Real-Time Water Quality Deployment Report

Lower Churchill River Network

September 1 to
October 5, 2011

Newfoundland Labrador

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

Contents

General **1**

Quality Assurance and Quality Control **1**

Data Interpretation **4**

Churchill River below Metchin River **4**

Churchill River below Grizzle Rapids **11**

Churchill River above Muskrat Falls **18**

Churchill River below Muskrat Falls **25**

Conclusions **32**

Appendix 1 ..... **33**

Newfoundland Labrador

Real-Time Water Quality Deployment Report

Lower Churchill River Network

September 1 to October 5, 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 September 1, 2011, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 34-35 days. Instruments were removed on October 4/5.

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 (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 September 1 to October 4/5, 2011 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, September 1– October 4/5, 2011

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45707)	Sep 1, 2011	Deployment	Good	Excellent	Excellent	Good	Fair
	Oct 4, 2011	Removal	Good	Fair	Excellent	n/a	n/a
Below Grizzle Rapids (45699)	Sep 1, 2011	Deployment	Excellent	Excellent	Excellent	Good	Fair
	Oct 4, 2011	Removal	Excellent	Excellent	Good	Excellent	Excellent
Above Muskrat Falls (47589)	Sep 1, 2011	Deployment	Excellent	Excellent	Good	Excellent	Poor
	Oct 4, 2011	Removal	Excellent	Excellent	Good	Excellent	Excellent
Below Muskrat Falls (45700)	Sep 1, 2011	Deployment	Good	Good	Excellent	n/a	n/a
	Sep 2, 2011	Removal	Good	Good	Excellent	n/a	n/a
Below Muskrat Falls (45708)	Sep 2, 2011	Deployment	Good	Excellent	Excellent	Excellent	Poor
	Oct 5, 2011	Removal	Good	Good	Excellent	Poor	Marginal

- At the station below Metchin River, temperature, pH, specific conductivity and dissolved oxygen all ranked 'good' or 'excellent' at deployment while turbidity ranked 'fair'. The field instrument read a value of 0.0NTU and the QA/QC instrument read a value of 7.0NTU. Turbidity values are typically 0NTU at this station and the QA/QC instrument was reading high throughout the day at other sampling stations. A calibration error with the QA/QC instrument is likely the cause of the discrepancy between the two instruments. Temperature and conductivity ranked 'good' or 'excellent' at removal while pH ranked 'fair'. The field instrument read a value of 7.25 and the QA/QC instrument read a value of 6.63. This difference is likely related to insufficient stabilization time for the QA/QC instrument. Dissolved oxygen and turbidity were not ranked due to sensor failure on September 21.
- At the station below Grizzle Rapids, temperature, pH, specific conductivity and dissolved oxygen all ranked 'good' or 'excellent' at deployment while turbidity ranked 'fair'. The field instrument read a value of 0.0NTU and the QA/QC instrument read a value of 5.8NTU. Turbidity values are typically 0NTU at this station and the QA/QC instrument was reading high throughout the day at other sampling stations. A calibration error with the QA/QC instrument is likely the cause of the discrepancy between the two instruments. At removal, all parameters ranked 'good' or 'excellent'.
- At the station above Muskrat Falls, temperature, pH, specific conductivity and dissolved oxygen all ranked 'good' or 'excellent' at deployment while turbidity ranked 'poor'. The field instrument read a value of 3.9NTU and the QA/QC instrument read a value of 16.5NTU. Turbidity values have a median value of 5.0NTU throughout the deployment period, indicating that the 4.0NTU reading is most likely correct in the comparison. The QA/QC instrument was reading high throughout the day at other sampling stations. A

calibration error with the QA/QC instrument is likely the cause of the discrepancy between the two instruments. At removal, all parameters ranked 'good' or 'excellent'.

- At the station below Muskrat Falls, temperature, pH and conductivity all ranked either 'good' or 'excellent' at deployment on September 1. There was an error with the DO and turbidity sensors as they were not functioning properly and therefore have no ranking comparisons. ENVC staff returned to the station the next day on September 2 with a replacement instrument and removed the instrument with the sensor issue. At removal on September 2, temperature, pH and conductivity all ranked either 'good' or 'excellent'. DO and turbidity were not ranked due to sensor failure.
- On September 2, a new instrument was deployed at the station below Muskrat Falls. Temperature, pH, specific conductivity and dissolved oxygen all ranked 'good' or 'excellent' at deployment while turbidity ranked 'poor'. The field instrument read a value of 7.4NTU and the QA/QC instrument read a value of 17.9NTU. The QA/QC instrument was reading high throughout the day at other sampling stations. A calibration error with the QA/QC instrument is likely the cause of the discrepancy between the two instruments. Temperature, pH and specific conductivity all ranked either 'good' or 'excellent' at removal on October 5. Dissolved oxygen and turbidity were not ranked due to sensor failure mid way through the deployment period on September 13.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from September 1 to October 4/5 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 ranged from 7.90°C to 16.10°C during this deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures in the fall season (Figure 2). Water temperature fluctuates diurnally.

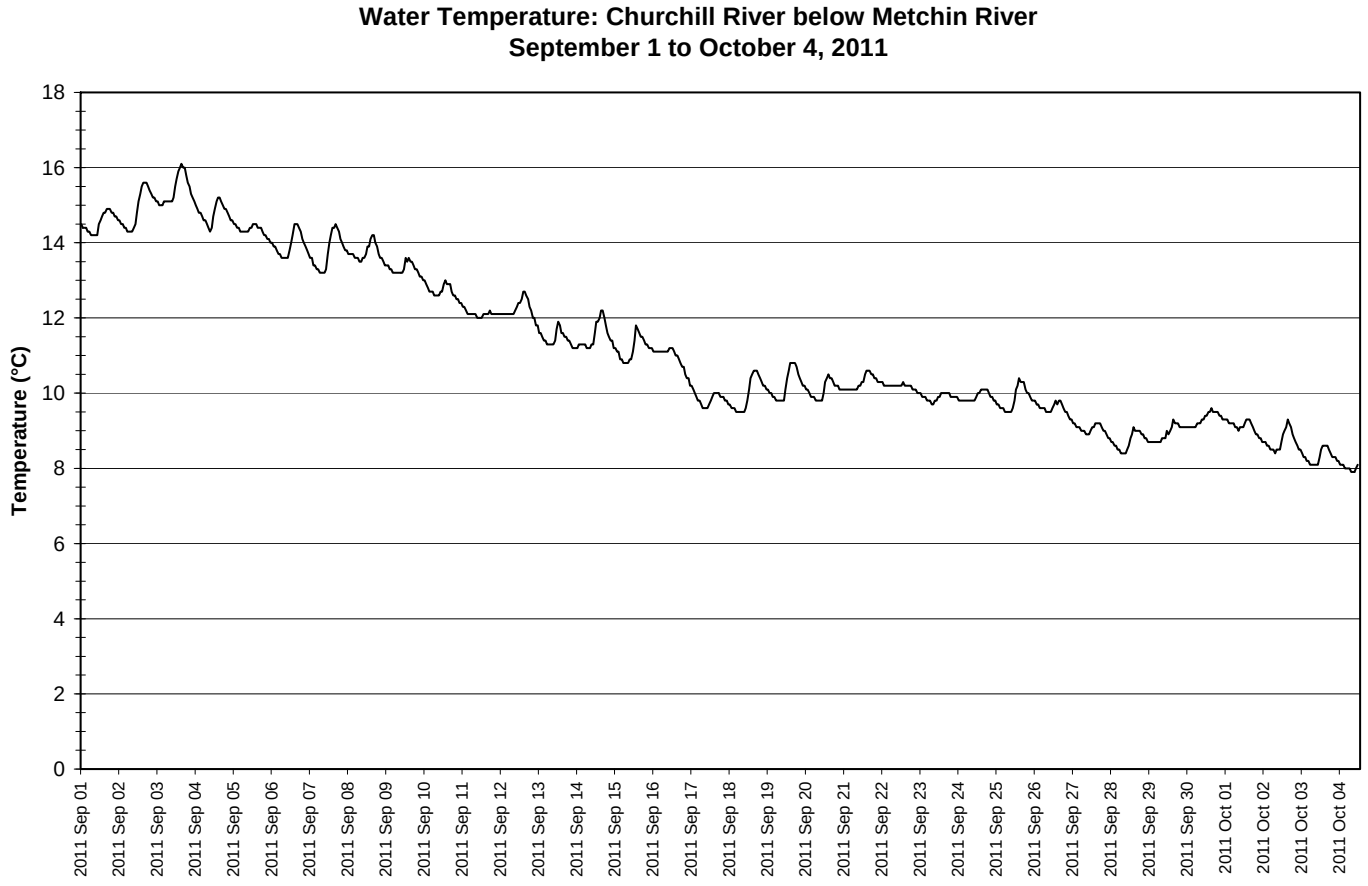


Figure 1: Water temperature at Churchill River below Metchin River

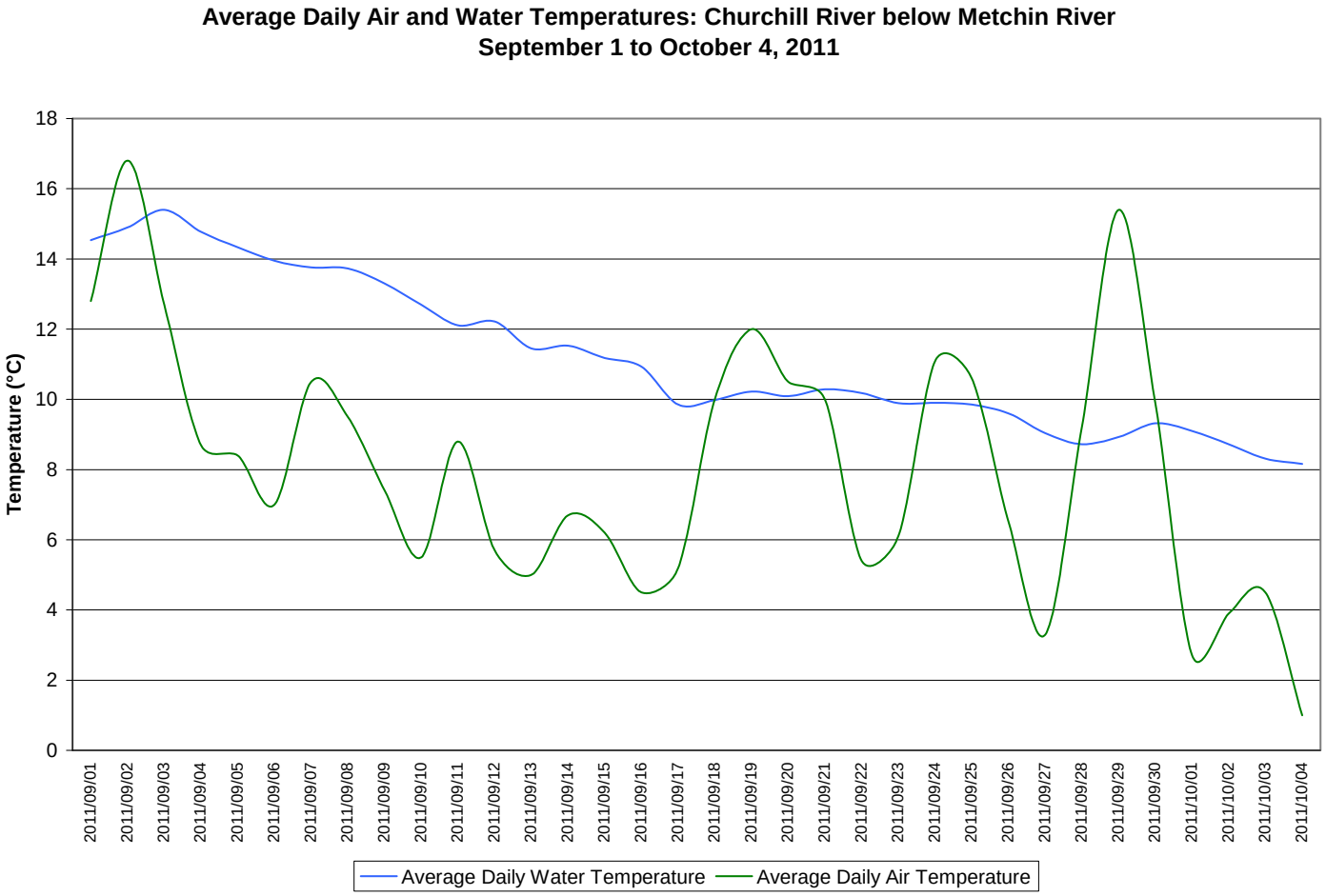


Figure 2: Average daily air and water temperatures at Churchill River below Metchin River (weather data recorded at Churchill Falls)

- pH typically ranges between 7.13 and 7.36 pH units and remains stable throughout the deployment period (Figure 3).
- pH drops significantly on September 21 for a period of 4 hours to as low as 5.94. This decrease occurs at the same time when the dissolved oxygen and turbidity sensors failed (Figures 5 and 6). The pH sensor appears only to have 'failed' for a period of 4 hours and recovers for the remainder of the deployment period.
- All values during the deployment, with the exception of the sharp decrease on September 21, are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

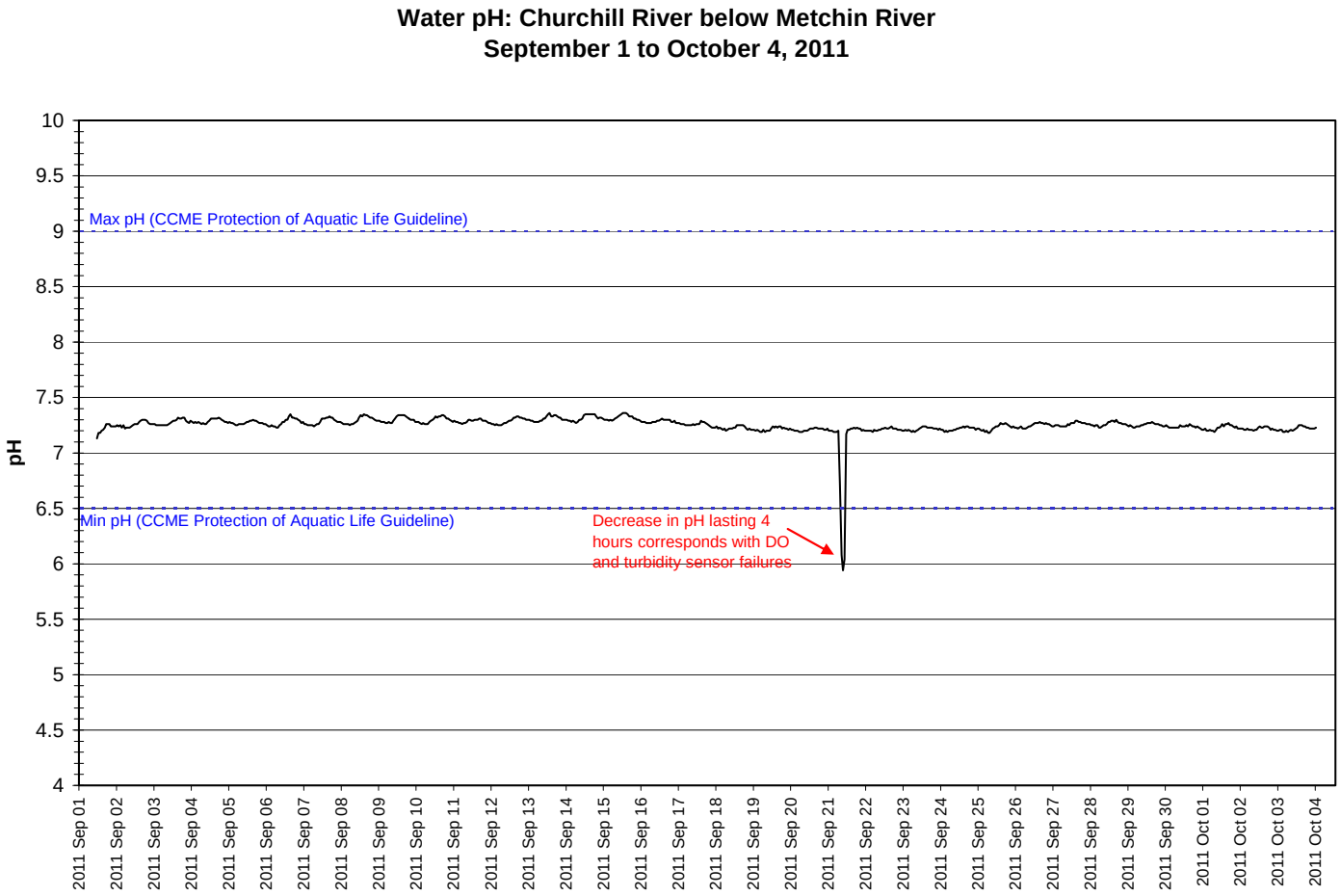


Figure 3: pH at Churchill River below Metchin River

- Specific conductivity ranges from 19.8 to 21.7µS/cm during the deployment period, averaging 20.7µS/cm (Figure 4). Specific conductivity decreases midway through the deployment period.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage decreases during the first two weeks before it increases mid way through the deployment period. Stage decreases again for the final 10 days of the deployment period. As stage decreases, specific conductivity generally increases due to the increased concentration of dissolved solids in the water column. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

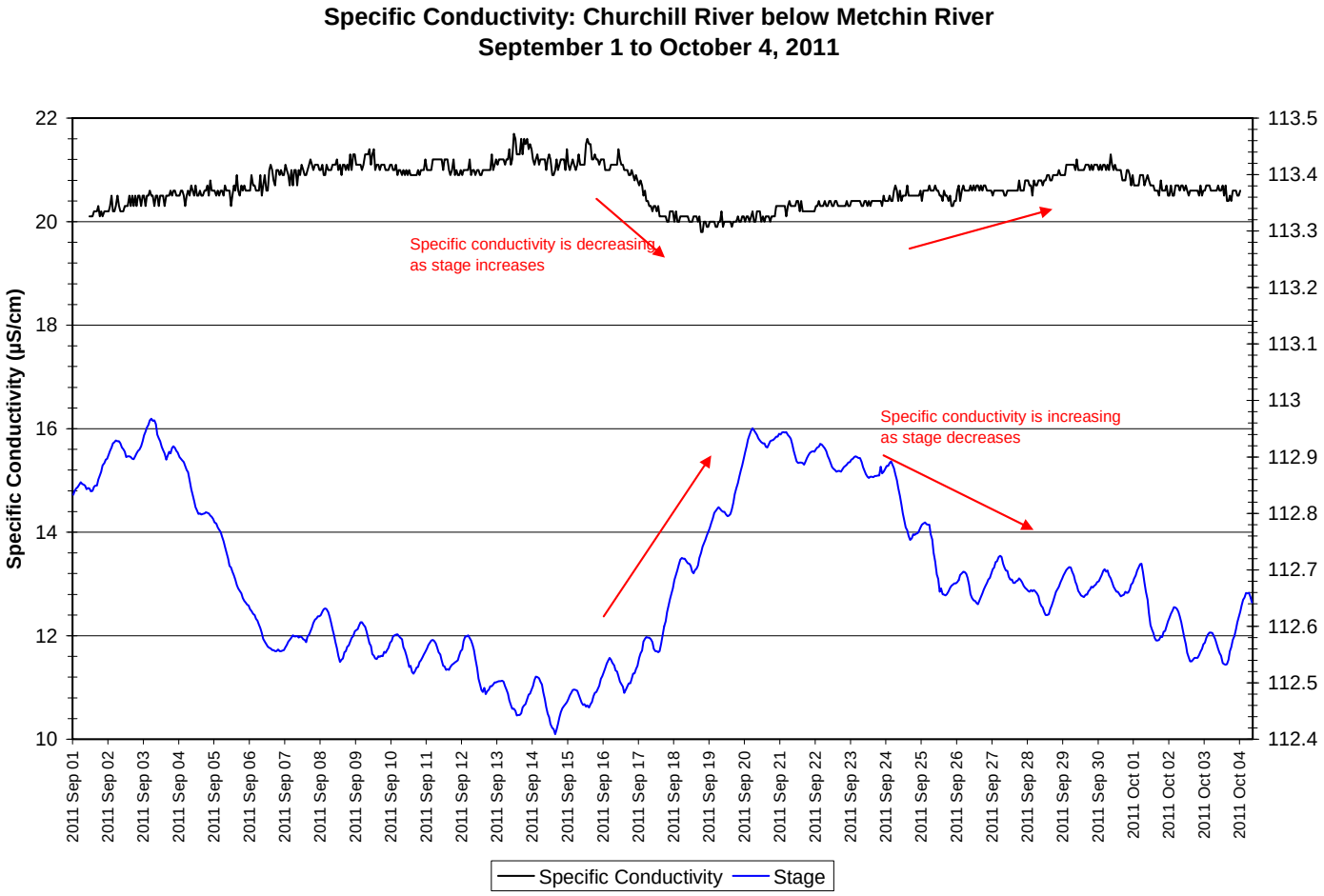


Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- The dissolved oxygen sensor failed on September 21, 2011. All data for dissolved oxygen concentration and percent saturation recorded after this date until the end of the deployment on October 4 has been removed from the dataset.

- Between September 1 and 21, the saturation of dissolved oxygen ranged from 90.7 to 97.3% and a range of 9.36 to 10.71mg/l was found in the concentration of dissolved oxygen with a median value of 9.86 mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. For the first week of the deployment period, dissolved oxygen values are at or just below the minimum CCME Guideline for the Protection of Aquatic Life at Early Life Stages. As the water temperature cools, dissolved oxygen content increases and remains above the guideline for the remainder of the deployment period. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is increasing slightly throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 2).

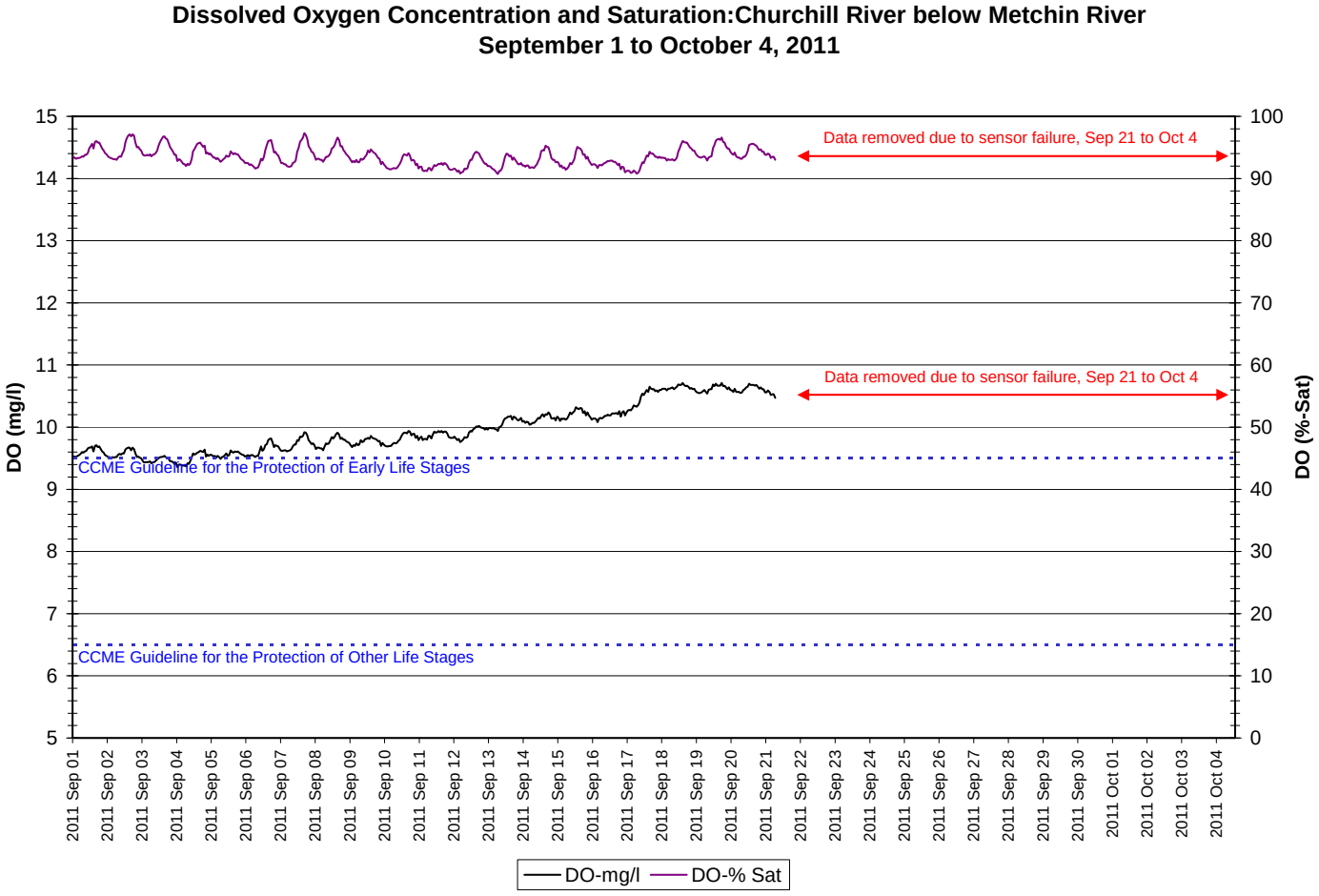


Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- The turbidity sensor failed on September 21, 2011. All data for turbidity recorded after this date until the end of the deployment on October 4 has been removed from the dataset.
- Between September 1 and 21, 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 11.0NTU) for very short periods of time (1-4 hours). These are not considered water quality events as they are isolated and infrequent occurrences.

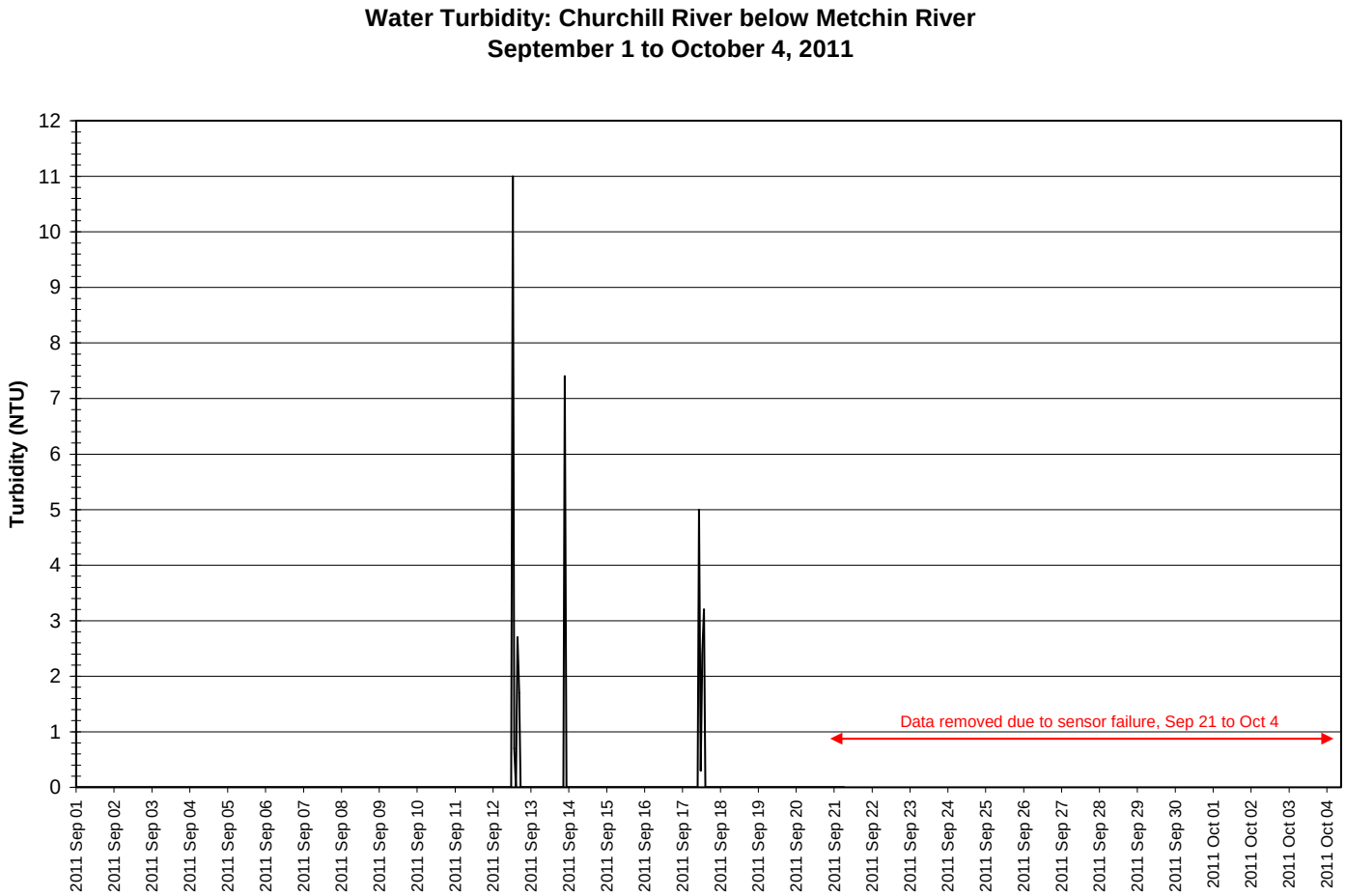


Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage decreases during the first two weeks, increases for a week and then decreases for the remaining 10 days. Precipitation records vary throughout the deployment period.

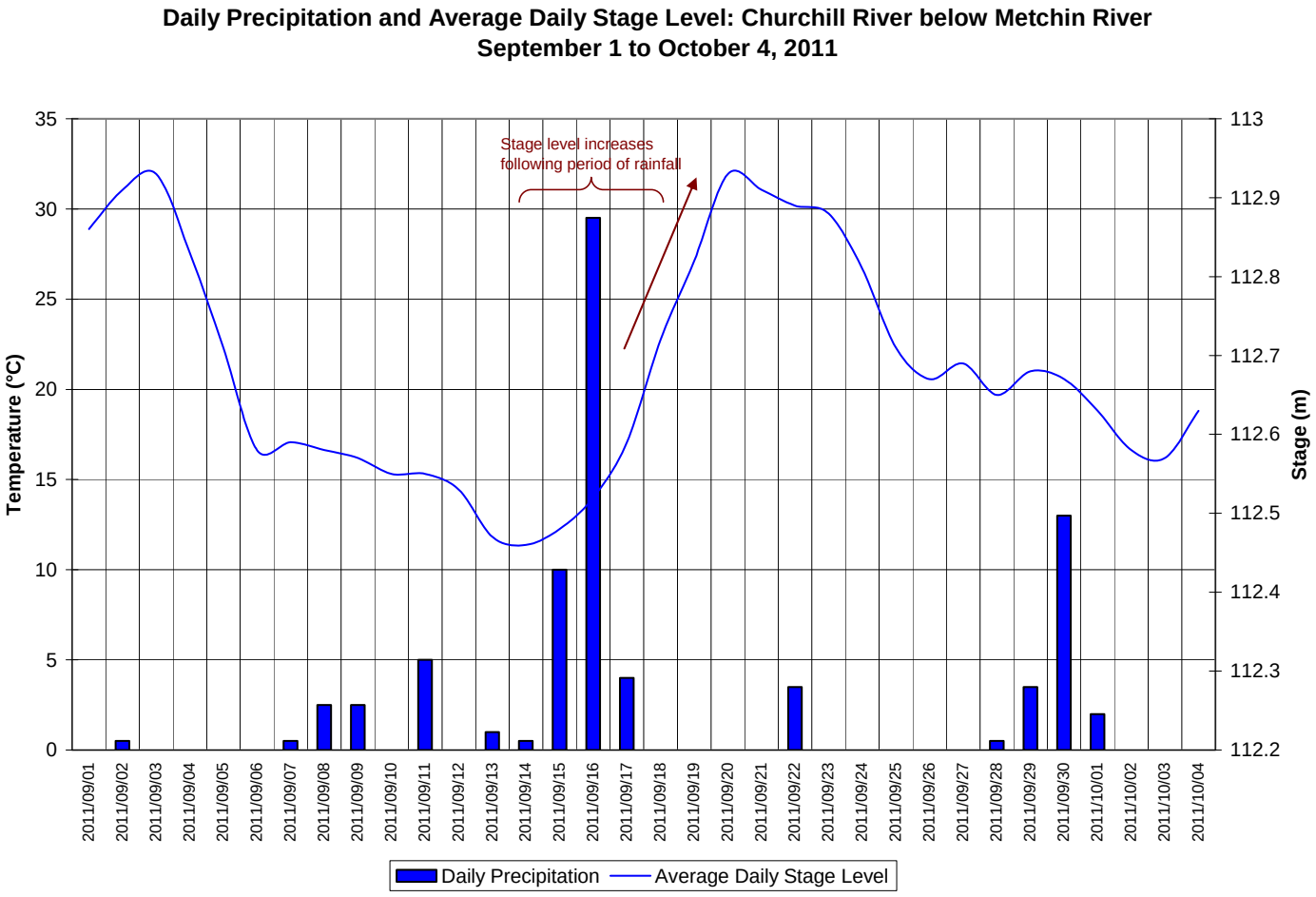


Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranged from 8.70 to 17.60^{o}C during this deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures in the fall season (Figure 9). Water temperature fluctuates diurnally.

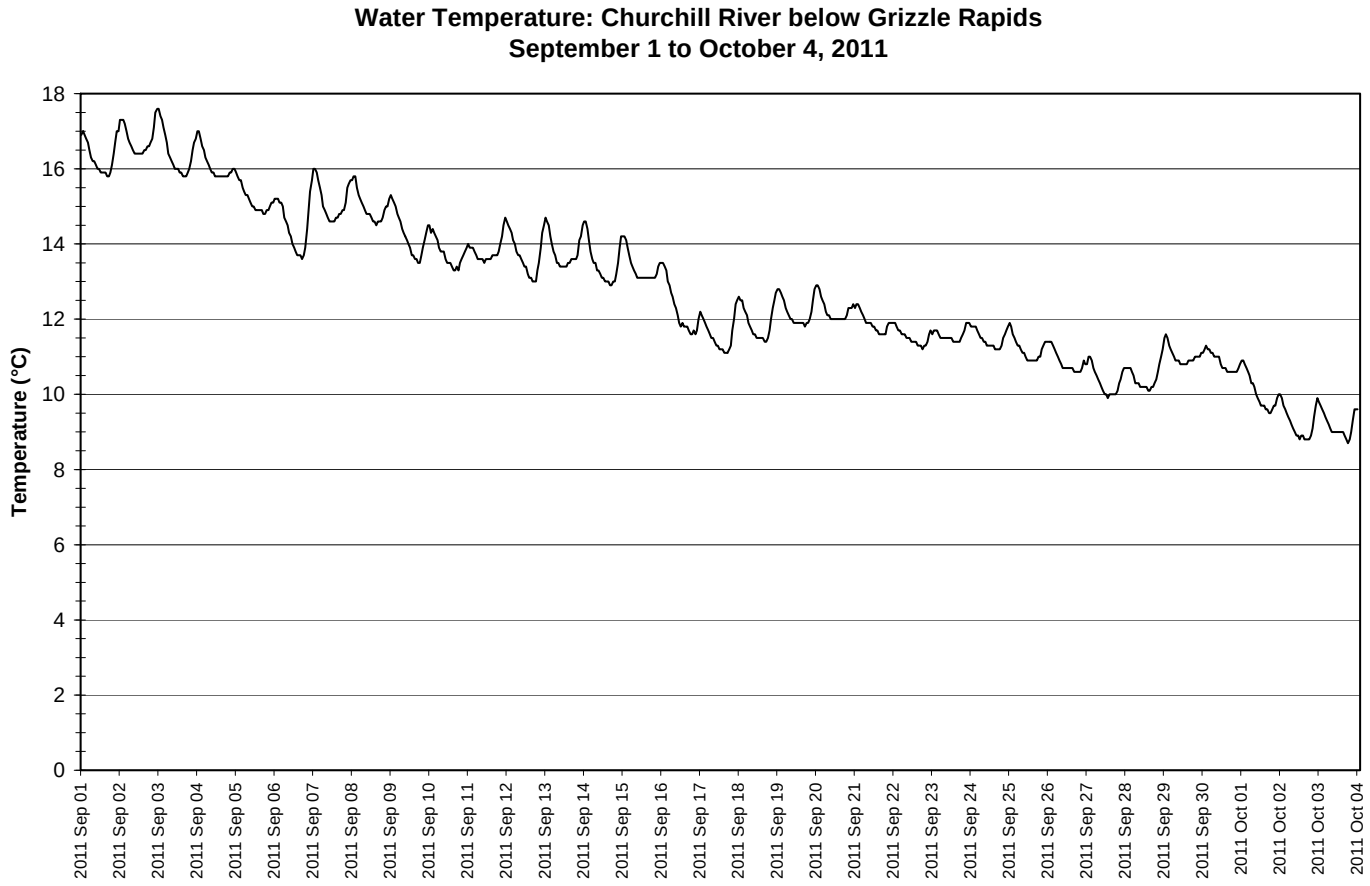


Figure 8: Water temperature at Churchill River below Grizzle Rapids

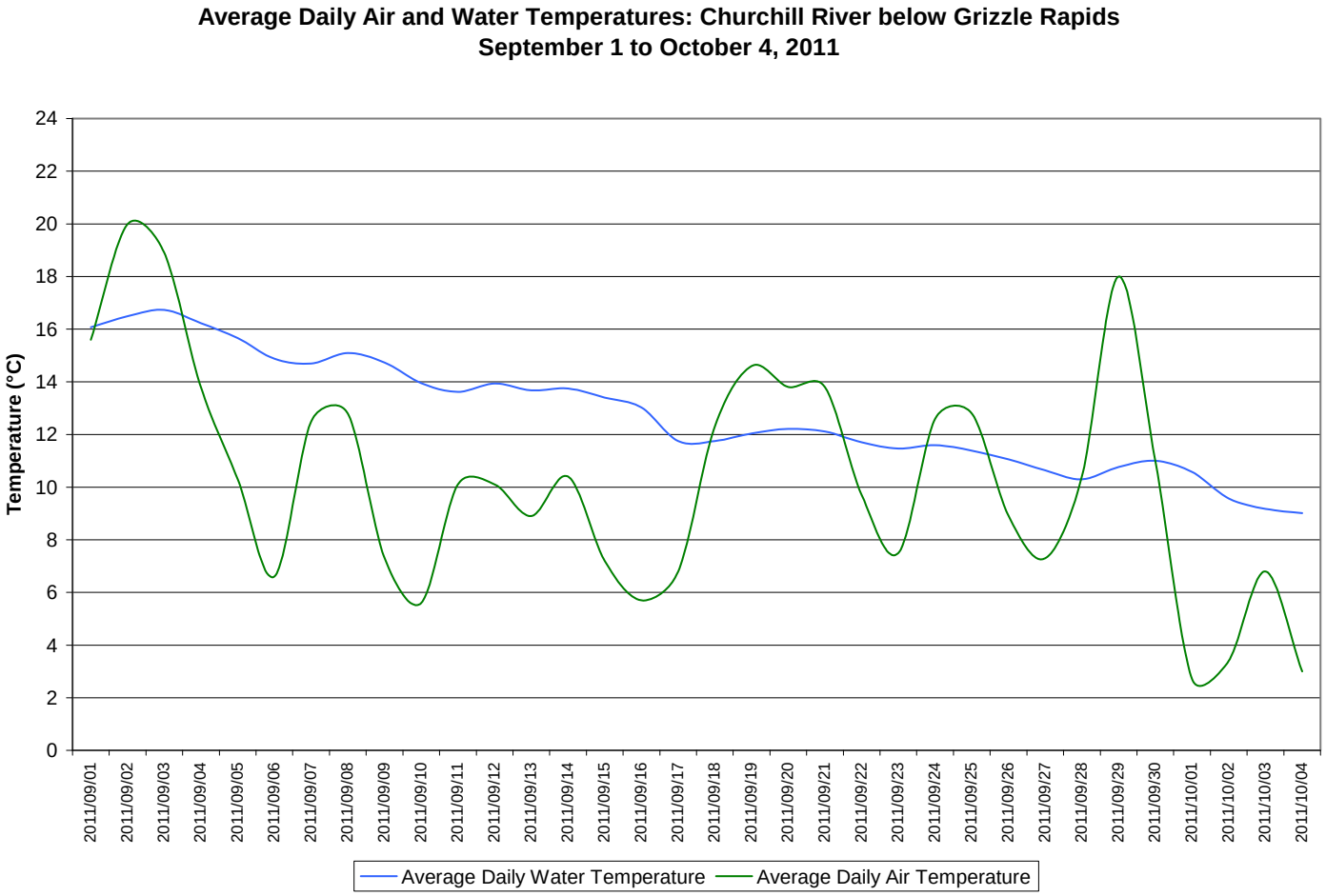


Figure 9: Average daily air and water temperatures at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 7.07 and 7.44 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).

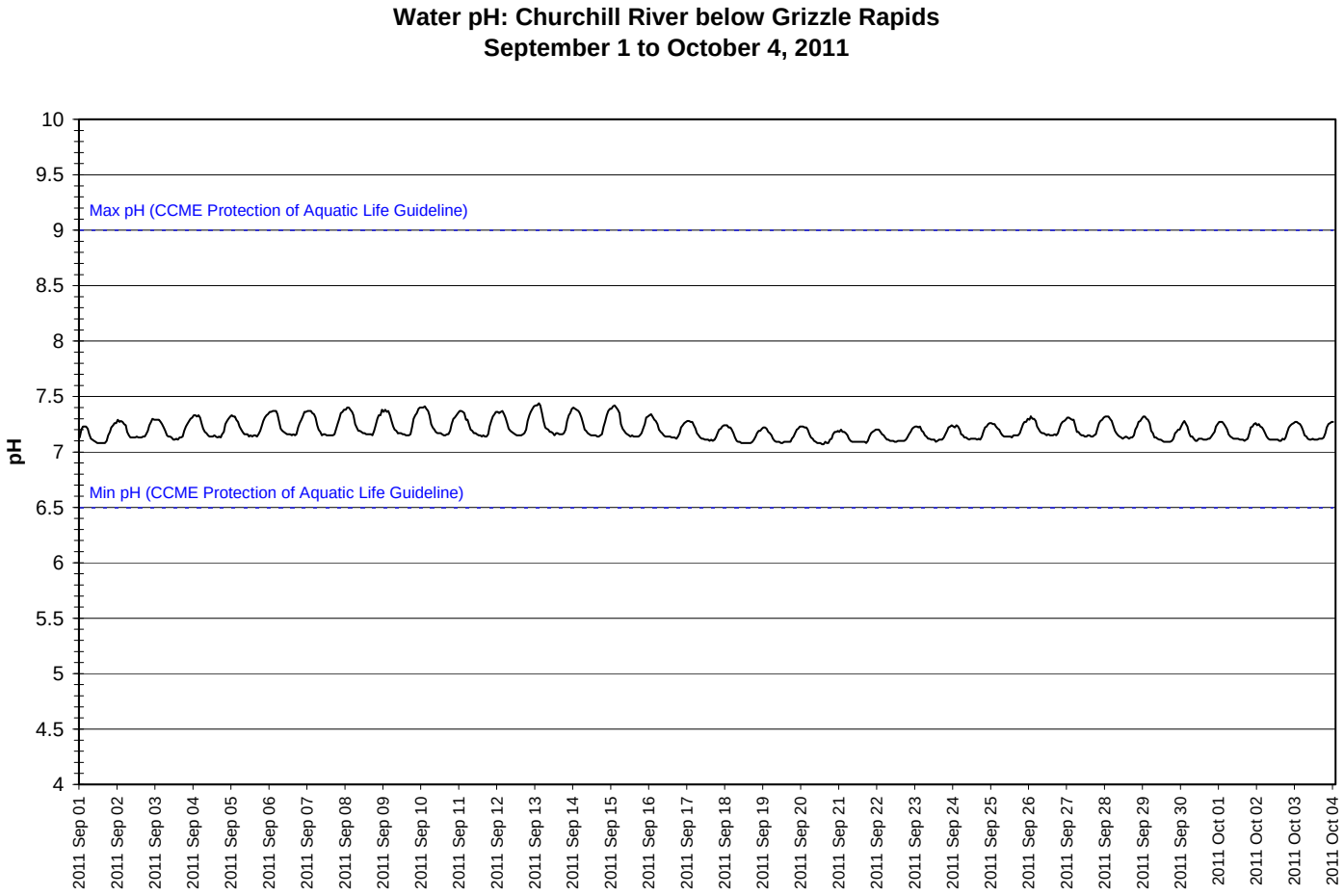


Figure 10: pH at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 16.2 to 17.8µS/cm during the deployment period (Figure 11). Specific conductance decreases mid way through the deployment period.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating throughout the deployment period. As stage increases midway through the deployment period, specific conductivity decreases. The reduction in water level increases the concentration of dissolved solids in the water column consequently increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

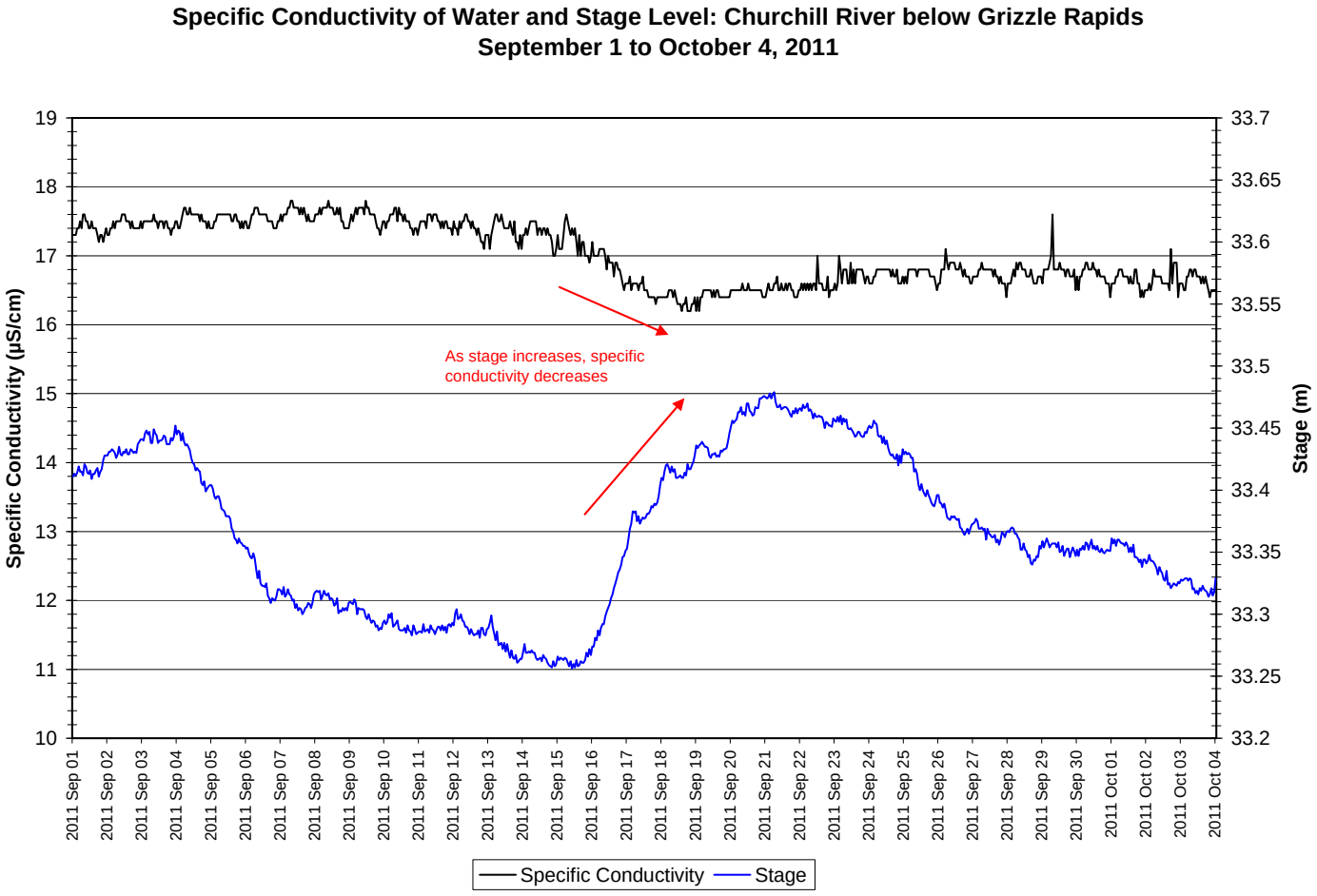


Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- The saturation of dissolved oxygen ranged from 92.5 to 101.9% and a range of 9.29 to 11.42mg/l was found in the concentration of dissolved oxygen with a median value of 9.39mg/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. For the first week of the deployment period, dissolved oxygen values are at or just below the minimum CCME Guideline for the Protection of Aquatic Life at Early Life Stages. As the water temperature cools, dissolved oxygen content increases and remains above the guideline for the remainder of the deployment period. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 9).

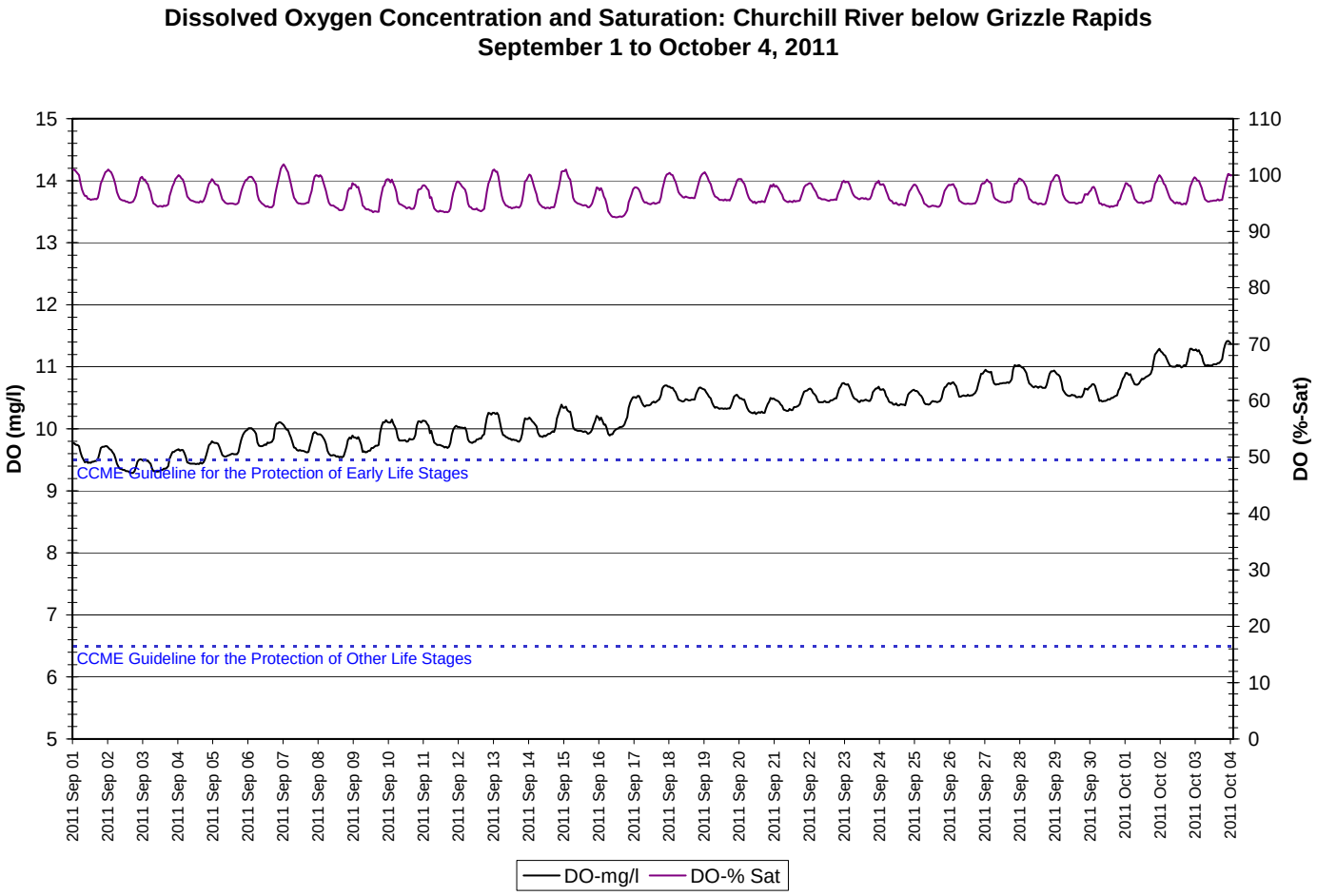


Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values remain at 0NTU for the entire length of the deployment period (Figure 13). There is generally no natural background turbidity value at this station.

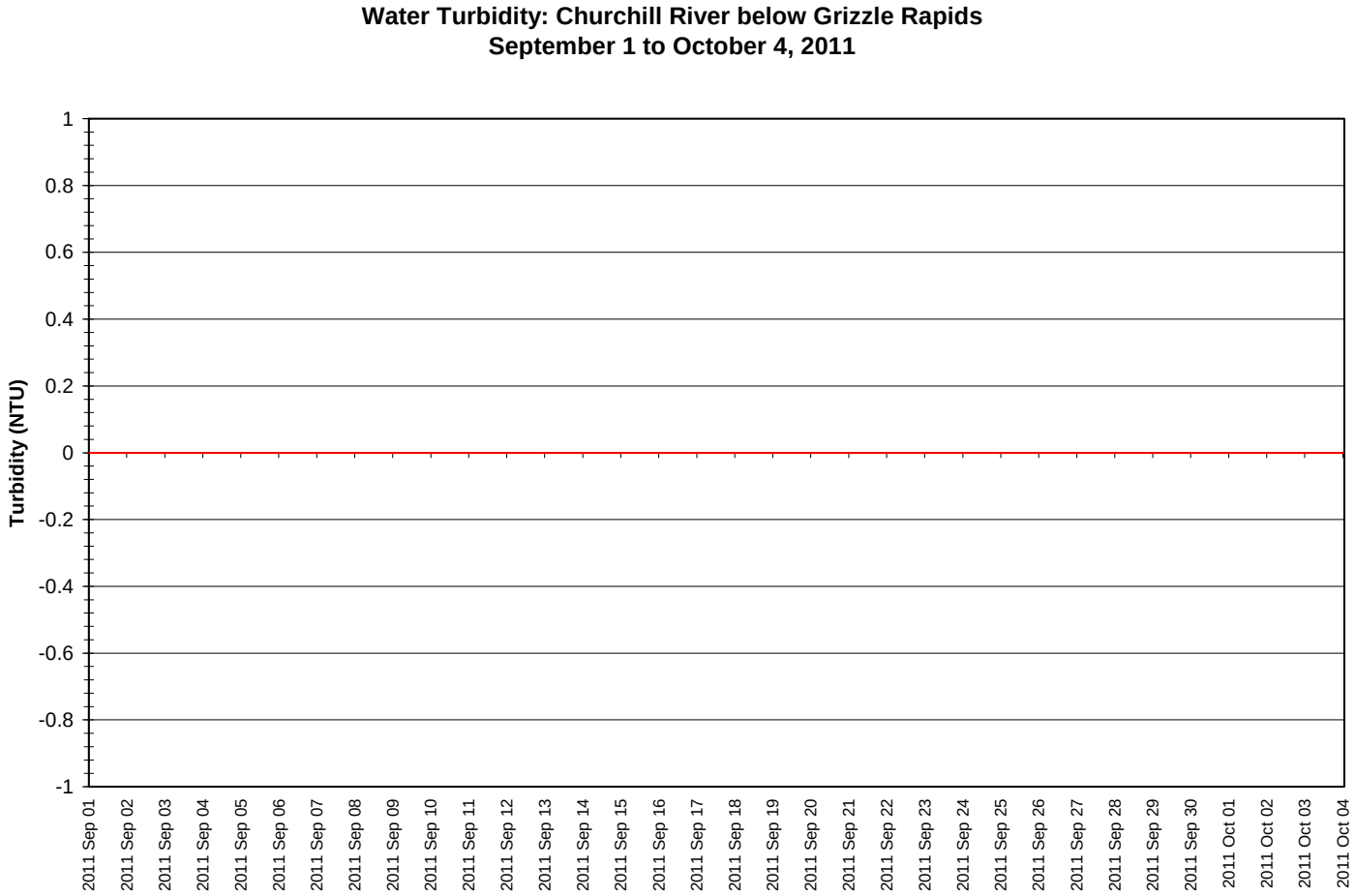


Figure 13: Turbidity and stage level at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage decreases during the first two weeks, increases for a week and then decreases for the remaining 10 days. Precipitation records vary throughout the deployment period.

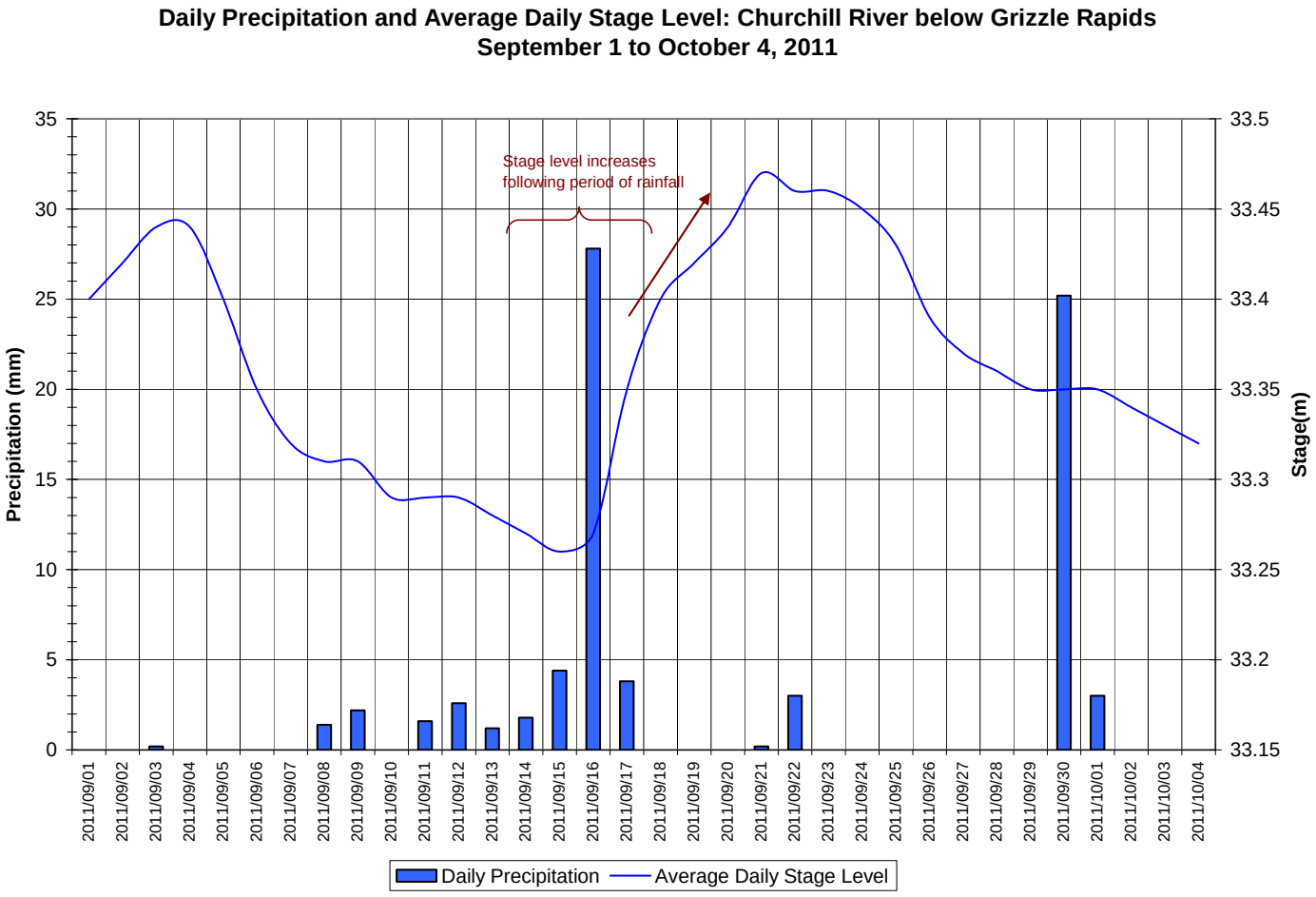


Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 8.89 to 17.28^{o}C during this deployment period (Figure 15).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall (Figure 16). Water temperature fluctuates diurnally.

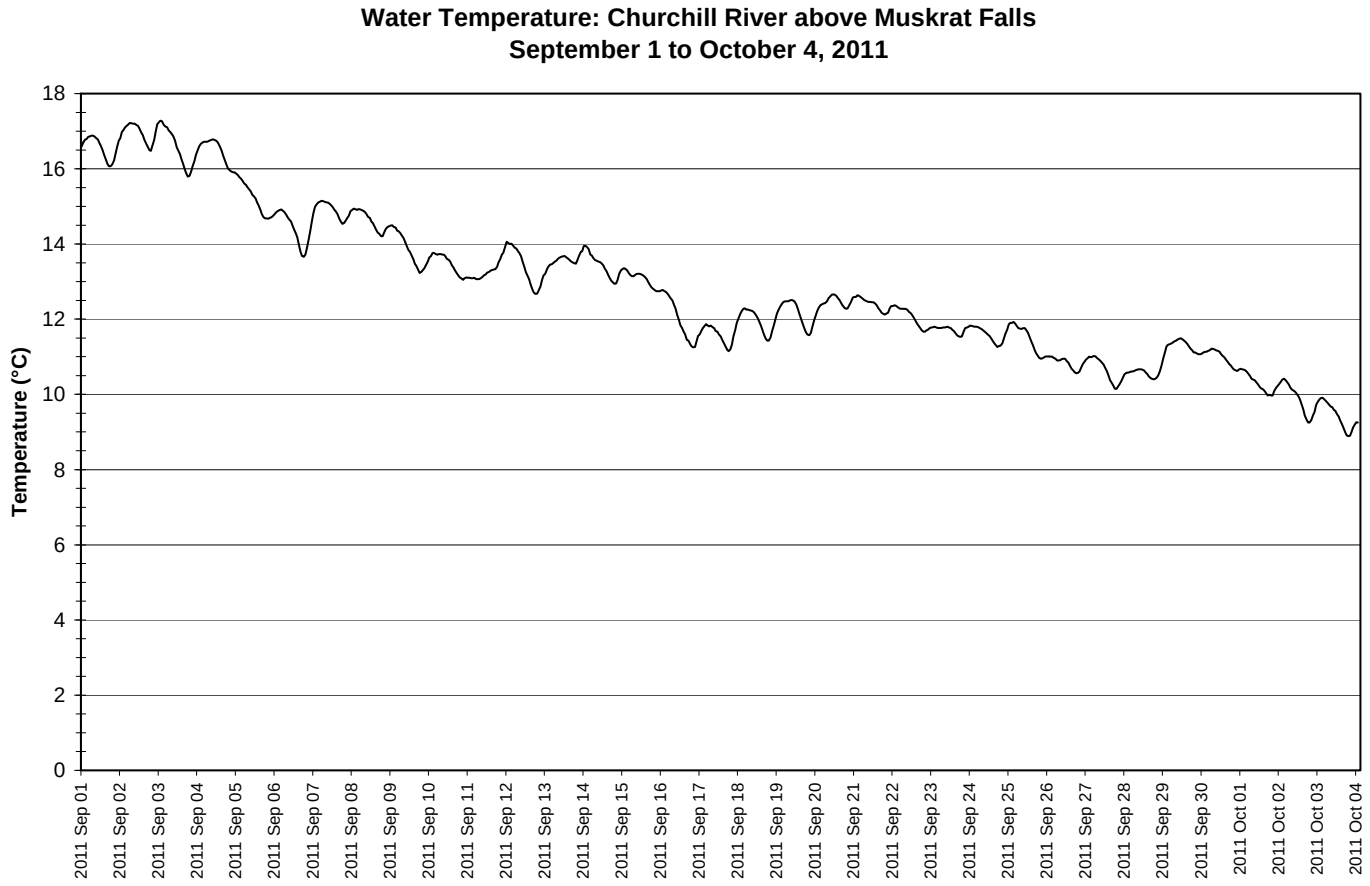


Figure 15: Water temperature at Churchill River above Muskrat Falls

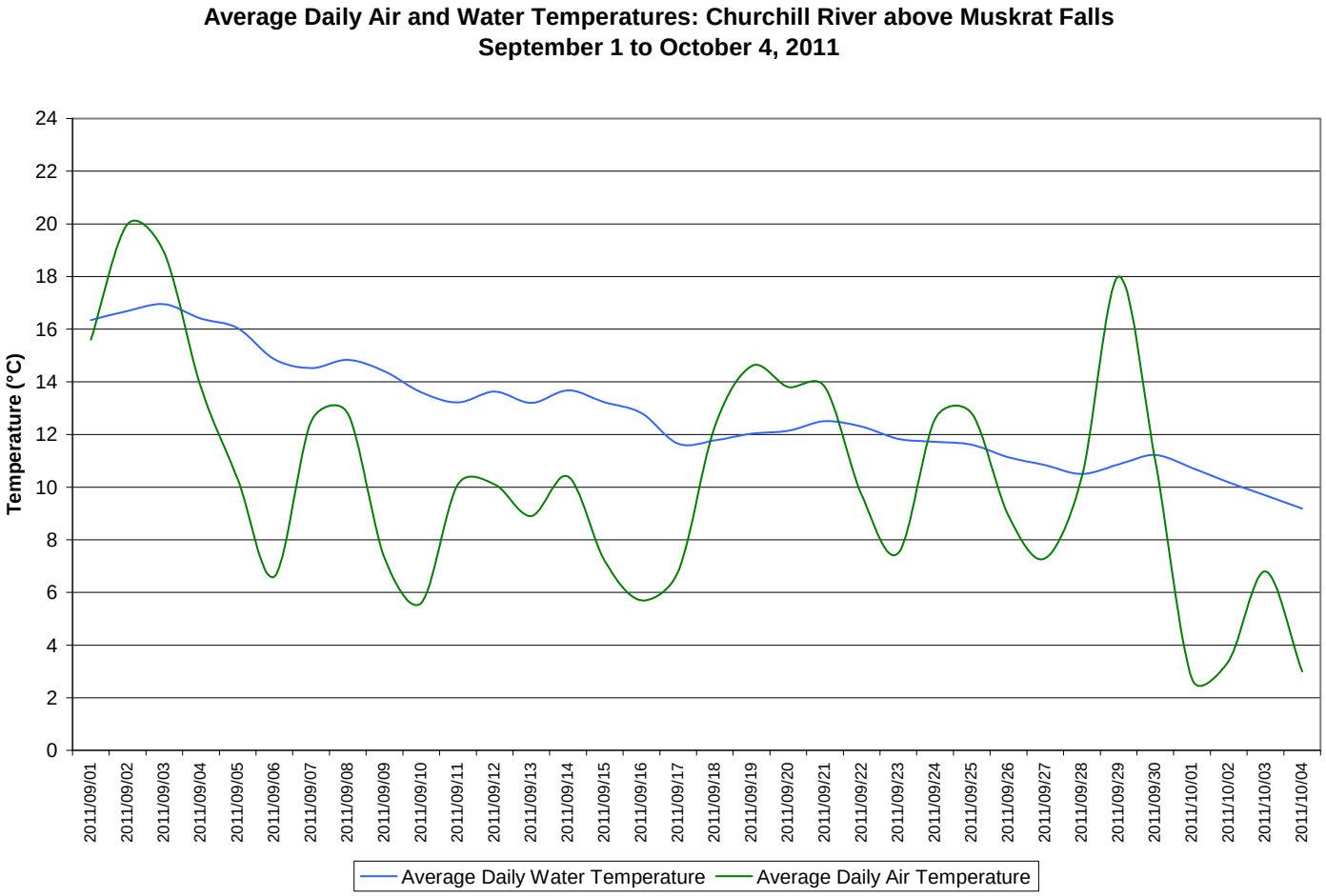


Figure 16: Average daily air and water temperatures at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 7.16 and 7.36pH units (Figure 17). pH values are very stable throughout the deployment period.
- All values are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

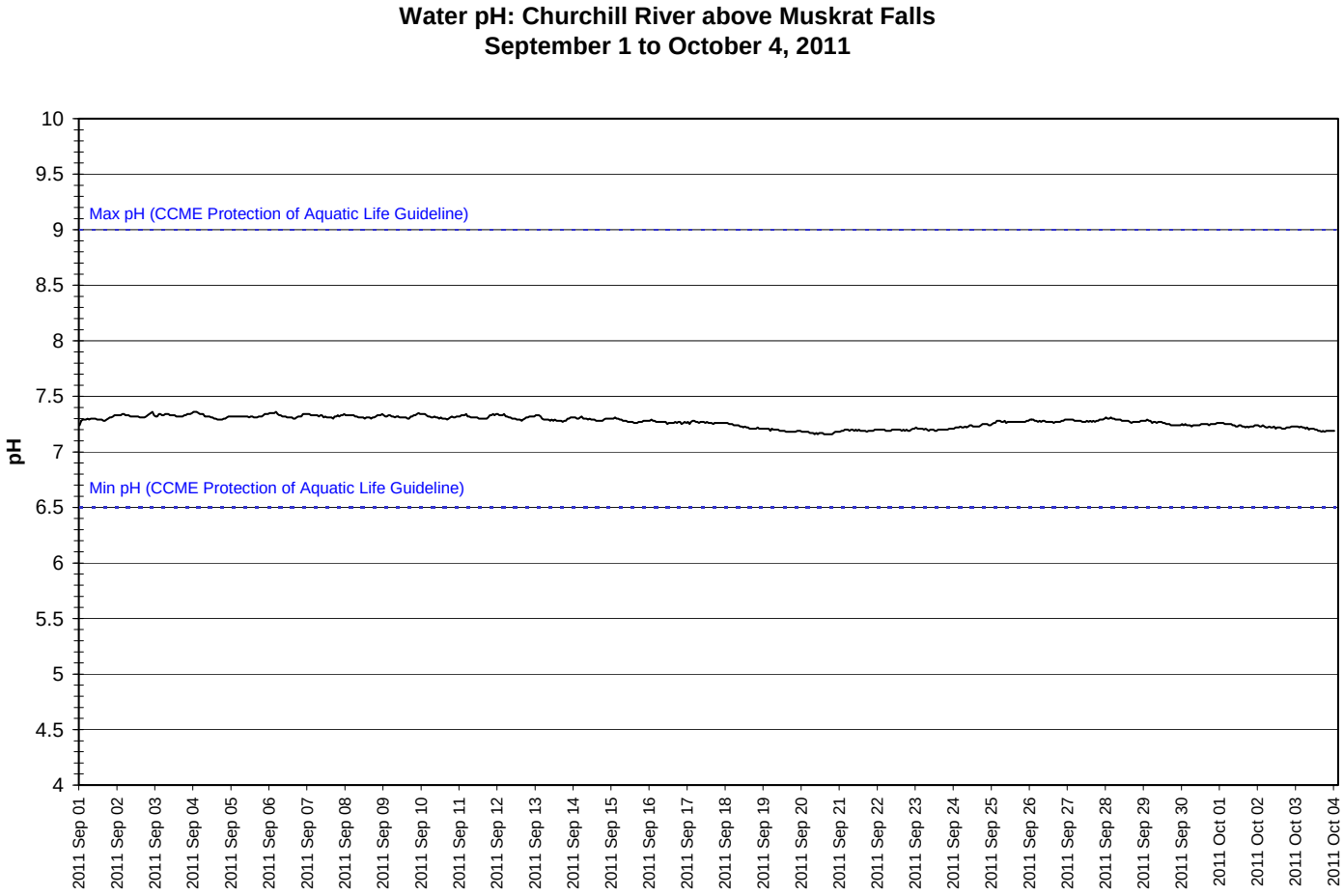


Figure 17: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges from 12.0 to 13.5µS/cm during the deployment period (Figure 18). Specific conductance decreases mid way through the deployment period.
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating throughout the deployment period. As stage increases midway through the deployment period, specific conductivity decreases. The reduction in water level increases the concentration of dissolved solids in the water column consequently increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

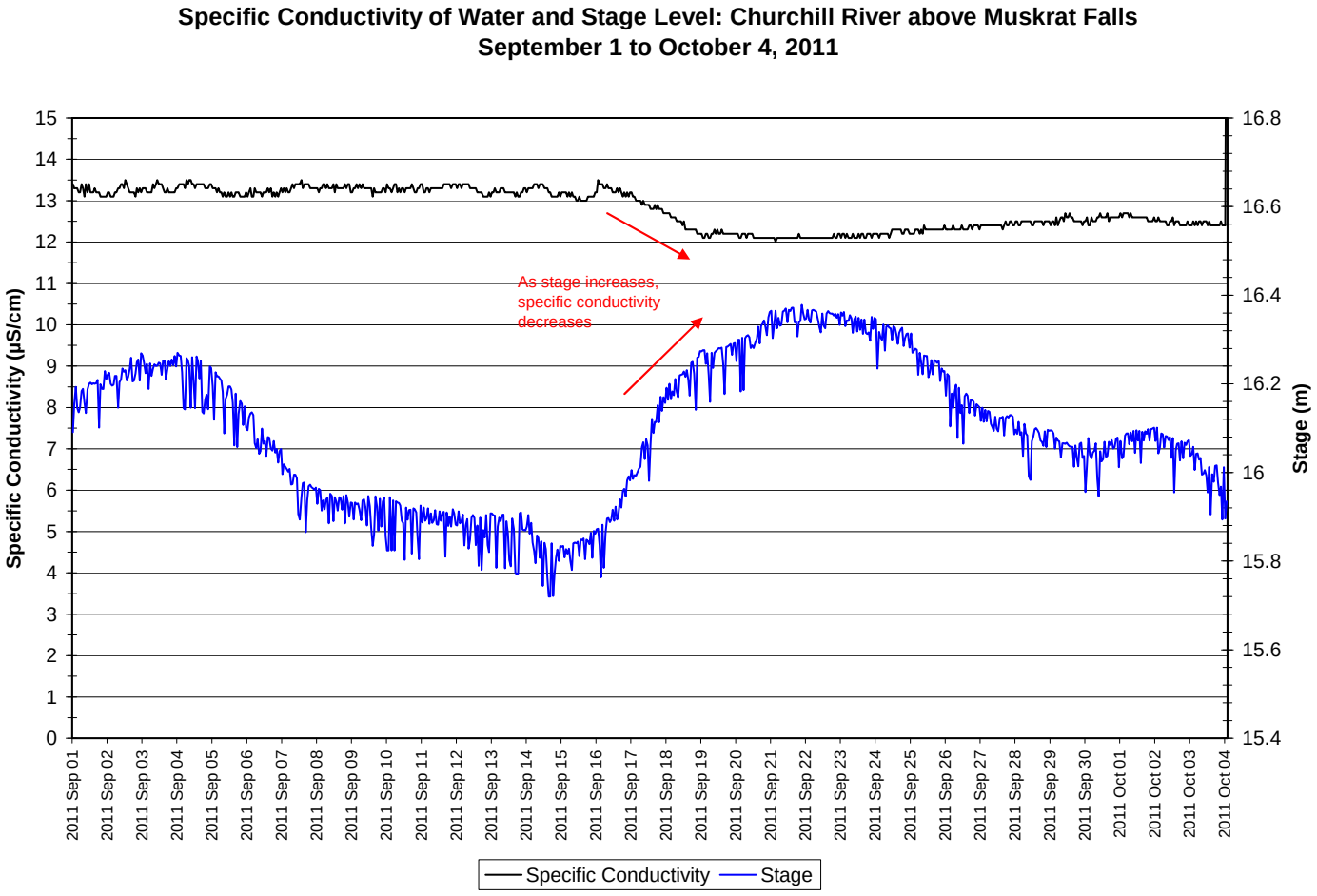


Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 92.3 to 99.0% and a range of 9.28 to 11.07mg/l was found in the concentration of dissolved oxygen with a median value of 10.25mg/l (Figure 19).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5mg/l. For the first week of the deployment period, dissolved oxygen values are at or just below the minimum CCME Guideline for the Protection of Aquatic Life at Early Life Stages of 9.5mg/l. As the water temperature cools, dissolved oxygen content increases and remains above the guideline for the remainder of the deployment period. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 16).

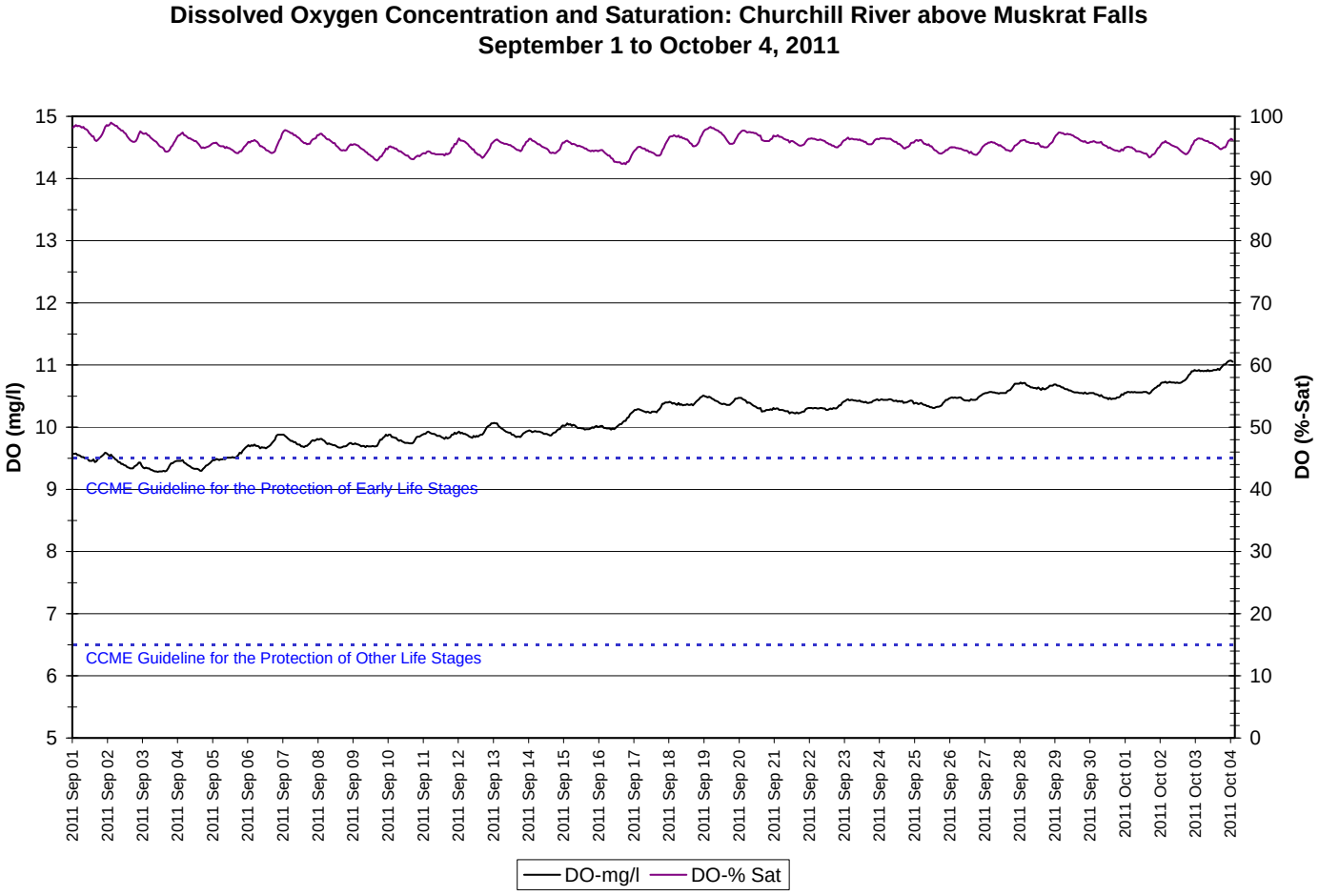


Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 1.0 and 100.0NTU, averaging 8.9NTU (Figure 20). A median value of 5.0NTU indicates there is a consistent natural background turbidity value at this station.
- There are a couple of instances where turbidity does spike to above average values. On September 7, turbidity spikes to nearly 700NTU for a period of one hour. On September 8-9, turbidity periodically spikes to above 100NTU for one hour at a time. The cause of these increases is unknown.
- There are several other turbidity spikes at lower magnitudes. Between September 12 and 19, turbidity increase correspond with rainfall events. Later in the deployment period on September 25 and October 3, turbidity increases occur without explanation.

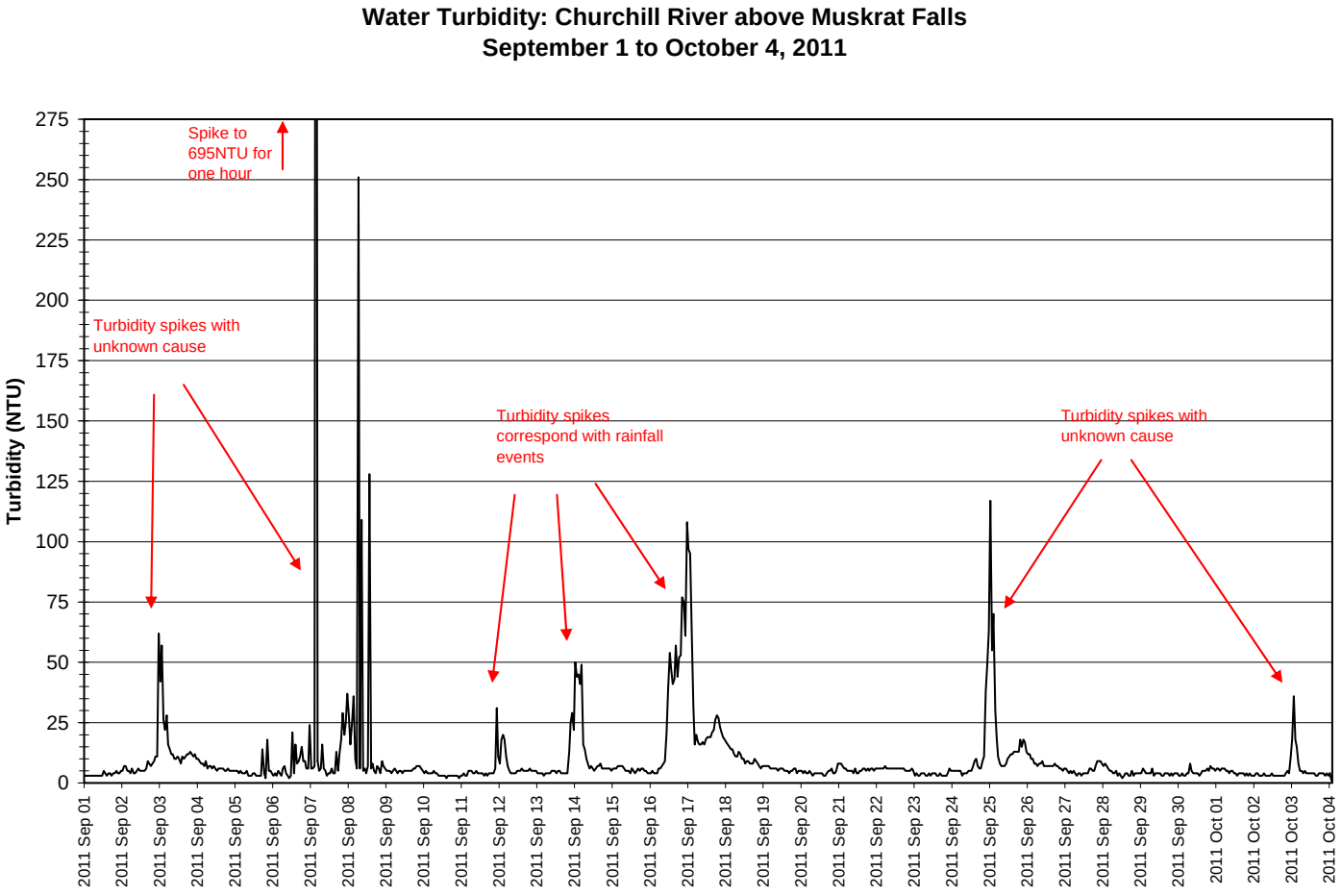


Figure 20: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage decreases during the first two weeks, increases for a week and then decreases for the remaining 10 days. Precipitation records vary throughout the deployment period.

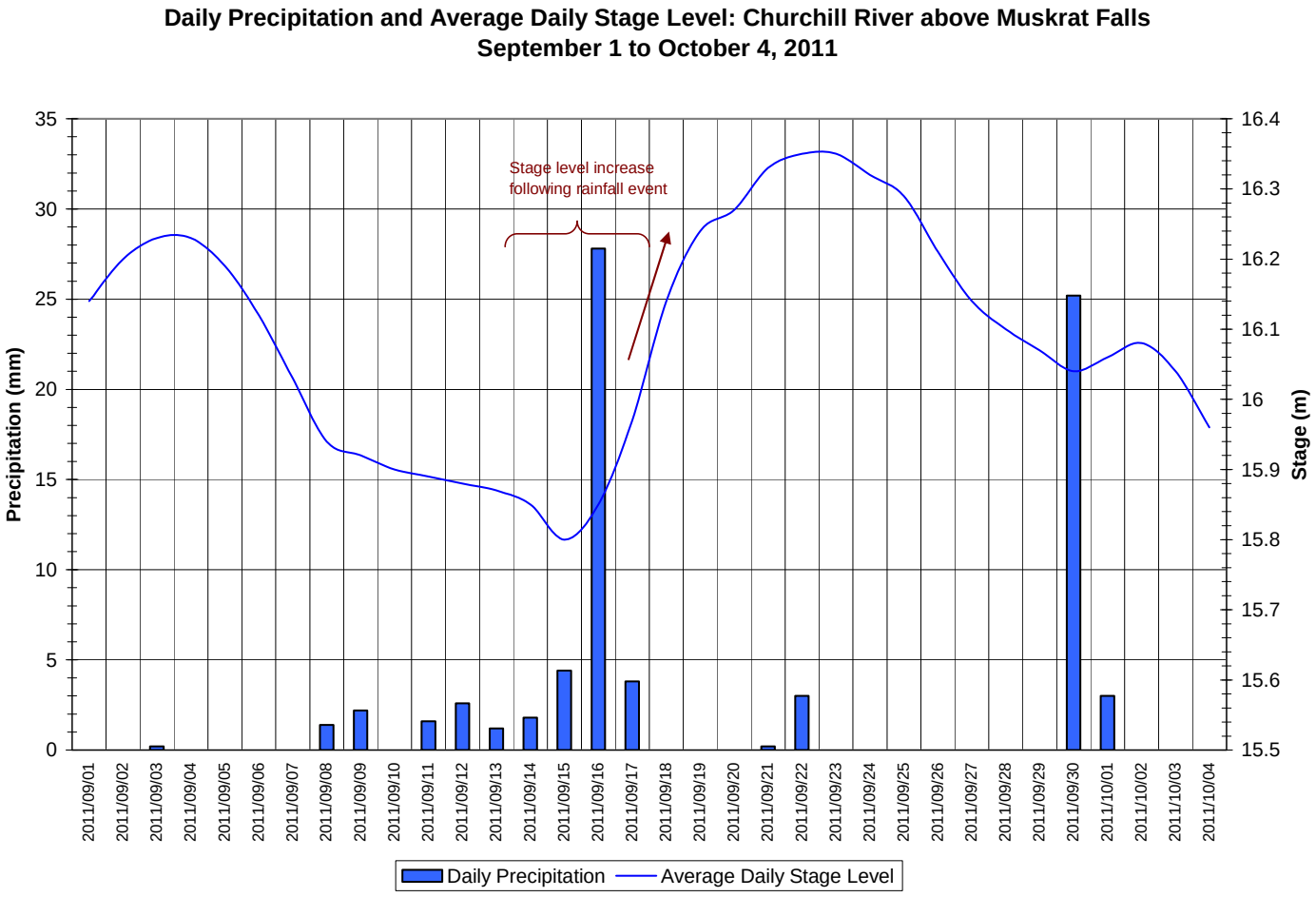


Figure 21: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The instrument deployed on September 1 experienced a dissolved oxygen sensor failure. The instrument was removed the following day, September 2, and replaced with a new instrument. Data collected for temperature, pH, specific conductivity and turbidity during September 1-2 is included in the discussion below. Dissolved oxygen, percent saturation and specific conductivity values have been removed from the data set during this time as the instrument was reporting inaccurate values.
- Water temperature ranges from 9.10 to 17.40^{o}C during this deployment period (Figure 22).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall season (Figure 23). Water temperature fluctuates diurnally.

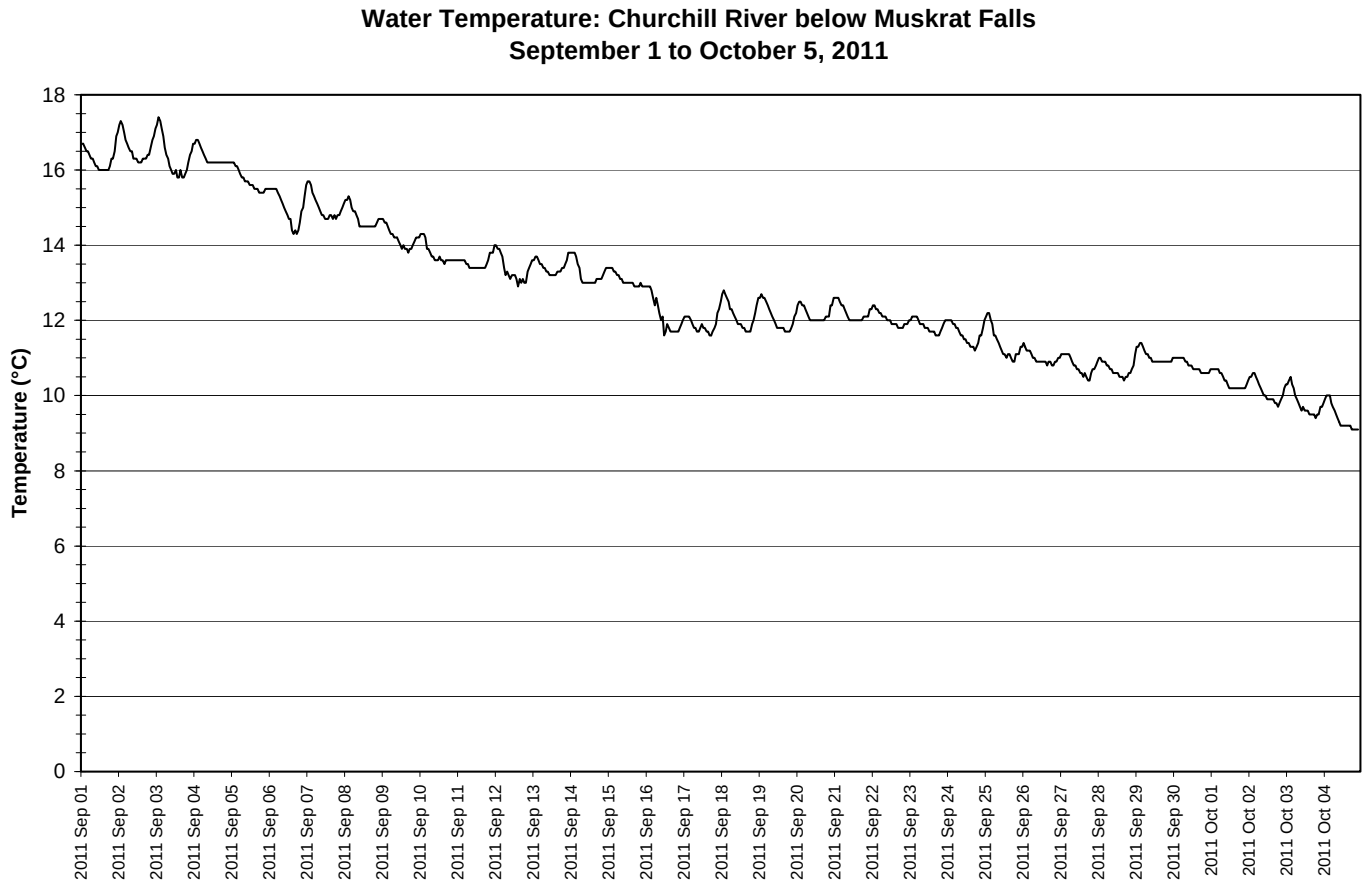


Figure 22: Water temperature at Churchill River below Muskrat Falls

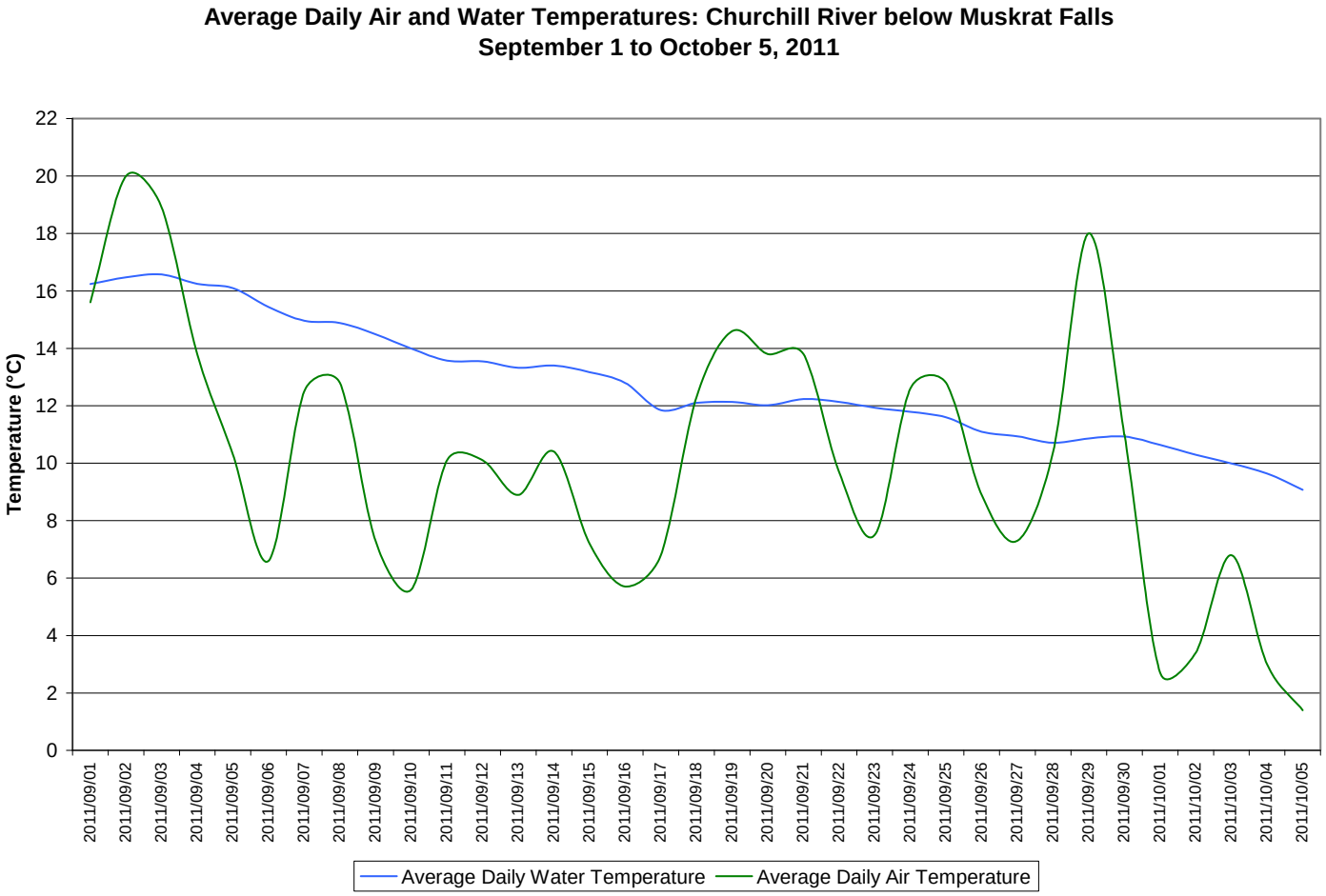


Figure 23: Average daily air and water temperatures at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 6.87 and 7.58 pH units (Figure 24). pH values generally remain stable and begin to decrease slightly near the end of 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).
- There is an increase in pH on September 14 that lasts for 6 hours. The cause of this increase is unknown. There is another increase on September 16-17 which corresponds with a significant rainfall event September 16-18.
- pH begins to decrease slightly near the end of the deployment period and may be a result of sensor drift.

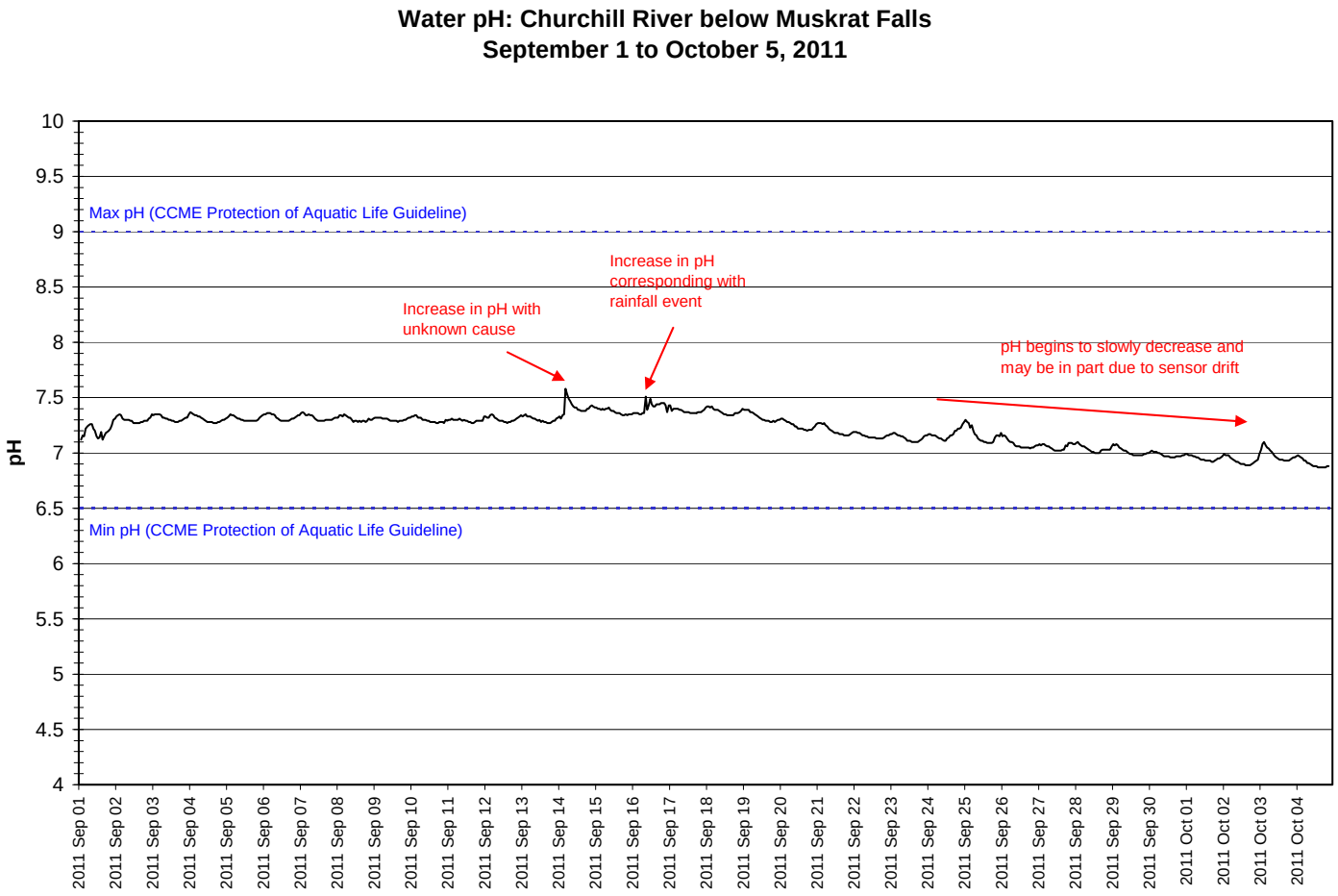


Figure 24: pH at Churchill River below Muskrat Falls

- Specific conductance generally remains between 18.1 and 20.8µS/cm, averaging 19.79µS/cm (Figure 25). Specific conductivity is generally stable throughout the deployment period and decreases in the middle of September.
- There are three occasions where specific conductivity drops below the average range. On September 17, values decrease sharply for about 8 hours. This decrease corresponds with a significant rainfall event and an increase in stage level. On September 25, specific conductivity decreases again sharply for another 8 hour period. This decrease does not correspond with a rainfall event and stage is decreasing at this time. A short (1 hour) decrease in specific conductivity occurs on October 3 and does not correspond with any weather related events.
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating throughout the deployment period. As stage increases midway through the deployment period, specific conductivity decreases. The reduction in water level increases the concentration of dissolved solids in the water column consequently increasing the specific conductivity. Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.

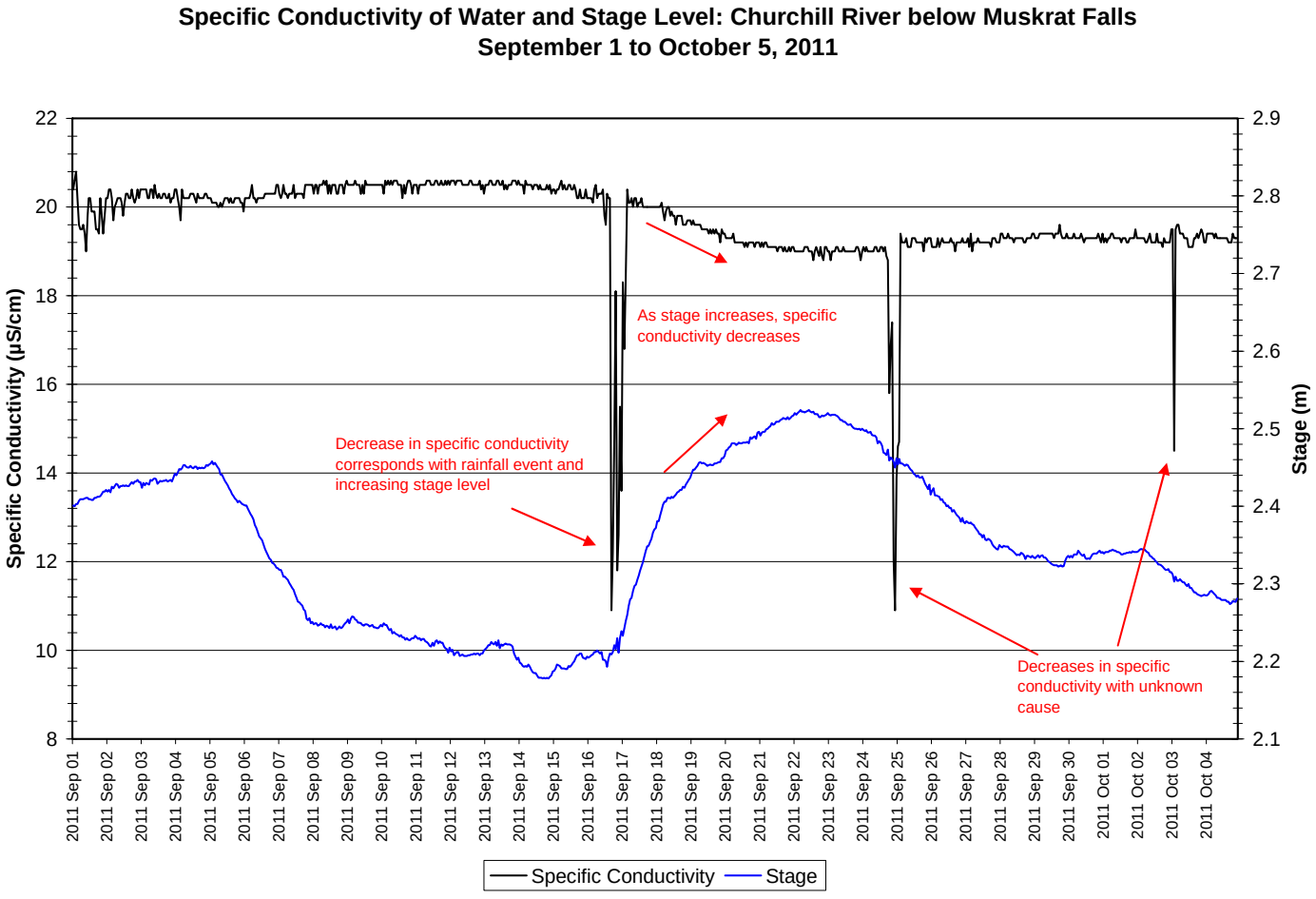


Figure 25: Specific conductivity and stage level at Churchill River below Muskrat Falls

- The dissolved oxygen sensor failed on September 13, 2011. All data for dissolved oxygen concentration and percent saturation recorded after this date until the end of the deployment on October 5 has been removed from the dataset.
- Between September 1 and 13, the saturation of dissolved oxygen ranged from 99.7 to 109.5% and a range of 9.82 to 11.00mg/l was found in the concentration of dissolved oxygen with a median value of 10.64 mg/l (Figure 26).
- All values were above both the minimum CCME Guidelines for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 26.
- Dissolved oxygen content is increasing slightly throughout the first part of the deployment period. This trend is expected given the cooling air and water temperatures during the fall season (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.

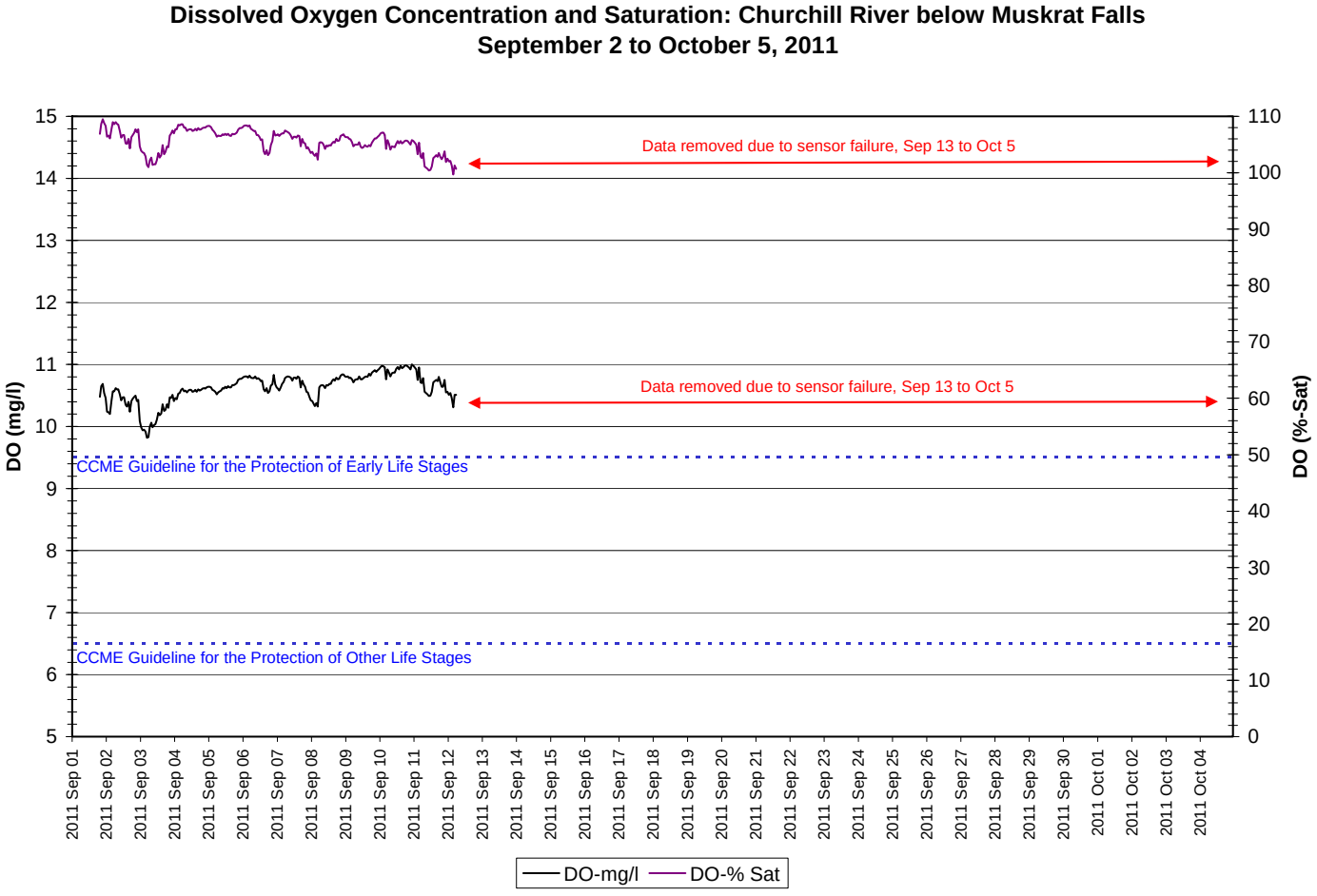


Figure 26: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- The turbidity sensor failed on September 13, 2011. All data for turbidity recorded after this date until the end of the deployment on October 5 has been removed from the dataset.
- Between September 1 and 13, turbidity generally remains at <40NTU (Figure 27). A median value of 4.5 NTU indicates there is a consistent natural background turbidity value at this station.
- There are several instances where turbidity increases (to over 400NTU) however these increases are usually for very short periods of time (1-4 hours). No significant rainfall events occur during the time the sensor was working properly. It is unknown what caused these increases.

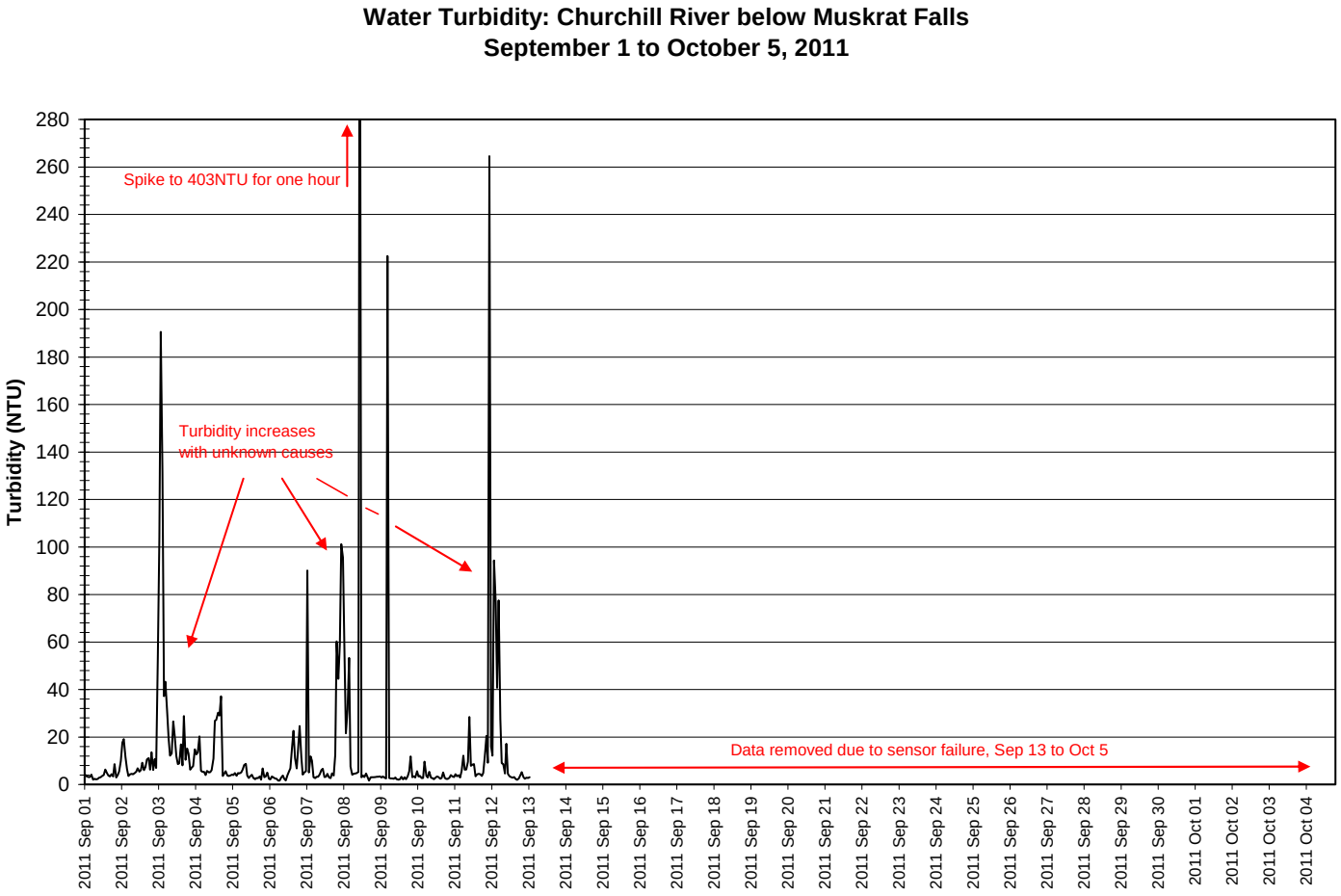


Figure 27: Turbidity at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 28). Stage decreases during the first two weeks, increases for a week and then decreases for the remaining 10 days. Precipitation records vary throughout the deployment period.

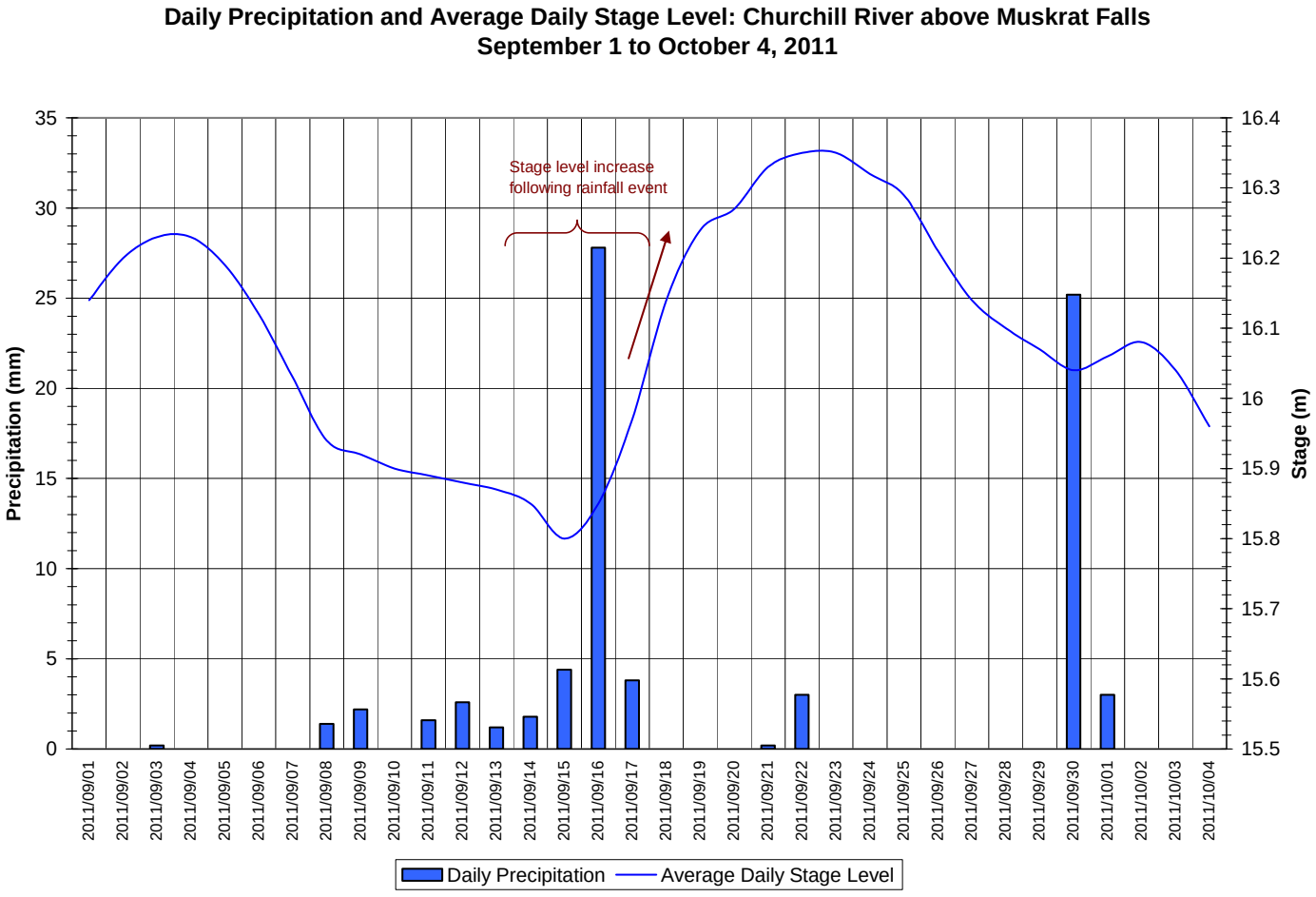


Figure 28: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

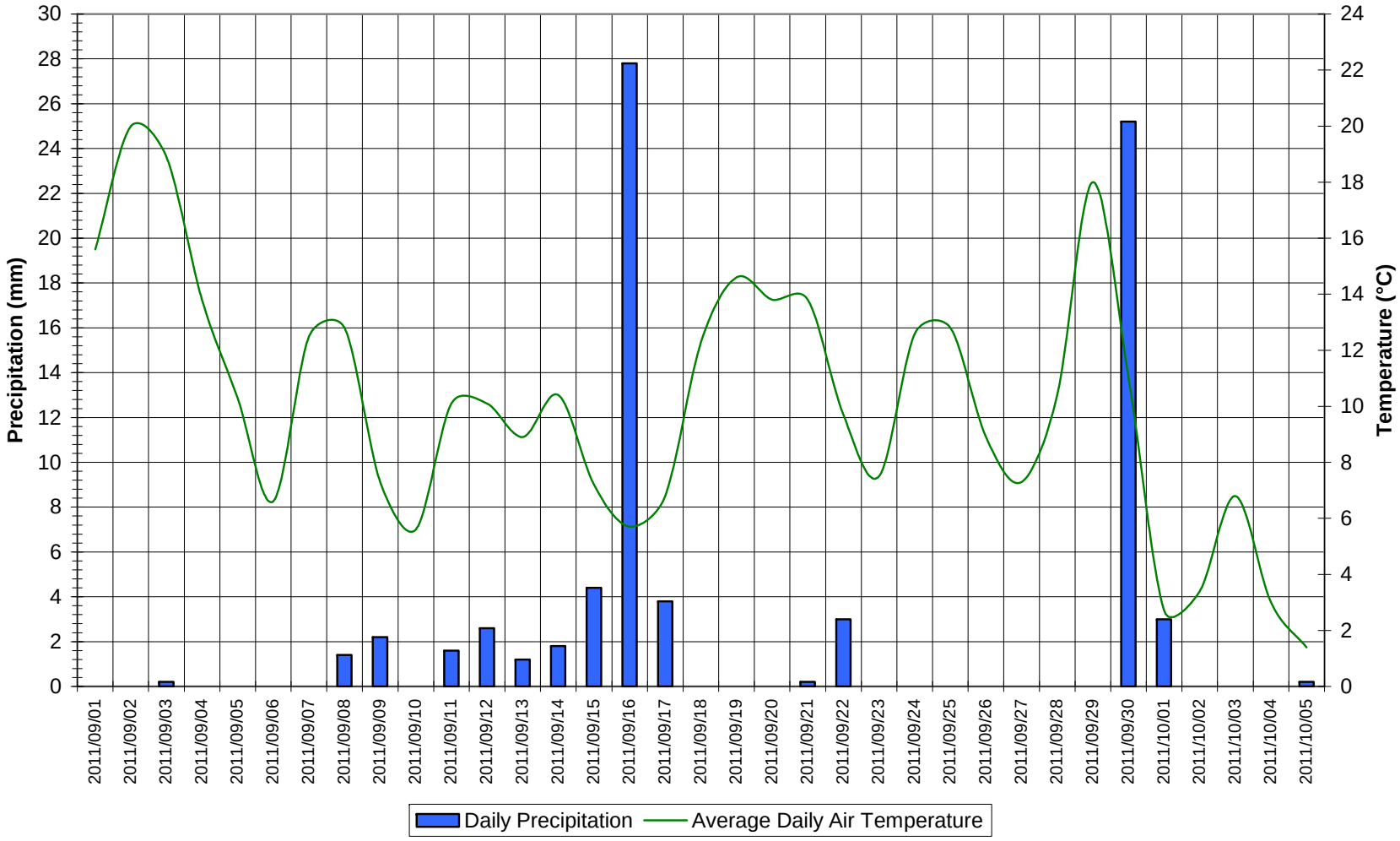
Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from September 1 to October 4/5, 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 decreased for the first 2 weeks of the deployment period followed by an increase for 1 week. Stage then steadily decreases for the remainder of the period.
- Water temperature was decreasing consistently at all stations throughout the deployment period due to the cooling ambient air temperatures in the region during the fall season. Water temperature typically ranged between 8°C and 17°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life and very consistent at all stations. There was a decrease in pH lasting 6 hours which was only noticeable at the station furthest upstream below Metchin River. The instrument deployed at the station below Muskrat Falls may have experienced sensor drift near the end of the deployment period showing slightly decreasing values.
- Specific conductivity was generally stable at all stations, ranging between 18 and 20µS/cm. Specific conductance dropped mid way through the deployment period at all stations which corresponded well with an increase in stage level.
- Dissolved oxygen content was increasing throughout the deployment period at all four stations as water temperatures were cooling consistently. 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 just slightly below the CCME Guideline for the Protection of Aquatic Life for Early Life stage for the first week of the deployment period when the water temperatures were warmest. As water temperatures cooled, dissolved oxygen content increased and remained above the guideline for the duration of the deployment period. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the Muskrat Falls, 6km upstream. The dissolved oxygen sensor failed at stations below Muskrat Falls and below Metchin River on September 13 and 21 respectively.
- Turbidity events were infrequent and of low magnitude at stations below Metchin River and below Grizzle Rapids which 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 and vary from 1 to 8 days. The turbidity sensor failed at stations below Muskrat Falls and below Metchin River on September 13 and 21 respectively.

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

Appendix 1

Average Daily Air Temperature and Daily Precipitation: Happy Valley Goose Bay, NL
September 1 to October 5, 2011



Average Daily Air Temperature and Daily Precipitation: Churchill Falls, NL
September 1 to October 5, 2011