# Real-Time Water Quality Deployment Report

## Lower Churchill River Network

**September 22 to**
**November 3, 2010**

Newfoundland Labrador

**Government of Newfoundland & Labrador**
**Department of Environment and Conservation**
**Water Resources Management Division**

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## General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This monthly deployment period illustrates and discusses water quality related events from September 22 to November 3, 2010; a period of 42 days.
- On September 21, 2010, real-time water quality monitoring instruments were deployed at all four Lower Churchill River Stations.

## Maintenance and Calibration of Instrument

- As part of the Quality Assurance and Quality Control protocol (QAQC), 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.
  - ► At deployment and removal, a QA/QC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Sonde and QAQC Sonde at deployment, a qualitative statement is made on the data quality (Table 1).
  - ► At the end of a deployment period, readings are taken in the water body from the Field Sonde 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.

**Table 1: Ranking classifications for deployment and removal**

| | 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 |

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.
- Deployment and removal comparison rankings for the Churchill River stations deployed between September 21 and November 2/3, 2010 are summarized in Table 2.

**Table 2: Comparison rankings for Churchill River stations, September 21 – November 2/3, 2010**

| Station Churchill River | Date | Action | Comparison Ranking | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature | pH | Conductivity | Dissolved Oxygen | Turbidity |
| Below Muskrat Falls | Sep 21, 2010 | Deployment | Good | Excellent | Excellent | Excellent | Poor |
| | Nov 3, 2010 | Removal | Fair | Good | Excellent | Excellent | Fair |
| Above Muskrat Falls | Sep 21, 2010 | Deployment | Good | Fair | Excellent | Excellent | Good |
| | Nov 2, 2010 | Removal | Good | Fair | Excellent | Excellent | Excellent |
| Below Grizzle Rapids | Sep 21, 2010 | Deployment | Excellent | Excellent | Excellent | Excellent | Excellent |
| | Nov 2, 2010 | Removal | Excellent | Fair | Excellent | Excellent | Excellent |
| Below Metchin River | Sep 21, 2010 | Deployment | Excellent | Good | Excellent | Excellent | Excellent |
| | Nov 2, 2010 | Removal | Good | Fair | Excellent | Excellent | n/a* |

* The turbidity sensor on the instrument deployed at the station below Metchin River reported erratic, uncharacteristic data for the entire deployment period due to a large invertebrate living on the sensor. Data for this period is not valid and therefore not ranked.

- The turbidity sensor on the instrument deployed at the station below Muskrat Falls ranked “poor” at deployment. This may have been in part caused by the placement of the QAQC sonde in the water adjacent to the field sonde. Weather conditions were unfavourable at the time and also could have affected the ability to obtain a stable turbidity reading.

## Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from September 22 to November 2/3 in the Lower Churchill River Network.
- 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 QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request. Where appropriate, corrected data for water quality parameters are indicated.

Churchill River below Muskrat Falls

- Water temperature ranged from 3.80 to 12.40$^{o}$C during this deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the decreasing ambient air temperatures in the fall season (Appendix 1). Water temperature fluctuates diurnally.

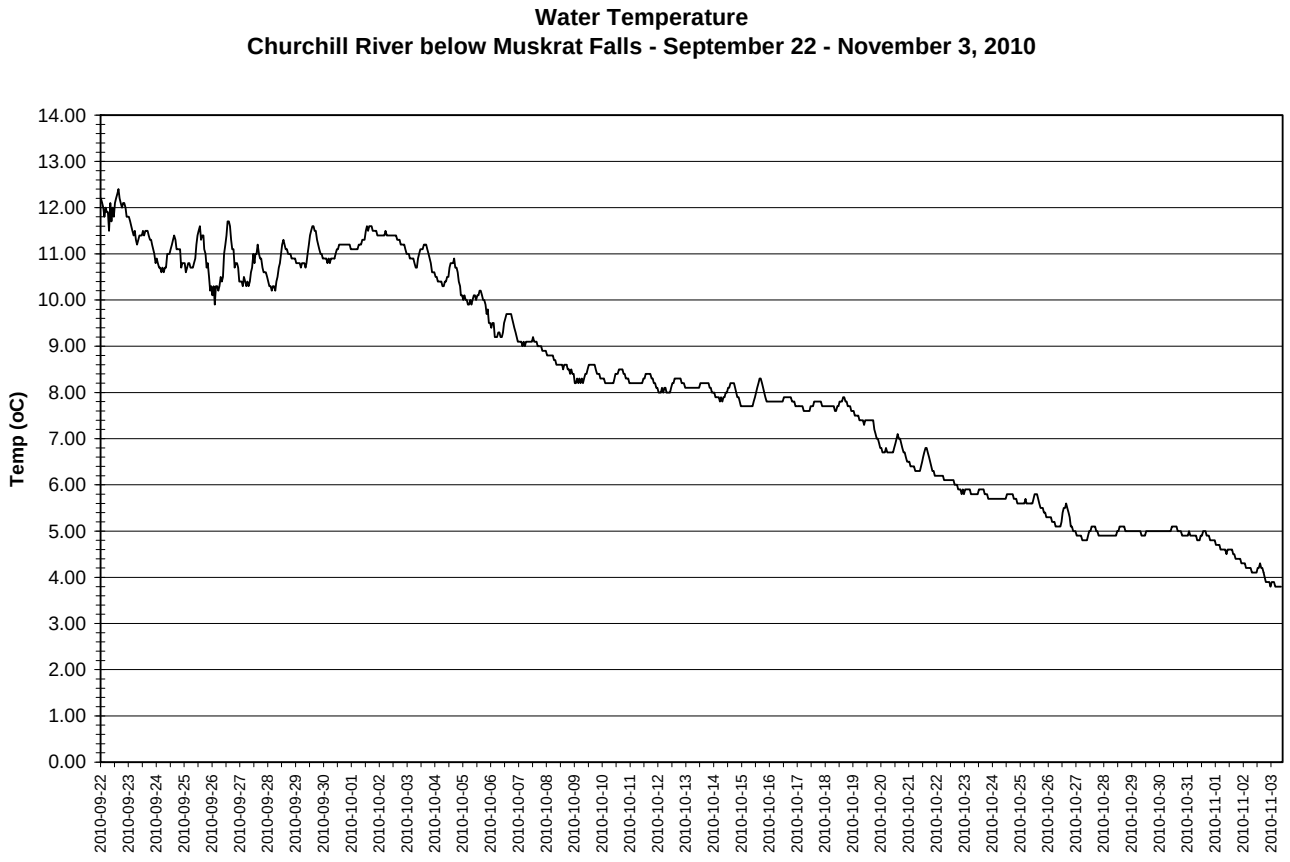


**Figure 1: Water temperature at Churchill River below Muskrat Falls**

- pH ranges between 6.87 and 7.63 pH units and generally decreases throughout the deployment period (Figure 2).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life.
- At the beginning of the deployment period, there is some variation in pH values for a period close to three days. It is unknown what the cause of this variation is.

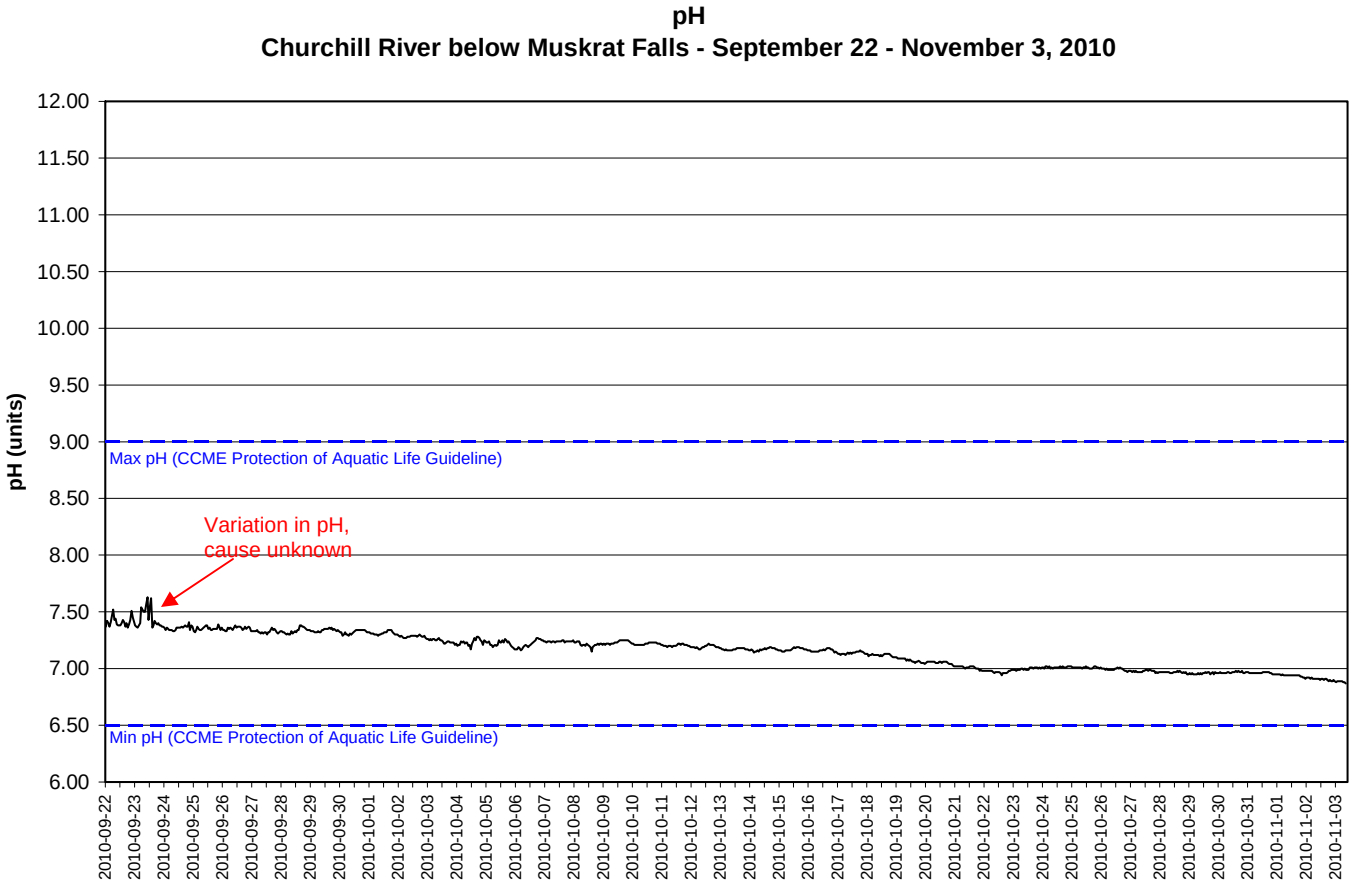


**Figure 2: pH at Churchill River below Muskrat Falls**

- Specific conductivity ranges from 18.2 to 23.0µS/cm during the deployment period (Figure 3). Specific conductance generally increases throughout the deployment period.
- Stage is included in Figure 3 to illustrate the inverse relationship between conductivity and water level. Stage generally remains stable throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 3).
- Increases in specific conductivity on September 30 and October 9 both correspond with rainfall events recorded at Goose Bay (Appendix 1). These events are indicated on the Figure 3 in green.

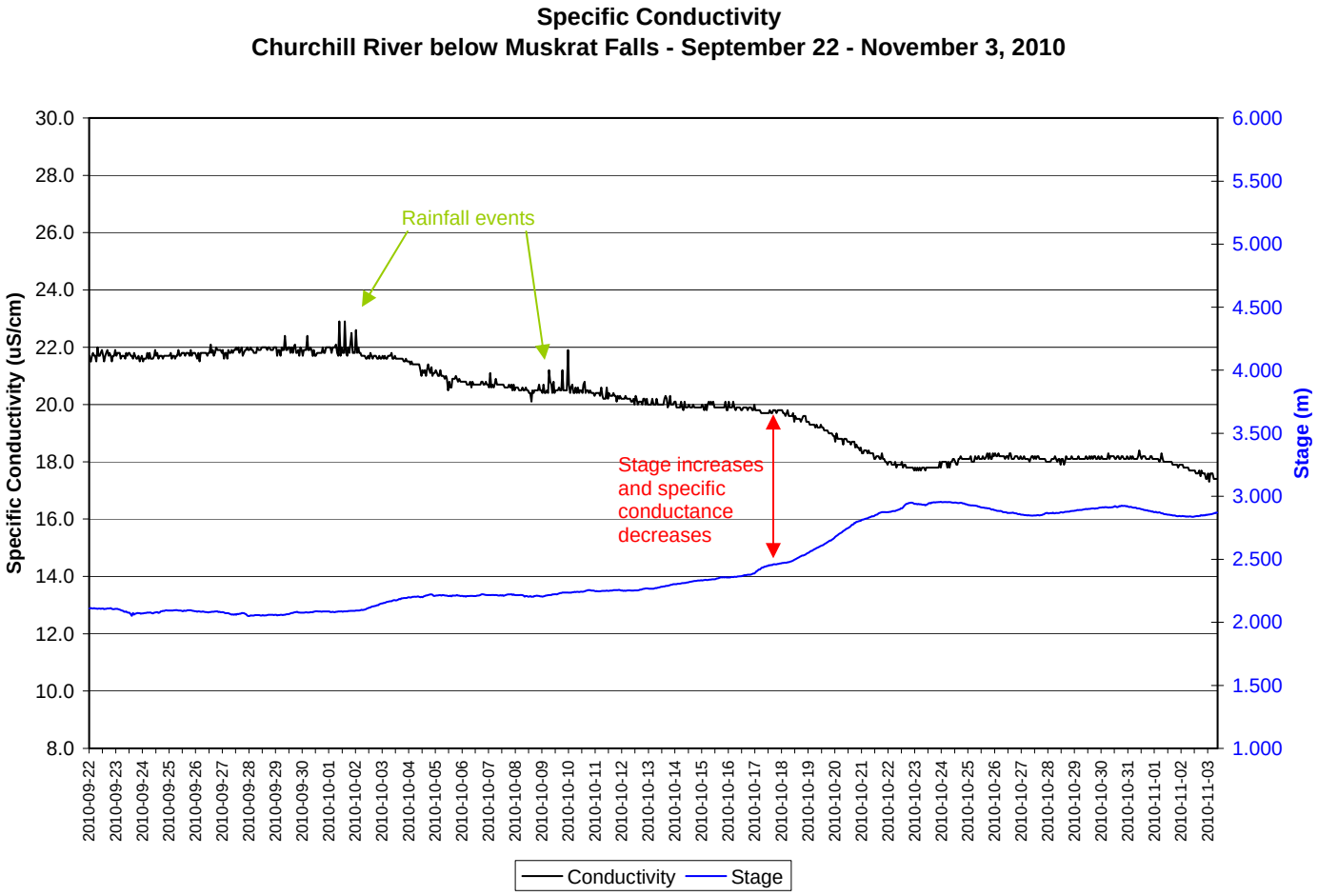


**Figure 3: Specific conductivity at Churchill River below Muskrat Falls**

- The saturation of dissolved oxygen ranged from 97.6 to 109.8% and a range of 10.59 to 14.18mg/l was found in the concentration of dissolved oxygen with a median value of 12.41 mg/l (Figure 4).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 4
- Dissolved Oxygen content increase slightly throughout the deployment period. This trend is expected given the decreasing air and water temperatures (Figure 1 & Appendix 1).

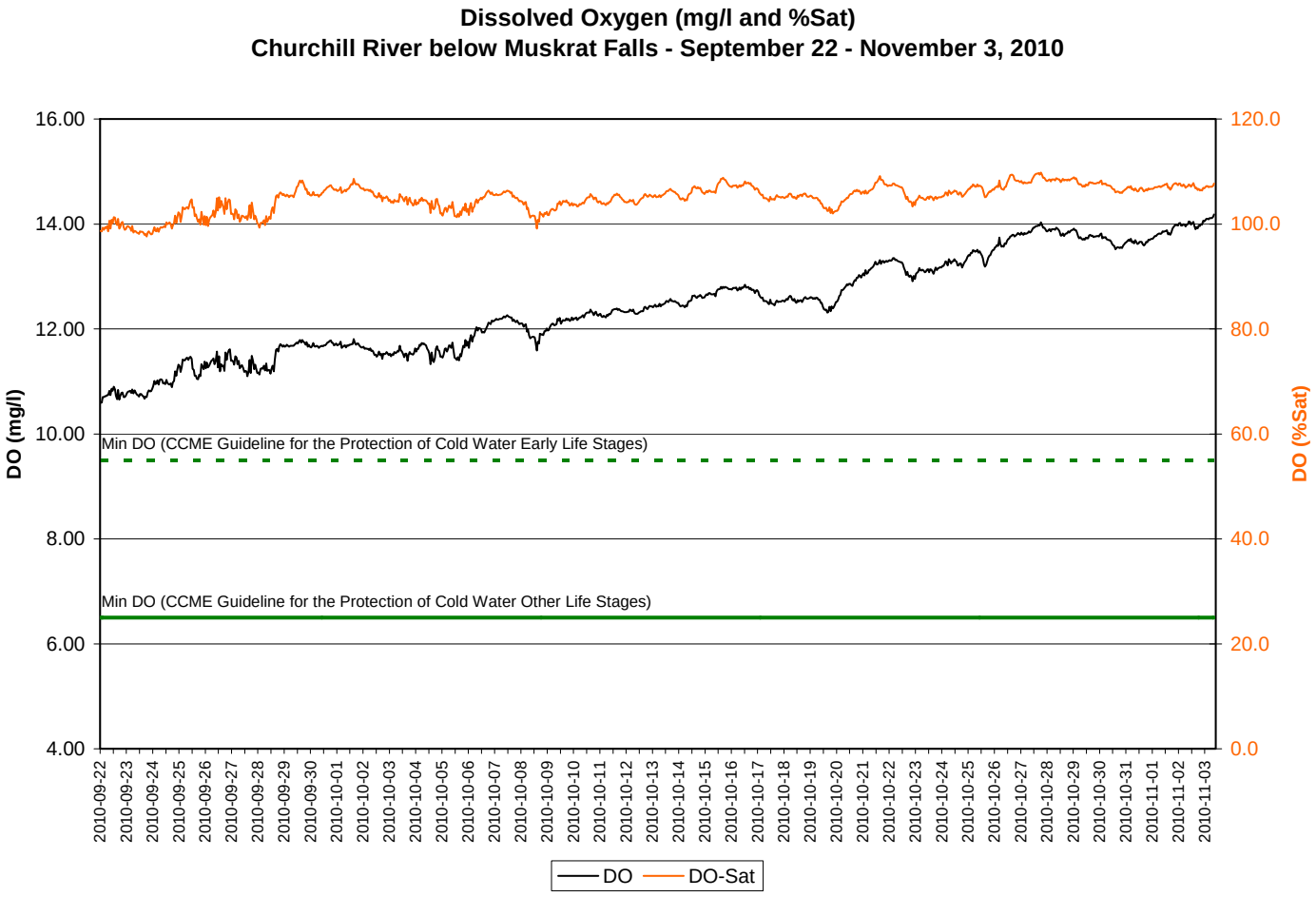


**Figure 4: Dissolved Oxygen at Churchill River below Muskrat Falls**

- A range of 0.1 to 506.0 NTU was recorded for turbidity for this deployment period (Figure 5). A median value of 3.6 NTU indicates there is a consistent natural background turbidity value at this station.
- The turbidity data for this station between September 22 and November 3 is uncharacteristic. On September 23, turbidity values spike to 506NTU. During the days following, turbidity continues to vary before leveling off at a very low reading (<1NTU). There is no weather related event recorded in the area that would justify the values recorded. Another turbidity event occurs starting on October 3, lasting for 4 days. This event corresponds with significant rainfall. After this event, turbidity gradually rises throughout the remainder of the deployment period which is very unusual and likely not accurate. Upon removal, the field sonde was reading upwards of 80NTU, while the QAQC sonde was reading <5NTU. The water was visually clear for this site. It is likely that there was some type of sensor error. Turbidity data for this month should be used with caution however average values still reflect this sites natural chemistry.

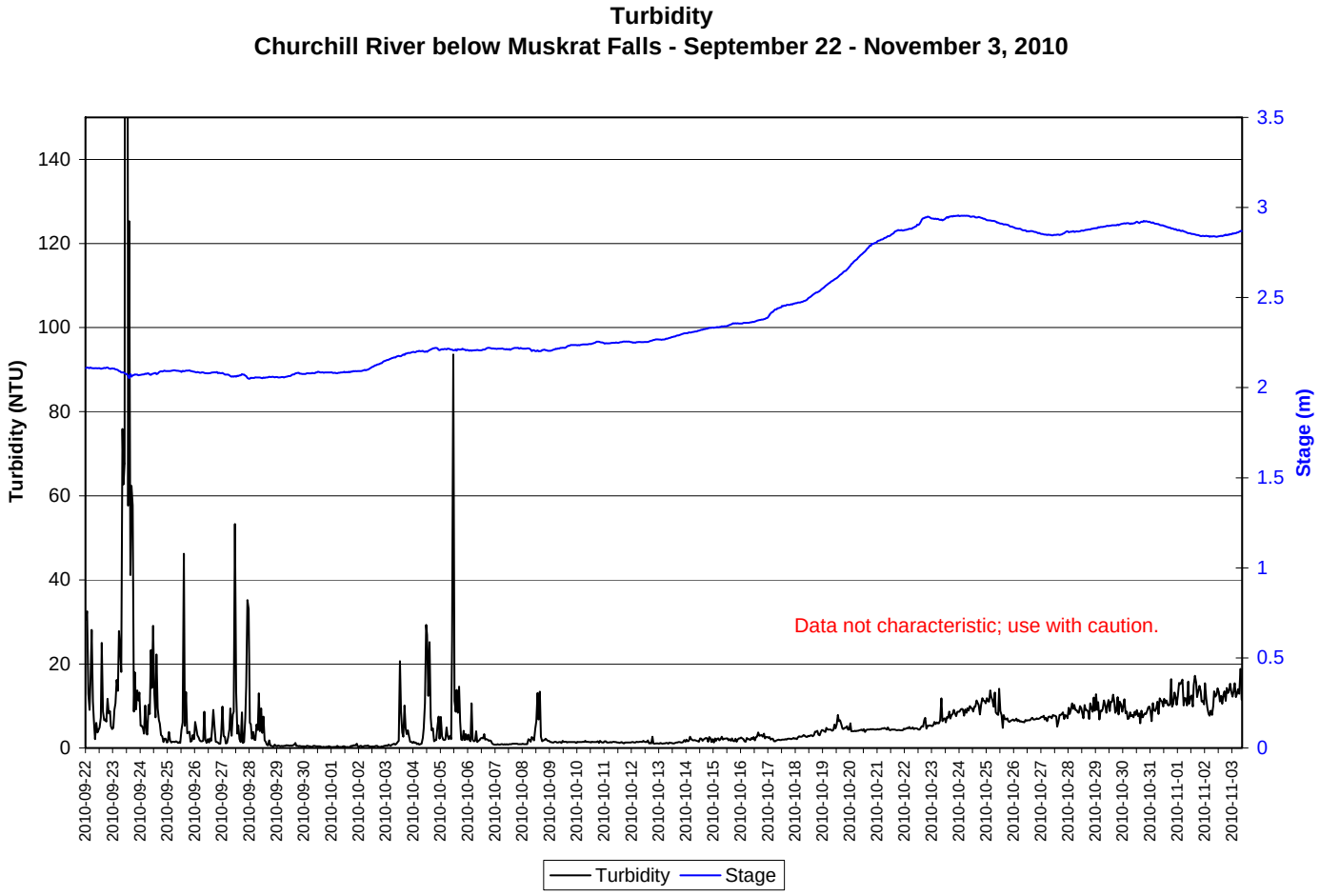


**Figure 5: Turbidity at Churchill River below Muskrat Falls**

Churchill River above Muskrat Falls

- Water temperature ranges from 3.58 to 12.00°C during this deployment period (Figure 6).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the decreasing ambient air temperature in the fall (Appendix 1). Water temperature fluctuates diurnally.

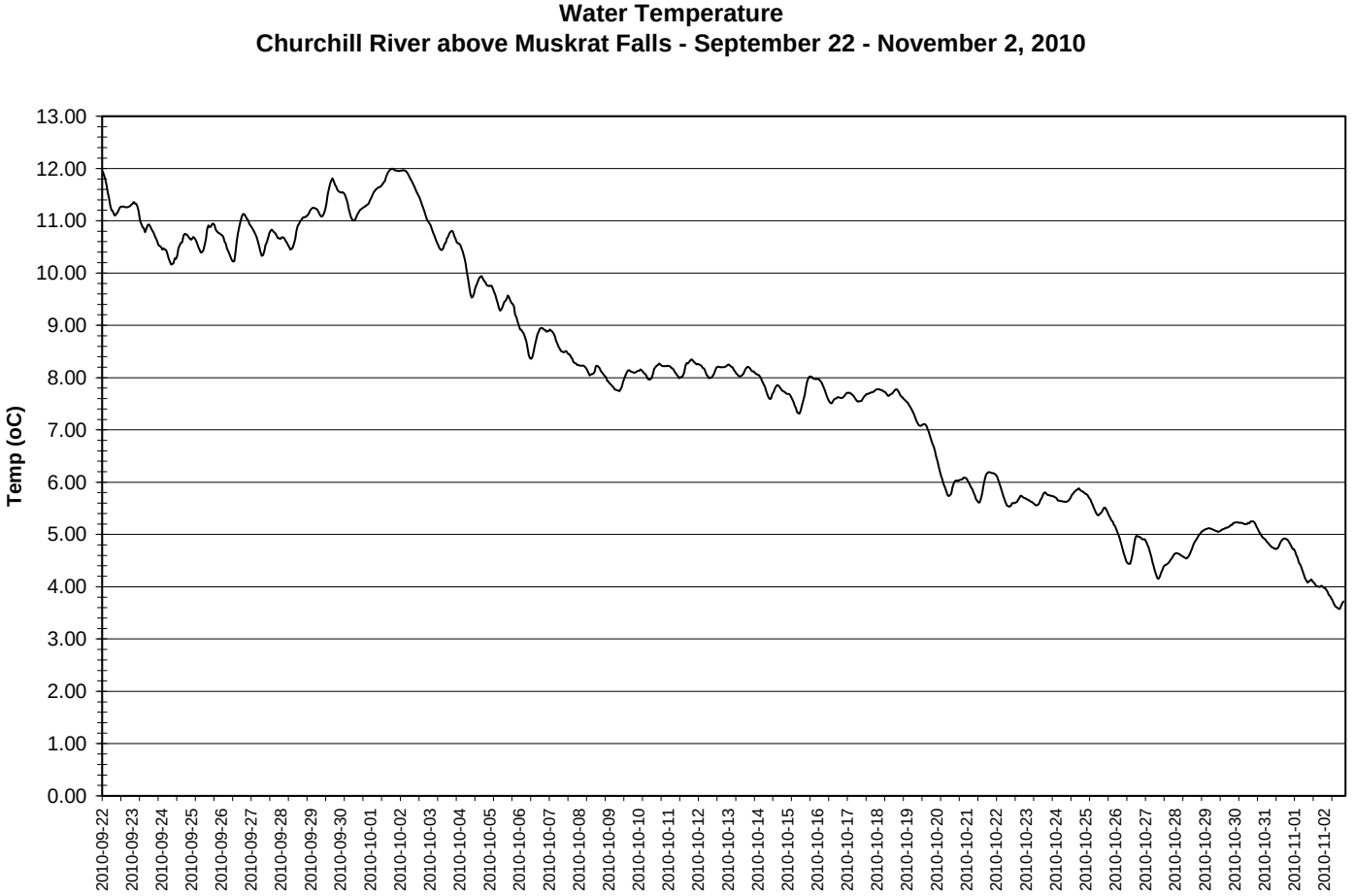


**Figure 5: Water temperature at Churchill River above Muskrat Falls**

- pH ranges between 6.08 and 7.08 pH units (Figure 7). pH values are decreasing throughout the deployment period.
- From September 22 to October 21, all values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 7). After October 21, pH values are just below the minimum guideline of 6.5.
- pH was corrected based on bio-fouling error which was calculated at removal, during an instrument field cleaning. The corrected pH still shows a decreasing trend, which is expected, but does not decrease as much as the true sensor reading. All values for corrected pH are within the CCME Guidelines for the Protection of Aquatic Life.

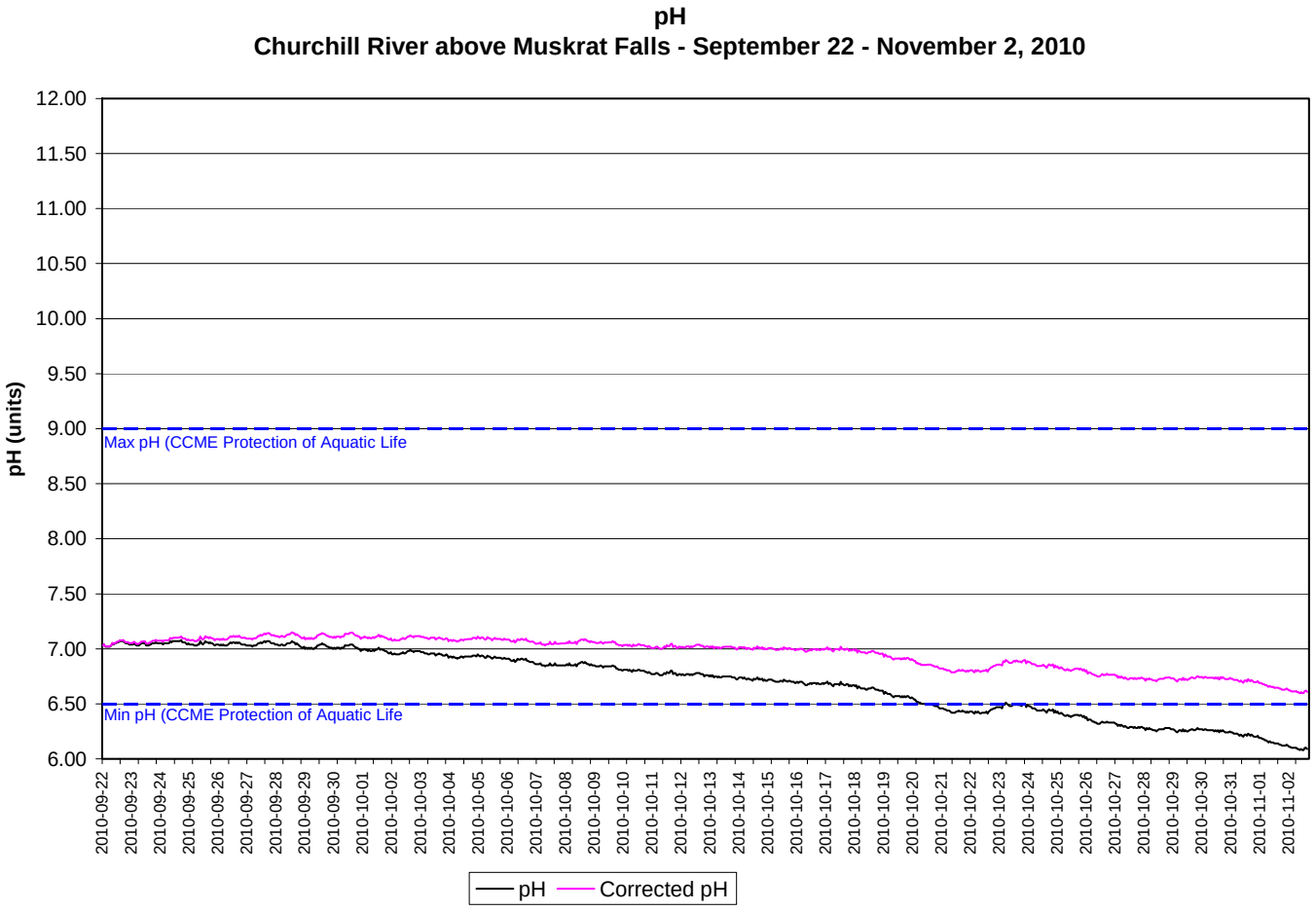


**Figure 6: pH at Churchill River above Muskrat Falls**

- Specific conductivity ranges between 16.9 and 24.0µS/cm during the deployment period (Figure 8).
- Stage is included in Figure 8 to illustrate the inverse relationship between conductivity and water level. Stage generally remains stable throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 8).
- Several increases in specific conductivity correspond with rainfall events. These events are indicated in green on Figure 8.

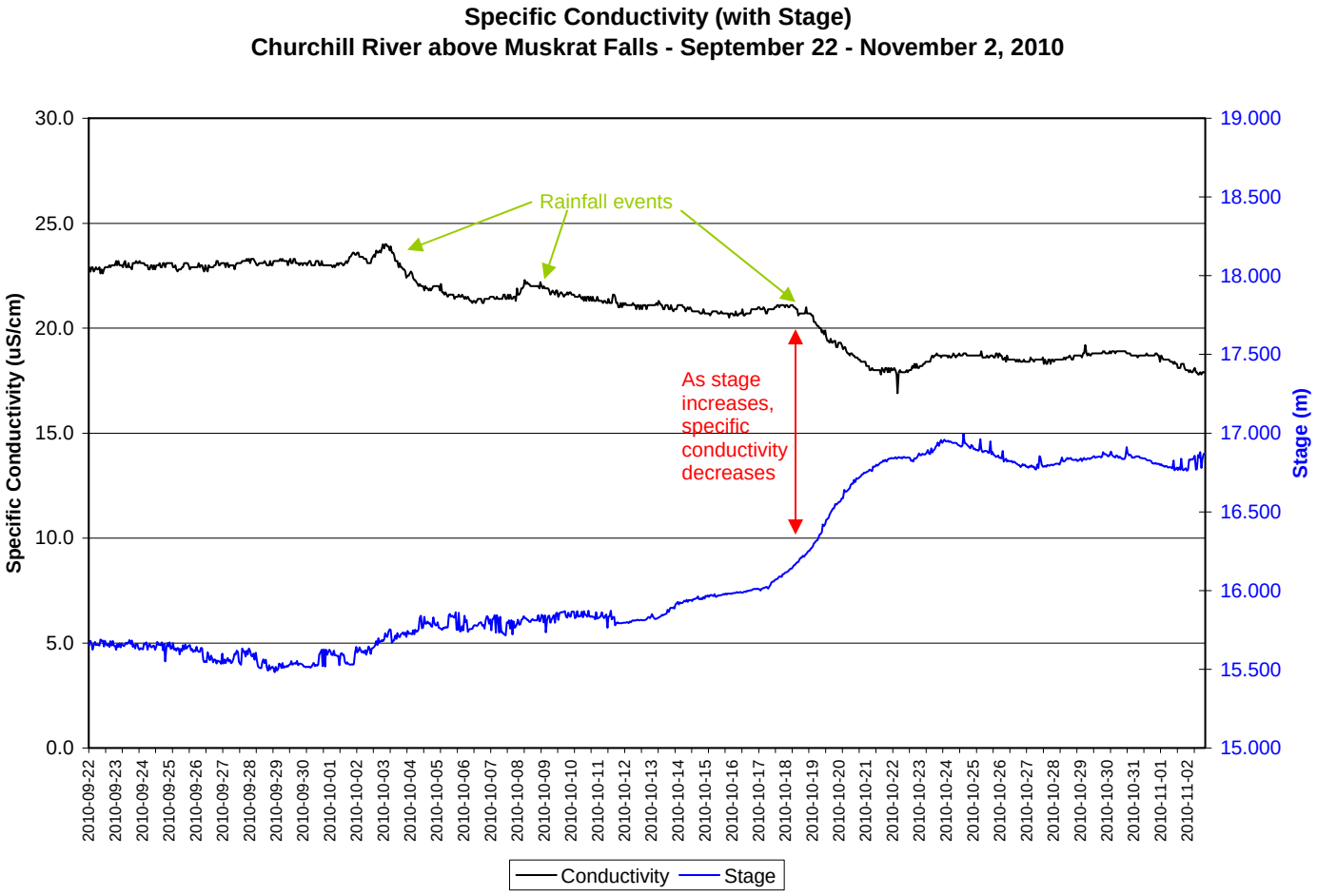


**Figure 7: Specific conductivity at Churchill River above Muskrat Falls**

- The saturation of dissolved oxygen ranged from 93.6 to 99.0% and a range of 10.25 to 12.67mg/l was found in the concentration of dissolved oxygen with a median value of 11.28mg/l (Figure 9).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 9.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decreasing air and water temperatures (Figure 6 & Appendix 1).

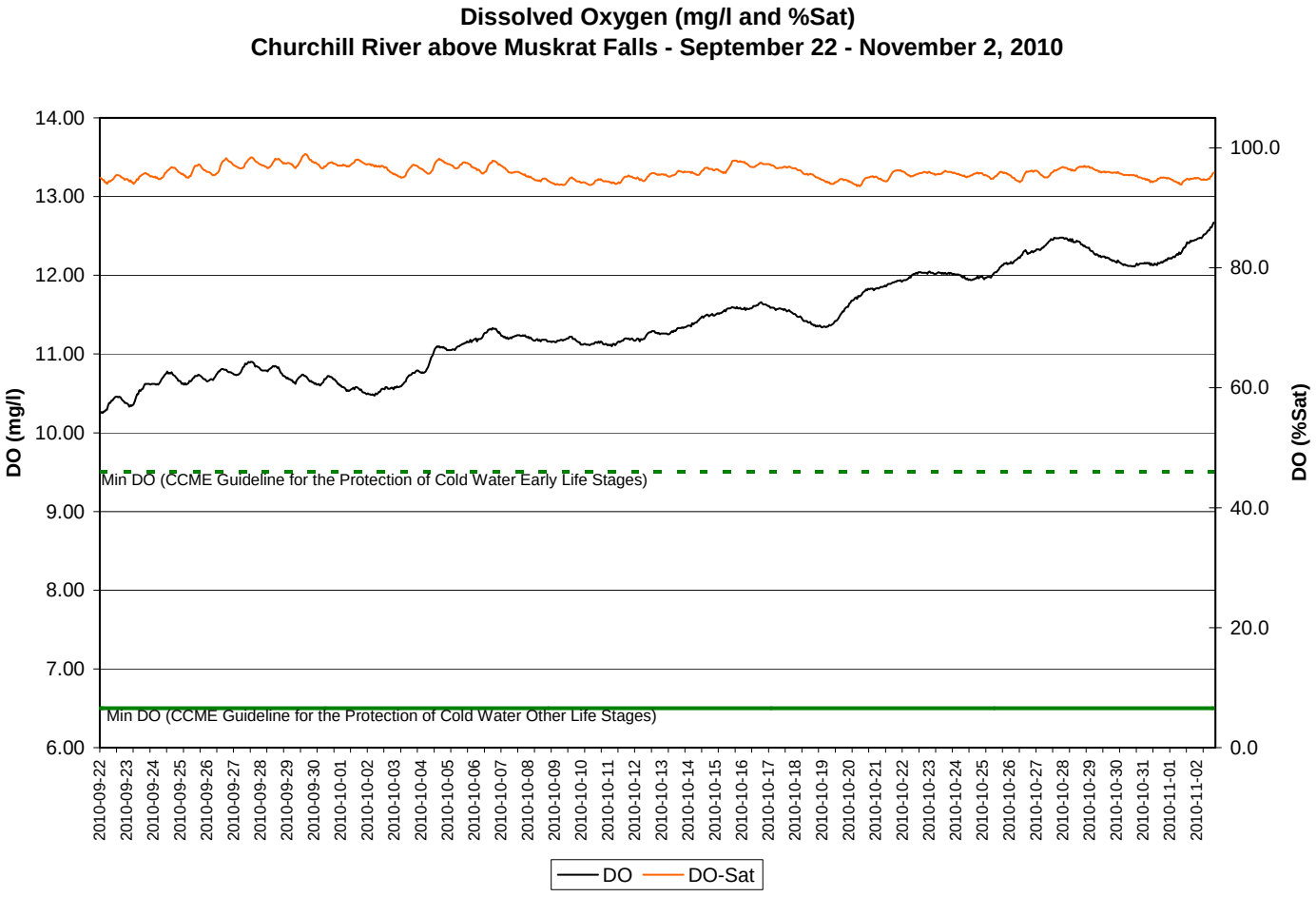


**Figure 8: Dissolved oxygen at Churchill River above Muskrat Falls**

- A range of 0.0 to 169.0 NTU was recorded for turbidity for this deployment period (Figure 10). A median value of 1.0 NTU indicates there is a minimal natural background turbidity value at this station.
- A turbidity event from September 23-25, recorded turbidity values up to 169NTU. This event does not correspond with rainfall but it does correspond with high wind speeds. Rainfall events correspond with increase in turbidity recorded October 2-6 and Oct 17-22. Windy conditions may have also caused turbidity increases October 23-25.

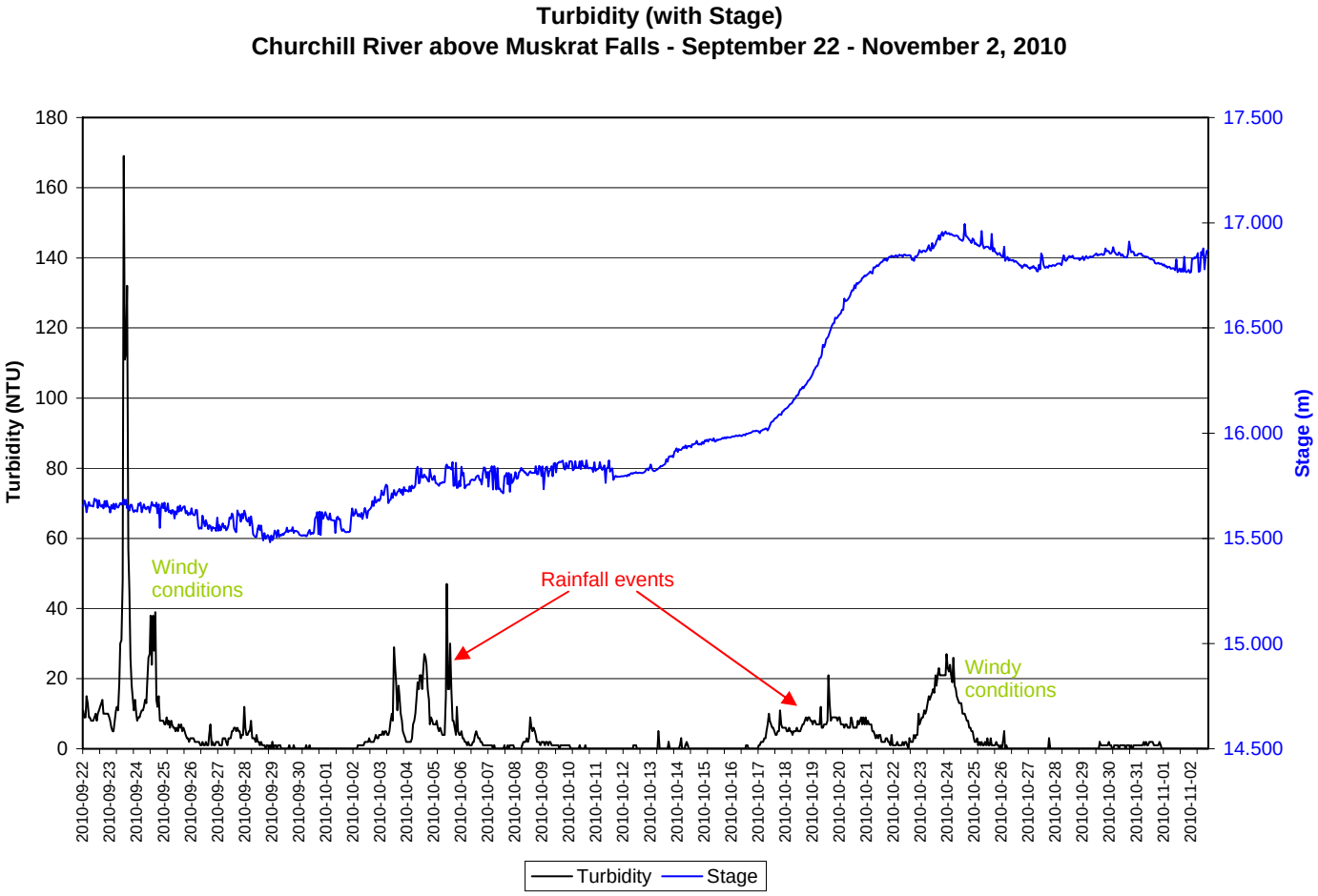


**Figure 9: Turbidity at Churchill River above Muskrat Falls**

Churchill River below Grizzle Rapids

- On September 22, the transmission error that prevented data from being transmitted in real time from July 12 onward, was resolved.
- Water temperature ranges from 4.2 to 12.80$^{o}$C during this deployment period (Figure 11).
- Water temperature is decreasing throughout the deployment period (Figure 11). This trend is expected given the decreasing ambient air temperatures (Appendix 1). Water temperature fluctuates diurnally.

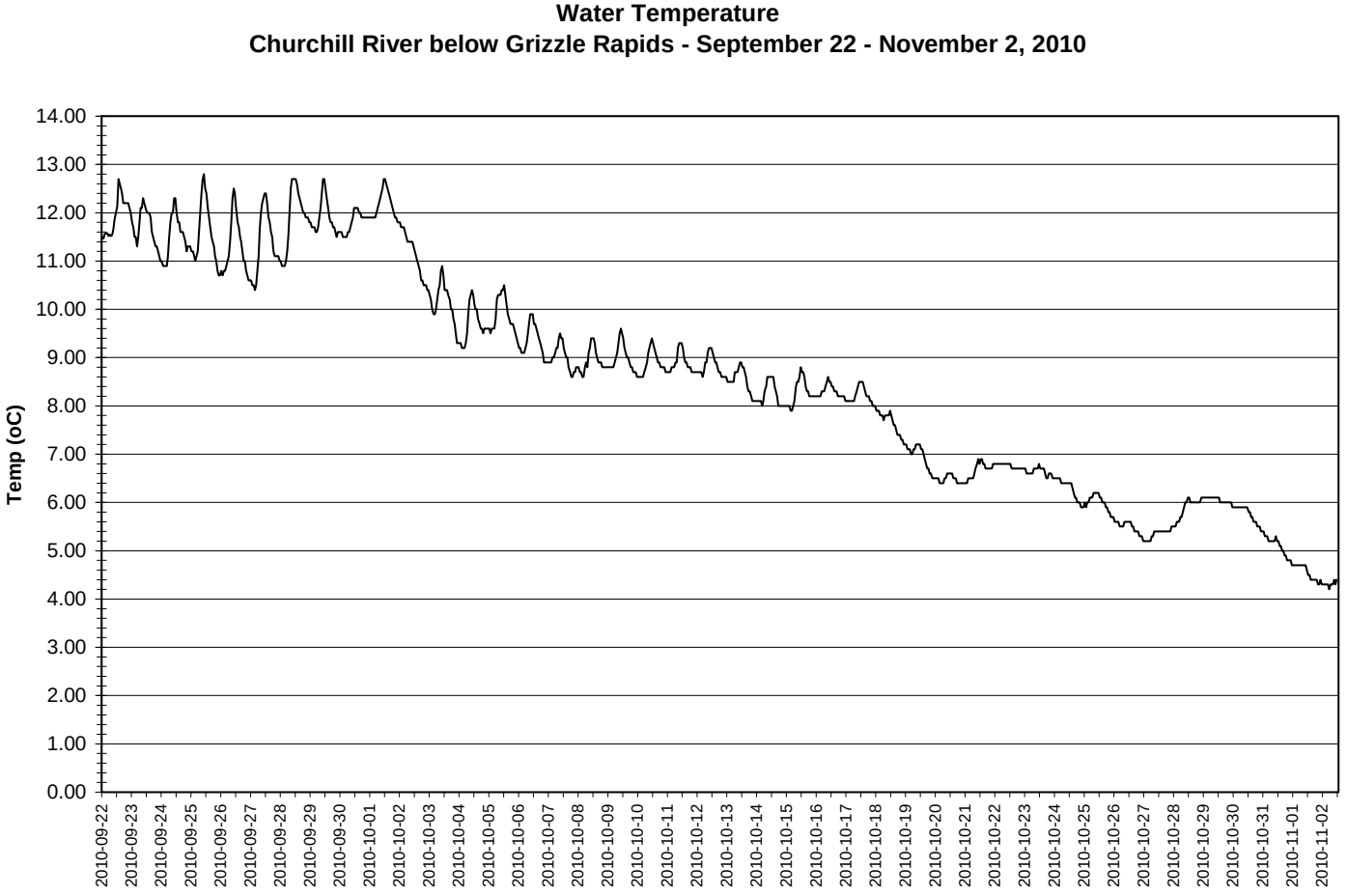


**Figure 11: Water temperature at Churchill River below Grizzle Rapids**

- pH ranges between 6.80 and 7.50 pH units (Figure 12). pH values are decrease slightly throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 12).

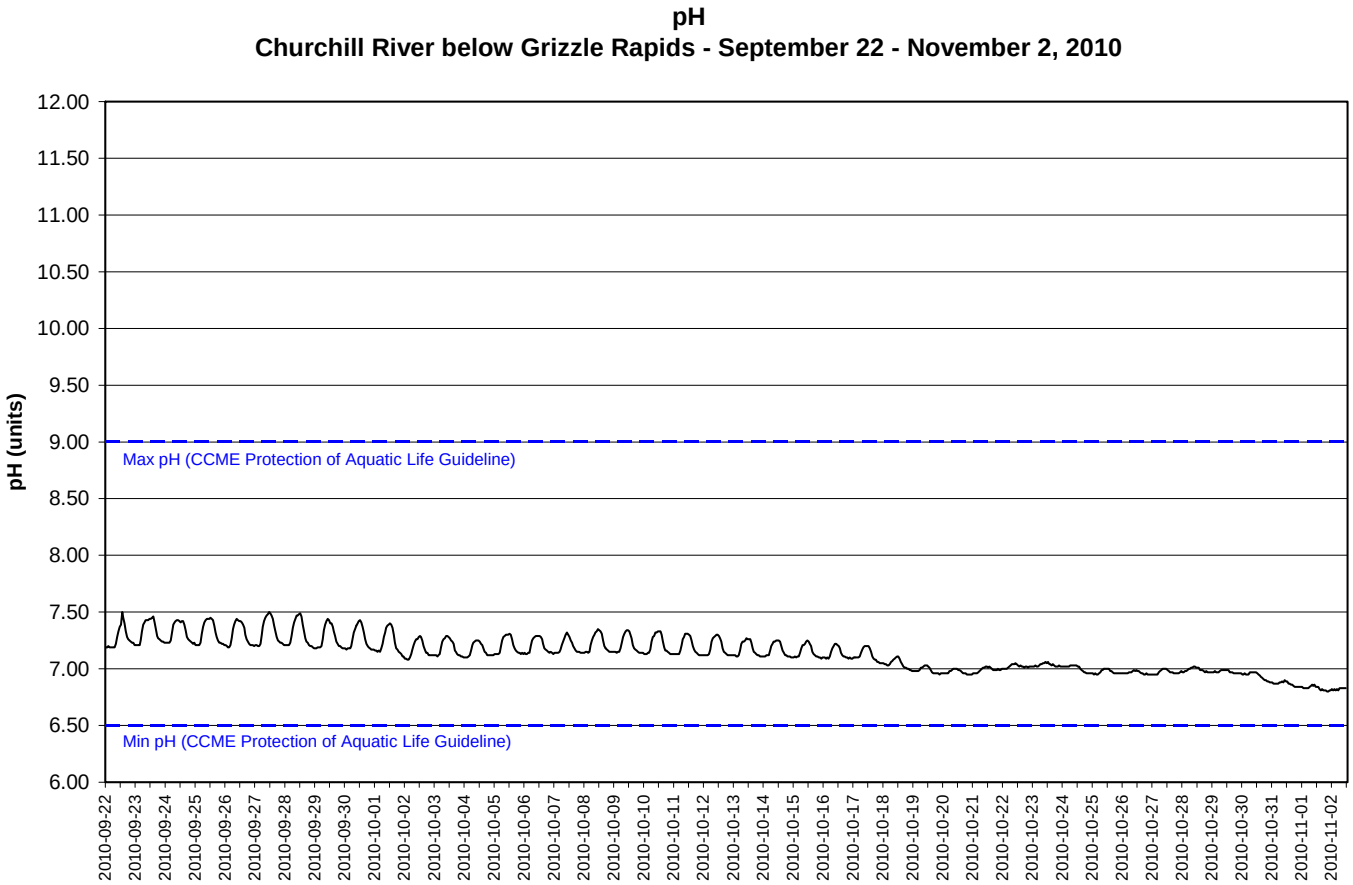


**Figure 12: pH at Churchill River below Grizzle Rapids**

- Specific conductivity ranges between 17.3 and 22.0µS/cm during the deployment period (Figure 13). Specific conductance generally decreases throughout the deployment period.
- Stage is included in Figure 13 to illustrate the inverse relationship between conductivity and water level. Stage generally remains stable throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 13).

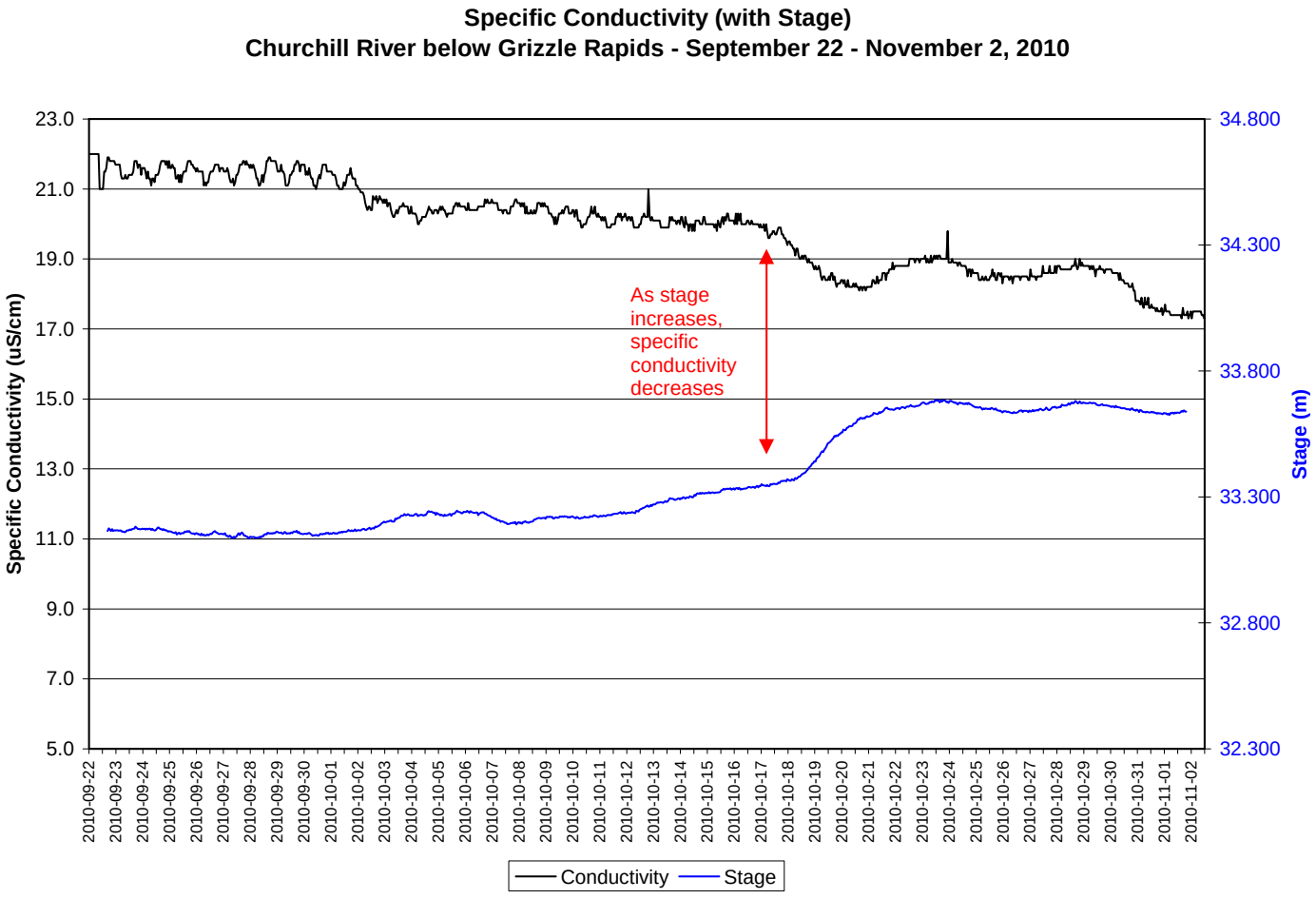


**Figure 13: Specific conductivity at Churchill River below Grizzle Rapids**

- The saturation of dissolved oxygen ranged from 91.4 to 101.1% and a range of 9.88 to 12.15mg/l was found in the concentration of dissolved oxygen with a median value of 11.07mg/l (Figure 14).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 14.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decreasing air and water temperatures during the deployment period (Appendix 1, Figure 11).

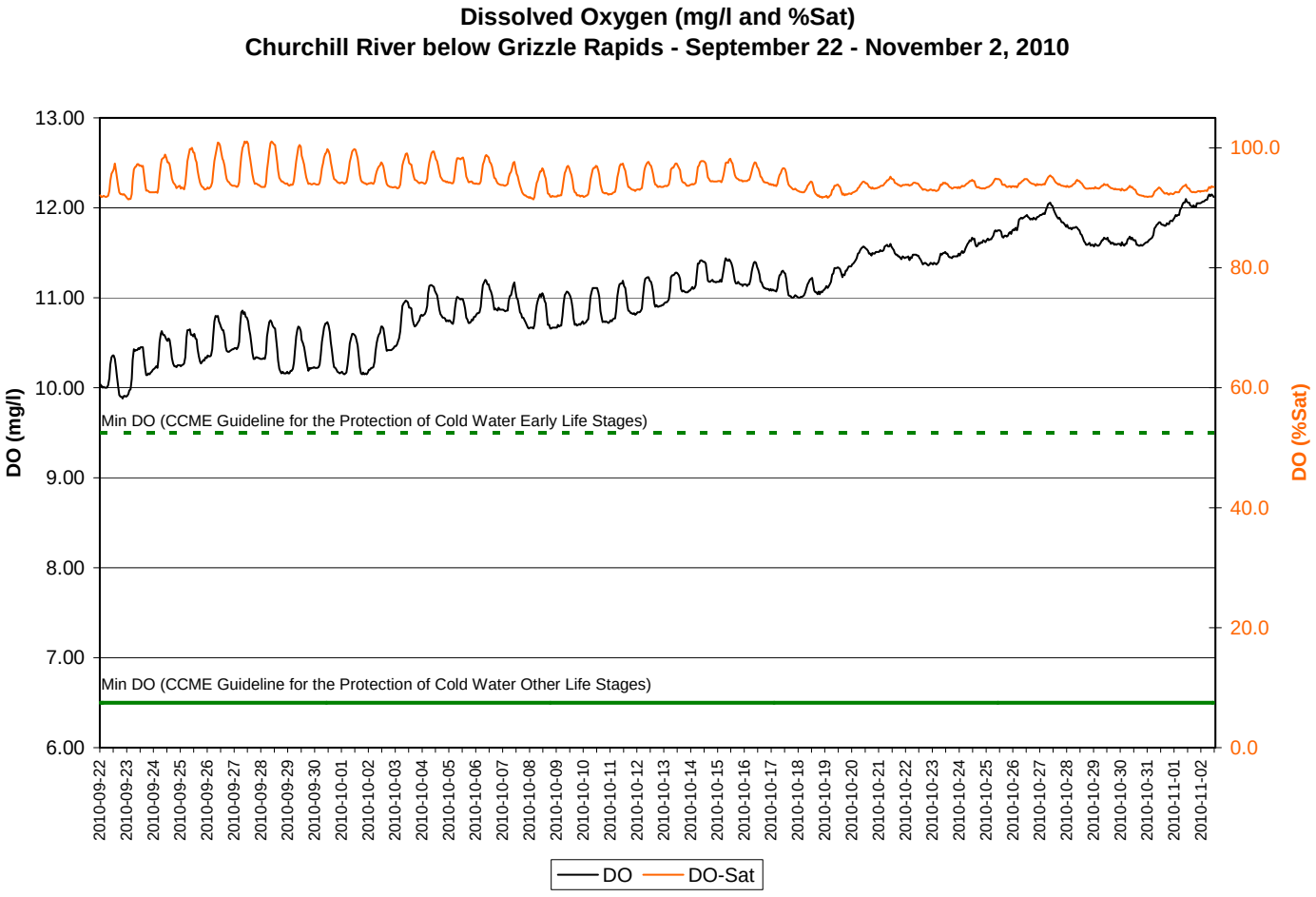


**Figure 14: Dissolved oxygen at Churchill River below Grizzle Rapids**

- Turbidity remains at 0.0NTU for the entire deployment period with the exception of one event (Figure 15).
- Between October 24 and 25, turbidity spikes to as high as 38.4NTU. There is no precipitation data for this area during this time. This site is naturally clear with very few turbidity events and it is unknown what caused this spike.

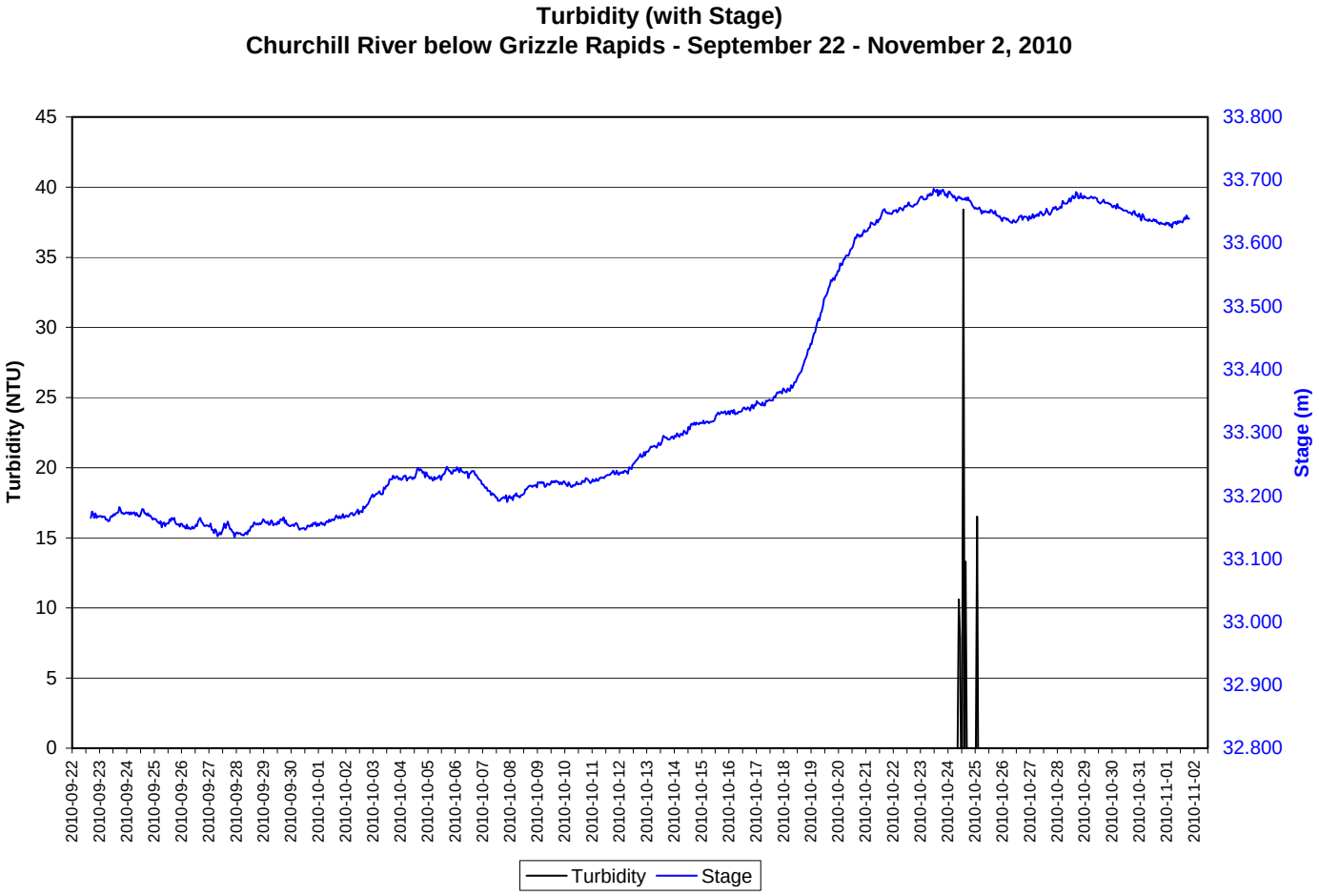


**Figure 15: Turbidity at Churchill River below Grizzle Rapids**

Churchill River below Metchin River

- Water temperature ranges from 1.90 to 11.30$^{o}$C during this deployment period (Figure 16).
- Water temperature is decreasing throughout the deployment period. This trend is expected given decreasing ambient air temperatures (Appendix 1). Water temperature fluctuates diurnally.

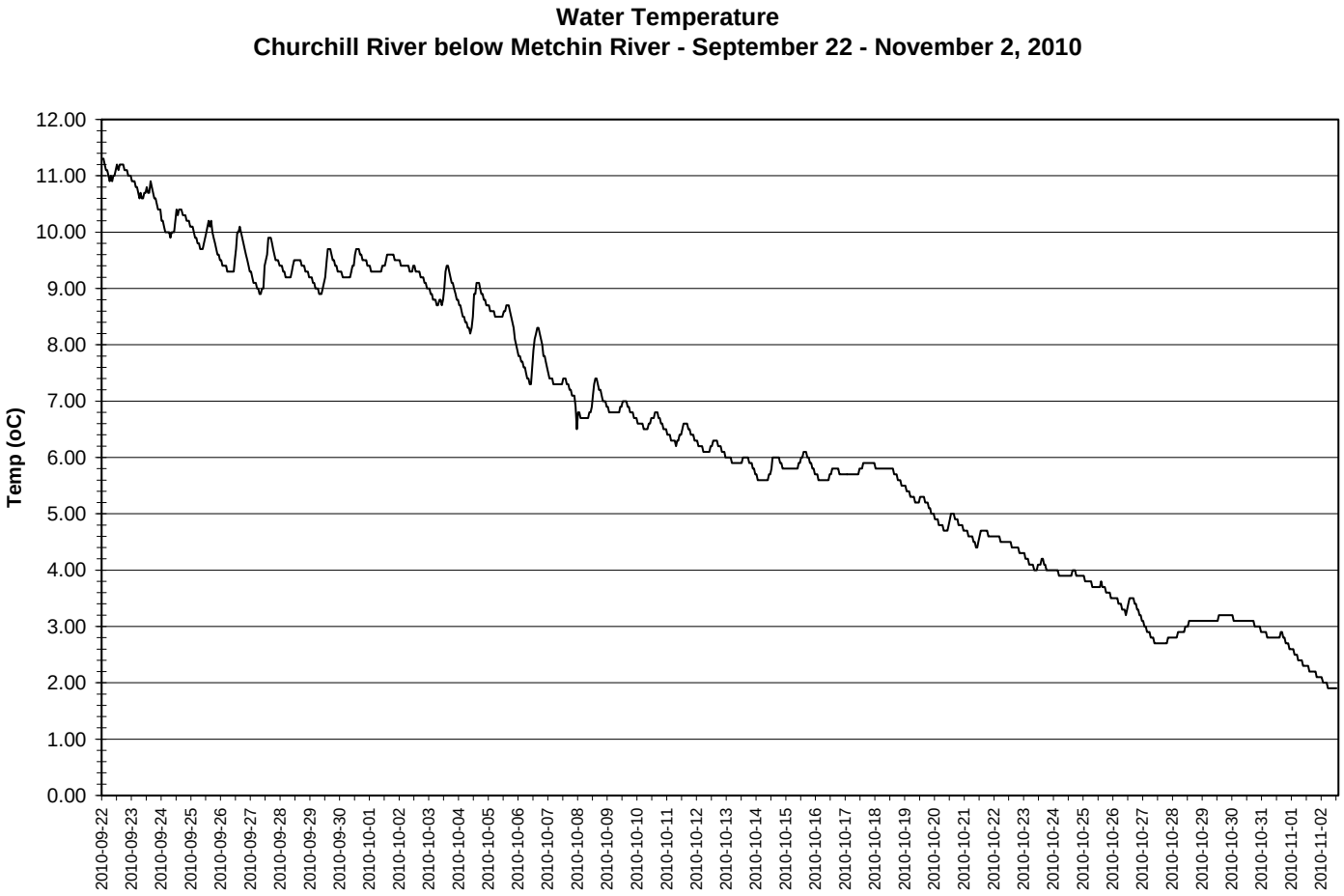


**Figure 16: Water temperature at Churchill River below Metchin River**

- pH ranges between 7.00 and 7.40 pH units (Figure 17). pH values are consistent throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

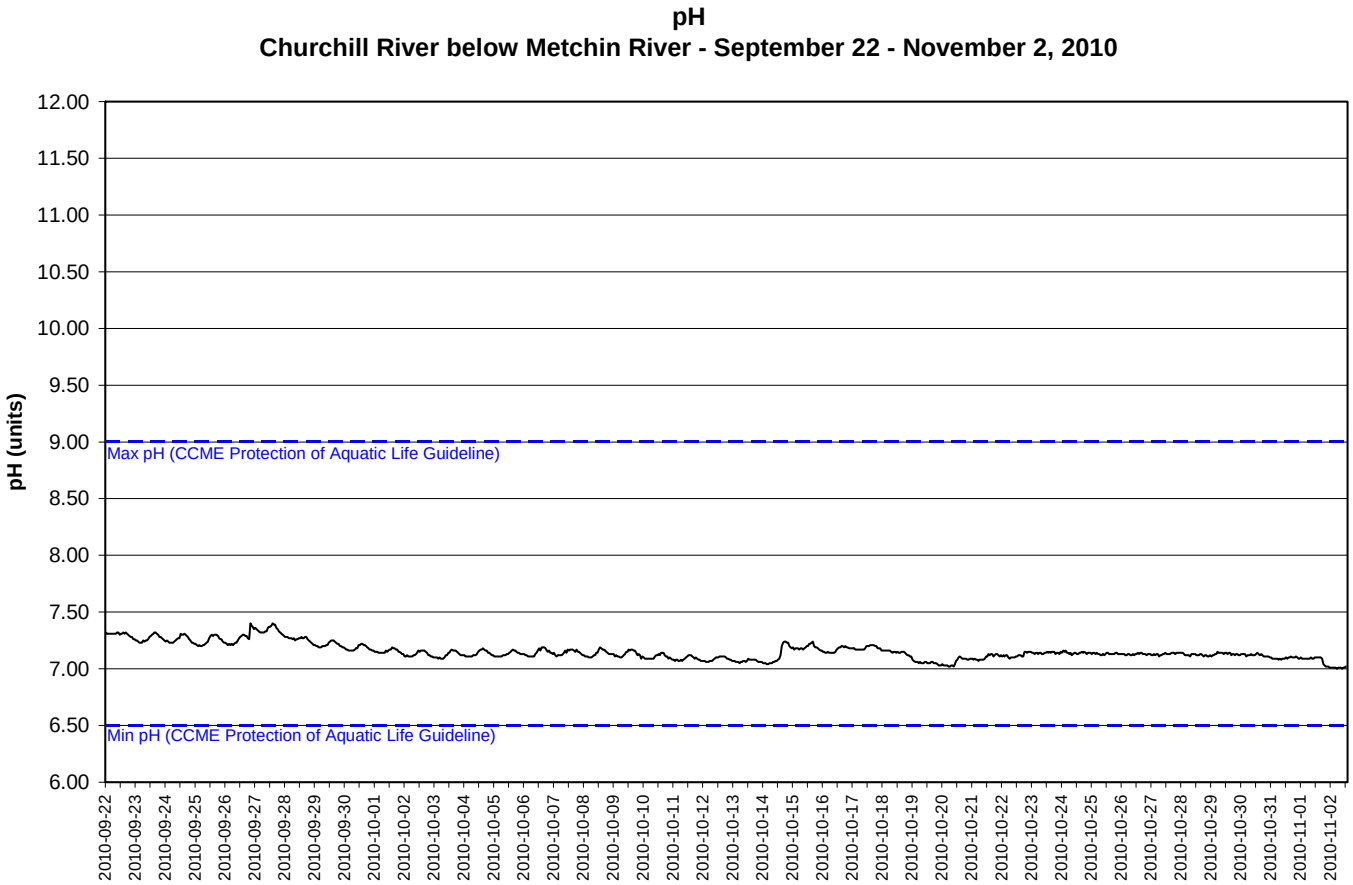


**Figure 17: pH at Churchill River below Metchin River**

- Specific conductivity ranged from 20.0 to 23.1µS/cm during the deployment period (Figure 18). Specific conductance generally decreases throughout the deployment period.
- Variability in specific conductance most often can be related back to weather events. The nearest weather station to the site below Metchin River is located in Churchill Falls. However, for much of the time between May and November 2010, precipitation data is missing from the dataset. Generally, as stage increases, conductivity decreases.

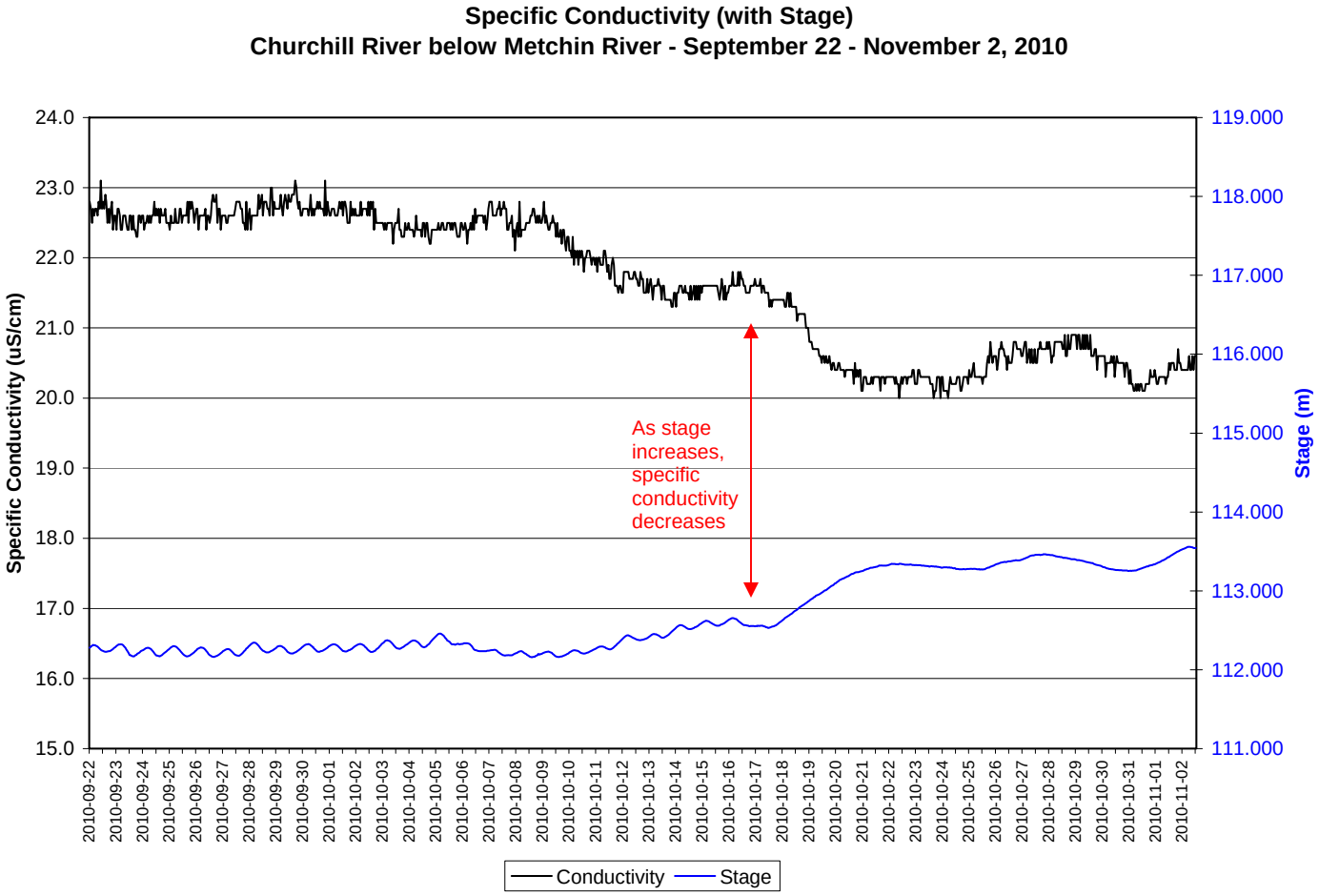


**Figure 18: Specific Conductivity at Churchill River below Metchin River**

- The saturation of dissolved oxygen ranged from 90.5 to 95.6% and a range of 9.99 to 13.15mg/l was found in the concentration of dissolved oxygen with a median value of 11.38mg/l (Figure 19).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 19.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decreasing air and water temperatures during the deployment period (Appendix 1, Figure 16).

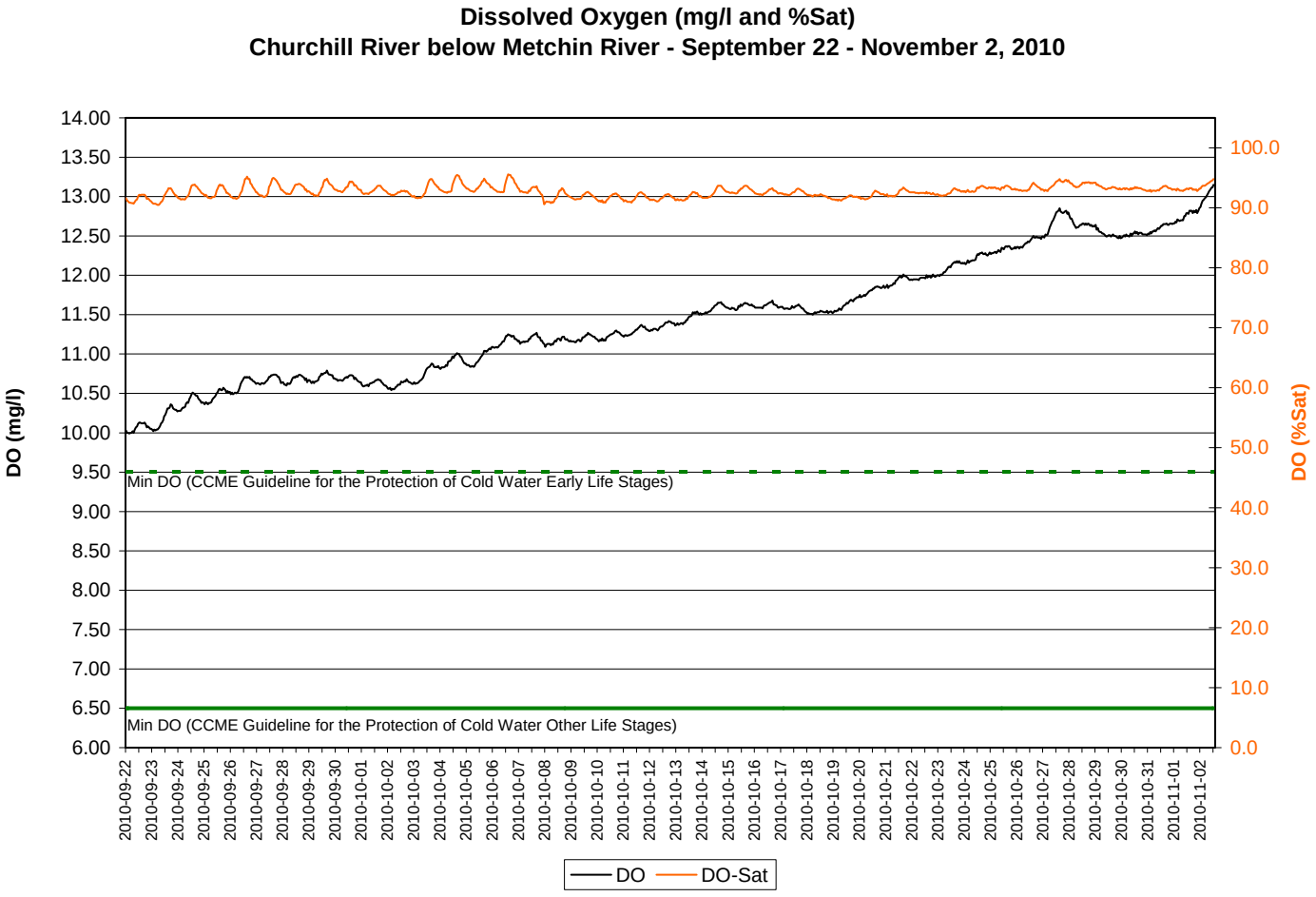


**Figure 19: Dissolved oxygen at Churchill River below Metchin River**

- Turbidity data collected at this station during this time is inaccurate and removed from the data set during QAQC procedures. Turbidity values were erratic and uncharacteristic at this station starting just one week in to the deployment (Figure 20). Turbidity values continued to rise and fluctuate throughout the deployment period. At removal on November 3, a large stonefly (*Pteronarcyidae*) was found attached to the turbidity sensor (Figure 21). It is likely this was the cause of the erratic turbidity readings.

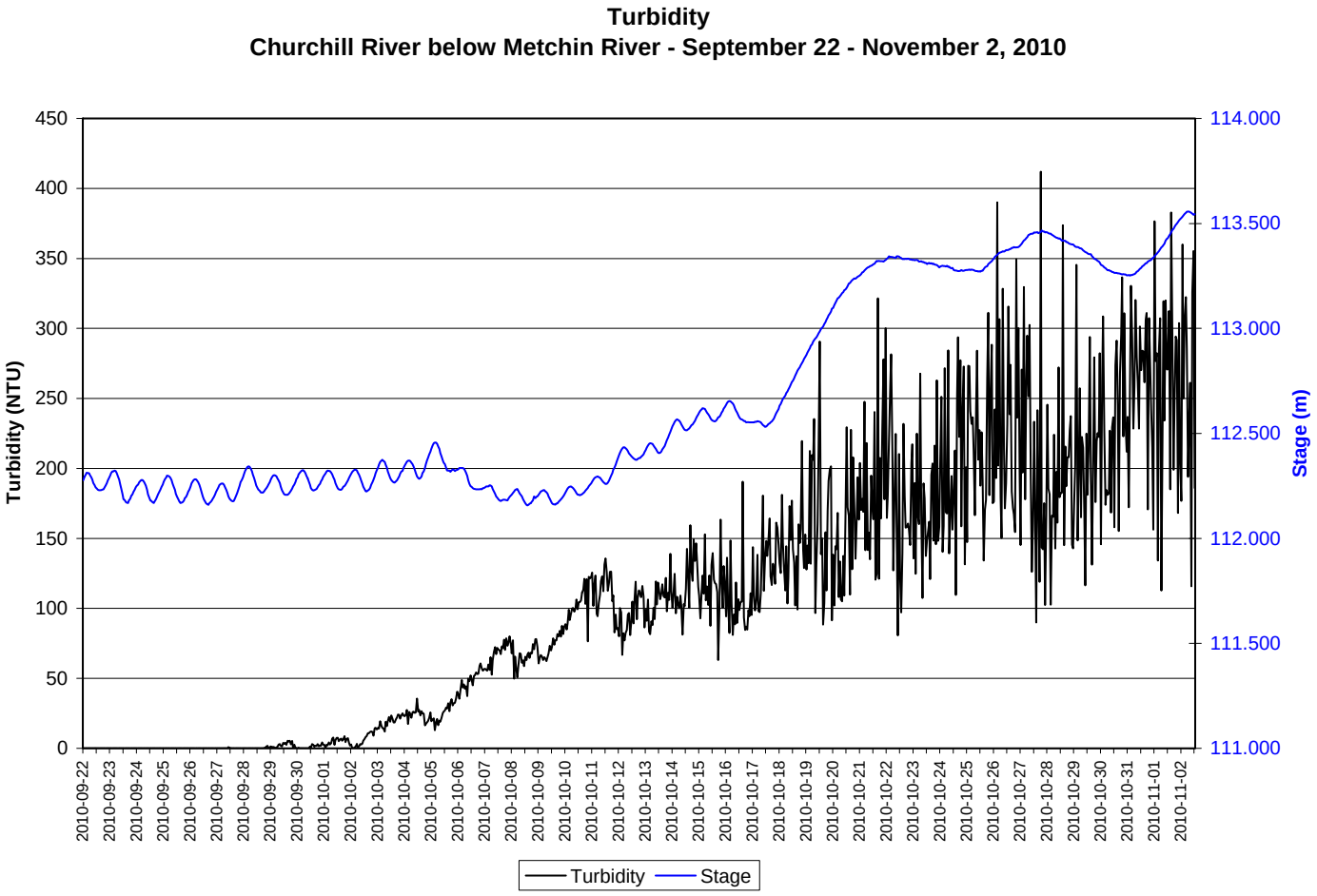


**Figure 20: Turbidity at Churchill River below Metchin River**

**Figure 21: Stonefly found on turbidity sensor at station below Metchin River, November 2, 2010**

## Conclusions

- Instruments at water quality monitoring stations on the Lower Churchill River were deployed at all four stations between September 22 and November 23, 2010.
- No significant water quality events were captured during this time. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- A stone fly was found attached to the turbidity sensor at the station below Metchin River and is likely the cause of erratic turbidity data collected during the deployment period.
- Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen. pH values did fall below the guideline at the station above Muskrat Falls during the second half of the deployment period. Corrected pH values at this station suggest this was a result of sensor drift and biofouling.

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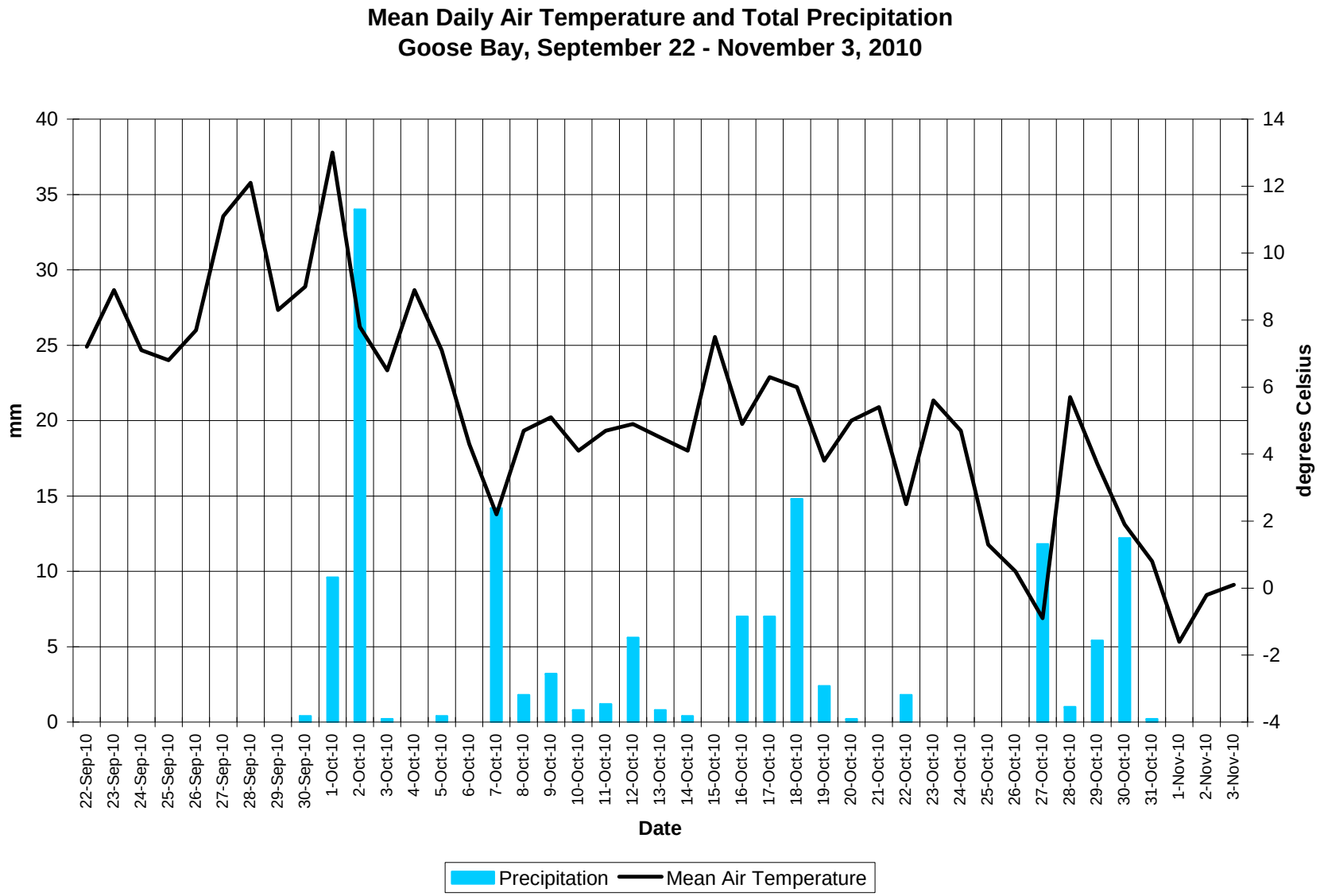
# Appendix 1


Mean Daily Air Temperature and Total Precipitation
Goose Bay, September 22 - November 3, 2010
mm
degrees Celsius
Date
Precipitation
Mean Air Temperature
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15
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2-Nov-10
3-Nov-10

**Mean Daily Air Temperature and Total Precipitation**
**Churchill Falls, September 22 - November 3, 2010**