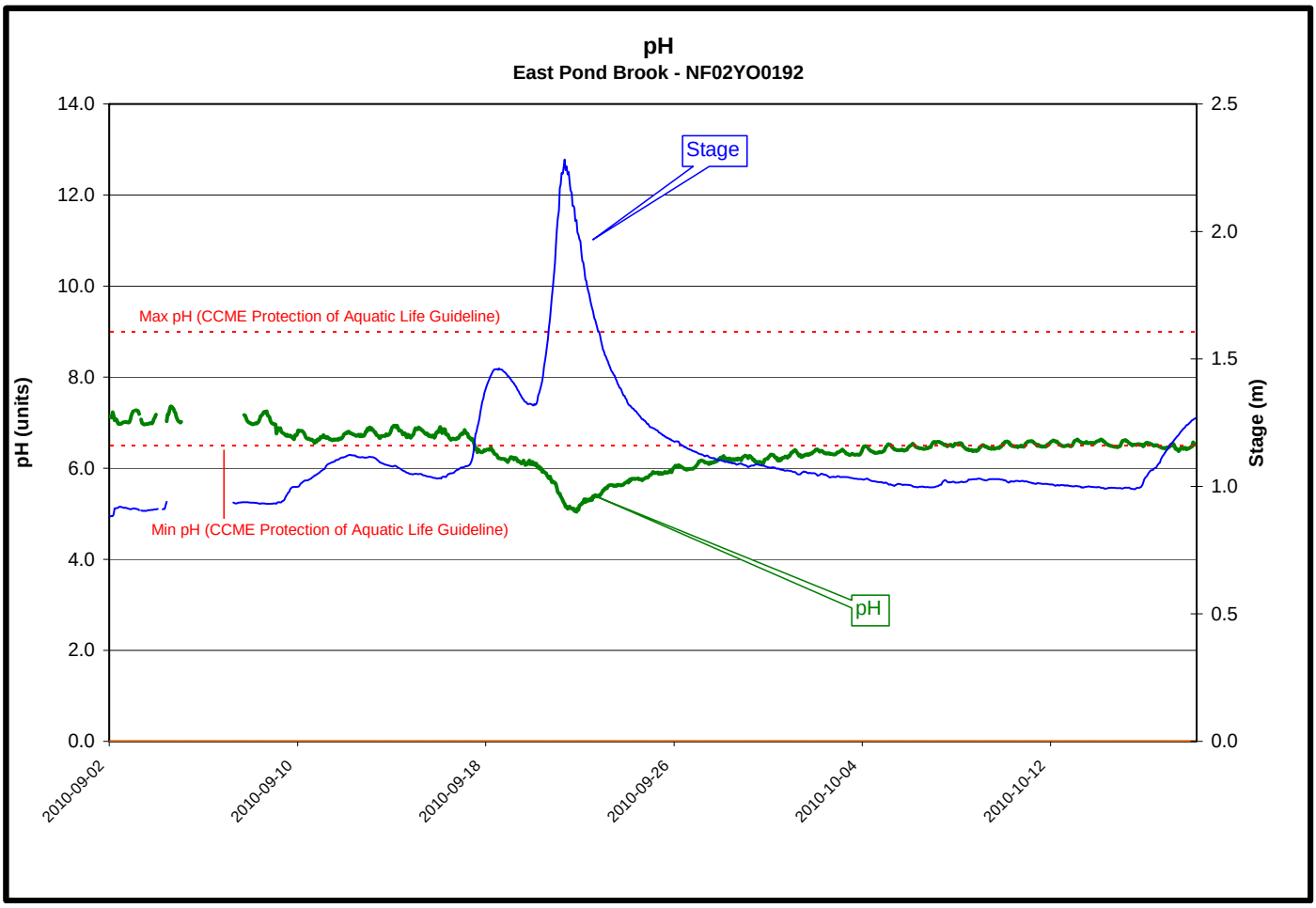

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 17.0 µS/cm to a maximum of 57.0 µS/cm.
- Lowest specific conductivity values are reported when stage is highest following major precipitation events on September 18, 2010 and September 21, 2010.
- The QA/QC protocol could not be employed to calculate a correction factor for this data.

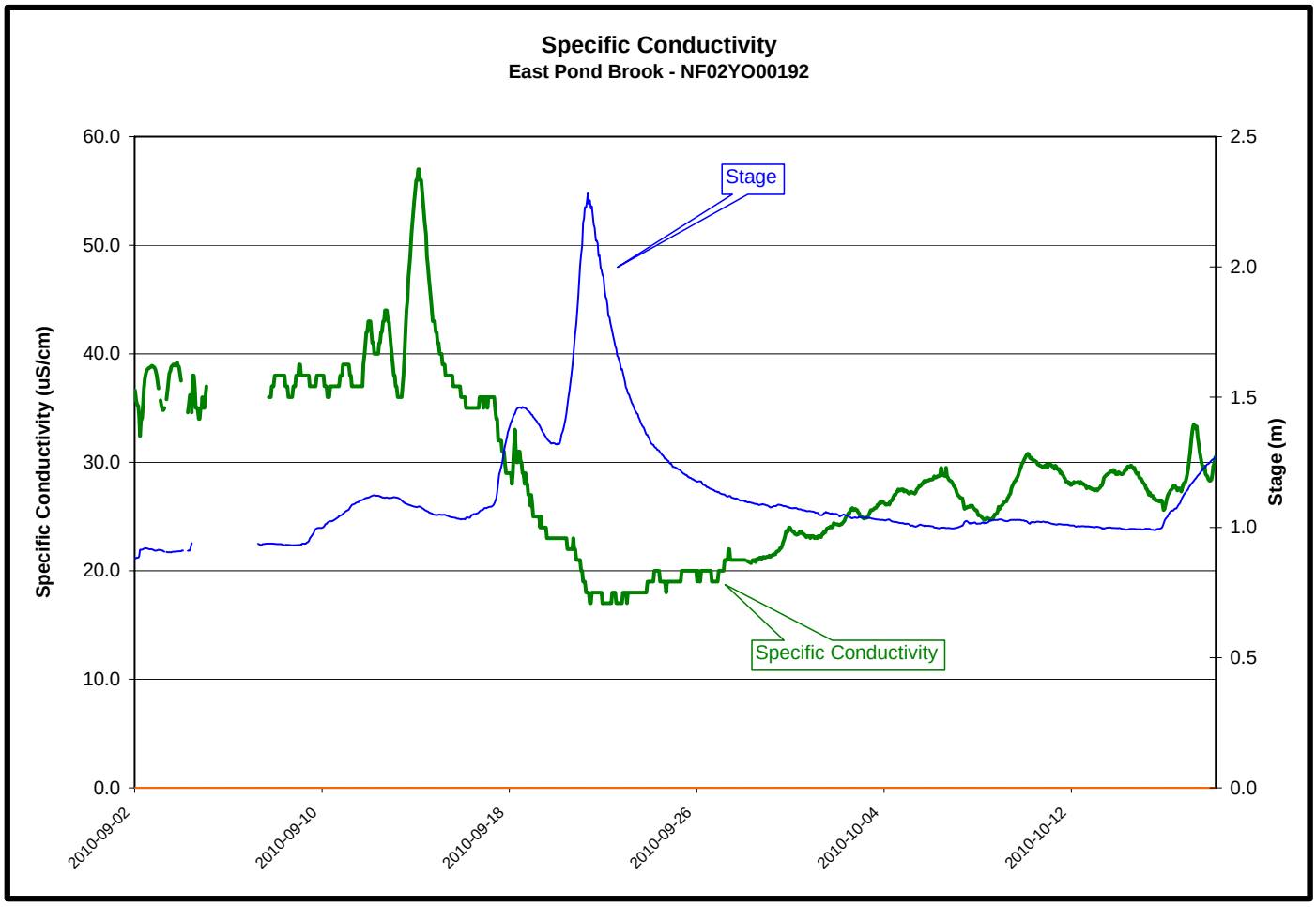

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 8.02 mg/L to a maximum of 12.24 mg/L over the deployment period.
- Dissolved oxygen is inversely proportional to water temperature.
- Throughout most of the deployment period, 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). Lower dissolved oxygen values are considered to be solely a function of the naturally warmer temperatures during this period.
- The QA/QC protocol could not be employed to calculate a correction factor for this data.

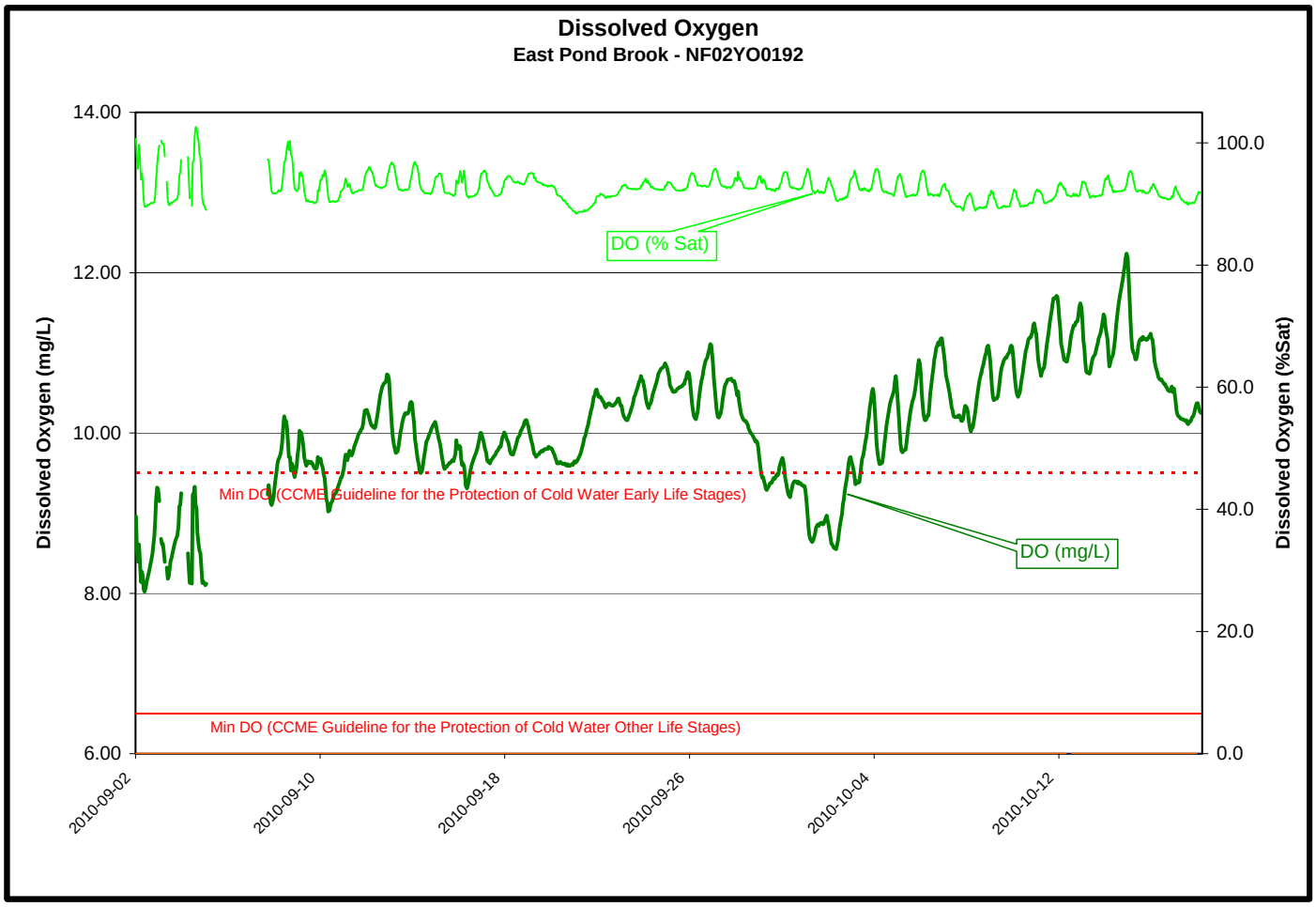

Figure 10

- The turbidity values **(Figure 11)** ranged from a minimum of 0.0 NTU to a maximum of 331.1 NTU.
- Turbidity values in this stream are typically near zero; the higher peaks being insignificant events when natural stream debris passed near the sensor. These peaks are observed during a period of increased discharge, presumably resultant from precipitation events and subsequent runoff.
- Neither *in situ* nor grab sample measurements nor visual observations indicated turbidity issues.
- The QA/QC protocol could not be employed to calculate a correction factor for this data.

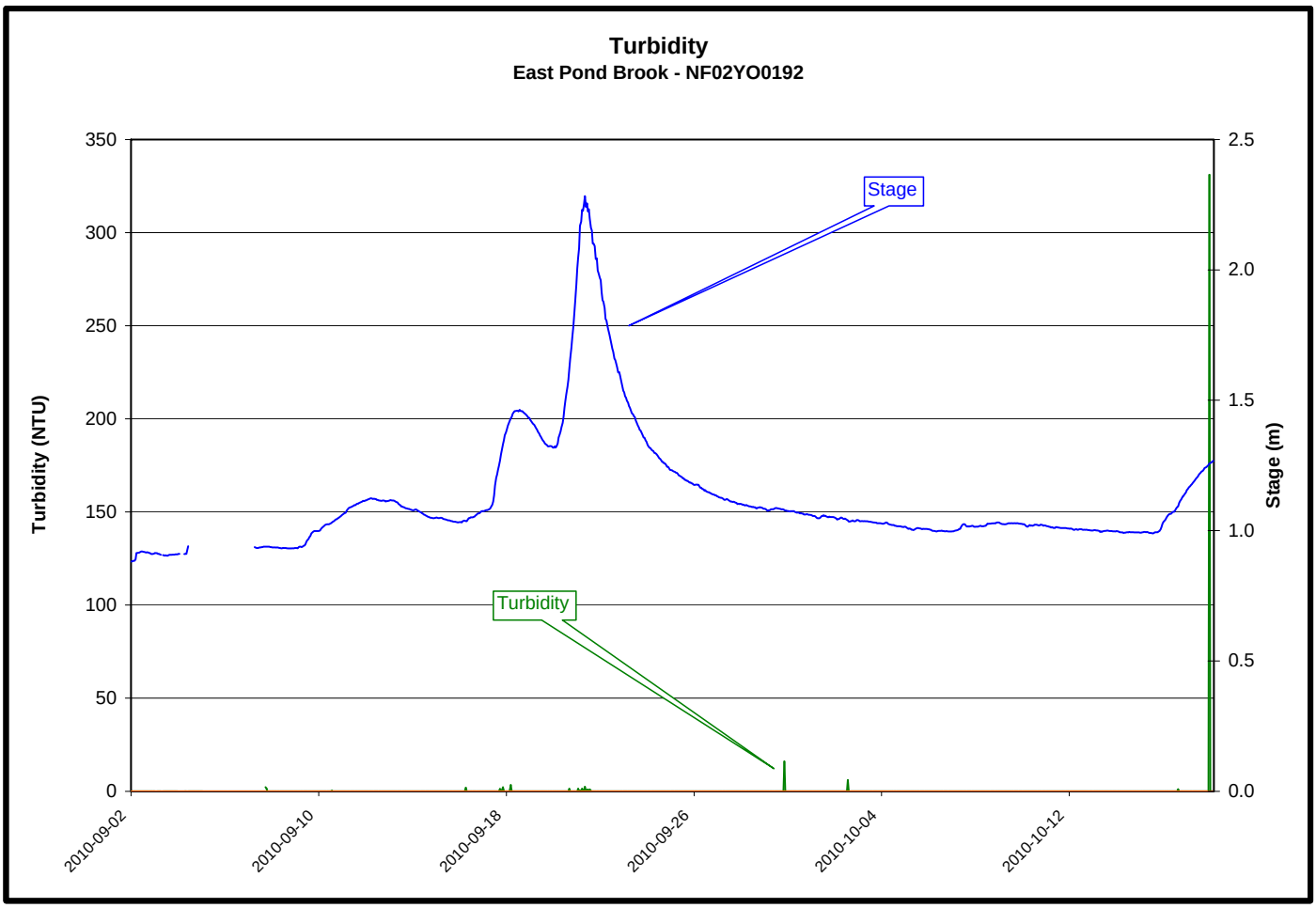

Figure 11

- The stage **(Figure 12)** or water level ranged from a minimum of 0.88 m to a maximum of 2.28 m with the peaks on September 18, 2010 and September 21, 2010 corresponding to precipitation events associated with Hurricane Igor.
- The highest peak of 2.28 meters is well above the normal range for this stream, with evidence of water and detritus above and outside the normal stream channel.

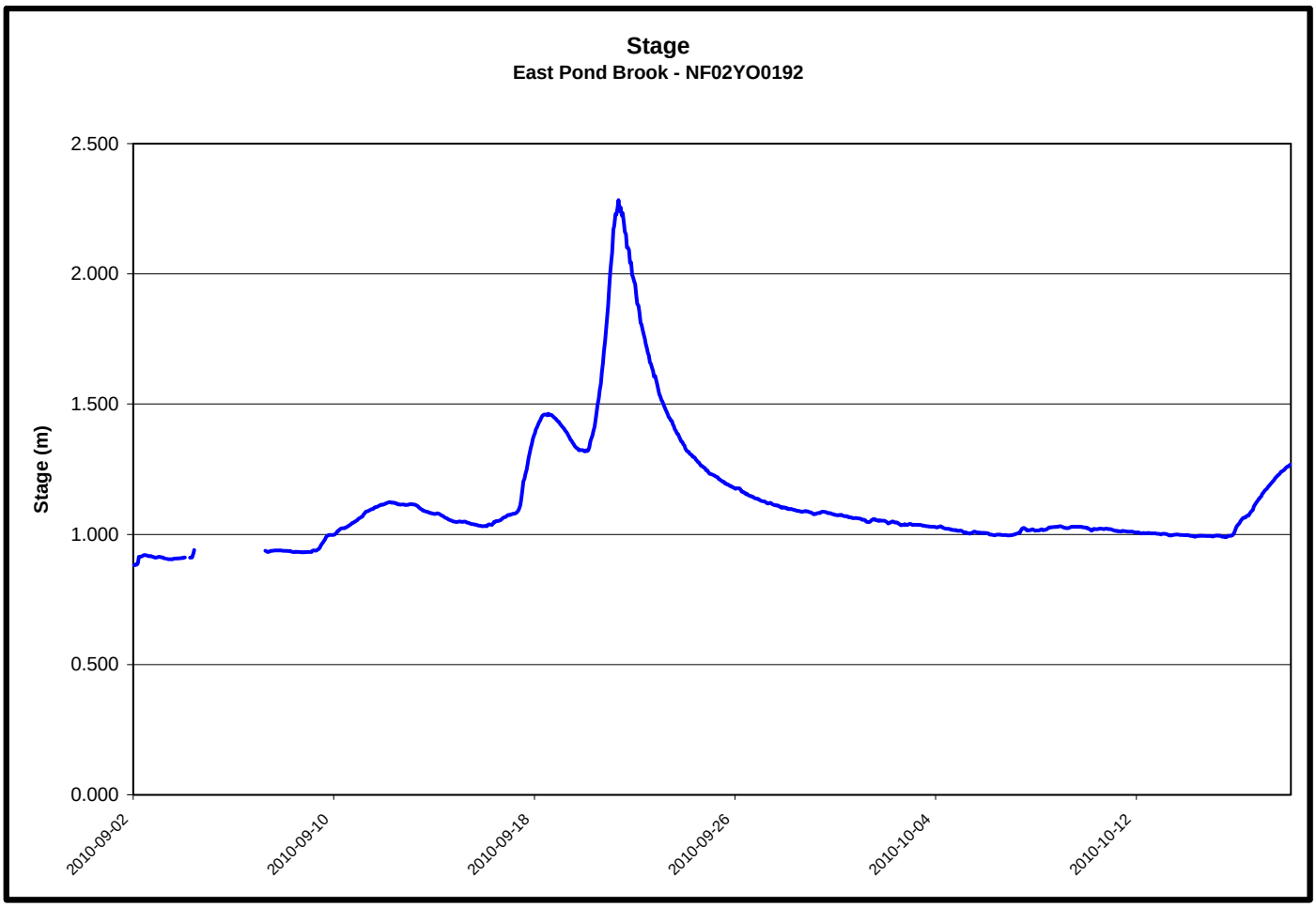

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.04 ˚C to a maximum of 5.42 ˚C; generally increasing over the deployment period.
- There appears to be little correlation with water elevation.

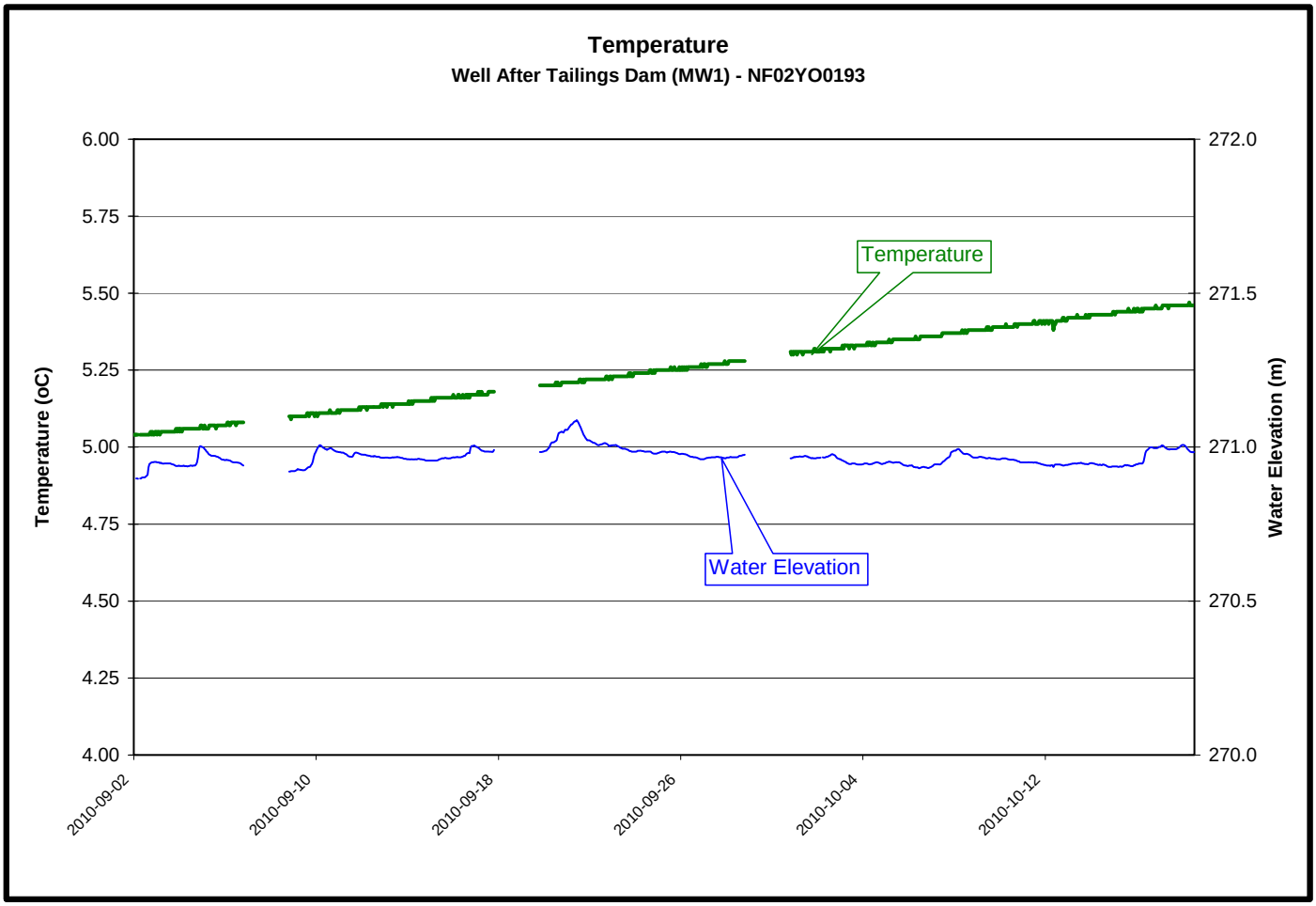

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 8.82 to a maximum of 8.87 over the deployment period
- There was very little variability.

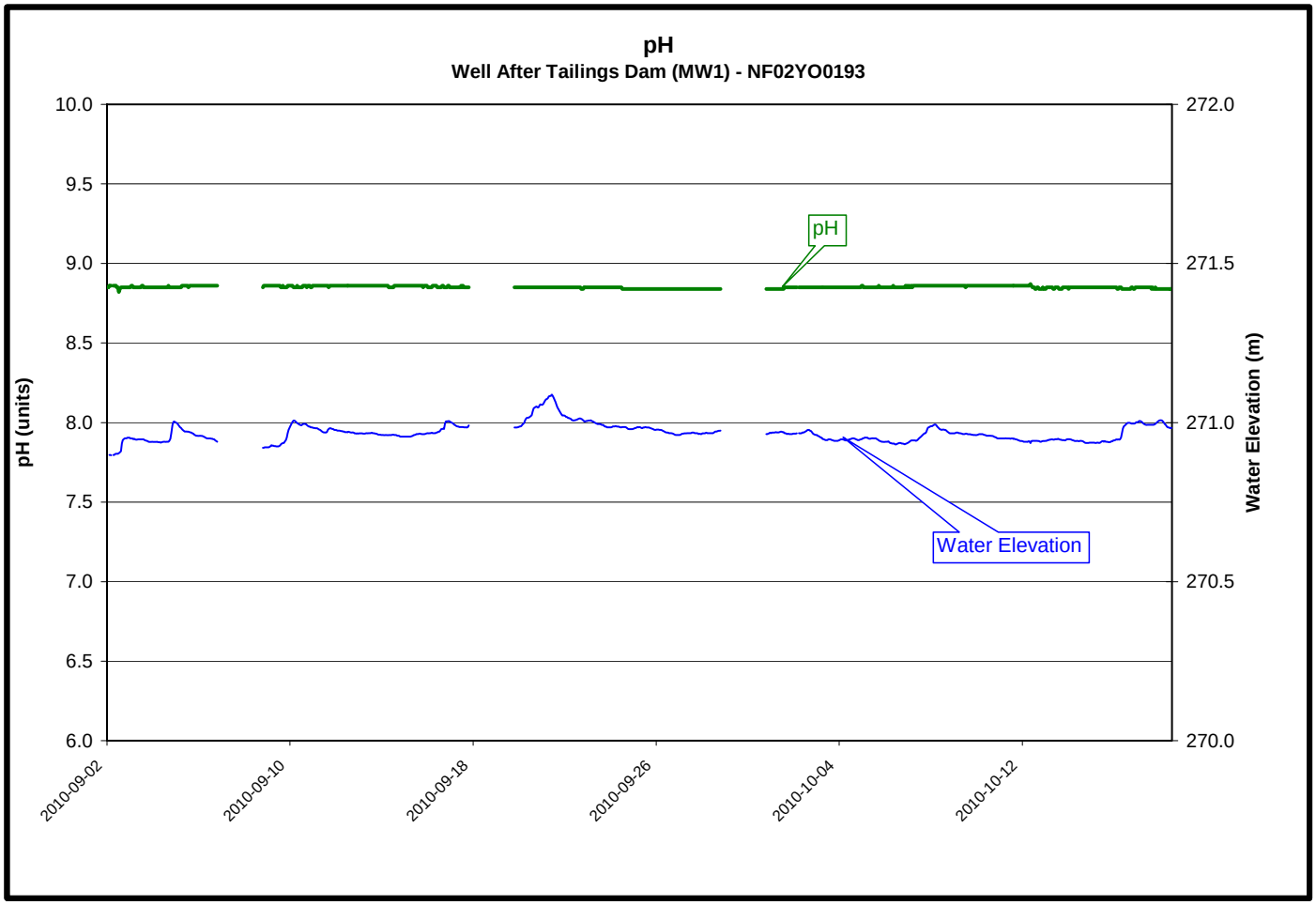

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.544 mS/cm to a maximum of 0.564 mS/cm.
- There was a slight increase throughout the deployment period.

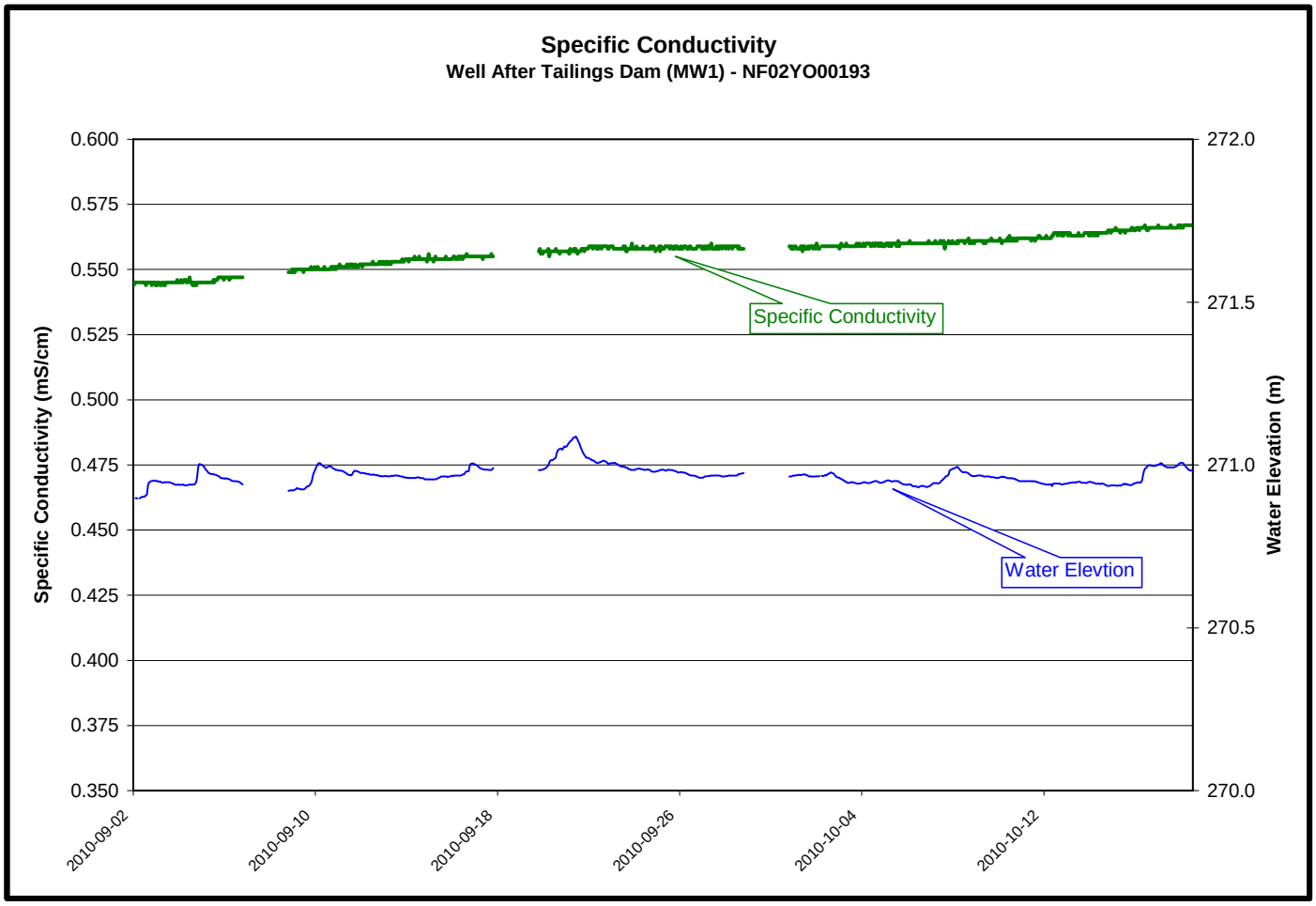

Figure 15

- The Water Elevation ranged from a minimum of 270.90 m to 271.09 m through the deployment period.
- The highest water level was on September 21, 2010, following a major precipitation event associated with Hurricane Igor.

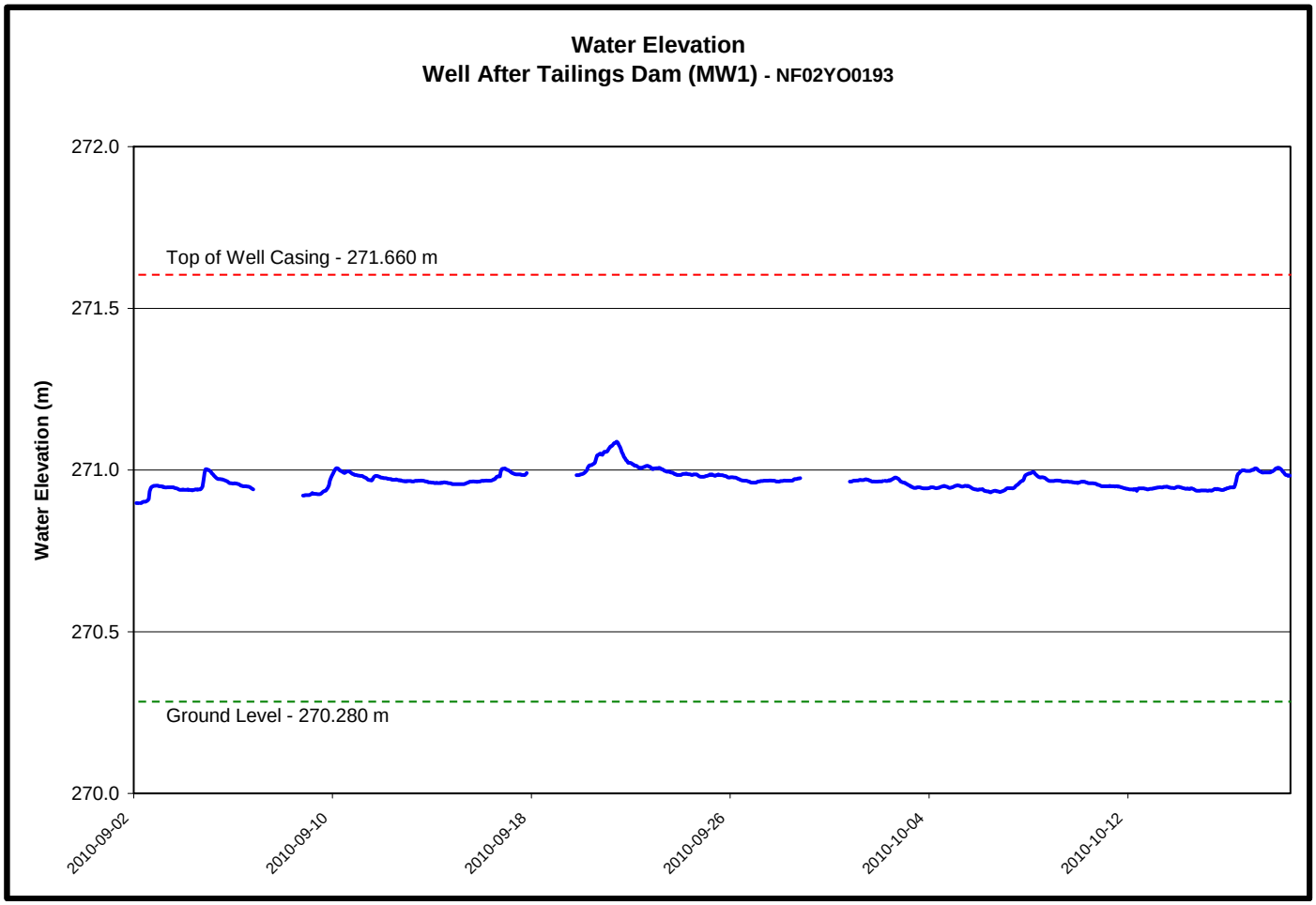

Figure 16

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