Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

May 27 to
June 30, 2011

Newfoundland Labrador

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

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 stations on the Lower Churchill River at English Point and Lake Melville East of Little River.
- On May 27, 2011, real-time water quality monitoring instruments were deployed for the first time at stations on the Lower Churchill River at English Point and Lake Melville East of Little River. Instruments were deployed for a period of 33-34 days. Instruments were removed on June 29/30.

Station Review

- In fall 2010, two new Real Time Water Monitoring Stations were successfully established by Department of Environment and Conservation (ENVC) in partnership with Environment Canada (EC). The stations are located on the Lower Churchill River near the confluence with Goose Bay (Lake Melville) at English Point, and on Lake Melville, east of Little River (Figure 1).
- The objective of the network extension is to identify and track any emerging water quality or quantity management issues and ensure protection of ambient water resources.
- The two stations established in Fall 2010 work in combination with the existing Lower Churchill River Network of real time water quality monitoring stations. The existing stations are located on the Lower Churchill River below Metchin River, below Grizzle Rapids and above and below Muskrat Falls (Figure 2).
- The 2 new stations measure water quality parameters including water temperature, pH, specific conductivity, dissolved oxygen, and turbidity. Percent saturation and total dissolved solids are calculated from the measured parameters. Water quality monitoring is the primary responsibility of ENVC.
- The 2 stations are also monitoring water quantity (stage level). Water quantity monitoring is the primary responsibility of EC. ENVC staff reporting on water quality will have access to water quantity information if necessary to understand and explain water quality fluctuations.
- Stations were built in August 2010. In late September 2010, ENVC and EC staff installed equipment and tested communications. EC began recording stage level at this time. The ENVC webpage was updated to include the 2 new stations in October 2010. No water quality monitoring instrumentation was installed in 2010 due to inclement weather conditions and operational restrictions. Water quality monitoring instruments were first deployed on May 27, 2011 when ice and snow conditions permitted following the winter season.
- The 2 stations will remain deployed, with regular scheduled maintenance visits, until late October 2011 when they will be removed for the winter season.

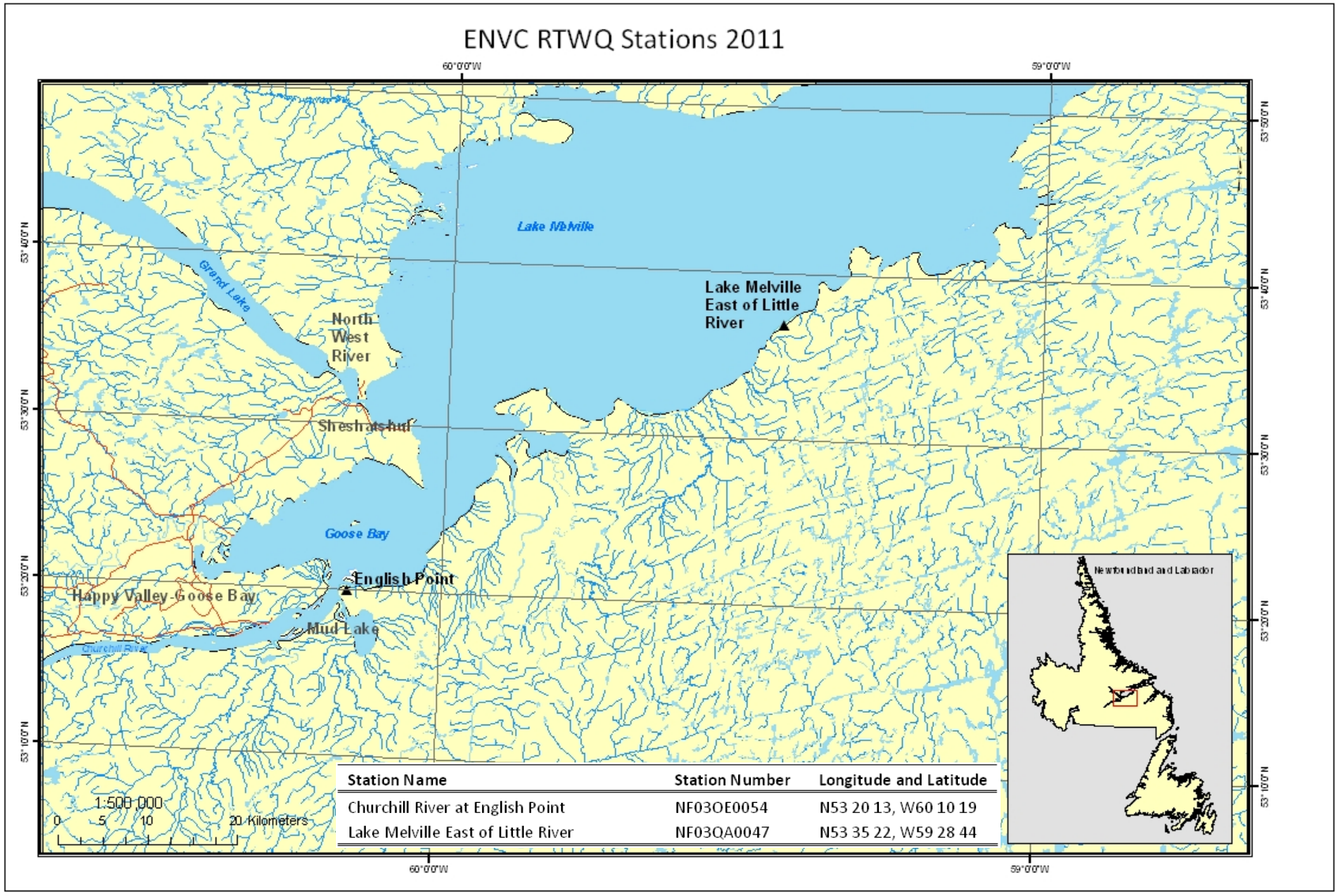

Figure 1: Map of two new ENVC RTWQ stations on the Churchill River at English Point and at Lake Melville east of Little River

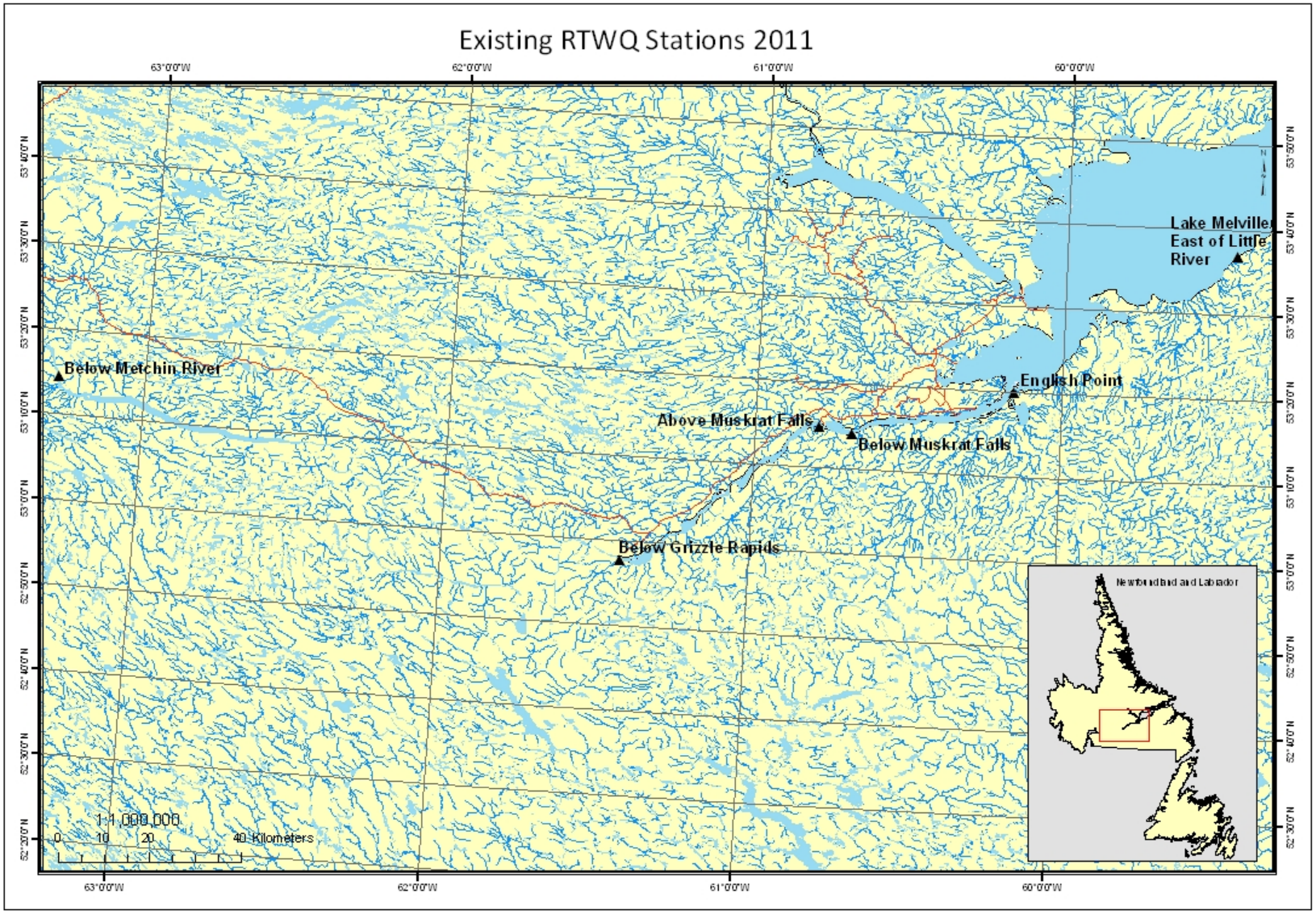

Figure 2: Map of all existing RTWQ stations on the Lower Churchill River and Lake Melville

Figure 3: (left) Aerial view of RTWQ station on Churchill River at English point (right) Station shelter at English Point.

Figure 4: (left) Aerial view of RTWQ station on Lake Melville east of Little River

(right) Conduit extending from station shelter at Lake Melville 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 QA/QC 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 May 27 and June 29/30, 2011 are summarized in Table 2.

Table 2: Comparison rankings for English Point and Lake Melville stations, May 27 – June 29/30, 2011

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
English Point	May 27, 2011	Deployment	Excellent	Good	Good	Excellent	Good
	Jun 29, 2011	Removal	Good	Excellent	Good	Good	Good
Lake Melville	May 27, 2011	Deployment	Good	Good	Excellent	Excellent	Excellent
	Jun 30, 2011	Removal	Excellent	Excellent	Excellent	Excellent	Poor

- At the station on Churchill River at English Point, all parameters ranked 'good' or 'excellent' at both deployment and removal. Despite the instrument being nearly exposed to air at the time of removal on June 29, the sensors were the only part of the instrument still remaining in the water and continued to give accurate readings.
- At the station on Lake Melville East of Little River, all parameters ranked 'good' or 'excellent' at deployment. At removal, temperature, pH, specific conductivity and dissolved oxygen all ranked 'excellent'. Turbidity however was ranked 'poor'. The deployed instrument read a value of 55NTU while the QAQC instrument read a value of 10.3NTU. There was a certain amount of biofouling on the sonde but the turbidity wiper appeared to be cleaning the instrument properly so the significant disparity is unknown at this time.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from May 27 to June 29/30 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

- The water quality monitoring instrument was deployed for the first time at this station between May 27 and June 29. Upon retrieval, the instrument was barely remaining submerged (Figure 5). Only the sensor-end of the instrument was still in the water however with changing tides, currents and weather varying, it is likely the instrument was exposed to some light surf conditions in the final days of the deployment period. Biofouling residue covered most of the instrument sensors by the time of removal (Figure 6).

Figure 5: Instrument as found upon removal on June 29.

Figure 6: (left and right) Biofouling residue found on instrument at removal on June 29.

- Water temperature ranged from 3.40 to 16.20^{o}C during this deployment period (Figure 7).
- Water temperature is increasing throughout the deployment period. This trend is expected due to the increasing ambient air temperatures in the spring and summer seasons (Figure 8). Water temperature fluctuates diurnally and with tidal influences.

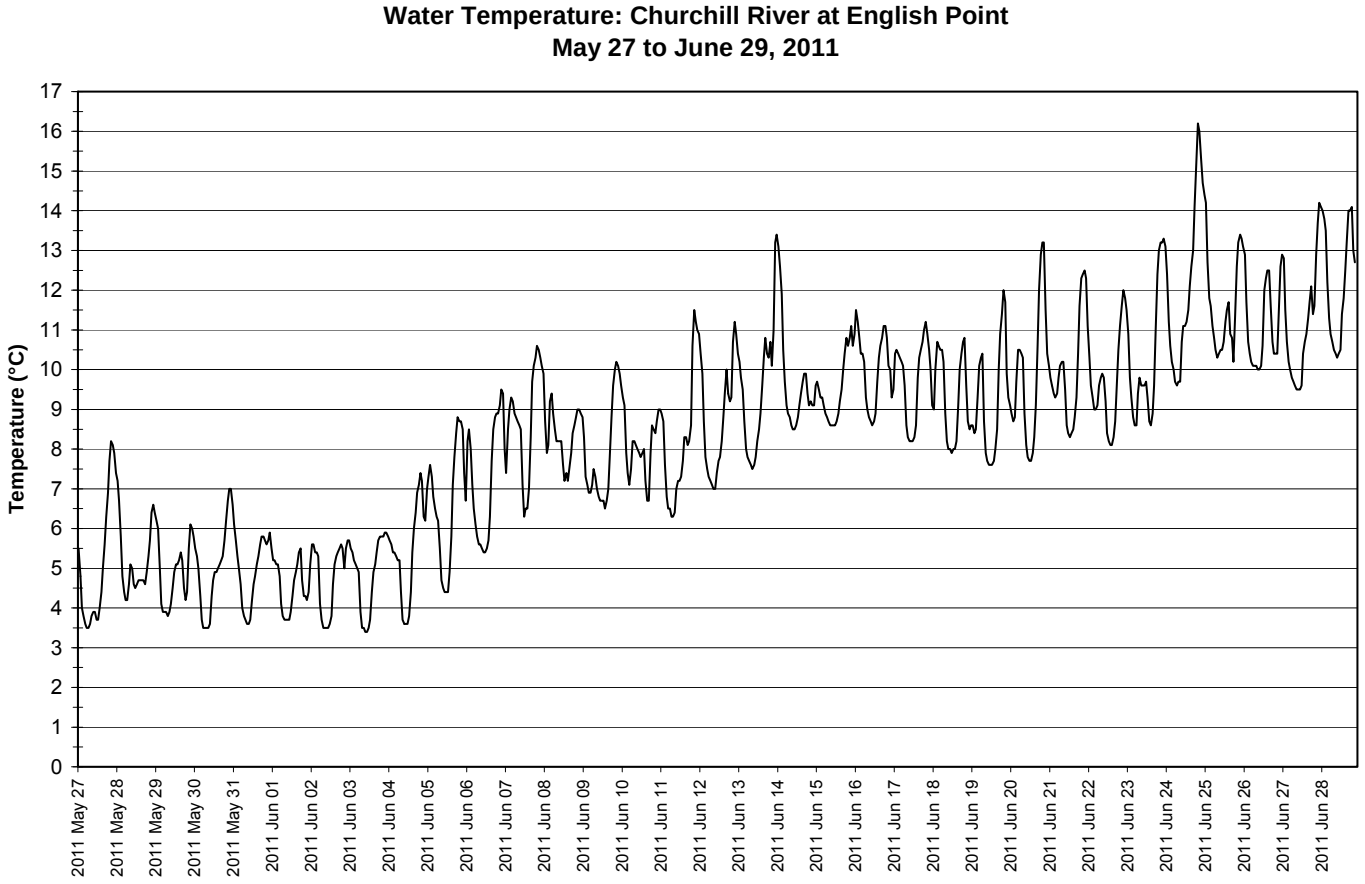

Figure 7: Water temperature at Churchill River at English Point

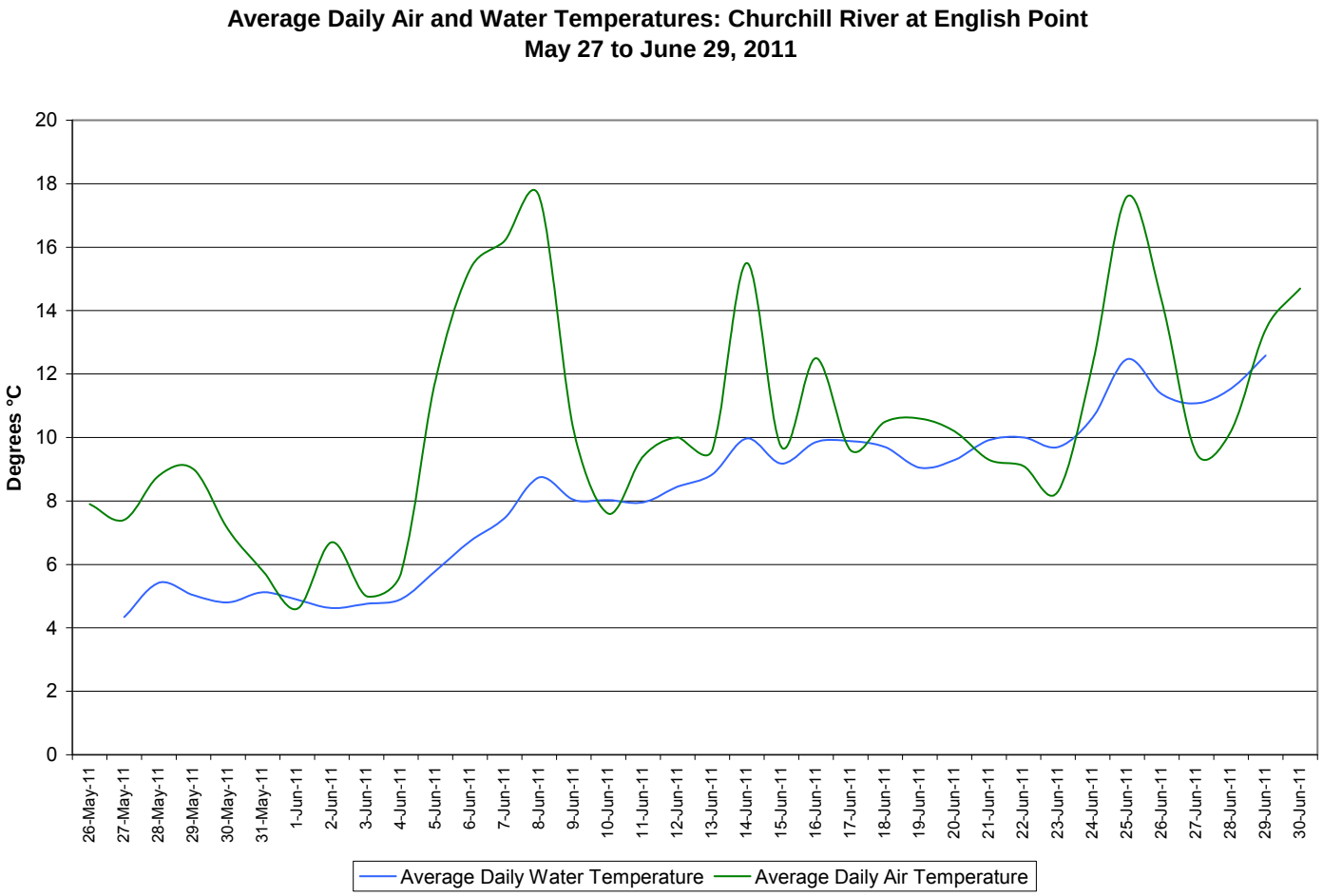

Figure 8: Average daily air and water temperatures at Churchill River at English Point (weather data collected at Goose Bay)

- pH ranges between 6.57 and 7.11 pH units and increases slightly throughout the deployment period (Figure 9).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). Near the end of the deployment period, as the water level drops and the instrument is in very shallow water, the fluctuations in pH caused by diurnal and tidal cycles are more apparent.

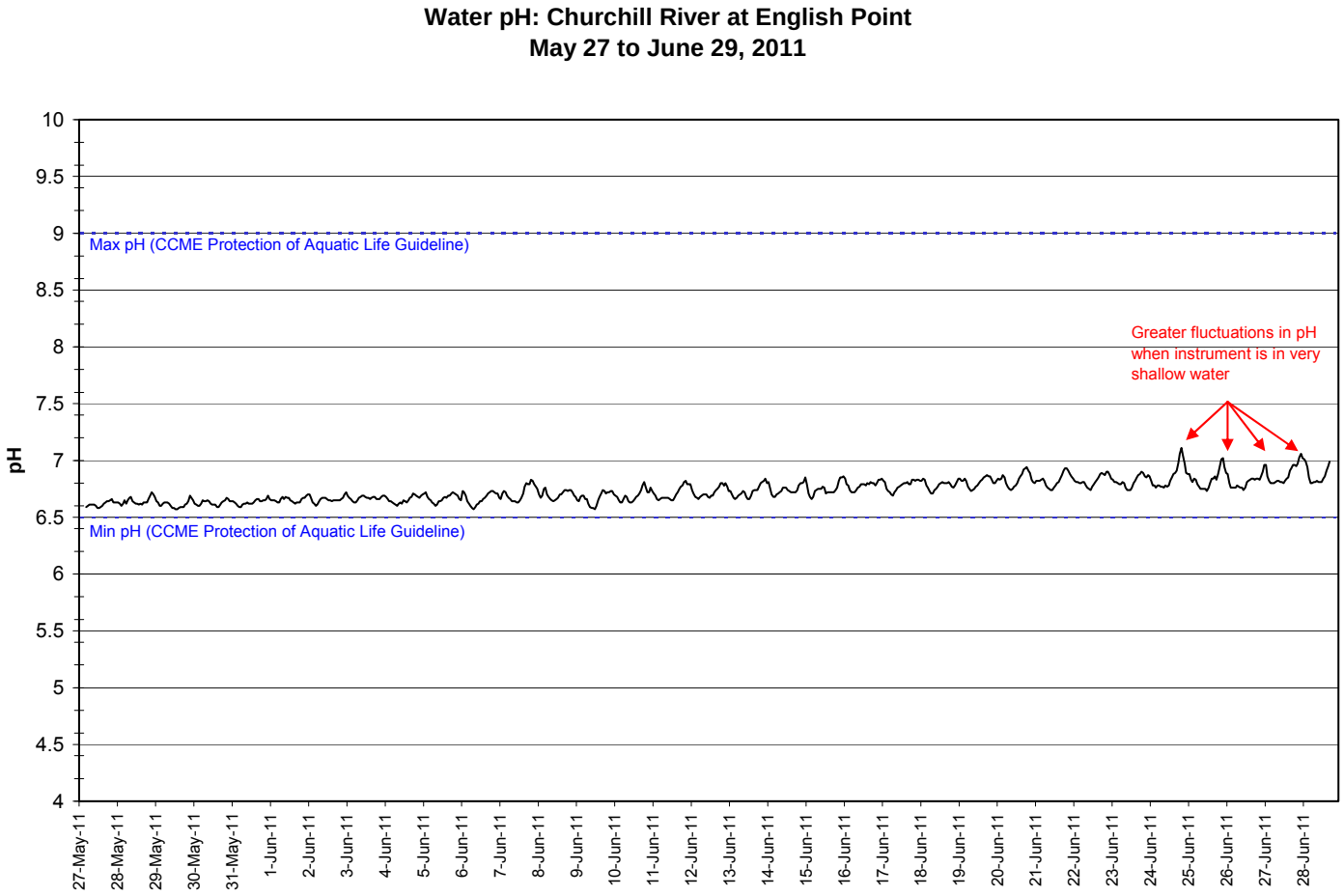

Figure 9: pH at Churchill River at English Point

- Specific conductivity ranges from 12.9 to 43.9µS/cm during the deployment period, averaging 26.7µS/cm (Figure 10).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the dissolved solids and salinity increase, increasing the specific conductivity and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily.
- Conductivity is least variable during this deployment period when tides are highest during the full moon on June 15. There is somewhat of a disruption in fluctuation patterns near the end of the deployment period when the instrument is nearly exposed and in very shallow water.

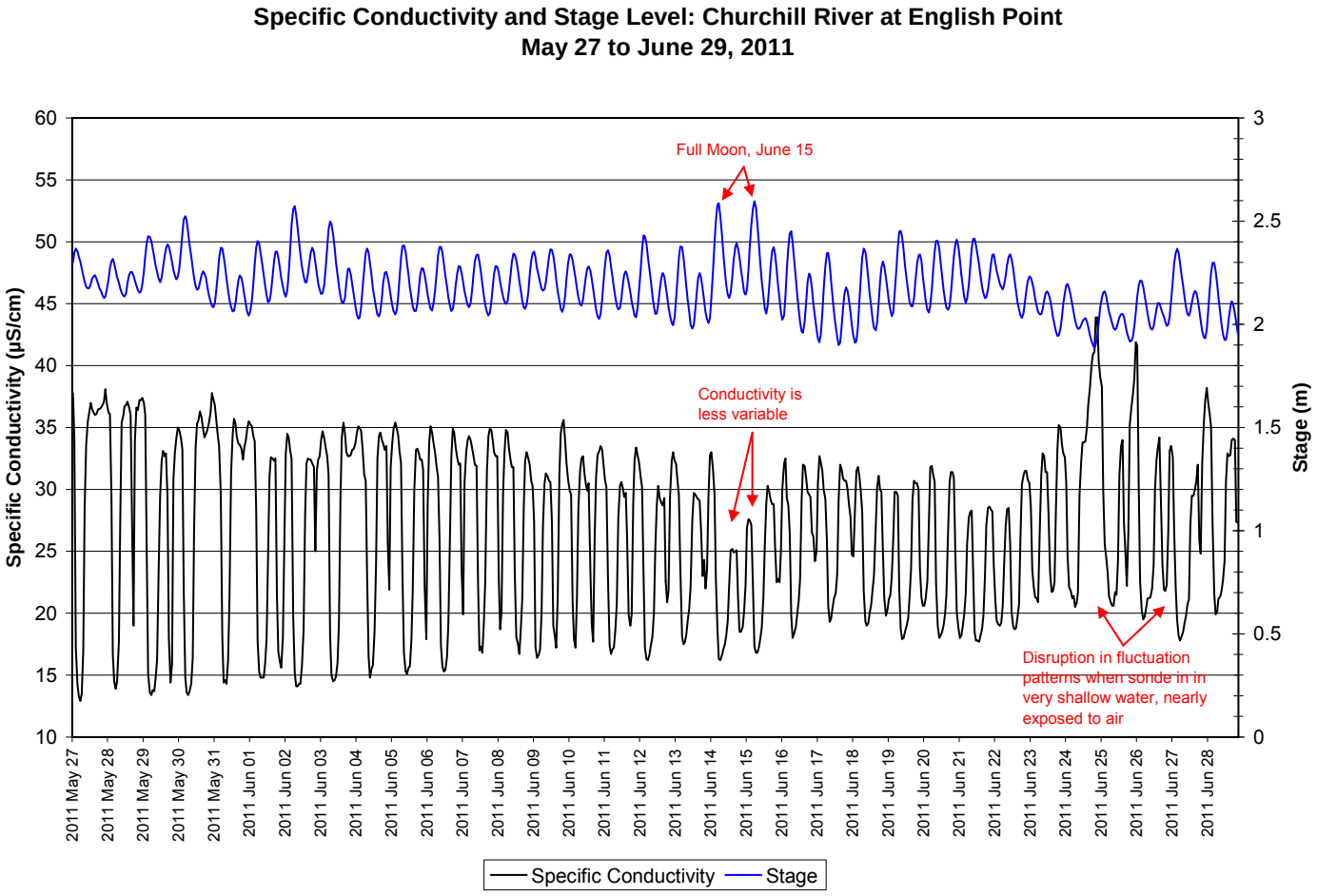

Figure 10: Specific conductivity and stage level at Churchill River at English Point

- The saturation of dissolved oxygen ranged from 88.7 to 114.3% and a range of 10.72 to 14.05mg/l was found in the concentration of dissolved oxygen with a median value of 12.02mg/l (Figure 11).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 11.
- Dissolved Oxygen content decreases slightly over the deployment period. This trend is expected given the increasing air and water temperatures (Figure 8). Dissolved oxygen content clearly fluctuates diurnally, displaying the inverse relationship to water temperature.

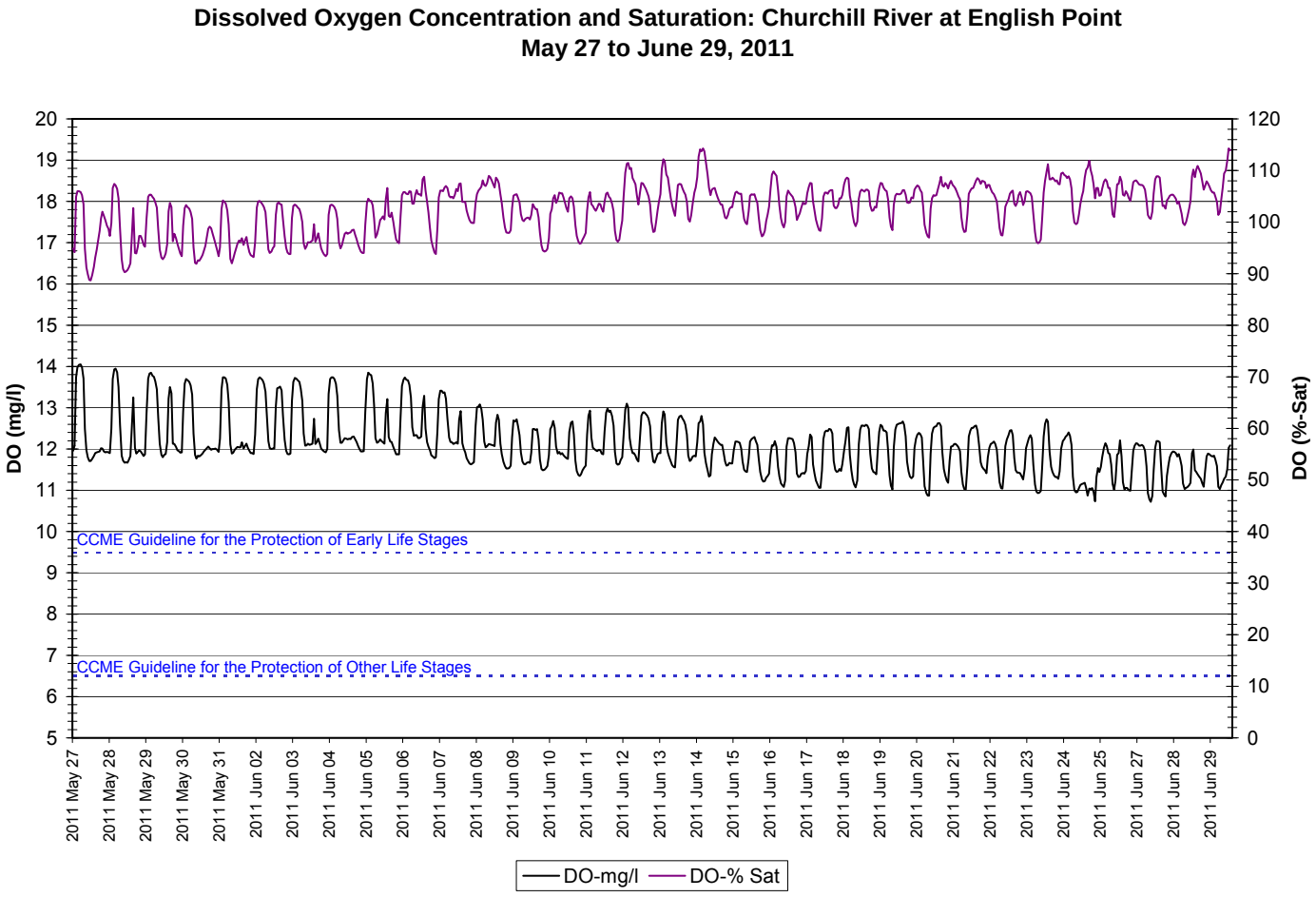

Figure 11: Dissolved oxygen and percent saturation at Churchill River at English Point

- A range of 3.6 to 152.3NTU was recorded for turbidity for this deployment period (Figure 12). A median value of 13.5 NTU indicates there is a natural background turbidity value at this station.
- There are several spikes in turbidity throughout the deployment period with the majority of them corresponding to rain and wind events. Turbidity spikes show typical recovery periods following the events, in some cases up to 2-3 days. Turbidity also fluctuates daily and is most likely related to the increases and decreases in water level with the tidal patterns.

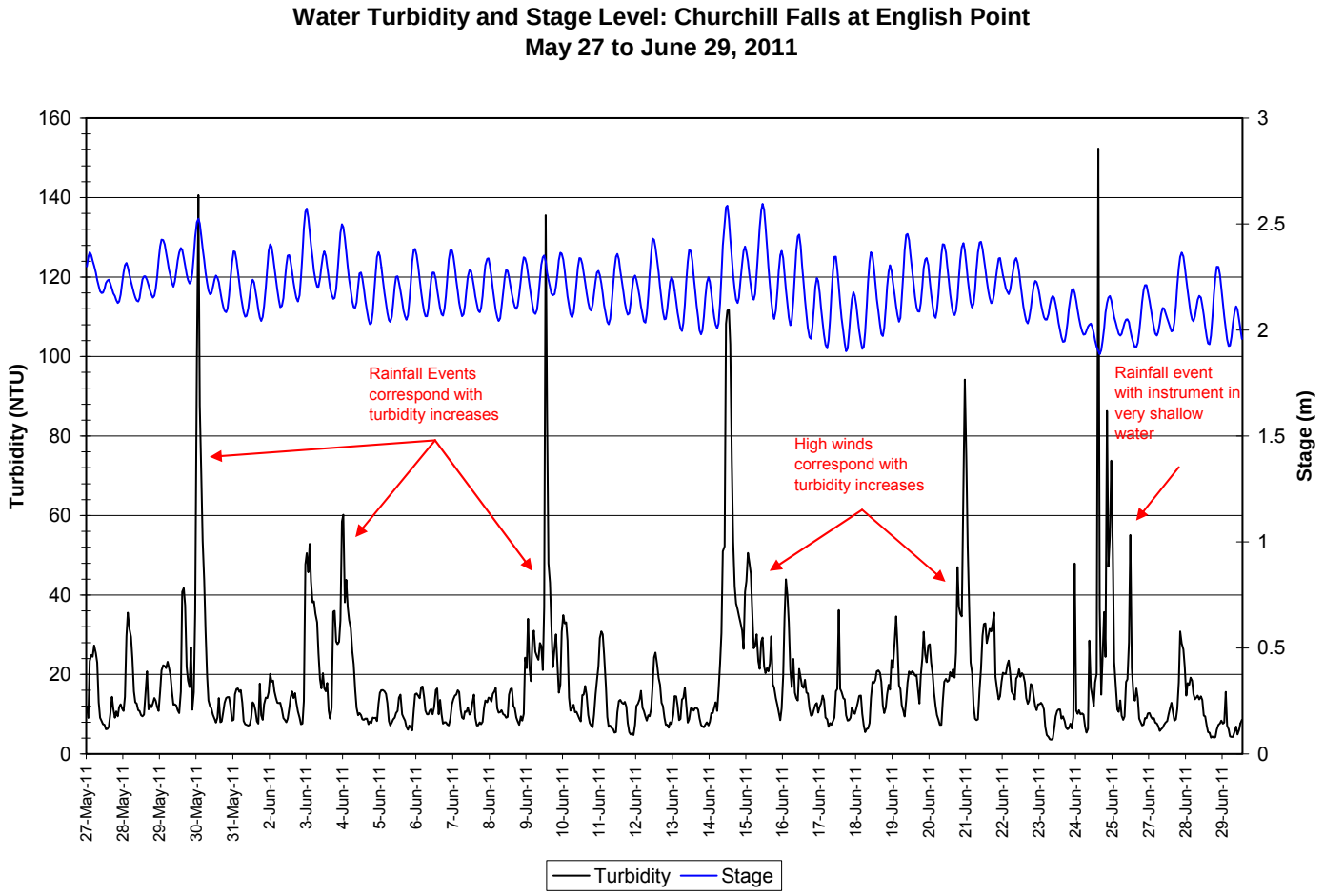

Figure 12: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 13). Stage is generally decreasing 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 12).
- In some instances, for example, the rainfall events between June 15 and 21, cause the water level in the river to rise in the days following.

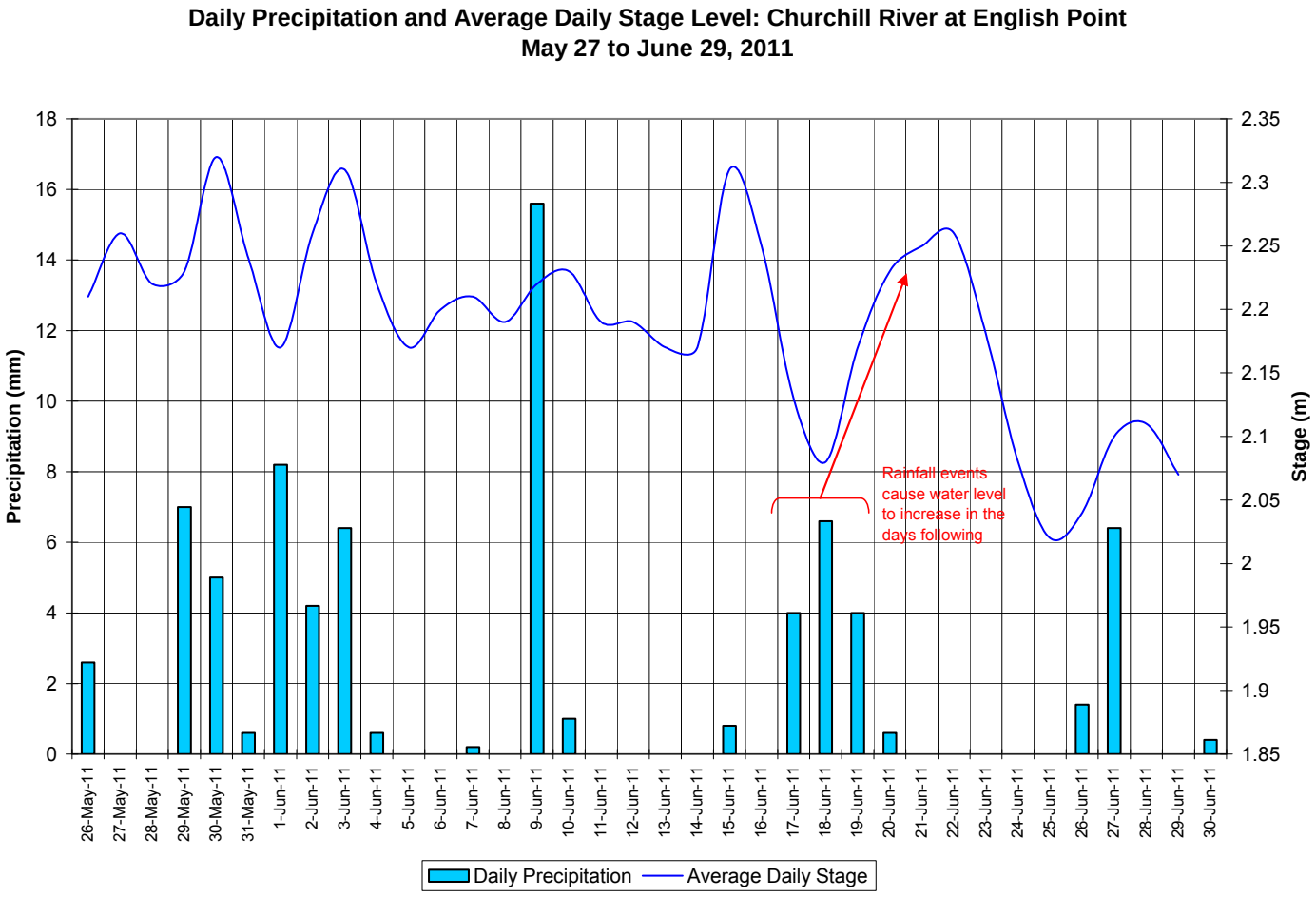

Figure 13: Stage and precipitation at Churchill River at English Point

Lake Melville East of Little River

- When initially deployed on May 30, the conduit was not long enough to deploy the sonde in the best possible location therefore the instrument was only placed in about 50cm of water. Arrangements were made to extend the conduit for the following deployment period. Upon retrieval on June 30, a significant amount of biofouling residue was found on the instrument including the protective case, sensor guard and sensors.
- On June 7, the station encountered a transmission error where all communication with the station ceased. Water quality data measured after June 7, was retrieved from the instrument's internal log file upon removal on June 30 and is used in the following data discussion. Water quantity data remains unavailable at this time. Environment Canada staff will be on site in July 2011 to repair the station and retrieve this data.

Figure 14: Biofouling residue found on protective casing (top left) as well as on sensor guard (top right), and instrument sensors (bottom left). Turbidity wiper still functioning properly and remove biofouling residue before each reading (bottom right)

- Water temperature ranges from 2.50 to 16.5^{o}C during this deployment period (Figure 15).
- Water temperature is generally increasing throughout the deployment period. This trend is expected given the increasing ambient air temperature in the spring (Figure 16). Water temperature fluctuates significantly on a daily basis.

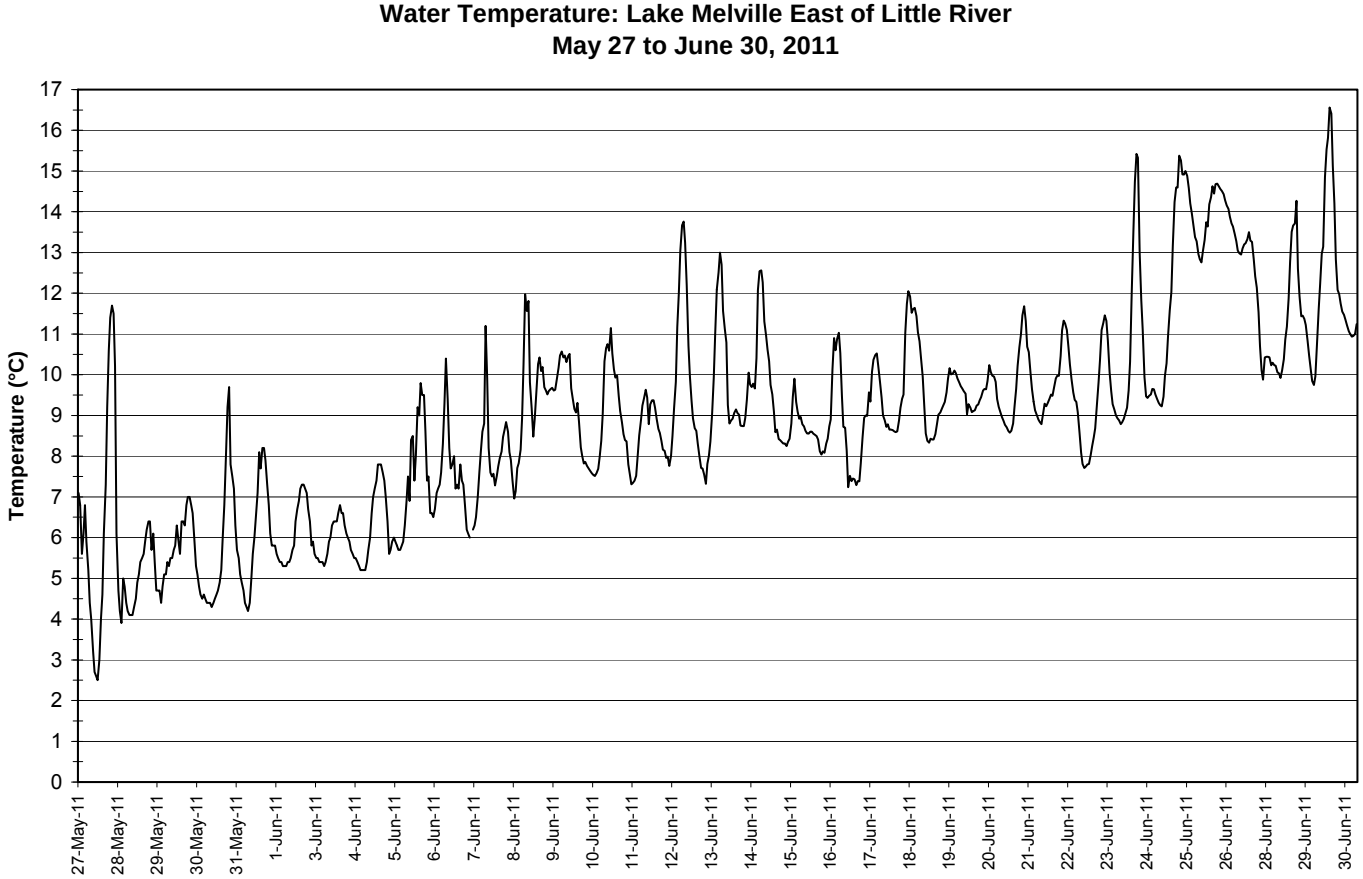

Figure 15: Water temperature at Lake Melville East of Little River

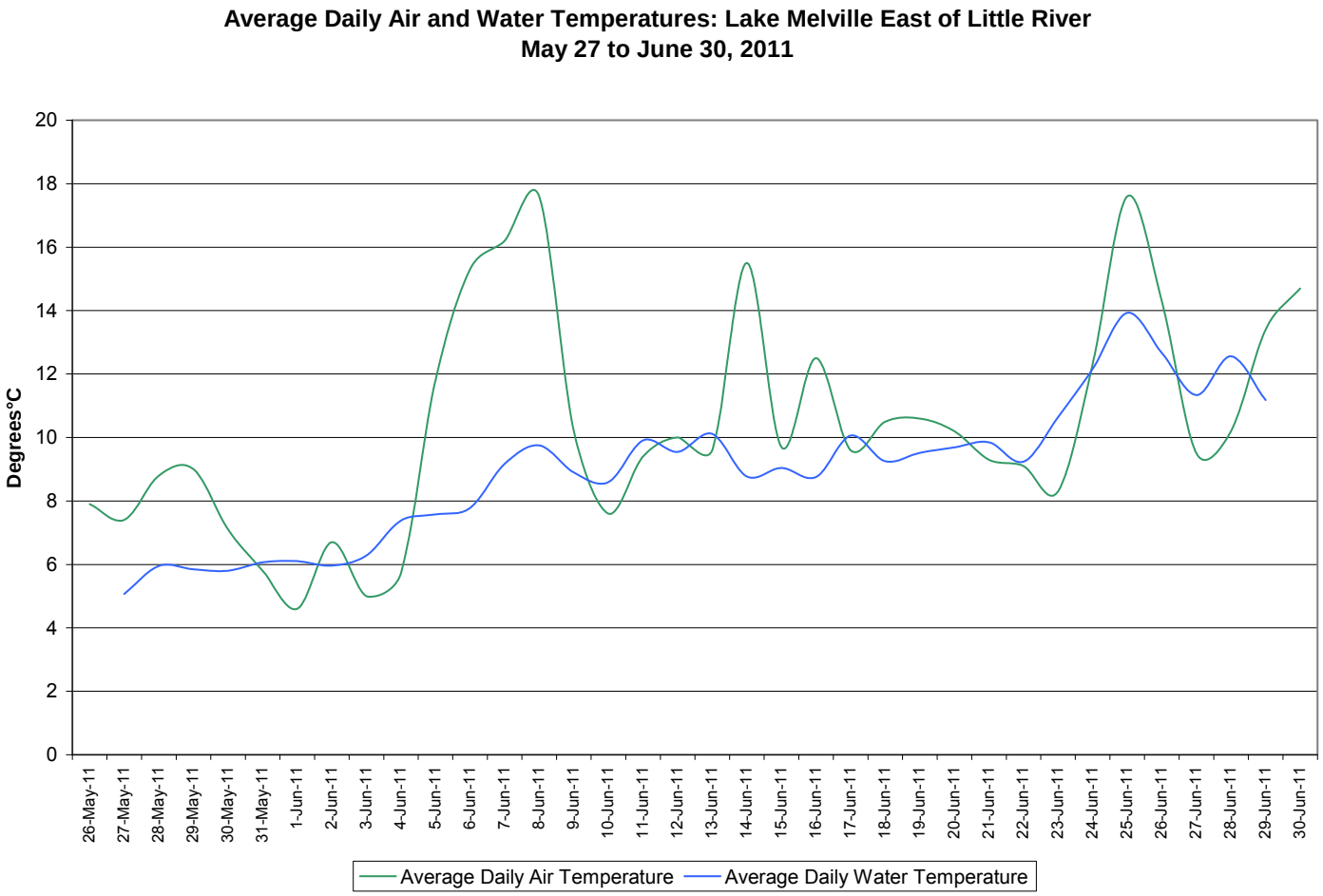

Figure 16: Average daily air and water temperatures at Lake Melville East of Little River (weather data collected at Goose Bay)

- pH ranges between 6.78 and 9.31 pH units (Figure 17). pH fluctuates daily.
- Most values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17). On a few occasions, pH increases above the maximum pH guideline of 9.0 units. These high pH values are short lived (1-2 hours) and occur at times when water temperature is high as well. These guidelines however, are for freshwater environments. If we consider this to be a 'marine' environment, the minimum and maximum pH guidelines would be then 7.0 and 8.7 respectively. Both the minimum and maximum guidelines for pH in marine environments are exceeded at different times throughout the deployment period but only for short periods of time.

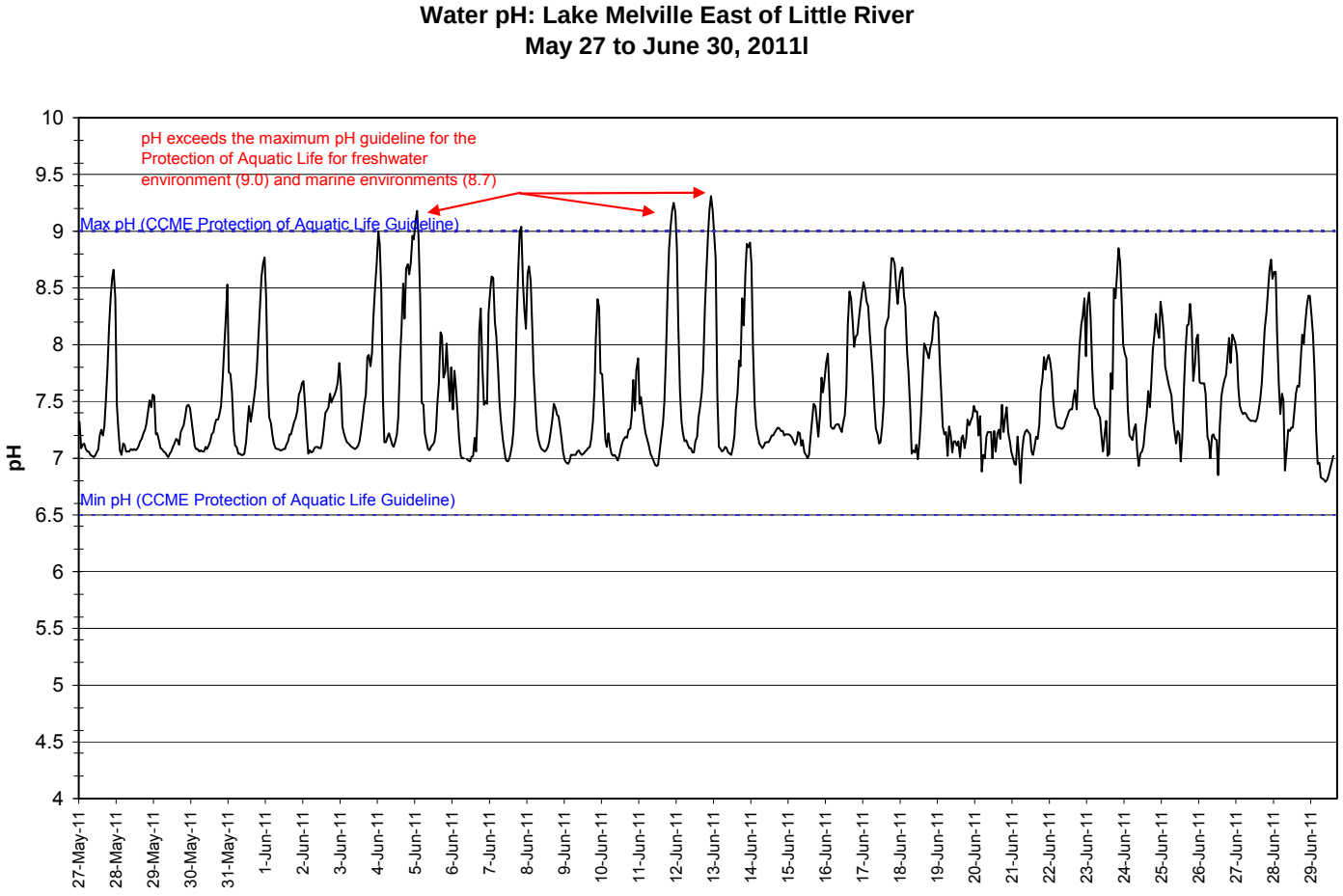

Figure 17: pH at Lake Melville East of Little River

- Specific conductivity ranges between 1643 and 11153µS/cm and fluctuates widely throughout the deployment period (Figure 18).
- From the beginning of the deployment on May 27 until mid-June, conductivity fluctuates between 1643 and 3793µS/cm, averaging 2820µS/cm, On June 15, conductivity begins to increase and remains high for the remainder of the deployment period however continues to fluctuate daily. Between June 15 and June 30 (removal), specific conductivity ranges between 2390 and 11153µS/cm, averaging 6679µS/cm. The reason for this increase midway through the deployment period may be related to an increase in turbidity at approximately the same time (Figure 20).

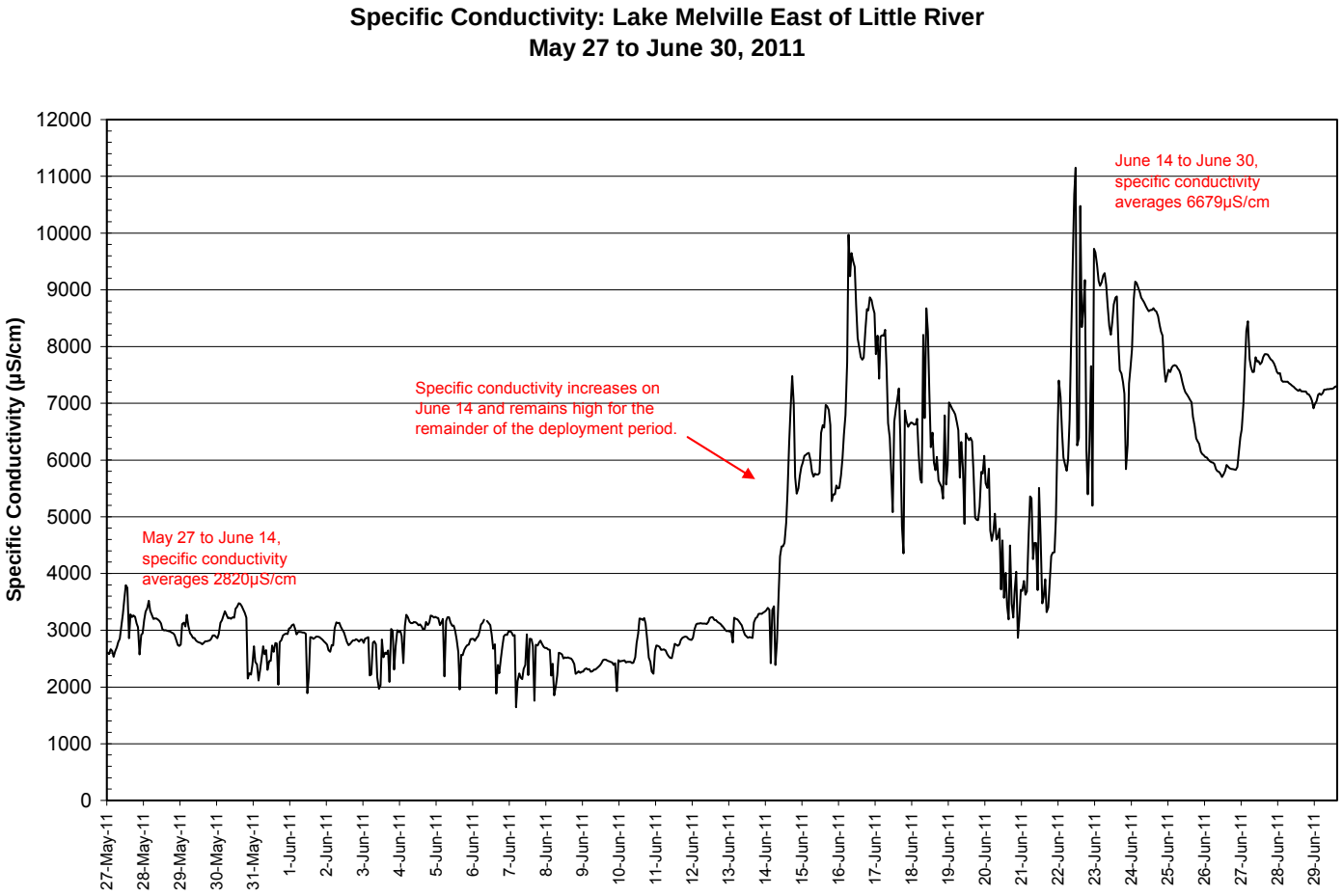

Figure 18: Specific conductivity at Lake Melville East of Little River

- The saturation of dissolved oxygen ranged from 88.7 to 146.7% and a range of 9.07 to 15.48mg/l was found in the concentration of dissolved oxygen with a median value of 11.96mg/l (Figure 19).
- Most values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 19. In one instance on June 26, dissolved oxygen drops below the minimum Guideline for the Protection of Aquatic Life in early stages however this event only last for 1 hour.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the increasing air and water temperatures (Figure 16). Dissolved oxygen content fluctuates daily reflecting its inverse relationship with water temperature.

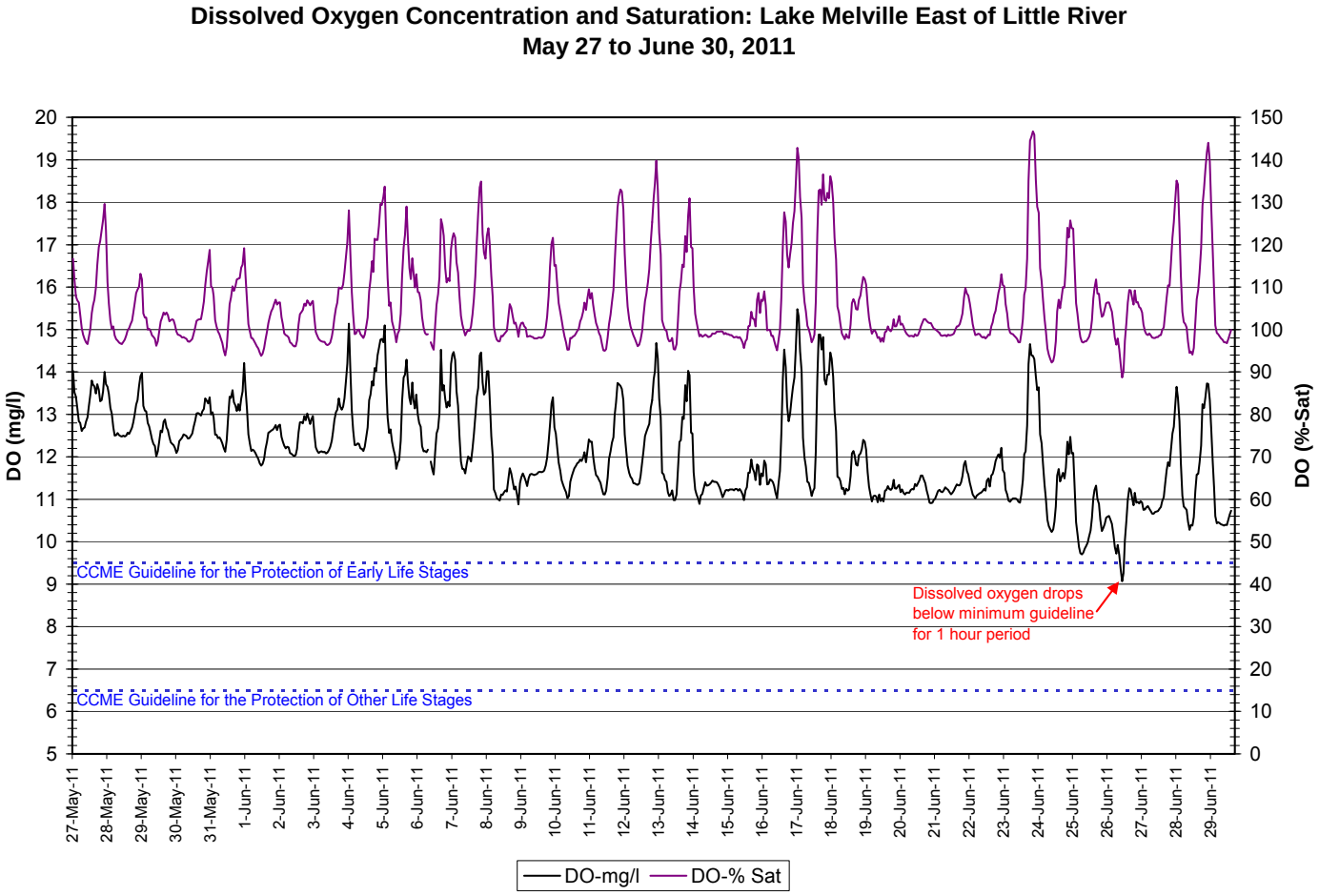

Figure 19: Dissolved oxygen and percent saturation at Lake Melville East of Little River

- A range of 6.9 to 188.7NTU was recorded for turbidity for this deployment period (Figure 20). A median value of 30.5 NTU indicates there is a consistent natural background turbidity value at this station.
- Turbidity spikes occur throughout the deployment period and generally correspond with rainfall events or high winds. This instrument is particularly susceptible to high winds because the lake environment can cause extreme surf conditions affecting the turbidity and stability of the readings by the instrument. Turbidity events show a typical recovery period, in some cases 2-3 days, before returning to background levels (~30NTU).

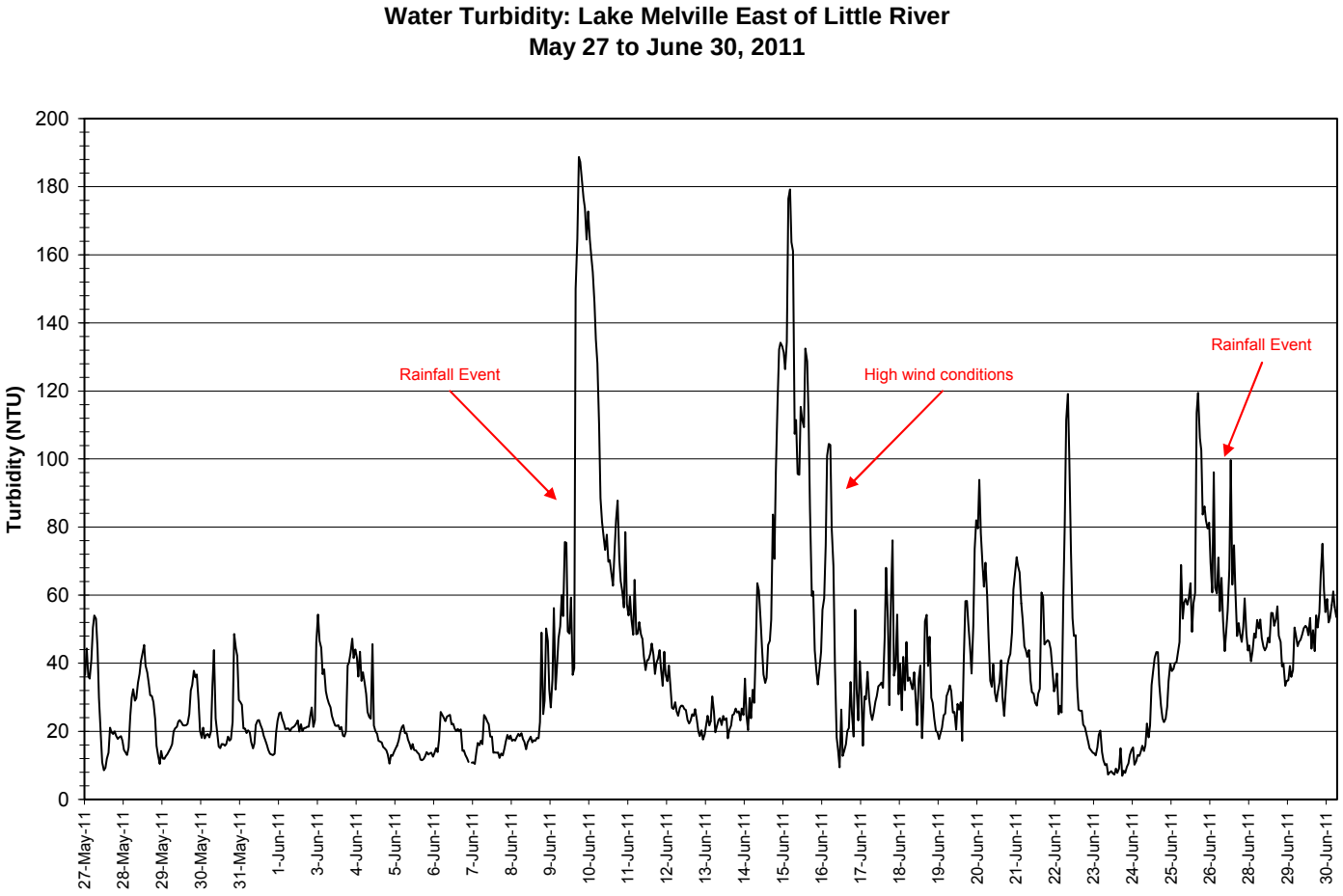

Figure 20: Turbidity at Lake Melville East of Little River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). The station only successfully transmitted data for 8 days after deployment therefore most of the stage data still remains unavailable until Environment Canada is able to repair the station. Precipitation events vary throughout the deployment period.

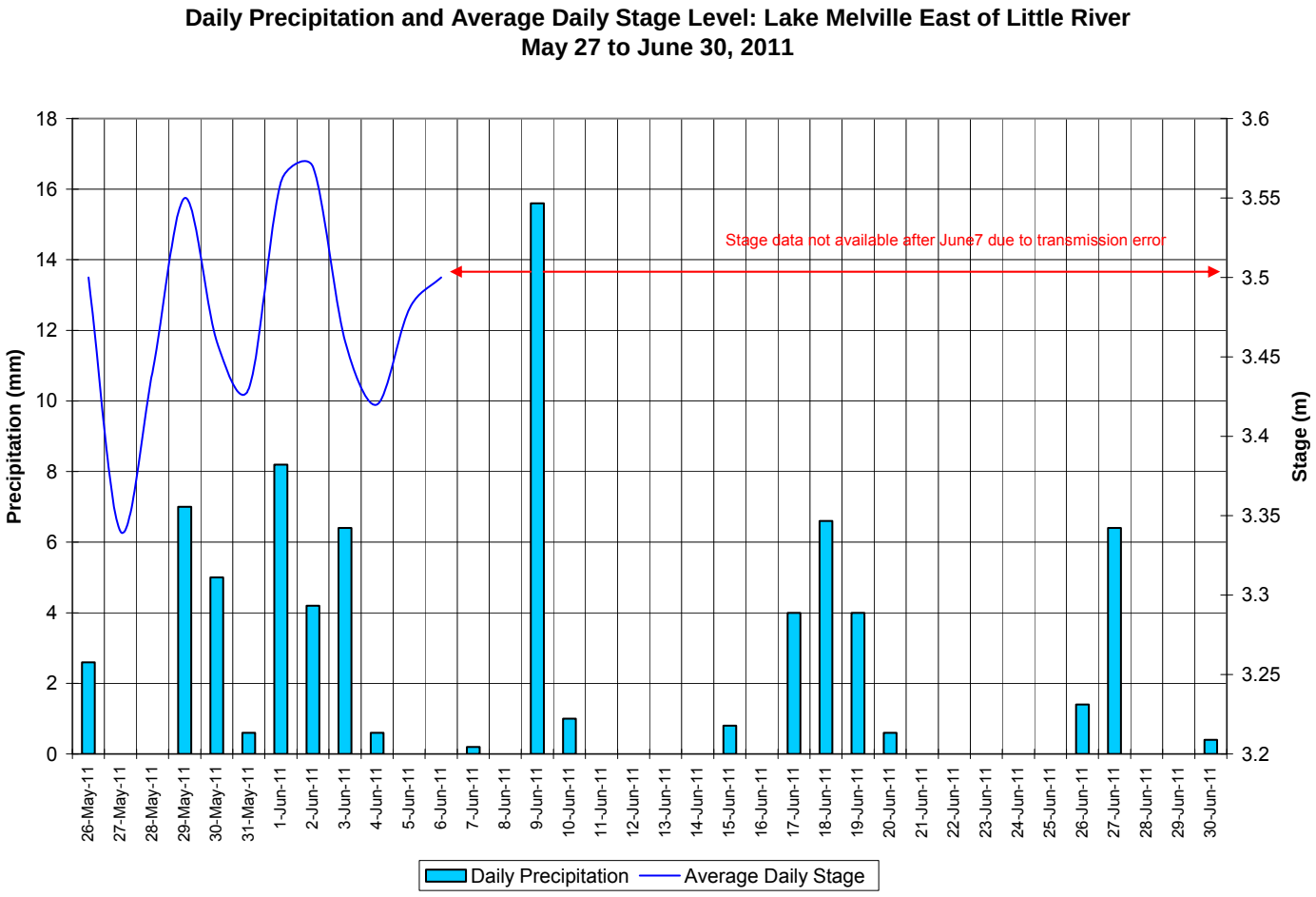

Figure 21: Stage and precipitation at Lake Melville East of Little River

Conclusions

- ENVC in cooperation with EC established two new real time water quality and quantity monitoring stations in Fall 2010. Water quantity data collection began in September 2010 while water quality data collection started on a seasonal basis in May 2011.
- The 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 2 new stations augment the data collected from the existing stations on the Lower Churchill River.
- Instruments at water quality monitoring stations on the Lower Churchill River at English Point and on Lake Melville East of Little River were deployed on May 27 and removed on June 29 & 30.
- The instrument at English Point nearly became exposed to water as the stage level dropped significantly in the river during the month of June. A transmission error at the station on Lake Melville prevented data from being transmitted in real time between June 7 and June 30. Data was retrieved from the instruments internal log file.
- In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations. Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen. Events which exceeded the CCME Guidelines were for the most part short lived and not of great magnitude beyond the guideline.

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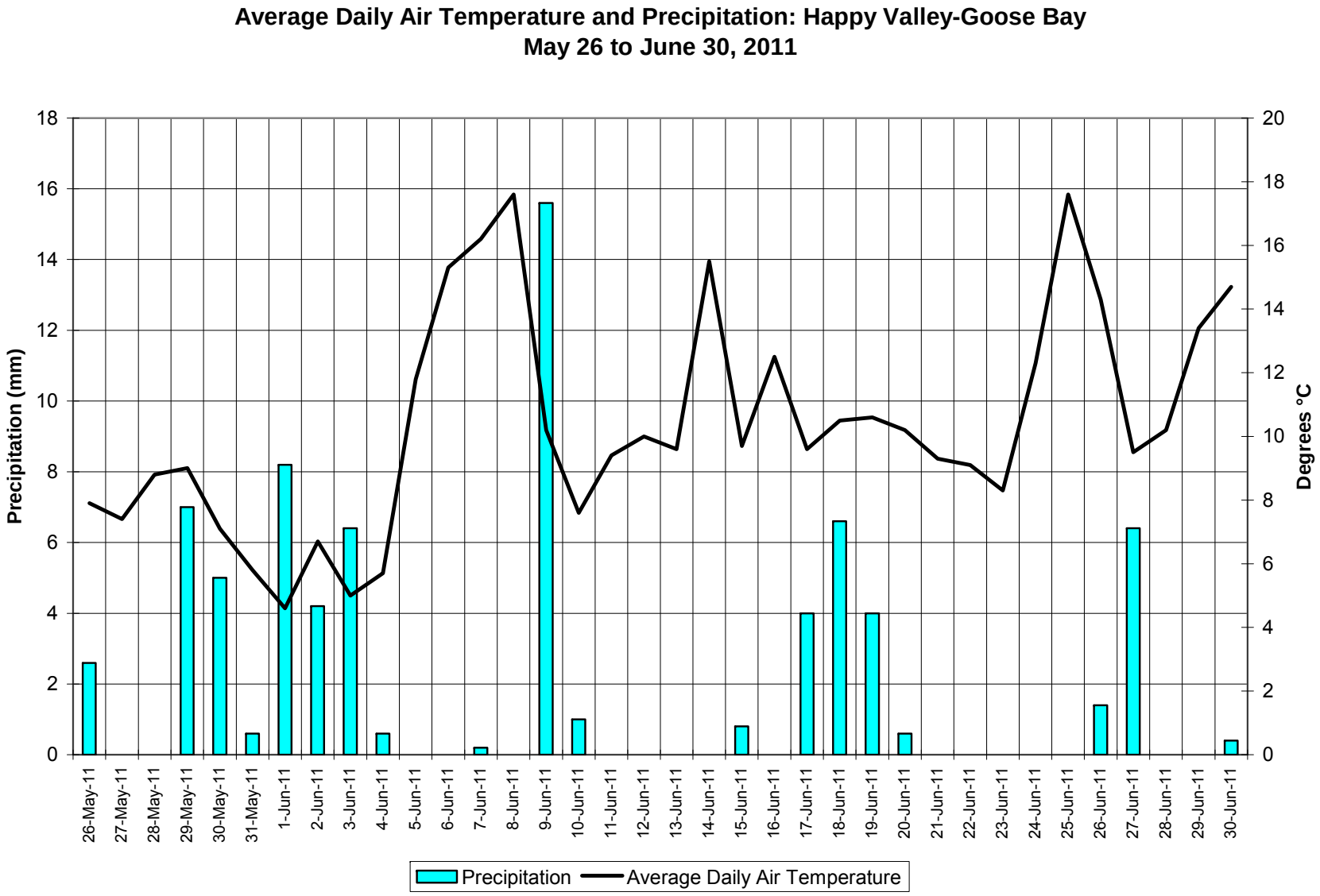
Appendix 1


Average Daily Air Temperature and Precipitation: Happy Valley-Goose Bay
May 26 to June 30, 2011
Precipitation (mm)
Degrees °C
0
2
4
6
8
10
12
14
16
18
20
26-May-11
27-May-11
28-May-11
29-May-11
30-May-11
31-May-11
1-Jun-11
2-Jun-11
3-Jun-11
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Precipitation
Average Daily Air Temperature