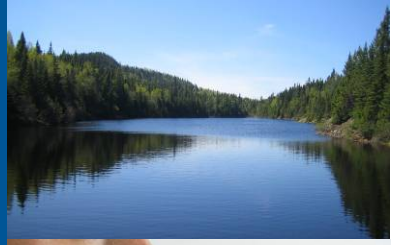
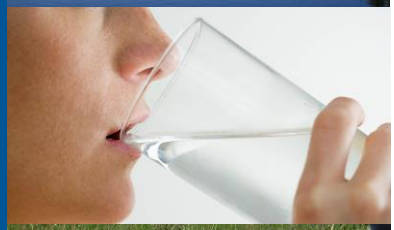



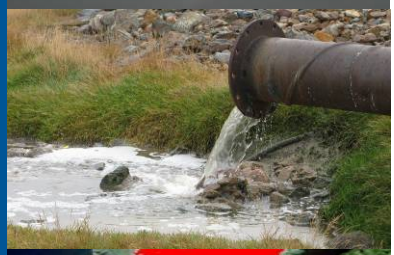


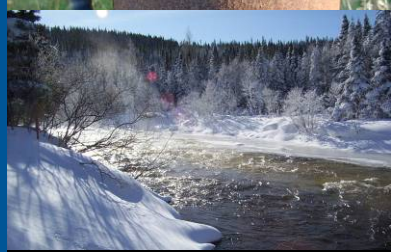

Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2012-05-10 to 2012-07-04

2012-08-17

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.
- Planned discharge of effluent from Polishing Pond into the receiving waters (Tributary to Gills Pond Brook) began on May 14, 2012 and continued until the end of the deployment period.

Maintenance and Calibration of Instrumentation

- After being cleaned and freshly calibrated the new **DataSondes®**(s/n 62268) for Tributary to Gills Pond Brook and (s/n 62267) for East Pond Brook were installed on May 10, 2012, and remained deployed continuously until July 4, 2012, a 54 day period. These new units replace the regular ones (s/n 43245 and s/n 43794 respectively) which are out for maintenance and will be used as alternate or back-up units in the future.
- A **MiniSonde®** borrowed from another project was used for QA/QC purposes during the removal of the instruments. This unit was recently factory-serviced and was cleaned and calibrated to the same standards.
- The regular **Quanta G®** (s/n 00035) has remained deployed continuously in Monitoring Well After Tailings Dam Station (MW1) since September 7, 2011 and was removed on May 14, 2012, 4 days into the current reporting 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 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 end of the deployment period is shown in **Table 2** for Tributary to Gill's Pond Brook and **Table 3** for East Pond Brook.

- 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. No ranking is available for the beginning of the deployment. The ranking for the removal of the unit on May 14, 2012 is shown in **Table 4**.
- A revised Turbidity calibration protocol for the **DataSondes®** in Tributary to Gills Pond Brook and East Pond Brook, as well as the QA/QC instrument (which is intended to make the sensor more sensitive and accurate at the lower end of the scale) was employed during the deployment period on May 14, 2012. Accordingly, turbidity measurements for the first 4 days of the deployment period have been removed from the data set. Therefore, no ranking is available for Turbidity for each of these streams during deployment.
- For the Tributary to Gills Pond Brook Station, there is no ranking for Turbidity during the removal of the instrument. The QA/QC instrument, despite being recently calibrated, was reporting an erroneous value.
- The East Pond Brook Station experienced some problems whereby in-stream debris caused some interference with the Turbidity sensor from June 23, 2012 through the end of the deployment period. Accordingly, all turbidity data for this period are unreliable and have been removed from the data set. Based upon this and the unreliability of the turbidity sensor on the QA/QC instrument, there is no ranking for Turbidity during the removal of the instrument.

- 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**
2012-05-10 Deployment	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA
2012-07-04 Removal	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2012-05-10 Deployment	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA
2012-07-04 Removal	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	N/A

Table 3

Well After Tailings Dam (MW1) Station (NF02YO0193)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2012-05-14 Removal	pH (units)	Good
	Sp. Conductivity (mS/cm)	Good

Table 4

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of 6.42 ˚C to a maximum of 27.80 ˚C.
- Temperature generally increased throughout the deployment period.
- There appears to be little correlation with stage, although during peak flows, the diurnal variation in temperature is less, presumably due to precipitation, cloud cover and lower daytime ambient temperatures.

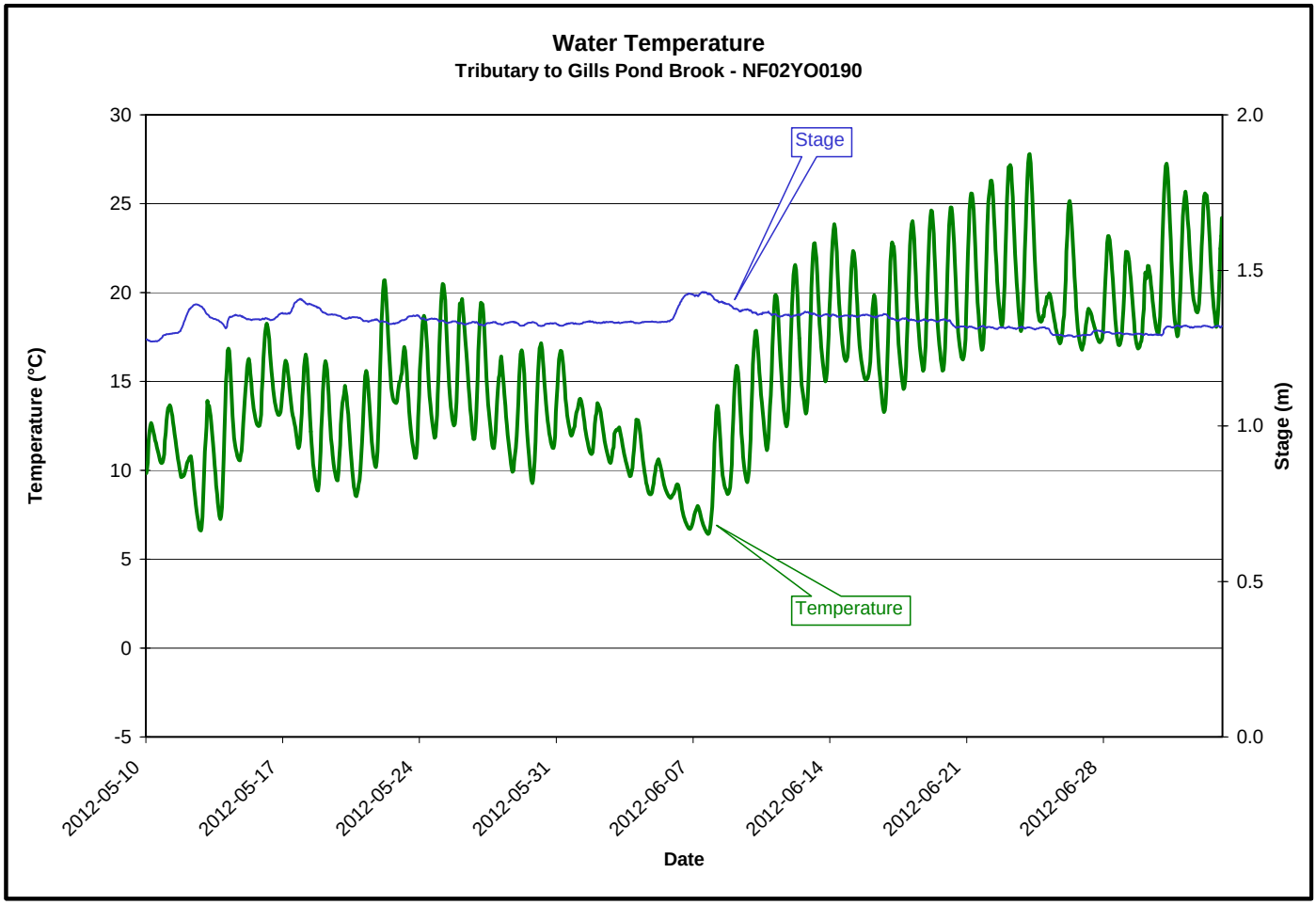

Figure 1

- Throughout the deployment period pH values (**Figure 2**) ranged from a minimum of 6.28 to a maximum of 7.16 with the majority of values falling near or 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*.
- An inverse relationship with stage is obvious during several events over much of this deployment period.
- The background pH of this stream is normally around the lower limit of the recommended range.
- There is no significant change in pH following the onset of discharge from the Polishing Pond on May 14, 2012.

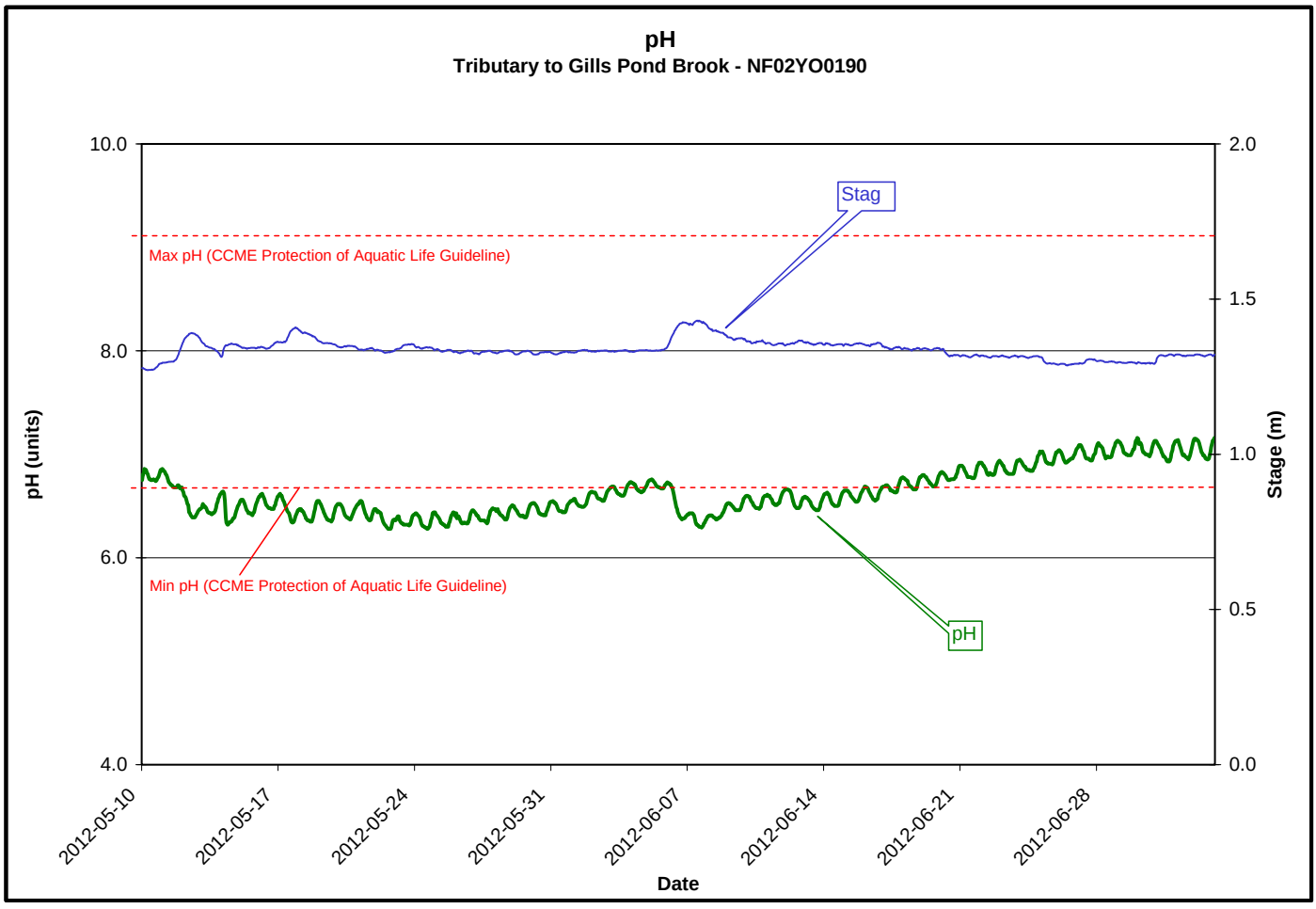

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 24.5 µS/cm to a maximum of 1319.0 µS/cm over the deployment period.
- A significant increase in specific conductance is obvious following the onset of discharge from the Polishing Pond on May 14, 2012. Conductivity continued to increase throughout the deployment period.
- Some of the 'V' shaped dips are the result of dilution caused by precipitation/runoff events, indicated by increases in the stage.

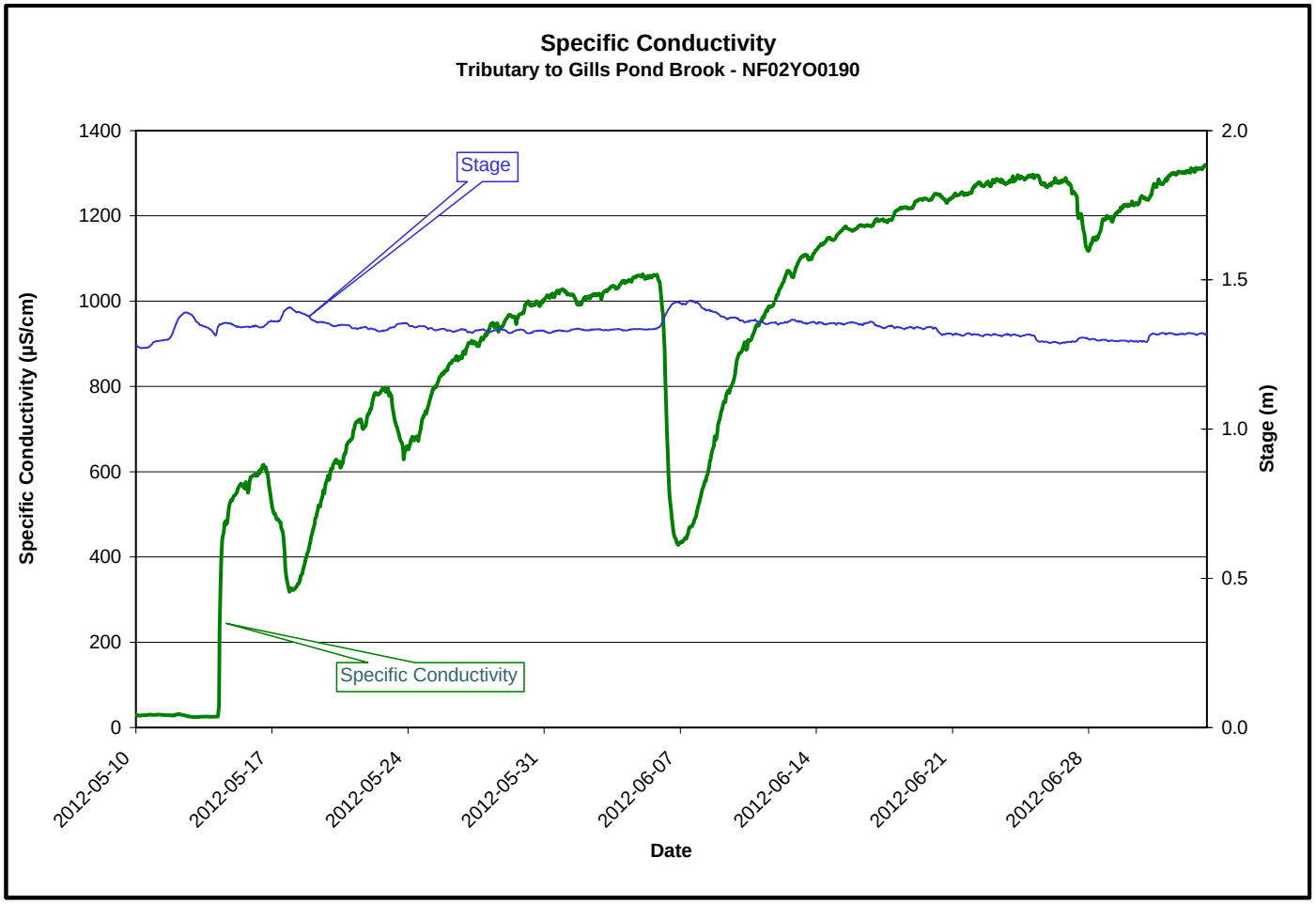

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 7.55 mg/L to a maximum of 11.37 mg/L over the deployment period, with the percent saturation ranging between 87.3 and 100.7.
- Dissolved oxygen is generally inversely proportional to water temperature.
- All of the dissolved oxygen values fell above the lower 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.

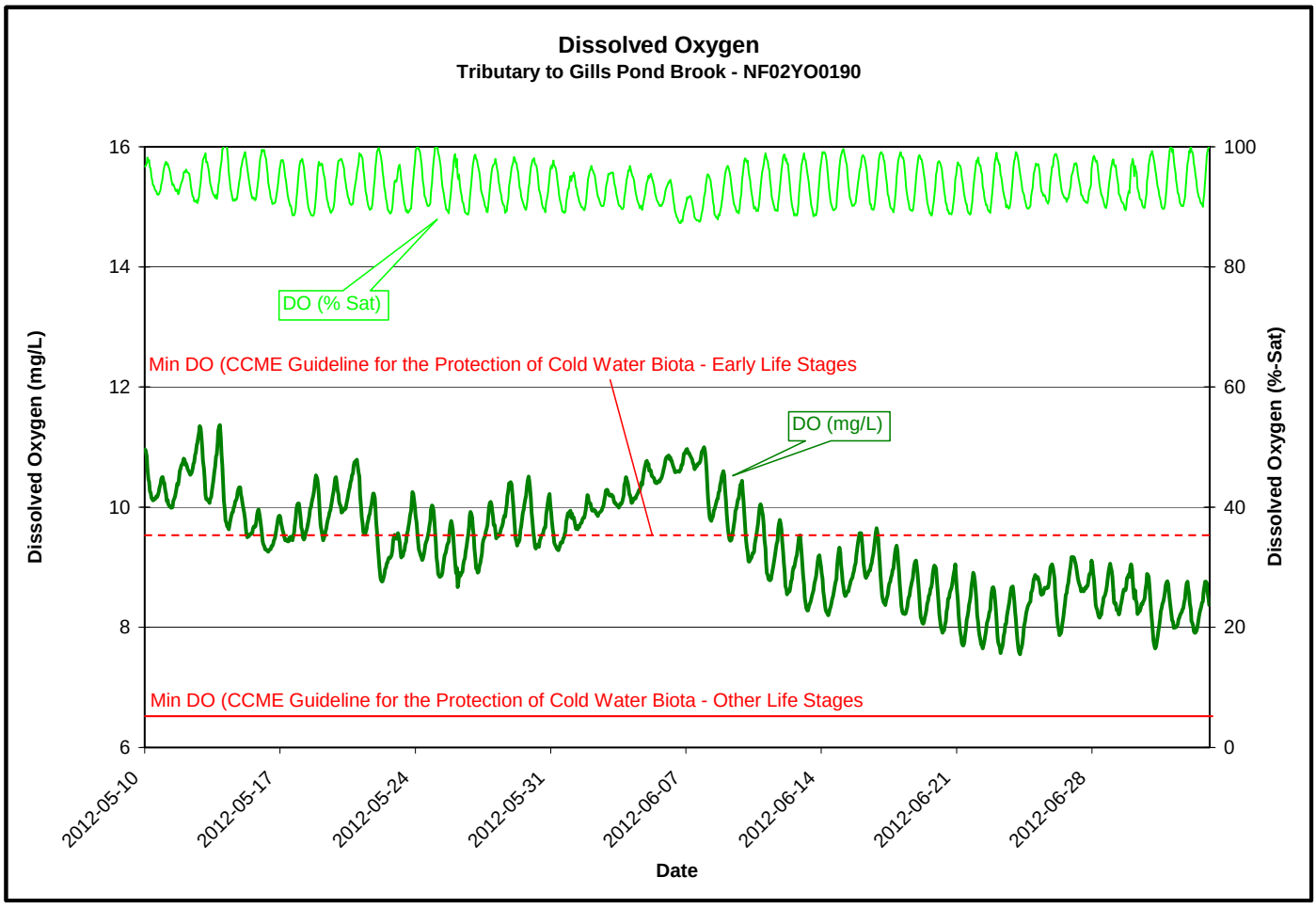

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 13.4 NTU.
- Based upon previous investigation, it has been determined that turbidity values may be artificially increased due to air entrainment during higher flows.
- The individual turbidity spikes are likely due to air bubbles or in-stream debris passing over the sensor.
- Neither in-situ nor grab sample measurements nor visual observation indicated turbidity issues.

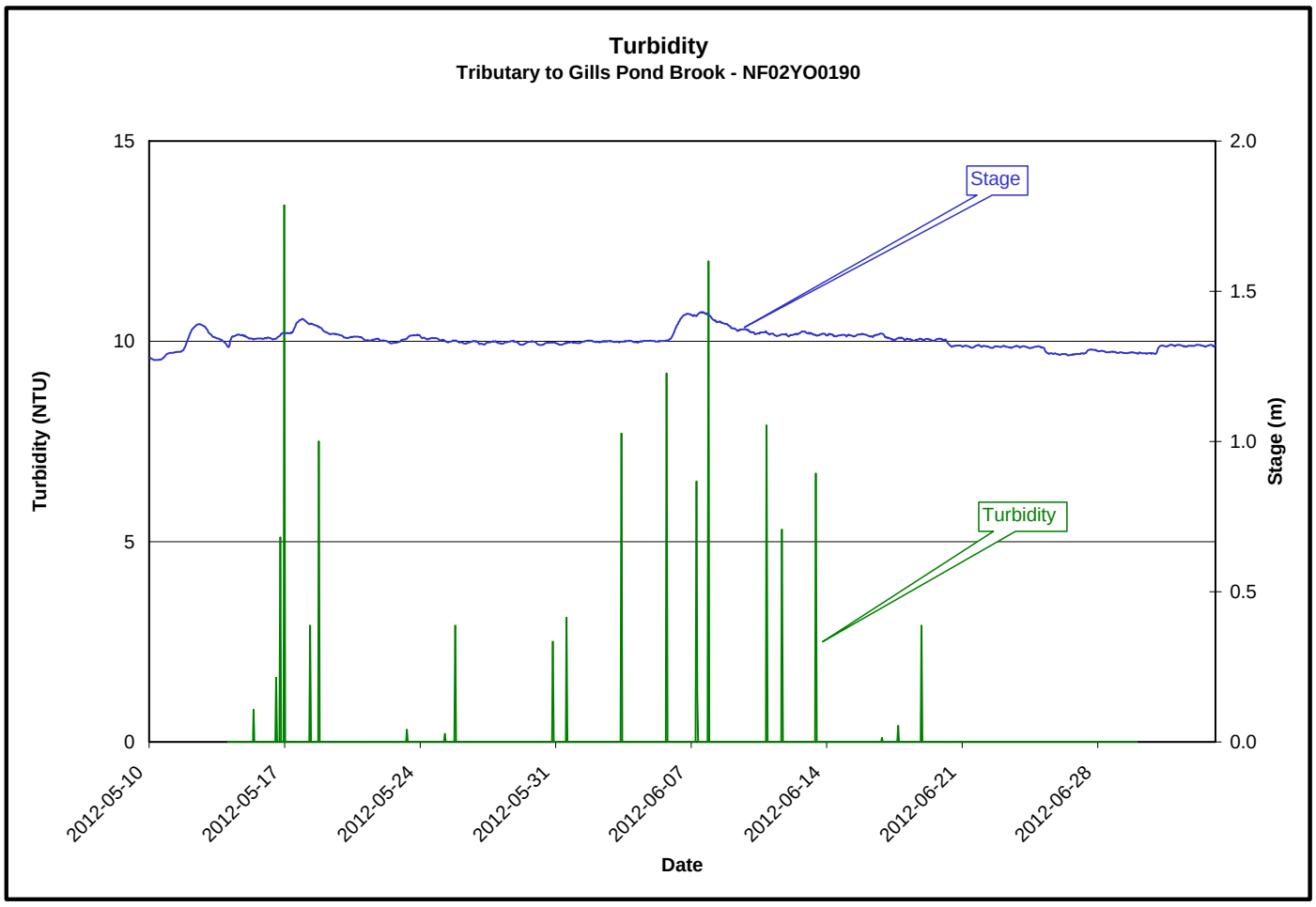

Figure 5

- The stage or water level ranged from a minimum of 1.27 m to a maximum of 1.43 m. The flow or discharge ranged from a minimum of 0.05 m^3/s to a maximum of 0.60 m^3/s (**Figure 6)**.
- There was a slight increase in stage and flow following the onset of discharge from Polishing Pond on May 14, 2012.
- The higher levels are the result of precipitation/runoff events.
- All values are within the normal range.

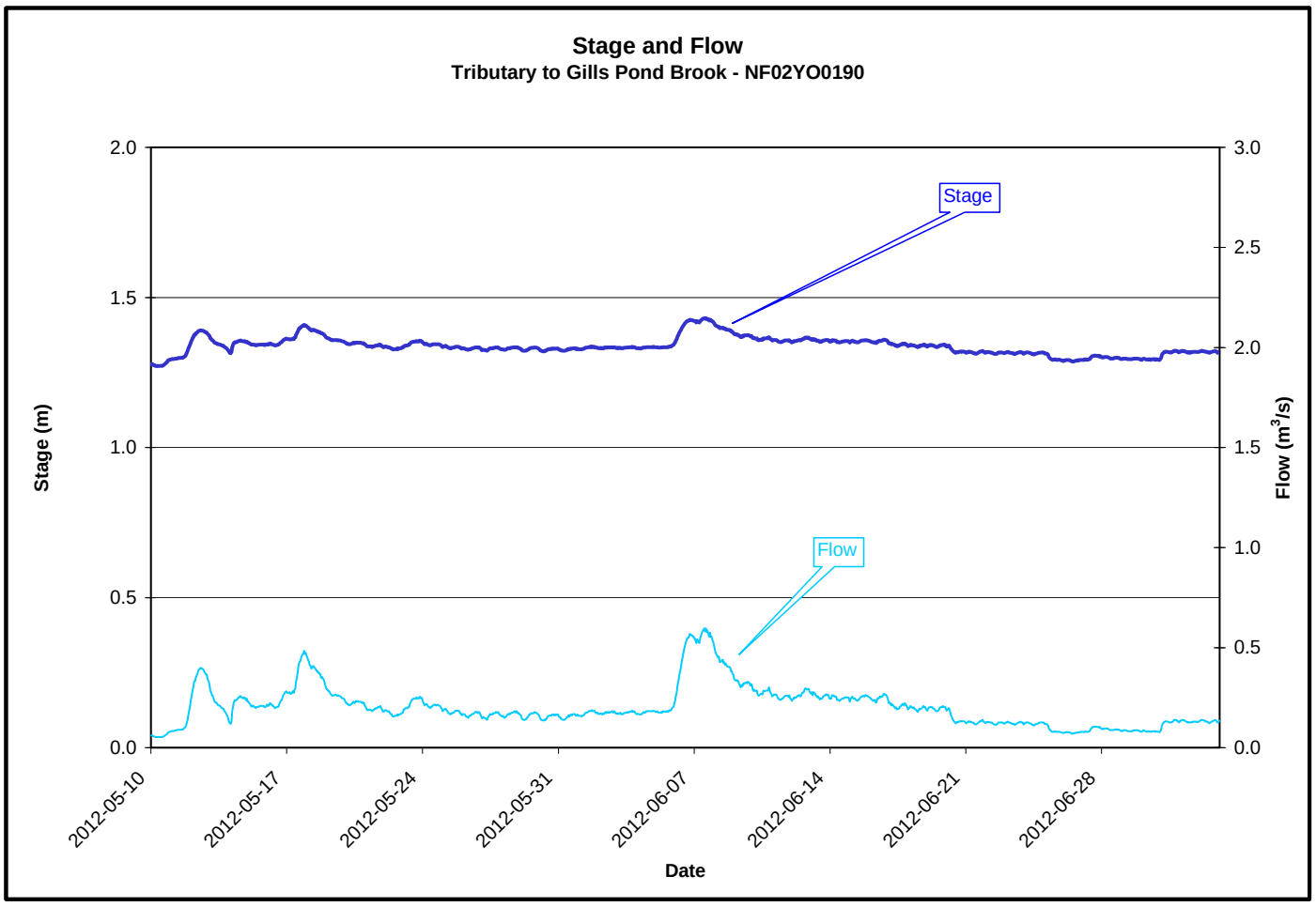

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 6.38 ˚C to a maximum of 29.05 ˚C.
- Temperatures generally increased throughout the deployment period.
- There appears to be little correlation with stage, although during peak flows, the diurnal variation in temperature is less, presumably due to precipitation, cloud cover and lower daytime ambient temperatures.

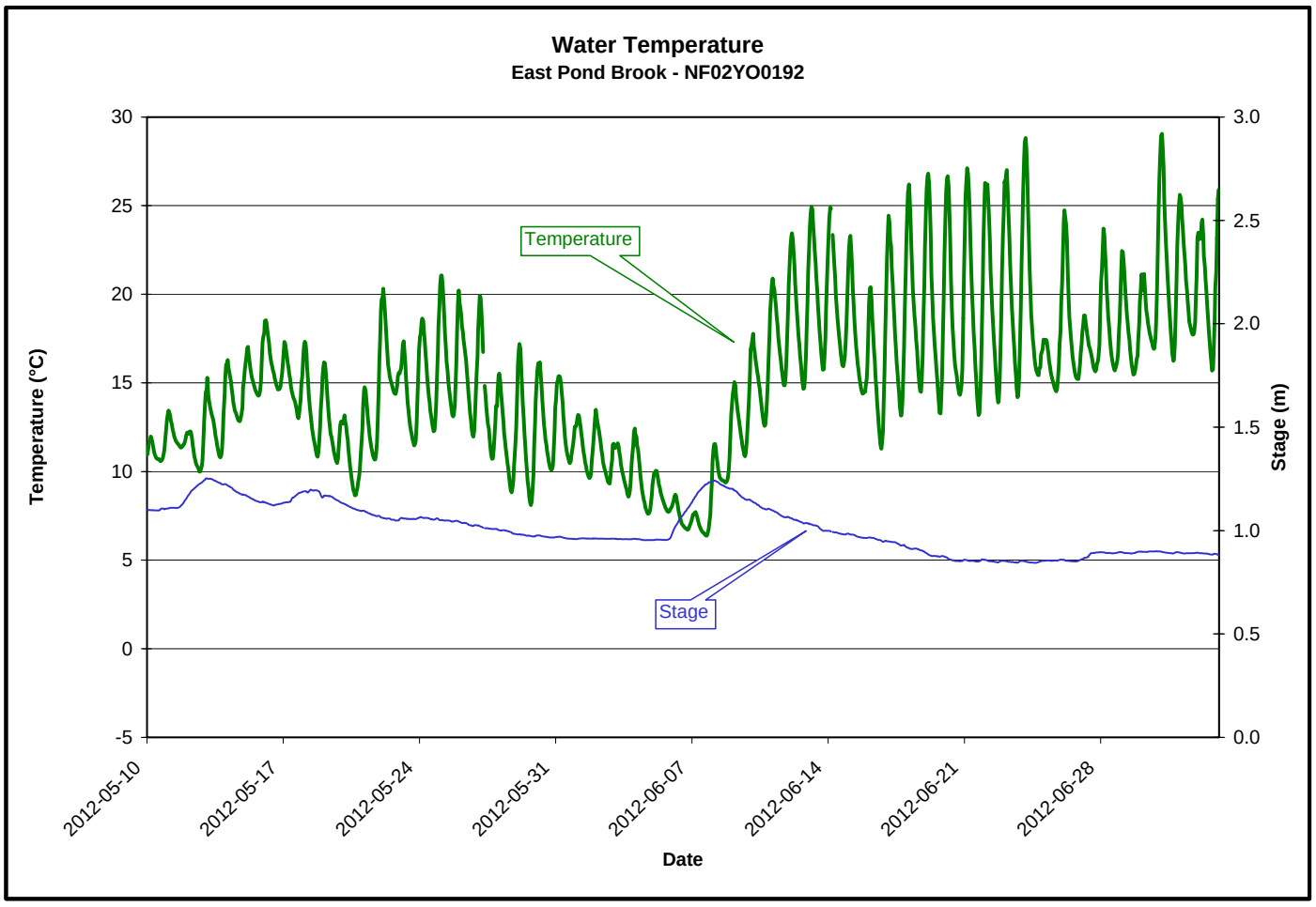

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.46 to a maximum of 7.22 with pH remaining fairly constant throughout the deployment period.
- There is a temporary decrease in pH corresponding with peak flows.
- For nearly all the deployment period, pH values fell just above 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 limit are not unusual.

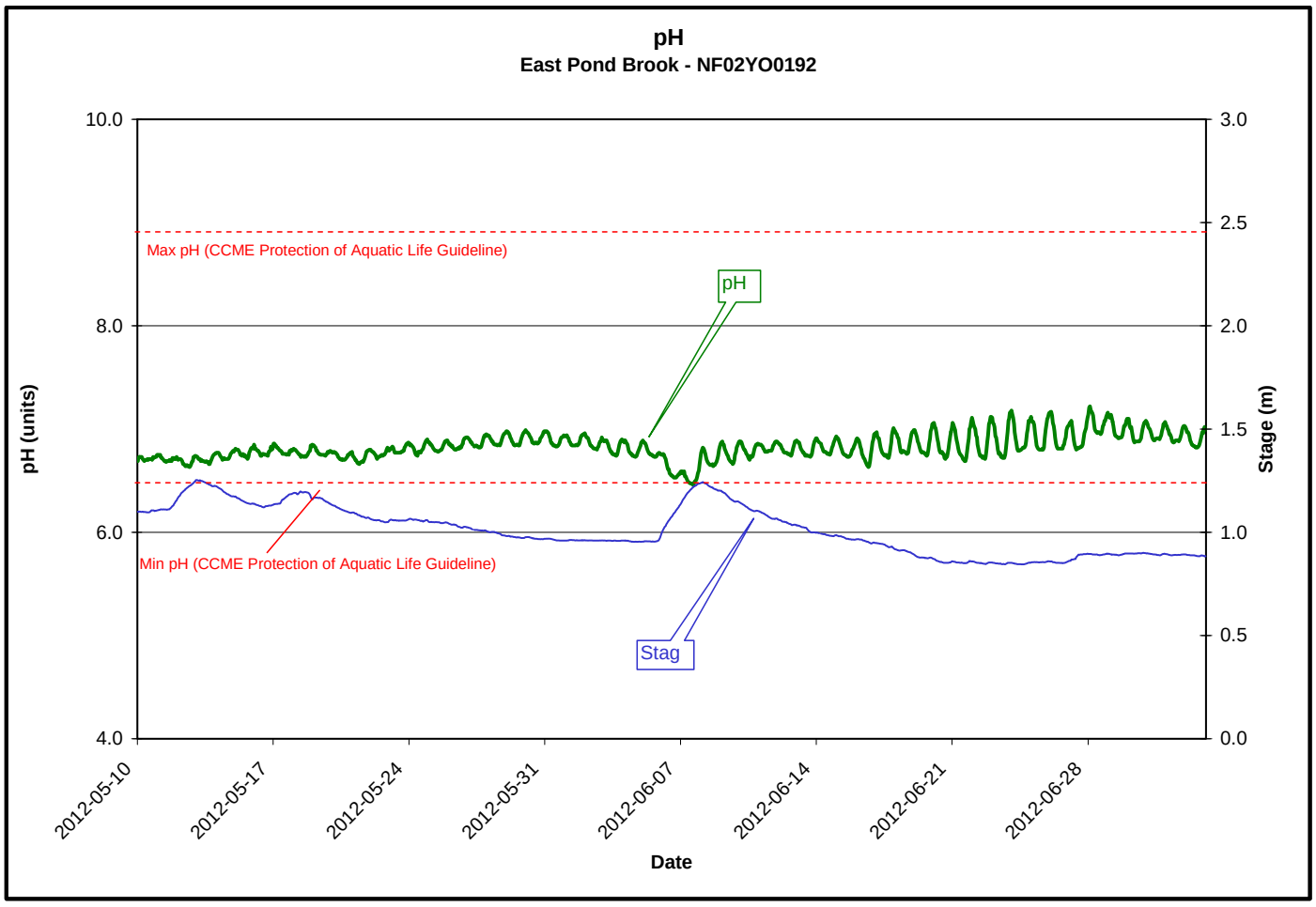

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 16.2 µS/cm to a maximum of 35.6 µS/cm, with a slight increase over the deployment period.
- There are notable increase in specific conductivity corresponding with higher flows.
- All values are within the normal range.

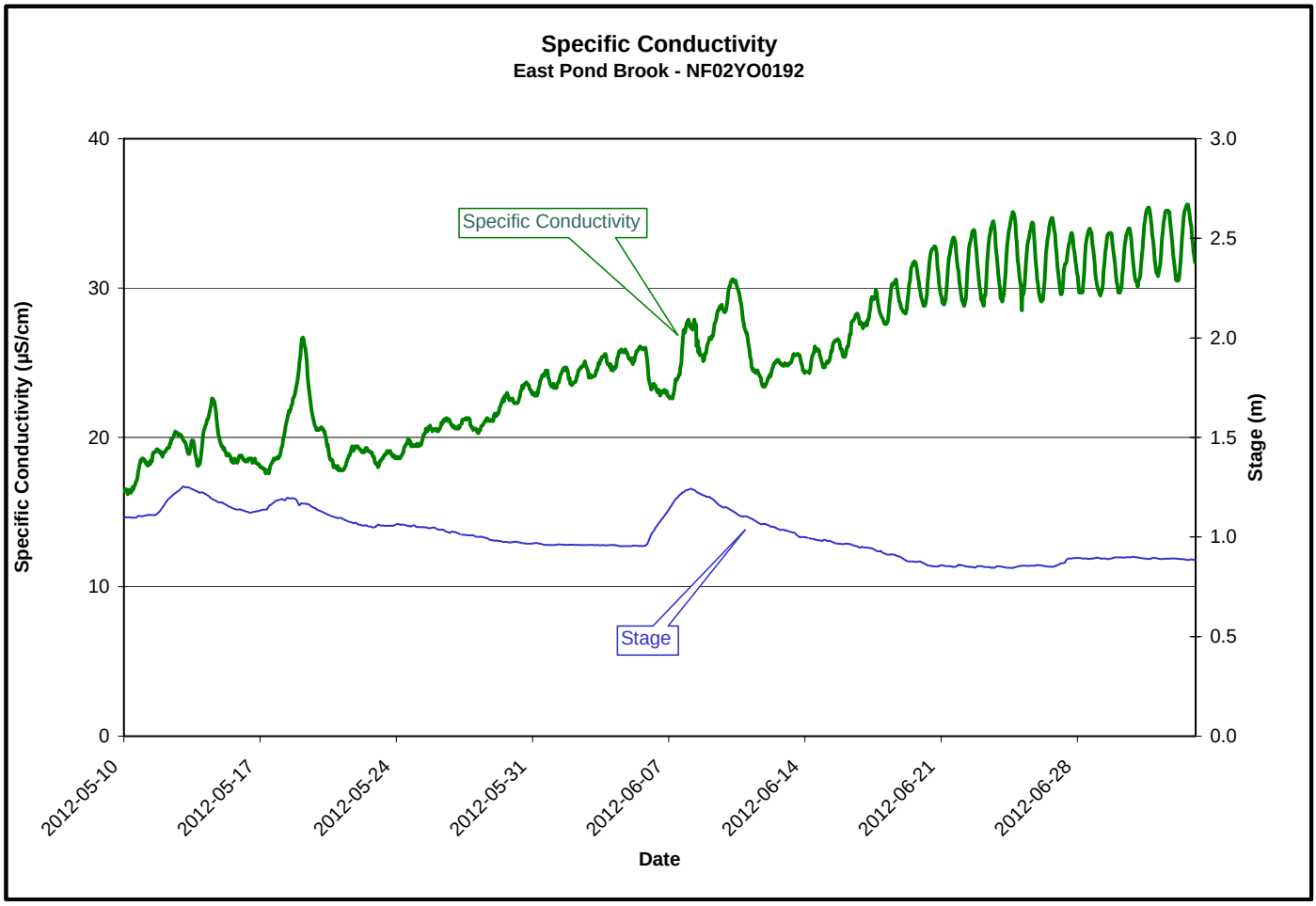

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 7.45 mg/L to a maximum of 11.61 mg/L over the deployment period, with the percent saturation ranging between 82.0 and 112.1.
- Dissolved oxygen is inversely proportional to water temperature.
- Throughout the deployment period, all dissolved oxygen values fell above the lower 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.

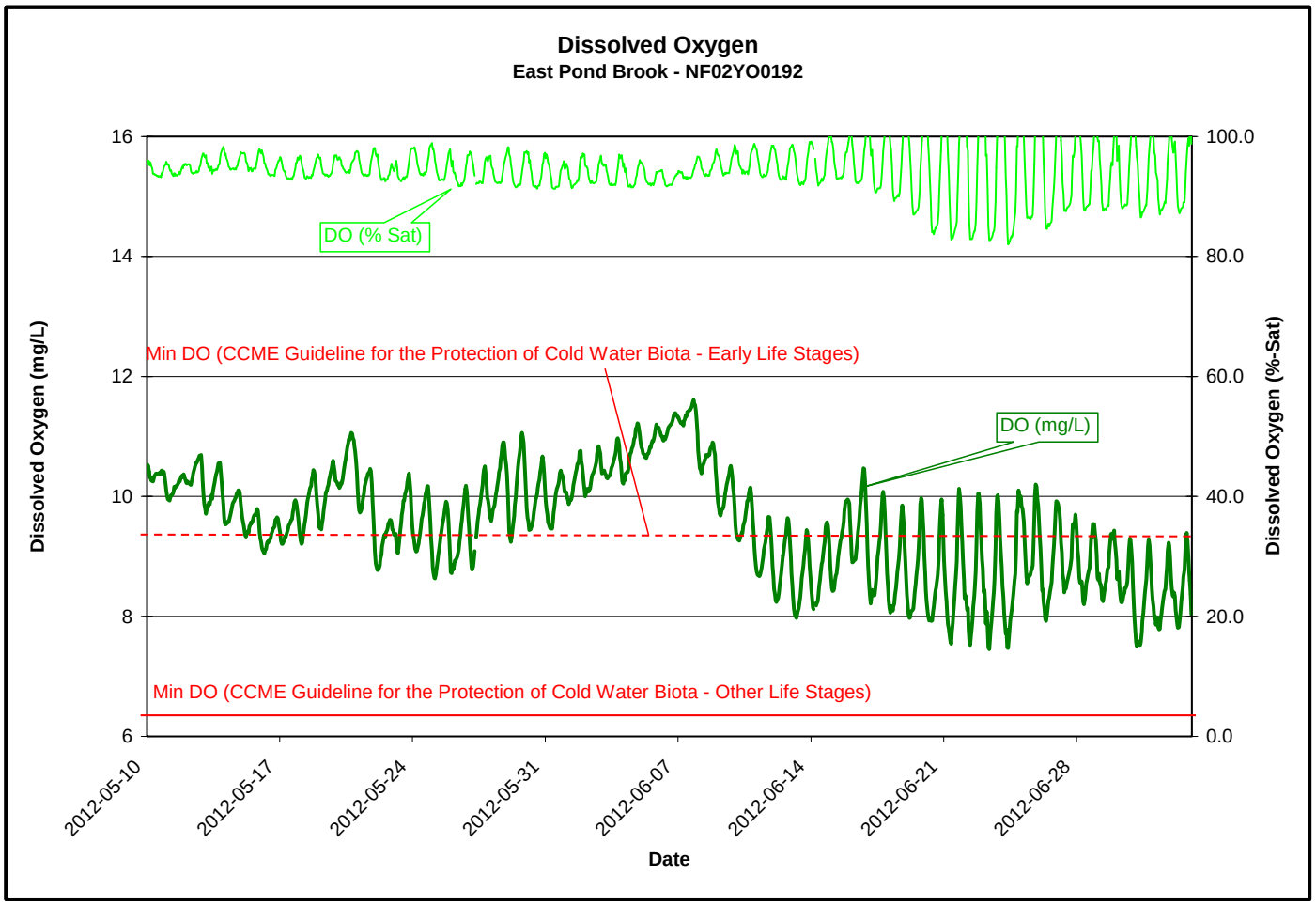

Figure 10

- The turbidity values (**Figure 11**) ranged from a minimum of 0.0 NTU to a maximum of 11.3 NTU.
- Turbidity values in this stream are typically near zero, with the measurements above zero representing the greater accuracy of the unit based upon the revised turbidity calibration protocol. The peaks typically represent insignificant events when natural in-stream debris or air bubbles passed near the sensor.
- Neither in-situ nor grab sample measurements nor visual observation indicated turbidity issues.

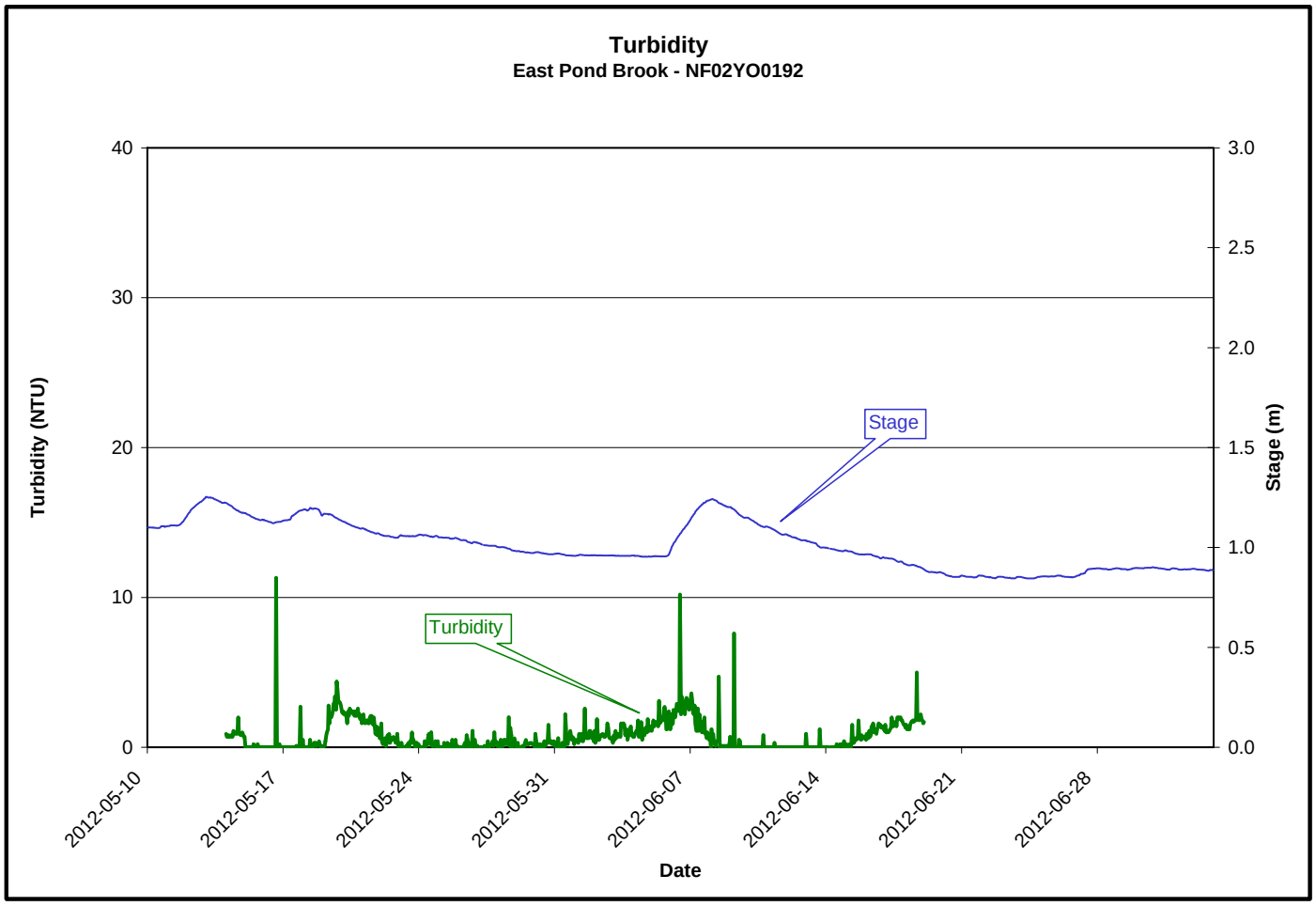

Figure 11

- The stage or water level ranged from a minimum of 0.85 m to a maximum of 1.25 m. The flow or discharge ranged from a minimum of 0.12 m^3/s to a maximum of 2.29 m^3/s **(Figure 12)**.
- The flow values for the lowest water levels could not be displayed, as the stage-flow curve for these extremely low levels has yet to be calculated.

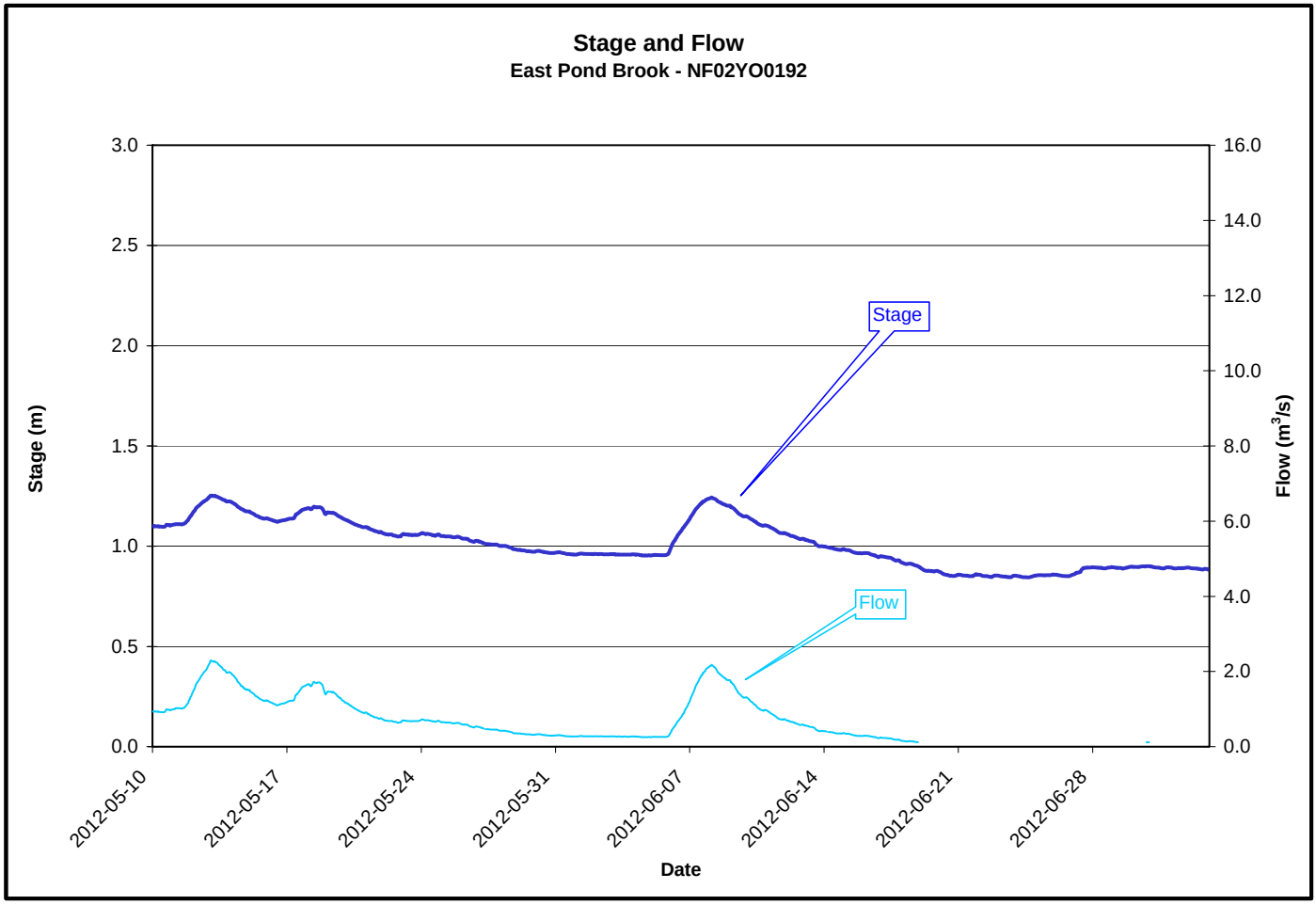

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.18 ˚C to a maximum of 5.22 ˚C with a slight decrease over the four day period.
- There appears to be little correlation with water elevation.

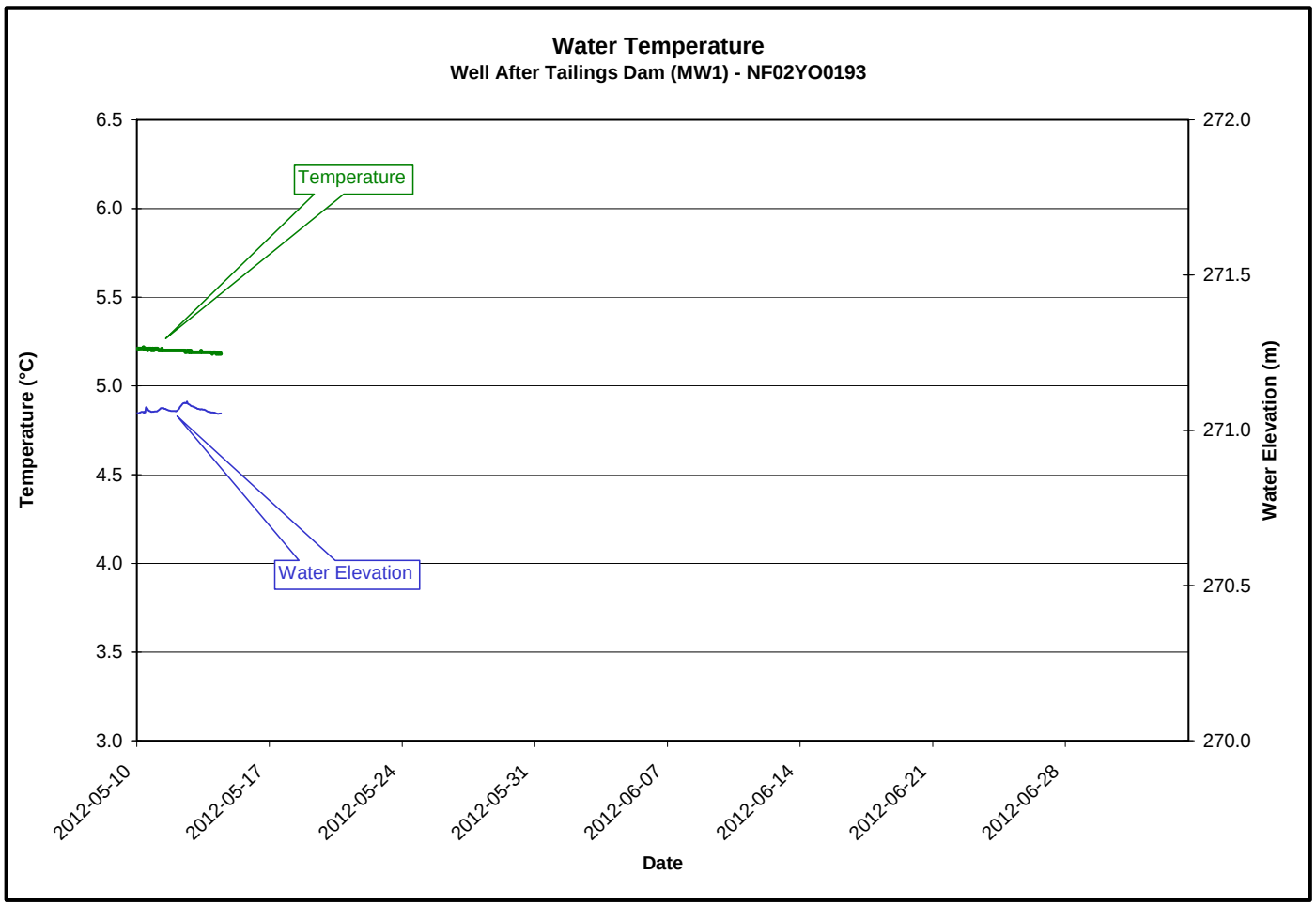

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 7.92 to a maximum of 8.13.
- The pH measurements appear to be somewhat erratic, and a little lower than the expected range, and thus are suspect and may not be reliable.
- It has subsequently been determined that the pH sensor could not be calibrated following its removal from the well. Accordingly, the sensor was returned to the vendor for factory servicing.
- There does not appear to be any correlation with water elevation.

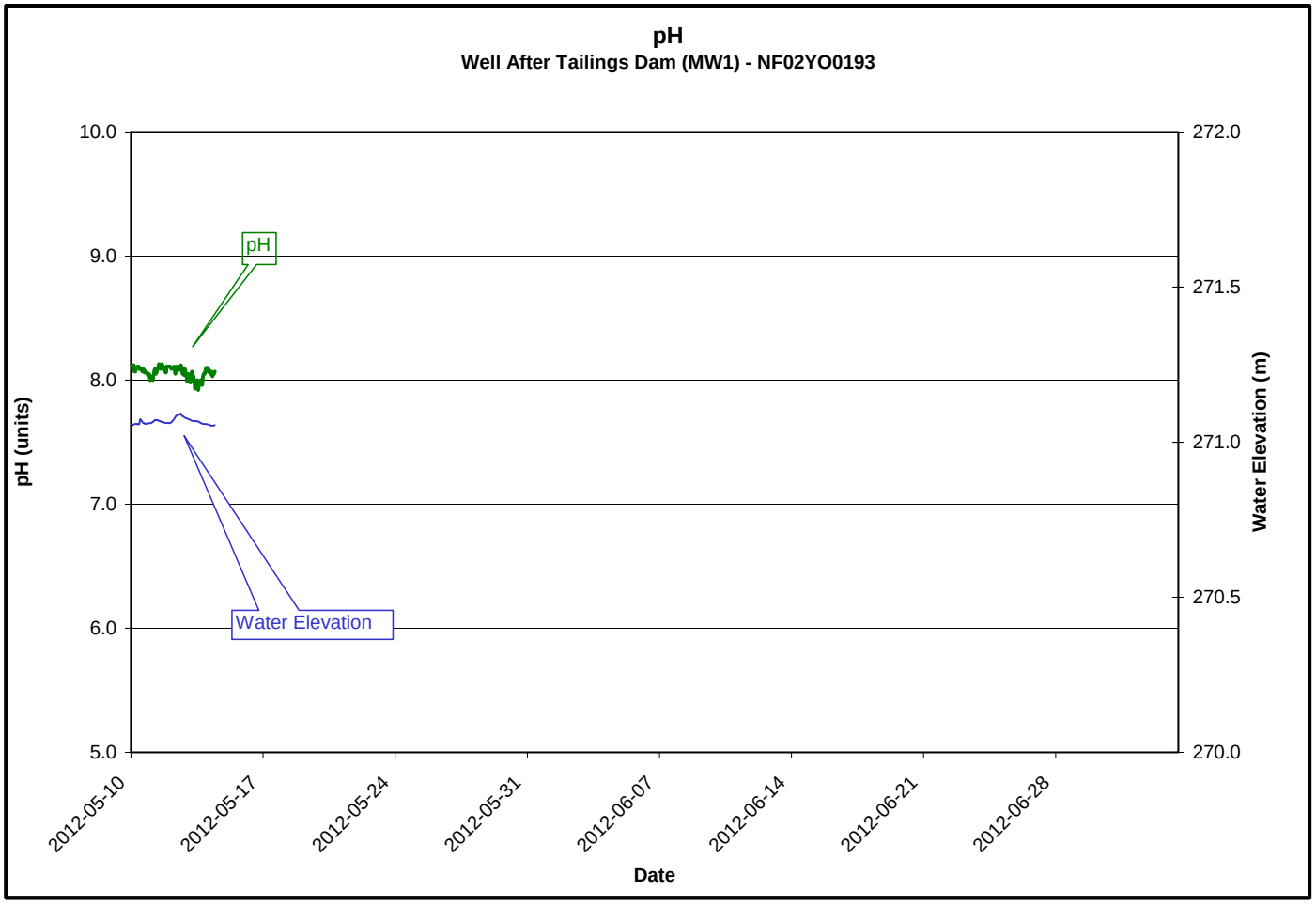

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.662 mS/cm to a maximum of 0.664 mS/cm, with values remaining fairly constant.

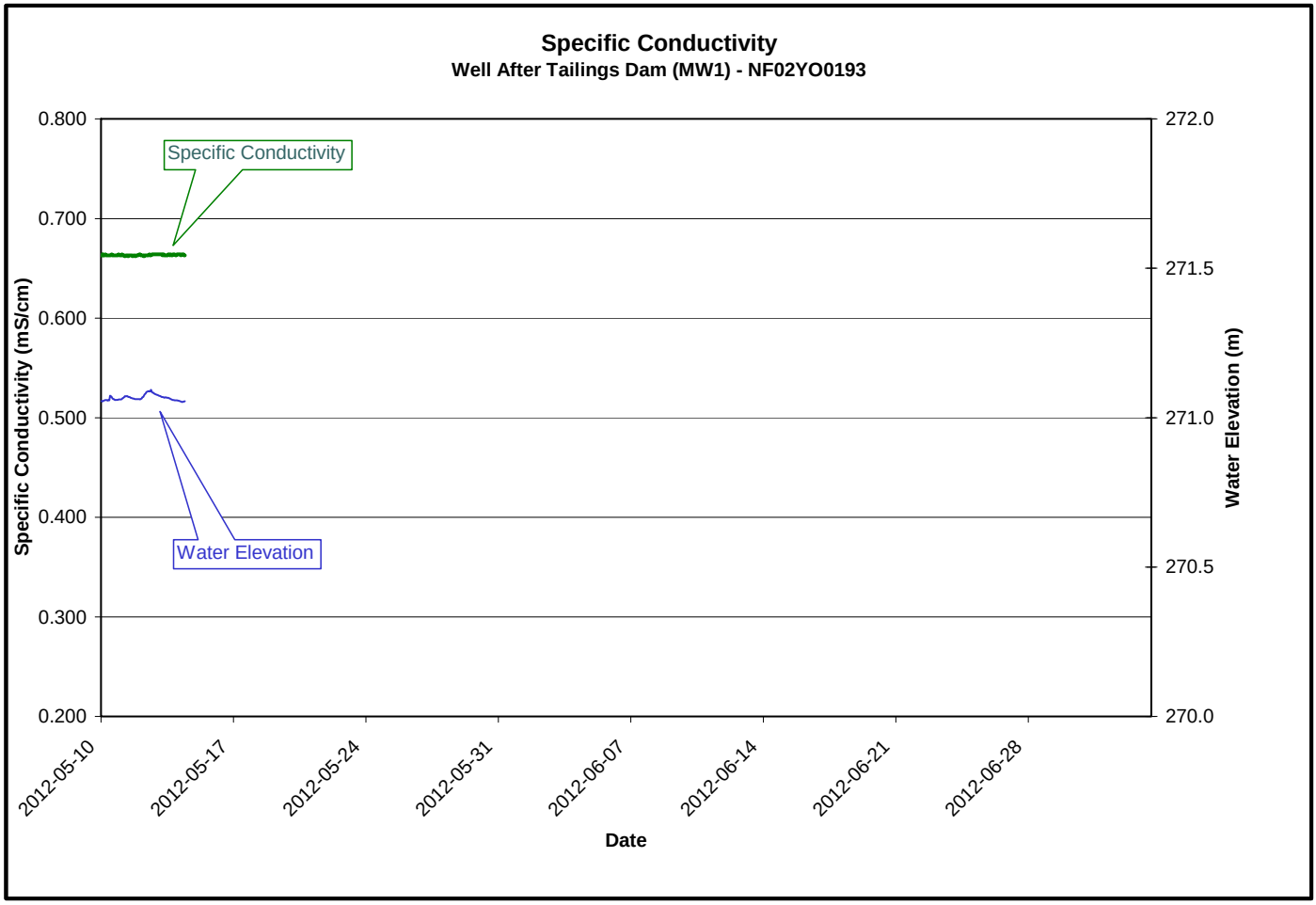

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.05 m to a maximum of 271.09 m. with a slight variation over the four day period.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by runoff from precipitation.

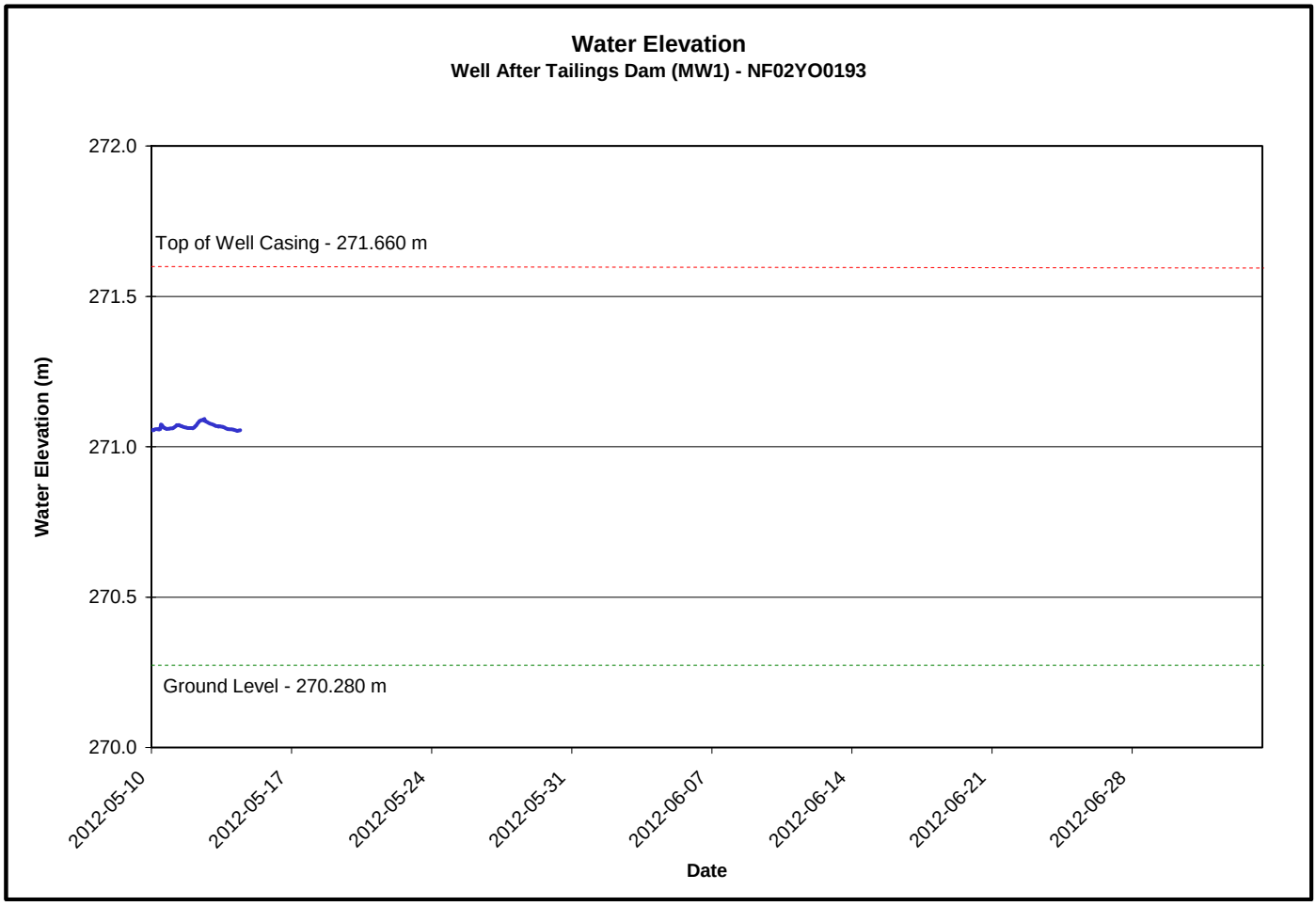

Figure 16

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