Real-Time Water Quality Deployment Report

Lower Churchill River Network

June 29 to
July 24, 2012

Newfoundland Labrador

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

Contents

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General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at the four stations on the Lower Churchill River: below Metchin River, below Grizzle Rapids and above and below Muskrat Falls.
- On June 29, 2012, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 25 days. Instruments were removed on July 24.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), 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 Instrument is temporarily deployed along side the Field Instrument. 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 Instrument and QA/QC Instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (C)	<=+/-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 instrument 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 instrument the entire instrument 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 Lower Churchill River stations deployed from June 29 to July 24, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, June 29 – July 24, 2012

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45707)	Jun 29, 2012	Deployment	n/a*	n/a*	n/a*	n/a*	n/a*
	Jul 24, 2012	Removal	Good	Marginal	Good	Excellent	Excellent
Below Grizzle Rapids (45699)	Jun 29, 2012	Deployment	n/a*	n/a*	n/a*	n/a*	n/a*
	Jul 24, 2012	Removal	Excellent	Excellent	Good	Excellent	Excellent
Above Muskrat Falls (45708)	Jun 29, 2012	Deployment	Excellent	Good	Excellent	Excellent	Good
	Jul 24, 2012	Removal	Excellent	Fair	Good	Excellent	Excellent
Below Muskrat Falls (45700)	Jun 29, 2012	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Jul 24, 2012	Removal	Good	Marginal	Good	Excellent	Poor

* QAQC data unavailable due to error readings with the handheld display unit.

- At the station below Metchin River, QAQC comparison data is unavailable at deployment due to an issue with the hand held display unit reporting the readings. At removal, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'good' or 'excellent' at while pH ranked 'marginal'. The field instrument read a value of 6.97 and the QA/QC instrument read a value of 7.85. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. The QAQC instrument continued to read high pH values for the remainder of the day and this discrepancy is noted at other stations downstream.
- At the station below Grizzle Rapids, QAQC comparison data is unavailable at deployment due to an issue with the hand held display unit reporting the readings. At removal, all parameters ranked either 'good' or 'excellent'.
- At the station above Muskrat Falls, all parameters ranked either 'good' or 'excellent' at deployment. At removal, temperature, specific conductivity, dissolved oxygen and turbidity all ranked either 'good' or 'excellent' while pH ranked 'fair'. The field instrument reported a value of 7.21 while the QAQC instrument reported a value of 7.98. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. The QAQC instrument continued to read high pH values for the remainder of the day and this discrepancy is noted at other stations both up and downstream.
- At the station below Muskrat Falls, all parameters ranked 'excellent' at deployment on June 29. At removal, temperature, specific conductivity, and dissolved oxygen all ranked either 'good' or 'excellent' while pH ranked 'marginal' and turbidity ranked 'poor'. For pH, the field instrument read a value of 7.06 and the QAQC instrument read a value of 7.90. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. The QAQC instrument continued to read high pH values for the remainder of the day and this discrepancy is noted at other stations on the

Lower Churchill visited that day. For turbidity, the field sonde reported a value of 38.8NTU while the QAQC instrument reported a value of 5.4NTU. This discrepancy may in part be caused by the amount of accumulated sand and silt found in the instrument casing when the instrument was retrieved.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from June 29 to July 24 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 QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Churchill River below Metchin River

- Water temperature ranges from 15.60°C to 18.80°C during the deployment period (Figure 1).
- Water temperature is increasing throughout the beginning of the deployment period. This trend is expected due to the warming ambient air temperatures in the summer season (Figure 2). Water temperature fluctuates diurnally.

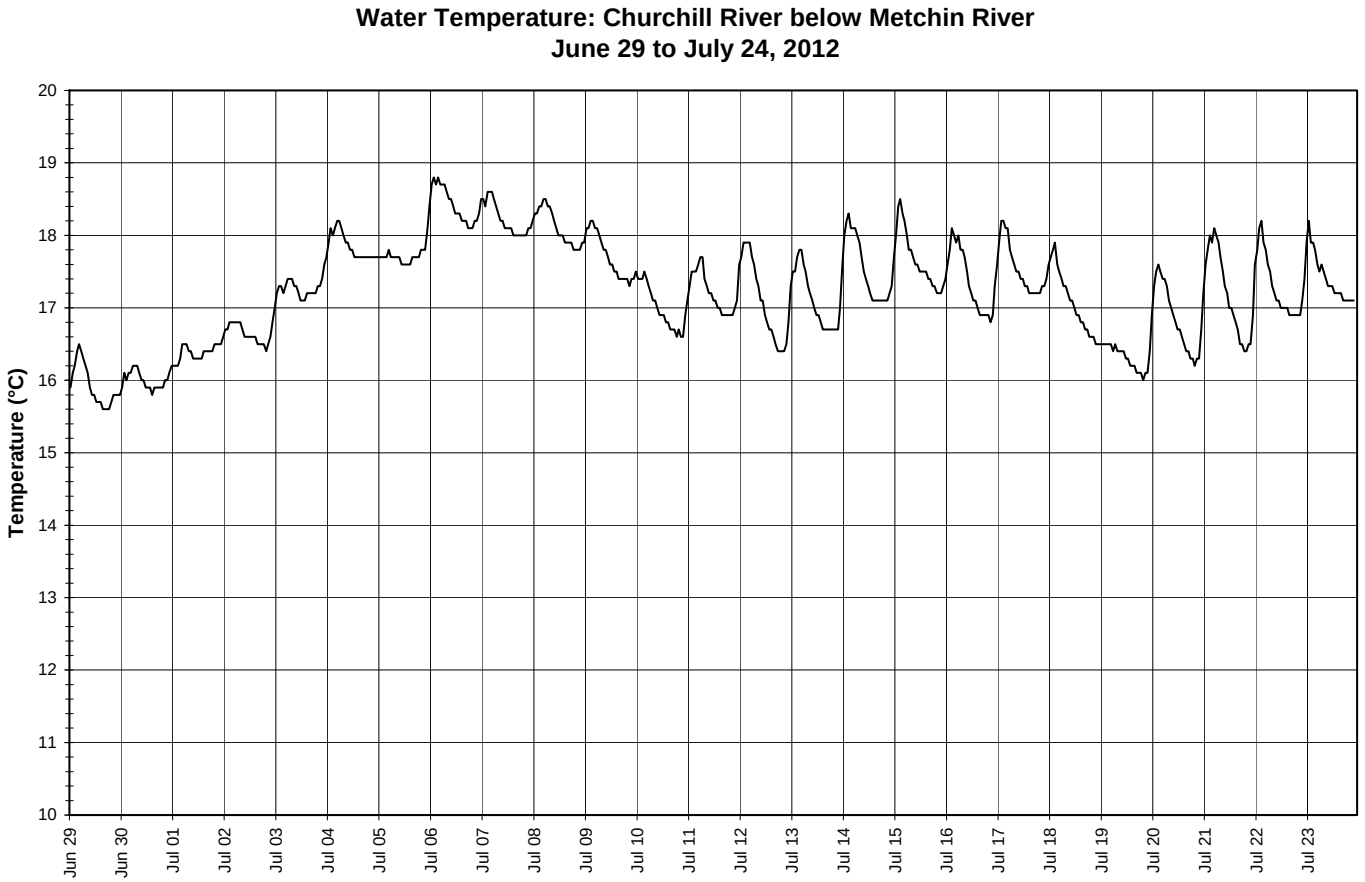

Figure 1: Water temperature at Churchill River below Metchin River

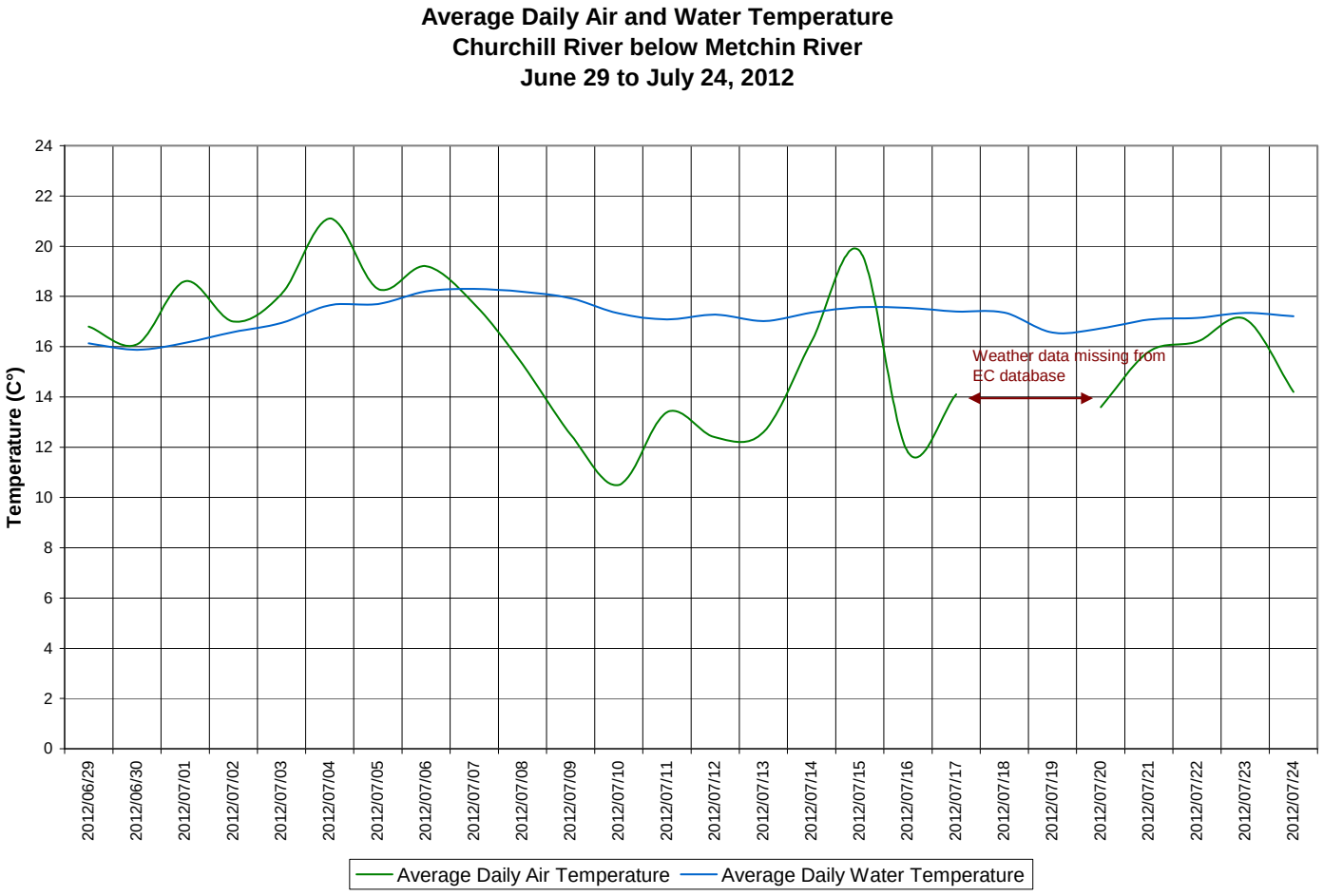

Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Churchill Falls, NL)

- pH ranges between 6.90 and 7.04 pH units and remains stable throughout the deployment period (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

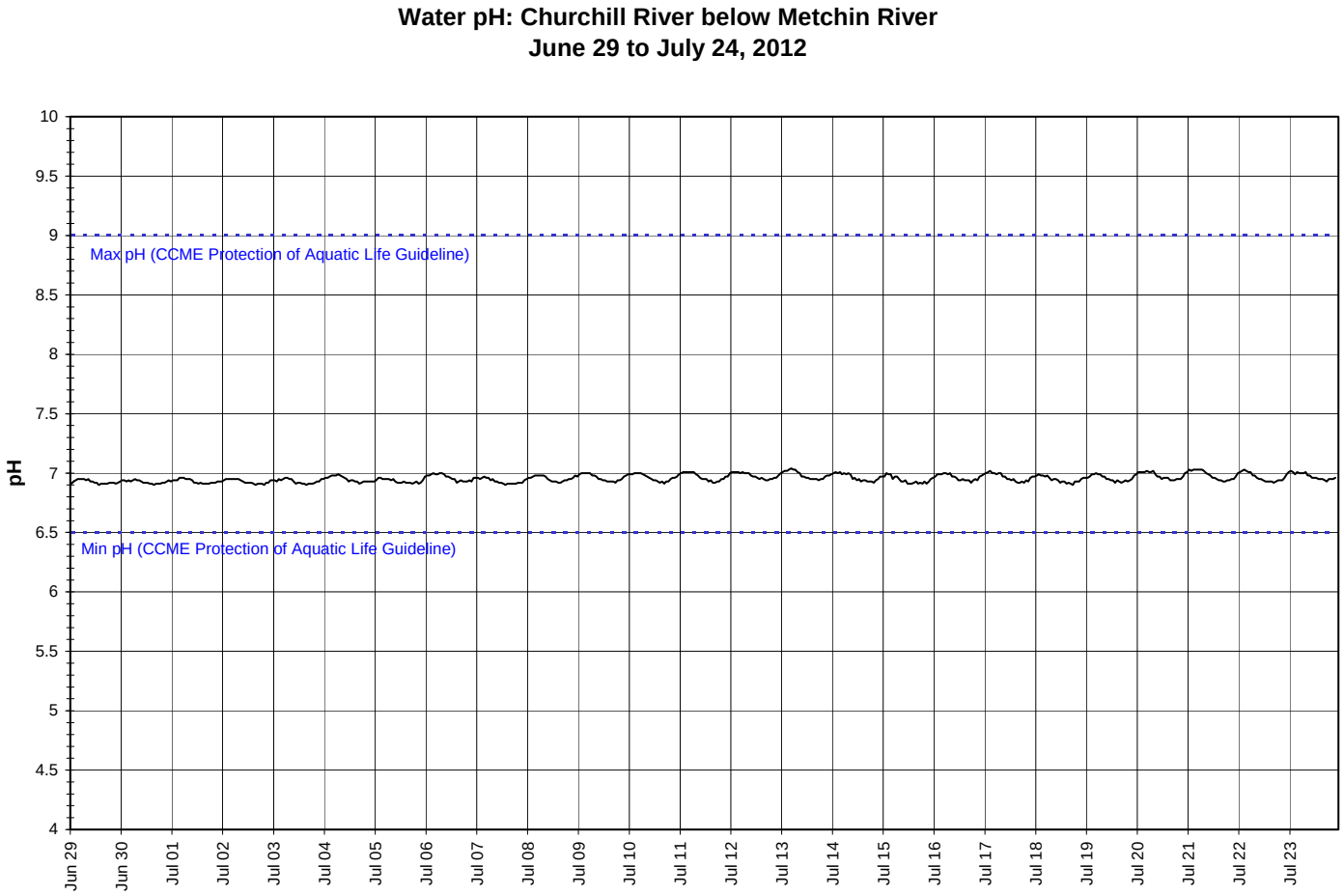

Figure 3: pH at Churchill River below Metchin River

- Specific conductivity ranges from 24.0 to 28.6µS/cm during the deployment period, averaging 26.1µS/cm (Figure 4).
- Specific conductivity is increasing throughout the deployment period.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period. As stage decreases, specific conductivity generally increases due to the increasing concentrations of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

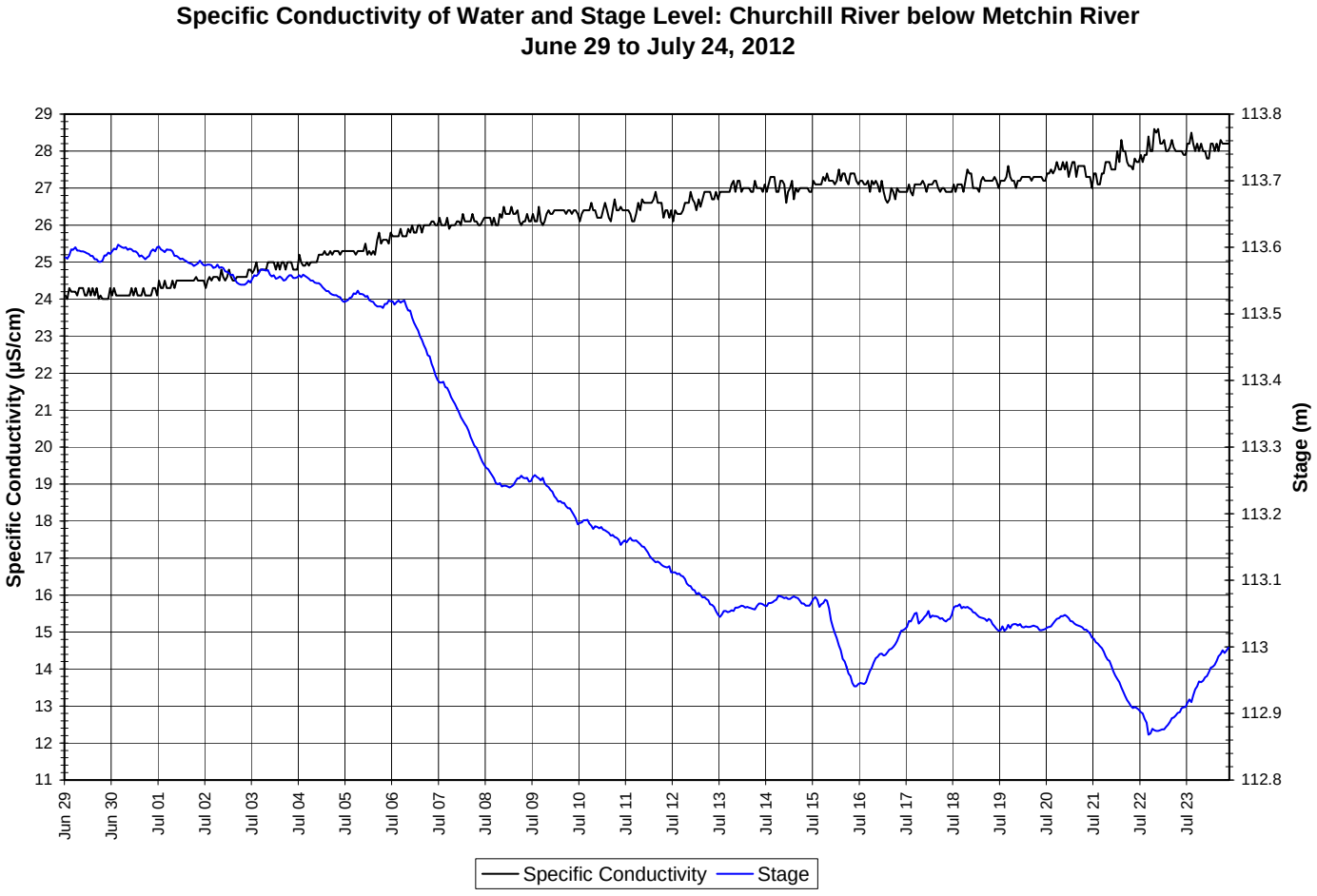

Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 89.9 to 98.0% and a range of 8.72 to 9.58mg/l was found in the concentration of dissolved oxygen with a median value of 8.96mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. Most values were below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l.. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 2).

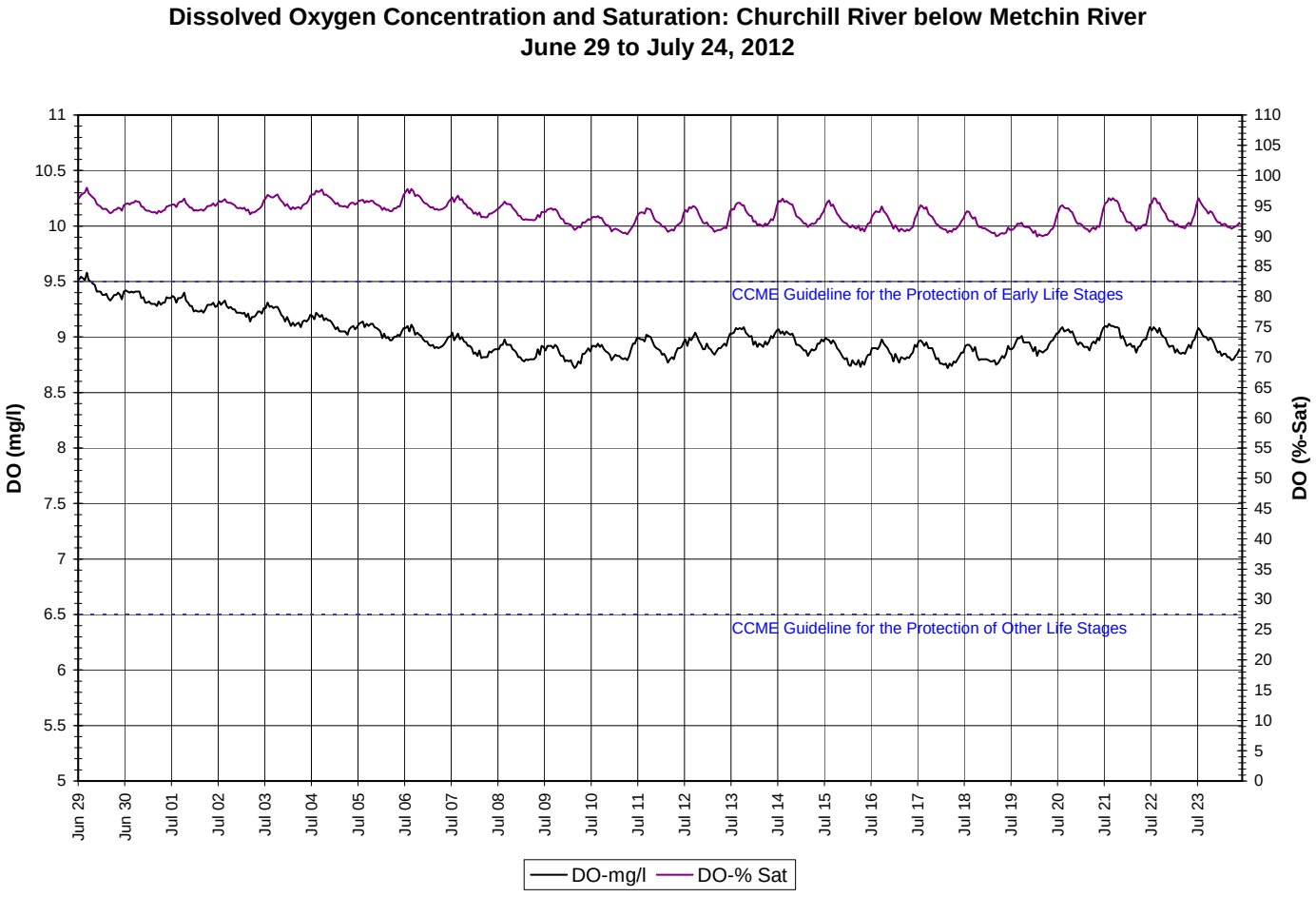

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity ranges between 0 and 238NTU throughout the deployment period (Figure 6). A median value of 5.8NTU indicates there is a natural background turbidity value at this station.
- In the past, turbidity at this station has generally been 0NTU with minimal increases at low magnitudes. The background turbidity may in part be caused by the silty river reach at this station and changing water levels. Stage level is decreasing throughout the deployment period. As stage decreases, especially in the end of the deployment period, the number of turbidity readings and their magnitude increase.

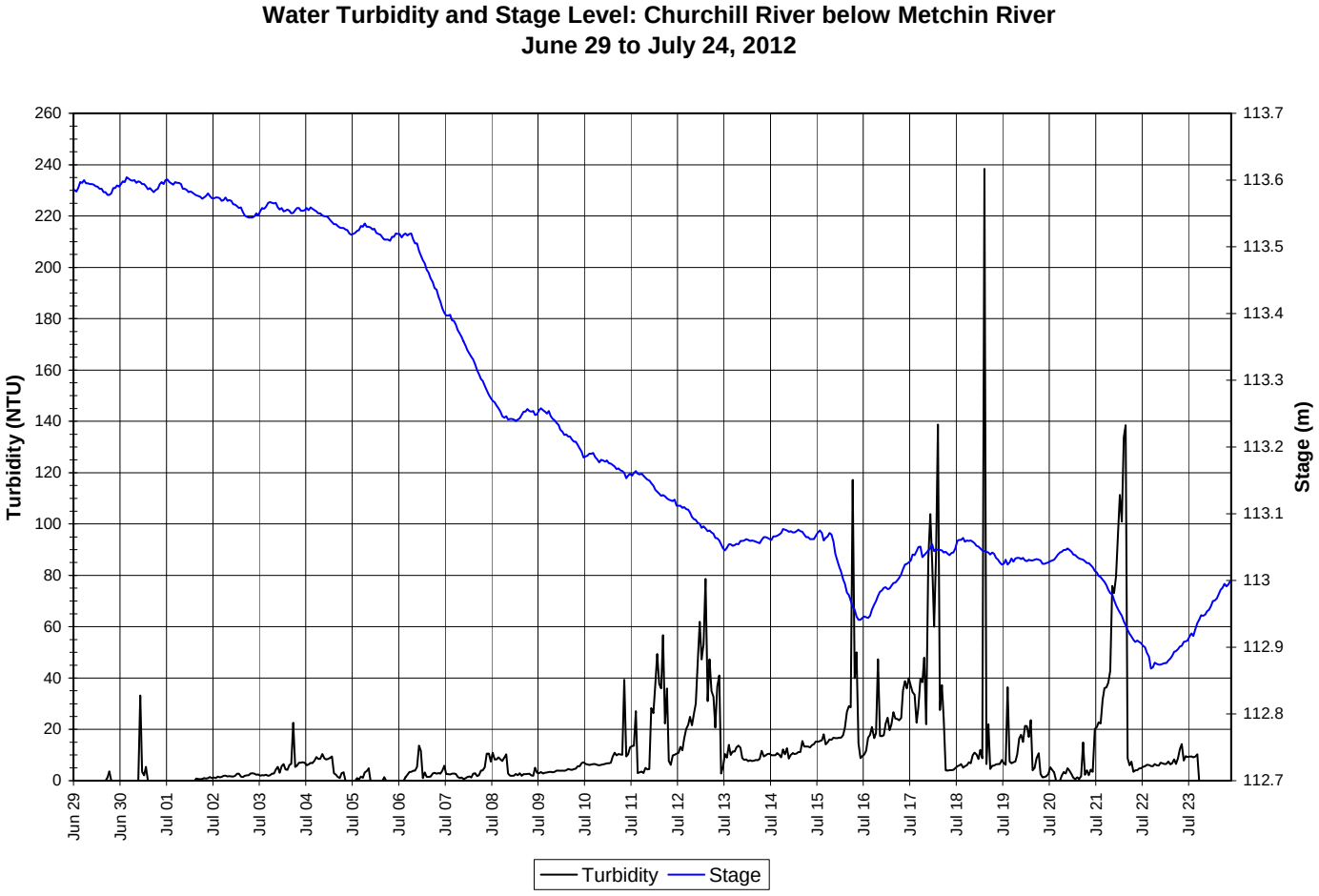

Figure 6: Turbidity at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is decreasing throughout the deployment period and precipitation records vary. Stage ranges between 113.6 and 112.87m, a difference of 0.73m.

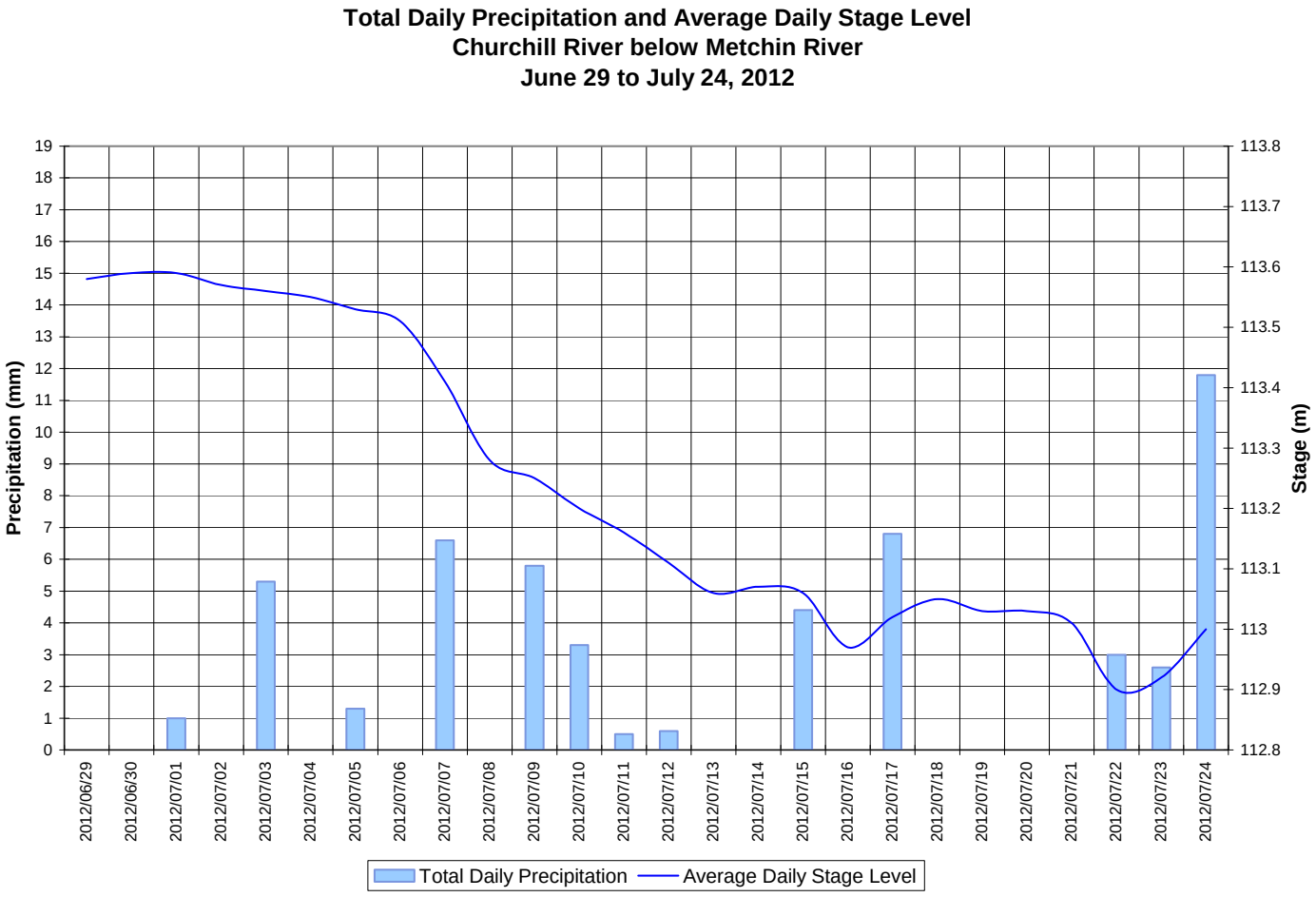

Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River

(weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranges from 14.60 to 19.70^{o}C during the deployment period (Figure 8).
- Water temperature is generally increasing throughout the deployment period. This trend is expected due to the warming ambient air temperatures in the summer season (Figure 9). Water temperature fluctuates diurnally.

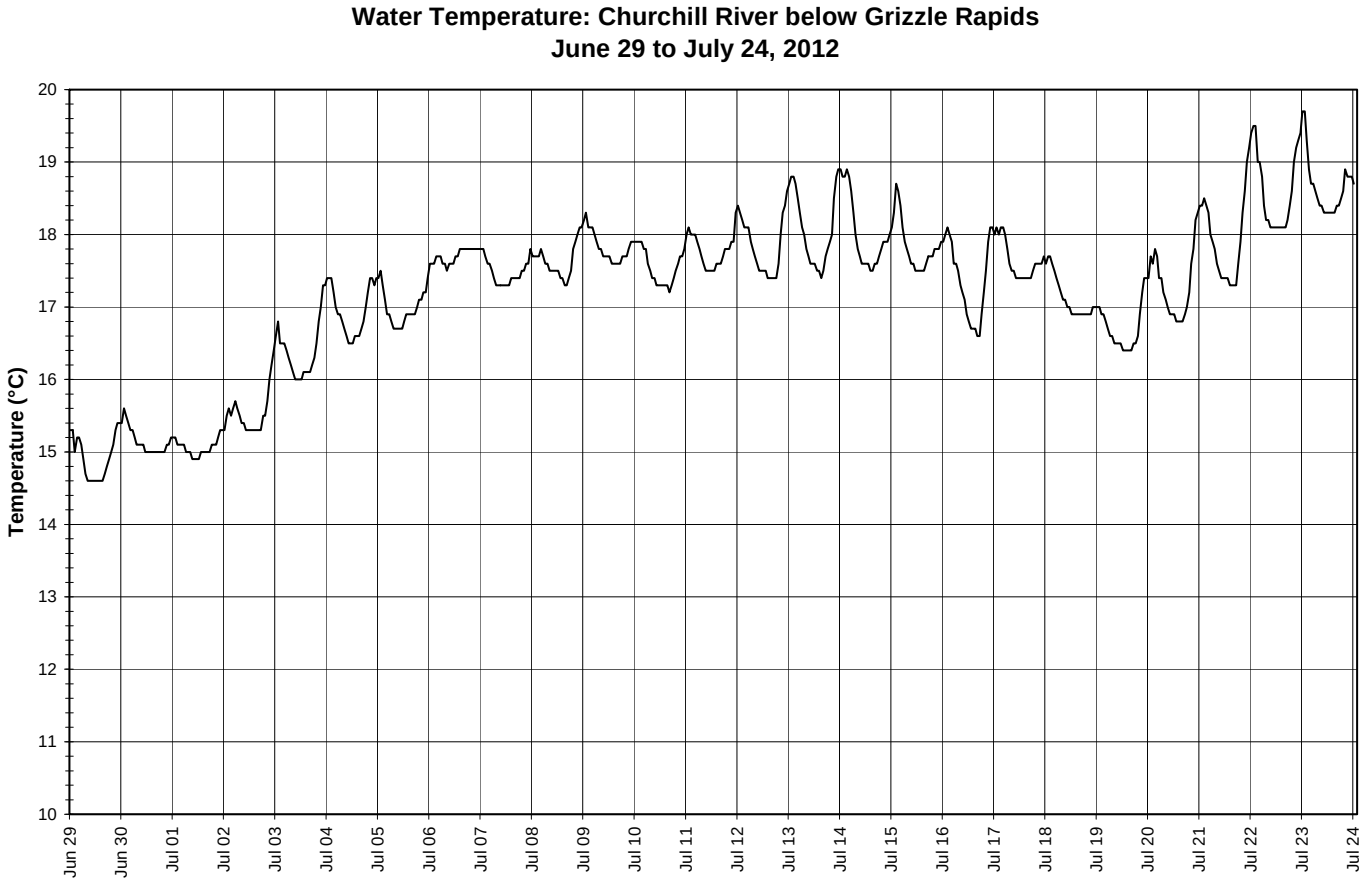

Figure 8: Water temperature at Churchill River below Grizzle Rapids

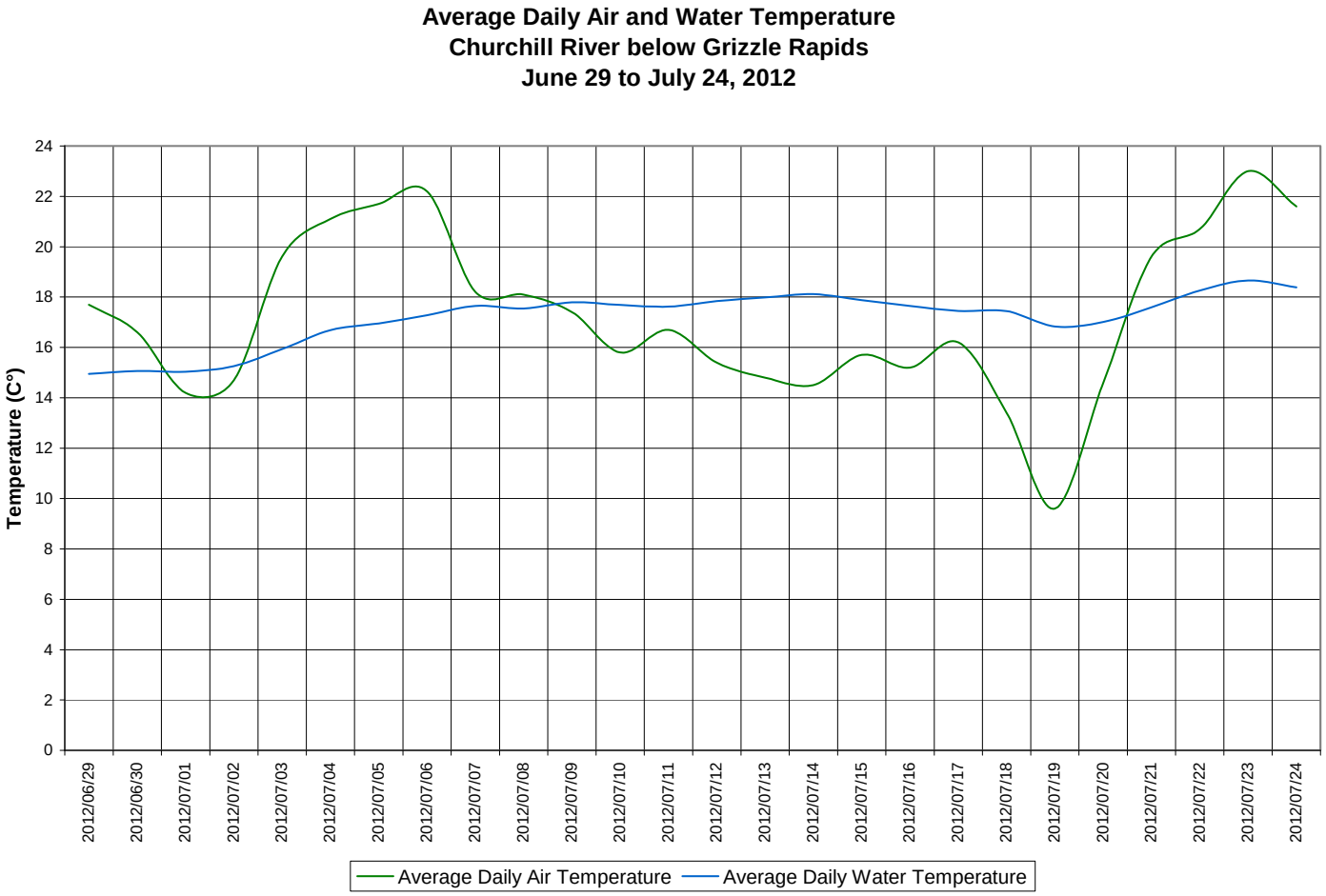

Figure 9: Average daily air and water temperature at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 6.91 and 7.22 pH units and remains very consistent throughout the deployment period (Figure 10). pH fluctuates diurnally.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

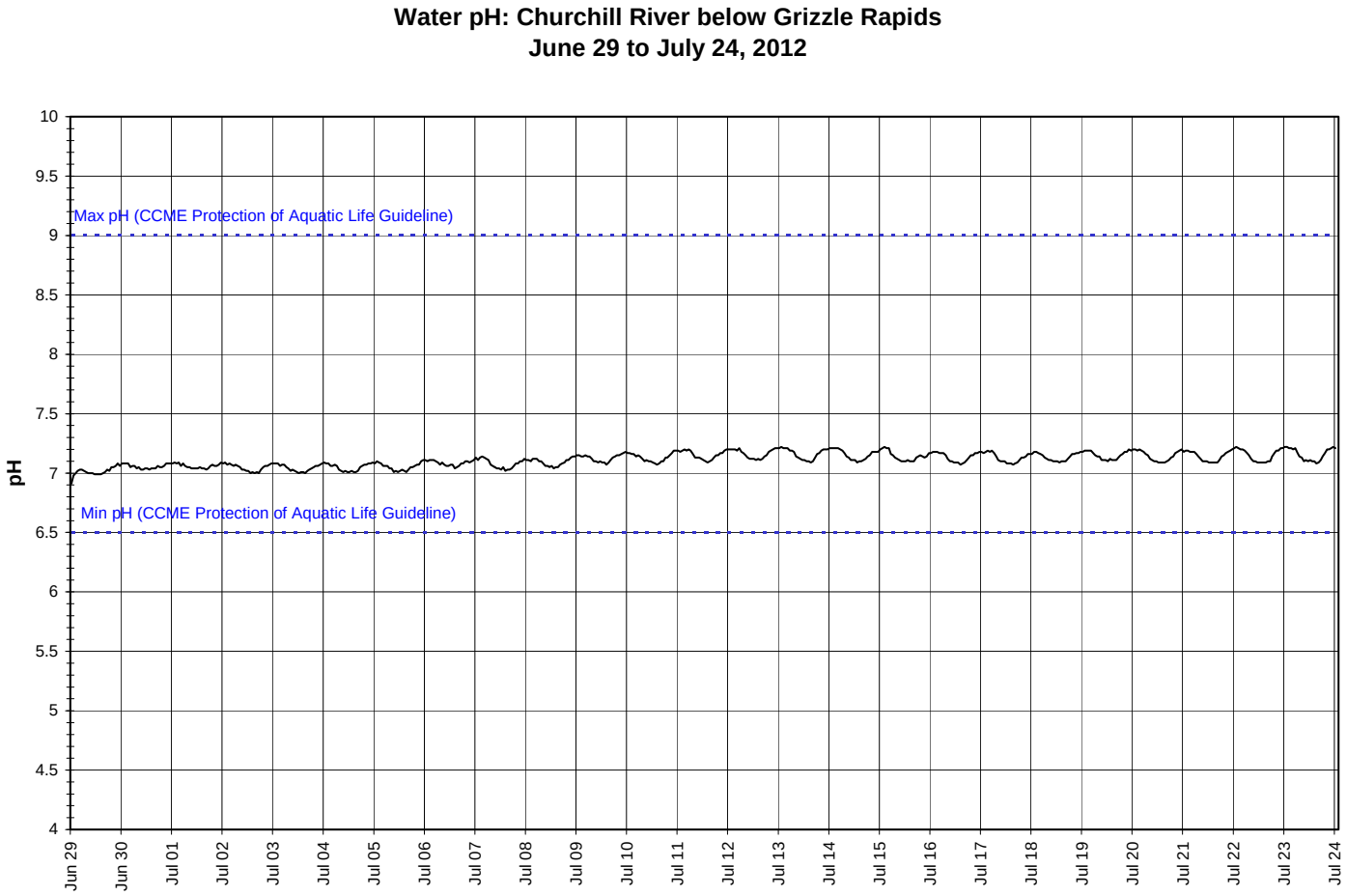

Figure 10: pH at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 24.1 to 25.9µS/cm during the deployment period, averaging 24.8µS/cm (Figure 11).
- Specific conductance is generally increasing throughout the deployment period.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period. As stage decreases, specific conductivity generally increases due to the increased concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

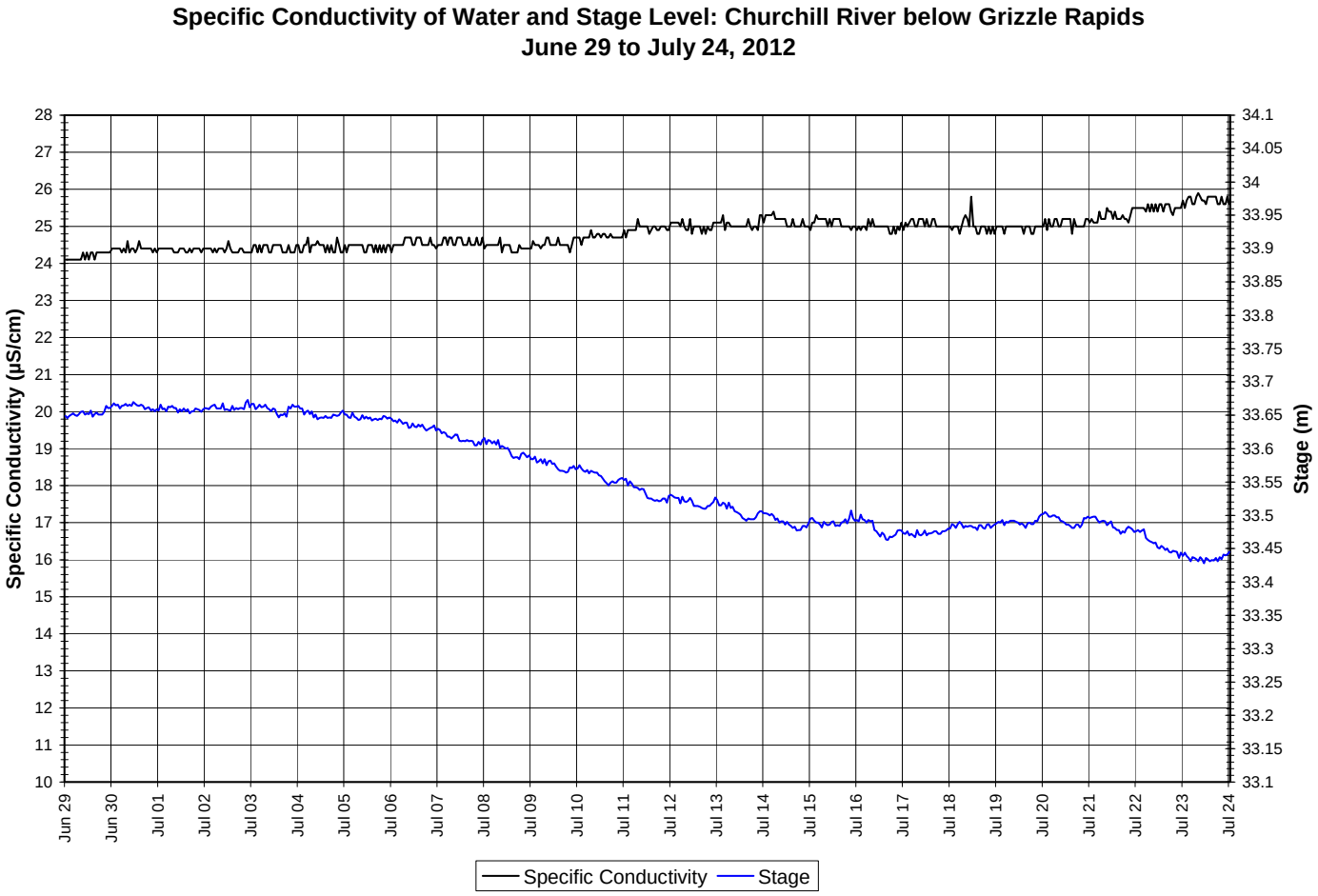

Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- The saturation of dissolved oxygen ranged from 96.1 to 102.7% and a range of 9.10 to 10.00mg/l was found in the concentration of dissolved oxygen with a median value of 9.40mg/l (Figure 12).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. Most values recorded were either just above or just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 9).

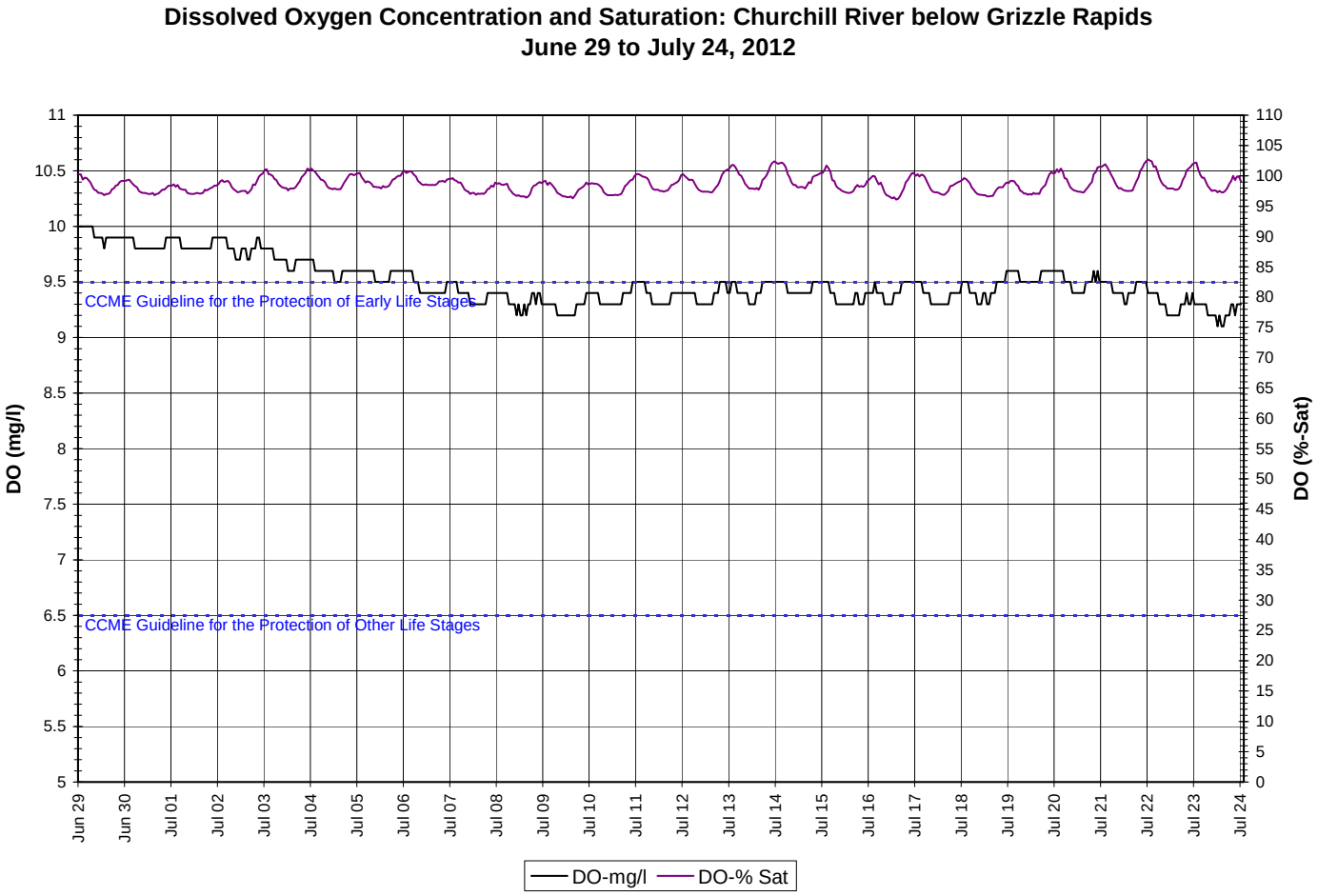

Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values remained at 0NTU for the entirety of the deployment period (Figure 13). This trend has been experienced in the past. The river reach at this station runs clear and quickly though Grizzle Rapids. It is not unusual to have no turbidity measurement recorded.

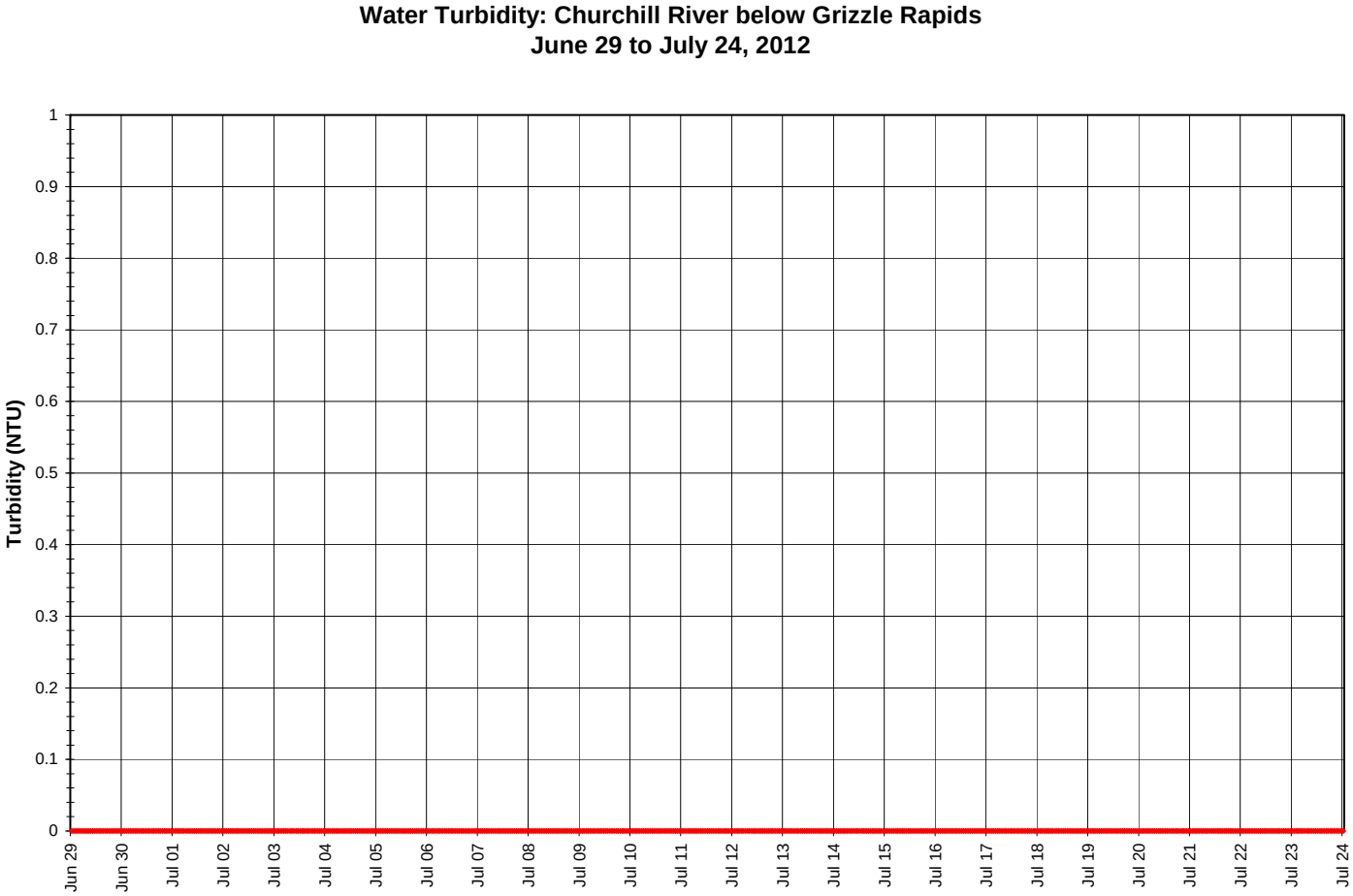

Figure 13: Turbidity at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is decreasing throughout the deployment period and precipitation records vary. Stage ranges between 33.43 and 33.67m, a difference of 0.24m.

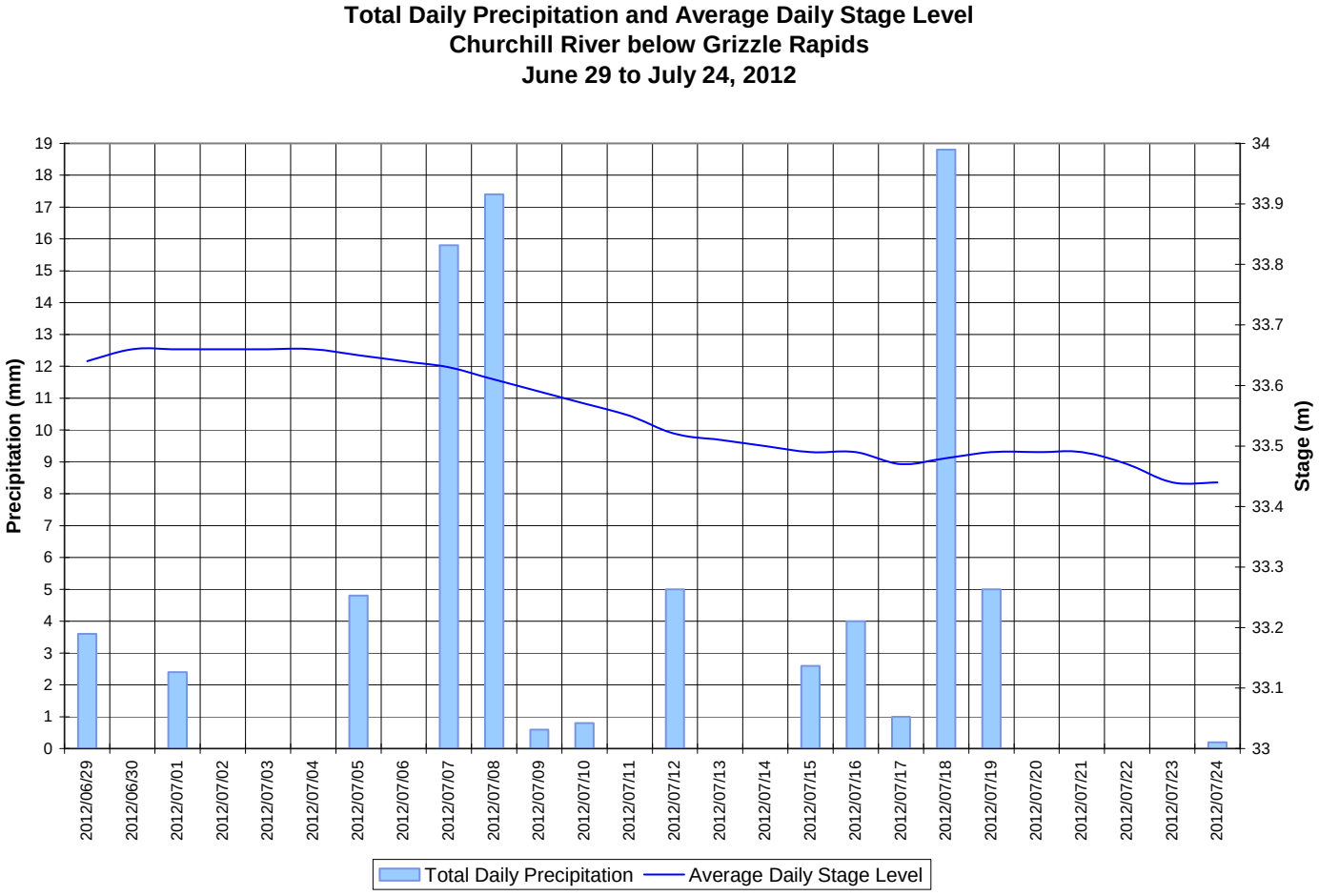

Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 15.04 to 19.37^{o}C during the deployment period (Figure 15).
- Water temperature is generally increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the summer season (Figure 16). Water temperature fluctuates diurnally.

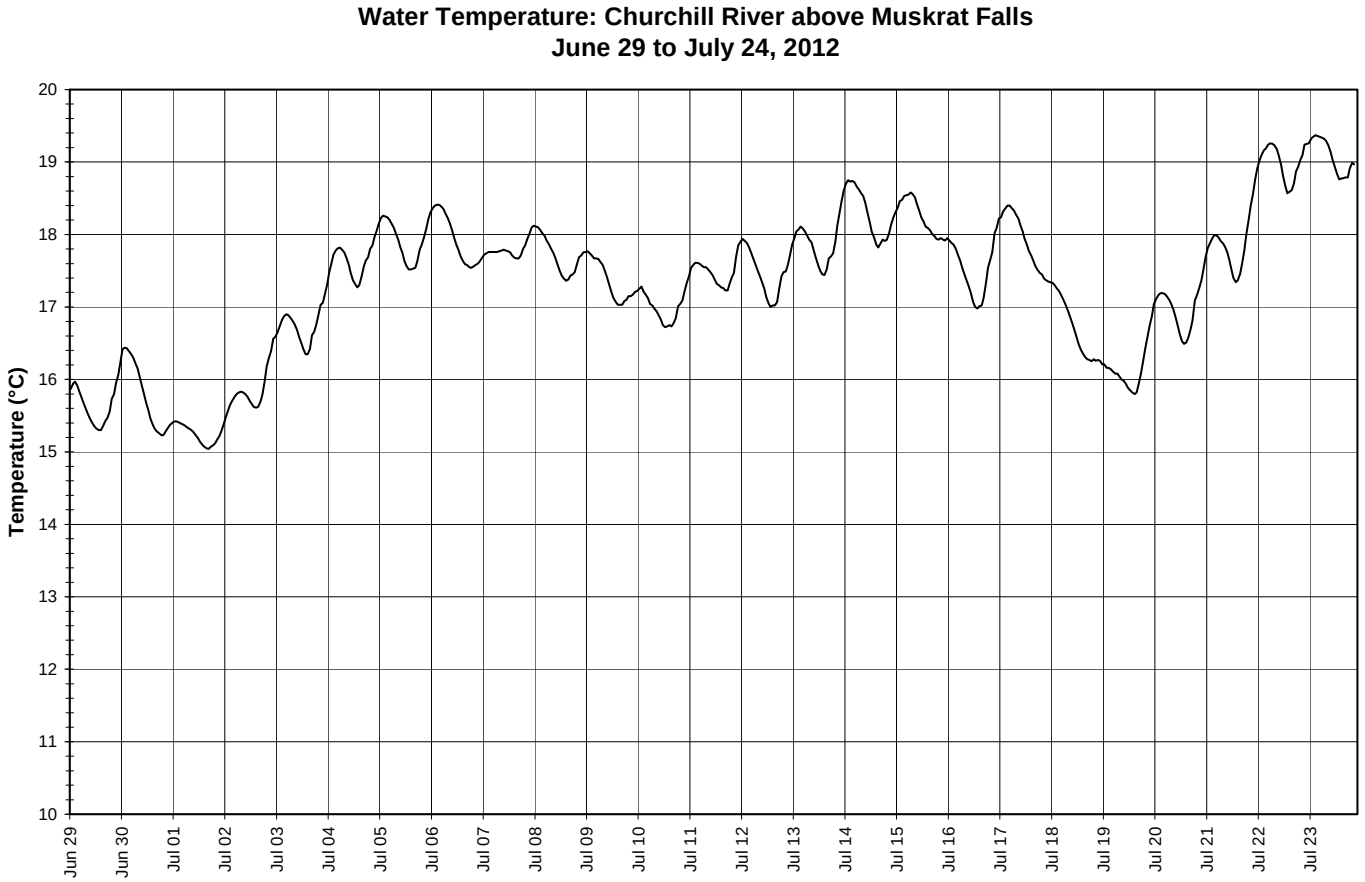

Figure 15: Water temperature at Churchill River above Muskrat Falls

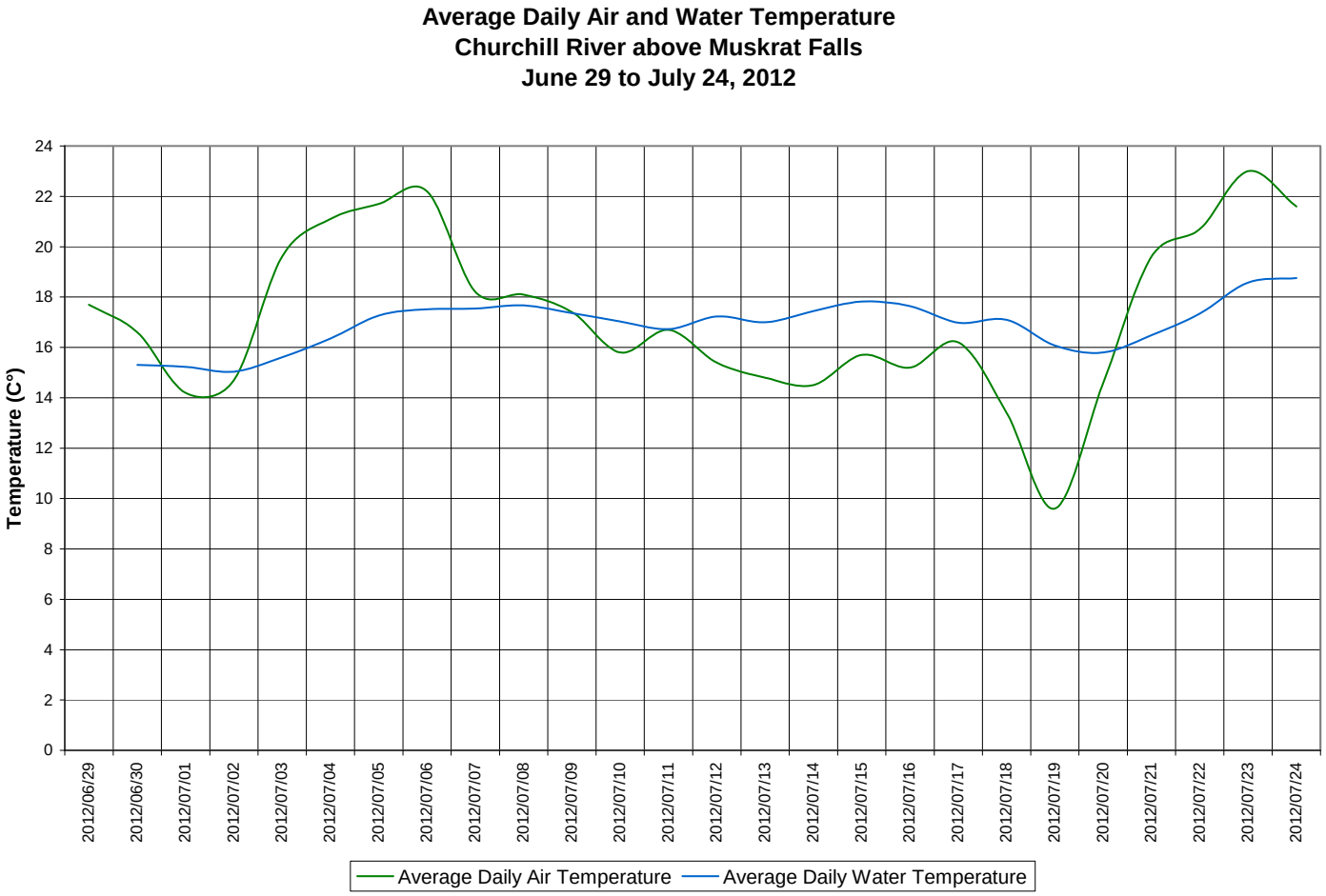

Figure 16: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 7.00 and 7.28 pH units (Figure 17). pH values are very stable throughout the deployment period.
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

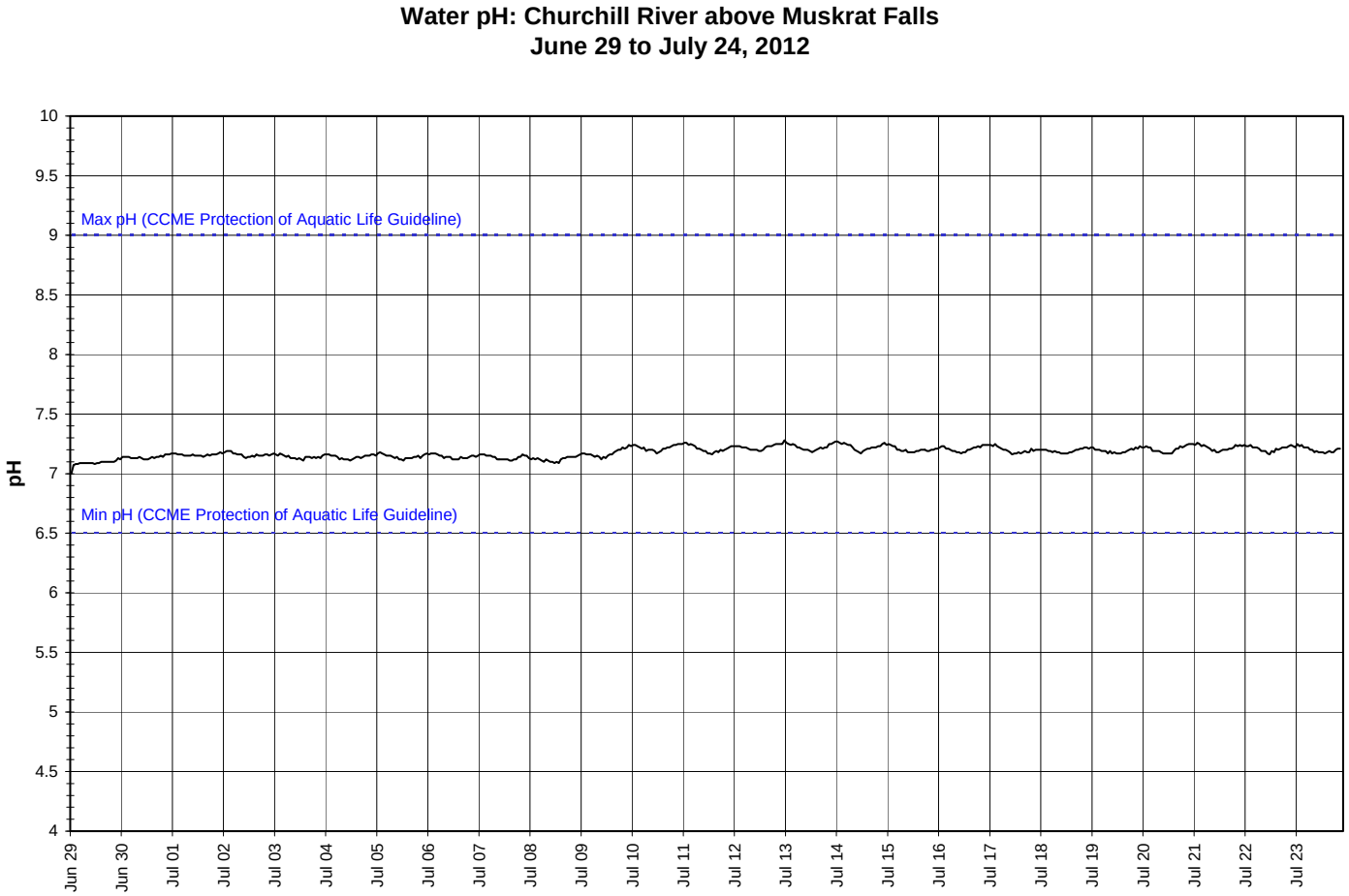

Figure 17: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges from 23.8 to 25.6µS/cm during the deployment period, averaging 24.6µS/cm. (Figure 18).
- Specific conductance is generally increasing throughout the deployment period.
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period. As stage decreases, specific conductivity generally increases due to the increased concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

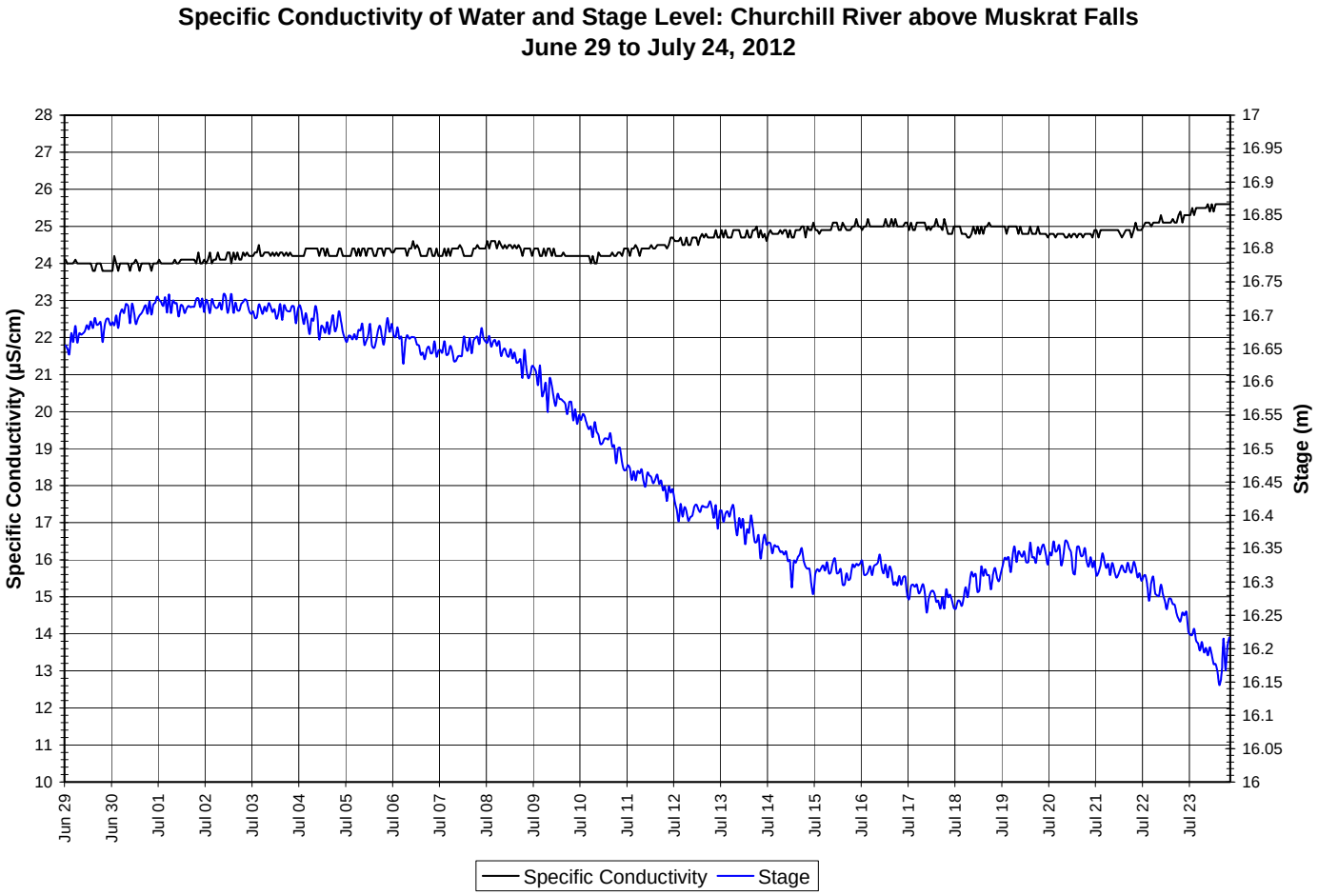

Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 93.8 to 101.5% and a range of 8.98 to 9.77mg/l was found in the concentration of dissolved oxygen with a median value of 9.0mg/l (Figure 19).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. Most values recorded were either just above or just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 16).

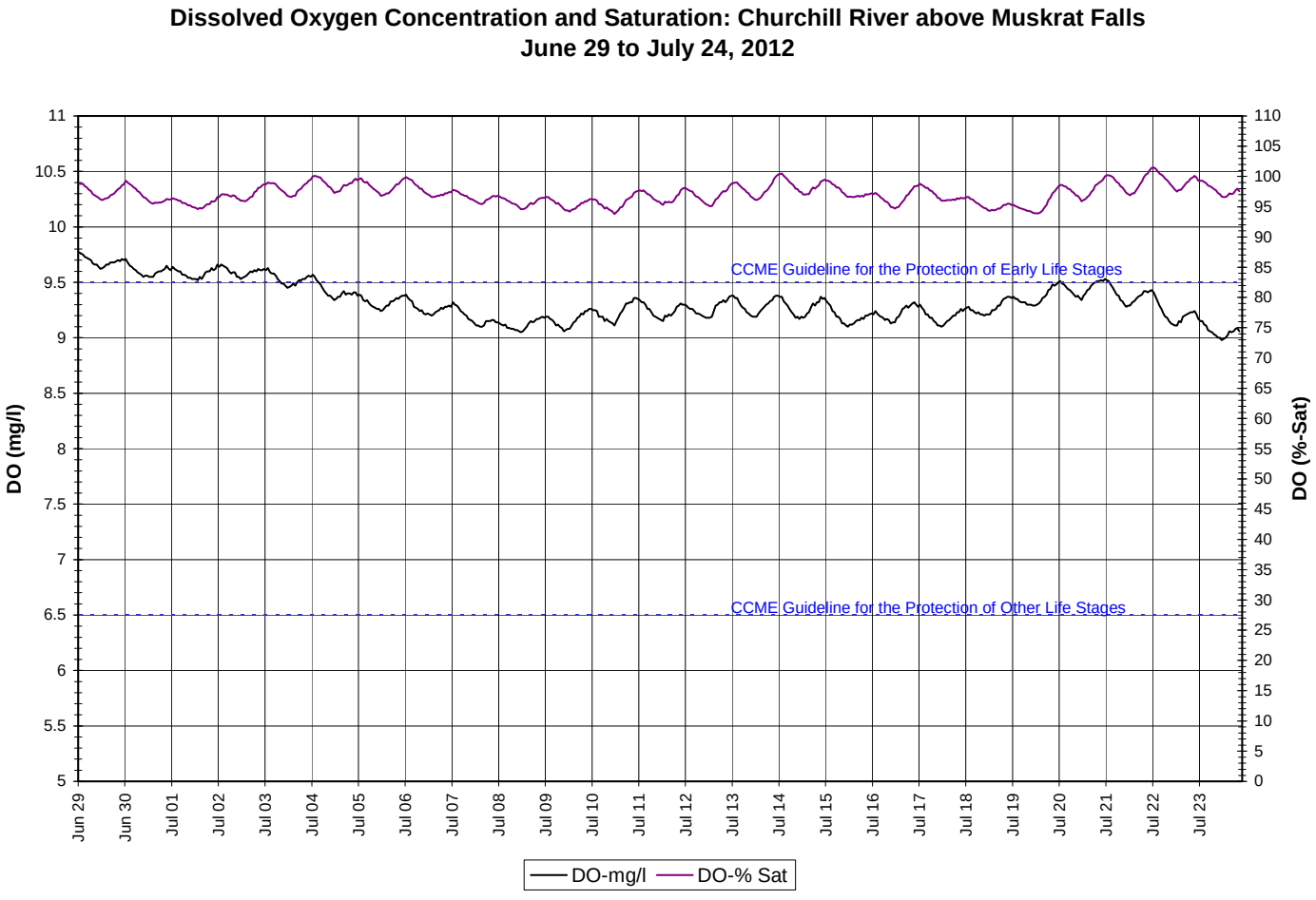

Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 0.0 and 27.0NTU, averaging 3.1NTU (Figure 20). A median value of 2.0NTU indicates there is a consistent natural background turbidity value at this station.
- From July 7 to 10 there is an increase in turbidity that corresponds with a two day rainfall event in which more than 30mm of precipitation was recorded in the area. This rainfall event likely caused increase runoff from the land and therefore turbidity increase in the water column. The turbidity readings spike on July 8 (~27NTU) and then recover to background values (~2-4NTU) from July 8 to 9. This station typically has natural background turbidity with frequent increases.

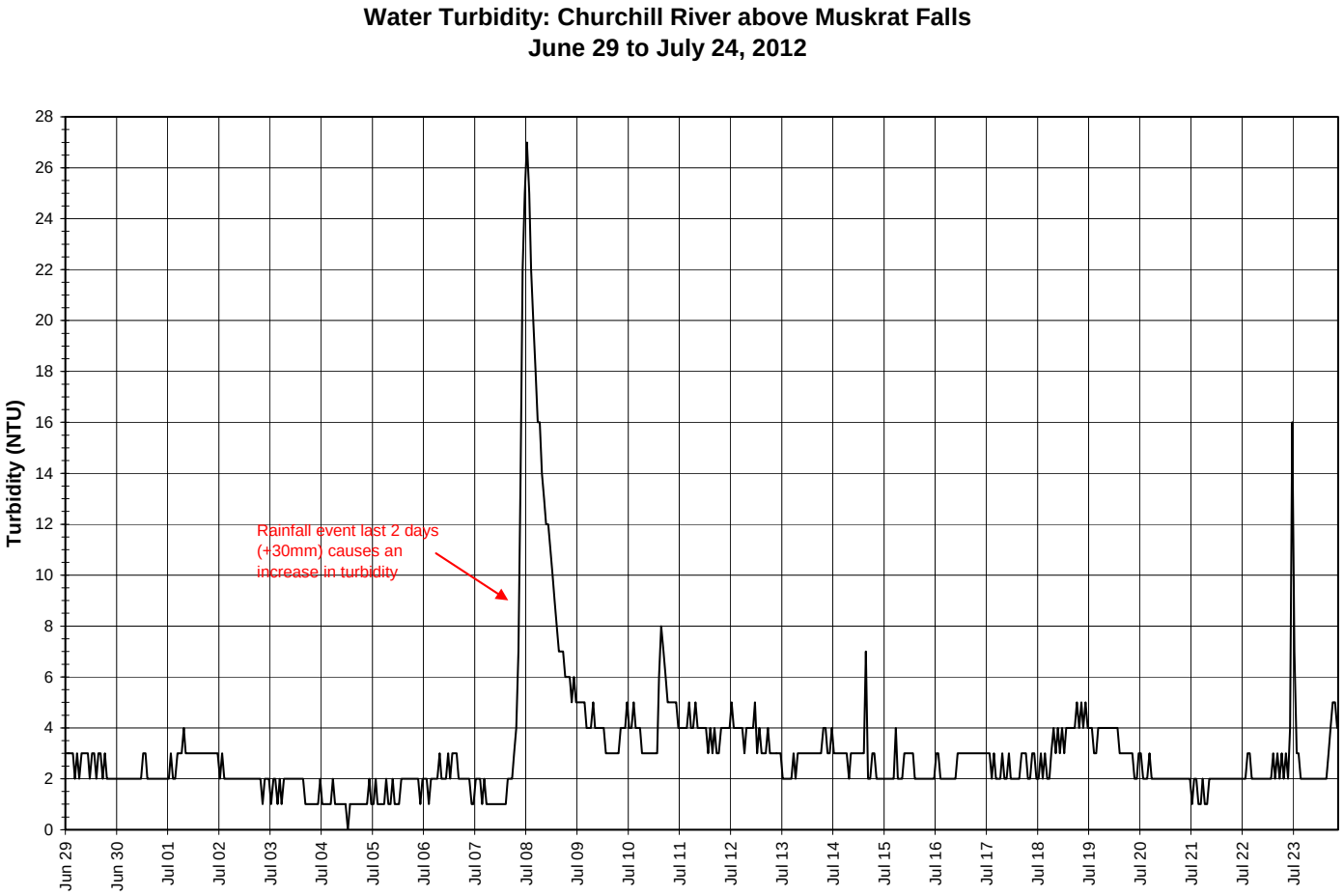

Figure 20: Turbidity at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is decreasing throughout the deployment period and precipitation records vary. Stage ranges between 16.15 and 16.73m, a difference of 0.58m.

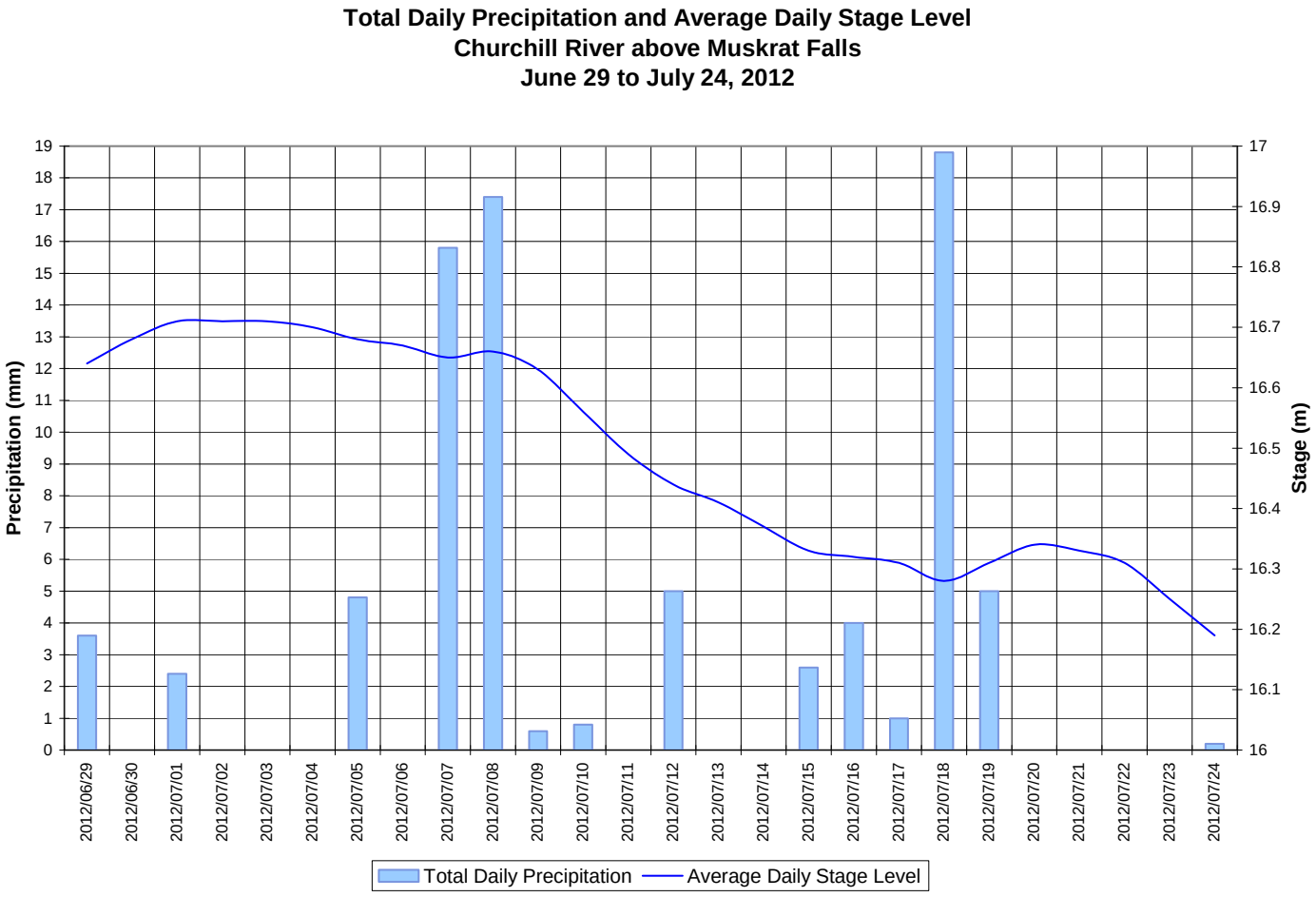

Figure 21: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- A transmission error at this station occurred from the beginning of the deployment period, June 29, until July 11 when Environment Canada were on site to rectify the problem. Data retrieved from the instruments internal log file is used in place of the missing data.
- Water temperature ranges from 15.01 to 19.10^{o}C during the deployment period (Figure 22).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the summer season (Figure 23). Water temperature fluctuates diurnally.

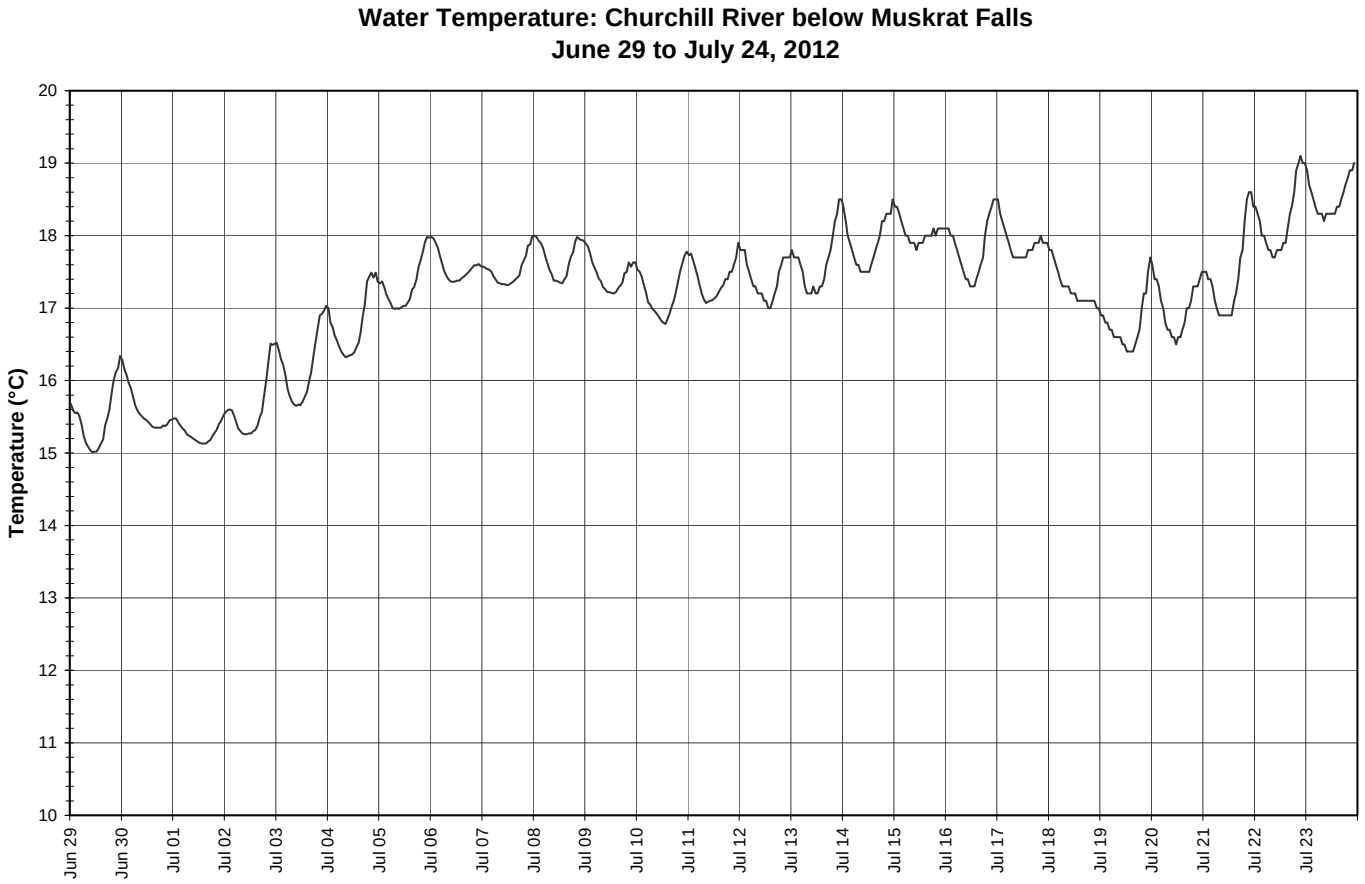

Figure 22: Water temperature at Churchill River below Muskrat Falls

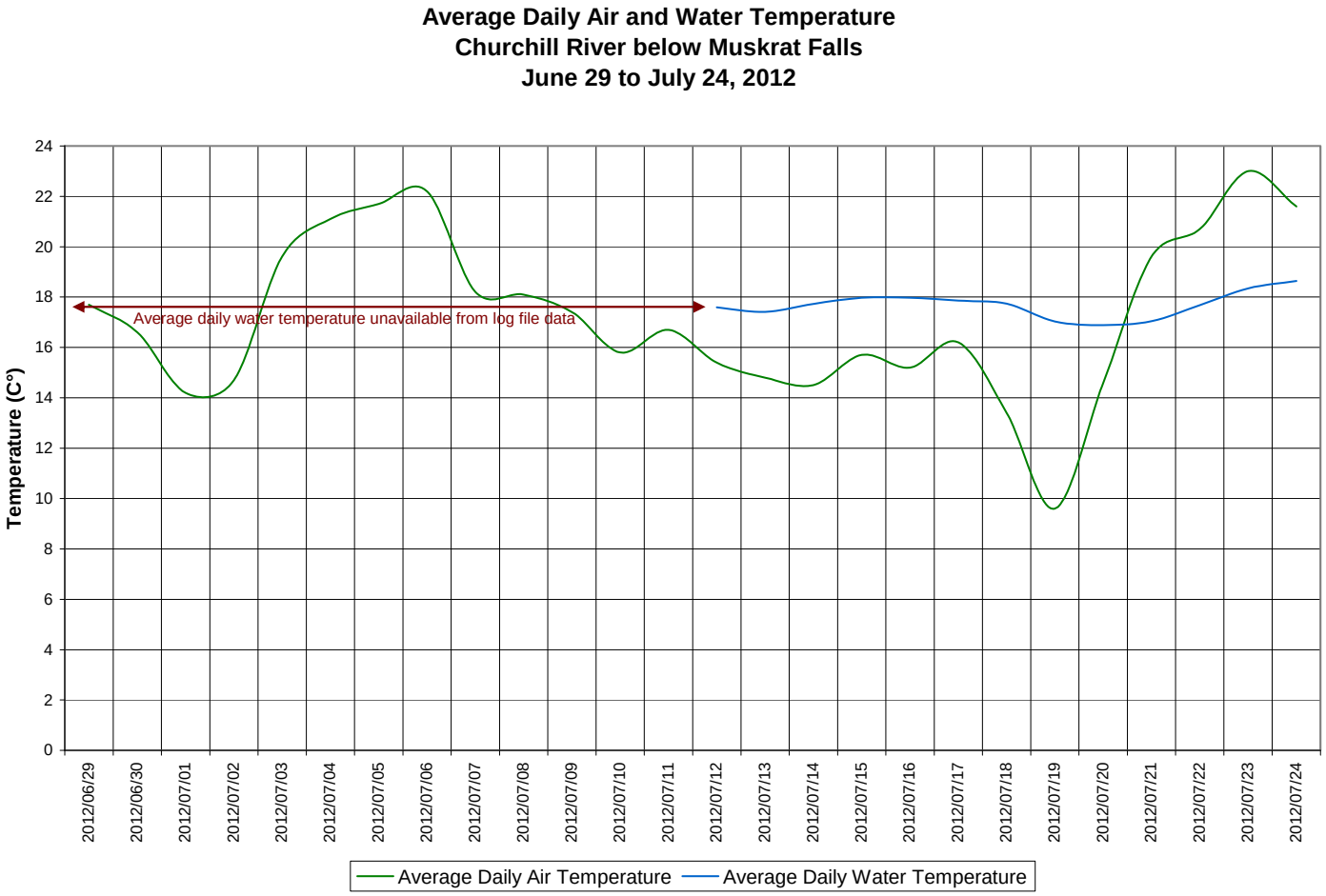

Figure 23: Average daily air and water temperature at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 6.90 and 7.14 pH units (Figure 24). pH values remain very stable throughout the deployment period.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 24).

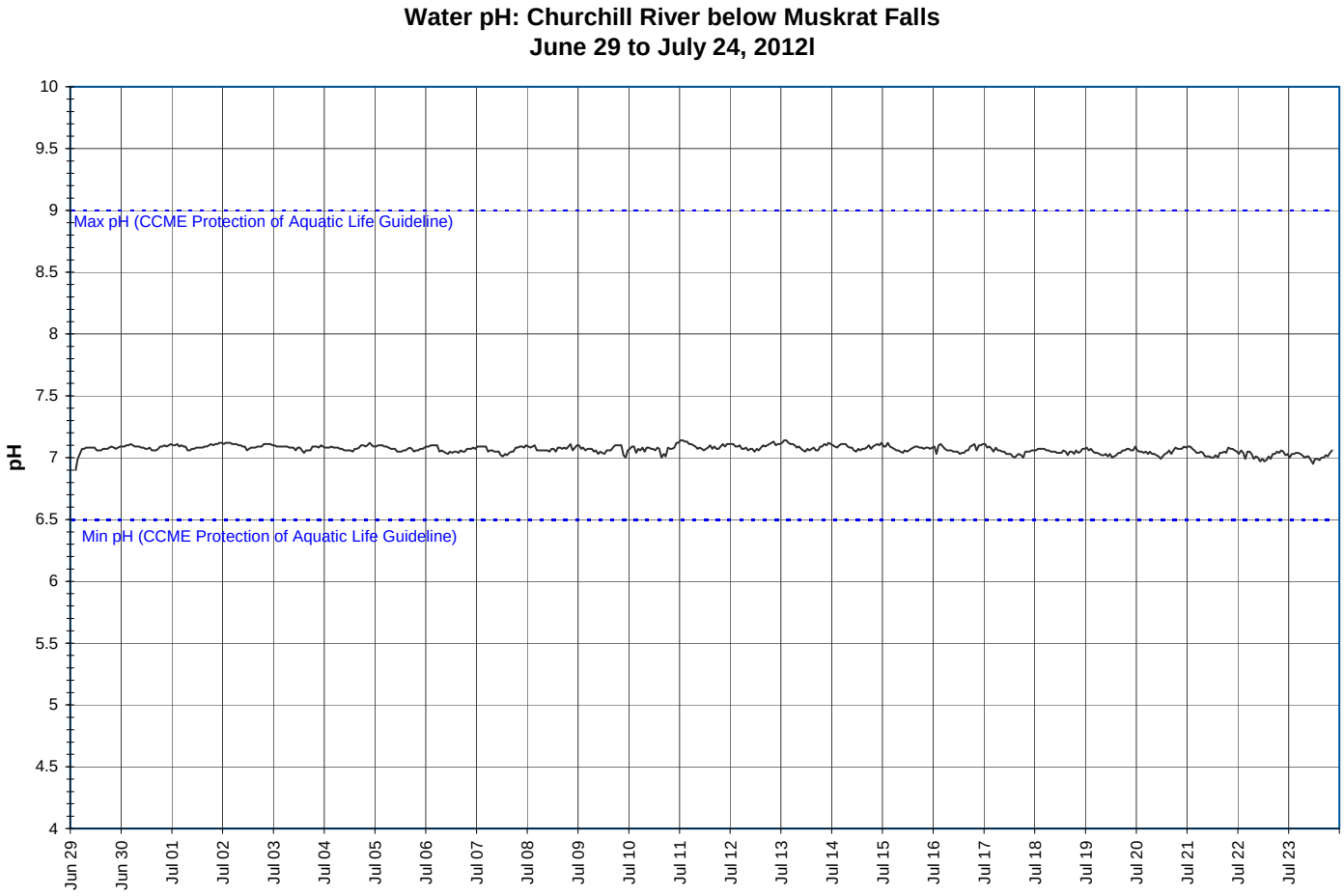

Figure 24: pH at Churchill River below Muskrat Falls

- Specific conductance remained between 22.0 and 25.7µS/cm, averaging 24.8µS/cm (Figure 25).
- Specific conductivity is generally increasing throughout the deployment period.
- Log file data only recorded specific conductivity to one decimal place from June 29 to July 11. Environment Canada staff onsite July 11 were able to rectify the data transmission error.
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. Although stage data is only available for the period of time the station transmitted correctly (July 11 onwards), stage levels are generally decreasing throughout the latter half of the deployment period. As stage decreases, specific conductivity generally increases due to the increasing concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

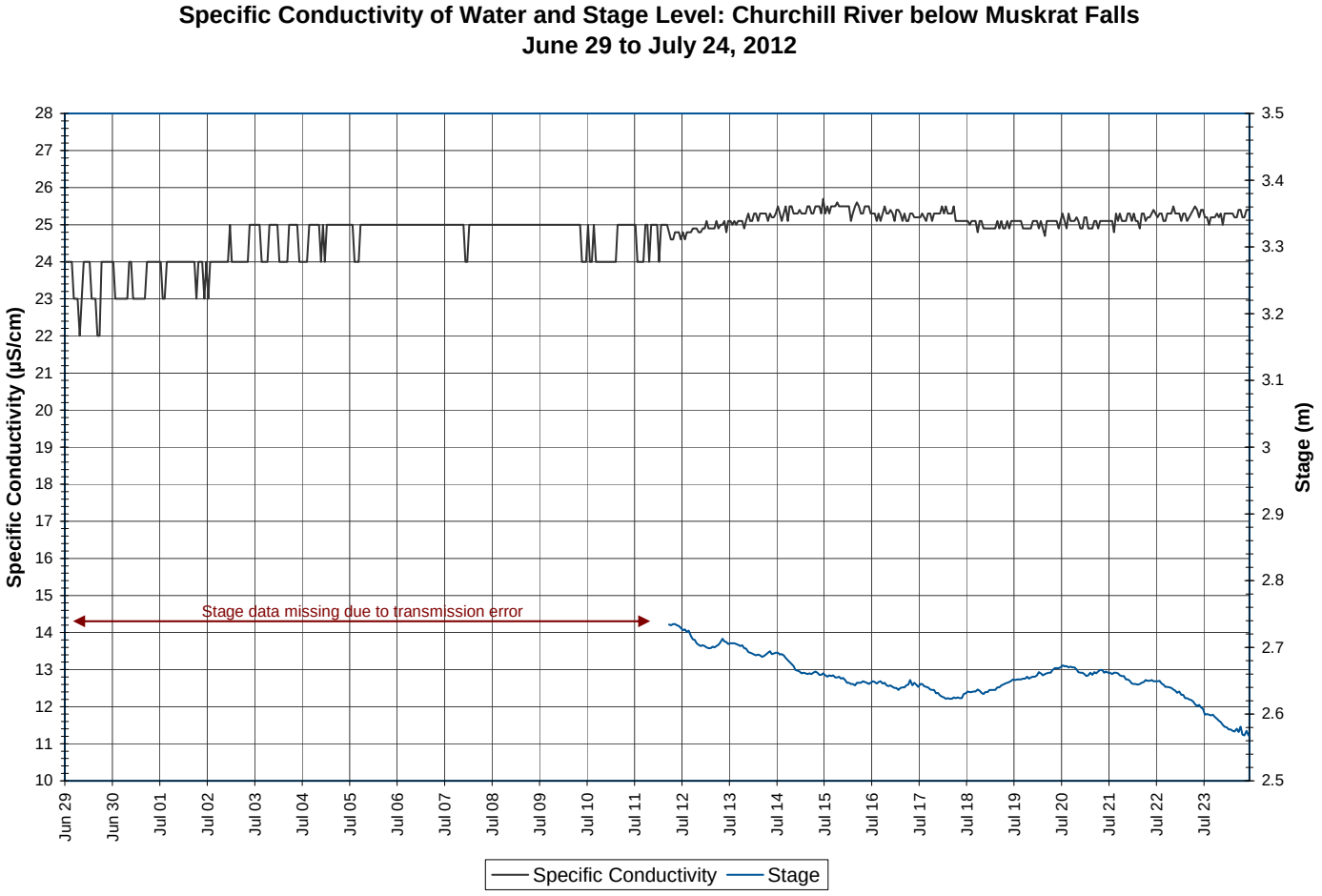

Figure 25: Specific conductivity and stage level at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 104.3 to 113.3% and a range of 10.03 to 11.10mg/l was found in the concentration of dissolved oxygen with a median value of 10.48mg/l (Figure 26).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5 mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 26.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the increasingly warmer air and water temperatures (Figure 23). Dissolved oxygen is typically higher at this station compared to the other stations further upstream due to the addition of oxygen to the water at Muskrat Falls.

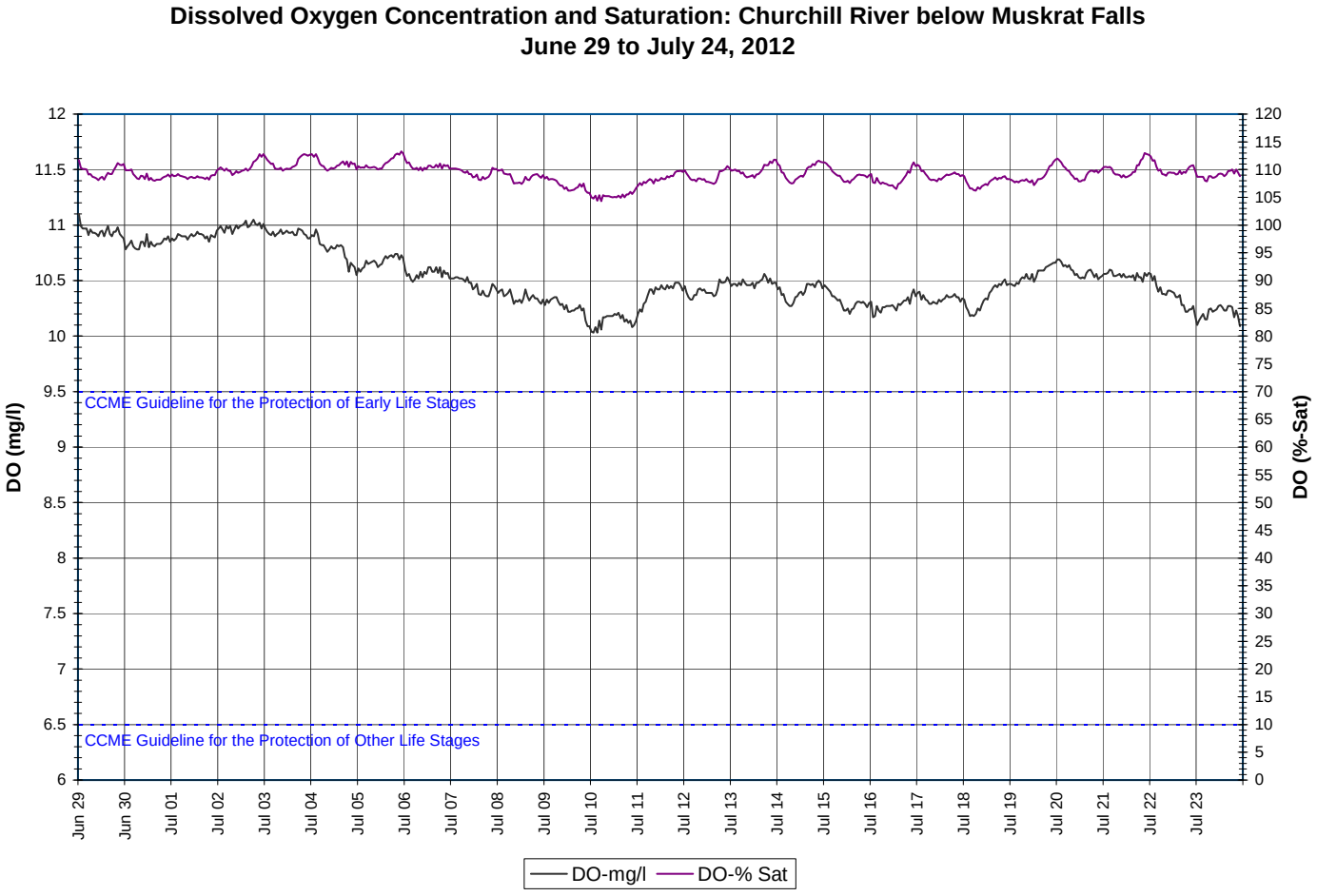

Figure 26: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- Turbidity ranges between 5.0 and 1911.0NTU throughout the deployment period (Figure 27 a & b). A median value of 17.4NTU indicates there is a consistent natural background turbidity value at this station.
- Turbidity is first graphed on a larger scale from 0 to 2000NTU in order to observe and identify high magnitude increases occurring at the beginning of the deployment period (between June 29 and July 2) (Figure 27a). Several times, turbidity values increase to as high at 1911NTU, and then return to background levels usually within 6-12 hours. It is unknown what caused these increases. Stage level data is unavailable for this time as the station was not transmitting properly prior to July 11.

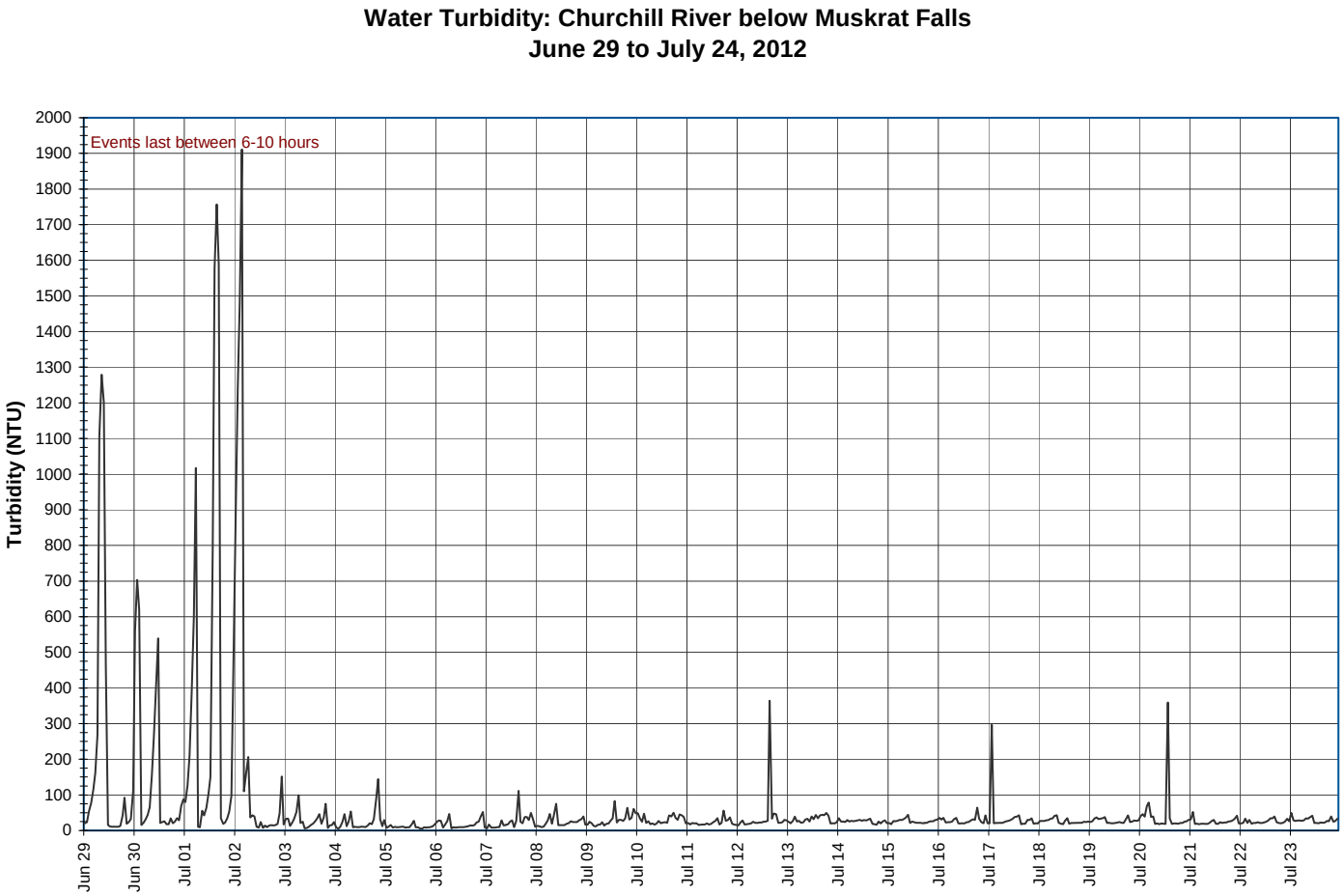

Figure 27a: Turbidity events between 0-2000NTU at Churchill River below Muskrat Falls

- Turbidity is graphed again on a smaller scale from 0 to 400NTU in order to observe and identify lower magnitude events (<400NTU) as well as observe natural turbidity background data (Figure 27b). Lower magnitude increases occur throughout the deployment period on July 12, 17 and 20. However, each increase only lasts for one hour indicating that these high readings are not in actuality turbidity events but rather an irregularity with the sensor.
- Background turbidity values are significant at this station and are the highest throughout all of the stations on the lower Churchill. This is likely in part due to the position of the station 6.15km below Lower Muskrat Falls. Median turbidity values range between 17.37 and 24.4NTU depending on if the erroneous values recorded at the beginning of the deployment period (400-1911NTU) are included in the calculation.

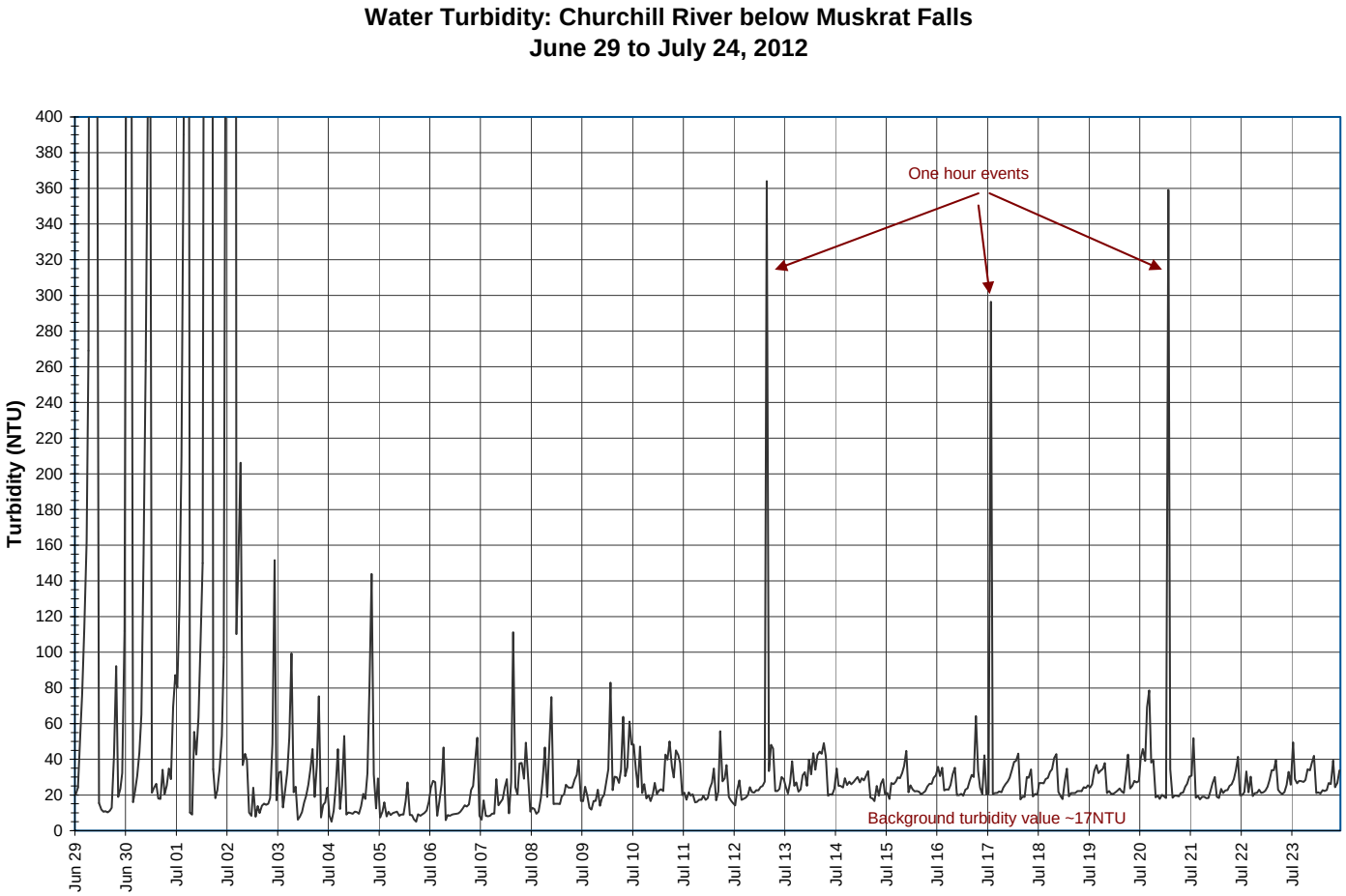

Figure 27b: Turbidity events between 0-400NTU at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 28). Stage is decreasing throughout the deployment period and precipitation records vary. Stage ranges between 2.74 and 2.57m, a difference of 0.17m.

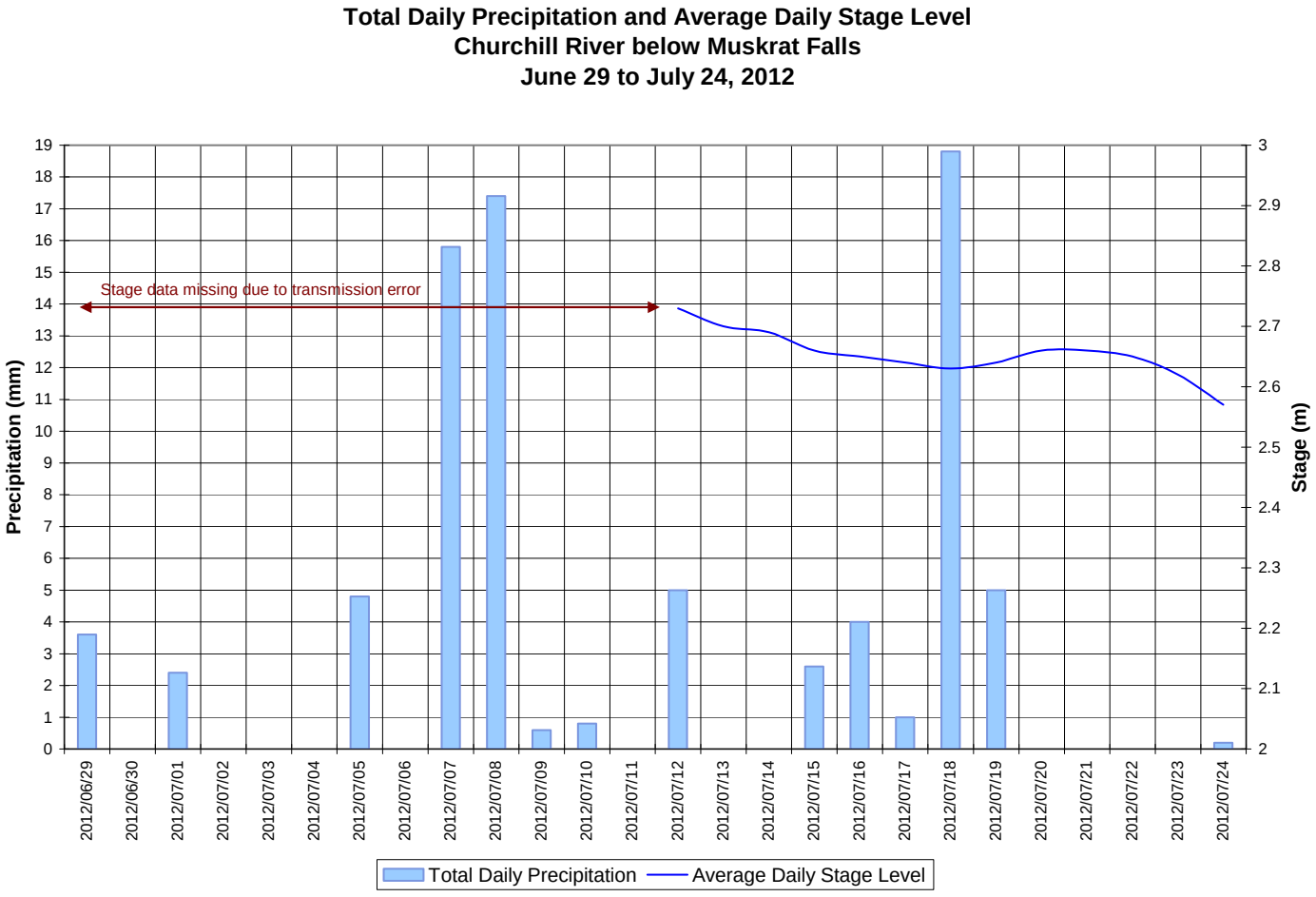

Figure 28: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from June 29 to July 24, 2012. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- Stage levels generally decreased throughout the deployment period at all stations.
- Water temperature was increasing consistently at all stations throughout the deployment period due to the increasingly warmer ambient air temperatures in the region during the summer season. Water temperature typically ranged between 15 and 19°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life and very consistent at all stations. pH is generally very neutral and stable at all stations along the Lower Churchill River ranging between 6.9 and 7.2 pH units.
- Specific conductivity was generally increasing at all stations, typically ranging between 23 and 26µS/cm.
- Dissolved oxygen content was generally decreasing throughout the deployment period. All values were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages at 6.5mg/l. Dissolved oxygen content below Metchin River, below Grizzle Rapids and above Muskrat Falls all hovered around the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5mg/l. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the Muskrat Falls, 6km upstream and all values remained above this guideline.
- Turbidity events were frequent and of moderate magnitude at the station below Metchin River which is unusual for this site. A background turbidity value of ~5.8NTU was also observed at this station. Turbidity values at the station below Grizzle Rapids remained at 0NTU throughout the deployment period which is typical of this station. Rainfall events recorded in the area correspond with turbidity increases at the station above Muskrat Falls. At the station below Muskrat Falls, a number of high magnitude events occur in the first week of the deployment period with each event lasting between 6-10 hours. Later in the deployment period, there are a number of smaller magnitude events that only last for 1 hour each. Turbidity events at this station do not necessarily correspond with weather related events. There is a consistent natural background turbidity value at both stations above and below Muskrat Falls.

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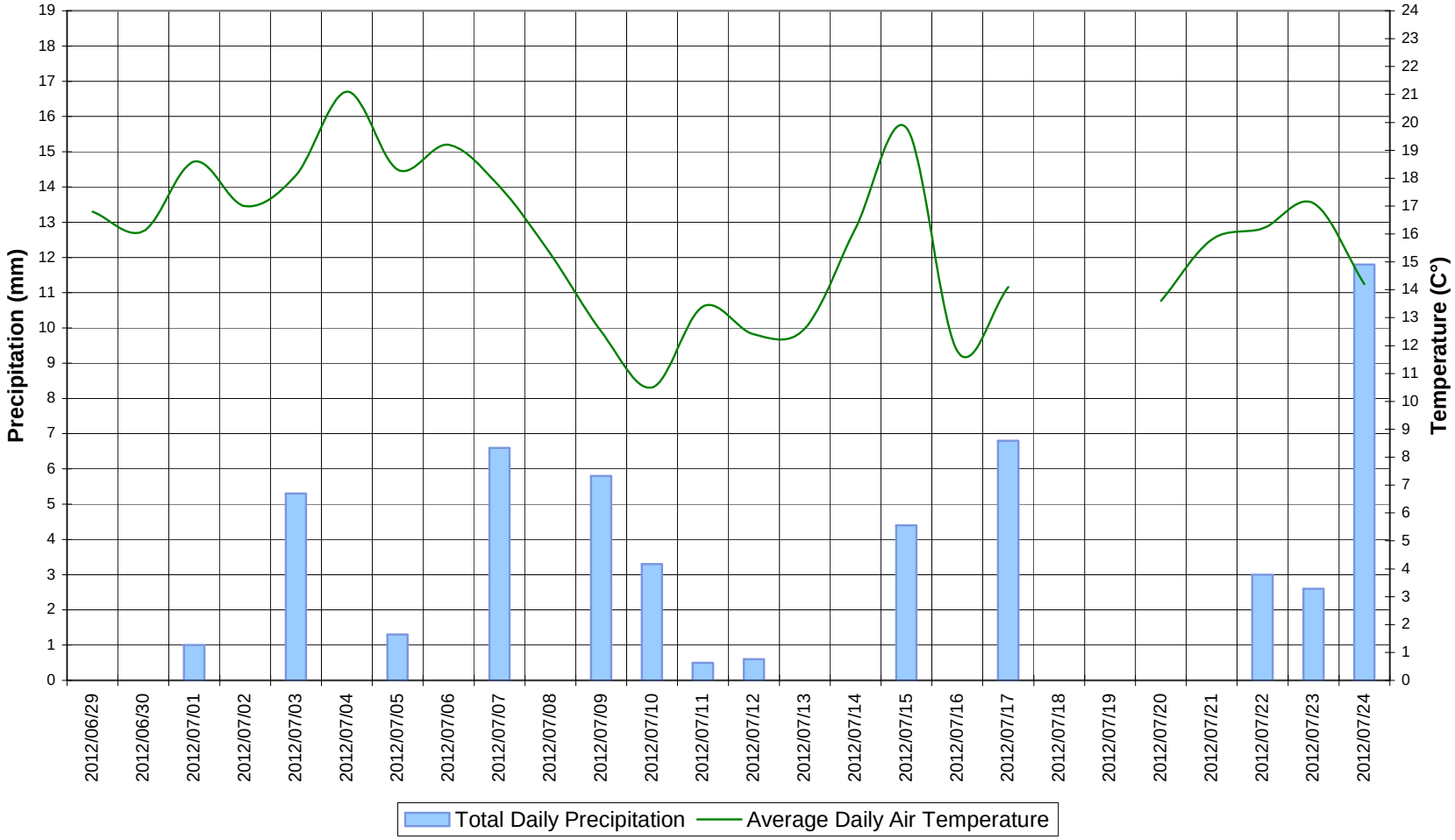
Appendix 1 – Weather Data – Environment Canada Historical Weather and Climate Database

Average Daily Air Temperature and Total Daily Precipitation
Churchill Falls
June 29 to July 24, 2012



Average Daily Air Temperature and Total Daily Precipitation
Happy Valley-Goose Bay
June 29 to July 24, 2012