Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

June 29 to
July 25, 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 June 29, 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 26 days. The instruments were removed on July 25.

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 June 29 and July 25, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Churchill River and Lake Melville stations, June 29- July 25, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Churchill R. at English Point	Jun 29, 2012	Deployment	Excellent	Good	Good	Excellent	Marginal
	Jul 25, 2012	Removal	Excellent	Good	Good	Excellent	Marginal
Lake Melville east of Little R.	Jun 29, 2012	Deployment	Good	Excellent	Excellent	Excellent	Good
	Jul 25, 2012	Removal	Excellent	Excellent	Poor	Excellent	Poor

- At Churchill River at English Point, temperature, pH, specific conductivity, and dissolved oxygen all ranked either 'good' or excellent' while turbidity ranked 'marginal'. The field instrument read a value of 10.5NTU and the QAQC instrument read a value of 19.2NTU. This discrepancy may have been due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization. At removal, temperature, pH, specific conductivity and dissolved oxygen all ranked either 'good' or 'excellent' while turbidity ranked 'marginal' again. The field instrument read a value of 16.5µS/cm while the QAQC instrument read a value of 8.4µS/cm. Similarly to the deployment rankings, this discrepancy may have been due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization.
- At the station on Lake Melville east of Little River, all parameters ranked either 'good' or 'excellent' at deployment. At removal, temperature, pH and dissolved oxygen all ranked 'excellent' while specific conductivity and turbidity both ranked 'poor'. For specific conductivity, the field instrument read a value of 7211uS/cm and the QAQC instrument read a value of 5472uS/cm. These are both very high conductivity measurements. The field instrument for this station is normally calibrated with a 1413uS/cm standard while the QAQC instrument is calibrated using a 100uS/cm. It is possible that the QAQC instrument has difficulty reading such high values of conductivity. For turbidity, the field instrument read a value of 84.8NTU while the QAQC instrument read a value of 51.8NTU. These are both very high turbidity values. Due to the windy and wavy nature of this site, the discrepancy between the measurements is likely related to the positioning of the instrument beside one another in the water body and the time allowed for stabilization.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from June 29 to July 25 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 14.60 to 21.30^{o}C during the deployment period (Figure 1).
- Water temperature is increasing and decreasing throughout the deployment period. The water temperature at this station is highly variable due to its shallow position at the river mouth. Daily average air temperature is very closely related to daily average water temperature (Figure 2).
- There is a noticeable decrease in water temperature on July 18 to 19 which corresponds with cool air temperatures and significant rainfall.
- Water temperature fluctuates diurnally and with tidal influences.

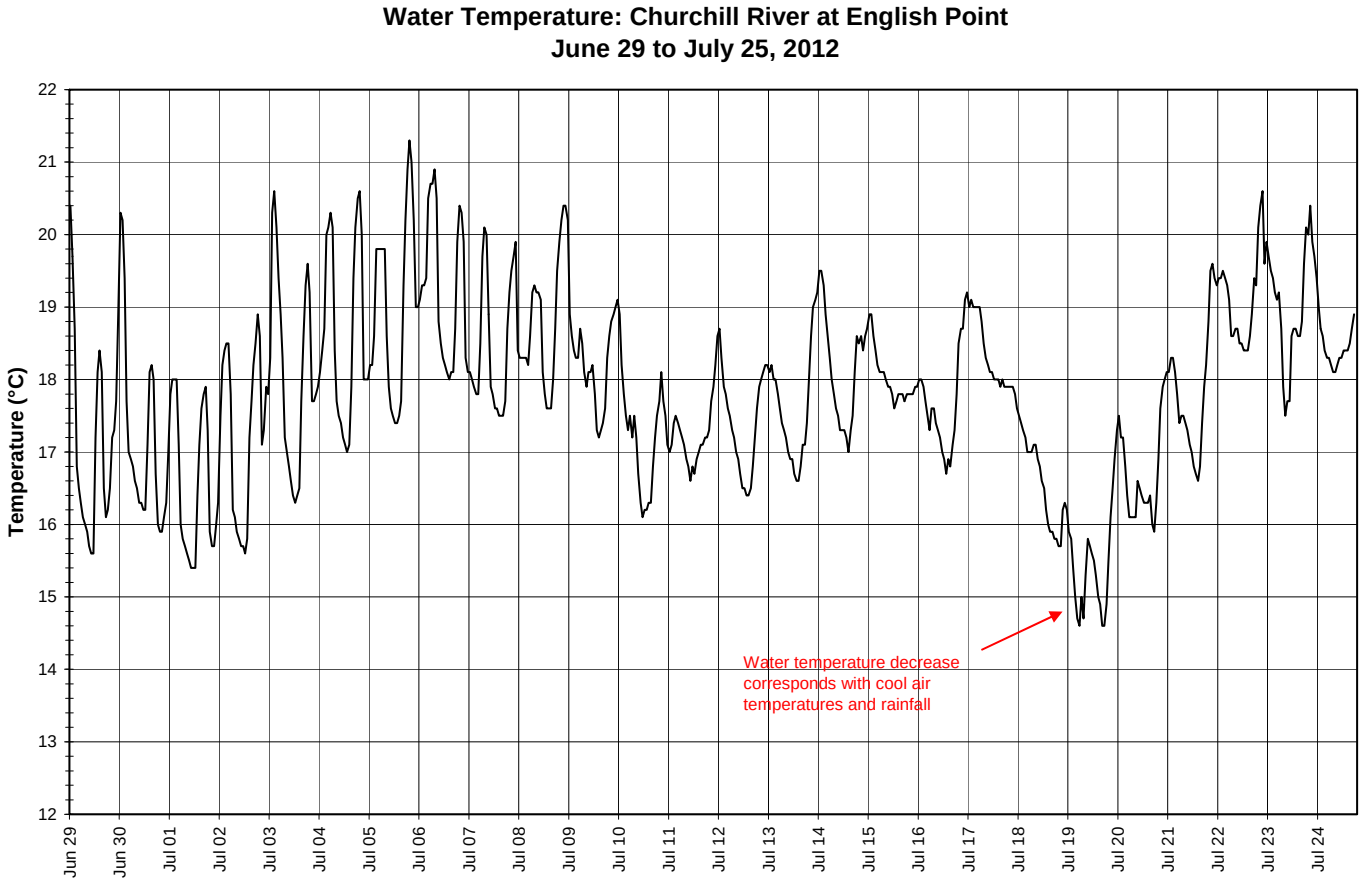

Figure 1: Water temperature at Churchill River at English Point

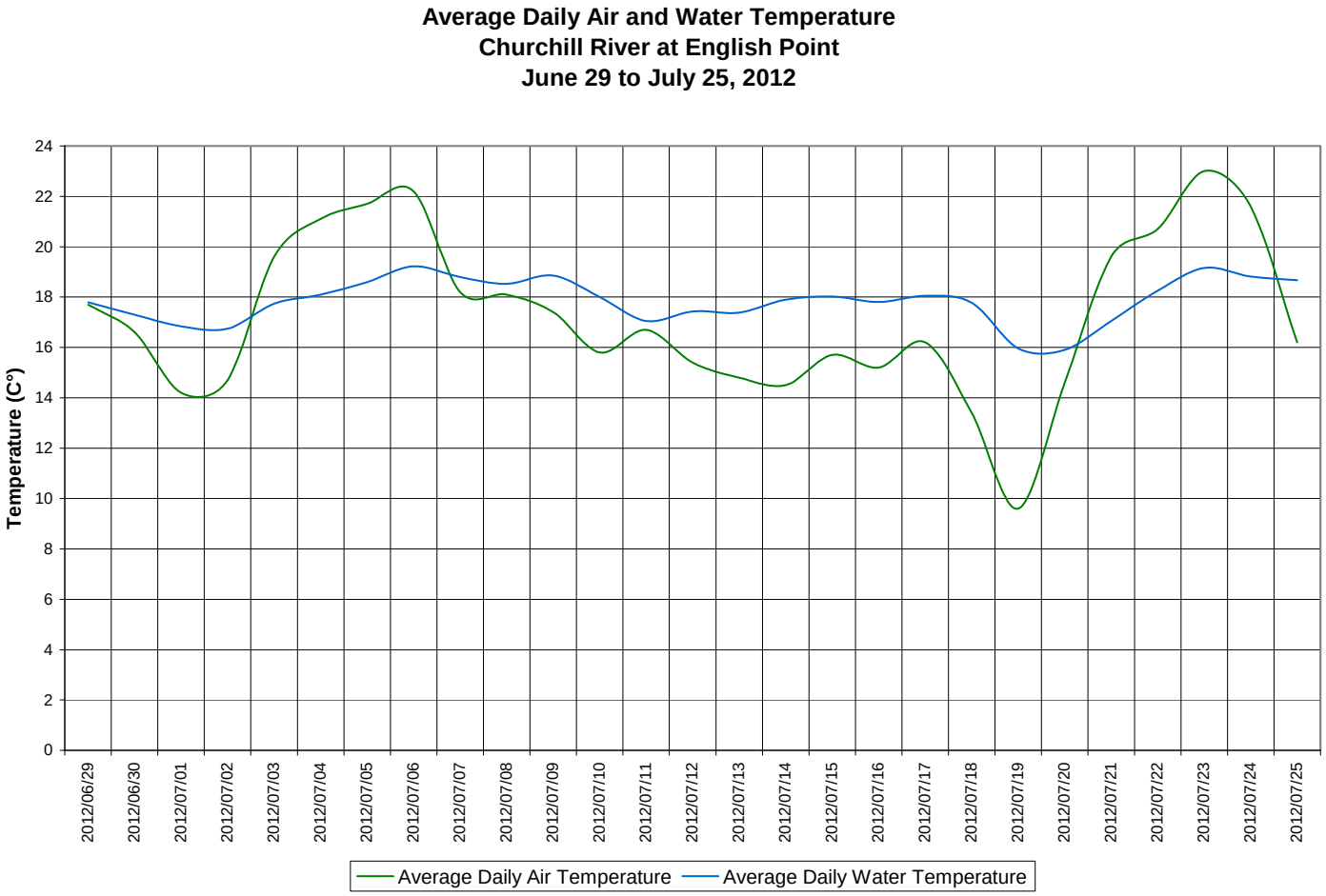

Figure 2: Average daily air and water temperatures at Churchill River at English Point

(weather data collected at Goose Bay)

- pH ranges between 6.44 and 7.20 pH units (Figure 3). pH values are generally stable and fluctuate diurnally and with tidal influences.
- Most values during the deployment 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.
- pH values drop just below the minimum guideline for a brief time in the last week of the deployment period.

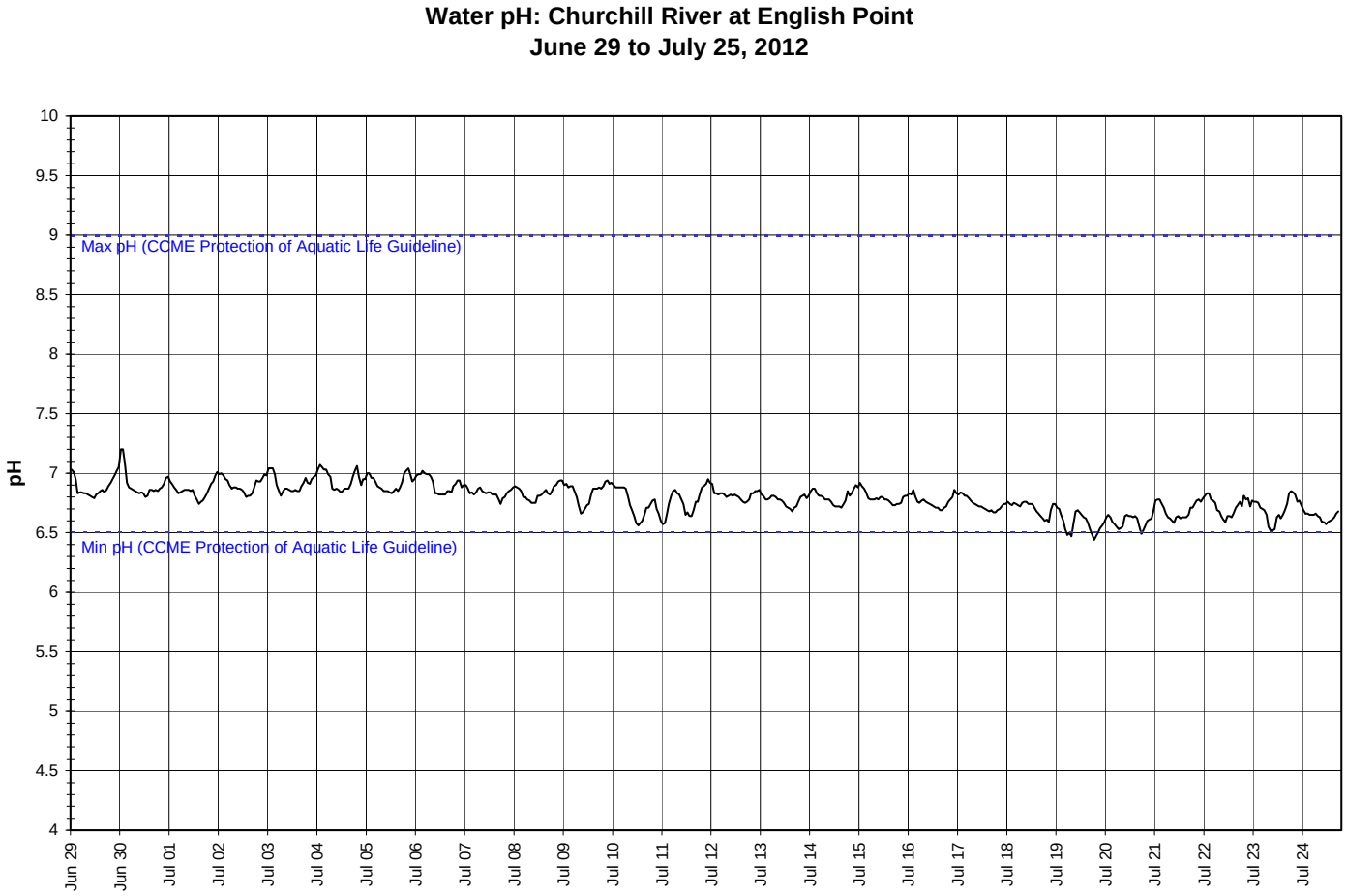

Figure 3: pH at Churchill River at English Point

- Specific conductivity ranges between 25.1 to 71.1µS/cm during the deployment period, averaging 39.6µS/cm (Figure 4).
- There is a notable decrease and change in pattern for specific conductivity on July 18. This corresponds with cool air and water temperatures as well as heavy rainfall.
- 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.

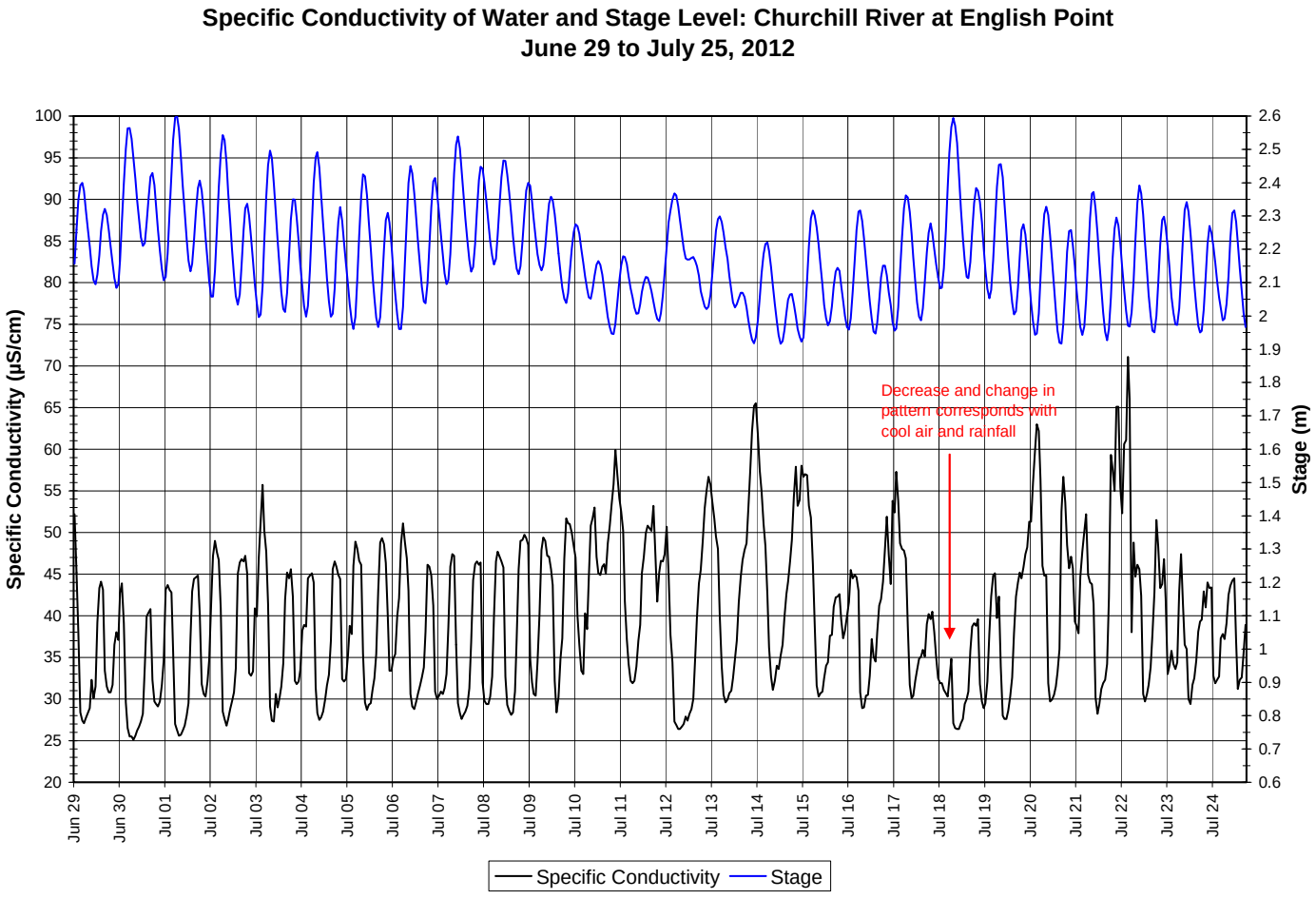

Figure 4: Specific conductivity and stage level at Churchill River at English Point

- The saturation of dissolved oxygen ranged from 87.1 to 112.3% and a range of 8.56 to 10.65mg/l was found in the concentration of dissolved oxygen with a median value of 9.58mg/l (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. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is stable throughout the deployment period and clearly fluctuates diurnally, displaying the inverse relationship with water temperature during day, night and tidal changes.

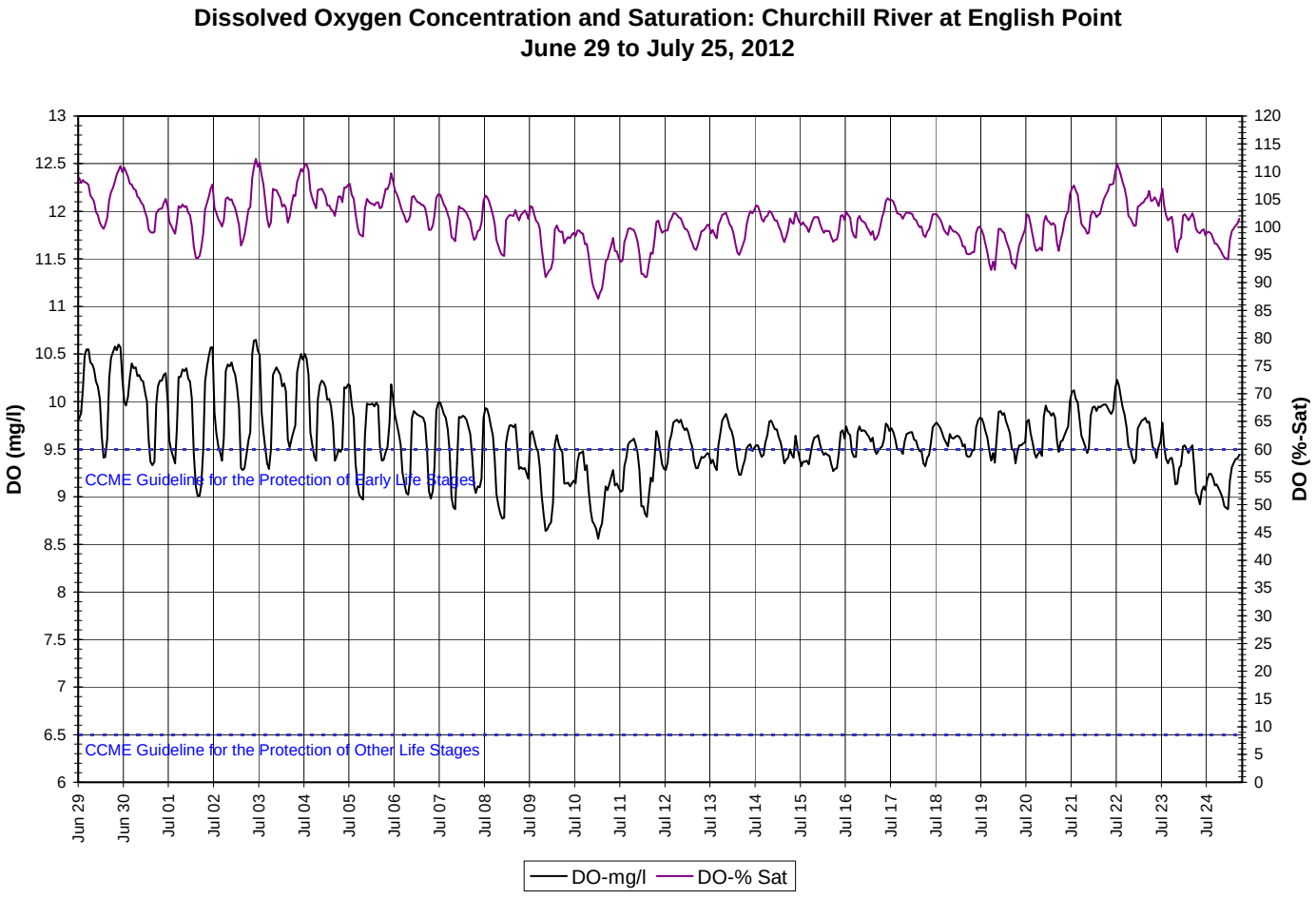

Figure 5: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity values generally remained below 100.0NTU (Figure 6). A median value of 11.6NTU indicates there is a natural background turbidity value at this station. Average turbidity at this station is about 16.5NTU.
- There is a significant increase in turbidity at the very end of the deployment period on July 24-25. Turbidity values increase to 346NTU. This increase in turbidity does not correspond with any weather related events recorded in the area. There are a number of smaller magnitude increases in turbidity throughout the deployment period as well. Heavy rainfall amounts recorded on July 18 correspond with an increase in turbidity. Precipitation events vary throughout the deployment period and may or may not cause turbidity increases (Figure 7).

Water Turbidity and Stage Level: Churchill River at English Point
June 29 to July 25, 2012

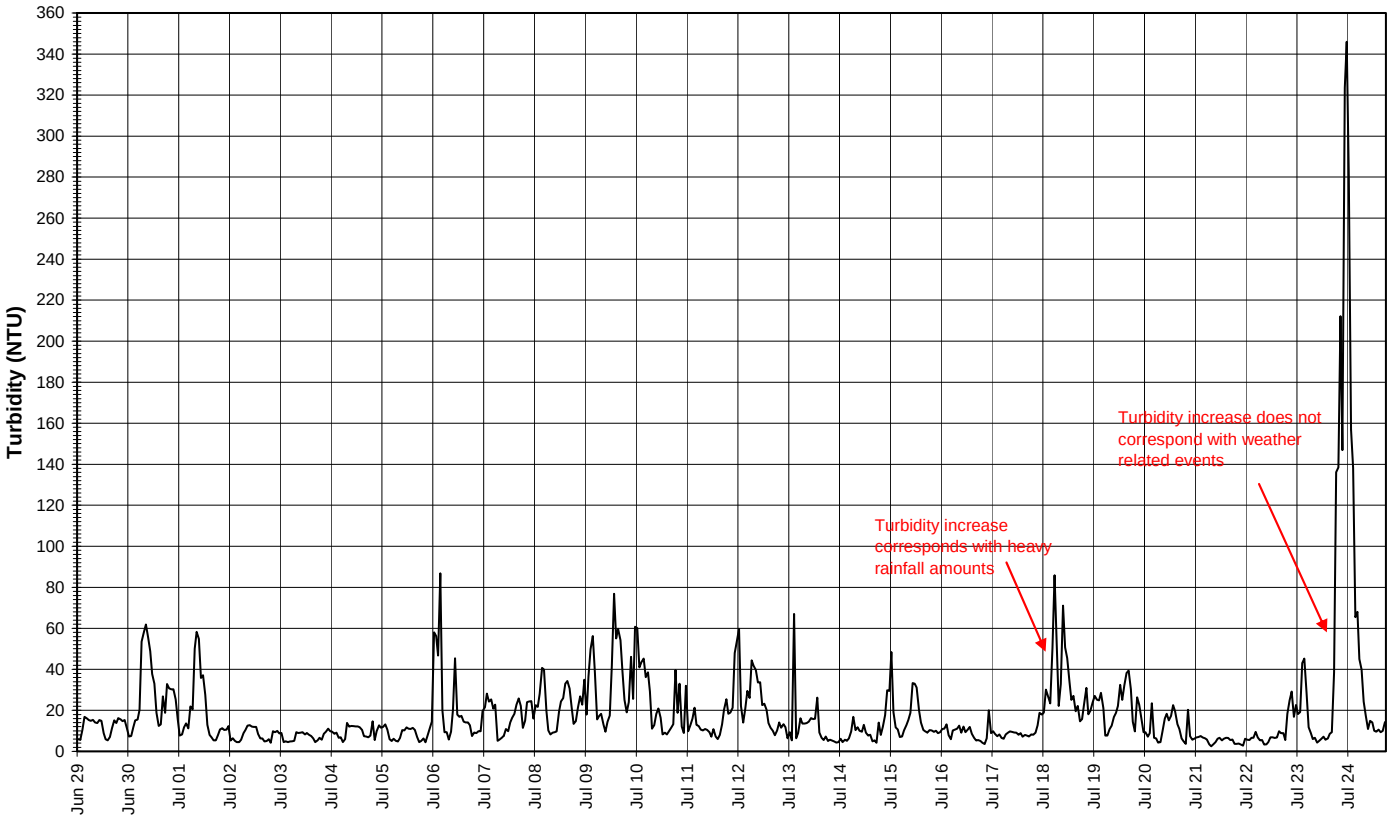

Figure 6a: Turbidity at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage remains relatively stable fluctuating throughout the deployment period with varying precipitation records. Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

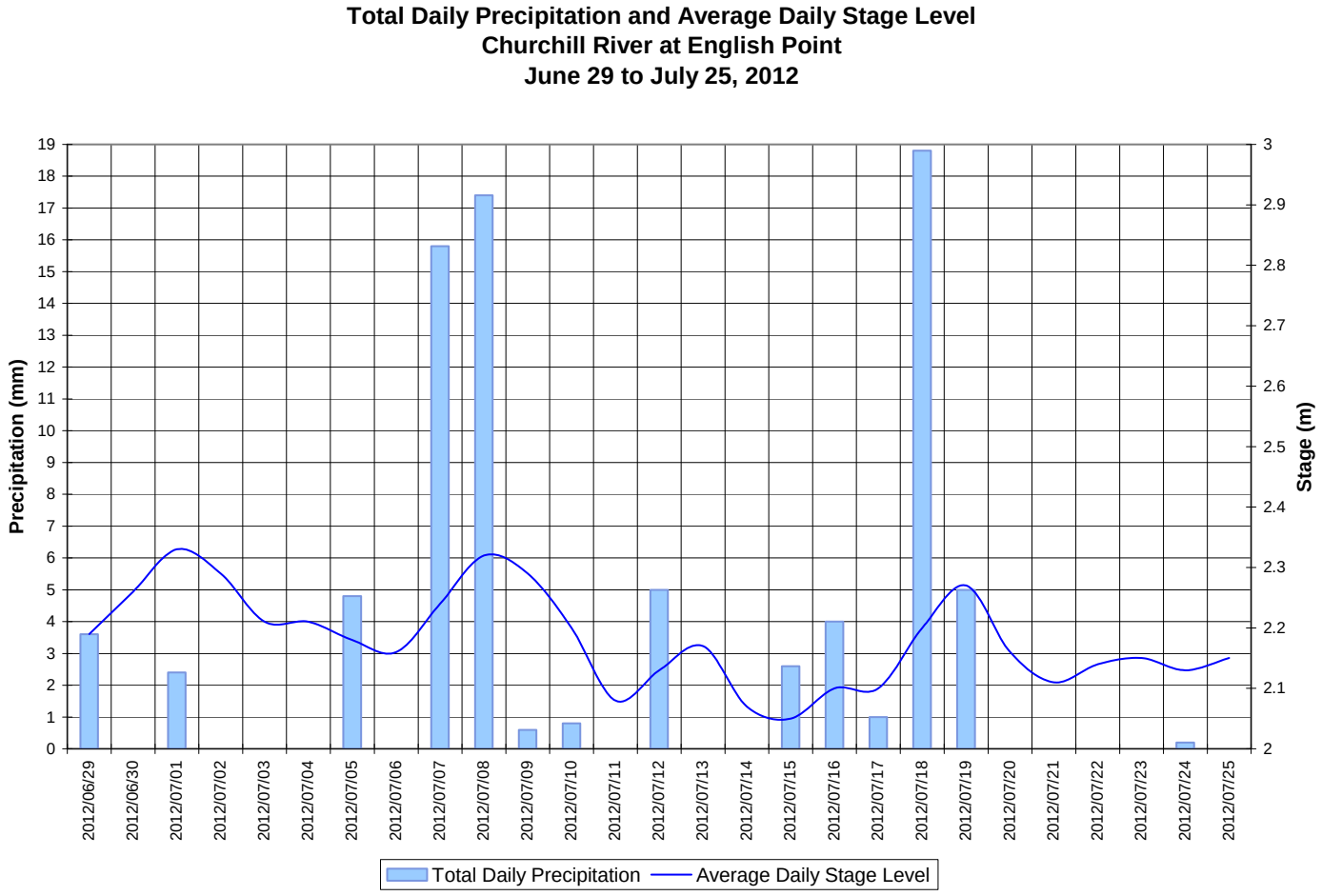

Figure 7: Stage and precipitation at Churchill River at English Point

Lake Melville East of Little River

- Water temperature ranges from 9.90 to 20.20°C during the deployment period (Figure 8).
- Water temperature is fluctuating throughout the deployment period and at one point drops to as low as 10°C for one hour on July 18. This drop in water temperature corresponds with cool air temperatures and heavy rainfall (~20mm) recorded at Goose Bay airport. This decrease also corresponds with a significant increase in specific conductivity (Figure 11) and change in dissolved oxygen (Figure 12).
- Water temperature fluctuates diurnally and with tidal influences.

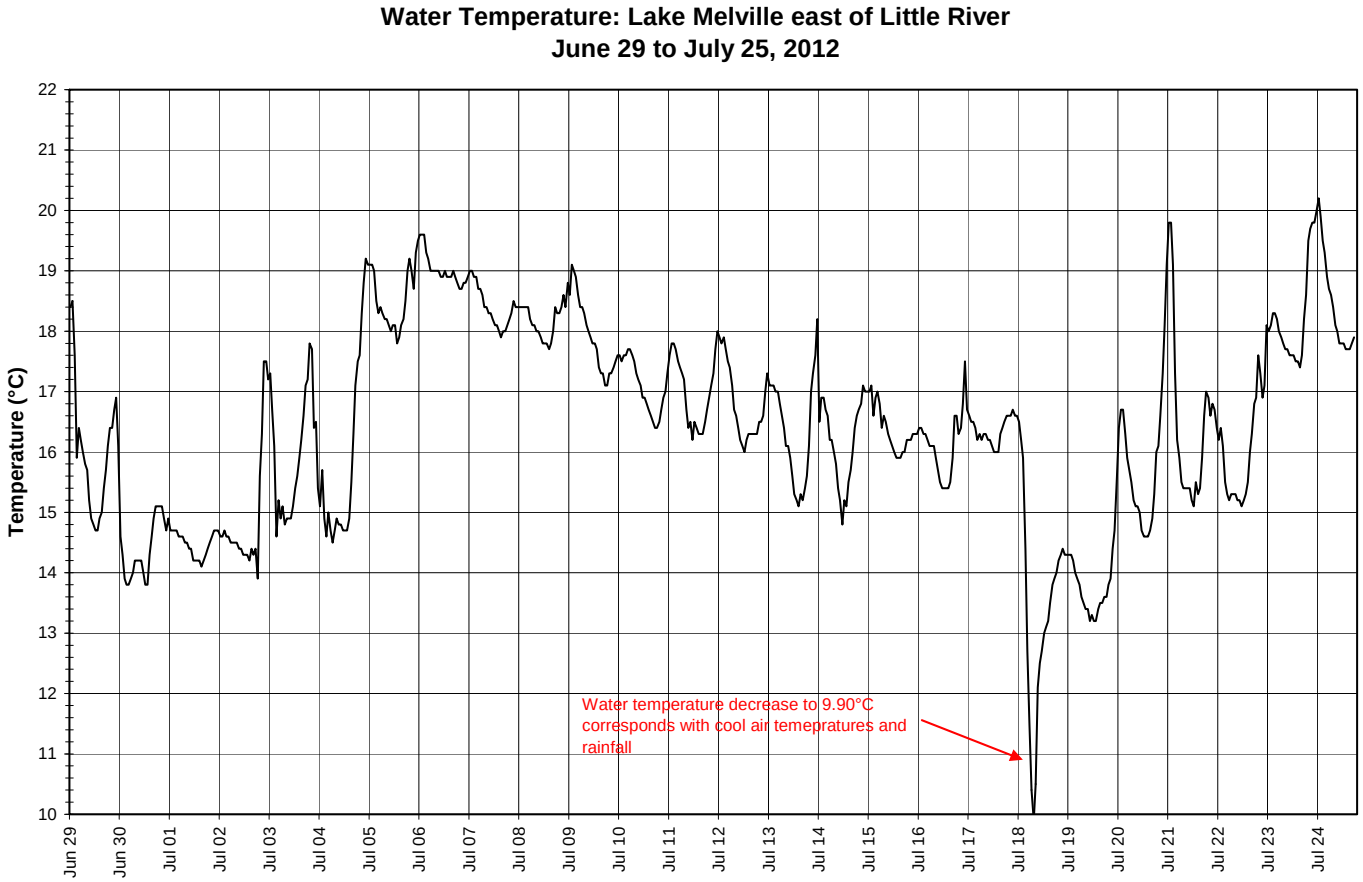

Figure 8: Water temperature at Lake Melville east of Little River

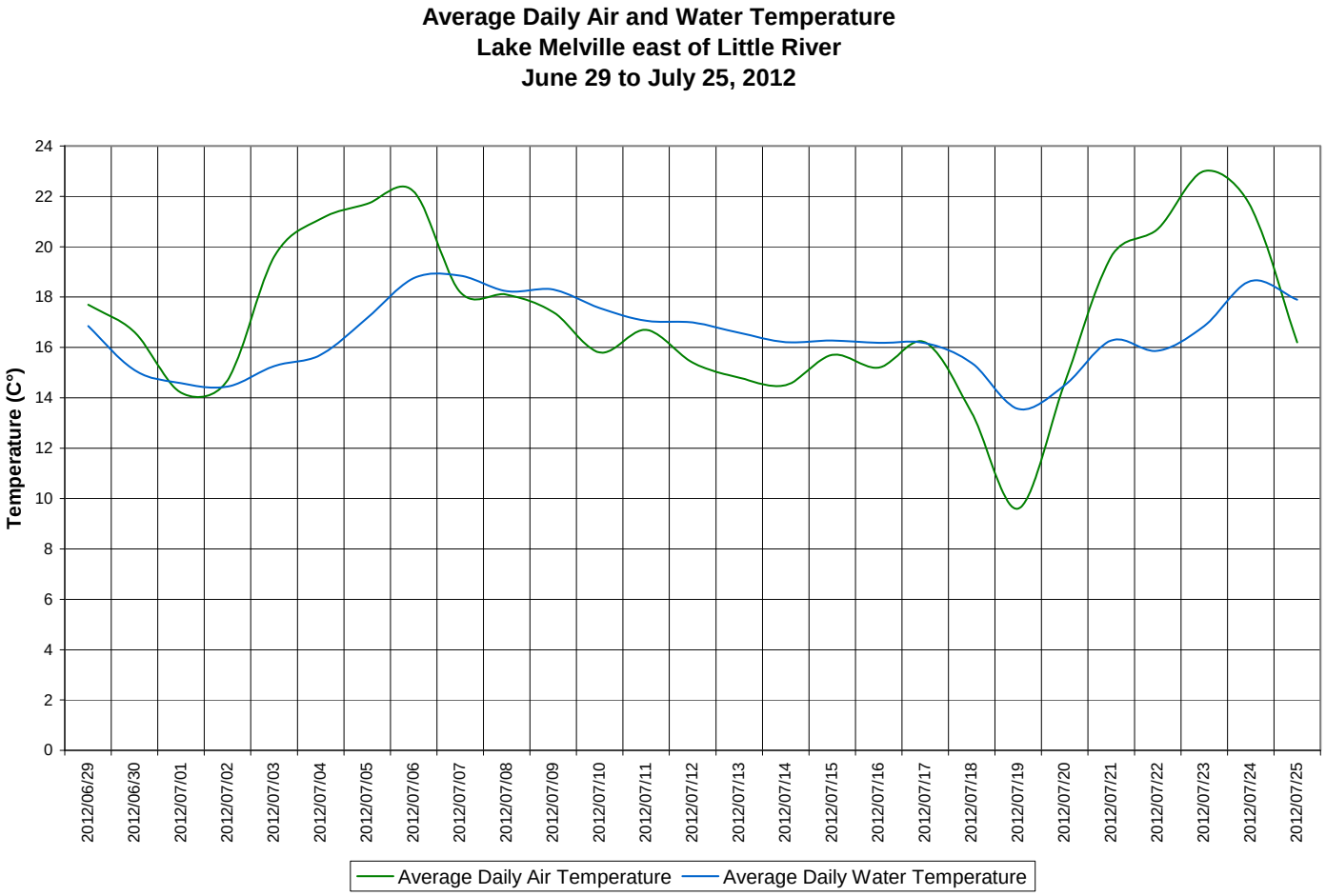

Figure 9: Average daily air and water temperatures at Lake Melville east of Little River (weather data collected at Goose Bay)

- pH ranges between 6.91and 8.77 pH units (Figure 10). pH values are generally stable and fluctuate diurnally and with tidal influences.
- Rainfall events on July 7 to 8 and July 18 correspond with changes in the regular pH fluctuation.
- 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).

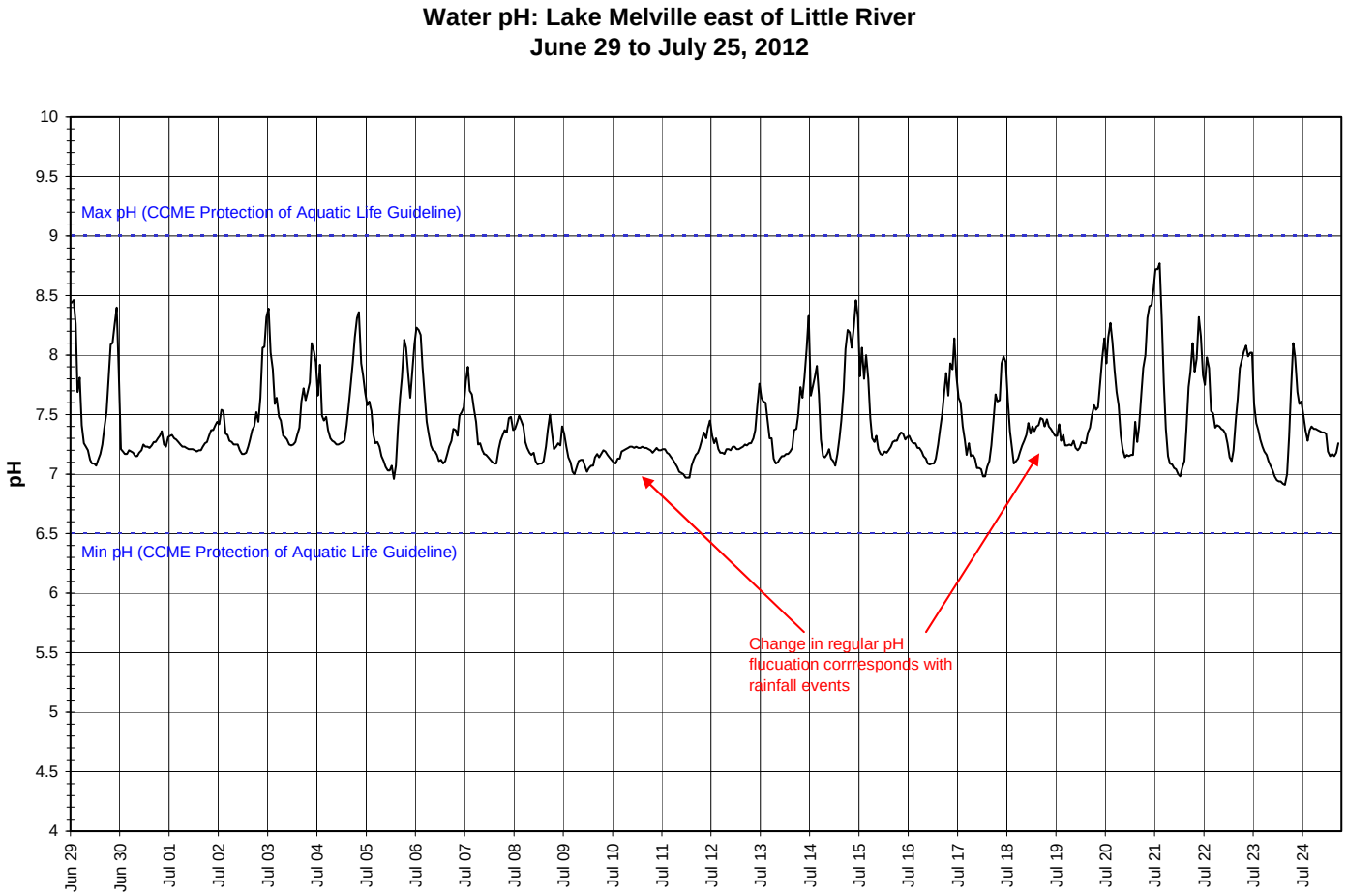

Figure 10: pH at Lake Melville east of Little River

- Specific conductivity ranges between 1755 to 10000µS/cm during the deployment period, averaging ~5400µS/cm (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. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period.
- A decrease in specific conductivity corresponds with a two day rainfall event July 7 to 8. Conductivity decrease from ~5000µS/cm to just below 2000µS/cm.
- There is a significant increase in specific conductivity on July 18 from ~6000µS/cm to over 24000µS/cm. This increase corresponds with a noticeable decrease in water temperature (Figure 8), air temperature (Figure 9) and ~20mm of precipitation recorded at Goose Bay airport. Changes in the fluctuation patterns of pH (Figure 10) and dissolved oxygen (Figure 13) are also noticed.

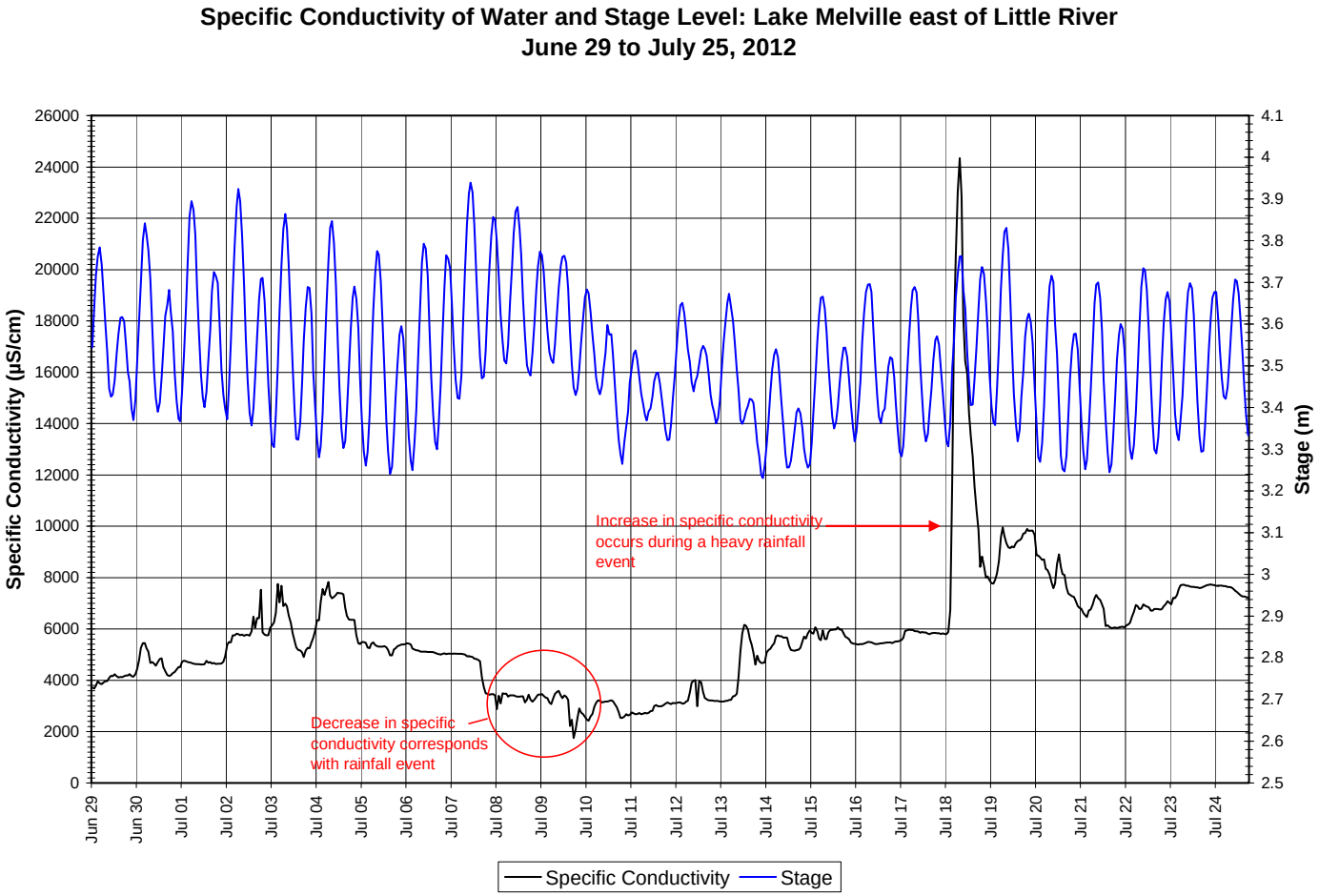

Figure 11: Specific conductivity and stage level at Lake Melville east of Little River

- The saturation of dissolved oxygen ranged from 87.2 to 139.0% and a range of 8.14 to 12.58mg/l was found in the concentration of dissolved oxygen with a median value of 9.62mg/l (Figure 12).
- All values were above the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stage of 6.5 mg/l. If this station is considered to be a marine environment, all values recorded for dissolved oxygen are also about the CCME Guideline for the Protection of Aquatic Life in Marine Environments. The guidelines are indicated in blue and green on Figure 12.
- Dissolved oxygen content is variable throughout the deployment period and clearly fluctuates diurnally, displaying the inverse relationship to water temperature during the day and night and with tidal influences.
- Rainfall events on July 7-8 and 18 temporarily disrupt the fluctuation pattern in dissolved oxygen and percent saturation (indicted in red on Figure 12).

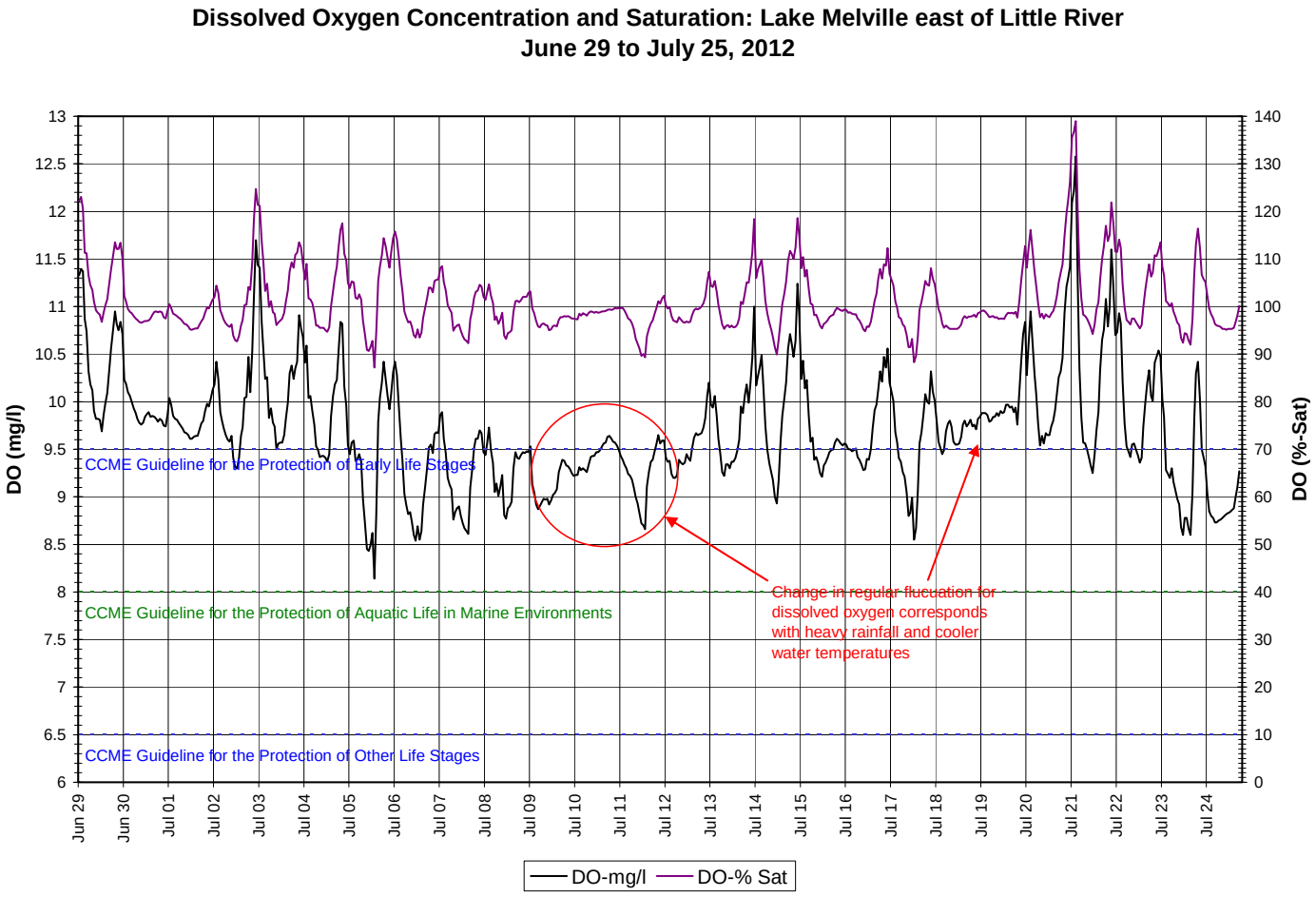

Figure 12: Dissolved oxygen and percent saturation at Lake Melville east of Little River

- Turbidity values ranged between 0.0 and 403.0NTU (Figure 13). A median value of 21.2NTU indicates there is a natural background turbidity value at this station.
- There is a long lasting, above average increase in turbidity in the middle of the deployment period. The turbidity event lasts over a period of 6 days between July 8 to14. Turbidity values increase to over 400NTU. A significant rainfall event (+30mm) is recorded at the Goose Bay airport just prior to the start of this increase (July 7-8).
- There is a less significant increase in turbidity on July 18 which corresponds with a decrease in water and air temperatures, increase in specific conductivity, and changes in dissolved oxygen and pH patterns.

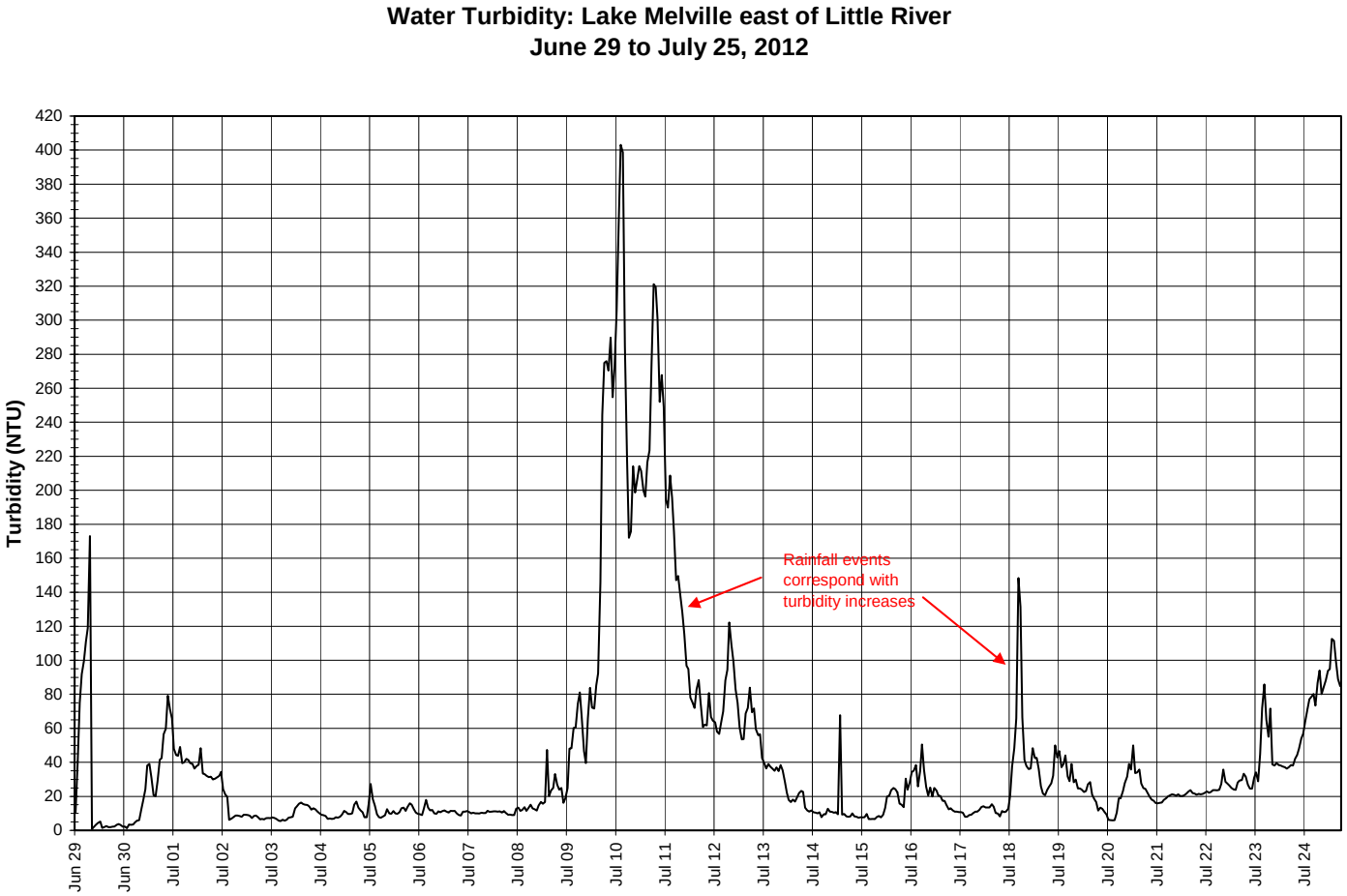

Figure 13: Turbidity at Lake Melville east of Little River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage remains relatively stable fluctuating throughout the deployment period with varying precipitation records. Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

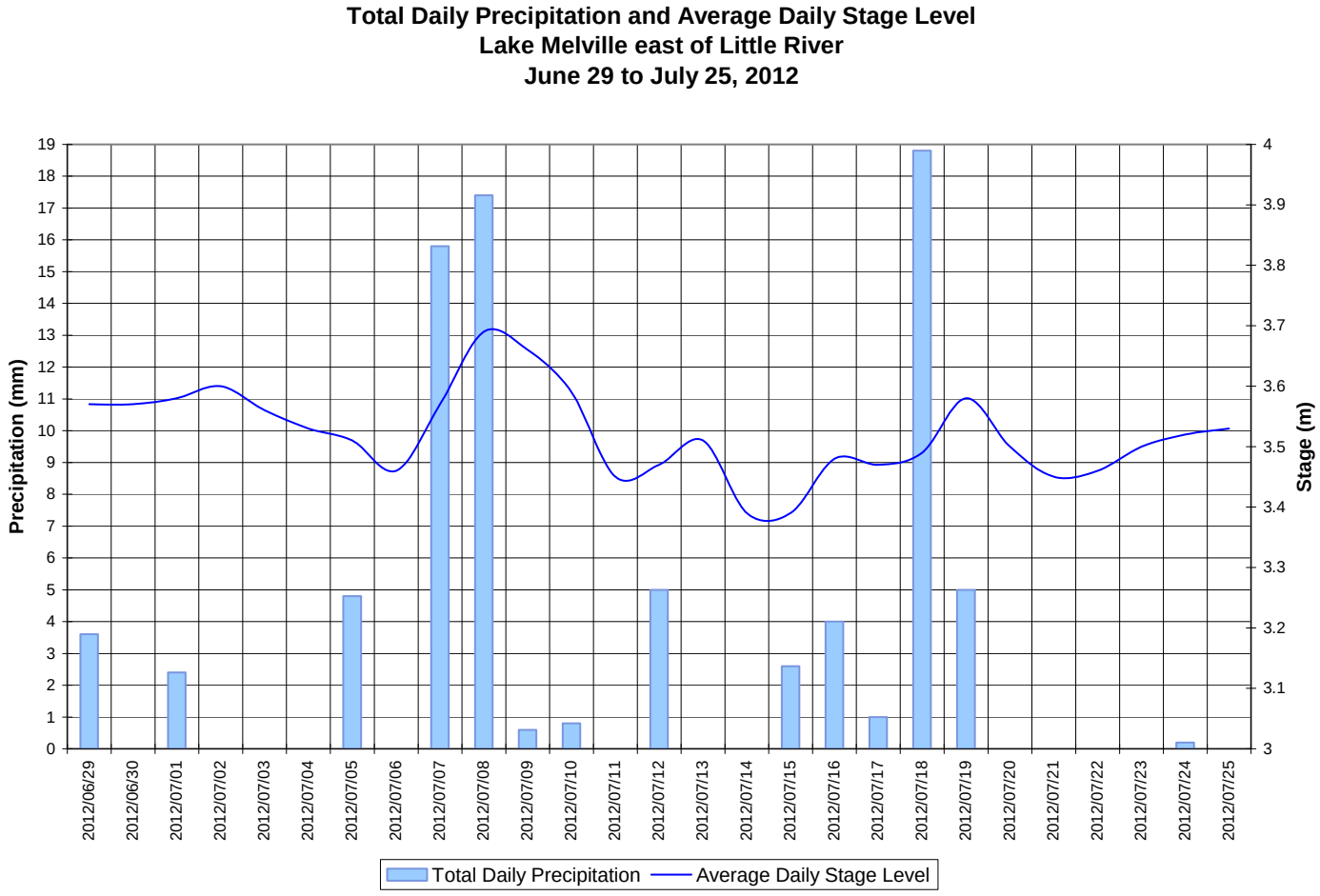

Figure 14: Stage and precipitation at Lake Melville east of Little River

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 June 29 and removed on July 25, a period of 26 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, in most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations. Significant rainfalls and decreases in air temperature on July 7-8 and 18 affected water temperature, specific conductivity, and turbidity. Water temperature and dissolved oxygen were generally stable throughout the deployment period. pH decreased slightly. Specific conductivity fluctuated regularly with changes in stage level and is highly influenced by the tides in the Atlantic Ocean. Turbidity varied throughout deployment period. Stage was relatively consistent.
- At Lake Melville east of Little River, weather related events could also most times be used to explain changes in water quality parameters. The significant rainfalls amounts recorded on July 7-8 and 18 and cool air temperatures caused changes in water temperature, pH, specific conductivity, dissolved oxygen and turbidity on corresponding days. Water quality parameters tend to be variable at this lake shore station and change rapidly with the tidal influences of the Atlantic Ocean.
- All values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH. For dissolved oxygen, all values recorded were above the minimum CCME Guideline for the Protection of Aquatic Life in Freshwater Environments (6.5mg/l) and at Lake Melville, all values were above the CCME Guideline for the Protection of Aquatic Life in Marine Environments (8.0mg/l).

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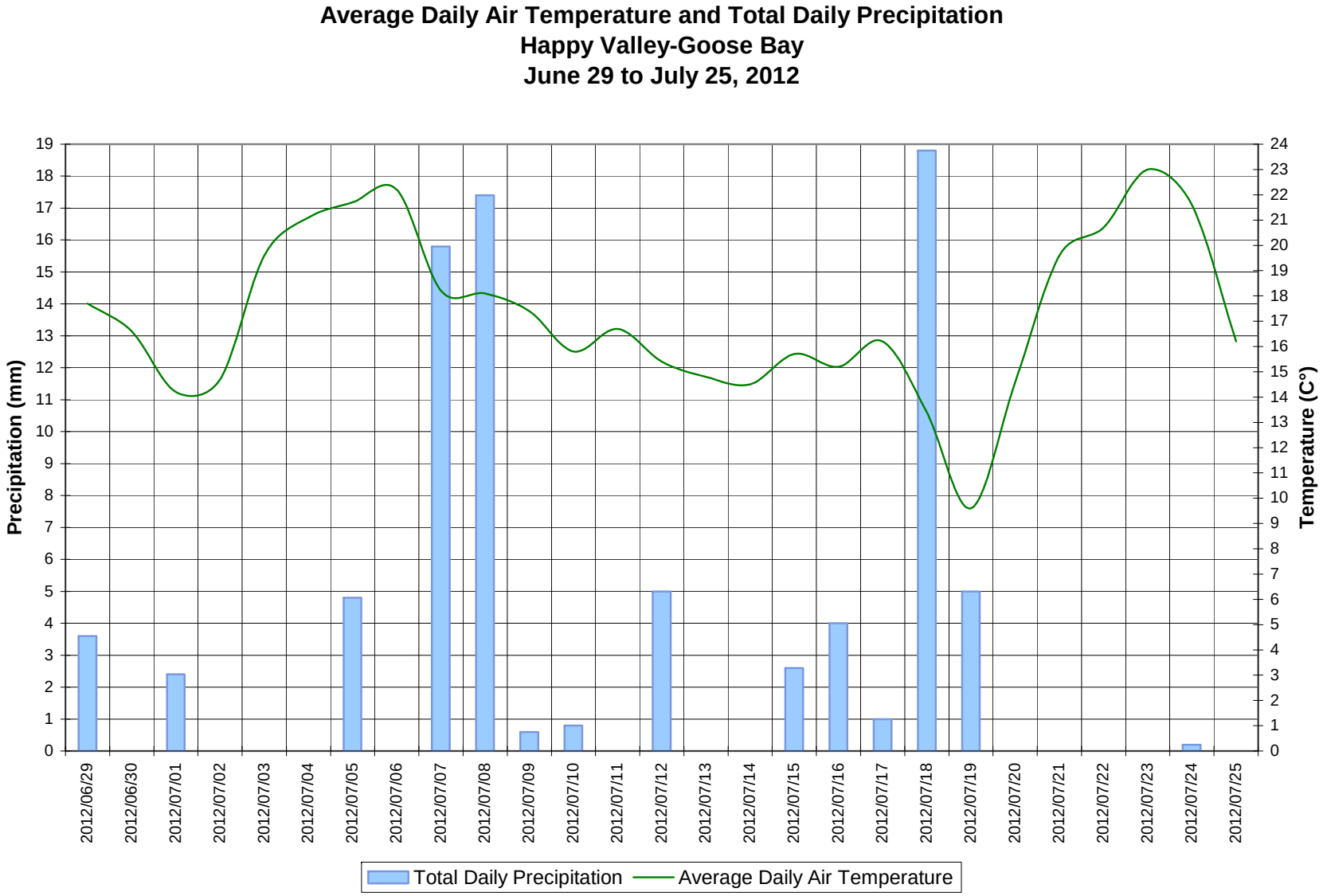
Appendix 1


Average Daily Air Temperature and Total Daily Precipitation
Happy Valley-Goose Bay
June 29 to July 25, 2012
Precipitation (mm)
Temperature (C°)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
2012/06/29
2012/06/30
2012/07/01
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2012/07/24
2012/07/25
Total Daily Precipitation
Average Daily Air Temperature