Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

September 26 to November 1, 2012

Newfoundland Labrador

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

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Contents

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 stations on the Lower Churchill River at English Point and Lake Melville east of Little River.
- On September 26, 2012, real-time water quality monitoring instruments were deployed at the stations on the Lower Churchill River at English Point and Lake Melville east of Little River. The instruments were deployed for a period of 28 and 35 days respectively. The instruments were removed on October 24 from the Lake Melville site and on November 1 from the English Point site.

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 QAQC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Sonde and QAQC Sonde at deployment 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 sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.
- Deployment and removal comparison rankings for the English Point and Lake Melville stations deployed between September 26 and October 24 & November 1, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Churchill River and Lake Melville stations, September 26 - October 24 & November 1, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Churchill R. at English Point	Sep 26, 2012	Deployment	Excellent	Fair	Good	Excellent	Fair
	Nov 1, 2012	Removal	Excellent	Good	Fair	Good	Poor
Lake Melville east of Little R.	Sep 26, 2012	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Oct 24, 2012	Removal	Excellent	Good	n/a‡	n/a‡	n/a‡

‡ Field instrument 47588 not functioning correctly from October 11. Values unavailable.

- At Churchill River at English Point, temperature, specific conductivity, and dissolved oxygen all ranked either 'good' or 'excellent' at deployment while pH and turbidity ranked 'fair'.

  For pH, the field instrument read a value of 6.80 and the QAQC instrument read a value of 7.39. The discrepancy in these values leading to the 'fair' ranking may in part be caused by the limited time the field instrument was in the water stabilizing to the environment. By the time of the first transmission at 12:30pm, the pH level on the field instrument had already increased to 7.09 pH units which when compared to the QAQC instrument value yields a 'good' ranking.

  For turbidity, the field instrument read a value of 20NTU while the QAQC instrument read a value of 13.1NTU. This discrepancy may also be in part caused by the limited stabilization time for the field and QAQC instruments or the slight difference in positioning of the instruments at this part of the river reach. The water is cloudy at this station and it is difficult to see the positioning of the instruments side by side on the river bottom.

  At removal, temperature, pH and dissolved oxygen all ranked either 'good' or 'excellent' while specific conductivity ranked 'fair' and turbidity ranked 'poor'.

  For specific conductivity, the field instrument read a value of 9.6µS/cm and the QAQC instrument read a value of 22µS/cm. Specific conductivity generally averages ~30µS/cm at this station however, for the last four days of the deployment period (October 24-November 1) the specific conductivity values reported by the field instrument had been lower at between ~9 to 15 µS/cm. There was no grab sample taken at this station on this day because no instrument was being re-deployed. The QAQC instrument's specific conductivity sensor was functioning well at other sites on the same day. It is unknown what caused this discrepancy.

  For turbidity, the field instrument read a value of 16.4NTU and the QAQC instrument read a value of 1.2NTU. This discrepancy may also be in part caused by the limited stabilization time for the field and QAQC instruments or the slight difference in positioning of the instruments at this part of the river reach. The water is cloudy at this station and it is difficult to see the positioning of the instruments side by side on the river bottom.

- At the station on Lake Melville east of Little River, all parameters ranked either 'good' or 'excellent' at deployment. At removal, temperature and pH ranked 'excellent' and 'good' respectively while specific conductivity, dissolved oxygen and turbidity were not ranked due to sensor failure on October 11. Data values collected from October 11 to 24 are invalid and have been removed from the data set.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from September 26 to October 24 and November 1 at the stations on the Churchill River at English Point and Lake Melville east of Little River.
- 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 at English Point

- Water temperature ranges from 4.20 to 13.80^{o}C during the deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. Average daily air temperature is very closely related to average daily water temperature (Figure 2).
- Water temperature fluctuates diurnally and with tidal influences.

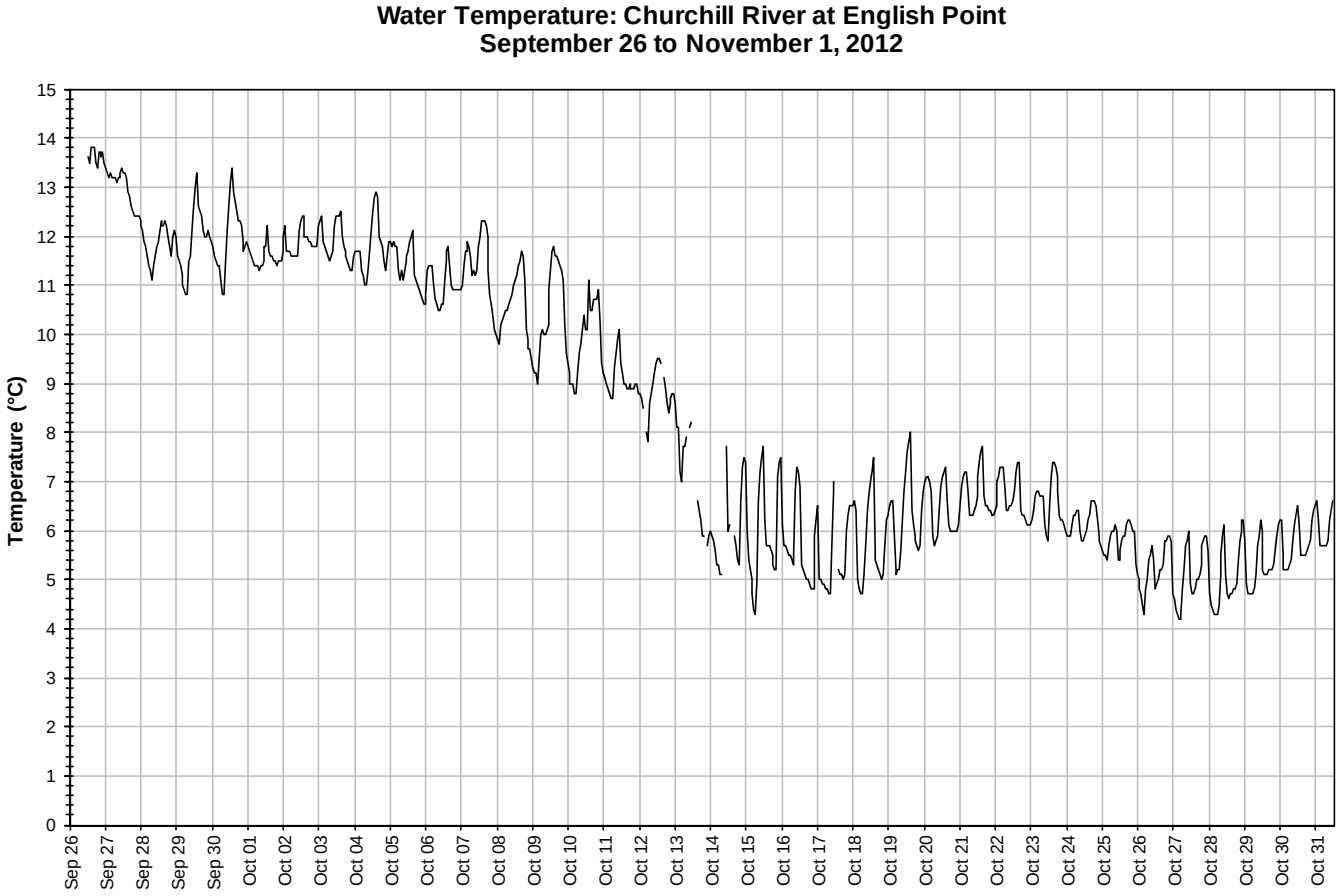

Figure 1: Water temperature at Churchill River at English Point

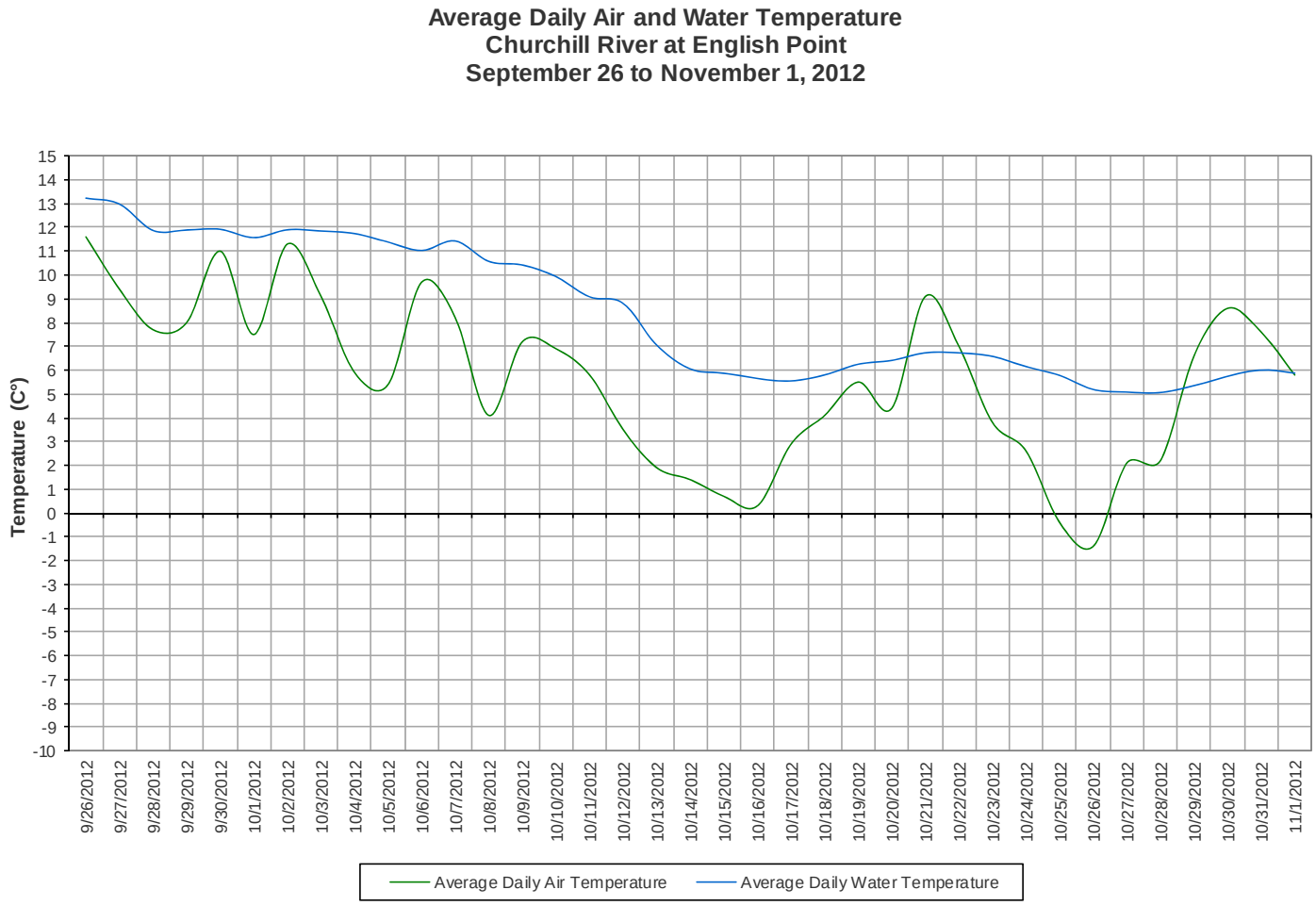

Figure 2: Average daily air and water temperatures at Churchill River at English Point

(weather data collected at Goose Bay)

- pH ranges between 6.21 and 7.44 pH units (Figure 3). pH values are generally stable for the first two and a half weeks of the deployment period. During this time, pH values are fluctuating on a daily basis. There is a short disruption in transmission on October 13. When the instrument returns online later that day, pH values begin to decrease gradually until October 22. From October 22-25, pH values are increasing again, all the while continuing to fluctuate daily. pH values decrease yet again on October 25-26 and stabilize between 6.3 and 6.5 pH units for the remainder of the deployment period on November 1. These events and other trends are indicated in red on Figure 3.
- These trends are no exactly typical for pH at this station. The disruption in transmission may have had an effect on the sensors measurements however this cannot be confirmed at this time. There are a number of precipitation events throughout the deployment period none of which correspond well with any of the changes seen in pH values or the disruption in transmission.
- All values between the start of the deployment period until around October 18 are within the minimum and maximum CCME Guidelines for the Protection of Aquatic Life of 6.5 and 9.0 respectively. Following October 18, values drop to just below the minimum guideline and then increase again to above 6.5 on from October 23 to 26. After October 26, pH values decrease again to below the guideline.

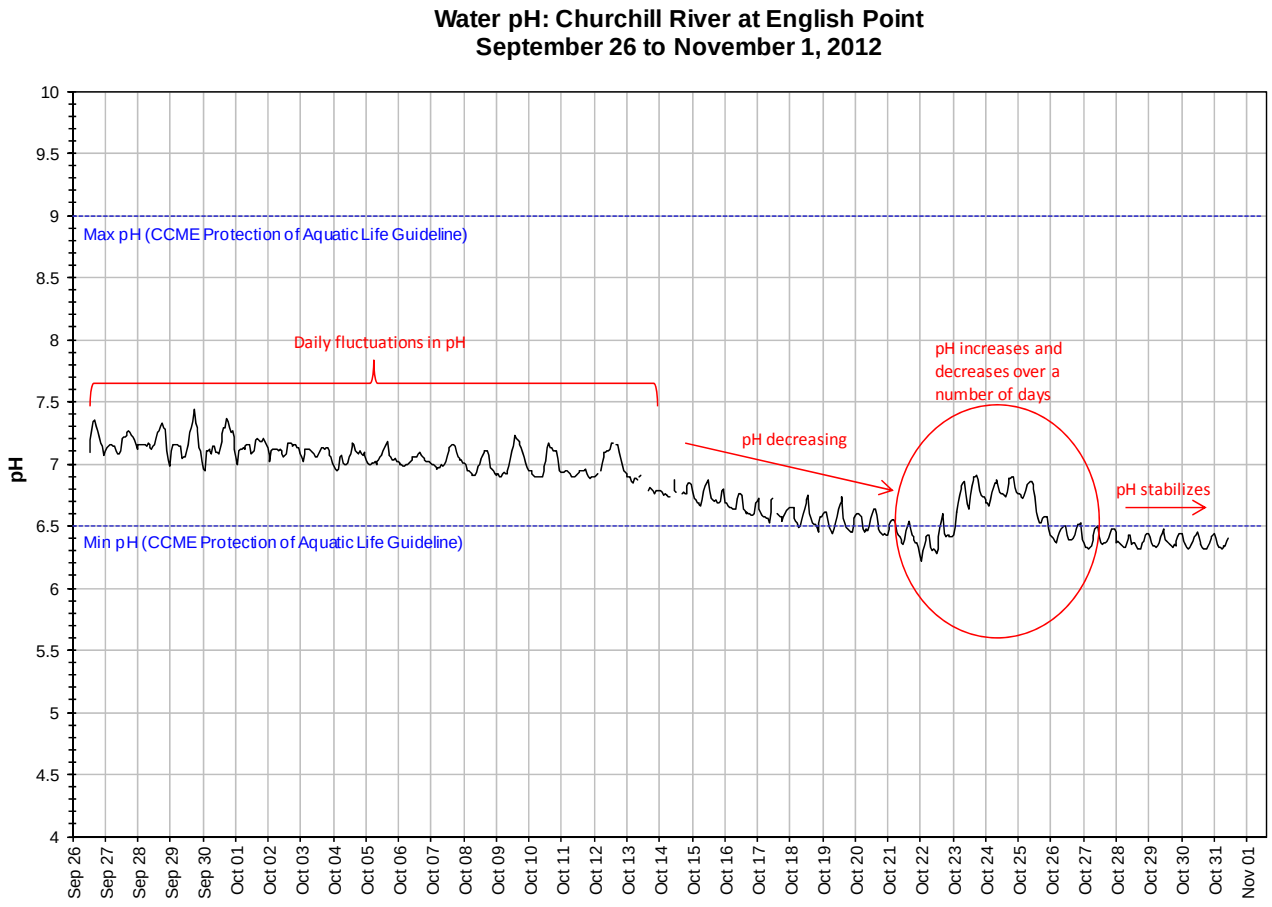

Figure 3: pH at Churchill River at English Point

- Specific conductivity ranges between 7.2 to 67.8µS/cm during the deployment period, averaging 32.8µS/cm (Figure 4).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period.
- In the last four days of the deployment period, specific conductivity is lower than normal at this station (~10µS/cm). There are no changes in other water quality parameters during this time and no corresponding weather related events. Upon removal, the QAQC instrument read a value of 22µS/cm and the field instrument read a value of 9.6µS/cm. This may be an indication that the field instrument was reading incorrectly as there is no reason to explain this sudden drop in specific conductivity. Specific conductivity at stations upstream averaged ~20 µS/cm during the same period of time.

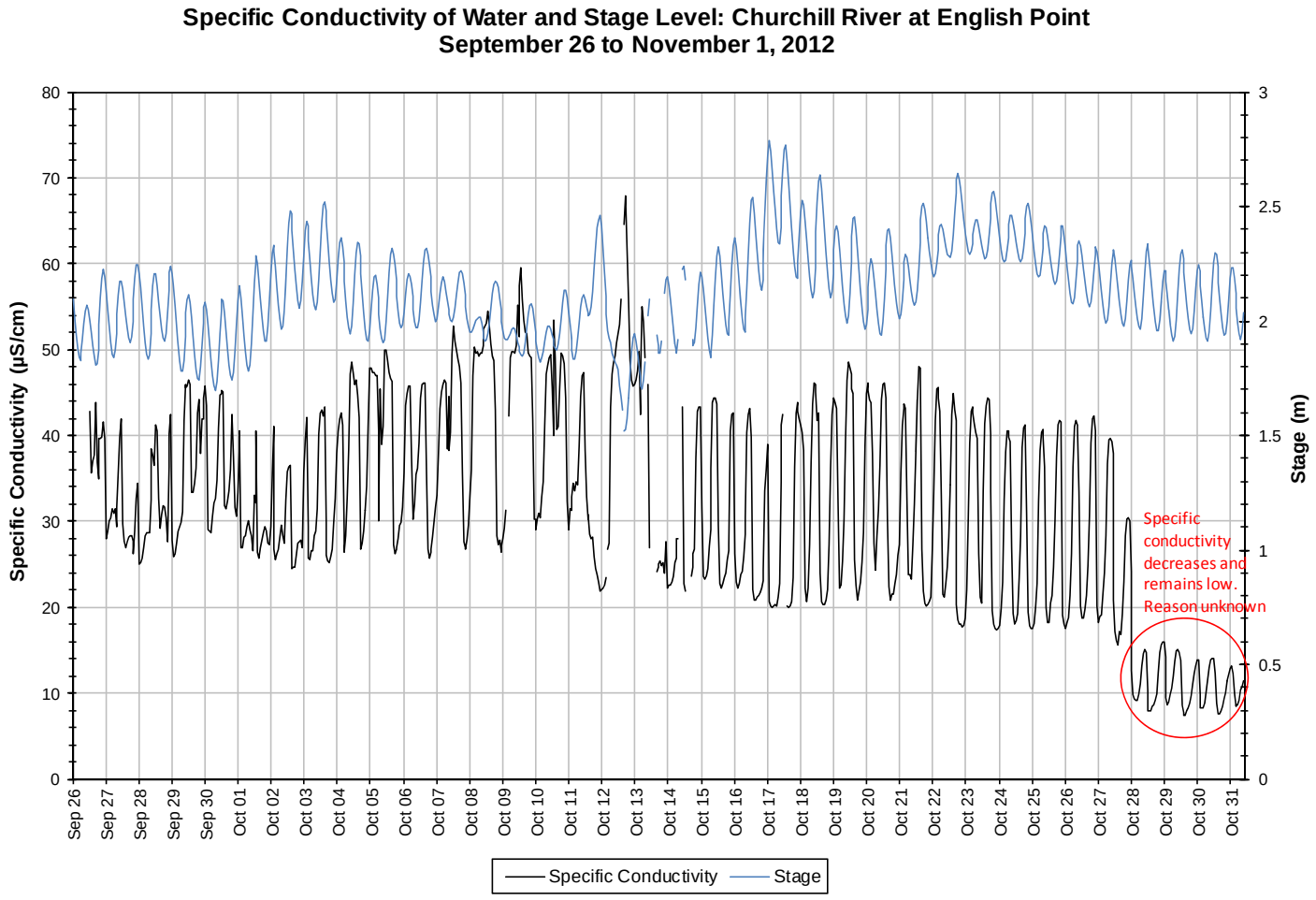

Figure 4: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 9.80mg/L and 13.52mg/L. The saturation of dissolved oxygen ranges from 89.6 to 107.6% (Figure 5). There are sporadic disruptions in data transmissions between October 12 & 15.
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l and Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decrease in water temperature. Dissolved oxygen clearly fluctuates diurnally, displaying an inverse relationship with water temperature during day, night and tidal changes.

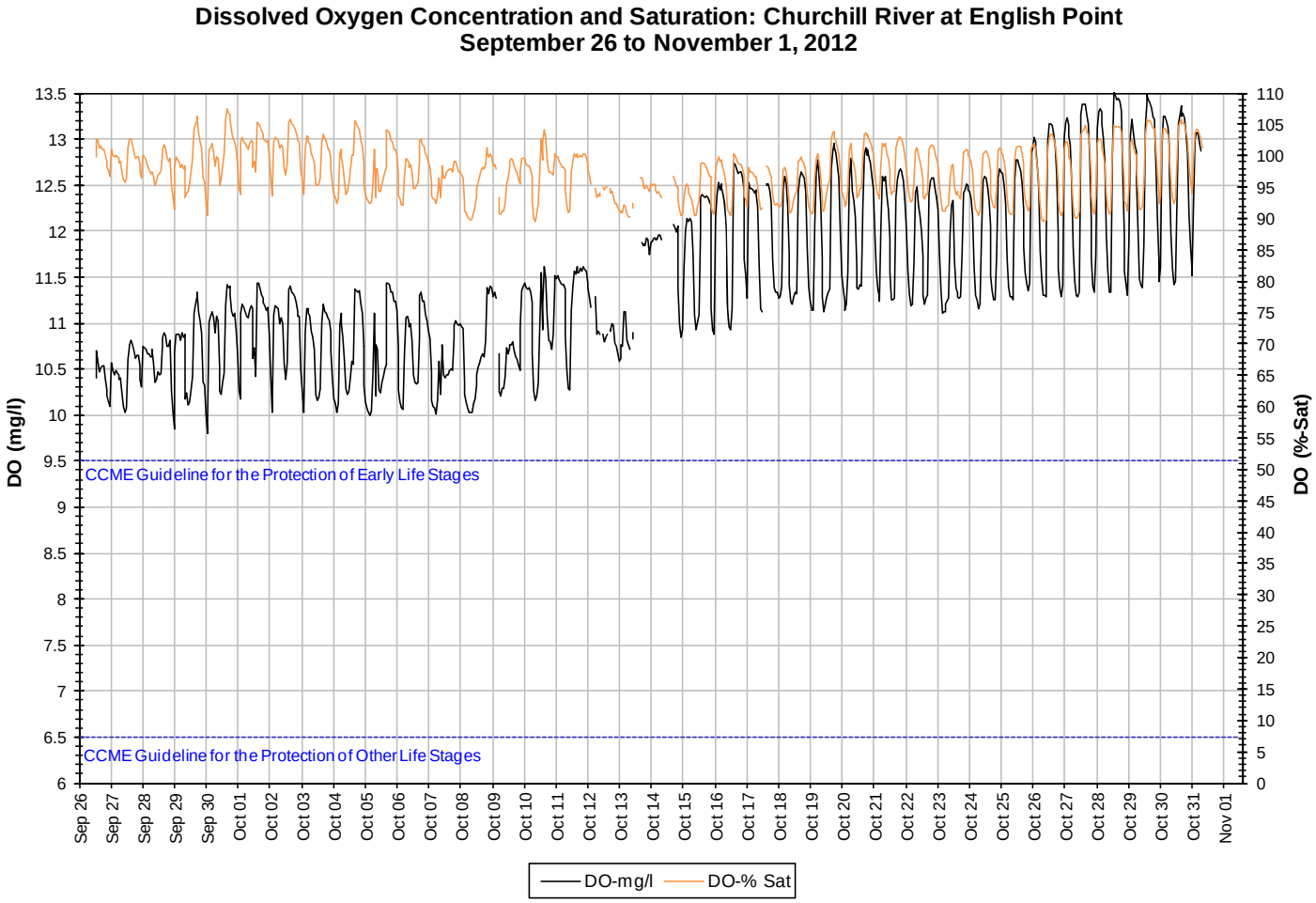

Figure 5: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity values range between 1 and 262NTU throughout the deployment period (Figure 6). A median value of 10.0NTU indicates there is a natural background turbidity value at this station.
- Turbidity values fluctuate throughout the deployment period and are of typical magnitude for this station. Turbidity trends are also similar to the station directly upstream below Muskrat Falls (median value 10.1NTU).
- A rainfall event on October 11 corresponds with an increase in turbidity to 262NTU on October 12. Rainfall events often cause increases in turbidity however there are a number of rainfall events throughout the deployment period, not all of which affect the turbidity levels.

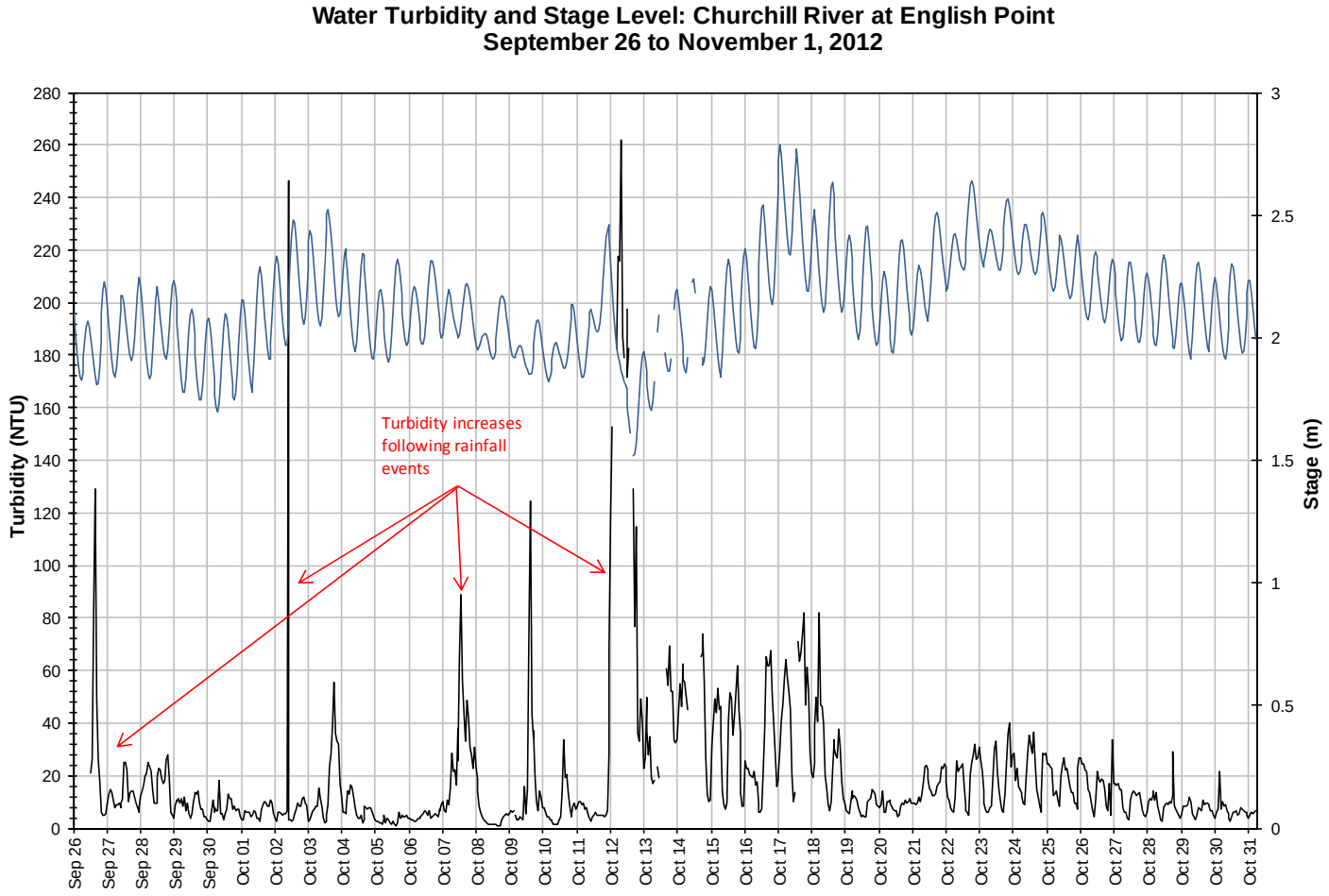

Figure 6: Turbidity to 2600NTU at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is fluctuating throughout the deployment period. Precipitation records are moderate in frequency and magnitude throughout the month.
- With hourly recordings, stage ranges from 1.52m to 2.79m, a difference of 1.27m. Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

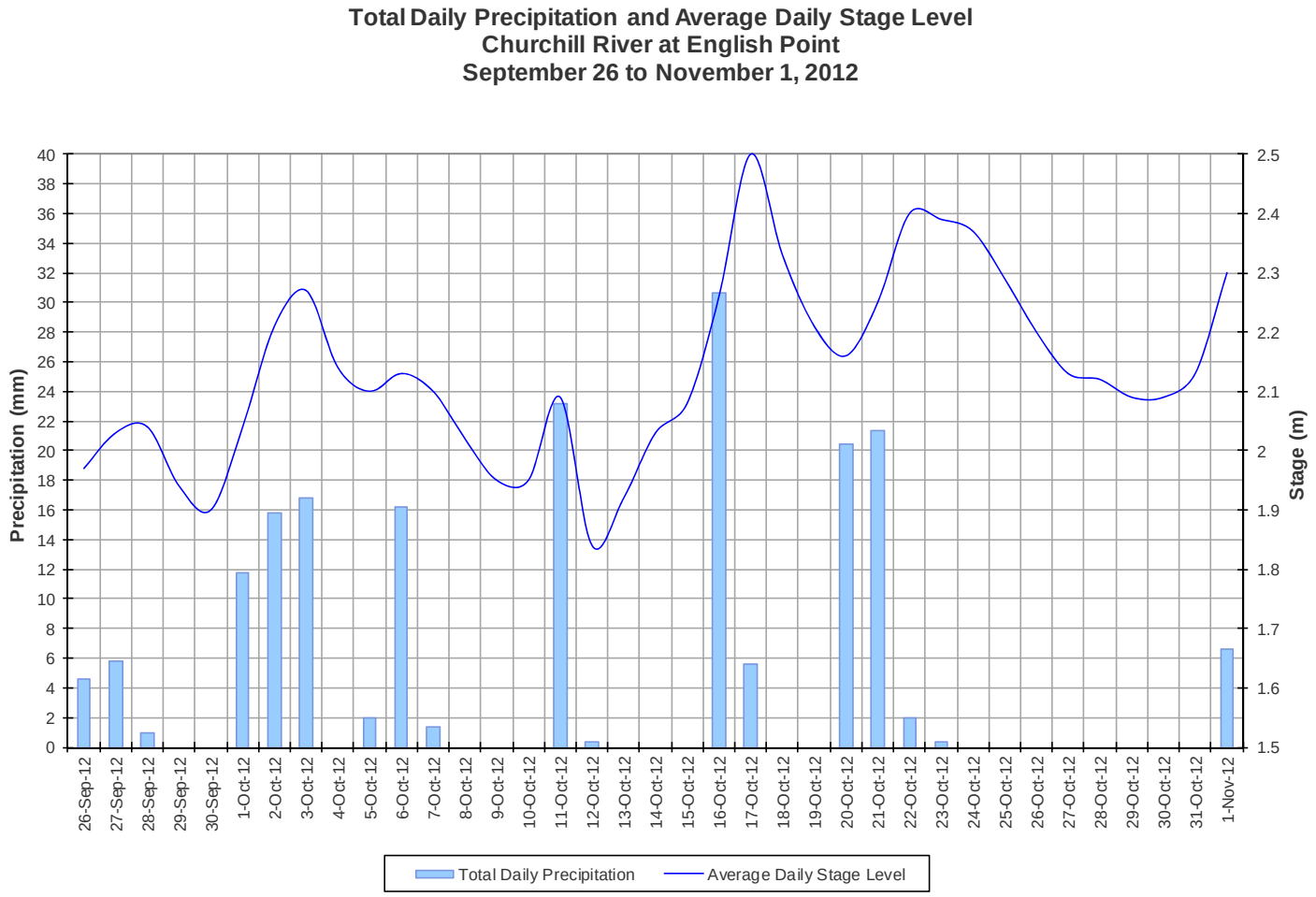

Figure 7: Stage and precipitation at Churchill River at English Point

Lake Melville East of Little River

- Water temperature ranges from 2.10 to 12.10^{o}C during the deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. Average daily air temperature is very closely related to average daily water temperature (Figure 9).
- Water temperature fluctuates diurnally and with tidal influences.

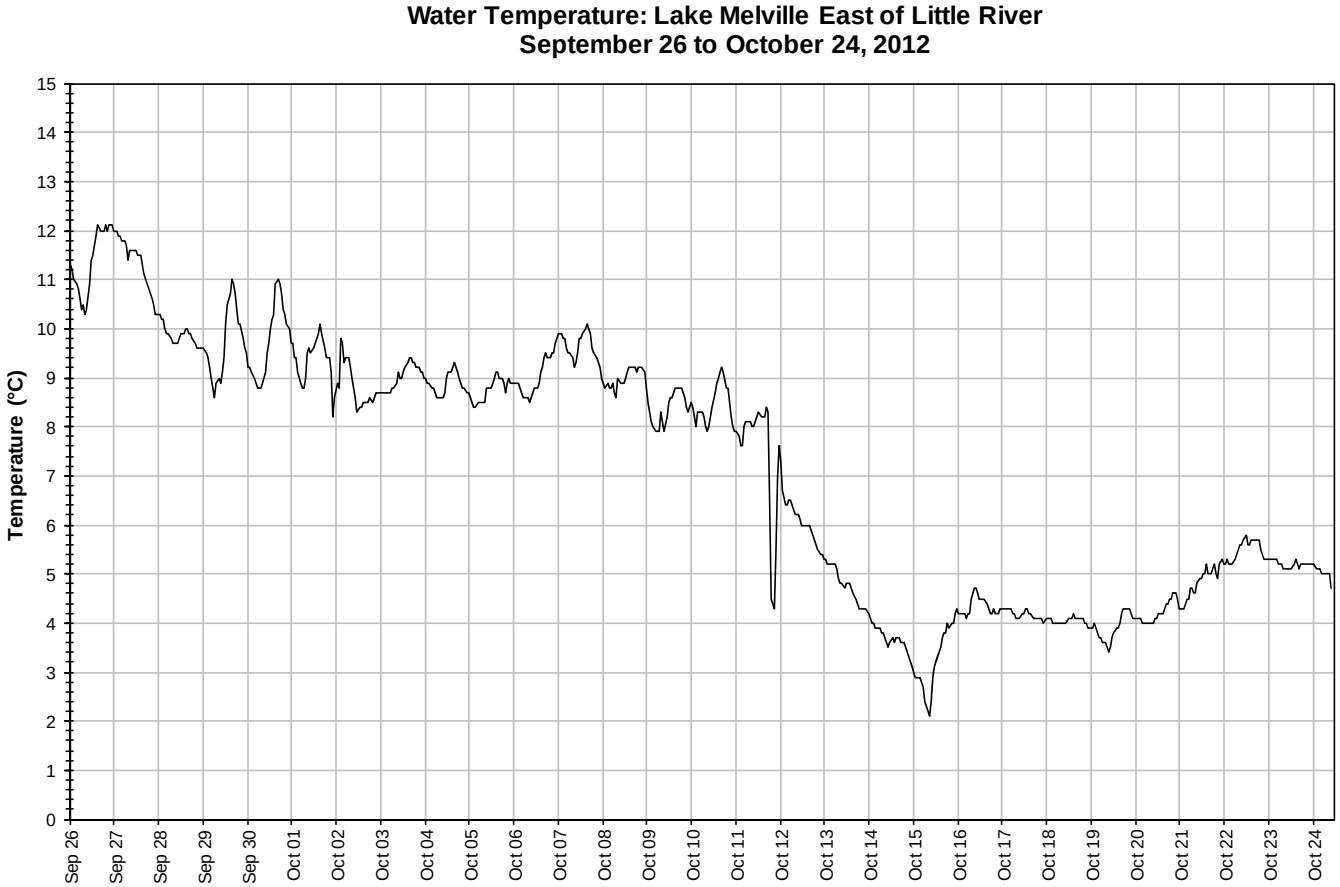

Figure 8: Water temperature at Lake Melville east of Little River

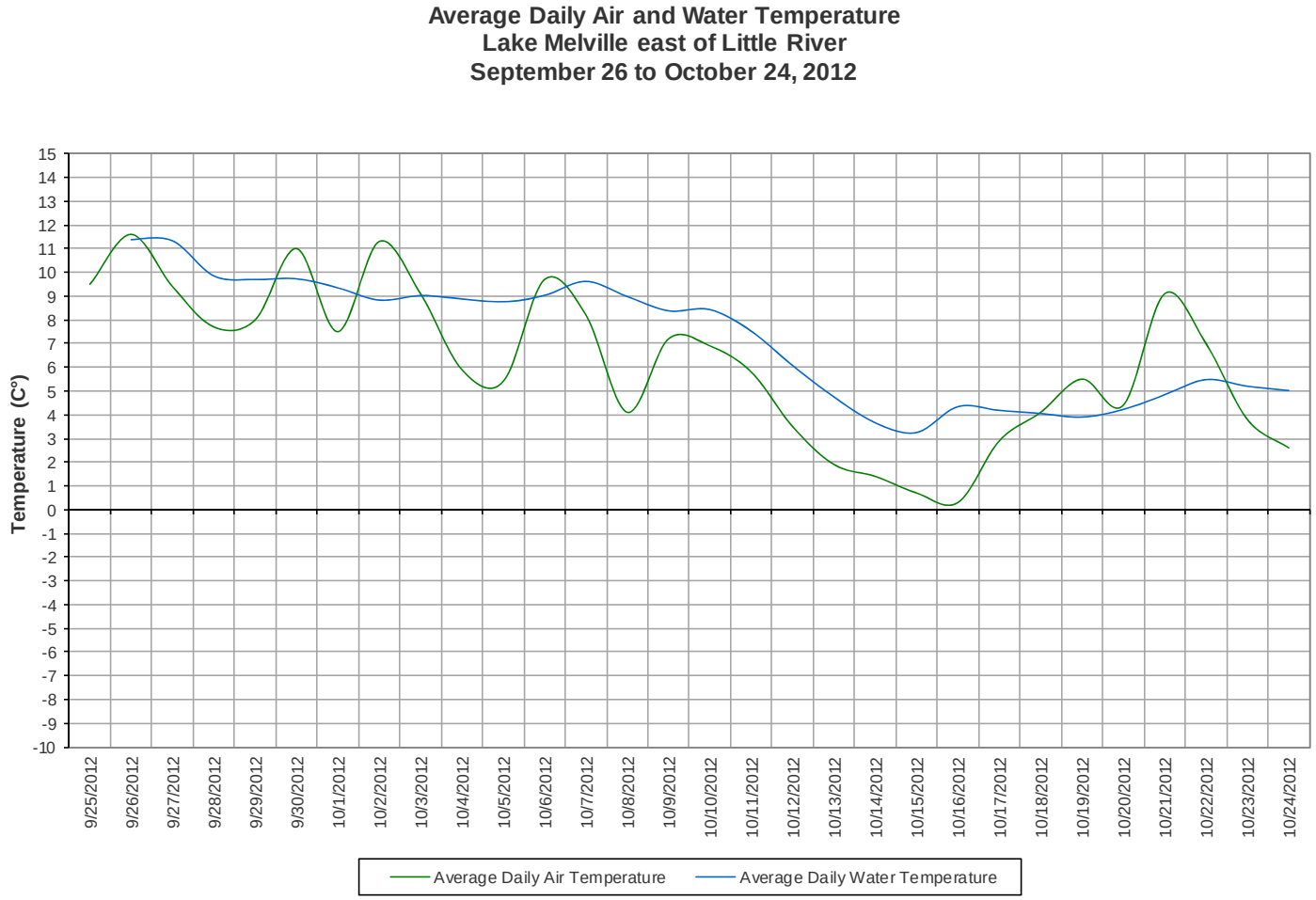

Figure 9: Average daily air and water temperatures at Lake Melville east of Little River

(weather data collected at Goose Bay)

- pH ranges between 7.55 and 8.61 pH units (Figure 10). For the first half of the deployment period, pH values consistently fluctuate diurnally. In the second half of the deployment period, this trend is less noticeable.
- All values during the deployment are within the minimum and maximum CCME Guidelines for the Protection of Aquatic Life of 6.5 and 9.0 (guidelines are indicated in blue on Figure 10).

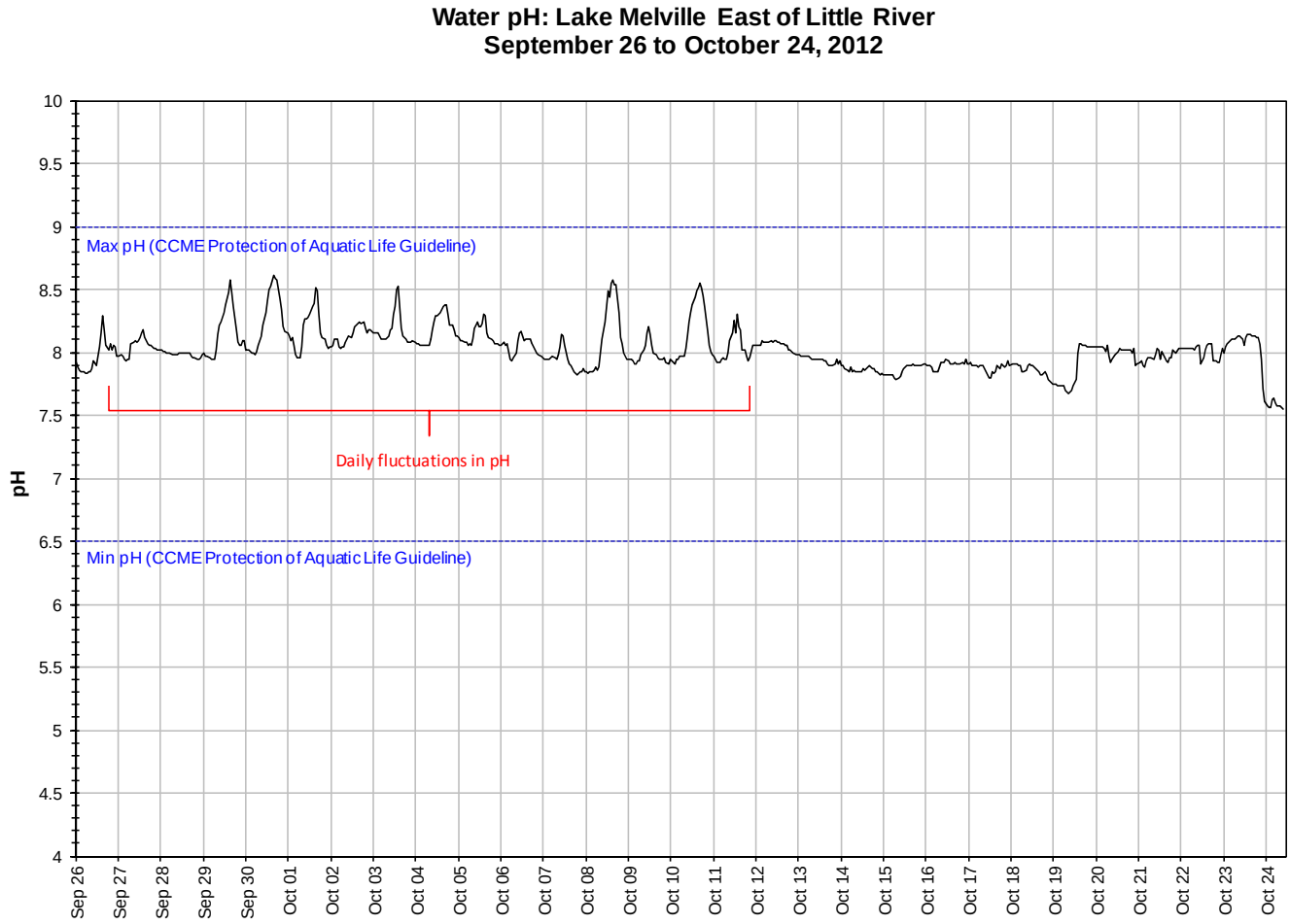

Figure 10: pH at Lake Melville east of Little River

- Specific conductivity ranges between 12000 to 30000µS/cm during the deployment period, averaging ~21000µS/cm (Figure 11). On October 11, the specific conductivity sensor, along with other sensors on the instrument, failed. The sensor failure corresponds with a moderate rainfall event on October 11 of >20mm. Inaccurate data values collected between October 11 and the time the instrument was retrieved on October 24 have been removed from the data set.
- Specific conductivity is increasing and decreasing throughout the first half of the deployment period. Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out.

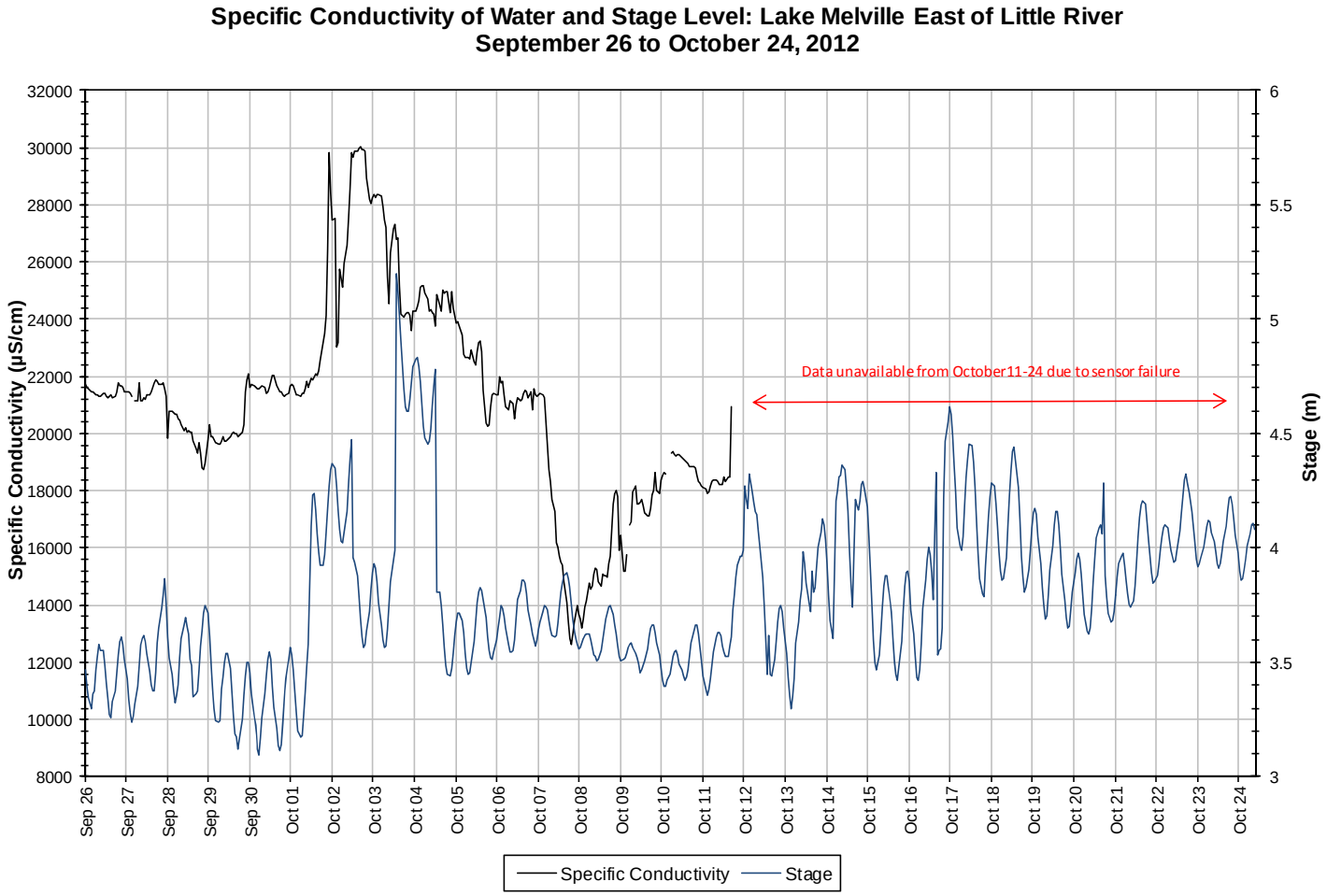

Figure 11: Specific conductivity and stage level at Lake Melville east of Little River

- Dissolved oxygen content ranges between 9.39mg/L and 12.67mg/L. The saturation of dissolved oxygen ranges from 92.7 to 122.6% (Figure 12). On October 11, the dissolved oxygen sensor, along with other sensors on the instrument, failed. The sensor failure corresponds with a moderate rainfall event on October 11 of >20mm. Inaccurate data values collected between October 11 and the time the instrument was retrieved on October 24 have been removed from the data set.
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stage of 6.5 mg/l. Almost all of the values recorded during the deployment period are above the CCME Guideline for the Protection of Cold Water Biota at Early Life Stage of 9.5 mg/l. Dissolved oxygen content falls just below this guideline for a short period of time near the beginning of the deployment period on September 27. 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 water temperature. Dissolved oxygen clearly fluctuates diurnally, displaying an inverse relationship with water temperature during day, night and tidal changes. The wide range in which percent saturation and dissolved oxygen content fluctuates may in part be due to the persistent wave action at the lake's shoreline.

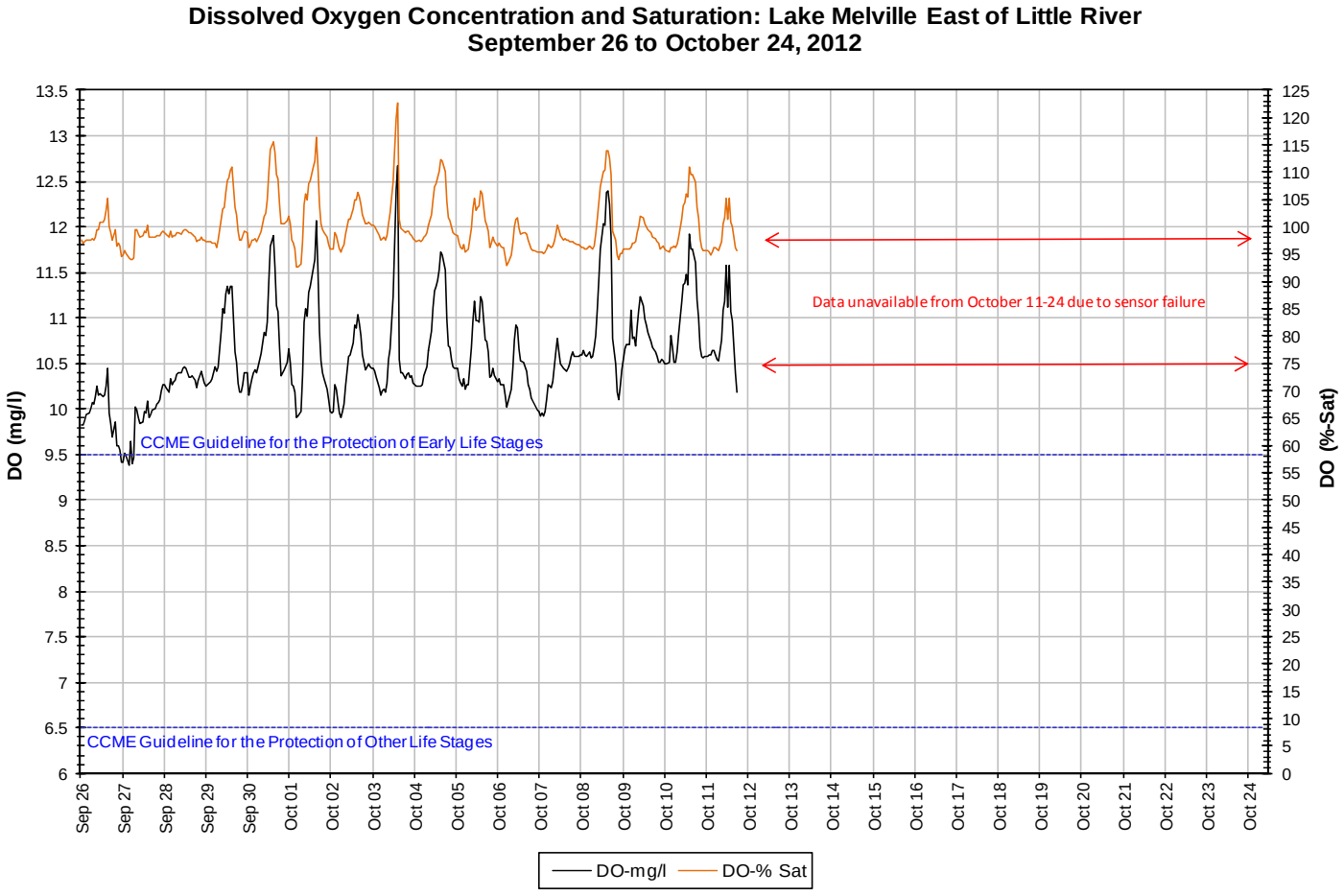

Figure 12: Dissolved oxygen and percent saturation at Lake Melville east of Little River

- Turbidity ranges from 1.4 to 583.0NTU throughout the first half of the deployment period (Figure 13). A median value of 21.6NTU indicates there is consistent natural background turbidity at this station. On October 11, the dissolved oxygen sensor, along with other sensors on the instrument, failed. The sensor failure corresponds with a moderate rainfall event on October 11 of >20mm.
- Turbidity values fluctuate significantly at this station which is likely due to the impact from waves on the instrument at the lake shoreline. The consistent wave action disturbs sediment on the bottom and often time there is a clear distinguishable difference in water color and quality in the littoral zone. The constant motion in this zone causes the turbidity readings to be high and constantly changing.
- There are a number of rainfall events throughout the deployment period some of which correspond with increases in turbidity (these events are indicated in red on Figure 13).

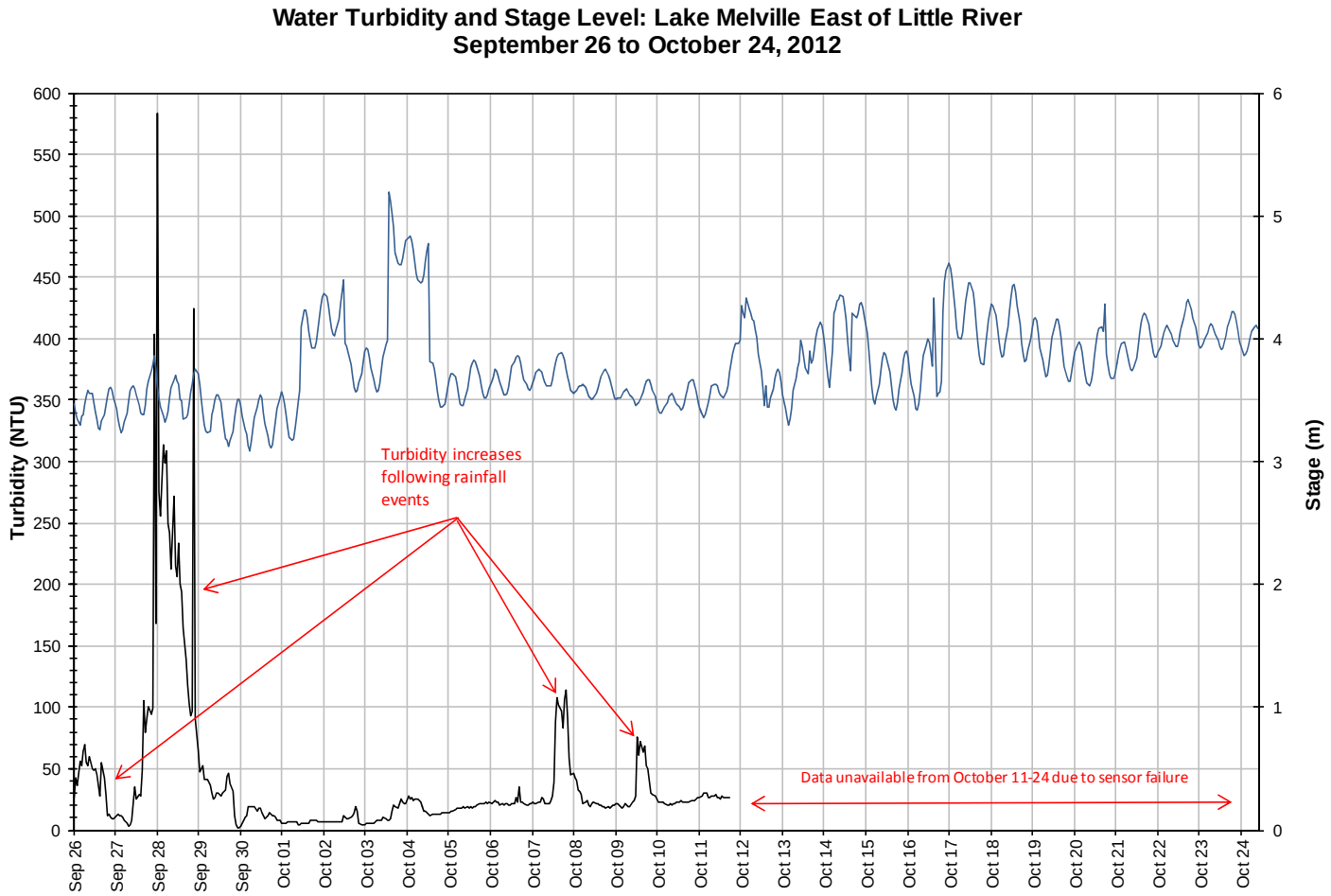

Figure 13: Turbidity at Lake Melville east of Little River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 12). Stage fluctuates throughout the deployment period. Precipitation records are moderate in frequency and magnitude throughout the month.
- With hourly recordings, stage ranges from 3.09m to 5.20m, a difference of 2.11m. Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

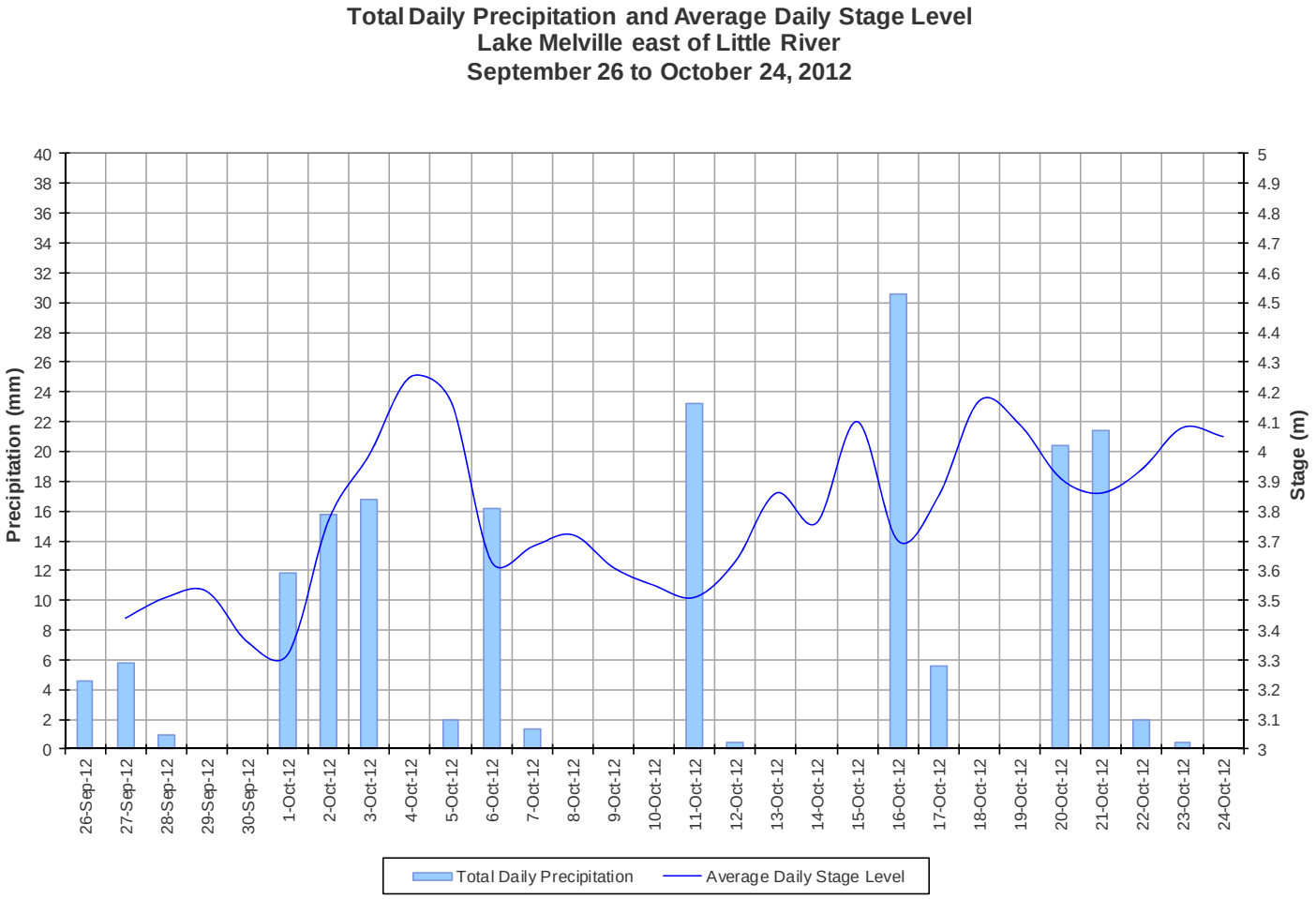

Figure 14: Stage and precipitation at Lake Melville east of Little River

Conclusions

- Water quality monitoring instruments at the stations on the Lower Churchill River at English Point and Lake Melville east of Little River were deployed on September 26 and removed on November 1 and October 24, respectively.
- These stations are an extension of the existing RTWQ Network on the Lower Churchill River, established to protect ambient water resources and catch emerging water quality issues. The data from these two stations augment the data collected from the existing stations on the Lower Churchill River.
- At Churchill River at English Point, water temperature was found to be closely related to air temperature, decreasing throughout the deployment period. Dissolved oxygen content showed a typical inverse relationship to water temperature and increased throughout the deployment period. pH values were consistent for the first half of the deployment period and then decreased gradually after October 11. pH values then increased and decreased over a number of days before remaining stable for the rest of the deployment period. Specific conductivity was consistent and typical for this station, fluctuating daily. Stage also consistently fluctuated daily. Turbidity generally remained below 10NTU however increased a few times well above this level up to 260NTU. These events were generally short lived and there were often corresponding weather events to propose an explanation.
- At Lake Melville east of Little River, water temperature also decreased throughout the deployment period. pH values were generally stable with regular daily fluctuations clearly evident in the first half of the deployment period. On October 11, dissolved oxygen, specific conductivity and turbidity sensors failed. This failure corresponds with a rainfall event however the cause of the sensor failure cannot be confirmed at this time. Data for dissolved oxygen, specific conductivity and turbidity has been removed from the data set between October 11 and October 24. Dissolved oxygen values showed an inverse relationship to water temperature and increased slightly during first half of the deployment period maintaining regular daily fluctuation. Specific conductivity increased and decreased throughout deployment period. Stage also fluctuated greatly between 3.1m and 5.2m. Turbidity values had a median value of 21.6NTU and varied widely between 1 and 584NTU. The instrument at this station is subjected to persistent wave action which could be affecting consistency of the data collected.
- For pH, all values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0) except for a period of time at the station at English Point when pH values dropped to just below the guideline between October 18-23 and October 25-November 1.
- For dissolved oxygen, all values recorded were above both the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l) with the exception of the station at Lake Melville, where dissolved oxygen values were just below 9.5mg/l for a number of hours on September 27.

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Appendix 1 – Weather Data, Environment Canada Historical Climate Database