# Real-Time Water Quality Deployment Report

## Lower Churchill River Network

**June 29 to**
**August 2, 2011**

Newfoundland Labrador

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

# Contents

Newfoundland Labrador

# Real-Time Water Quality Deployment Report

## Lower Churchill River Network

## June 29 to August 2, 2011

## 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, 2011, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 34 days. Instruments were removed on August 2.

## Quality Assurance and Quality Control

- 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 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 QAQC 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 (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 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 August 2, 2011 are summarized in Table 2.

**Table 2: Comparison rankings for Lower Churchill River stations, June 29– August 2, 2011**

| Station Churchill River | Date | Action | Comparison Ranking | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature | pH | Conductivity | Dissolved Oxygen | Turbidity |
| **Below Metchin River** | Jun 29, 2011 | Deployment | Good | Good | Excellent | Excellent | Good |
| | Aug 2, 2011 | Removal | Good | Excellent | Excellent | Excellent | Excellent |
| **Below Grizzle Rapids** | Jun 29, 2011 | Deployment | Excellent | Excellent | Excellent | Excellent | Excellent |
| | Aug 2, 2011 | Removal | Excellent | Excellent | Excellent | Excellent | Excellent |
| **Above Muskrat Falls** | Jun 29, 2011 | Deployment | Fair | Excellent | Excellent | Excellent | Good |
| | Aug 2, 2011 | Removal | Good | Excellent | Excellent | Fair | Good |
| **Below Muskrat Falls** | Jun 29, 2011 | Deployment | Good | Excellent | Excellent | Excellent | Excellent |
| | Aug 2, 2011 | Removal | Good | Excellent | Excellent | Excellent | Good |

- At the station below Metchin River, all parameters ranked ‘good’ or ‘excellent’ at both deployment and removal.
- At the station below Grizzle Rapids, all parameters ranked ‘excellent’ at both deployment and removal.
- At the station above Muskrat Falls, pH, conductivity, dissolved oxygen, and turbidity all ranked either ‘good’ or ‘excellent’ at deployment. Temperature was ranked ‘fair’. The field instrument read a value of 10.48°C while the QAQC instrument read a value of 11.04°C. The difference in temperatures may have been in part due to the different locations of the instruments in the water beside each other. Both temperature sensors were checked against a lab grade thermometer during calibration and maintenance on the previous day and were both within the recommended 0.2°C range. Temperature, pH, conductivity and turbidity all ranked either ‘good’ or ‘excellent’ at removal. Dissolved oxygen was ranked ‘fair’. The field instrument read 9.36mg/L while the QAQC instrument read 9.88mg/L. This difference may have been a result of the field instrument sensor drifting over the 34 day deployment period or insufficient time for the QAQC instrument reading to stabilize.
- At the station below Muskrat Falls, all parameters ranked ‘good’ or ‘excellent’ at both deployment and removal.

## Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from June 29 to August 2 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.

### Churchill River below Metchin River

- Water temperature ranged from 11.80 to 17.40$^{o}$C during this deployment period (Figure 1).
- Water temperature is increasing slightly throughout the deployment period. This trend is expected due to the increasing ambient air temperatures in the spring and summer seasons (Figure 2). Water temperature fluctuates diurnally.

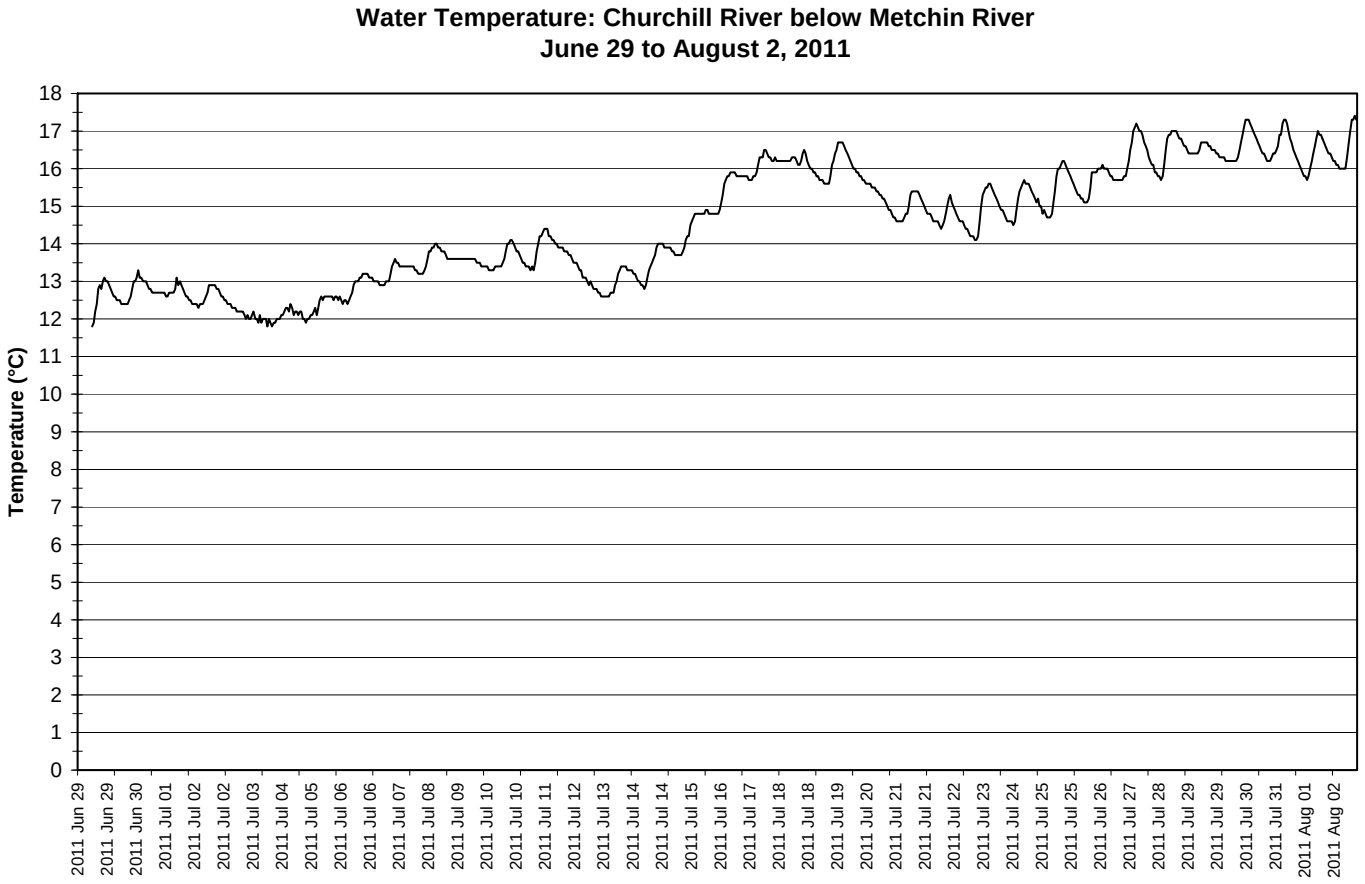



**Figure 1: Water temperature at Churchill River below Metchin River**

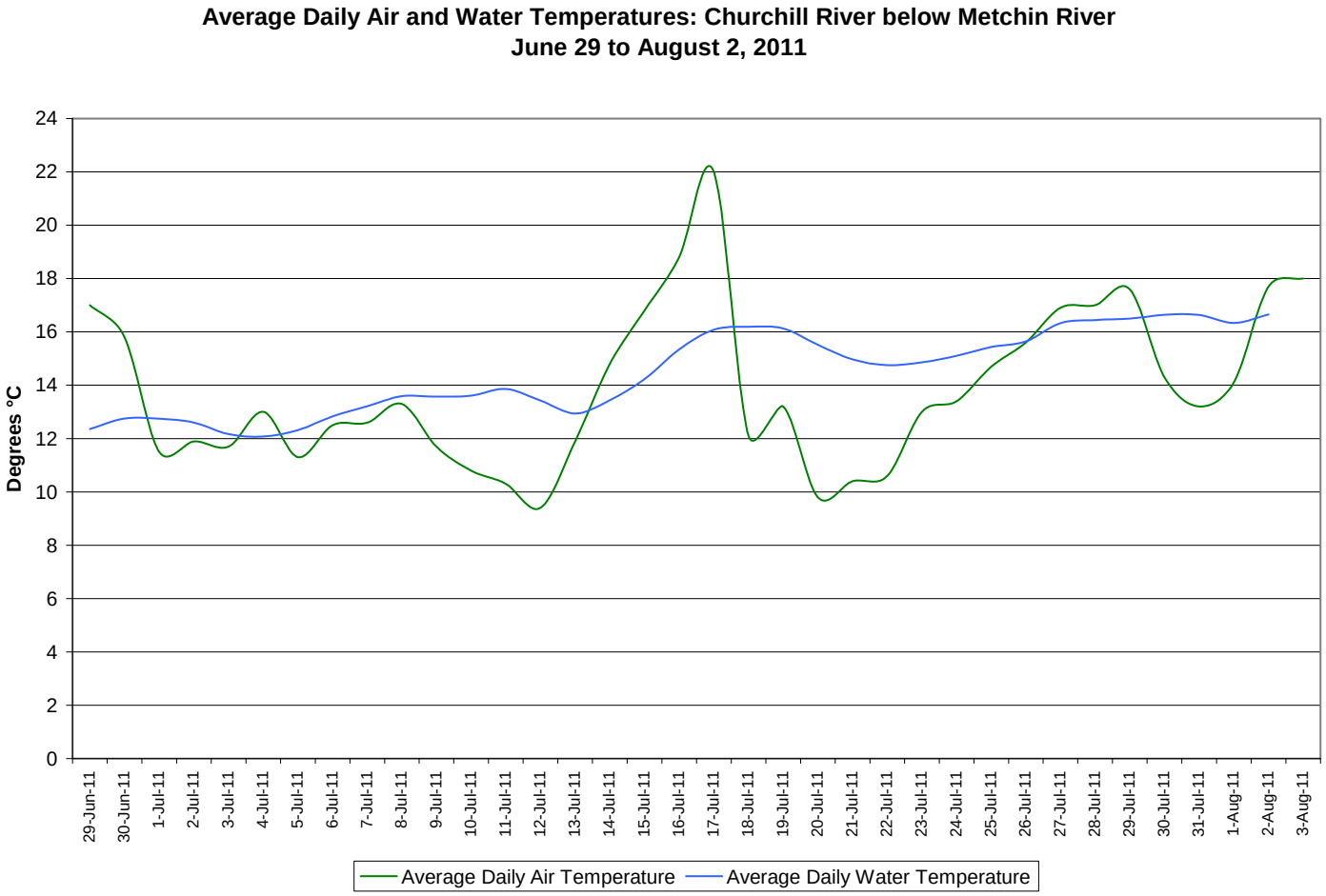



**Figure 2: Average daily air and water temperatures at Churchill River below Metchin River (weather data recorded at Churchill Falls)**

- pH ranges between 6.70 and 7.07 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 (between 6.5 and 9 pH units).

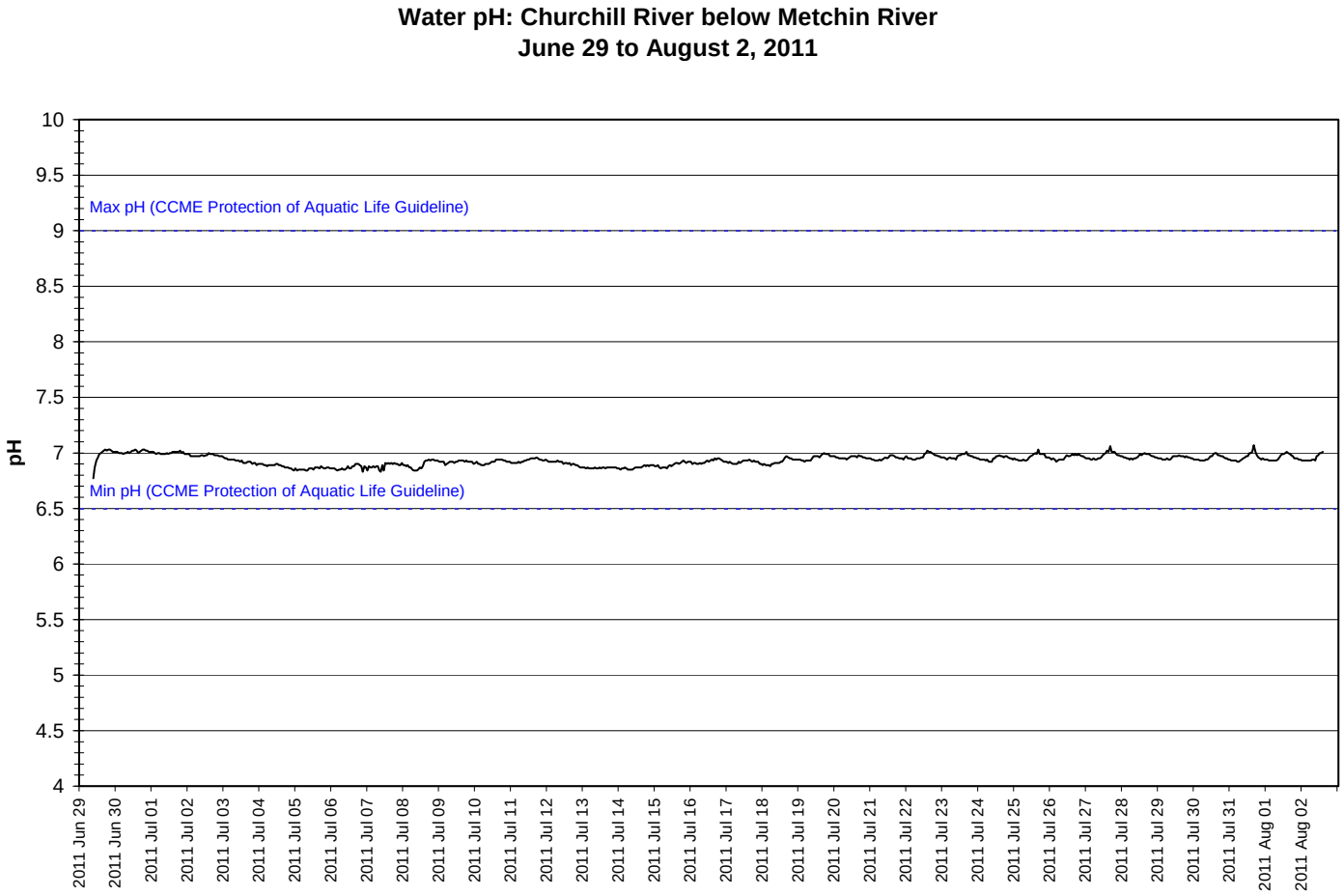



**Figure 3: pH at Churchill River below Metchin River**

- Specific conductivity ranges from 16.2 to 20.7µS/cm during the deployment period, averaging 18.3µS/cm (Figure 4). Specific conductance decreases during the first half of the deployment period and then generally increases during the latter half.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is increasing during the first half of the deployment period before it begins to decrease for the remainder of the deployment. As stage decreases, specific conductivity increases (indicated by red arrows on Figure 4). Reduction in water level increases the concentration of dissolved solids in the water column hence increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

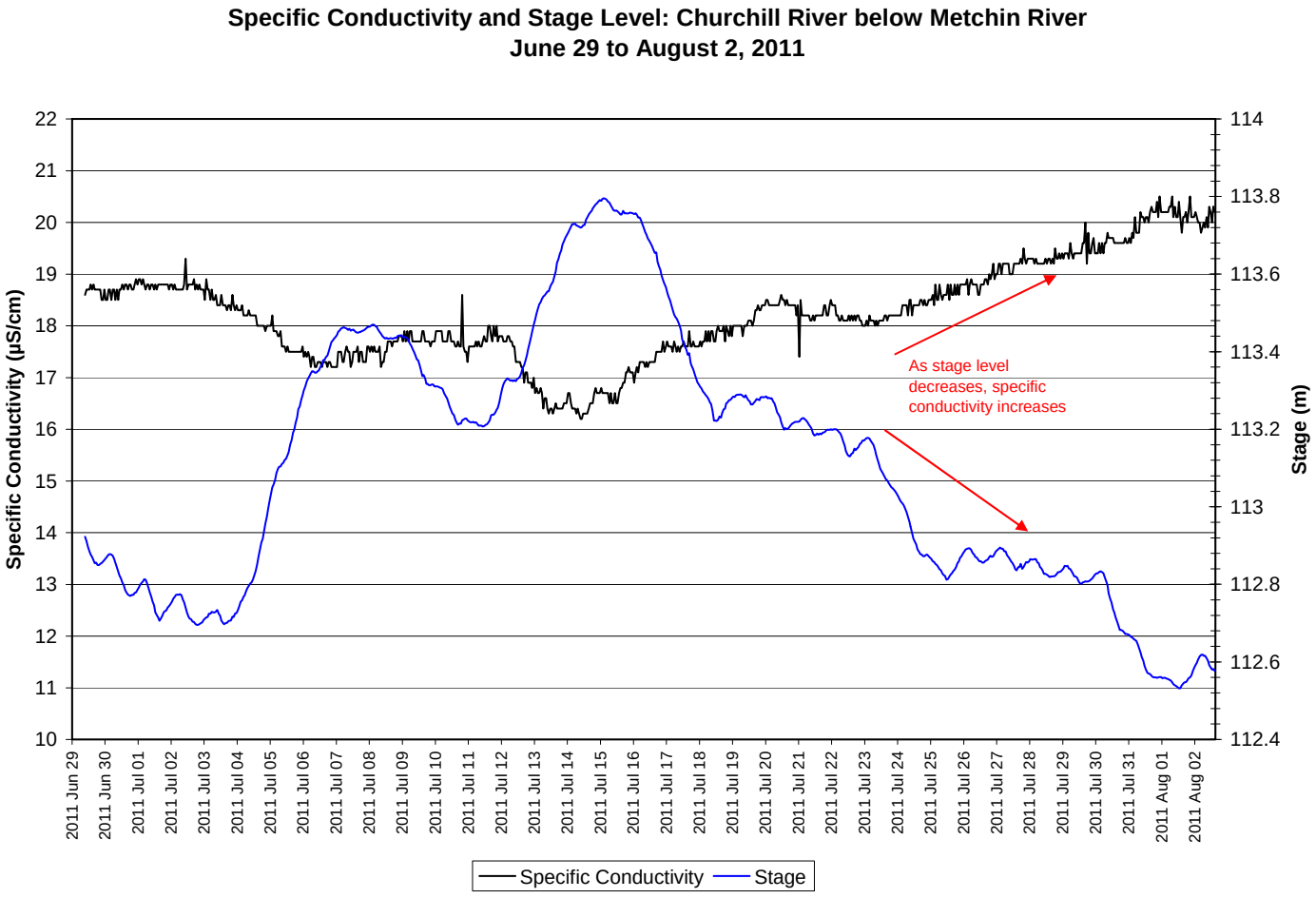



**Figure 4: Specific conductivity and stage level at Churchill River below Metchin River**

- The saturation of dissolved oxygen ranged from 93.9 to 101.5% and a range of 9.14 to 10.70mg/l was found in the concentration of dissolved oxygen with a median value of 9.94 mg/l (Figure 5).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Most 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 the deployment period, during very warm temperatures, the dissolved oxygen content fell to just below the guideline for the protection of aquatic life for early life stages. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content generally decreases throughout the deployment period. This trend is expected given the increasing air and water temperatures (Figure 2).

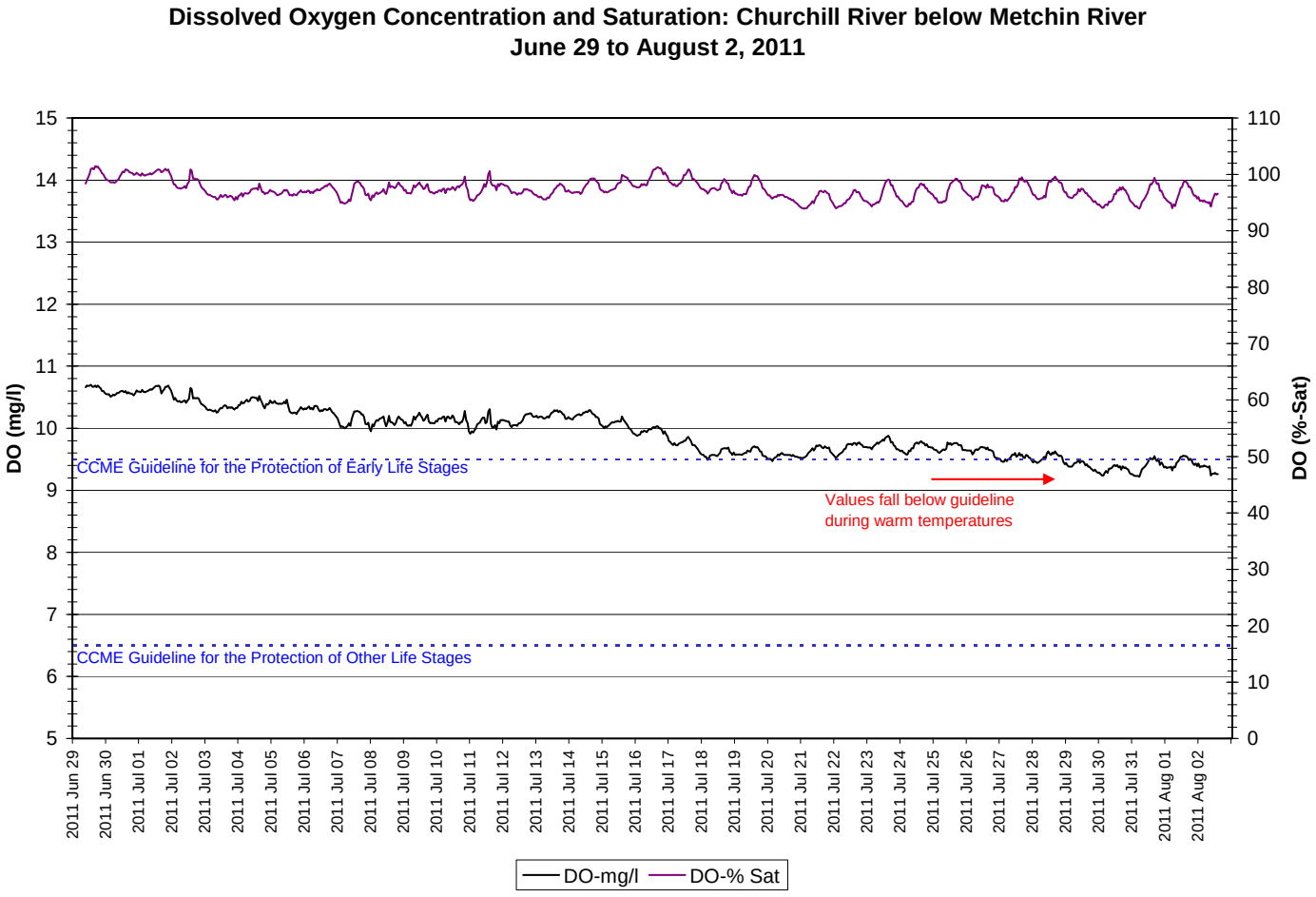



**Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River**

- Turbidity generally remains at 0NTU for the majority of the deployment period (Figure 6). A median value of 0 NTU indicates there is generally no natural background turbidity value at this station.
- There are several instances where turbidity increases (to as high at 859NTU) for very short periods of time (1-2 hours). These are not considered water quality events as they are isolated events. In a couple of instances, turbidity values do remain elevated for up to 10 hours however, the magnitude of these events is small (<15NTU). These events tend to correspond with precipitation events (indicated by red arrows on Figure 6).

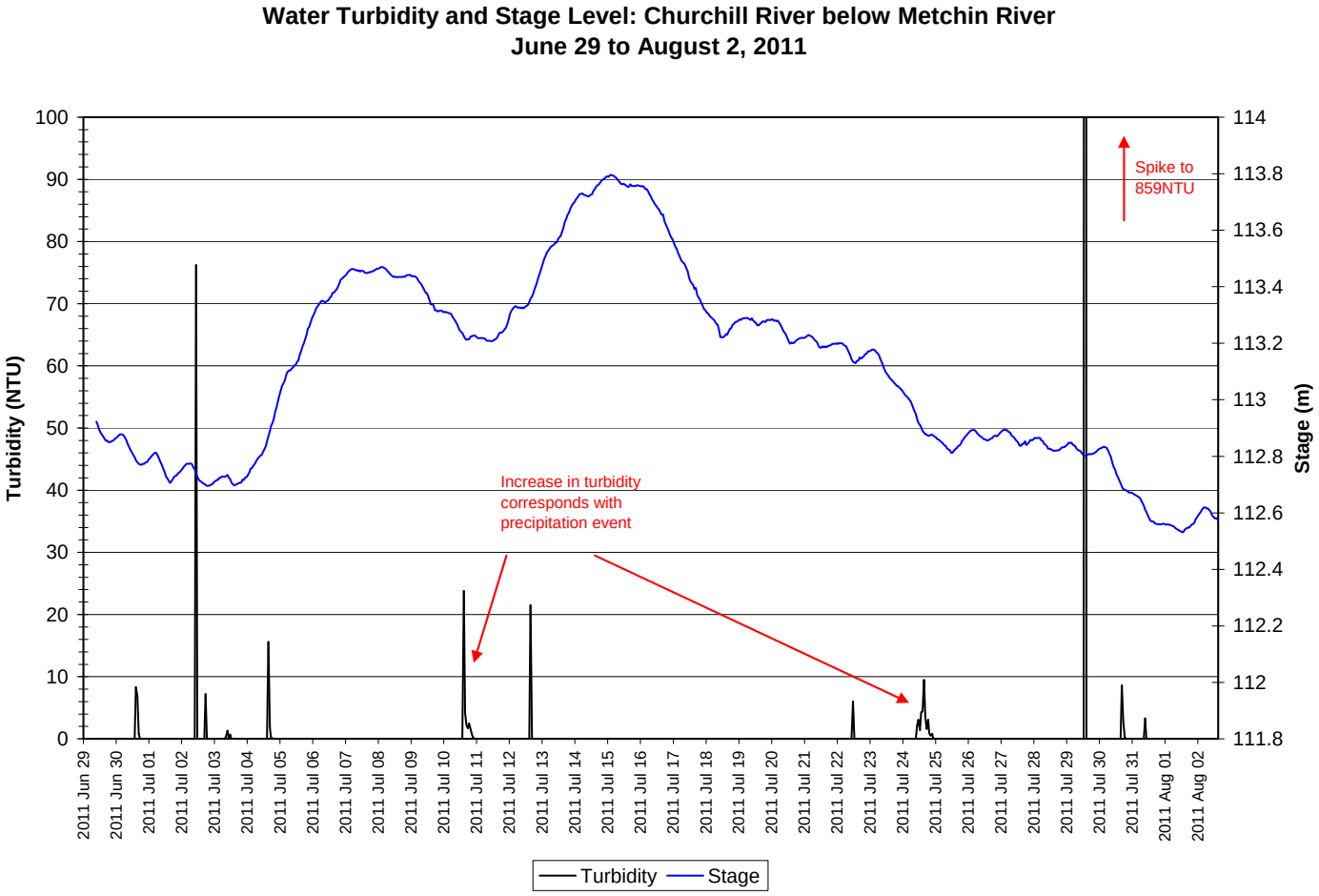



**Figure 6: Turbidity and stage level at Churchill River below Metchin River**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is primarily decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events between July 9 and 12, cause the water level in the river to rise in the days following.

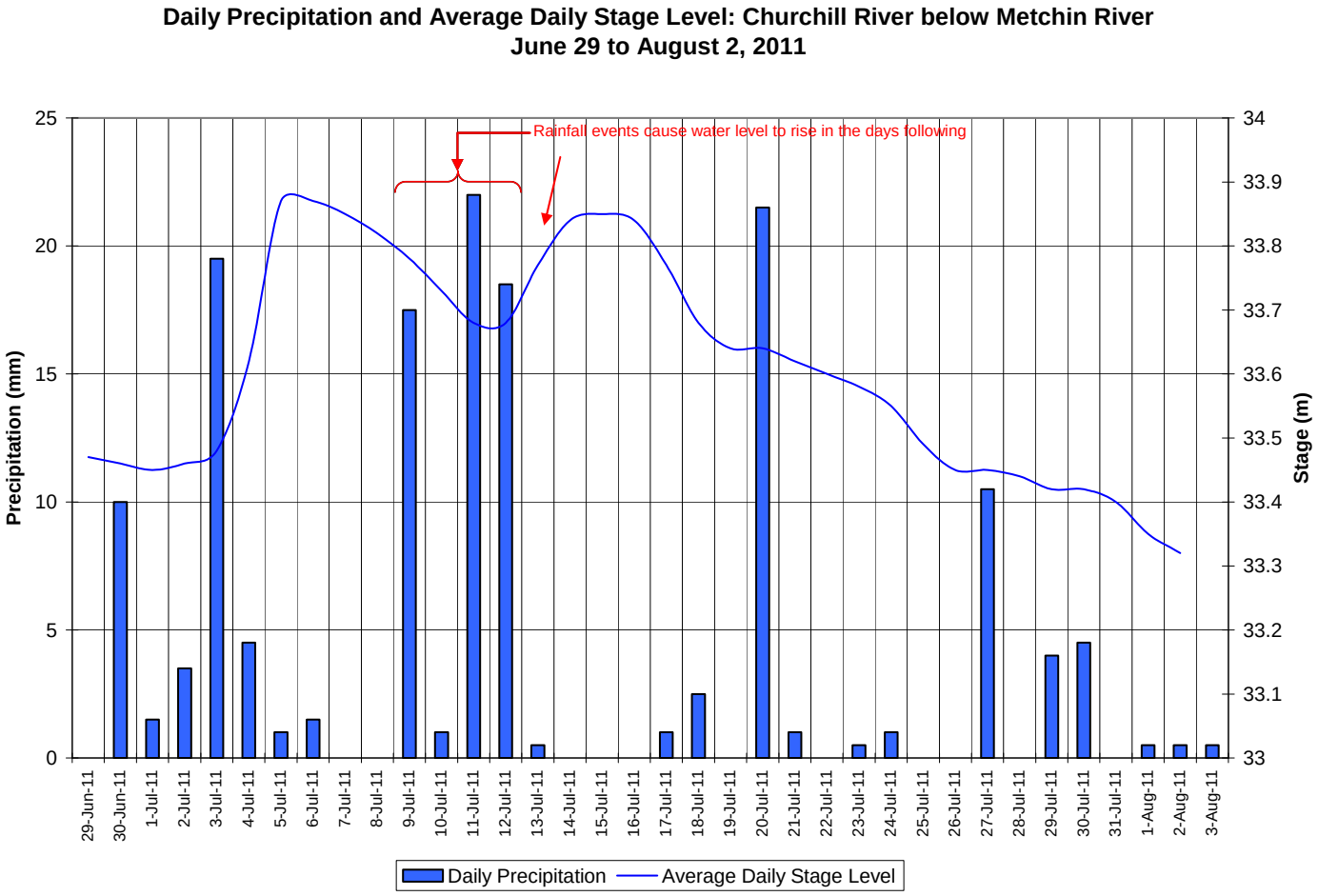



**Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)**

## Churchill River below Grizzle Rapids

- This station was deployed for the first time in 2011 on June 29. An ice wall remaining after the winter season prohibited ENVC staff from safely deploying the instrument in late May.
- Water temperature ranged from 10.0 to 19.2°C during this deployment period (Figure 8).
- Water temperature is increasing throughout the deployment period. This trend is expected due to the increasing ambient air temperatures in the summer season (Figure 9). Water temperature fluctuates diurnally, and is even more apparent near the end of the deployment period after a significant stage drop which leaves the instrument deployed in a shallow environment.

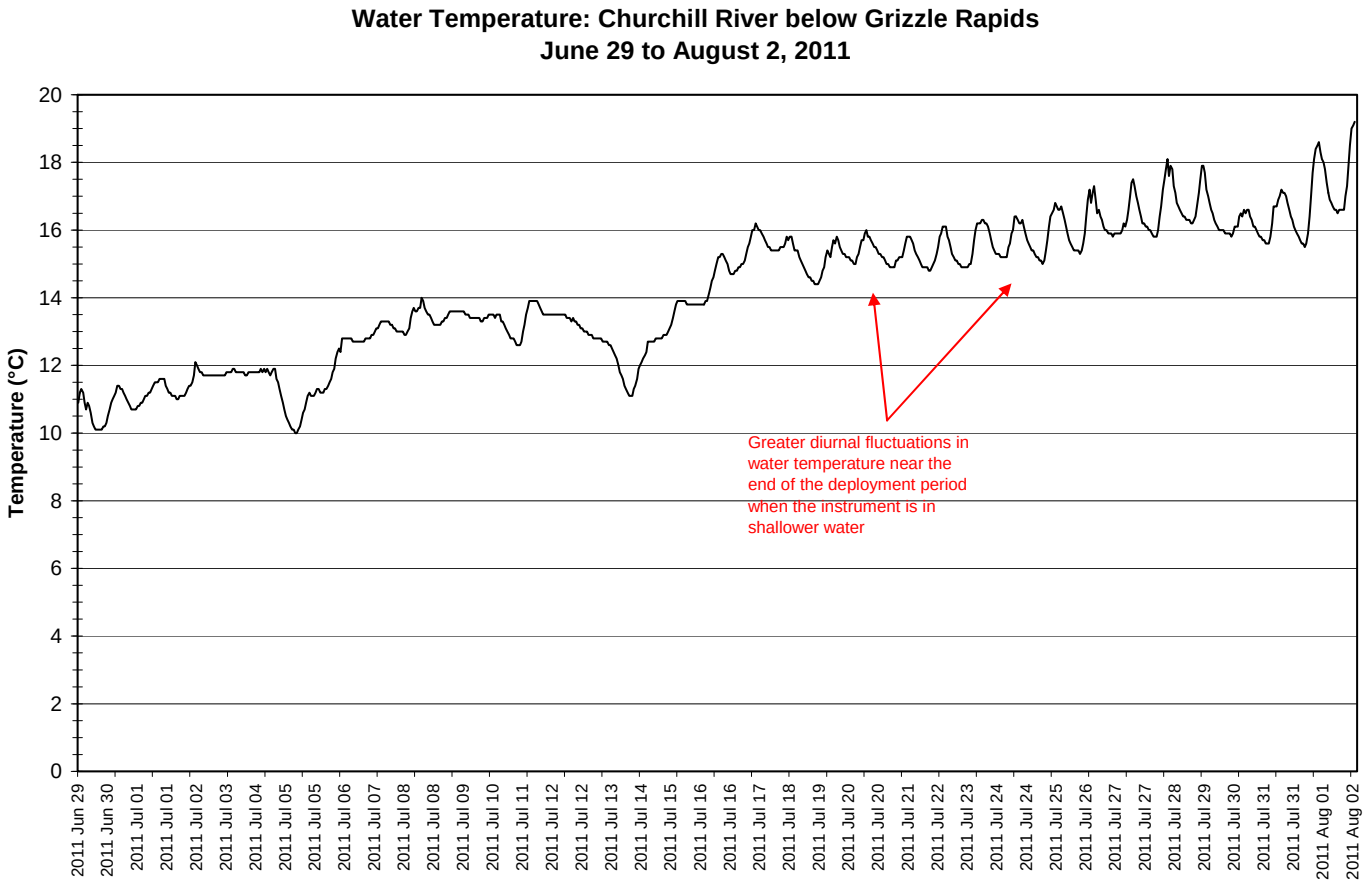



**Figure 8: Water temperature at Churchill River below Grizzle Rapids**

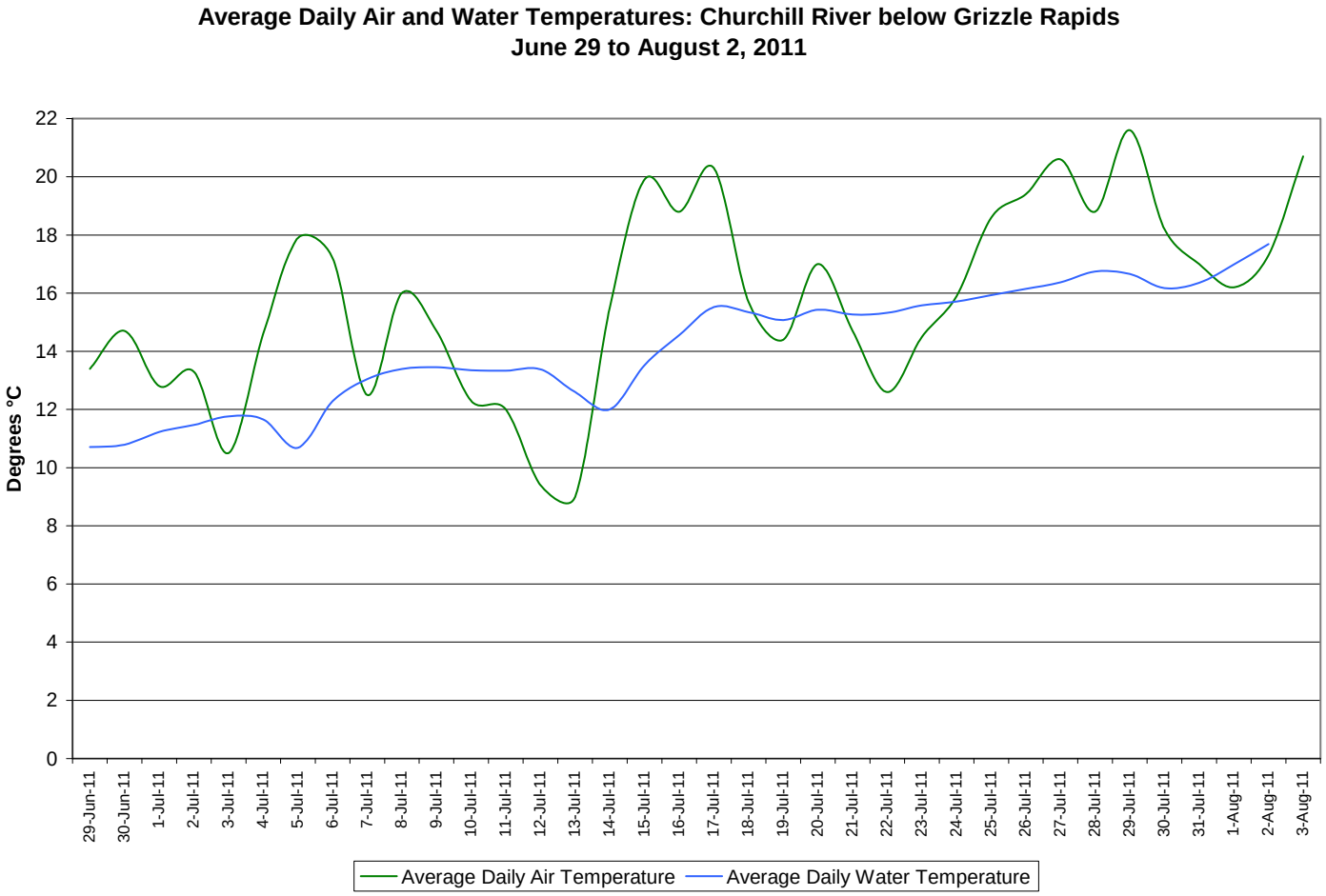



**Figure 9: Average daily air and water temperatures at Churchill River below Grizzle Rapids**

**(weather data recorded at Goose Bay)**

- pH ranges between 6.73 and 7.27 pH units and increases slightly throughout the deployment period (Figure 10).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units).
- There is a decrease in pH over a period of 3 days from July 4 to 6 (indicated by red arrows on Figure 10). This decrease corresponds with a rainfall event.

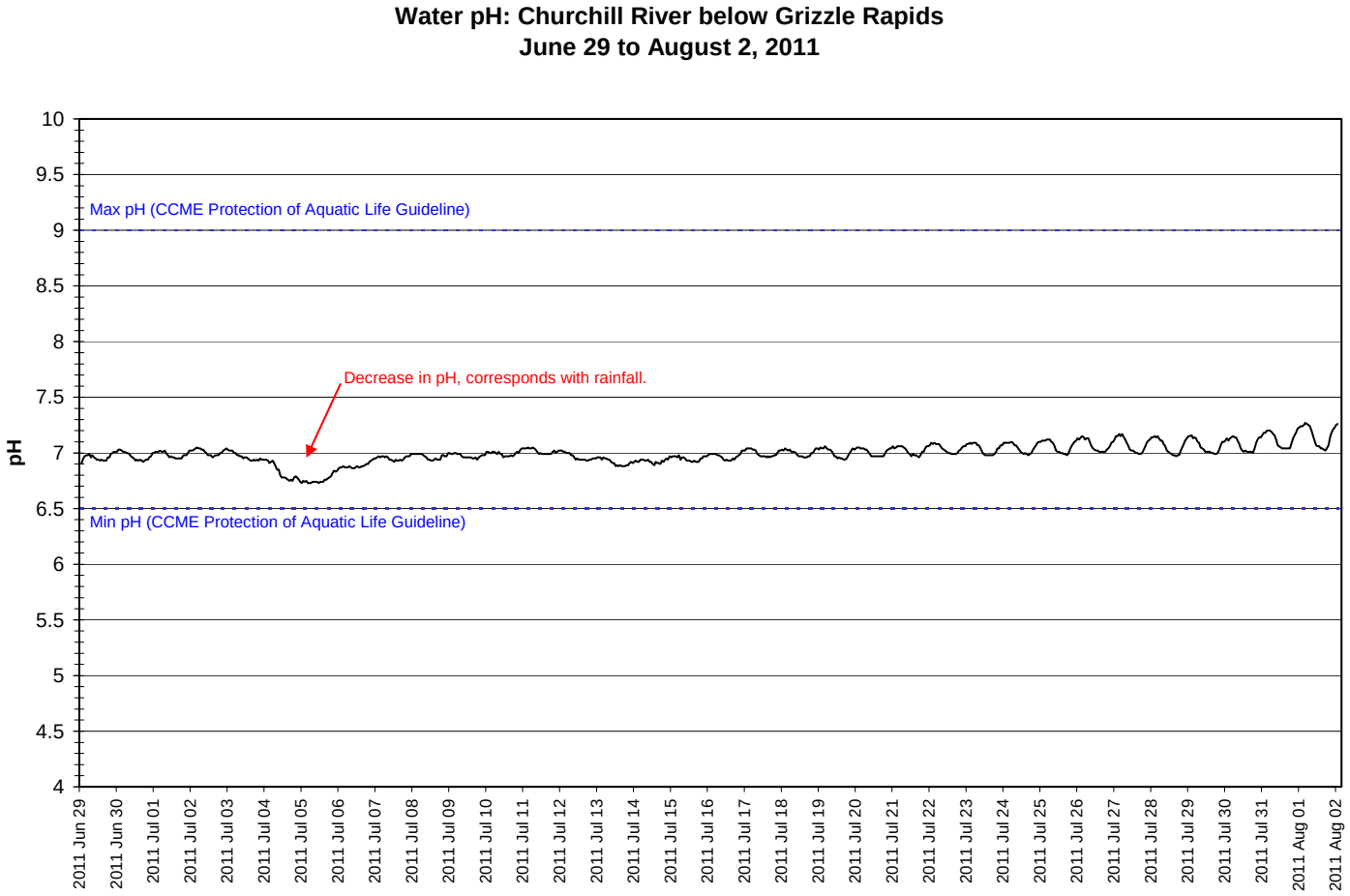



**Figure 10: pH at Churchill River below Grizzle Rapids**

- Specific conductivity ranges from 12.7 to 17.1µS/cm during the deployment period, averaging 15.1µS/cm (Figure 11). Specific conductance increases slightly throughout the deployment period.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage generally decreases throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 11). Reduction in water level increases the concentration of dissolved solids in the water column hence increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

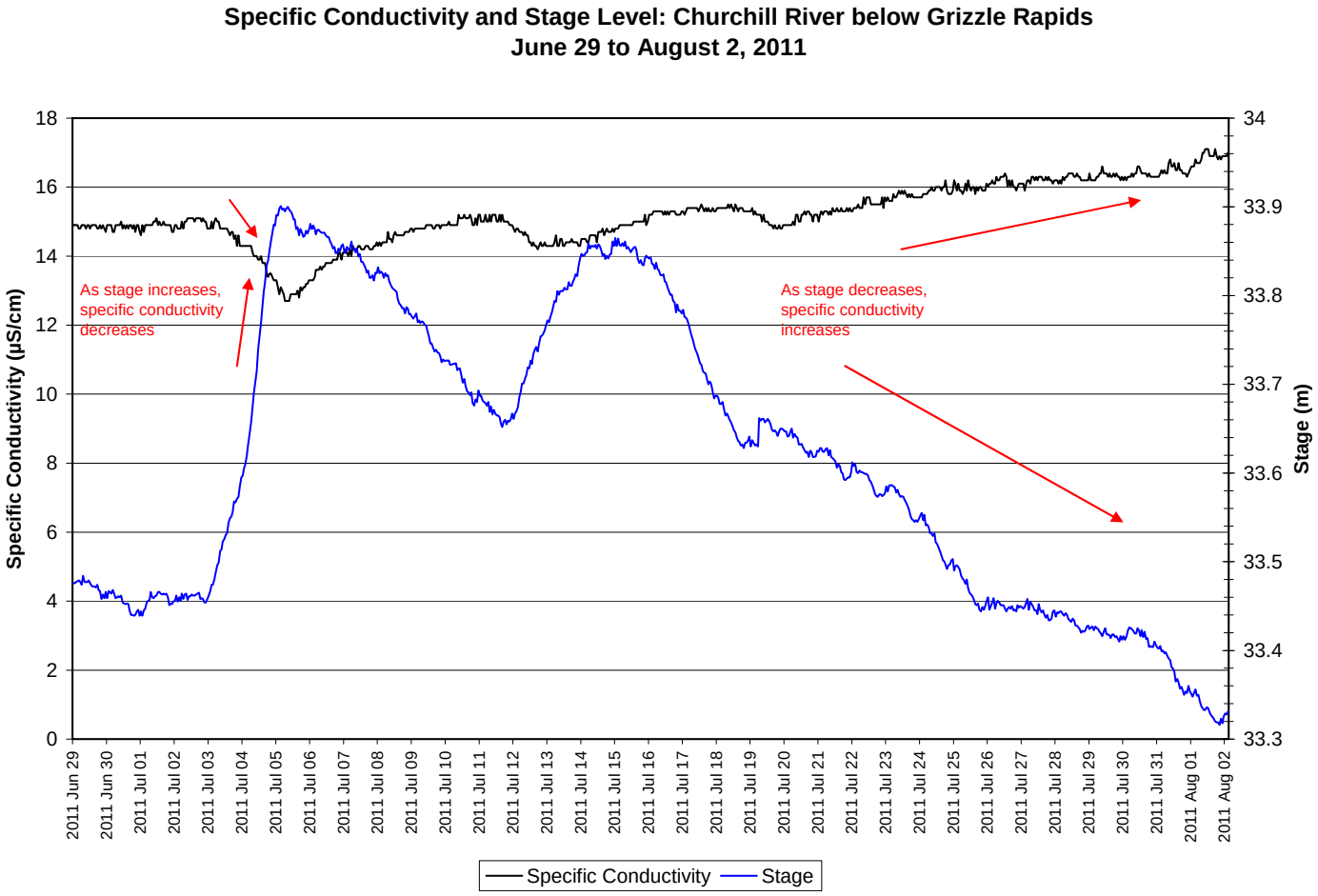



**Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids**

- The saturation of dissolved oxygen ranged from 95.6 to 104.3% and a range of 9.38 to 11.20mg/l was found in the concentration of dissolved oxygen with a median value of 10.12 mg/l (Figure 12).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Most values were above the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l with the exception of during the last few days of the deployment. 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 warm air and water temperatures (Figure 9). As the stage level dropped throughout the deployment period, the instrument was in an increasingly shallow environment allowing the water temperature to fluctuate more between day and night. As dissolved oxygen content is inversely related to temperature, there is also a greater diurnal fluctuation in oxygen content near the end of the deployment period.

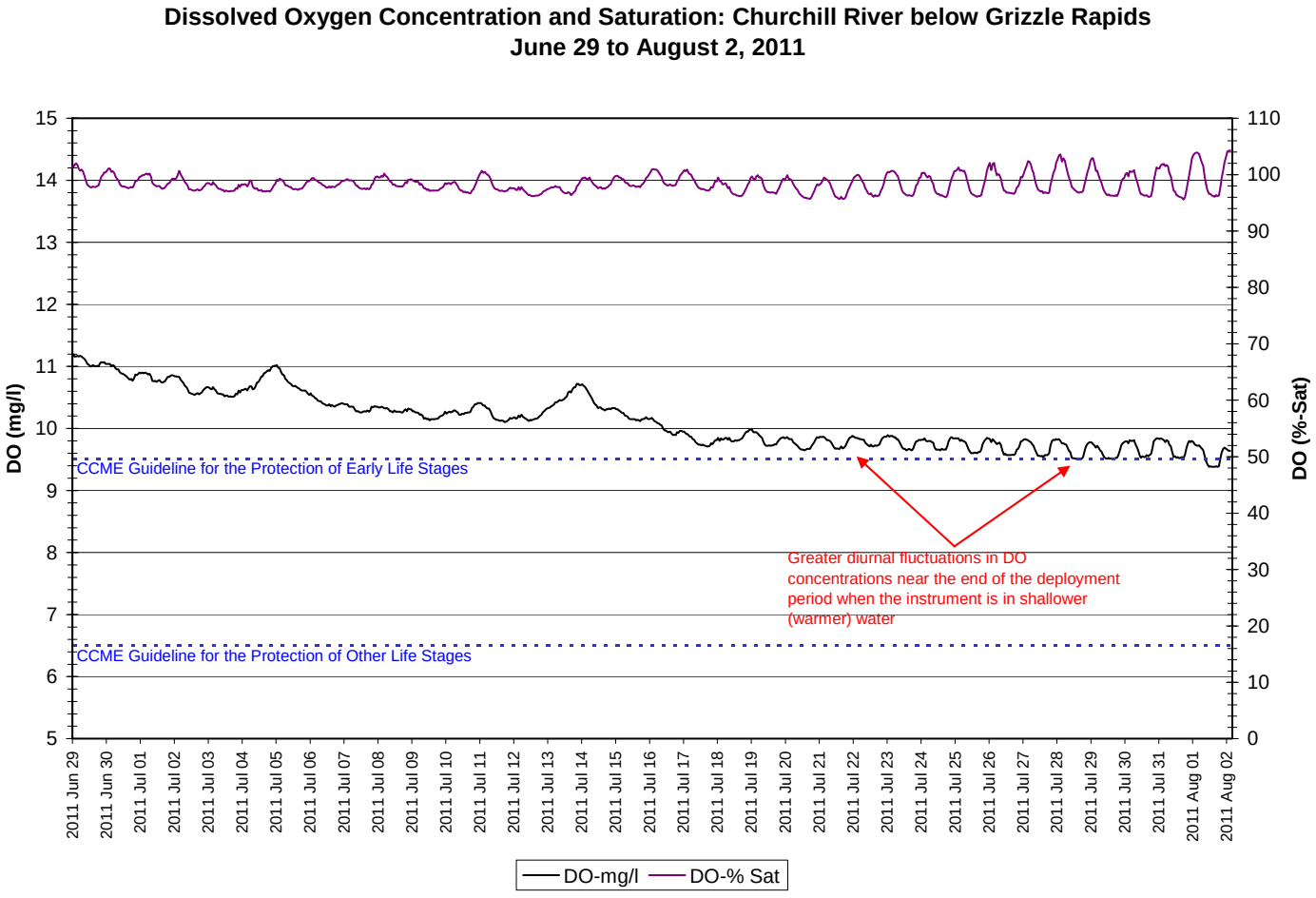



**Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids**

- A range of 0 to 41.79NTU was recorded for turbidity for this deployment period (Figure 13). A median value of 0 NTU indicates there is generally no natural background turbidity value at this station.
- Between July 4 and 6, turbidity spikes are frequent, reaching a high value of 41.79NTU. This event corresponds with a rainfall event lasting over a period of two days. Turbidity values recover to baseline values (0NTU) shortly after the event. Other turbidity spikes throughout the deployment period are of little magnitude (<5NTU) and short lived (1-2 hours).

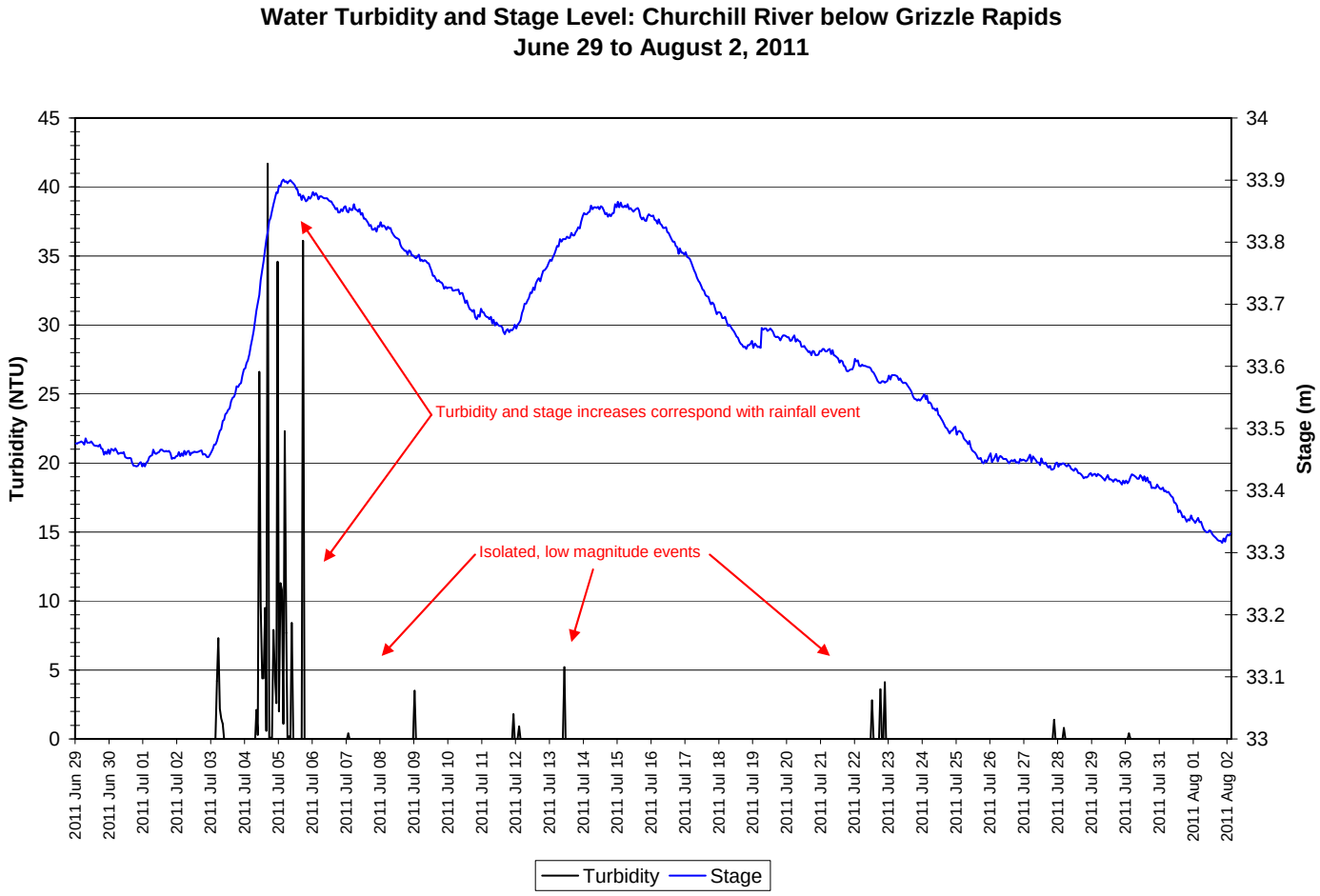



**Figure 13: Turbidity and stage level at Churchill River below Grizzle Rapids**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall event on July 3 to 4 causes the water level in the river to rise in the days following.

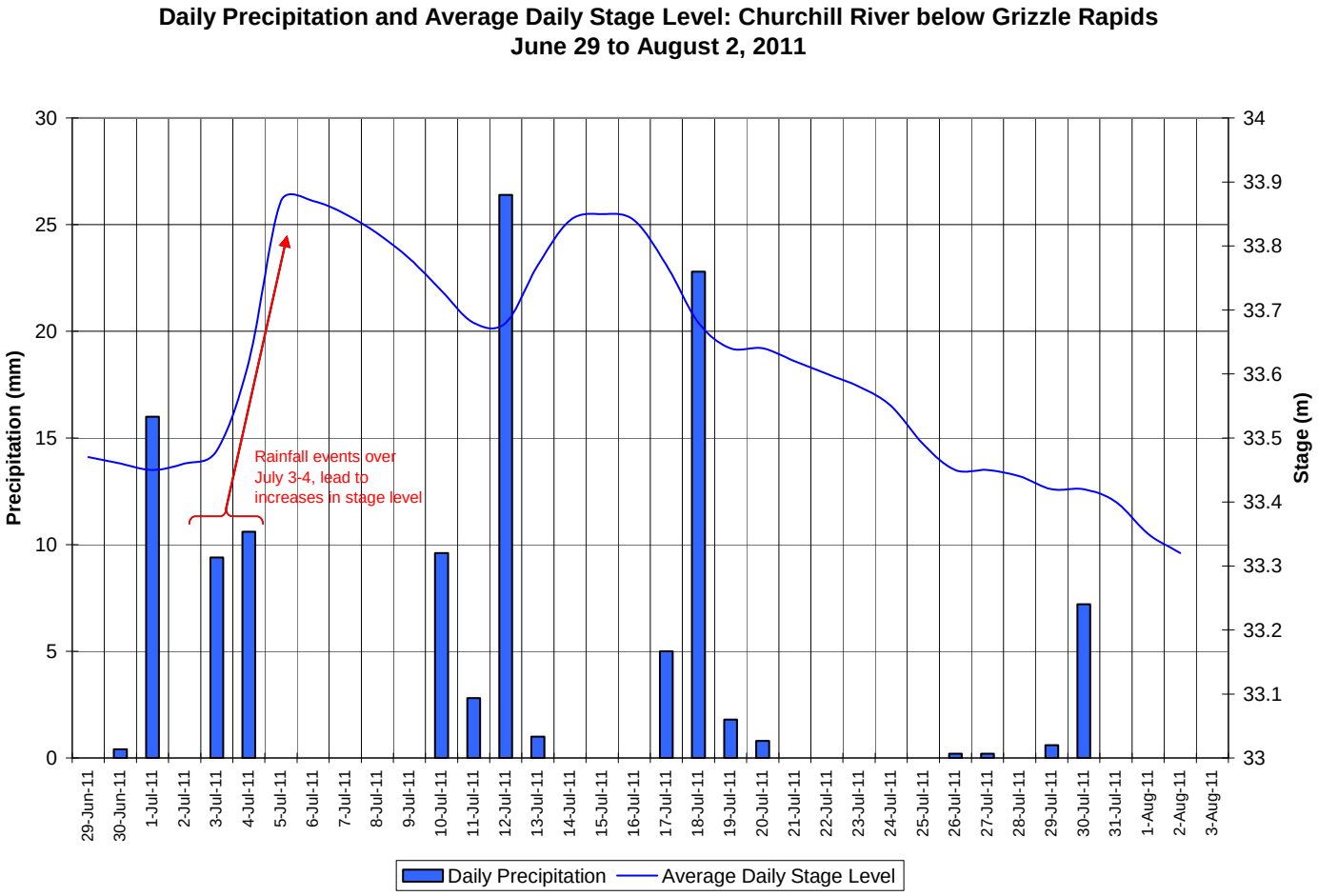



**Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)**

## Churchill River above Muskrat Falls

- Water temperature ranges from 10.48 to 18.02°C during this deployment period (Figure 17).
- Water temperature is generally increasing throughout the deployment period. This trend is expected given the increasing ambient air temperature in the summer months (Figure 18). Water temperature fluctuates diurnally.

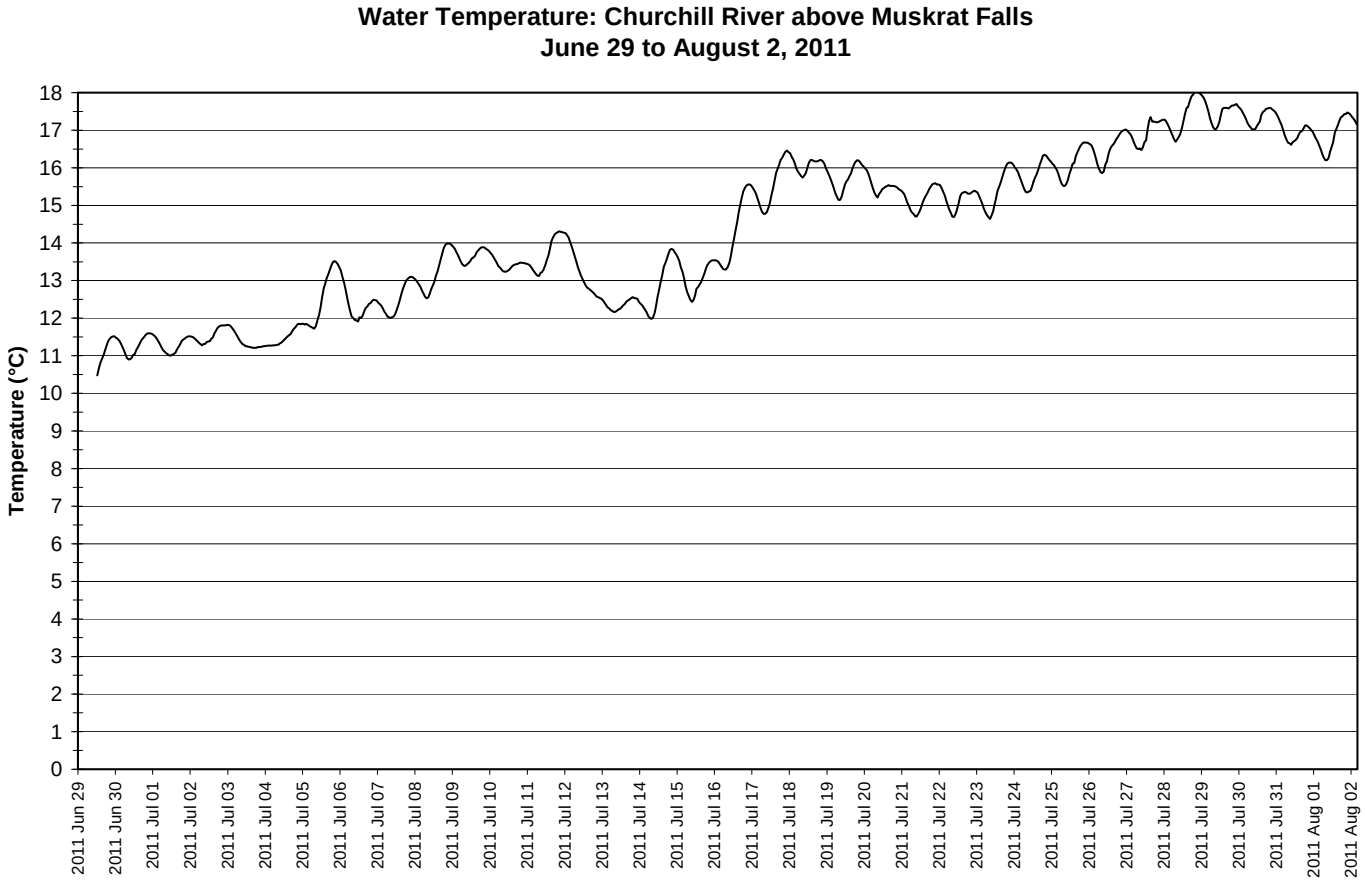



**Figure 15: Water temperature at Churchill River above Muskrat Falls**

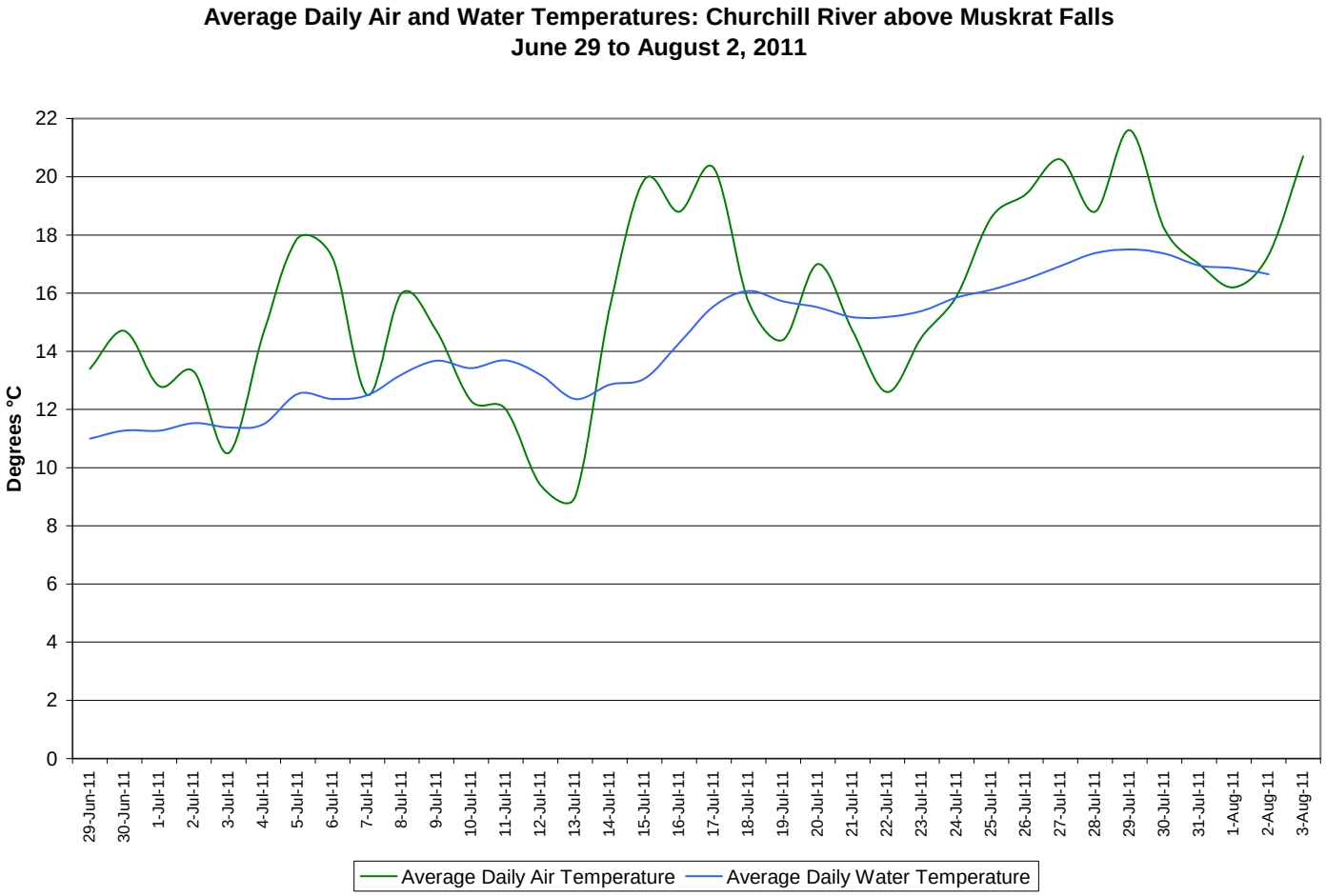



**Figure 16: Average daily air and water temperatures at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)**

- pH ranges between 6.68 and 7.08pH units (Figure 17). pH values are generally stable 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 (indicated in blue on Figure 17).
- There is a decrease in pH lasting over three days which corresponds with a rainfall event on July 3 and 4. This decrease in pH is also seen at station below Grizzle Rapids further upstream (Figure 10).

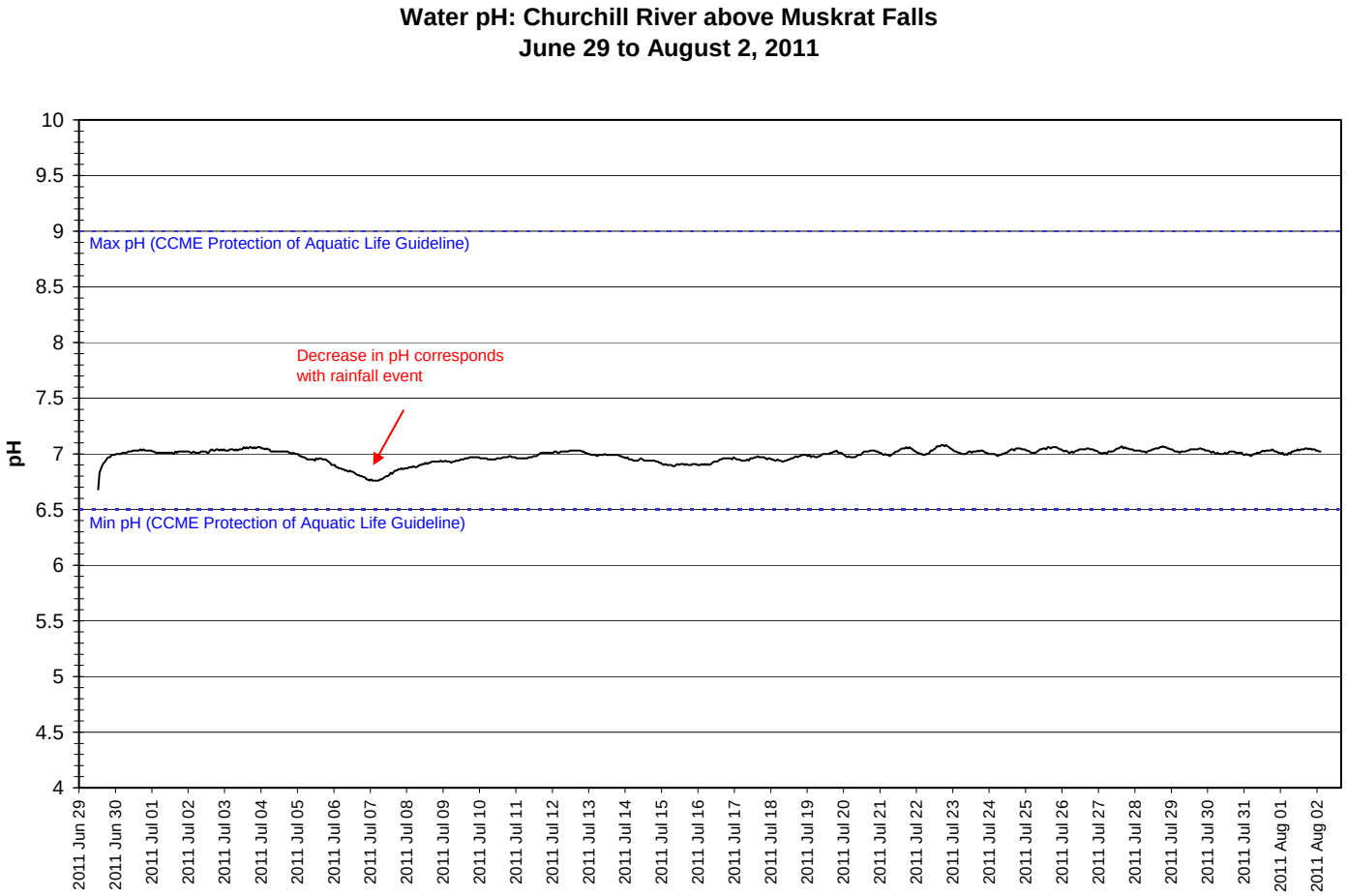



**Figure 17: pH at Churchill River above Muskrat Falls**

- Specific conductivity ranges between 13.9 and 19.2µS/cm and is primarily increasing throughout the deployment period (Figure 18).
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is increasing at the beginning of the deployment period and then is decreasing for the majority of the latter half. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 18). Reduction in water level increases the concentration of dissolved solids in the water column hence increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

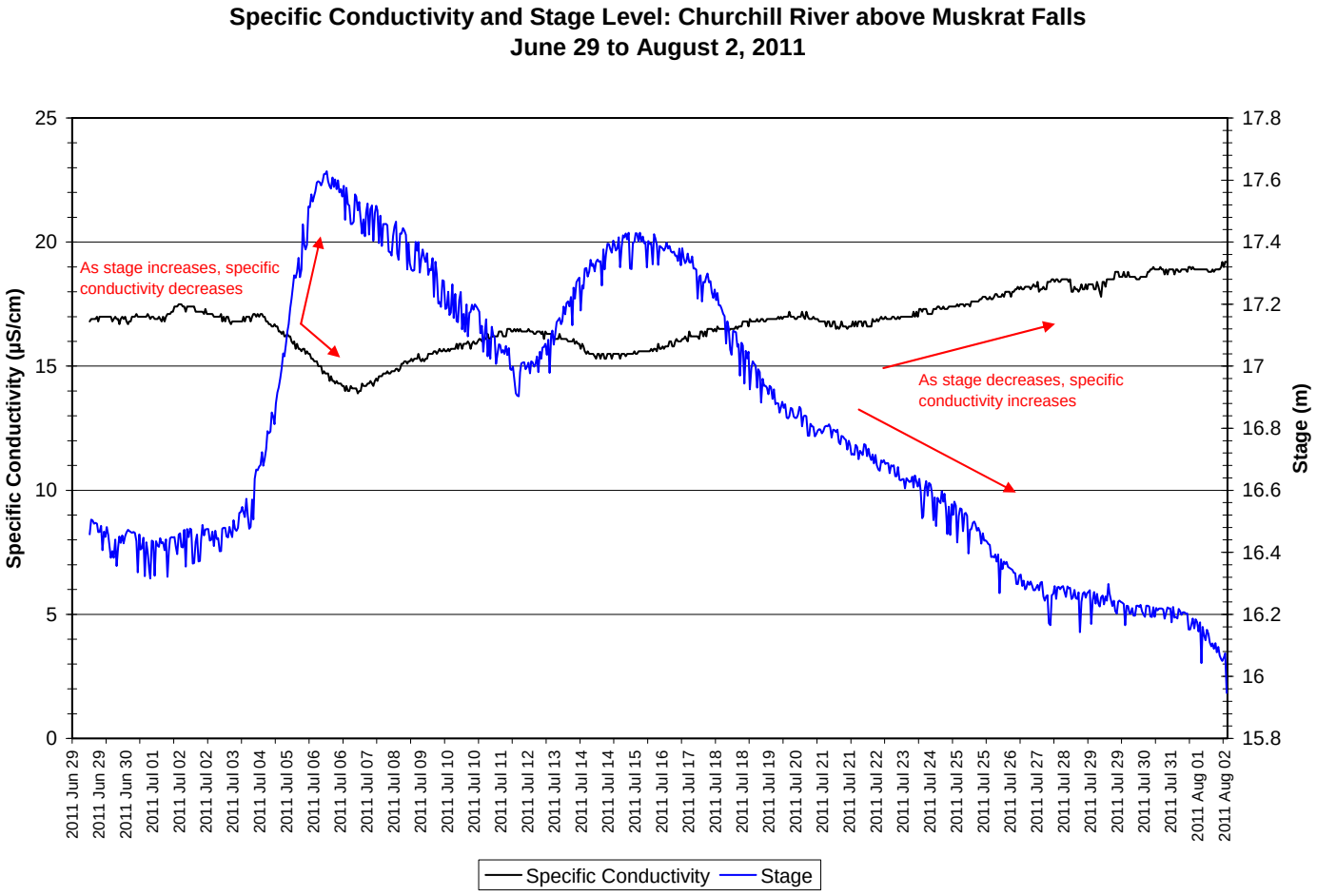



**Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls**

- The saturation of dissolved oxygen ranged from 92.3 to 98.9% and a range of 9.15 to 10.81mg/l was found in the concentration of dissolved oxygen with a median value of 9.80mg/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 . Most values were above 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 blue on Figure 19. Just over half way through the deployment period, dissolved oxygen contents falls just below the minimum CCME Guideline. At this time, stage had dropped considerably since initial deployment leaving the instrument in shallower (warmer) water. In addition to the shallow water, the air and water temperatures also reached a maximum for the summer season during this period.

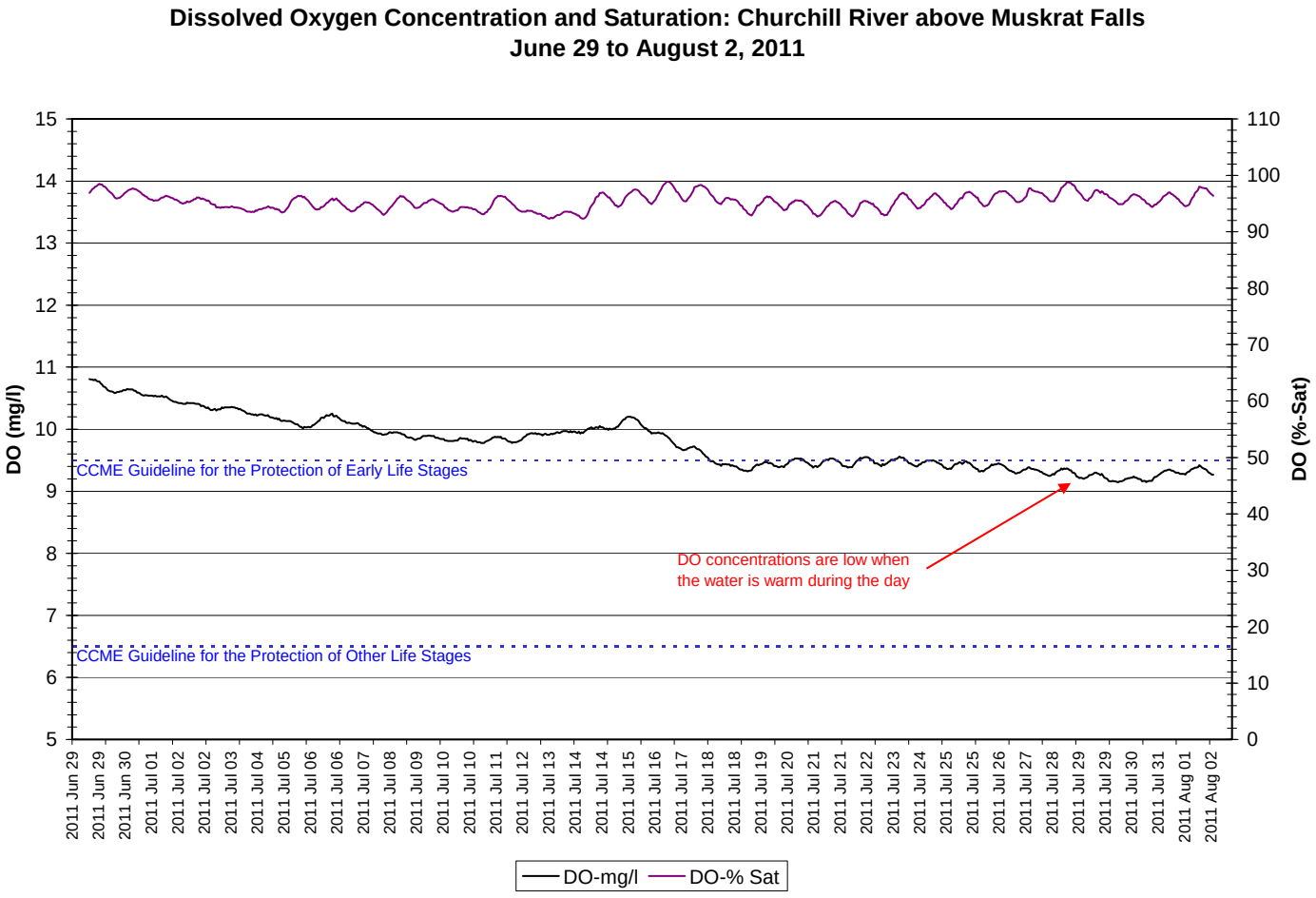



**Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls**

- A range of 2.0 to 41.0NTU was recorded for turbidity for this deployment period (Figure 20). A median value of 4.0 NTU indicates there is a consistent natural background turbidity value at this station.
- A turbidity event from July 3 to 8 recorded turbidity values up to 41NTU. This turbidity increase corresponds with a rainfall event lasting over 2 days. The recovery period (time for turbidity values to return to baseline levels, ~4NTU) lasts beyond the 2 day long rain event.
- Similarly, rainfall events recorded from July 10 to 13 have the same affect on turbidity, causing increases up to 37NTU and taking an additional 1-2 days to recover completely.

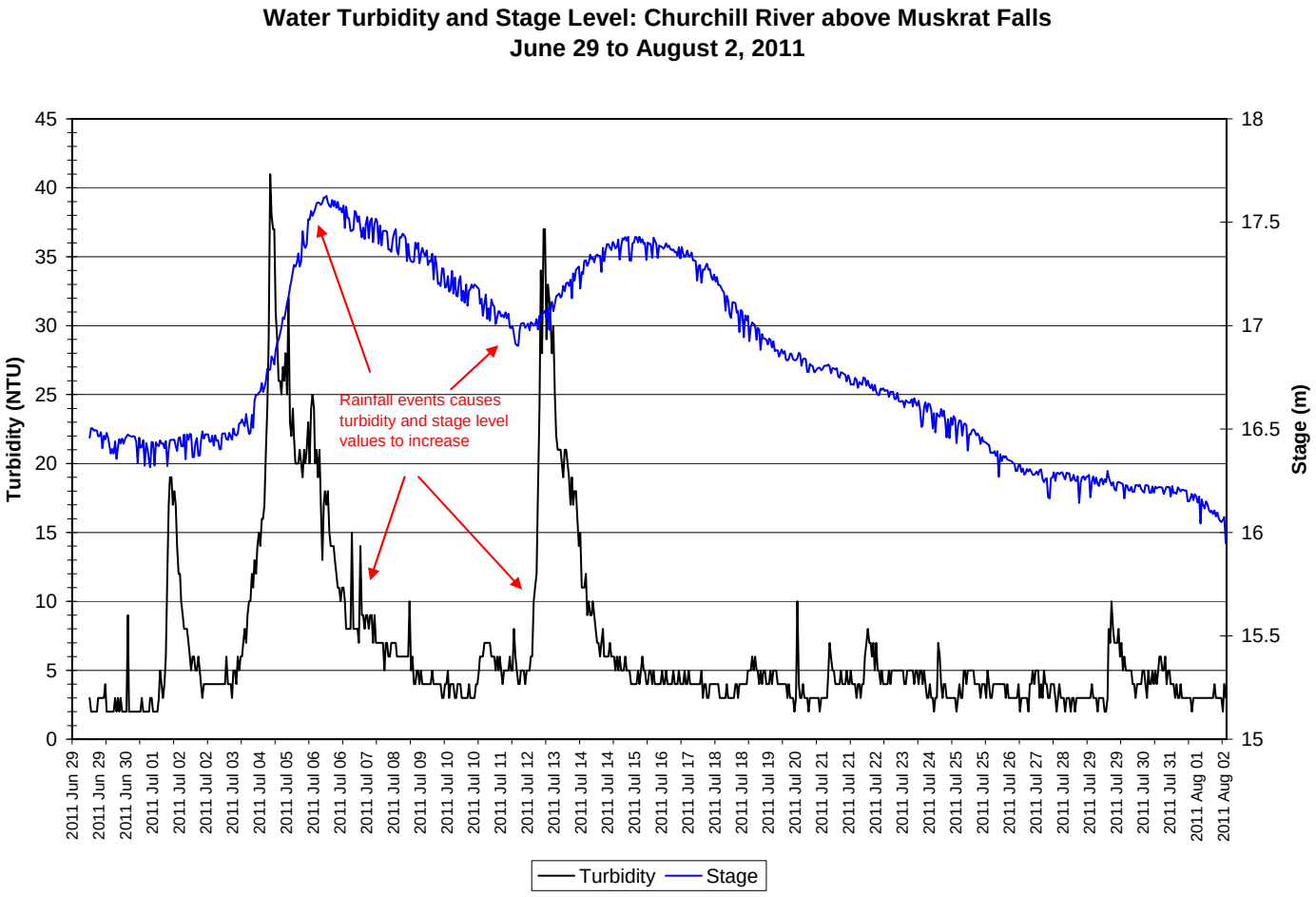



**Figure 20: Turbidity and stage level at Churchill River above Muskrat Falls**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events on July 3 and 4 cause the water level in the river to rise in the days following.

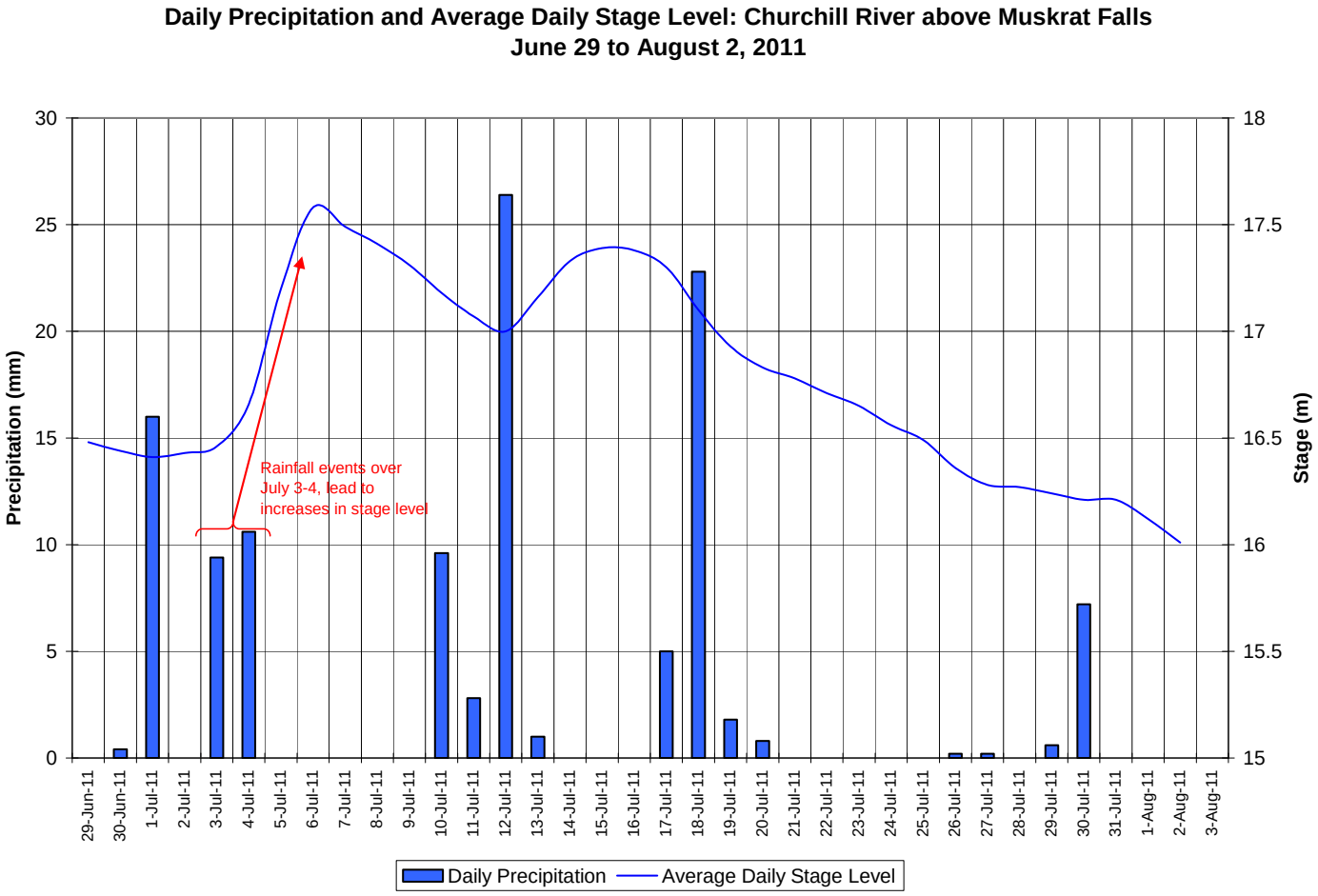



**Figure 21: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)**

## Churchill River below Muskrat Falls

- Water temperature ranges from 10.20 to 17.70°C during this deployment period (Figure 22).
- Water temperature is increasing throughout the deployment period. This trend is expected given increasing ambient air temperatures in the summer season (Figure 23). Water temperature fluctuates diurnally.

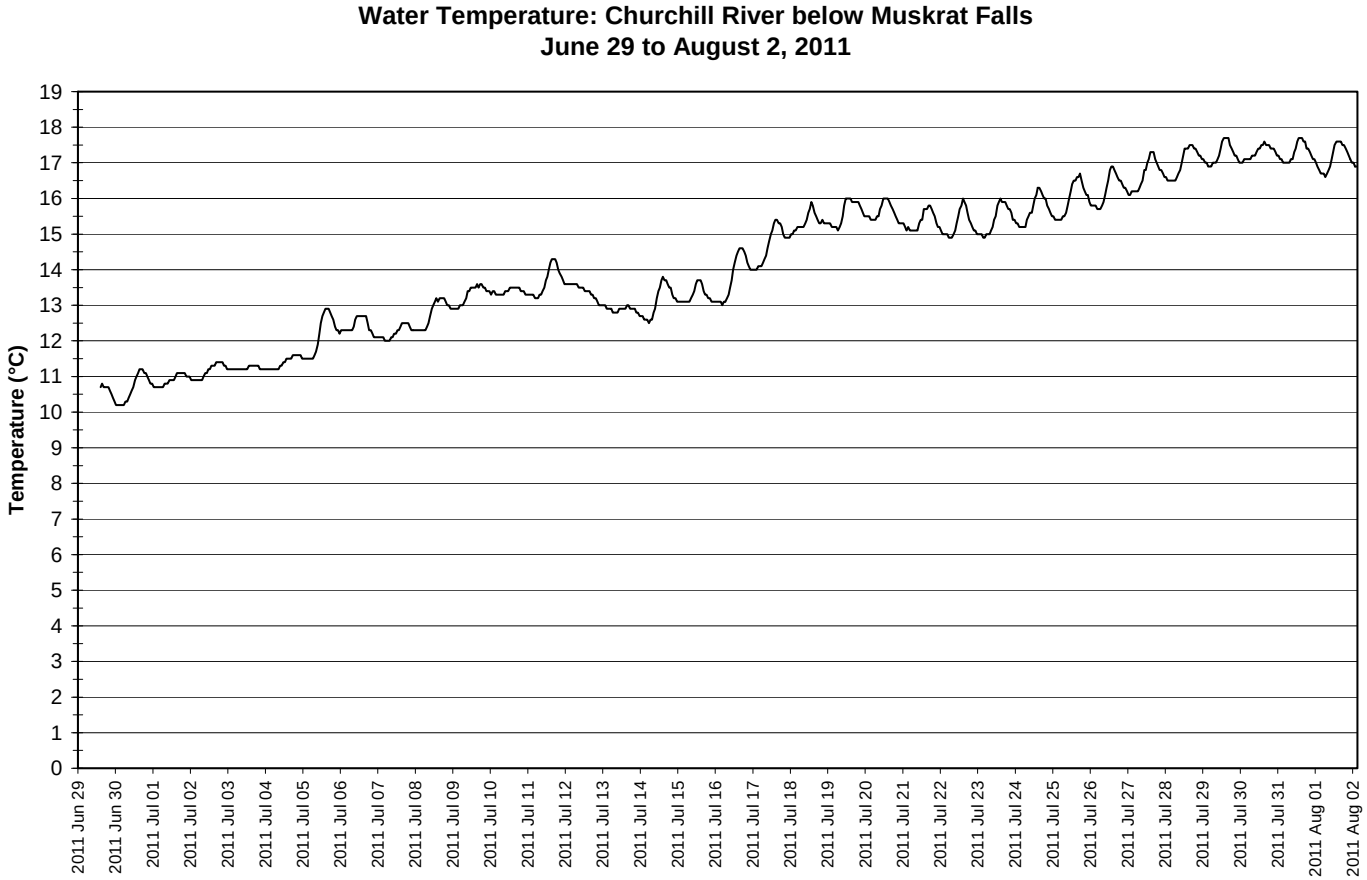



**Figure 22: Water temperature at Churchill River below Muskrat Falls**

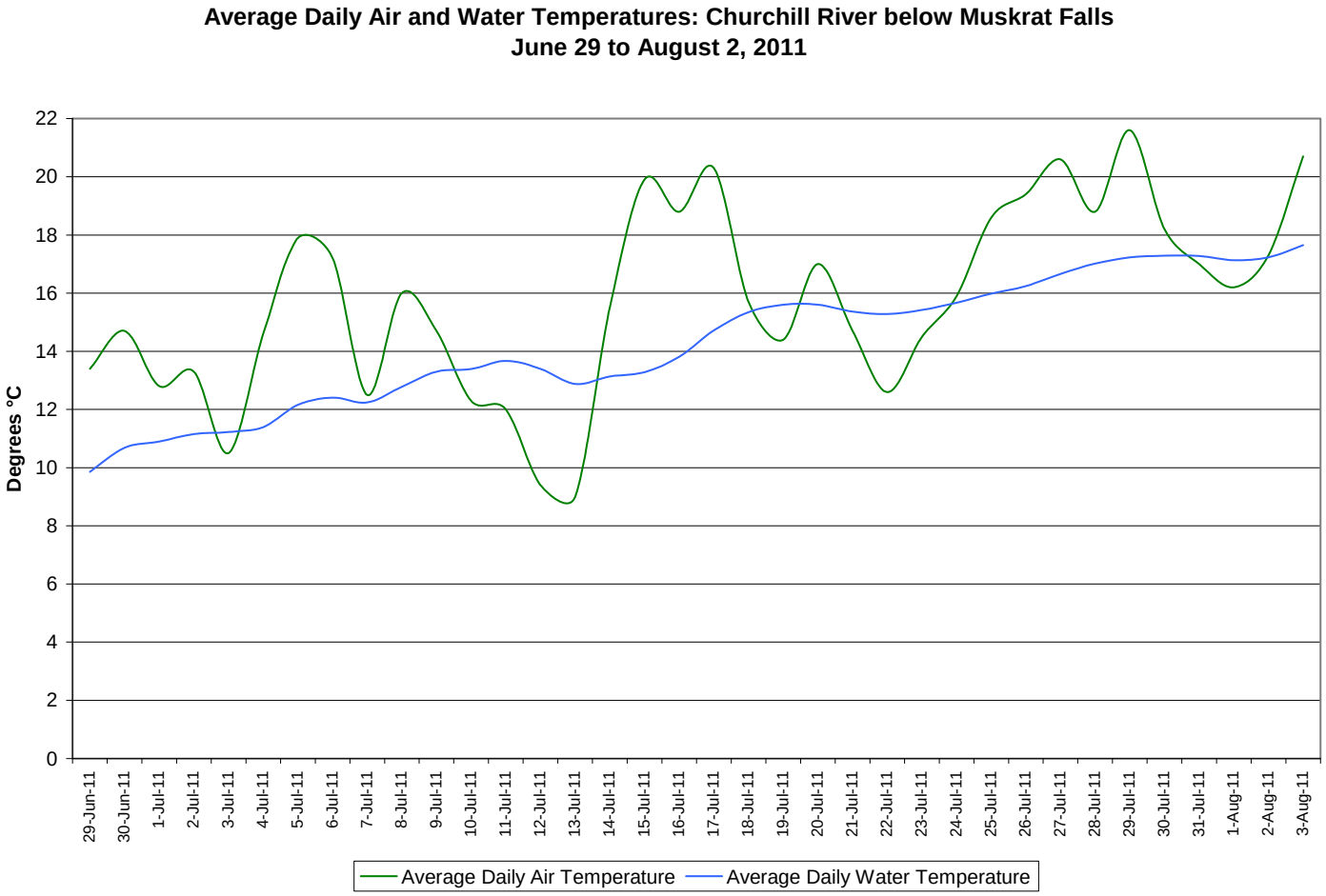



**Figure 23: Average daily air and water temperatures at Churchill River below Muskrat Falls**

**(weather data recorded at Goose Bay)**

- pH ranges between 6.55 and 6.92 pH units (Figure 24). pH values generally remain stable 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 24).
- As was noticeable at stations upstream above Muskrat Falls and below Grizzle Rapids, there is a decrease in pH around July 3 and 4. This decrease corresponds with rainfall events recorded in the area.

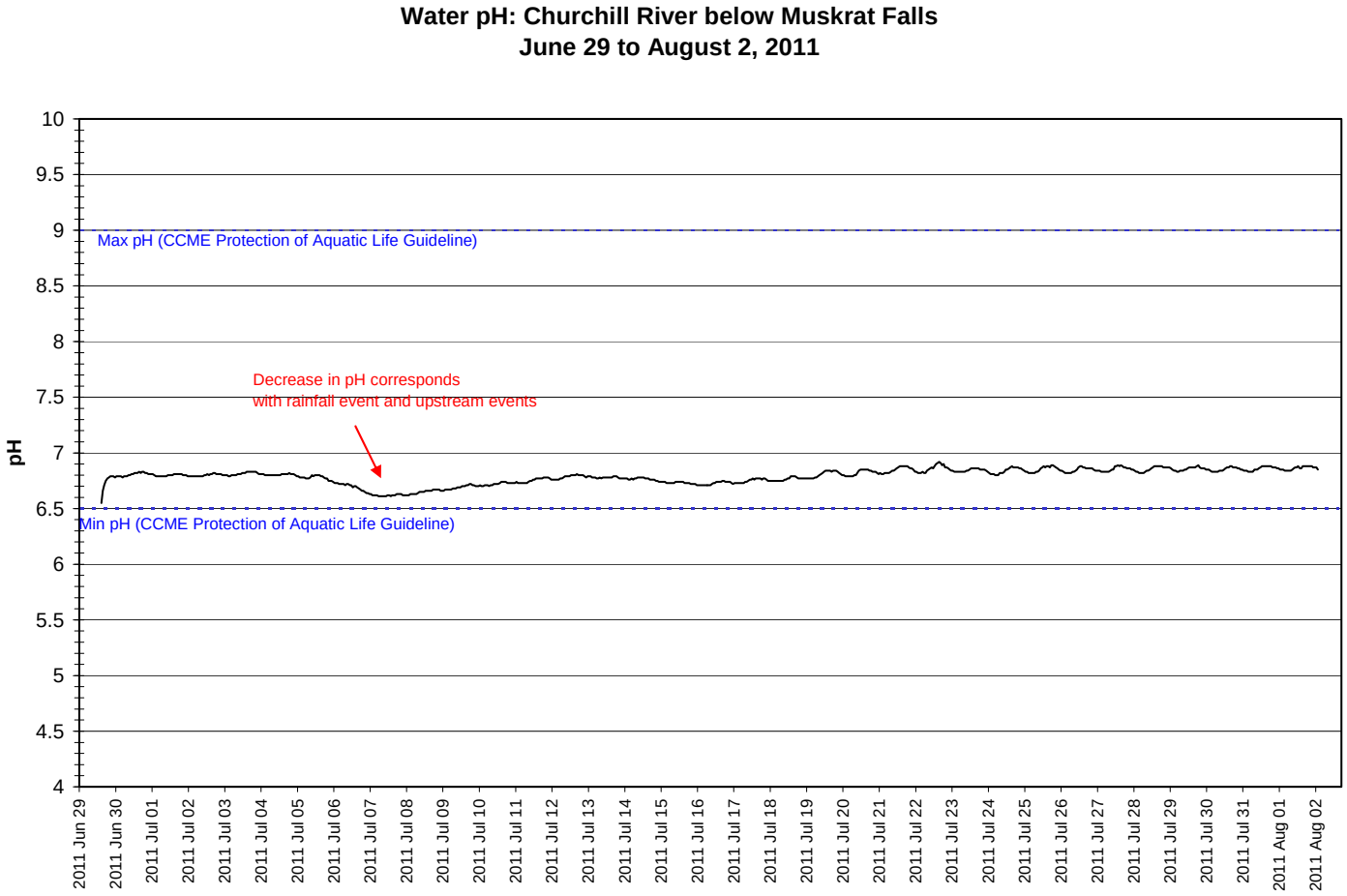



**Figure 24: pH at Churchill River below Muskrat Falls**

- Specific conductivity ranged from 13.9 to 18.3µS/cm during the deployment period (Figure 25). Specific conductance generally increases throughout the deployment period.
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. Stage is increasing during the first half of the deployment period and decreases for the latter half. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 25). Reduction in water level increases the concentration of dissolved solids in the water column hence increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

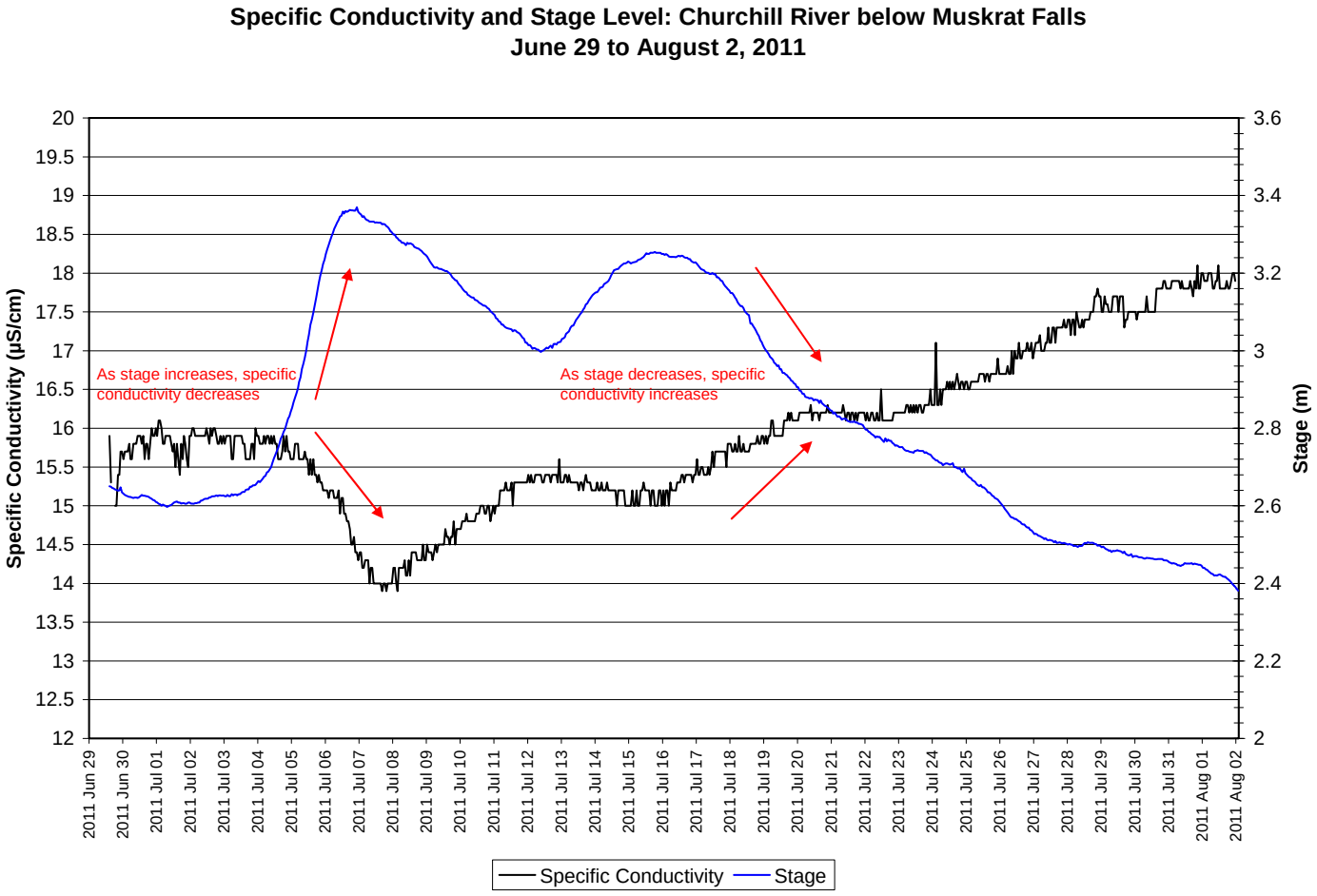



**Figure 25: Specific conductivity and stage level at Churchill River below Muskrat Falls**

- The saturation of dissolved oxygen generally ranged from 106.1 to 118.2% and a range of 10.54 to 12.70mg/l was found in the concentration of dissolved oxygen (Figure 26).
- 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 blue on Figure 26.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the increasing air and water temperatures during the deployment period (Figure 23).

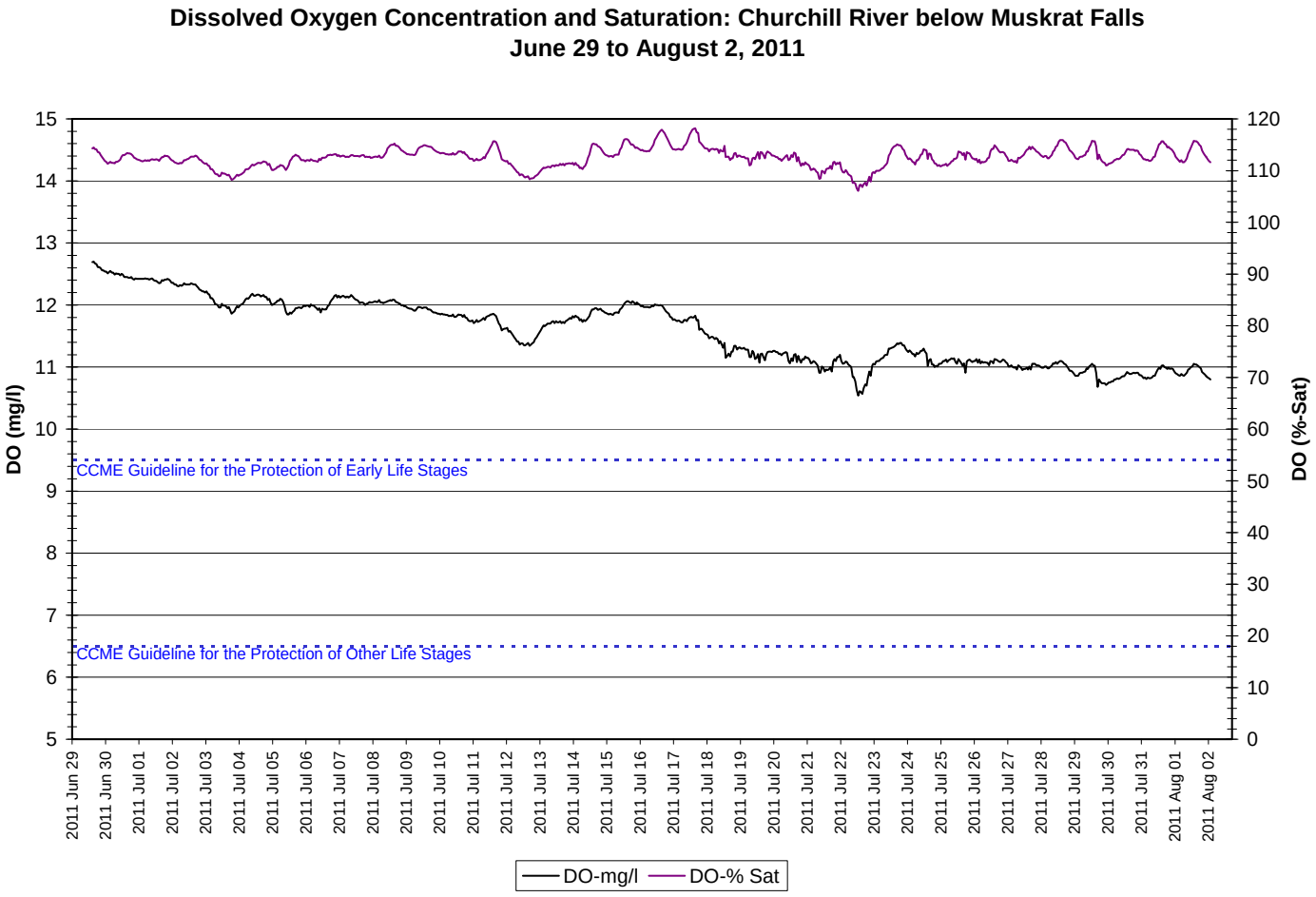



**Figure 26: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls**

- A range of 1.9 to 170.7NTU was recorded for turbidity for this deployment period (Figure 27). A median value of 5.3 NTU indicates there is a consistent natural background turbidity value at this station.
- Turbidity values generally remain under 20NTU for the first weeks of the deployment period. Rainfall events occurring during this time often have an impact on the turbidity values in the water column (July 3-4, and July 10-13). These events are indicated by the red arrows on Figure 27.
- On July 22, turbidity values rise to over 170NTU. This event lasts just under 12 hours. Turbidity peaks again to 127NTU less than a day later however, this time the event only last for one hour. Similarly, on July 29, turbidity rises to 146NTU for another one hour period. It is unknown what caused these increases in turbidity as there is no corresponding weather related event recorded during this time.

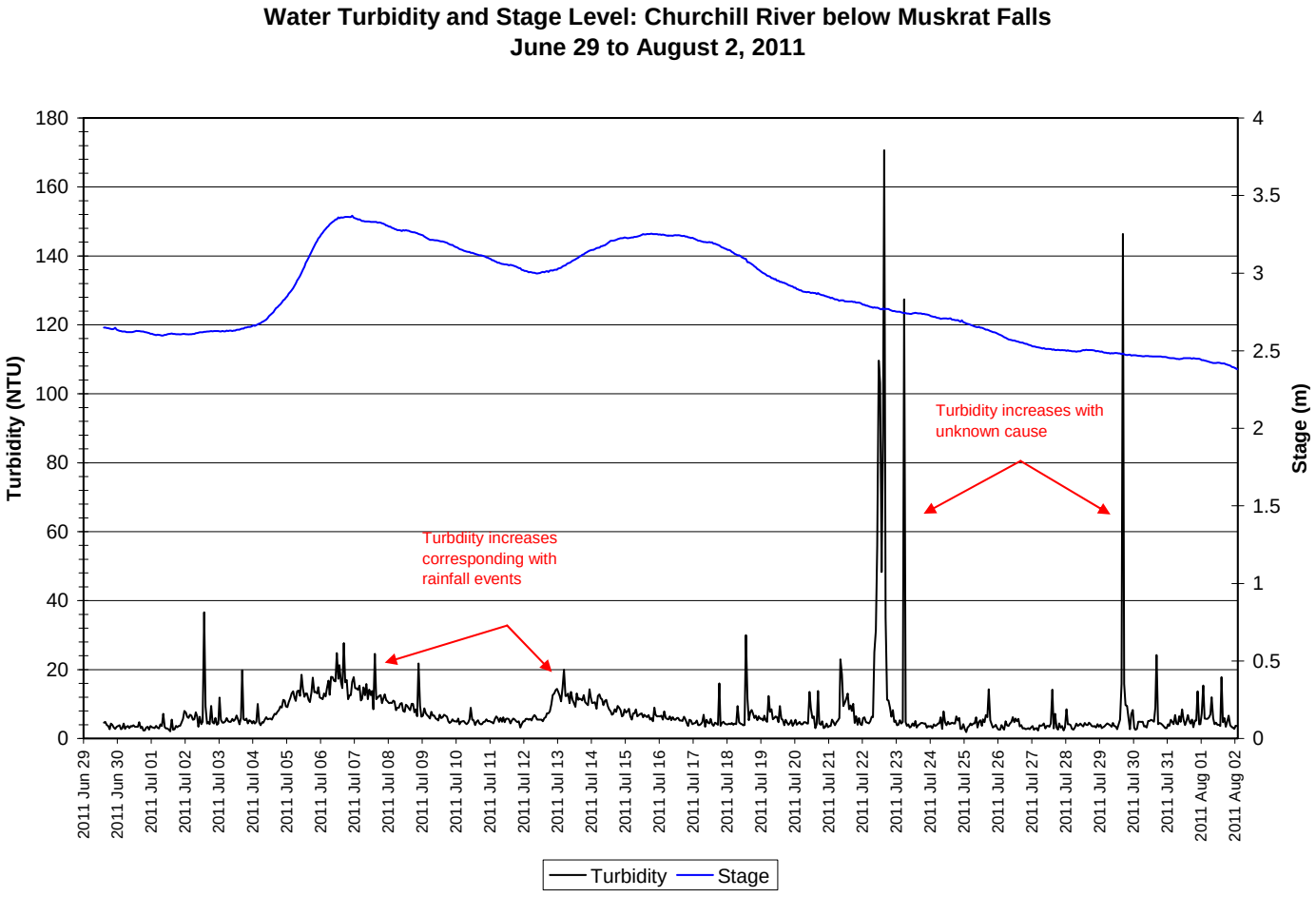



**Figure 27: Turbidity and stage level at Churchill River below Muskrat Falls**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 28). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events from July 3 to 4, cause the water level in the river to rise in the days following.

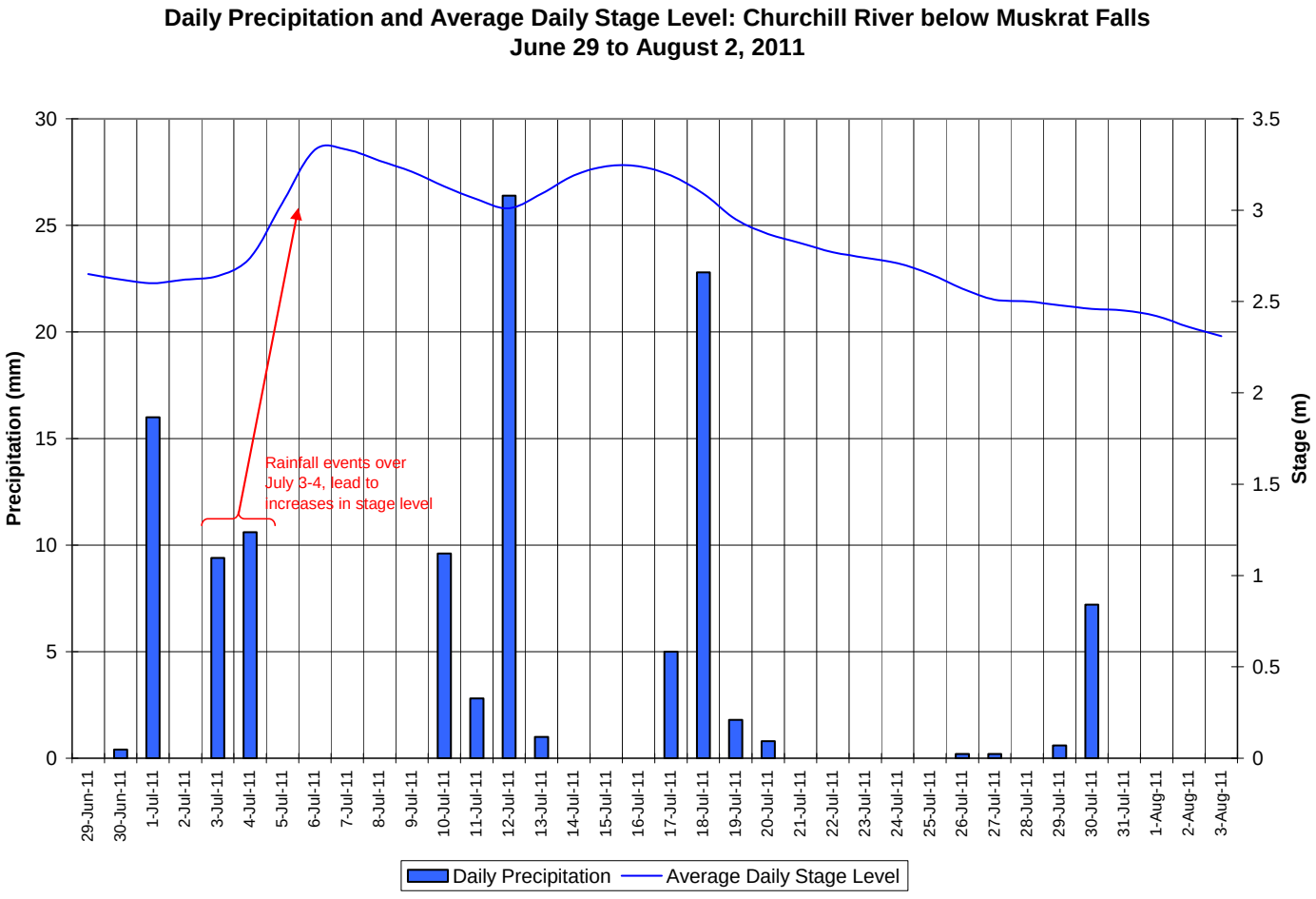


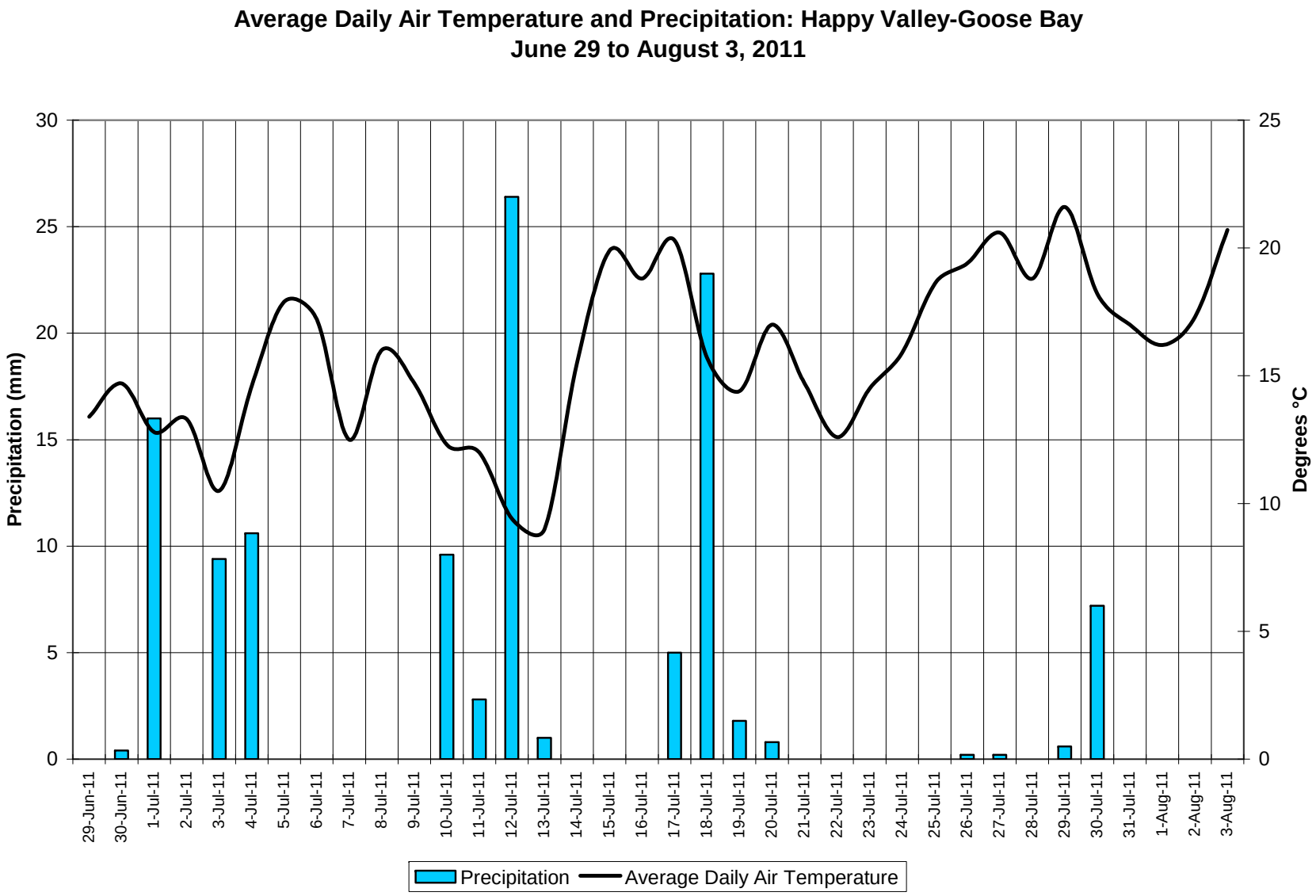

**Figure 28: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)**

## Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from June 29 to August 2, 2011.
- 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.
- Stage levels generally increased for the first part of the deployment period and then consistently decreased for the remaining time.
- Water temperature generally was increasing at all stations due to the warming ambient air temperatures in the region. As the stage level dropped throughout the deployment period the instrument were exposed to a shallower environment where the changes in temperature from night to day were more significant.
- pH values were all with in the recommended CCME Guidelines for the Protection of Aquatic Life. There was a decrease in pH lasting over 2 days which as noticeable at stations below Grizzle, and above and below Muskrat Falls.
- Specific conductance fluctuated inversely to the changing stage level. In most cases, as specific conductivity increased, stage decreased and vice versa.
- Similarly, dissolved oxygen content fluctuated inversely to water temperature. Dissolved oxygen content generally decreased throughout the deployment period at all four stations as the water temperature was rising. All values were above the CCME Guideline for the Protection of Aquatic Life for other life stages. Dissolved oxygen content at station below Metchin River, below Grizzle Rapids and above Muskrat Falls all saw the dissolved oxygen content fall just slightly below the CCME Guideline for the Protection of Aquatic Life for Early Life stage near the end of the deployment period when the water temperatures were at the seasonal high. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the water fall 6km upstream.
- Turbidity events were infrequent and of low magnitude at stations below Metchin River and below Grizzle Rapids as is typical for these stations. At the station above and below Muskrat Falls, there is a natural background turbidity value. These stations are also more susceptible to turbidity increases during rainfall and weather events. Recovery periods for turbidity events range depending on the size of the disturbance however generally last 3-4 days during this deployment period.

Prepared by:
Grace Gillis
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.896.5542
Fax: 709.896.9566

## Appendix 1


Average Daily Air Temperature and Precipitation: Happy Valley-Goose Bay
June 29 to August 3, 2011
Precipitation (mm)
Degrees °C
0
5
10
15
20
25
30
29-Jun-11
30-Jun-11
1-Jul-11
2-Jul-11
3-Jul-11
4-Jul-11
5-Jul-11
6-Jul-11
7-Jul-11
8-Jul-11
9-Jul-11
10-Jul-11
11-Jul-11
12-Jul-11
13-Jul-11
14-Jul-11
15-Jul-11
16-Jul-11
17-Jul-11
18-Jul-11
19-Jul-11
20-Jul-11
21-Jul-11
22-Jul-11
23-Jul-11
24-Jul-11
25-Jul-11
26-Jul-11
27-Jul-11
28-Jul-11
29-Jul-11
30-Jul-11
31-Jul-11
1-Aug-11
2-Aug-11
3-Aug-11
Precipitation
Average Daily Air Temperature

**Average Daily Air Temperature and Precipitation: Churchill Falls**
**June 29 to August 3, 2011**