Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

August 22 to September 26, 2012

Newfoundland Labrador

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

Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

August 22 to September 26, 2012

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 August 22, 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 34 days. The instruments were removed on September 26.

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 August 22 and September 26, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Churchill River and Lake Melville stations, August 22- September 26, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Churchill R. at English Point	Aug 22, 2012	Deployment	Good	Good	Excellent	n/a†	n/a†
	Sep 26, 2012	Removal	Excellent	n/a‡	n/a‡	n/a‡	n/a‡
Lake Melville east of Little R.	Aug 22, 2012	Deployment	Excellent	Good	Excellent	n/a†	n/a†
	Sep 26, 2012	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

† QAQC instrument 47589 dissolved oxygen and turbidity sensors not functioning correctly. Values unavailable.

‡ Field instrument 45042 not functioning correctly from September 19. Values unavailable.

- At Churchill River at English Point, temperature, pH and specific conductivity all ranked either 'good' or 'excellent' at deployment. Dissolved oxygen and turbidity were not ranked due to sensor malfunction on QAQC instrument 47589. At removal, temperature ranked 'excellent' while all other parameters were unable to be ranked due to sensor failure during the deployment period. Inaccurate data values have been removed from the data set and will not be further analyzed in this report. Comparison rankings are unavailable.
- At the station on Lake Melville east of Little River, temperature, pH, and specific conductivity all ranked either 'good' or 'excellent' at deployment. Dissolved oxygen and turbidity were not ranked due to sensor malfunction on QAQC instrument 47589. At removal, all parameters ranked 'excellent'.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from August 22 to September 26 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 12.00 to 20.00^{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.

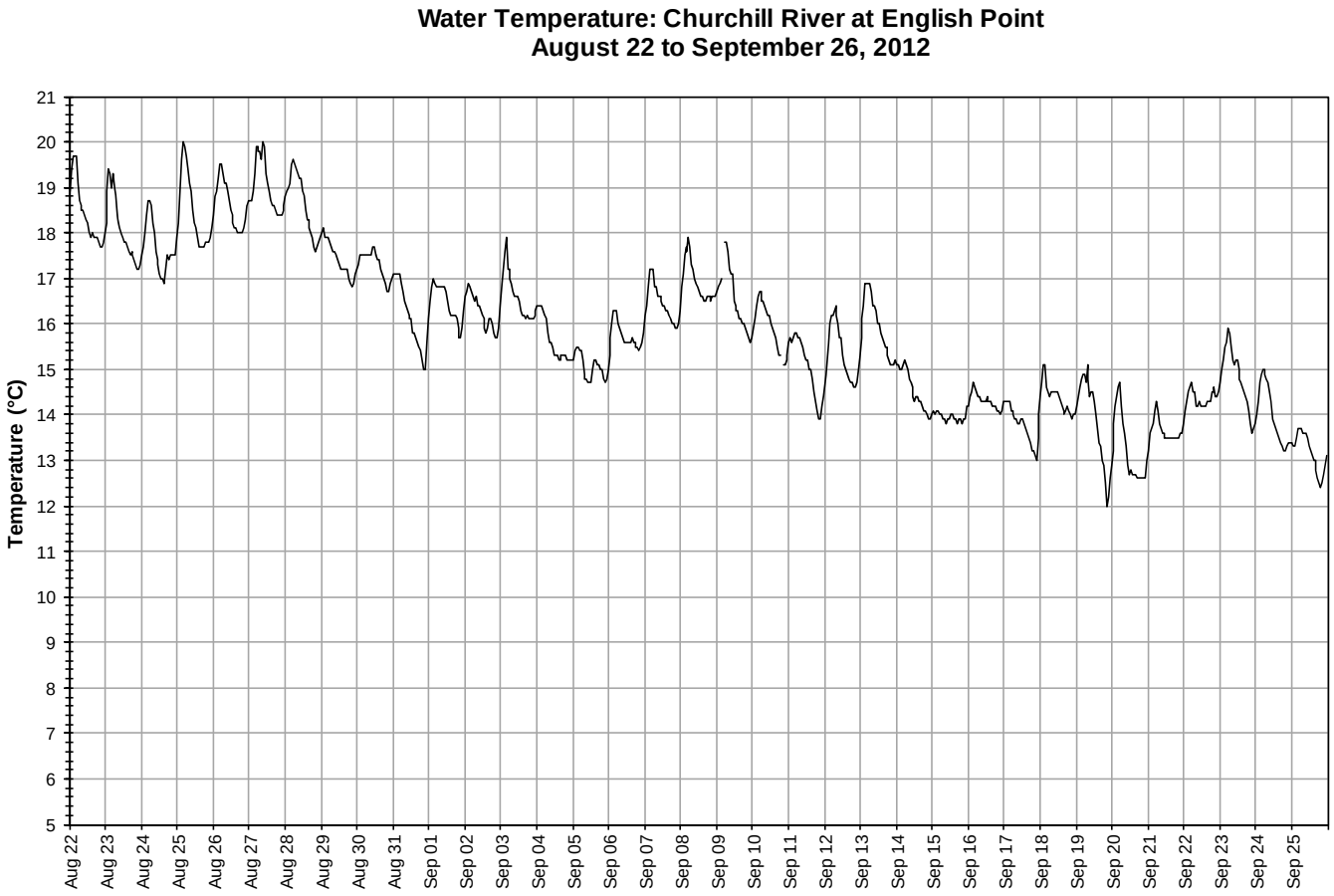

Figure 1: Water temperature at Churchill River at English Point

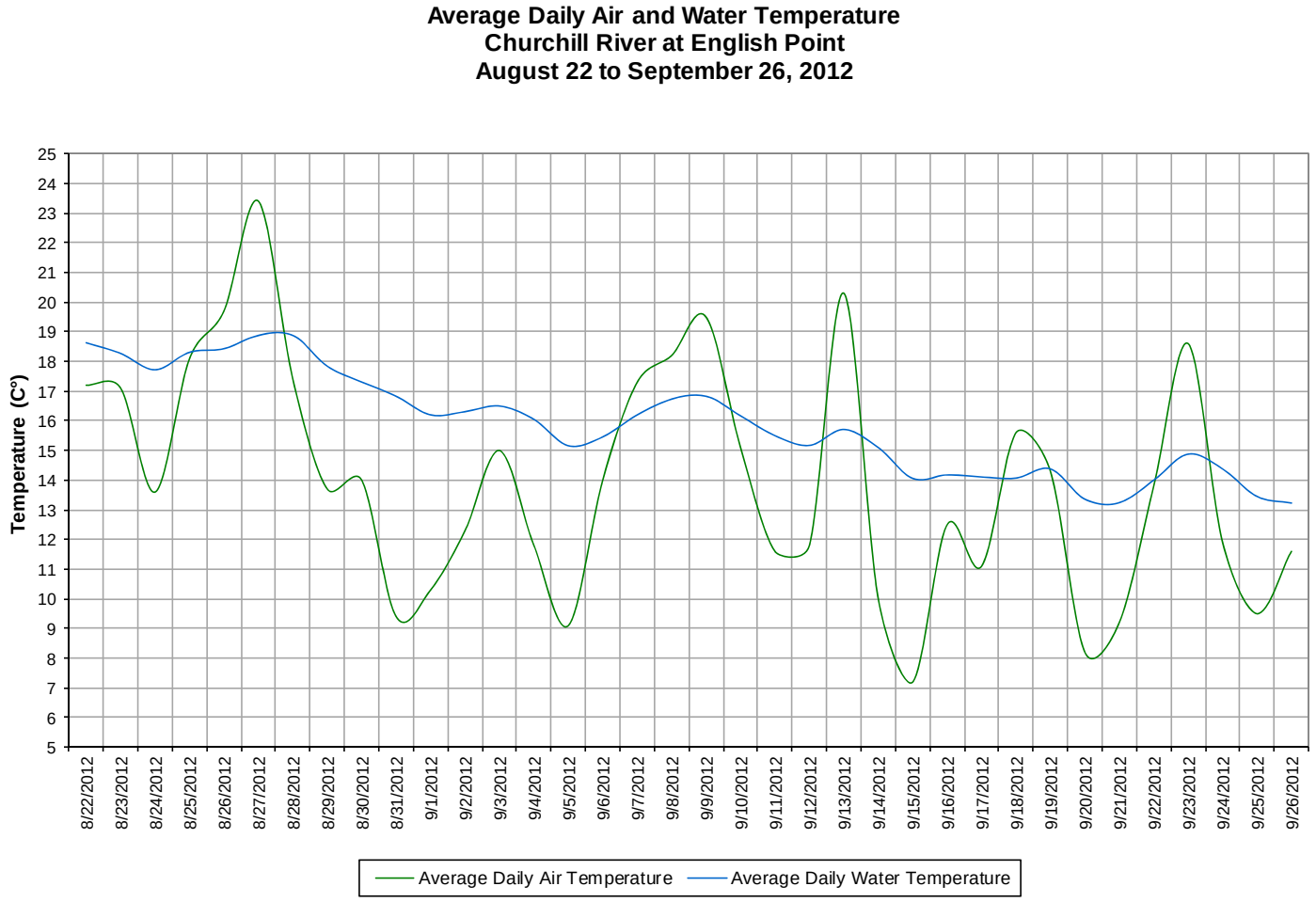

Figure 2: Average daily air and water temperatures at Churchill River at English Point (weather data collected at Goose Bay)

- pH ranges between 6.26 and 7.53 pH units (Figure 3). pH values are generally stable for the first three weeks of the deployment period. On September 13, the pH sensor, along with other sensors on the instrument, failed. Inaccurate data values collected between September 13 and the time the instrument was retrieved on September 26 have been removed from the data set.
- All values between the start of the deployment period until September 12 are within the minimum and maximum CCME Guidelines for the Protection of Aquatic Life of 6.5 and 9.0 respectively. Guidelines are indicated on Figure 3 in blue.

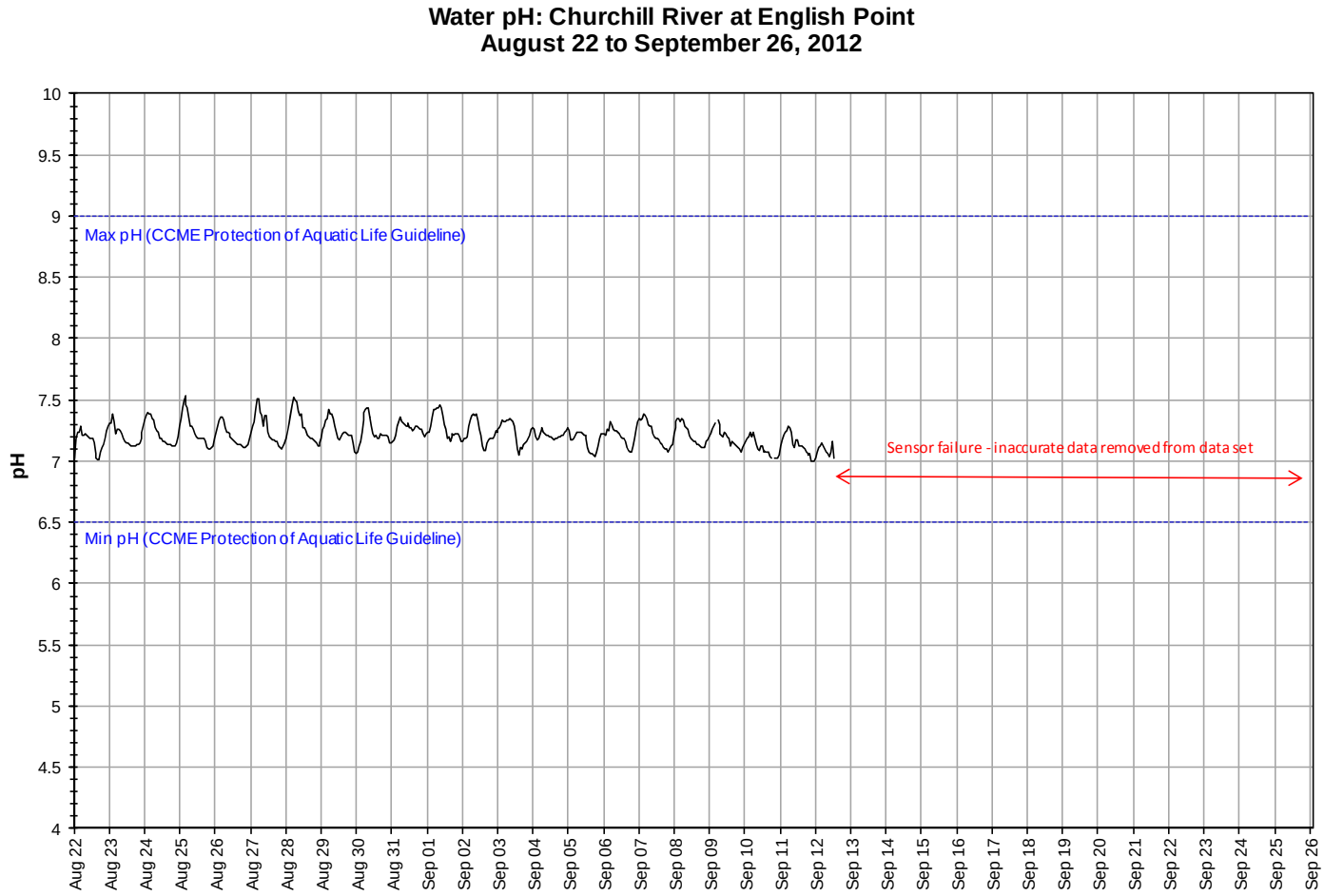

Figure 3: pH at Churchill River at English Point

- Specific conductivity ranges between 23.9 to 58.4µS/cm during the deployment period, averaging 33.0µS/cm (Figure 4). On September 13, the specific conductivity sensor, along with other sensors on the instrument, failed. Inaccurate data values collected between September 13 and the time the instrument was retrieved on September 26 have been removed from the data set.
- 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.

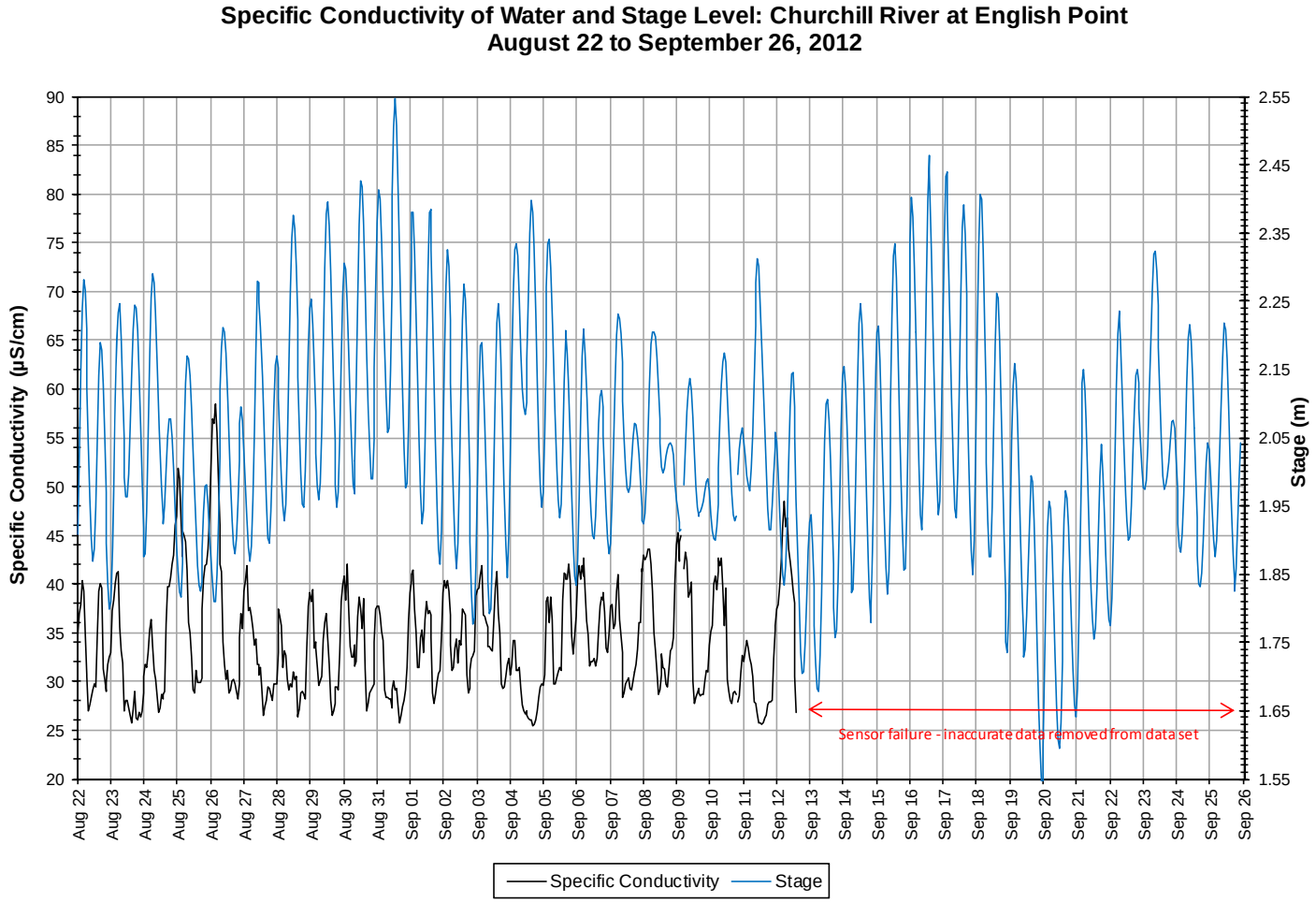

Figure 4: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 8.84mg/L and 10.60mg/L. The saturation of dissolved oxygen ranges from 90.9 to 112.2% (Figure 5). On September 19, the dissolved oxygen sensor failed. pH and specific conductivity and turbidity sensors failed 1 week earlier. Inaccurate data values for dissolved oxygen and percent saturation collected between September 19 and the time the instrument was retrieved on September 26 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. Over half 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 fluctuates above and below this guideline daily. 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 fluctuations in water temperature. Dissolved oxygen clearly fluctuates diurnally, displaying an inverse relationship with water temperature during day, night and tidal changes.

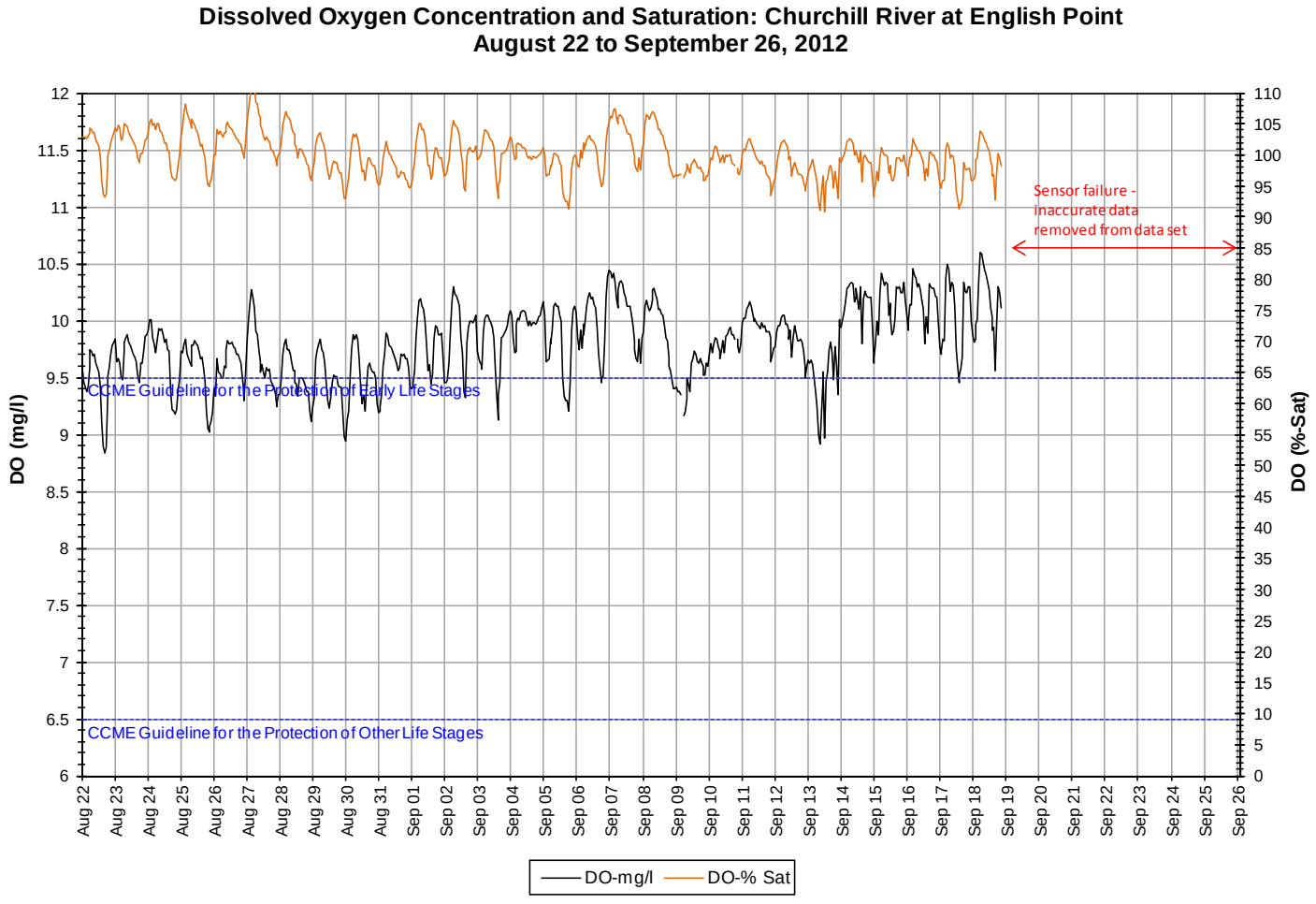

Figure 5: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity values ranged between 2.5 and 2409.0NTU throughout the deployment period (Figure 6a). A median value of 9.5NTU indicates there is a natural background turbidity value at this station. On September 13, the turbidity sensor, along with other sensors on the instrument, failed. Inaccurate data values collected between September 13 and the time the instrument was retrieved on September 26 have been removed from the data set.
- Turbidity generally remained <10NTU and is better depicted at a smaller scale in Figure 6b.
- In Figure 6a, all turbidity events are depicted at a full scale from 0 to 2600NTU. Turbidity values begin to increase around September 9. There are no particular weather related events or changes in stage that may have caused such significant changes in turbidity. Therefore, it is unknown what caused these increases however they may in part be due to sensor irregularities or malfunctions.

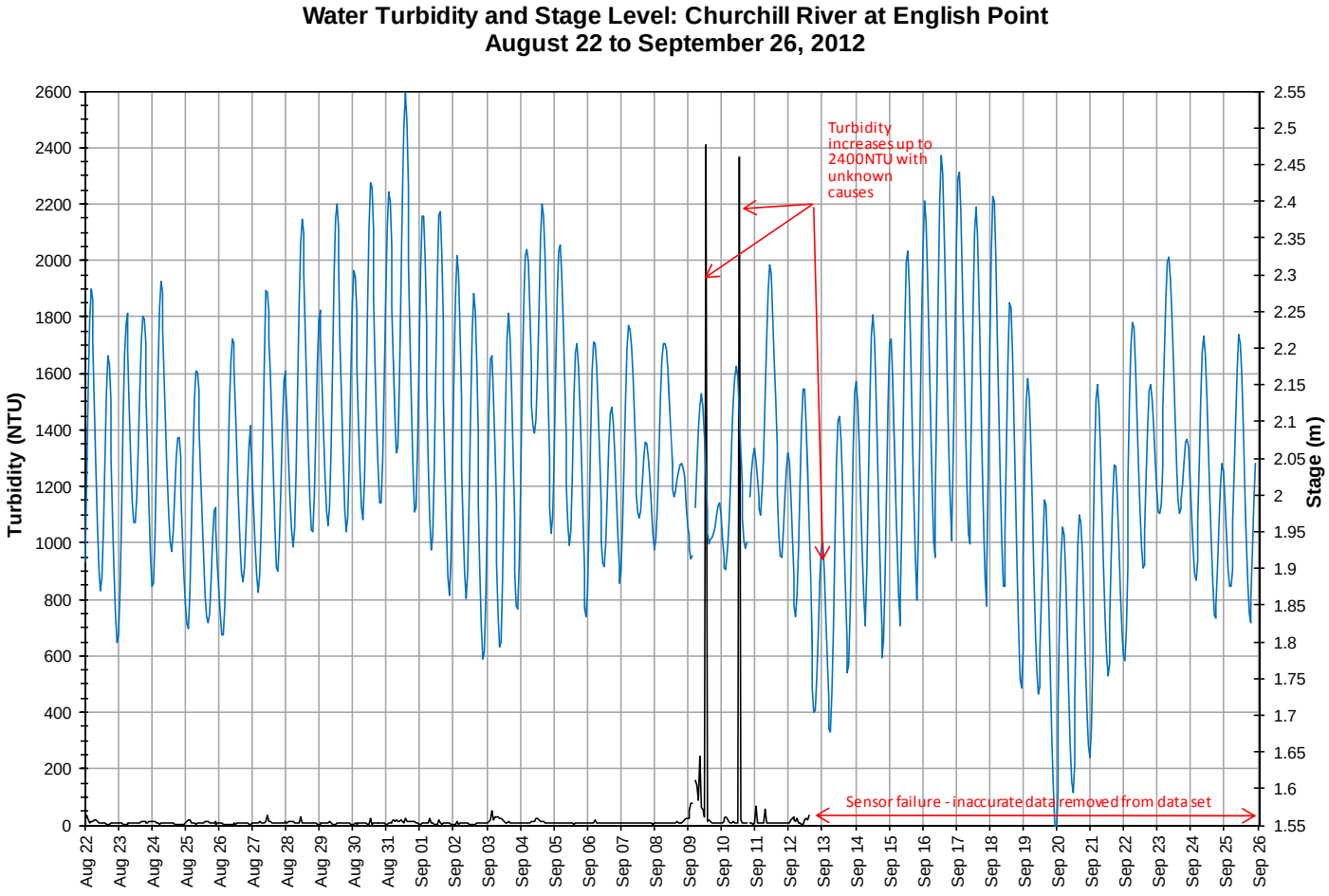

Figure 6a: Turbidity to 2600NTU at Churchill River at English Point

- Turbidity events between 0 and 100NTU are depicted in Figure 6b. At this scale, background turbidity values typically <10NTU are more apparent. There are a number of turbidity increases and fluctuations throughout the deployment period. Most of these fluctuations have no known causes and cannot be traced to particular weather events.

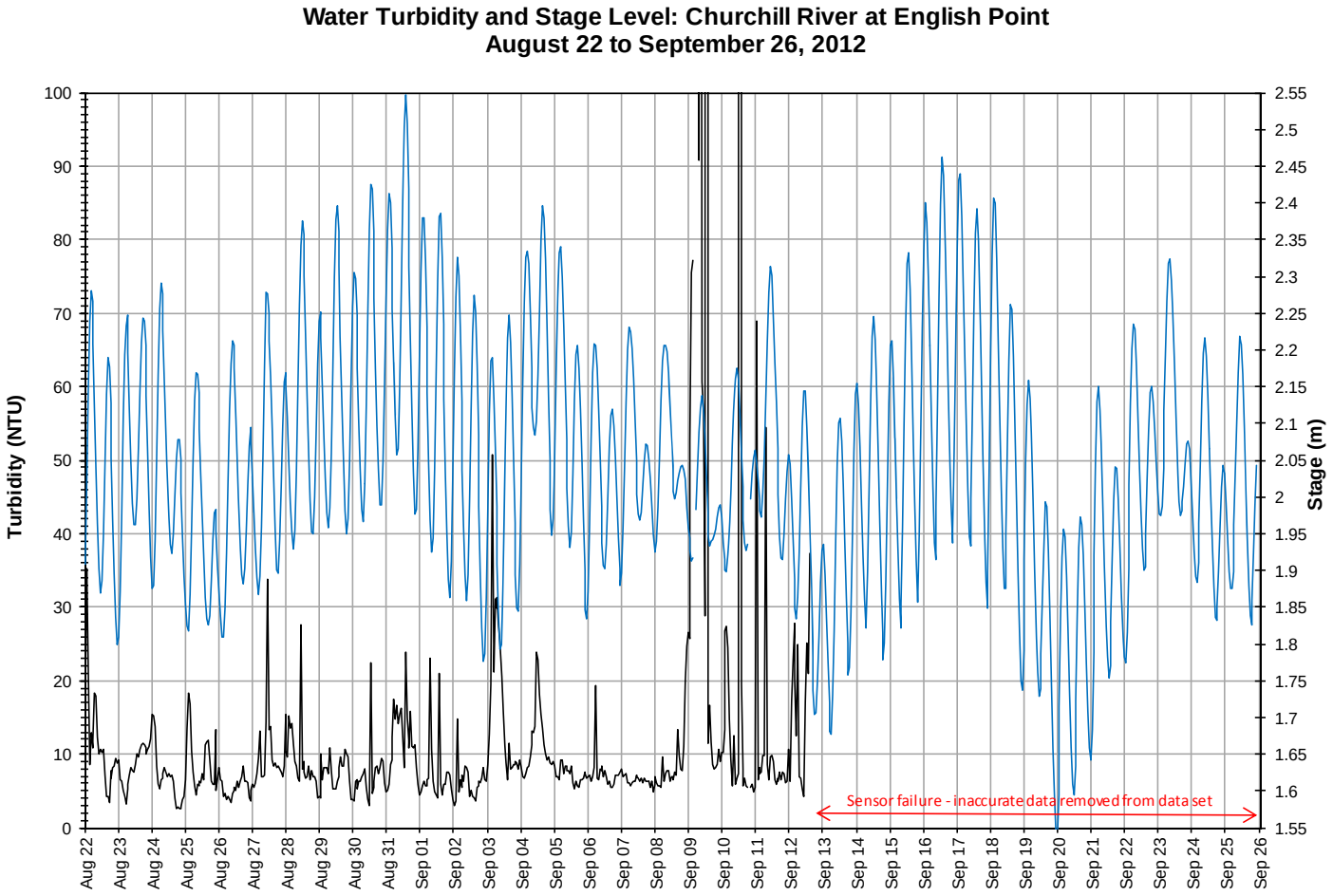

Figure 6b: Turbidity to 100NTU at Churchill River at English Point

- 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 vary and are low throughout the month. With hourly recordings, stage ranges from 1.54m to 2.55m, a difference of 1.01m.
- Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

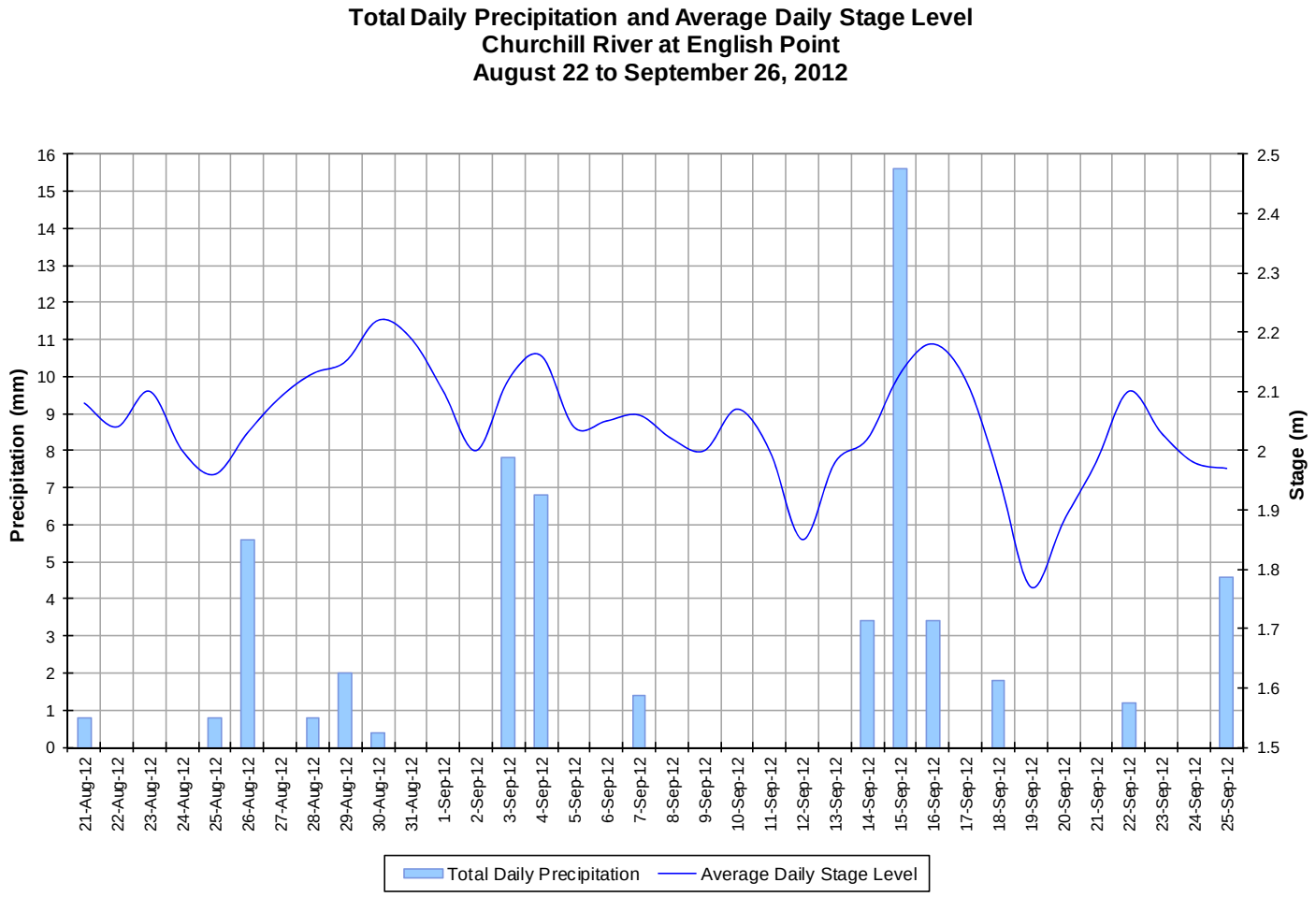

Figure 7: Stage and precipitation at Churchill River at English Point

Lake Melville East of Little River

- Water temperature ranges from 3.90 to 20.60^{o}C during the deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. There are a number of occasions where water temperature decreases drastically over a few hours and then increases again shortly thereafter. These sharp decreases correspond with decreases in air temperature. These events are indicated by red arrows in figure 8.
- Water temperature fluctuates diurnally and with tidal influences.

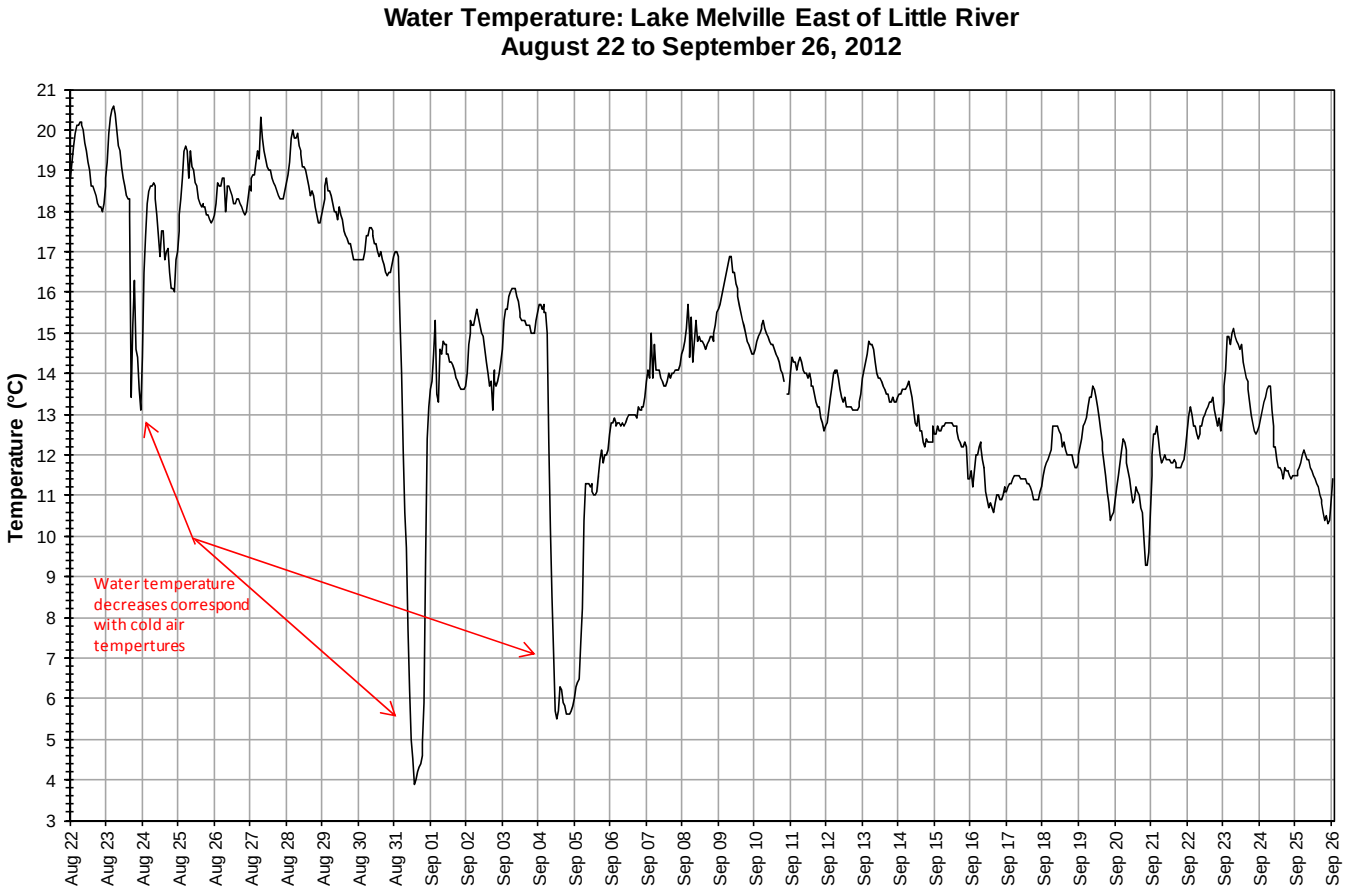

Figure 8: Water temperature at Lake Melville east of Little River

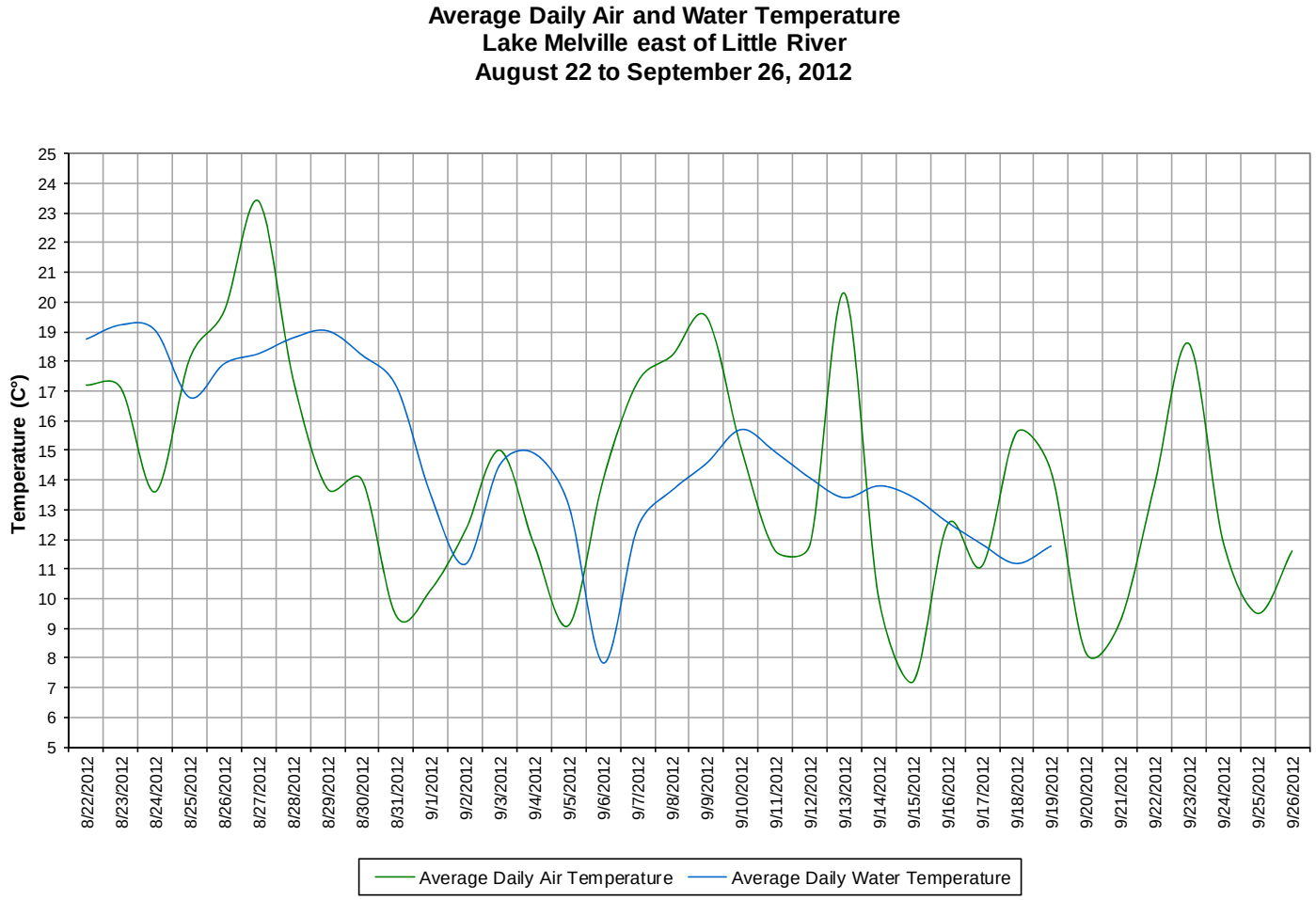

Figure 9: Average daily air and water temperatures at Lake Melville east of Little River (weather data collected at Goose Bay)

- pH ranges between 7.48 and 8.59 pH units (Figure 10). pH values are generally stable, fluctuating diurnally and with tidal influences.
- 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).

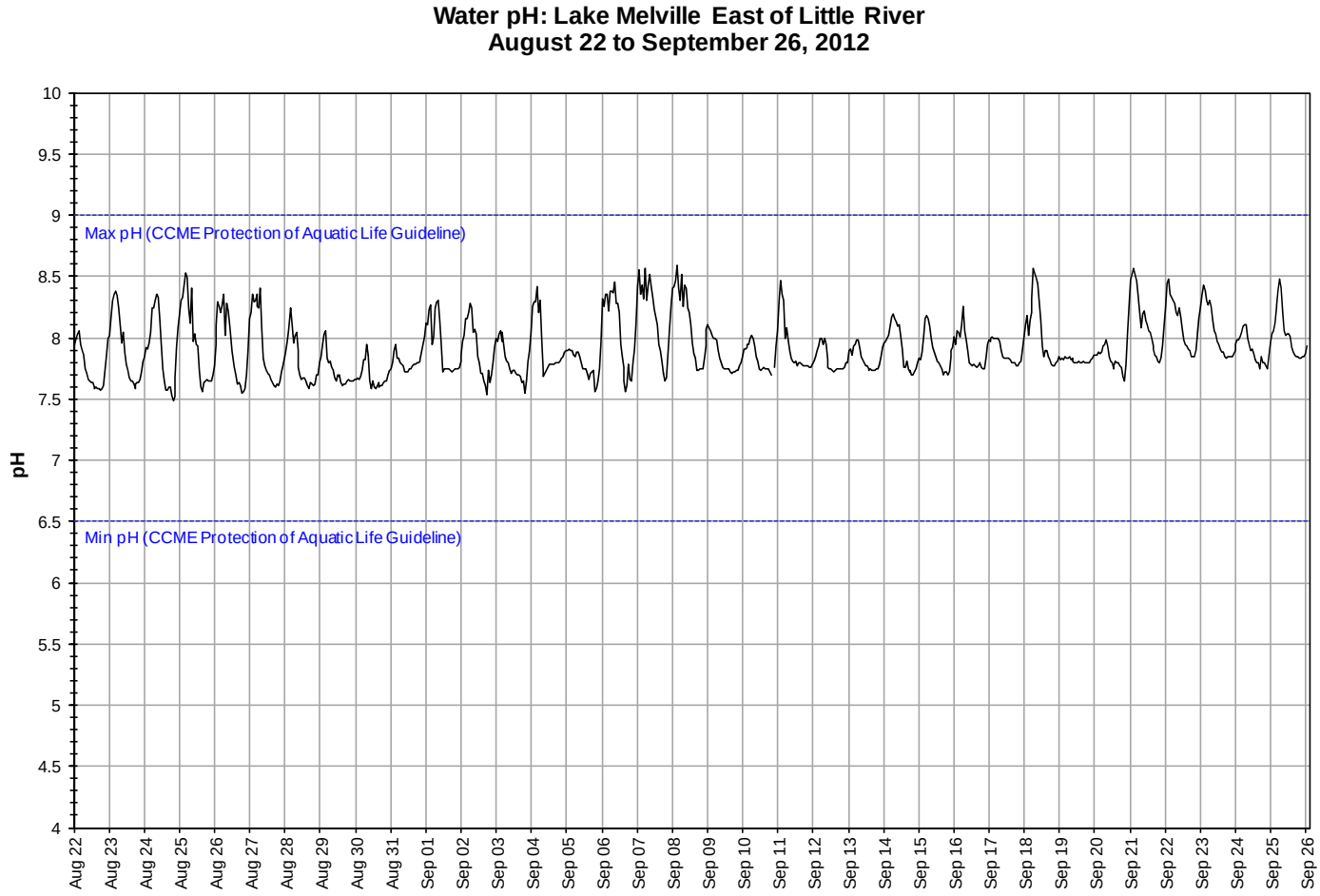

Figure 10: pH at Lake Melville east of Little River

- Specific conductivity ranges between 7900 to 35000µS/cm during the deployment period, averaging ~18000µS/cm (Figure 11).
- Specific conductivity is generally increasing throughout the deployment period. There are several occasions where specific conductivity does increase significantly over a number of hours and remains high from 12-48 hours. These events correspond with cold water and air temperatures. Examples are indicated in red on Figure 11.
- 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.

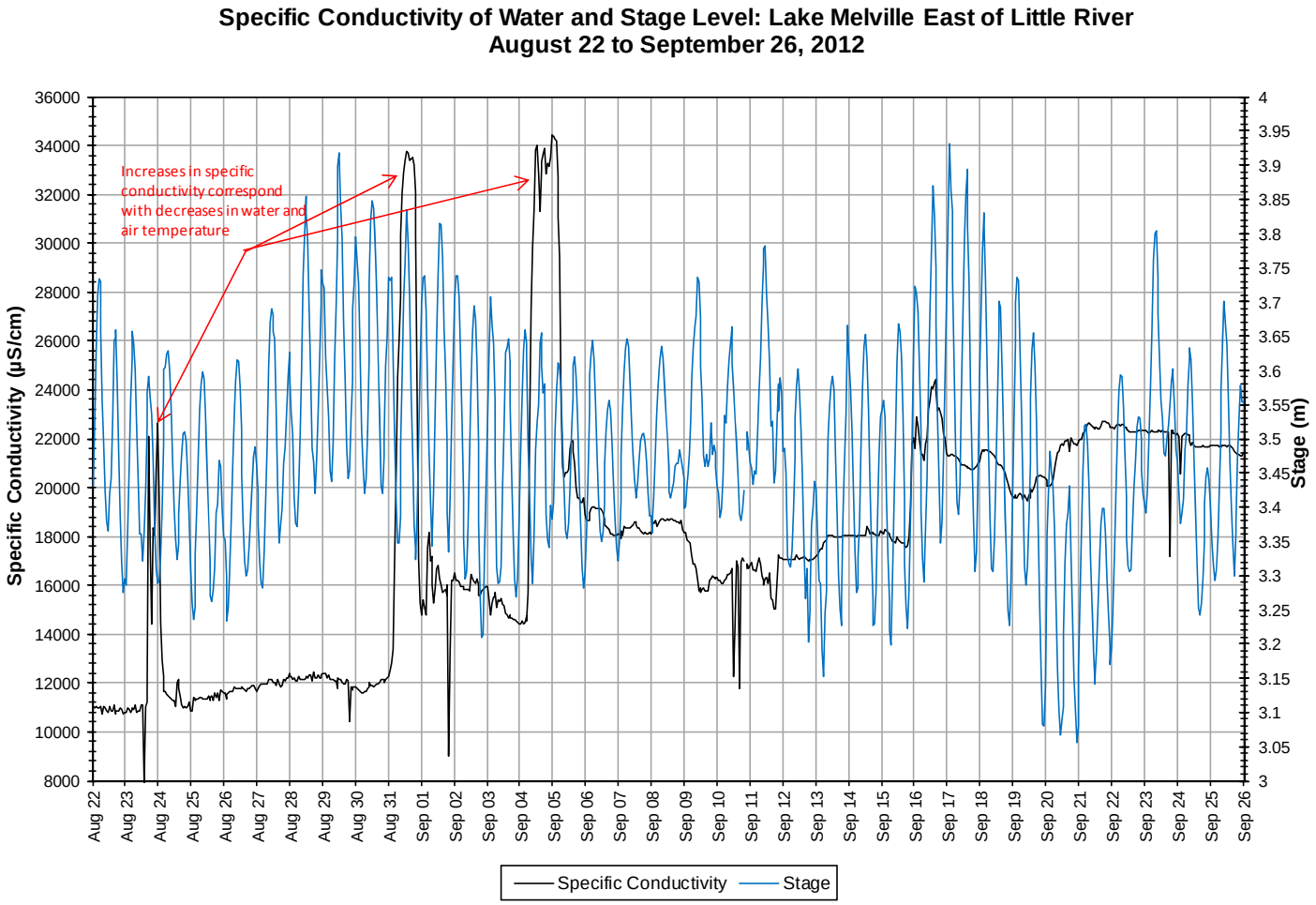

Figure 11: Specific conductivity and stage level at Lake Melville east of Little River

- Dissolved oxygen content ranges between 8.05mg/L and 13.67mg/L. The saturation of dissolved oxygen ranges from 81.7 to 141.9% (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stage of 6.5 mg/l. About half 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 fluctuates above and below this guideline daily. 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 changes in 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. Wave action can quickly introduce a lot of oxygen to the water column causing the readings to change significantly.

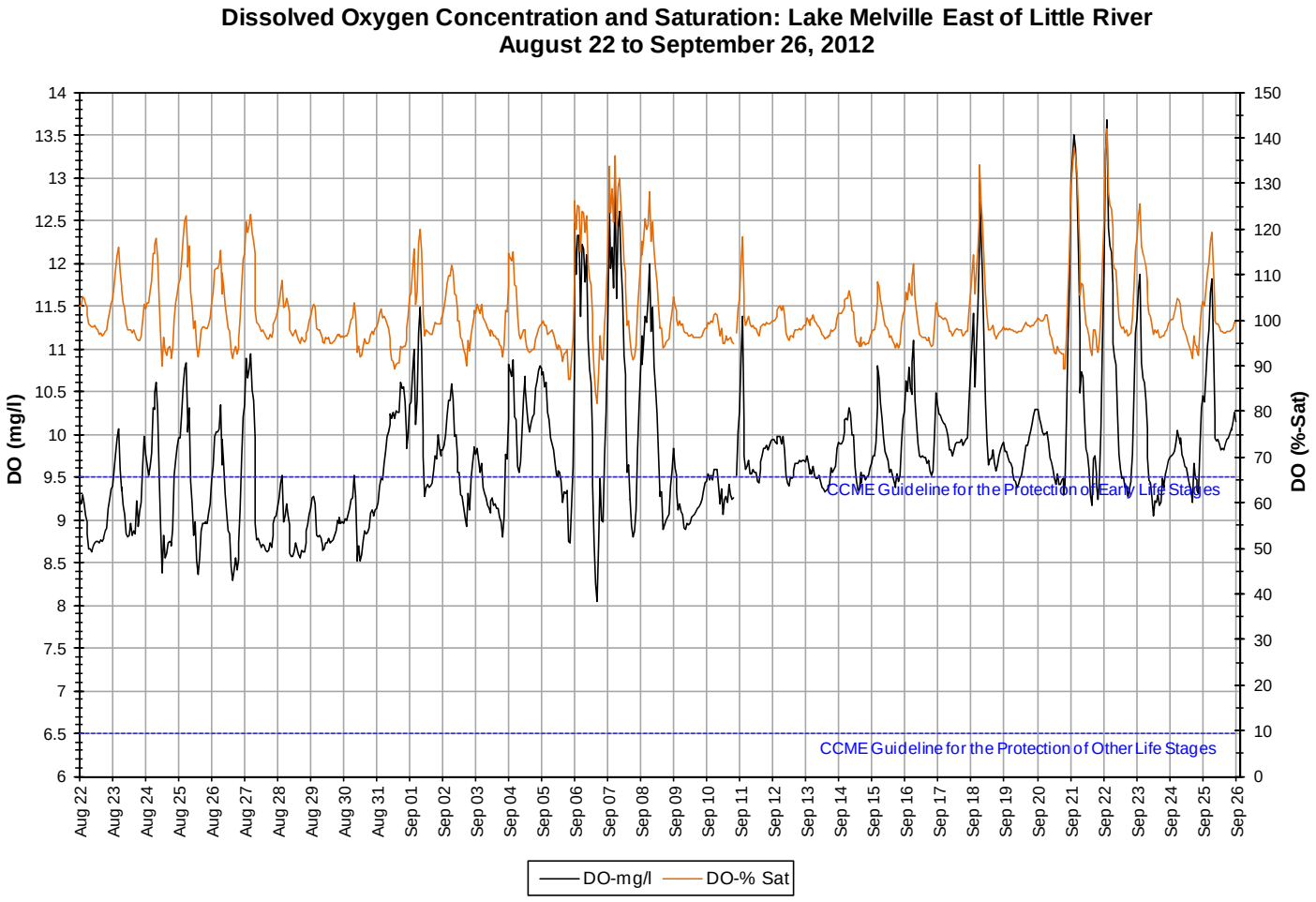

Figure 12: Dissolved oxygen and percent saturation at Lake Melville east of Little River

- Turbidity ranges from 0.0 to 334.0NTU throughout the deployment period (Figure 12). A median value of 8.9NTU indicates there is consistent natural background turbidity at this station.
- 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.

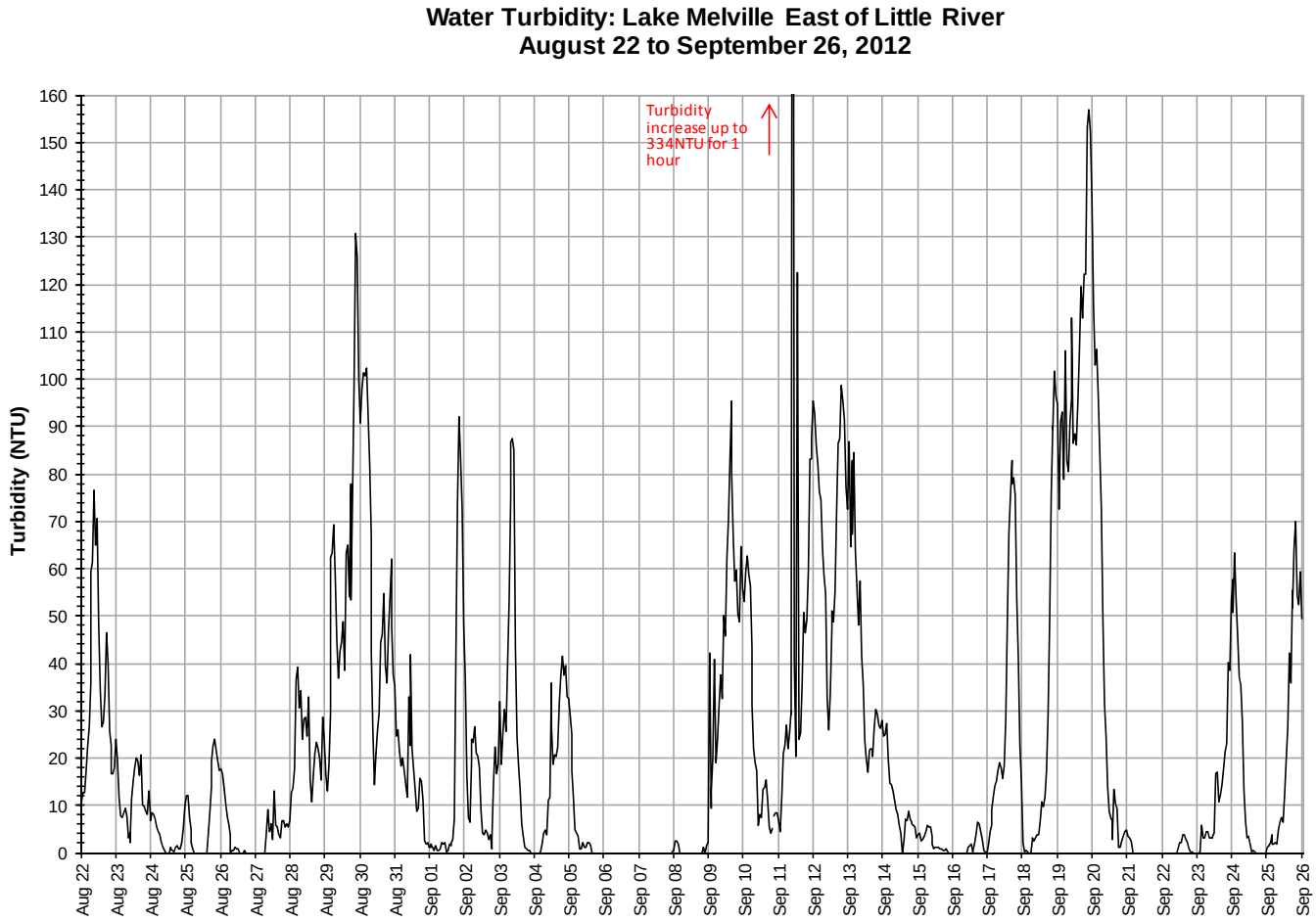

Figure 13: Turbidity at Lake Melville east of Little River

- 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 low throughout the month. With hourly recordings, stage ranges from 3.06m to 3.93m, a difference of 0.87m
- Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

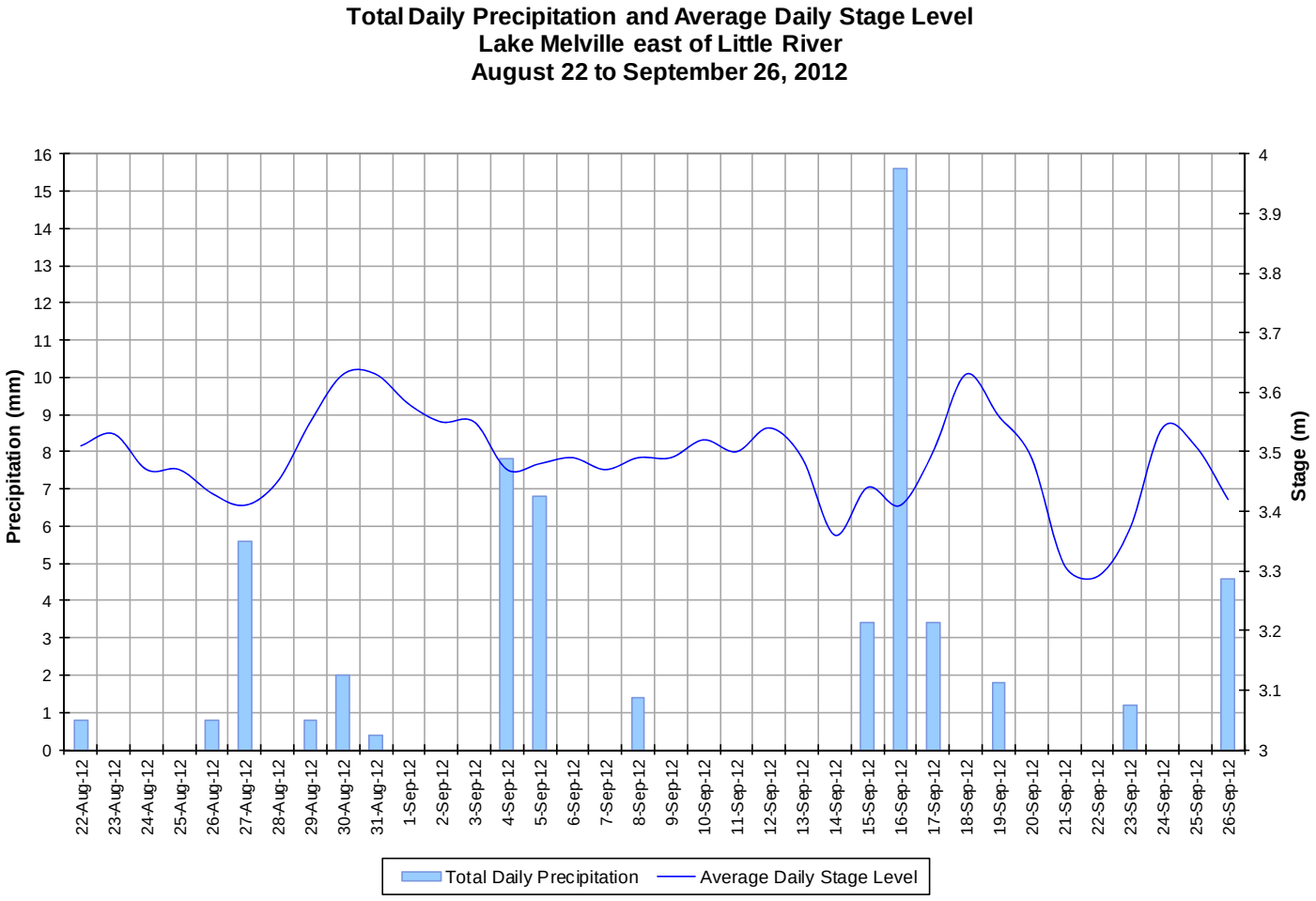

Figure 14: Stage and precipitation at Lake Melville east of Little River

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 August 22 and removed on September 26, a period of 34 days.
- 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, On September 13, sensors recording pH, specific conductivity, and turbidity all failed. On September 19, the dissolved oxygen sensor failed. Data recorded after these dates for the parameters listed have been removed from the dataset.
- At Churchill River at English Point, water temperature was found to be closely related to air temperature, decreasing throughout the deployment period. pH values were consistent and fluctuated daily. Between August 22 and September 19, dissolved oxygen content showed a typical inverse relationship to water temperature, increasing slightly. Specific conductivity and stage were generally stable and typical for this station. Turbidity generally remained below 9.5NTU however increased a few times well above this level up to 2400NTU. These events were short lived and there was no corresponding weather event to propose an explanation.
- At Lake Melville east of Little River, water temperature also decreased throughout the deployment period. On a few occasions water temperatures dropped dramatically and appeared to correspond with periods of cold air temperatures and increases in specific conductivity. Dissolved oxygen values showed an inverse relationship to water temperature and increased slightly during the month. pH values were generally stable with regular daily fluctuations. Specific conductivity increased throughout the deployment period and spiked significantly during periods of cold water temperatures. Turbidity records had a median value of 8.9NTU and varied widely between 0 and 334NTU. 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).
- For dissolved oxygen, at both stations, all values recorded were above the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stages (6.5mg/l). Dissolved oxygen content fluctuated above and below the minimum CCME Guideline for the Protection of Aquatic Life in Freshwater Environments at Early Life Stages (9.5mg/l).

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

Appendix 1 – Weather Data, Environment Canada Historical Climate Database