Real-Time Water Quality Deployment Report

Lower Churchill River Network

June 24 to July 23, 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 June 24 to July 23, 2010; a period of 29 days.
- On June 23, 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 June 23 and July 23, 2010 are summarized in Table 2.

Table 2: Comparison rankings for Churchill River stations, June 23-July 23, 2010

Station Churchill River	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Muskrat Falls	June 23, 2010	Deployment	Good	Good	Excellent	Excellent	Excellent
	July 23, 2010	Removal	Good	Good	Excellent	Good	Excellent
Above Muskrat Falls	June 23, 2010	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 23, 2010	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Below Grizzle Rapids	June 23, 2010	Deployment	Excellent	Fair	Excellent	Excellent	Excellent
	July 23, 2010	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Below Metchin River	June 23, 2010	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	July 23, 2010	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

- A transmission error at the station below Grizzle Rapids prevented data from being transmitted in real time between July 12 and July 23. The instruments internal log file was recovered to provide data for this period.
- A data logger connection error at the station below Muskrat Falls prevented data from being transmitted in real time between June 23 and July 17. The instruments internal log file was recovered to provide data for this period.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events 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

- A data logger connection error occurred between June 23 and July 17 at the station below Muskrat Falls. The instruments internal log file was recovered to provide data for this period.
- Water temperature ranges from 10.6 to 17.76^{o}C during this deployment period (Figure 1).
- Water temperature continues to increase throughout the deployment period and levels off in mid-July. This is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.

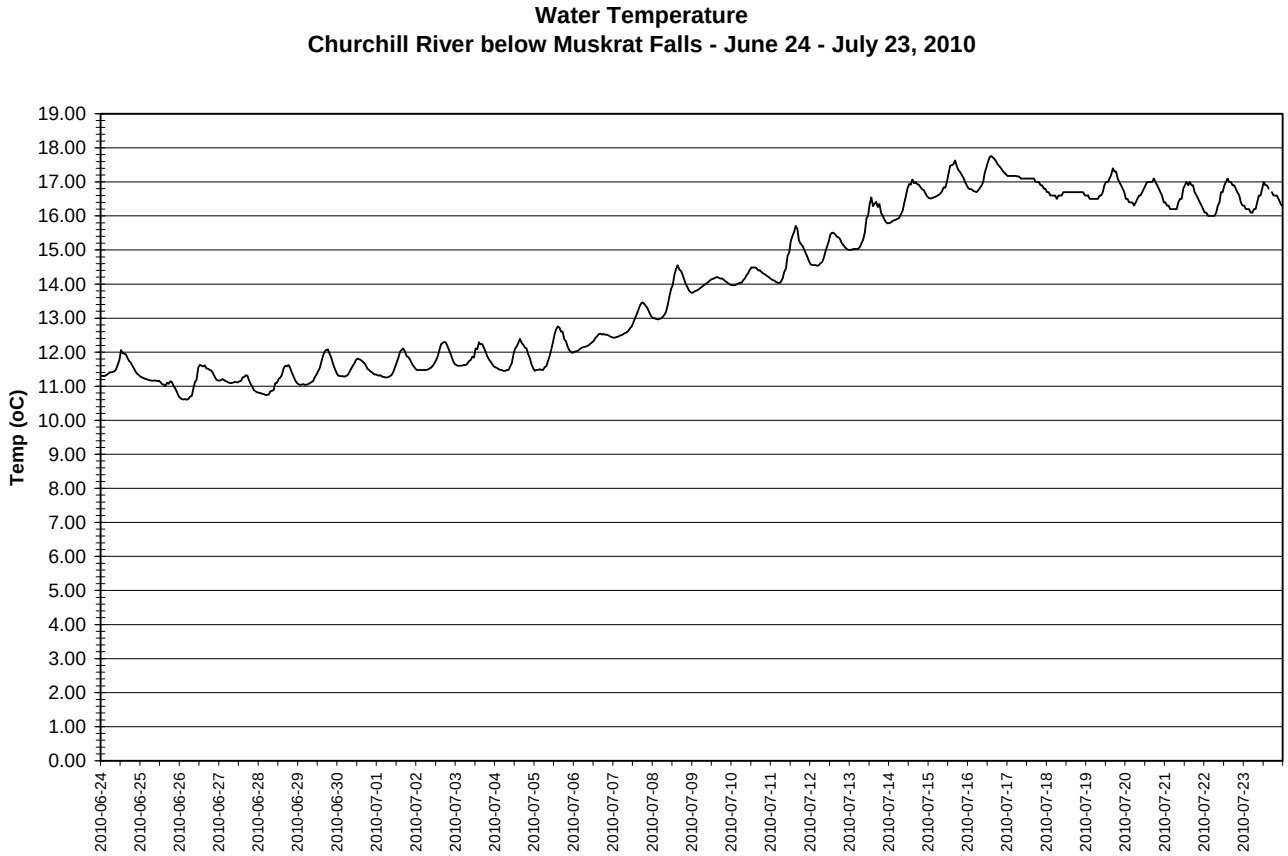

Figure 1: Water temperature at Churchill River below Muskrat Falls

pH ranges between 6.65 and 7.17 pH units and is consistent throughout the deployment period (Figure 2).

- All values during the deployment are within the recommended range as suggested by the CCME guidelines for the Protection of Aquatic Life.

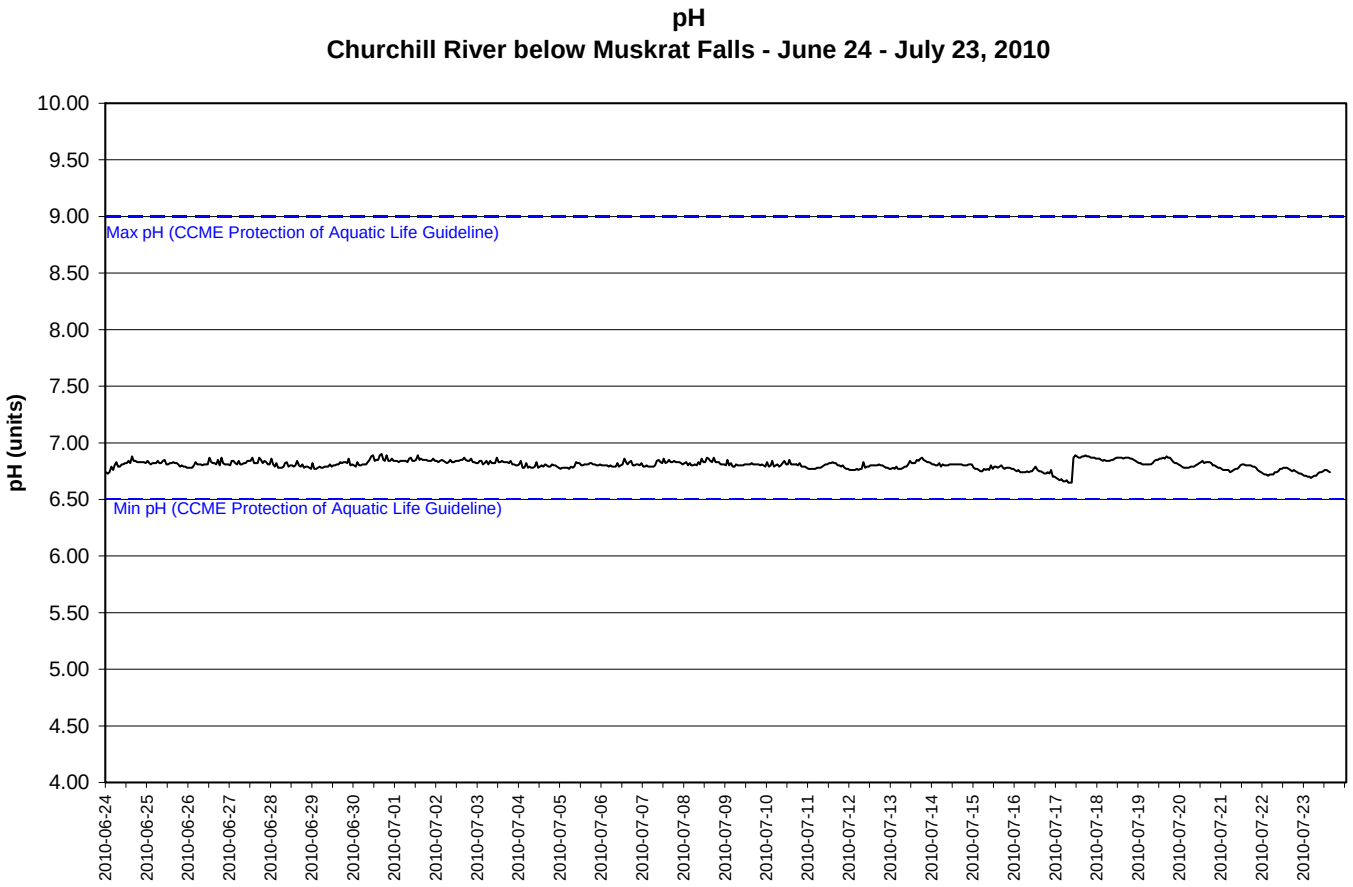

Figure 2: pH at Churchill River below Muskrat Falls

- The instruments internal log file was recovered to provide data for this period. The instrument only internally records specific conductance to zero decimal places.
- Specific conductivity ranged from 14 to 19µS/cm during the deployment period (Figure 3). Specific conductance increases slightly throughout the deployment period.

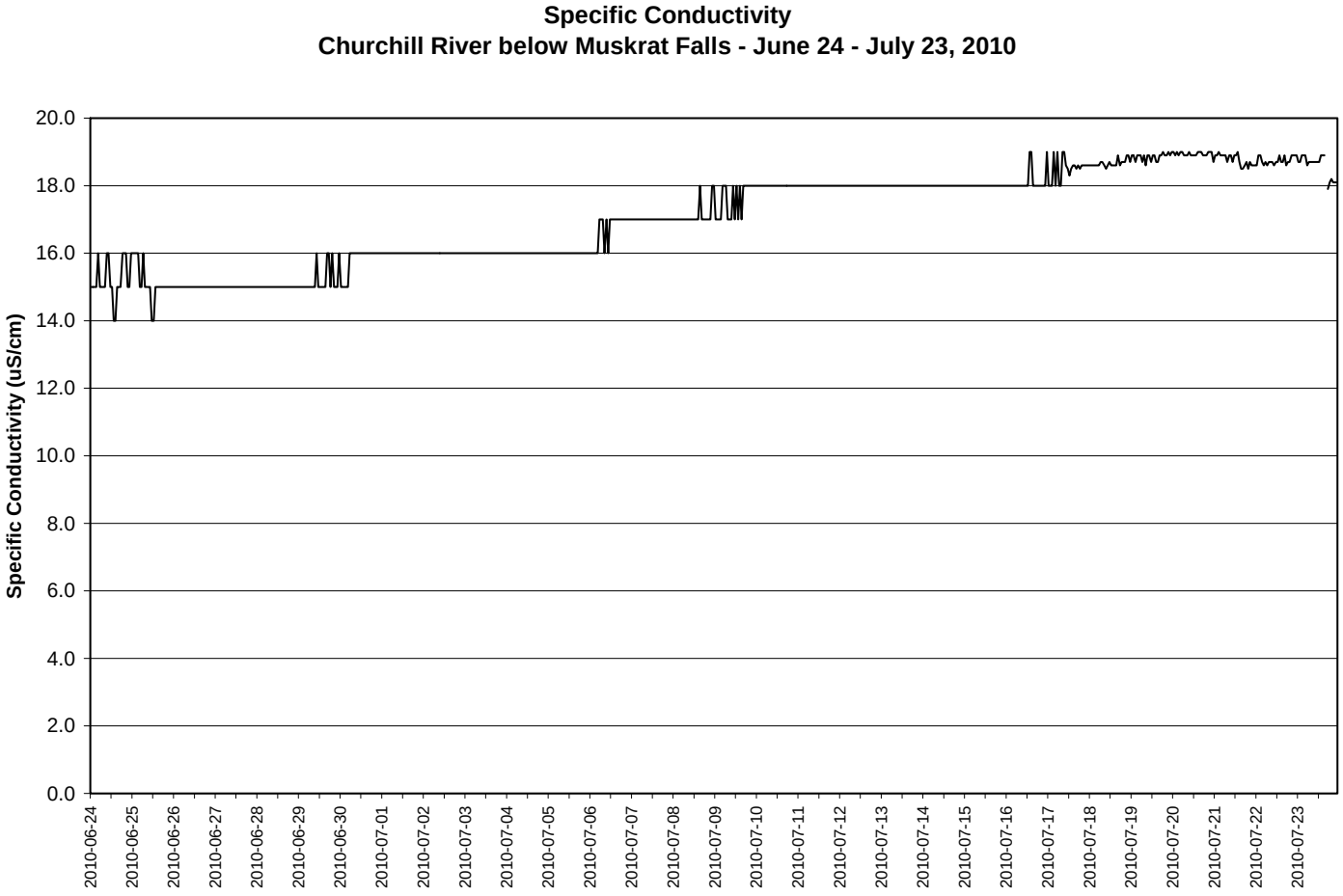

Figure 3: Specific conductivity at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 106.5 to 117.0% and a range of 10.56 to 12.26mg/l was found in the concentration of dissolved oxygen with a median value of 11.77 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 decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 1, Appendix 1).

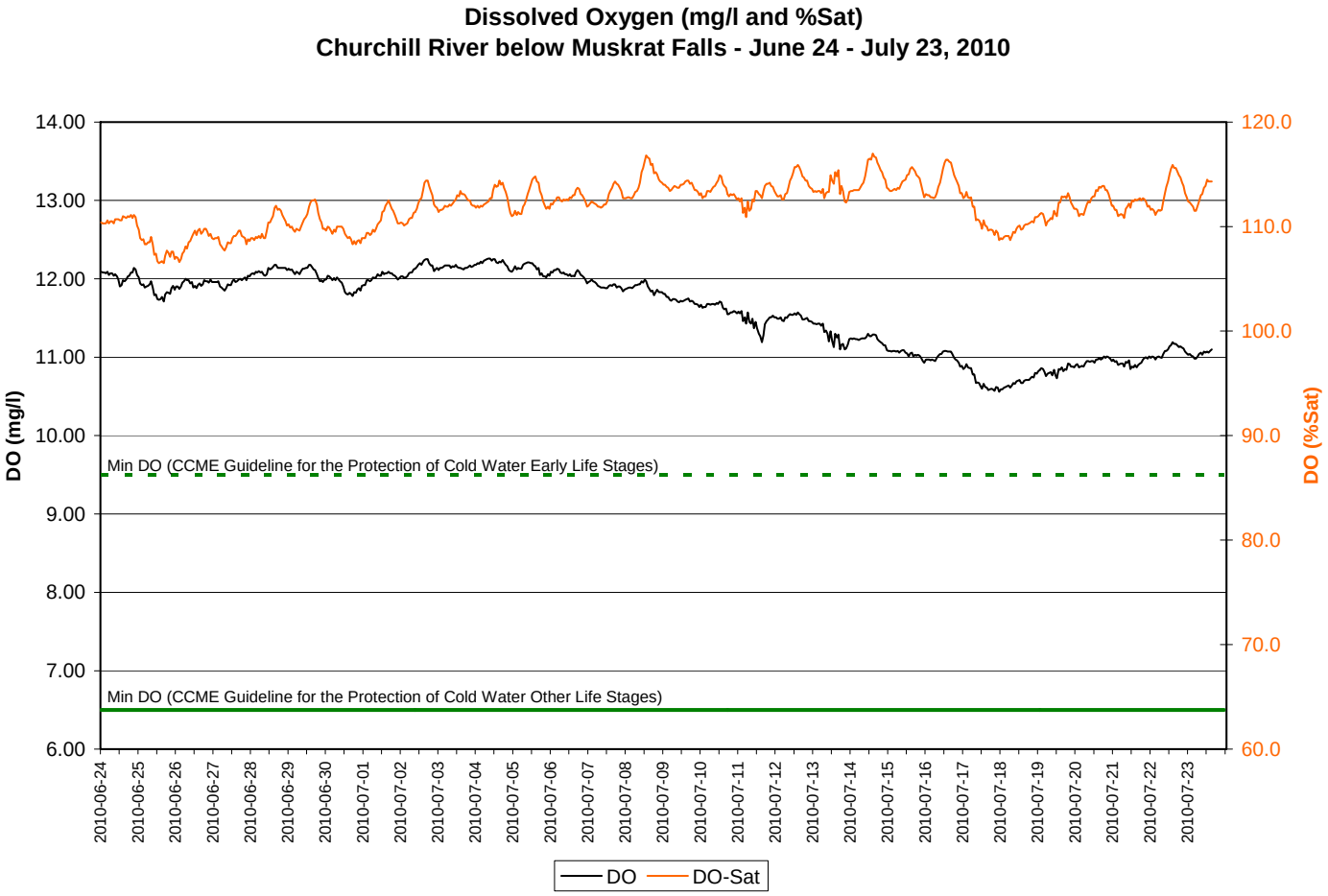

Figure 4: Dissolved Oxygen at Churchill River below Muskrat Falls

- A range of 0.0 to 112.9 NTU was recorded for turbidity for this deployment period (Figure 5). A median value of 3.8 NTU indicates there is a consistent natural background turbidity value at this station.
- One spike (to 944NTU) was recorded on June 23, just prior to the site visit and it likely erroneous, caused by debris blocking the sensor for one measurement (indicated in red on Figure 5).
- The spike on June 25, to 112NTU, corresponds with heavy rainfall events recorded in the area and follows a typical recovery period for a turbidity spike (i.e. does not return to background levels immediately but rather of over the course of hours/days). A spike on June 14 (to 63NTU) also corresponds with a rainfall event. Both events are indicated in blue on Figure 5.

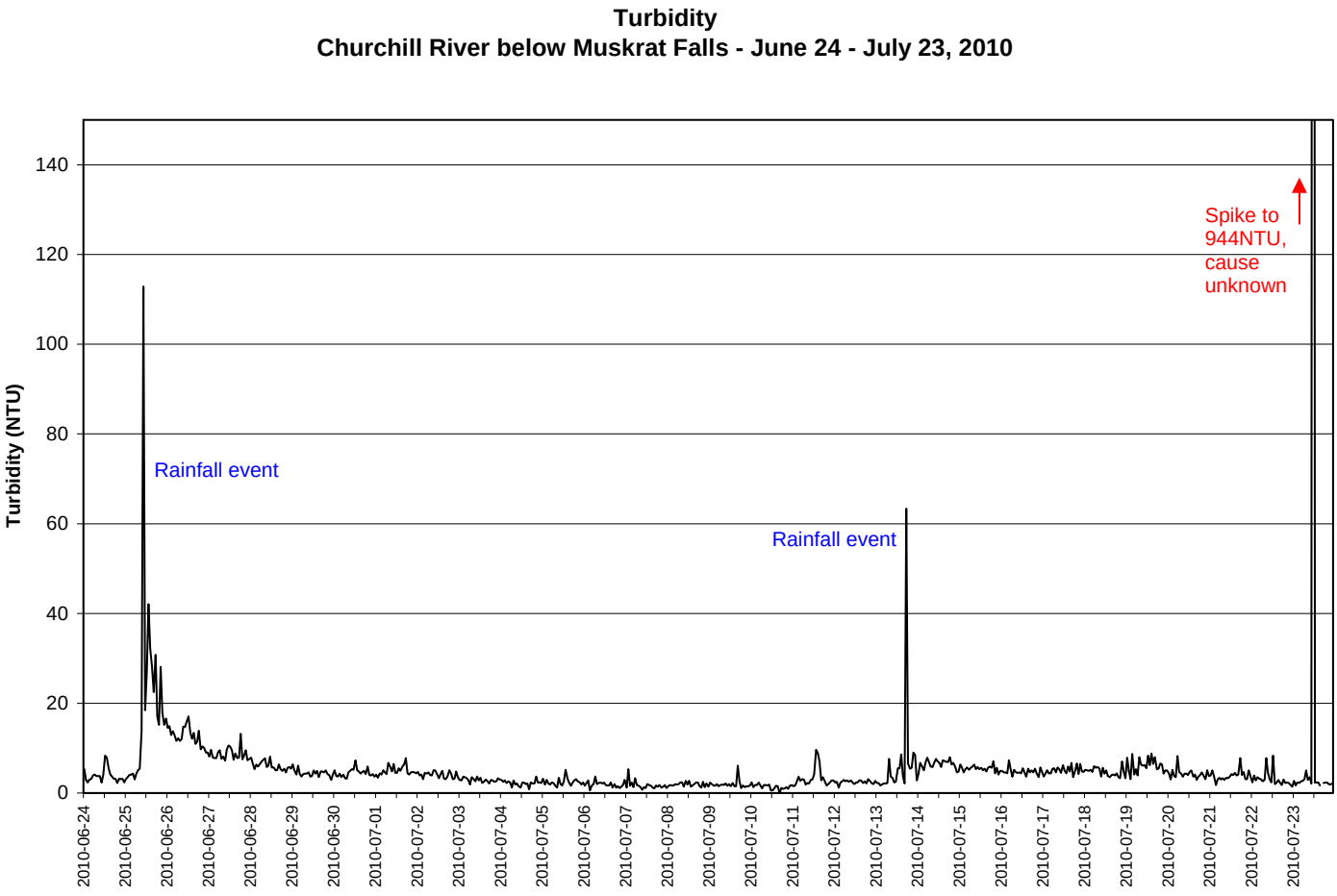

Figure 5: Turbidity at Churchill River below Muskrat Falls

Churchill River above Muskrat Falls

- Water temperature ranges from 10.5 to 18.26^{o}C during this deployment period (Figure 6).
- Water temperature continues to increase throughout the month of June, levelling off in July (Figure 6). This trend is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.

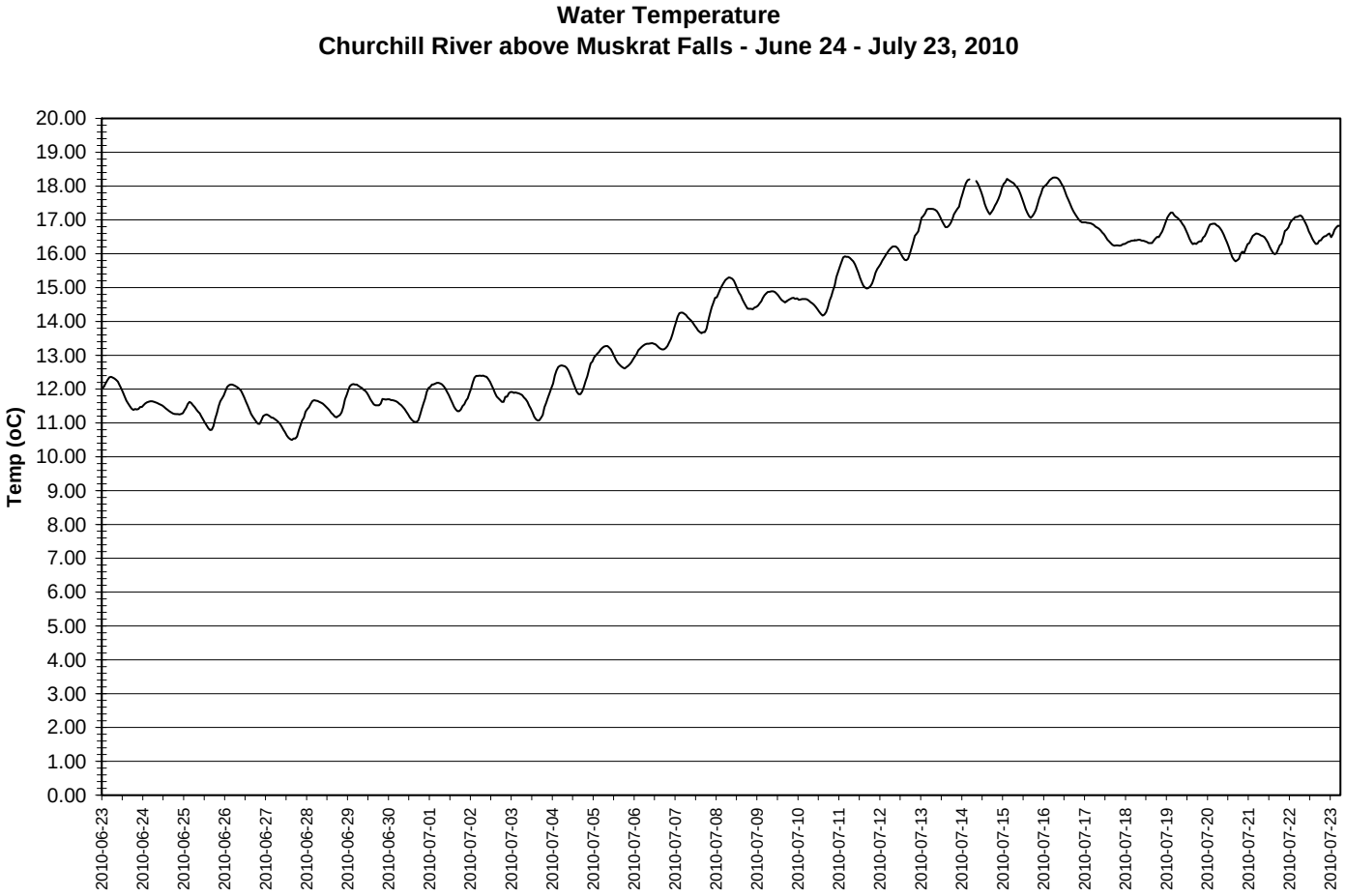

Figure 6: Water temperature at Churchill River above Muskrat Falls

- pH ranges between 6.88 and 7.24 pH units (Figure 7). pH values are consistent throughout the deployment period.
- All values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life.

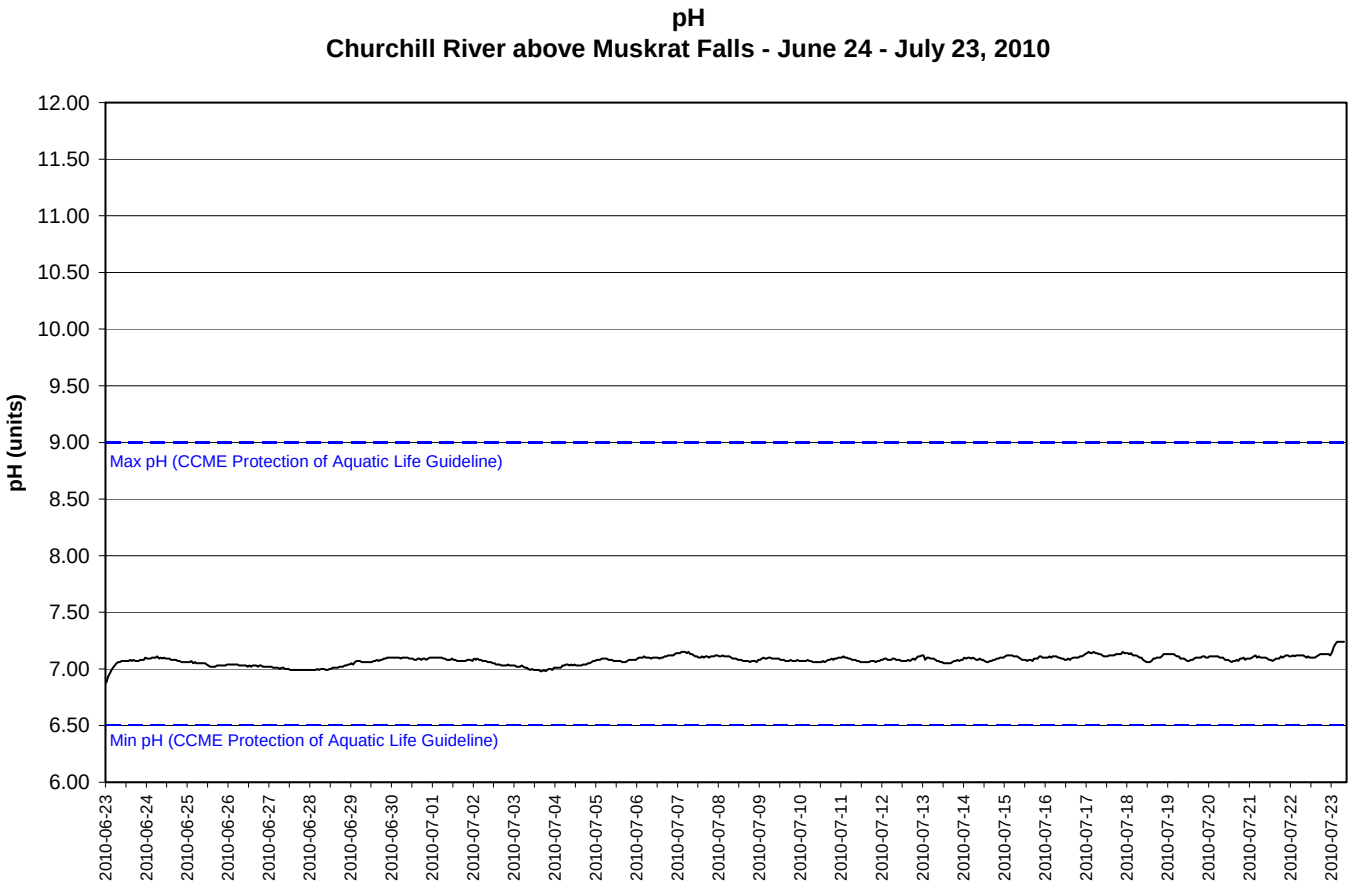

Figure 7: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges between 14.2 and 18.0µS/cm during the deployment period (Figure 8).
- Stage is included in Figure 8 to illustrate the relationship between conductivity and water level. Stage, generally decreases throughout the deployment period and conductivity increases. There are some instances where stage is increasing which correspond with decreases in specific conductivity (indicated by red arrows on Figure 8).

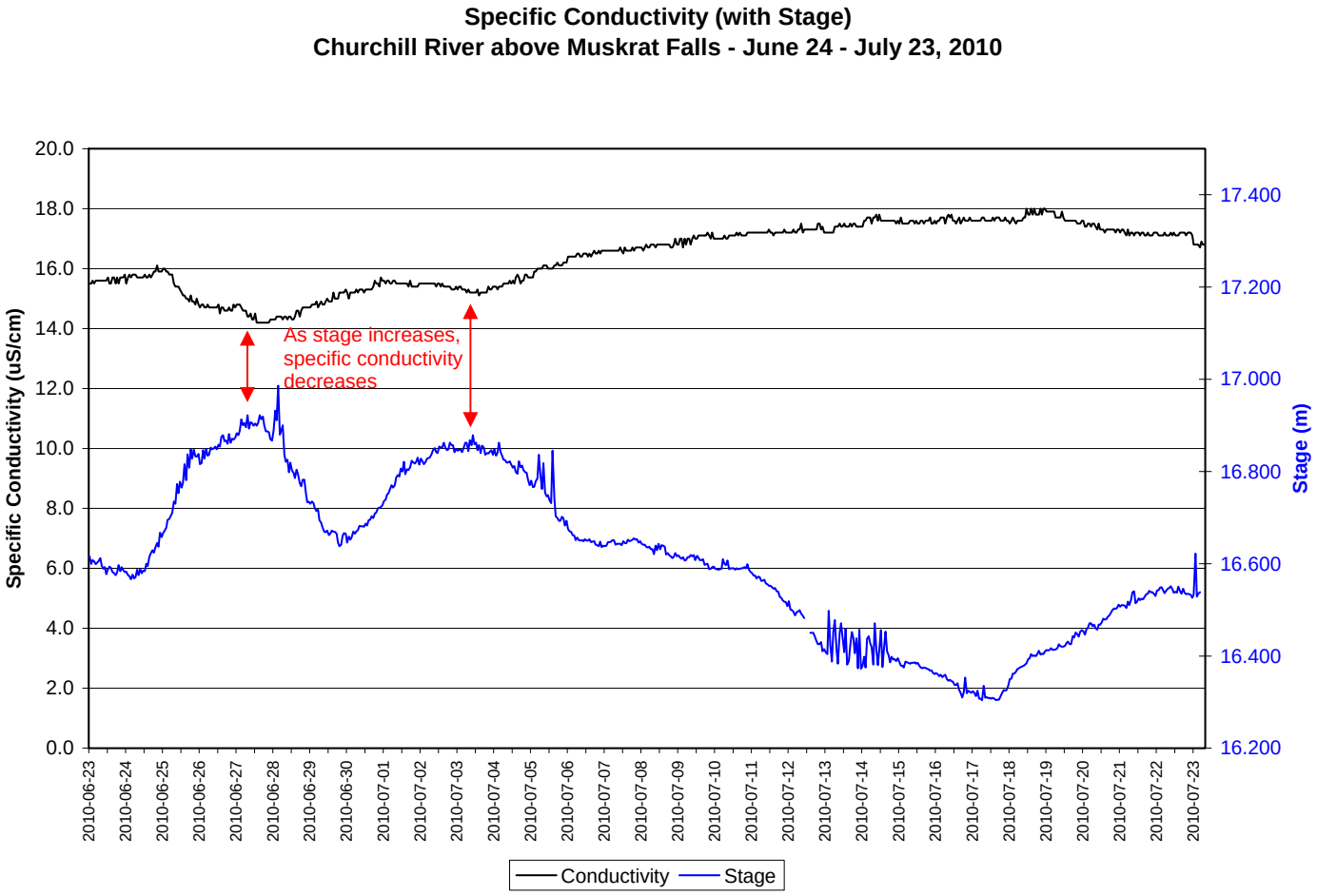

Figure 8: Specific conductivity at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 96.3 to 103.8% and a range of 9.50 to 10.95 mg/l was found in the concentration of dissolved oxygen with a median value of 10.36 mg/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 decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 6, Appendix 1).

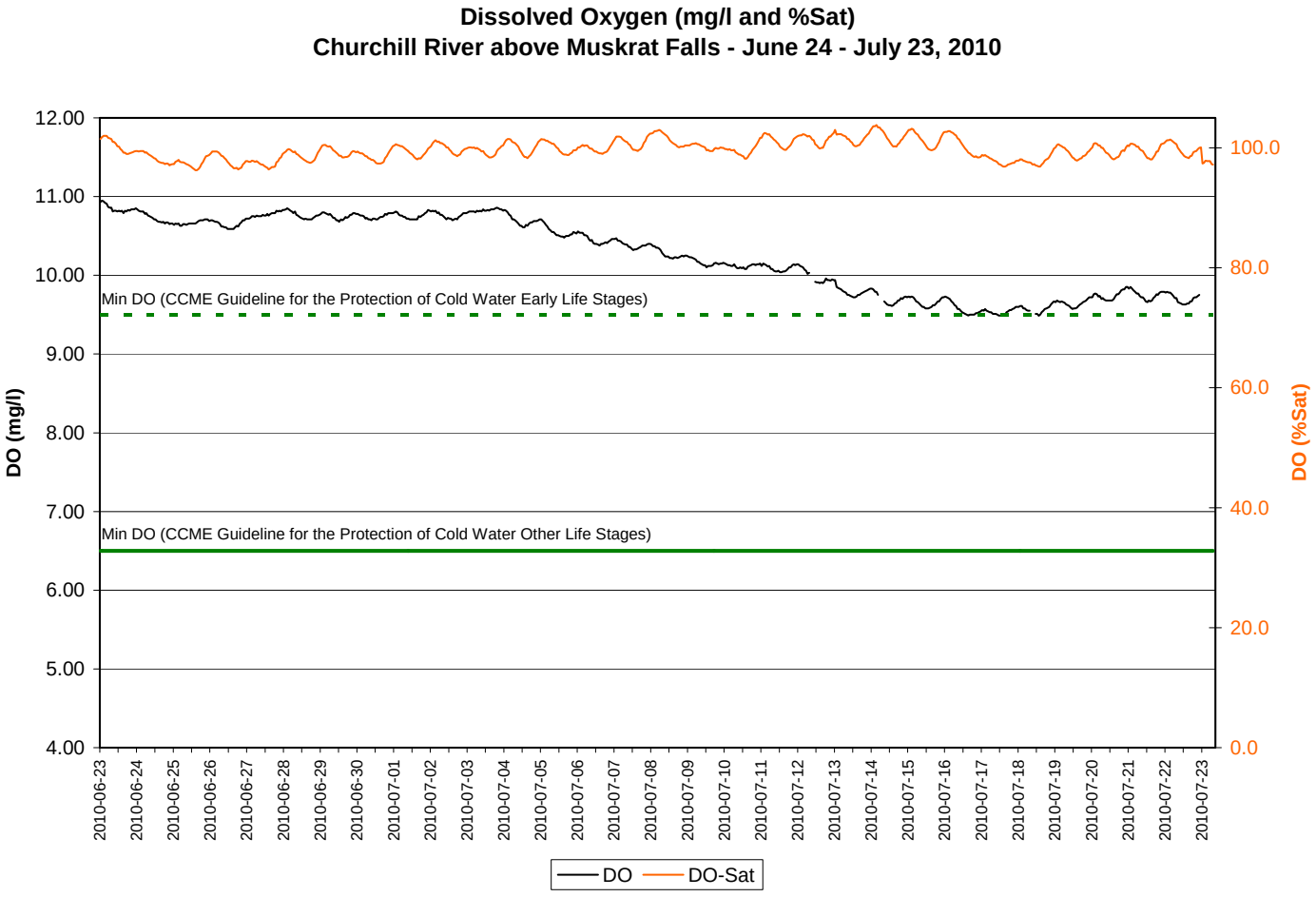

Figure 9: Dissolved oxygen at Churchill River above Muskrat Falls

- A range of 1.0 to 70.0 NTU was recorded for turbidity during this deployment period (Figure 10). A median value of 4.0 NTU indicates there is a consistent natural background turbidity value at this station.
- Two spikes near the beginning of the deployment period correspond with stage increase and a rainfall event lasting more than a couple of days. A third spike happens on July 13 and corresponds with high winds and a rainfall event. After this event, stage is variable for a period of 2 days which is likely related to the windy conditions that continued during this time (Appendix 1).

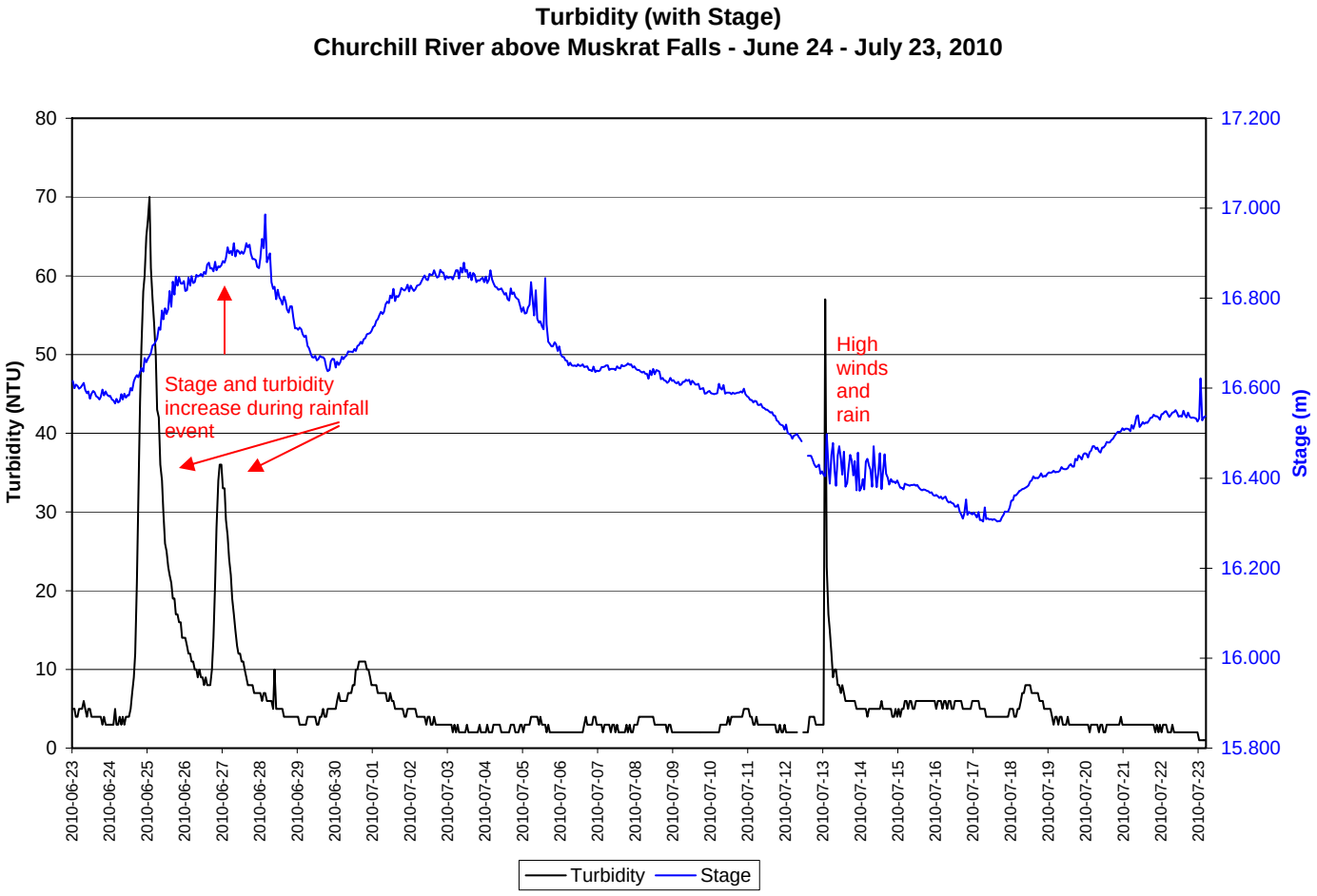

Figure 10: Turbidity at Churchill River above Muskrat Falls

Churchill River below Grizzle Rapids

- An instrument was deployed at this station for the first time in 2010 on June 23, however, the instrument sensors measuring turbidity and dissolved oxygen failed within hours of deployment. A return trip was planned for June 24 to switch the instrument with a clean calibrated instrument. Only data from the instrument deployed on June 24 is included in this discussion.
- A transmission error occurred on July 12 and the instruments internal log file was recovered to provide information for this period. Stage and flow data is not available for this time.
- Water temperature ranges from 9.80 to 17.71^{o}C during this deployment period (Figure 11).
- Water temperature is increasing throughout the deployment period (Figure 11). This trend is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.

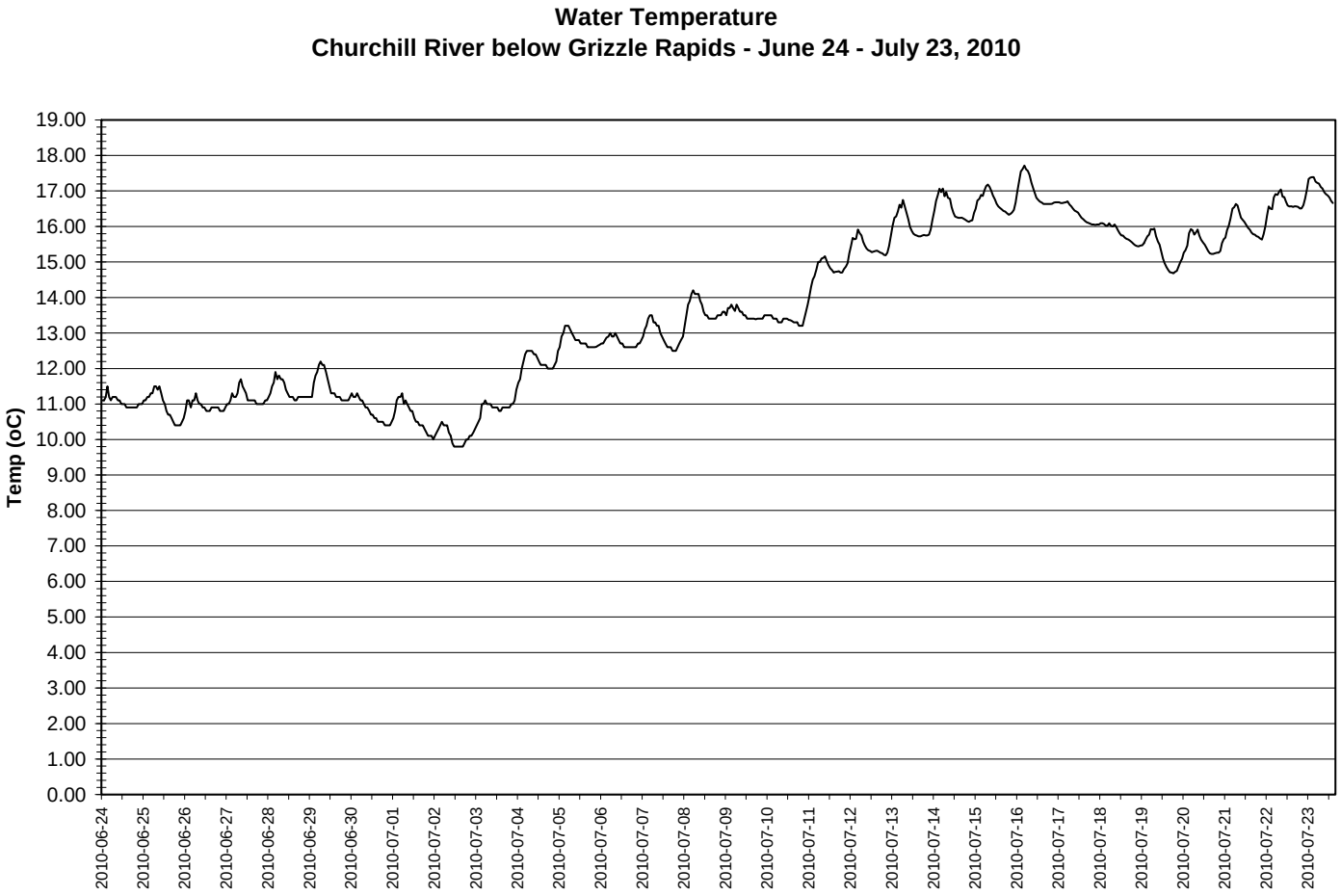

Figure 11: Water temperature at Churchill River below Grizzle Rapids

- pH ranges between 6.54 and 7.18 pH units (Figure 12). 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 12).

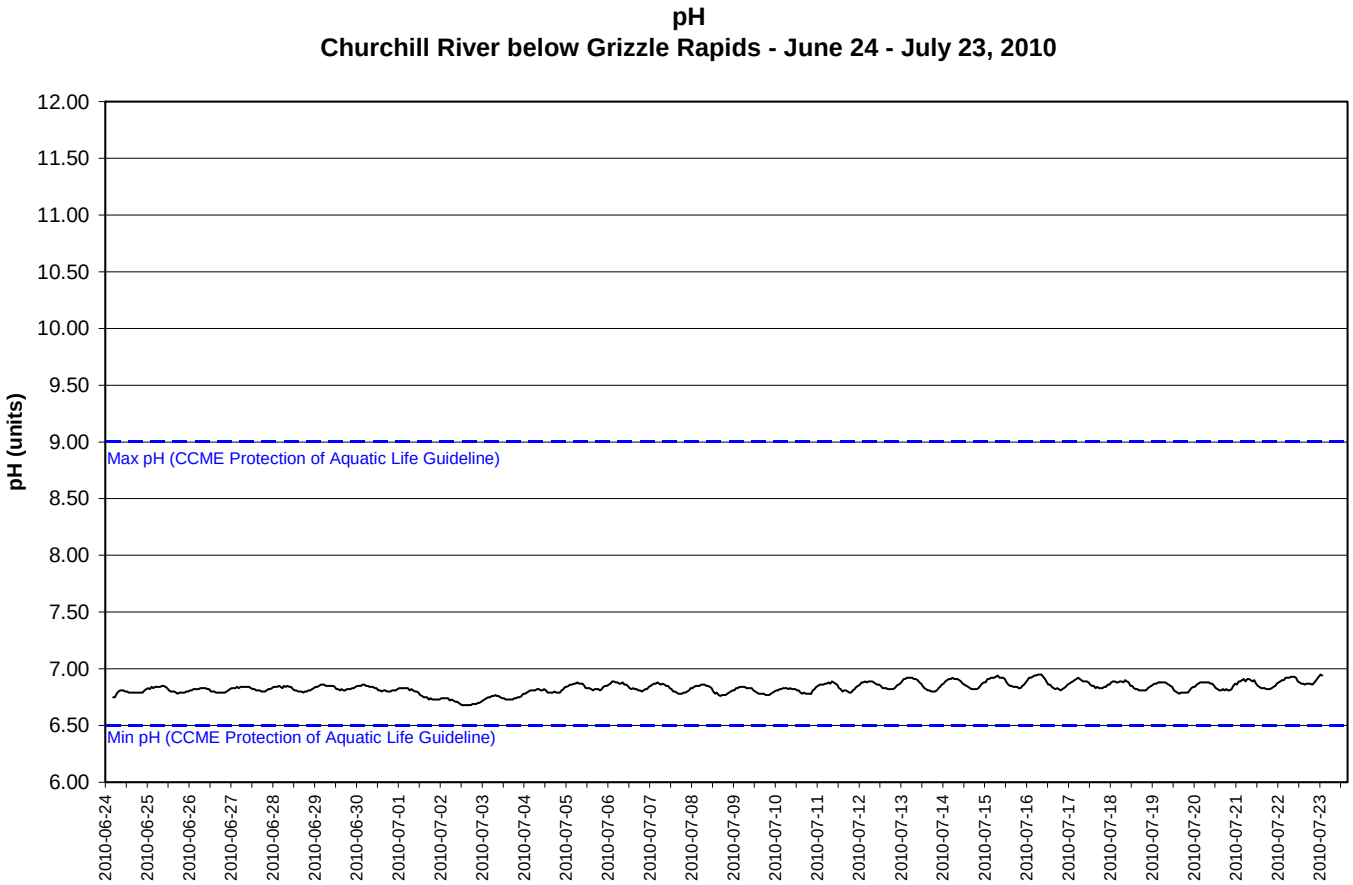

Figure 12: pH at Churchill River below Grizzle Rapids

- Data recovered from the instruments internal log file after July 12 only measures conductivity to 0 decimal places. Stage and flow data is not available for this time.
- Specific conductivity ranges between 13.3 and 15.0µS/cm during the deployment period (Figure 13). Specific conductance generally increases 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).

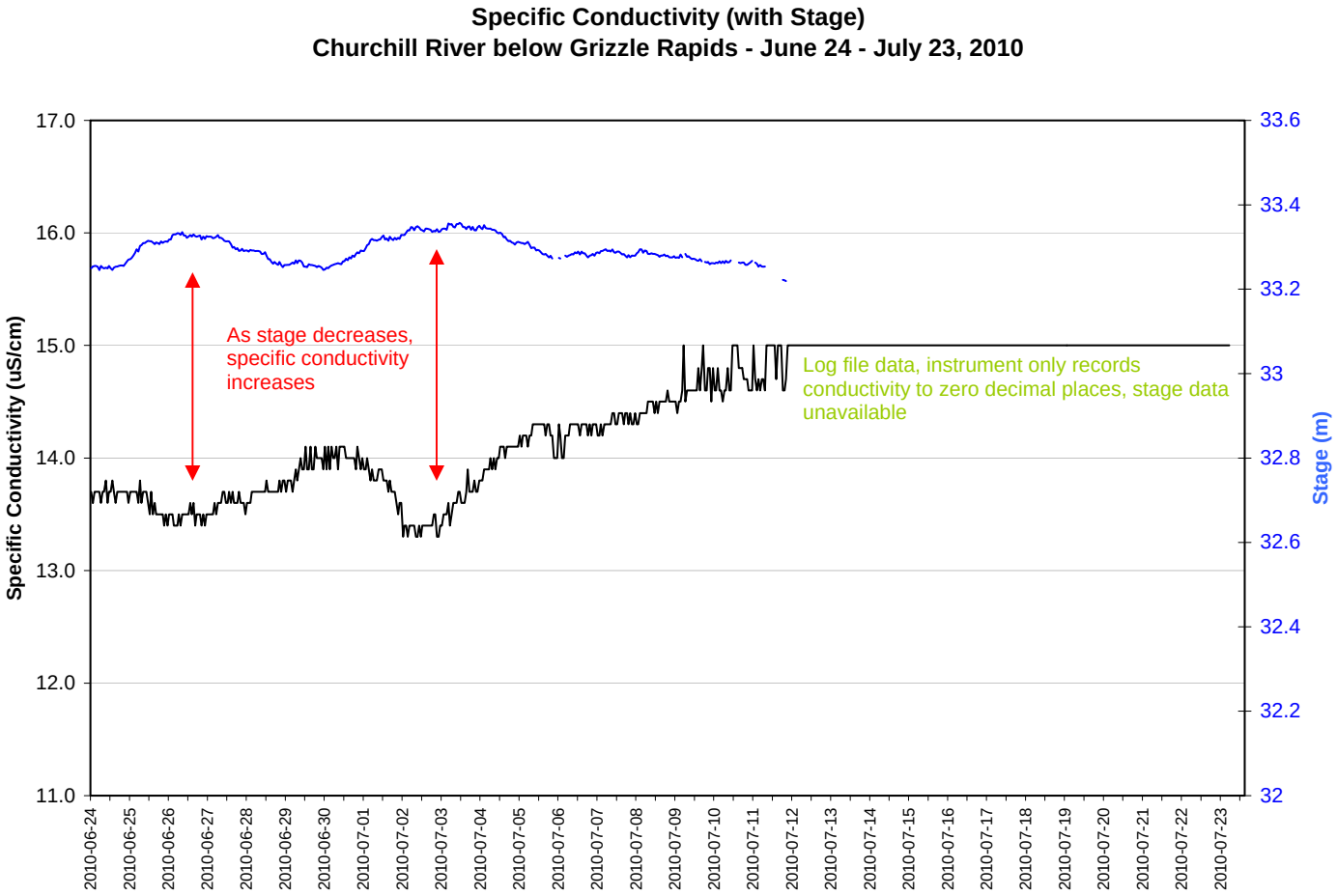

Figure 13: Specific Conductivity at Churchill River below Grizzle Rapids

- The saturation of dissolved oxygen ranged from 94.4 to 102.7% and a range of 9.53 to 11.11 mg/l was found in the concentration of dissolved oxygen with a median value of 10.33 mg/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 decreases slightly throughout the deployment period. This trend is expected given the increasing water and air temperatures (Figure 11, Appendix 1).

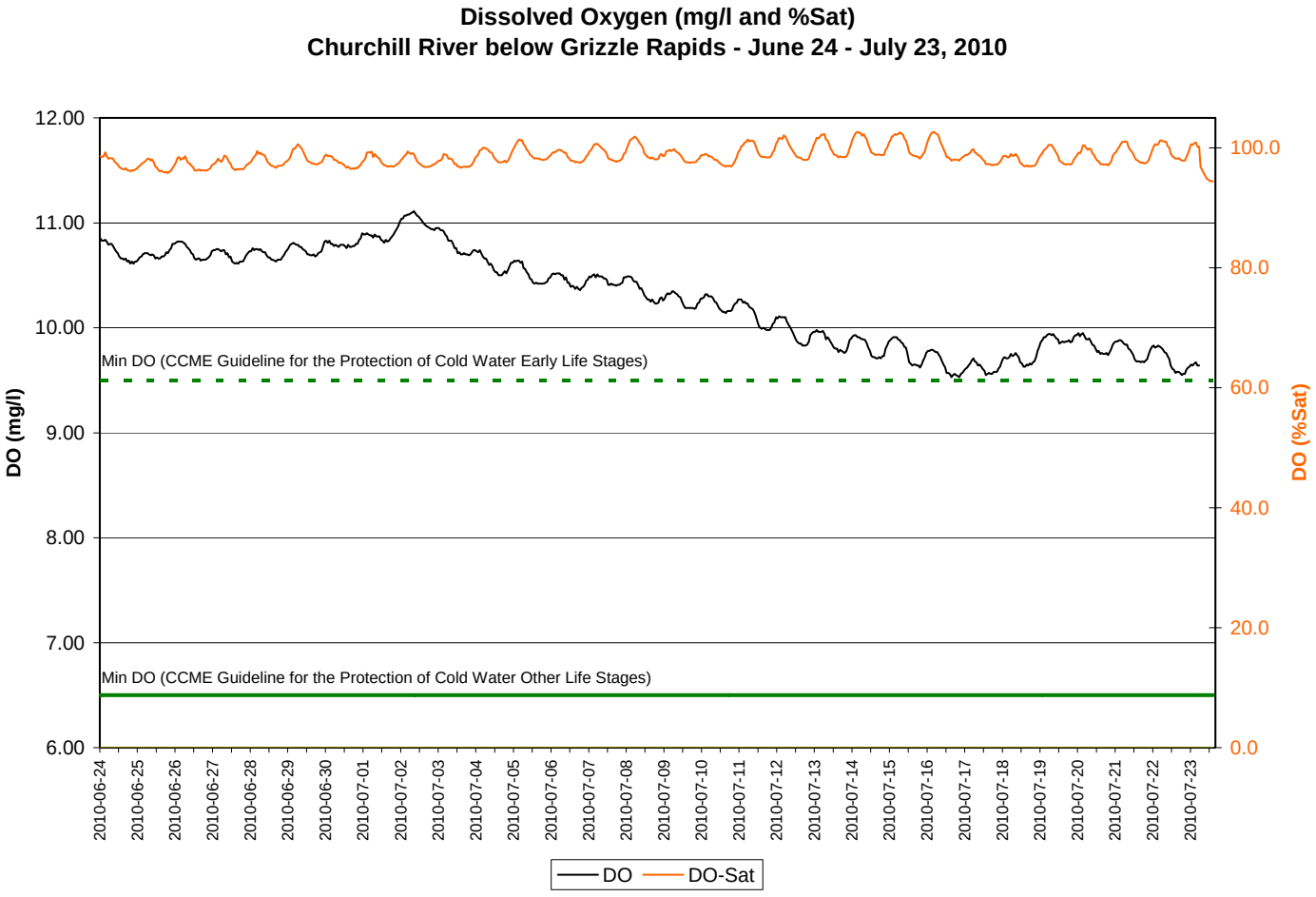

Figure 14: Dissolved oxygen at Churchill River below Grizzle Rapids

- A range of 0.0 to 12.7NTU was recorded for turbidity for this deployment period (Figure 15). A median value of 0.0 NTU indicates this site is naturally clear with out significant background turbidity.
- Two spikes in turbidity are recorded at this site during the deployment period. The first occurs on June 30 and last only for 2 hours. This event corresponds with a low stage reading. The second occurs on July 9 and only last for 1 hour indicating this is likely not a water quality event and rather a sensor error. It does not correspond with a weather related event.

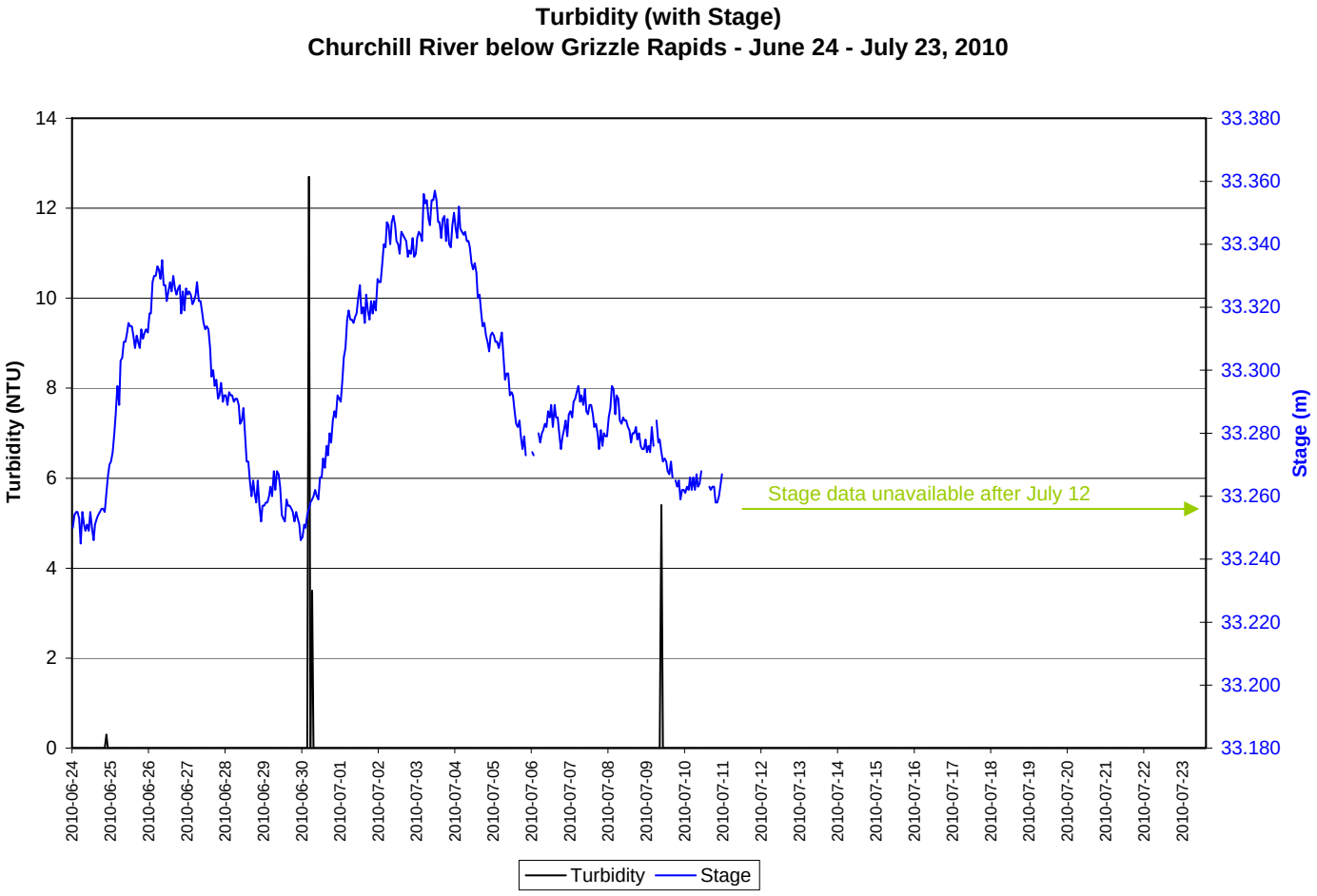

Figure 15: Turbidity at Churchill River below Grizzle Rapids

Churchill River below Metchin River

- Water temperature ranges from 10.90 to 17.40^{o}C during this deployment period (Figure 16).
- Water temperature continues to increase throughout the spring deployment before levelling off in mid-July (Figure 16). This trend is expected given the increasing ambient air temperature (Appendix 1). Water temperature fluctuates diurnally.

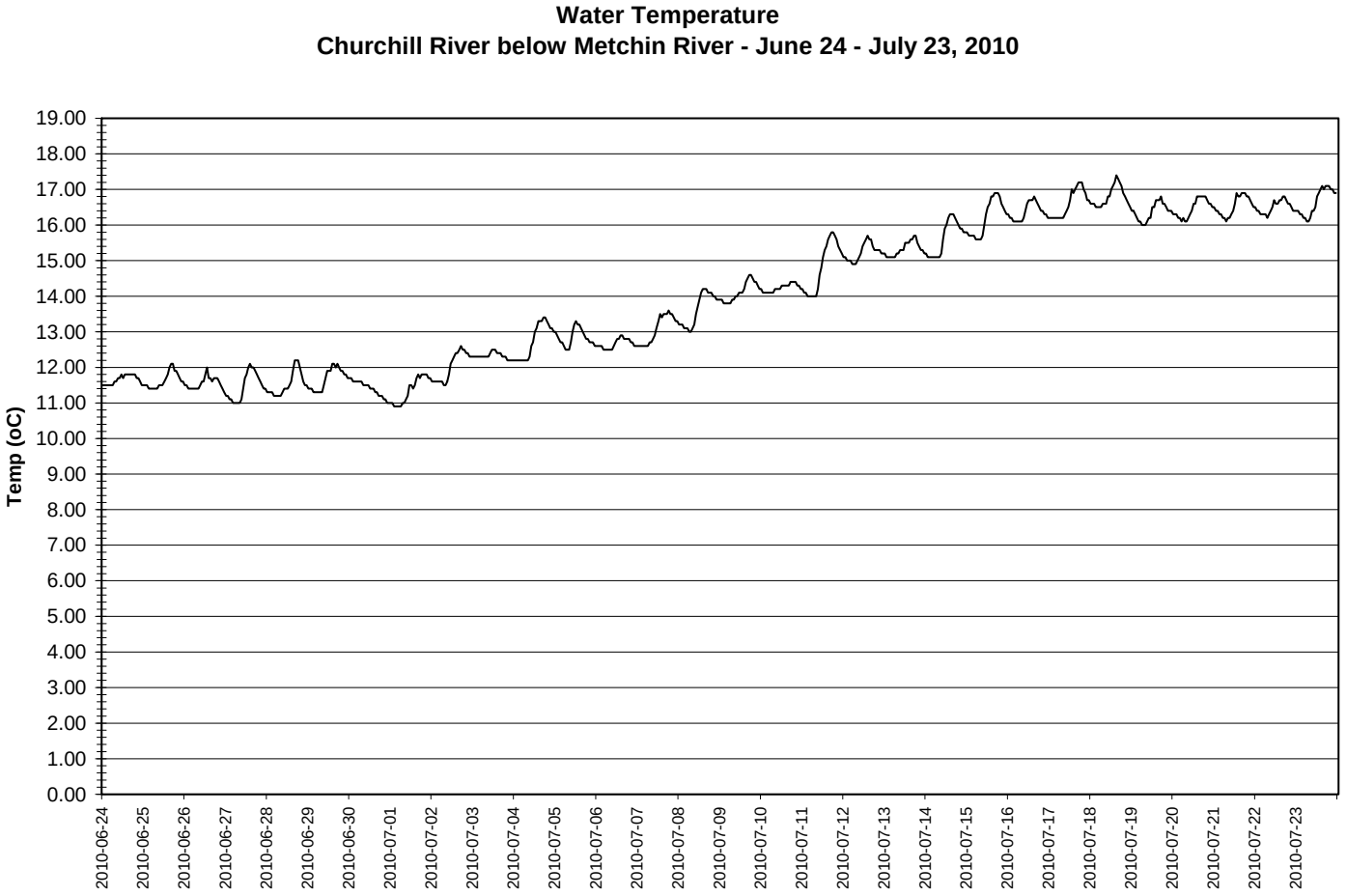

Figure 16: Water temperature at Churchill River below Metchin River

- pH ranges between 6.89 and 7.23 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).

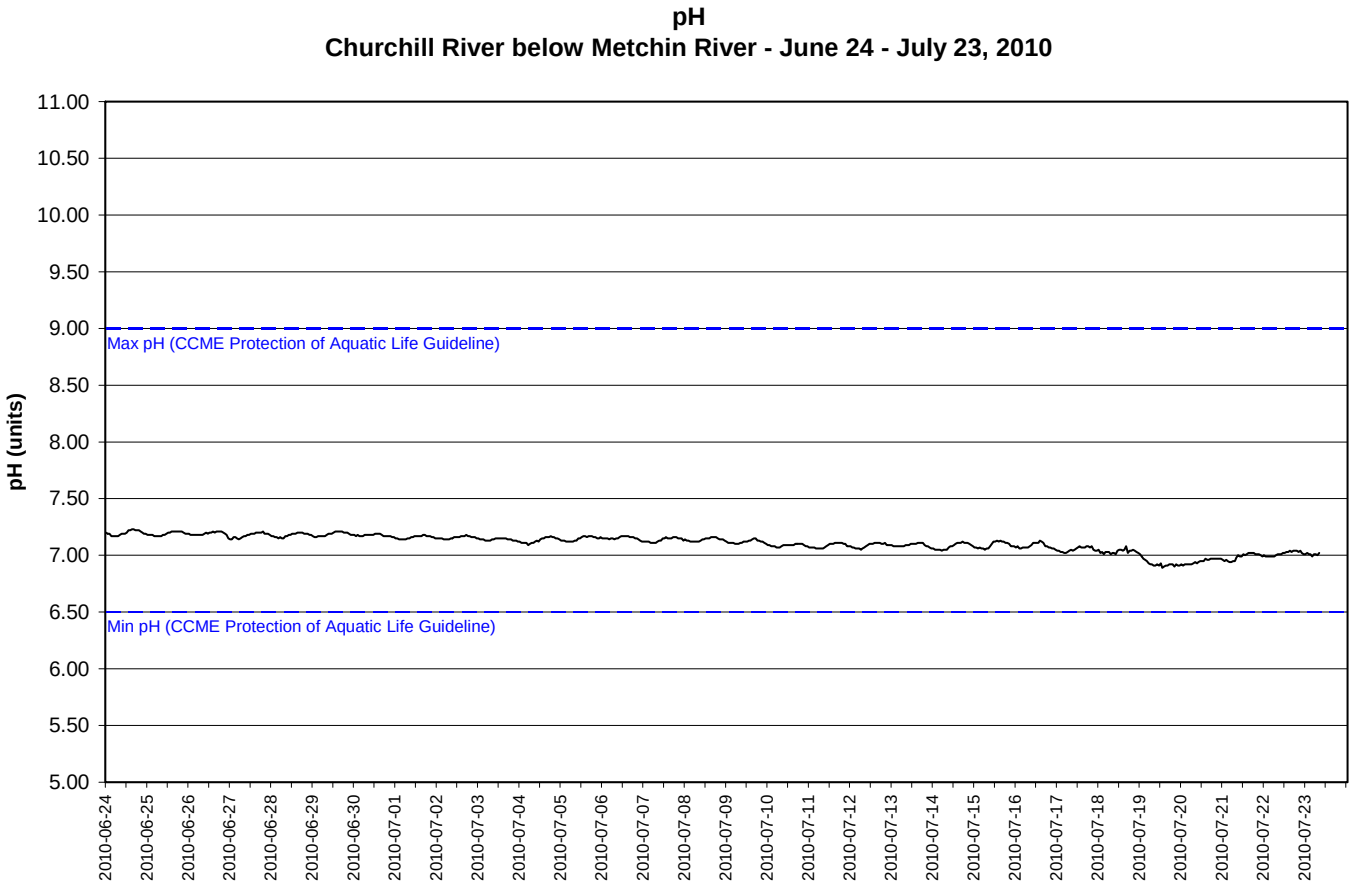

Figure 17: pH at Churchill River below Metchin River

- Specific conductivity ranged from 18.2 to 21.0µS/cm during the deployment period (Figure 18). Specific conductance fluctuates slightly 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. Stage can help determine some of the variability. Near the end of the deployment period, there is a significant drop in specific conductivity. This decrease corresponds with an increase in stage (indicated by red arrows in Figure 18).

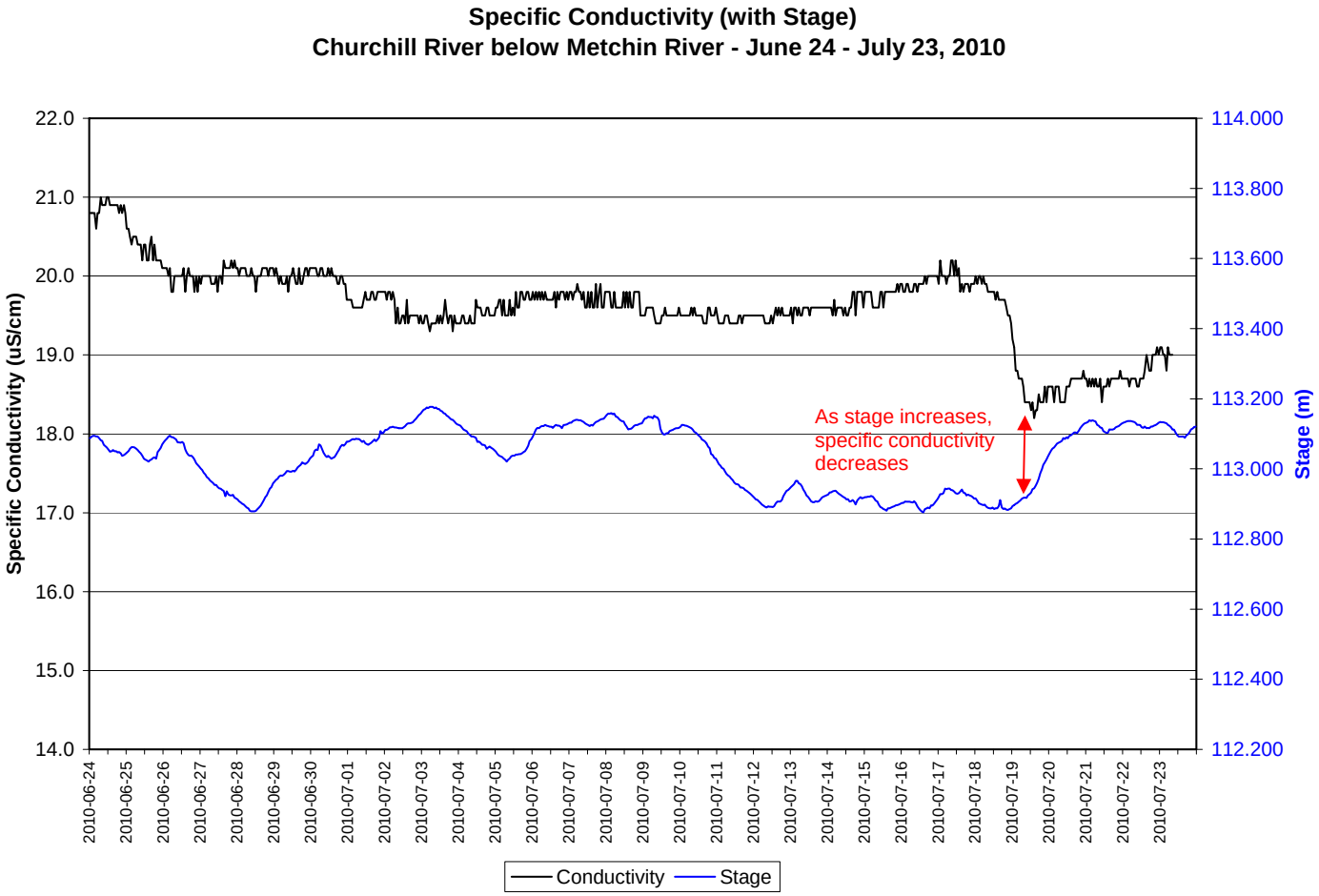

Figure 18: Specific conductivity at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 92.9 to 100.4% and a range of 9.16 to 10.49mg/l was found in the concentration of dissolved oxygen with a median value of 9.93mg/l (Figure 19).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. From June 24 to July 16, values were above the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. In the last week of deployment, dissolved oxygen values decrease to below the guideline to as low at 9.16mg/L. This trend is expected given the increasing water and air temperatures (Figure 16, Appendix 1).

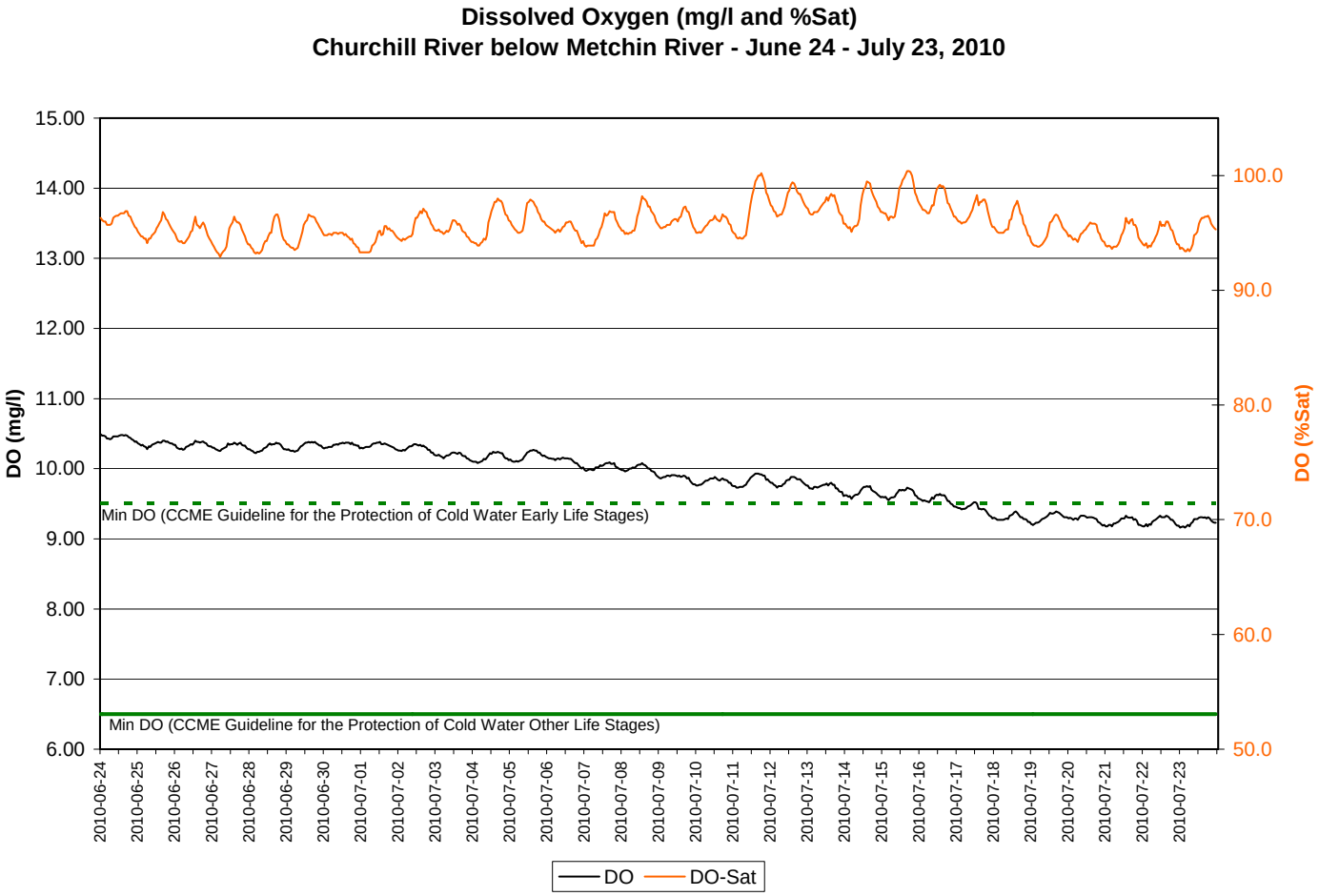

Figure 19: Dissolved Oxygen at Churchill River below Metchin River

- A range of 0.0 to 15.8 NTU was recorded for turbidity for this deployment period (Figure 16). A median value of 0.0 NTU indicates this site is naturally clear with out significant background turbidity values.
- One significant turbidity spike, to nearly 16NTU occurs from July 19 – 20. This spike occurs when stage is very low for a period of time. This spike could be a result from wind/wave action on the instrument and is not likely a water quality event.

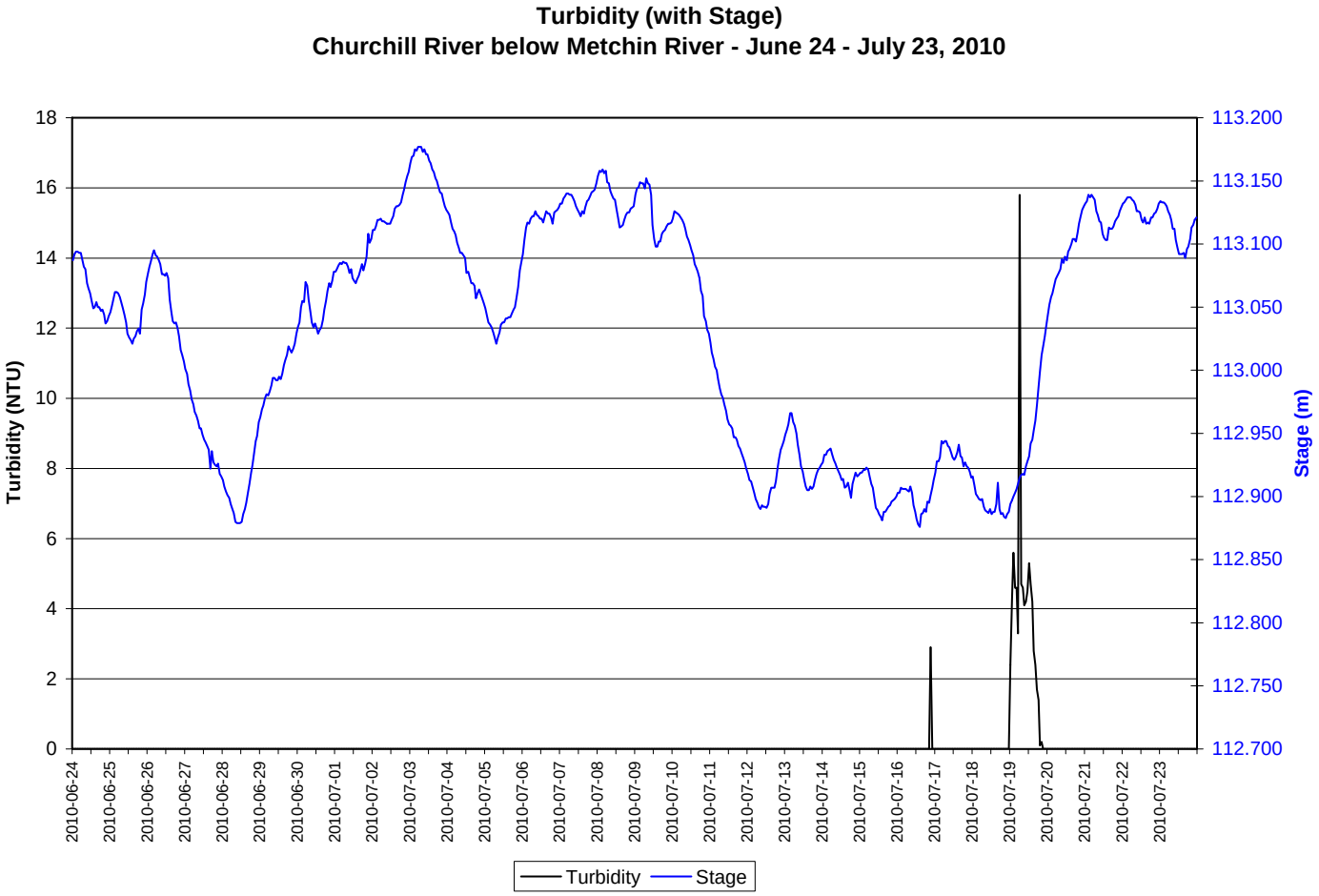

Figure 20: Turbidity at Churchill River below Metchin River

Conclusions

- Instruments at water quality monitoring stations on the Lower Churchill River were deployed at all four stations between June 23 and July 24.
- No significant water quality events were captured during this time. In most cases, weather related events or increases/decreases in water level could be used to explain the fluctuations.
- In most instances, all values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen with the exception of dissolved oxygen at the station below Metchin River.
- A transmission error at the station below Grizzle Rapids prevented data from being transmitted in real time between July 12 and July 23. The instruments internal log file was recovered to provide data for this period.
- A data logger connection error at the station below Muskrat Falls prevented data from being transmitted in real time between June 23 and July 17. The instruments internal log file was recovered to provide data for this period.

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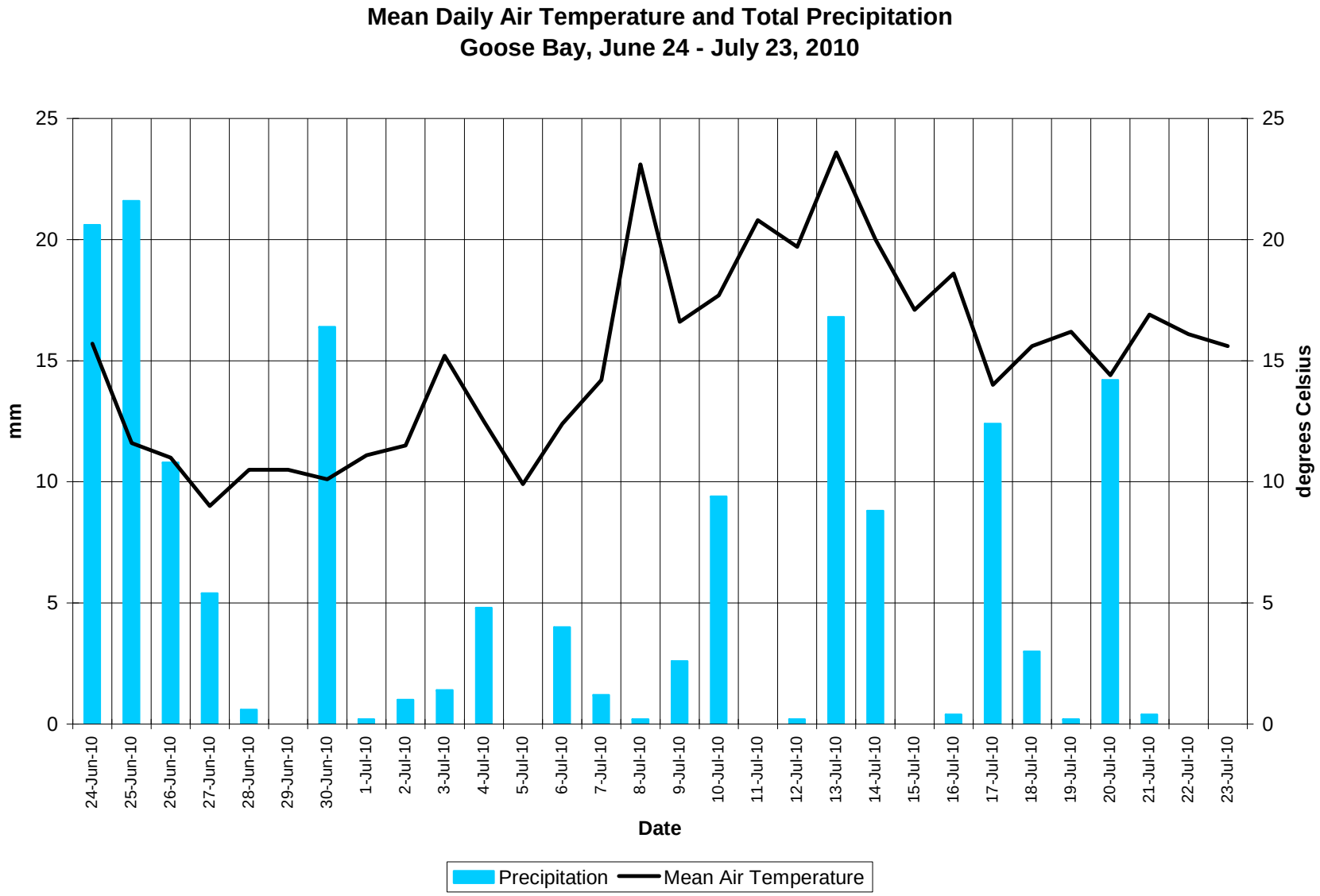
Appendix 1


Mean Daily Air Temperature and Total Precipitation
Goose Bay, June 24 - July 23, 2010
mm
degrees Celsius
Date
Precipitation
Mean Air Temperature
0
5
10
15
20
25
24-Jun-10
25-Jun-10
26-Jun-10
27-Jun-10
28-Jun-10
29-Jun-10
30-Jun-10
1-Jul-10
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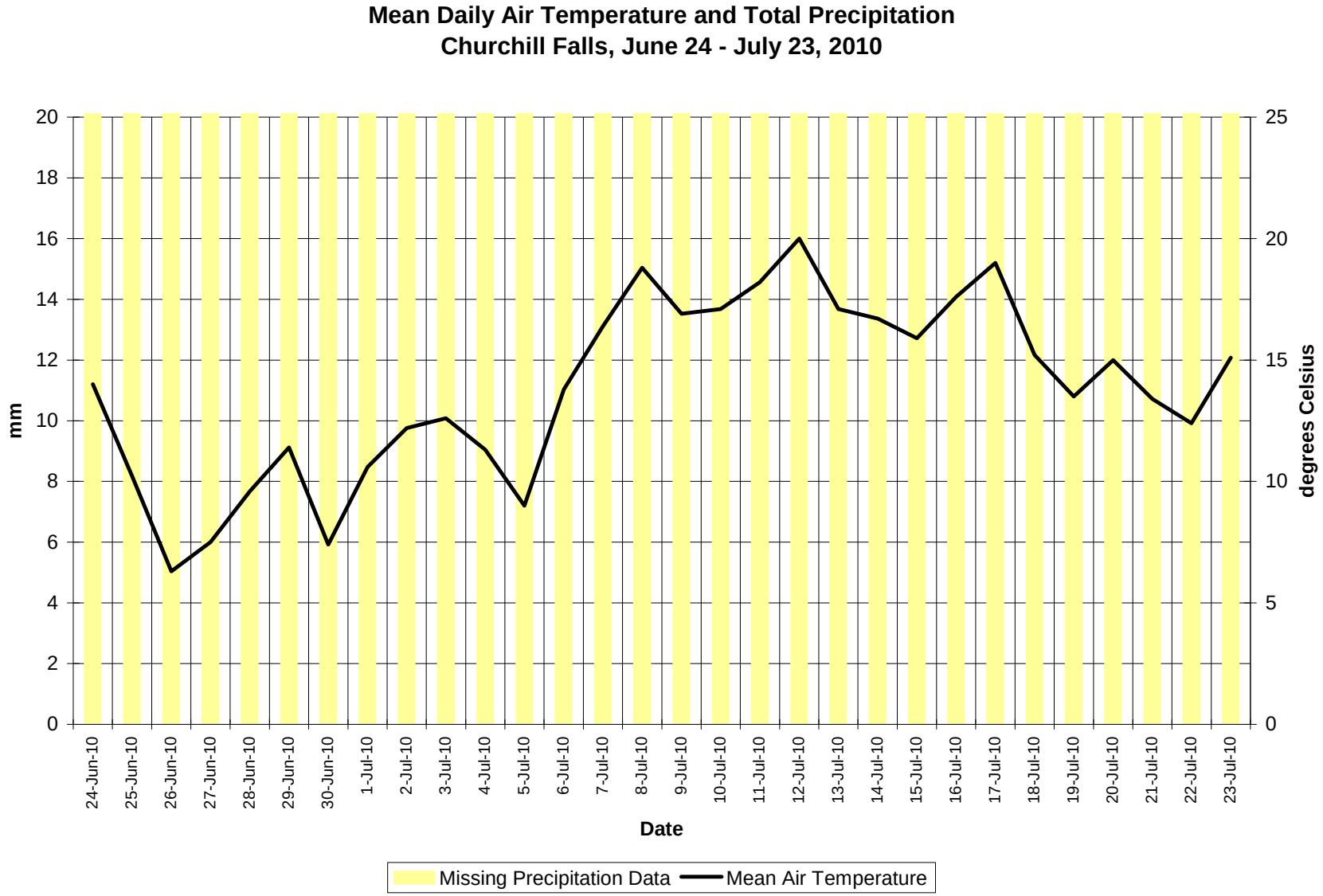
Mean Daily Air Temperature and Total Precipitation
Churchill Falls, June 24 - July 23, 2010
mm
degrees Celsius
Date
Missing Precipitation Data
Mean Air Temperature