# Real-Time Water Quality Annual Report

## Flora Creek below TLH

**June 7 to**
**October 15, 2014**

Newfoundland Labrador

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

## Contents

## Acknowledgements

The Real-Time Water Quality Monitoring station (RTWQ) at Flora Creek is fully funded by Cliffs Natural Resources - Wabush Mines. The program is made successful by a joint partnership between Cliffs Natural Resources, Environment Canada (EC), and the Newfoundland & Labrador Department of Environment & Conservation (ENVC).

Various individuals from each sector have been diligently involved to ensure this program is a successful operation, they include, Renee Paterson (ENVC), Sharlene Baird (Cliffs Natural Resources), Patrick Ryan (Cliffs Natural Resources), and Howie Wills (EC). In addition to these managers and program leads, there have been a team of individuals who work together to ensure the day to day operation of this station is providing quality data. Maria Murphy (ENVC) was responsible for this water quality station during 2014; responsibilities included deployment and removal of the instrument, maintenance and calibration of the instrument and preparation of monthly deployment reports. Leona Hyde and Kelly Maher are acknowledged for their assistance during deployment and removal procedures in 2014.

EC staff are essential in the operation of the data logging/communication aspect of the network. Staff of the Meteorological Service of Canada Division – Water Survey of Canada, visit the station regularly to ensure that the data logging and data transmitting equipment is working properly. EC is also the lead on dealing with stage and flow issues.

## Introduction

- The real-time water quality monitoring station on Flora Creek was established during the summer of 2014, a partnership between the Newfoundland & Labrador Department of Environment & Conservation (ENVC) and Cliffs Natural Resources.
- This station measures water quality parameters including water temperature, pH, specific conductivity, dissolved oxygen, turbidity, as well as water quantity parameters, stage, and flow. Parameters are recorded on an hourly basis during the deployment period.
- The official name of the station is Flora Creek below TLH, also referred to as the Flora Creek station.

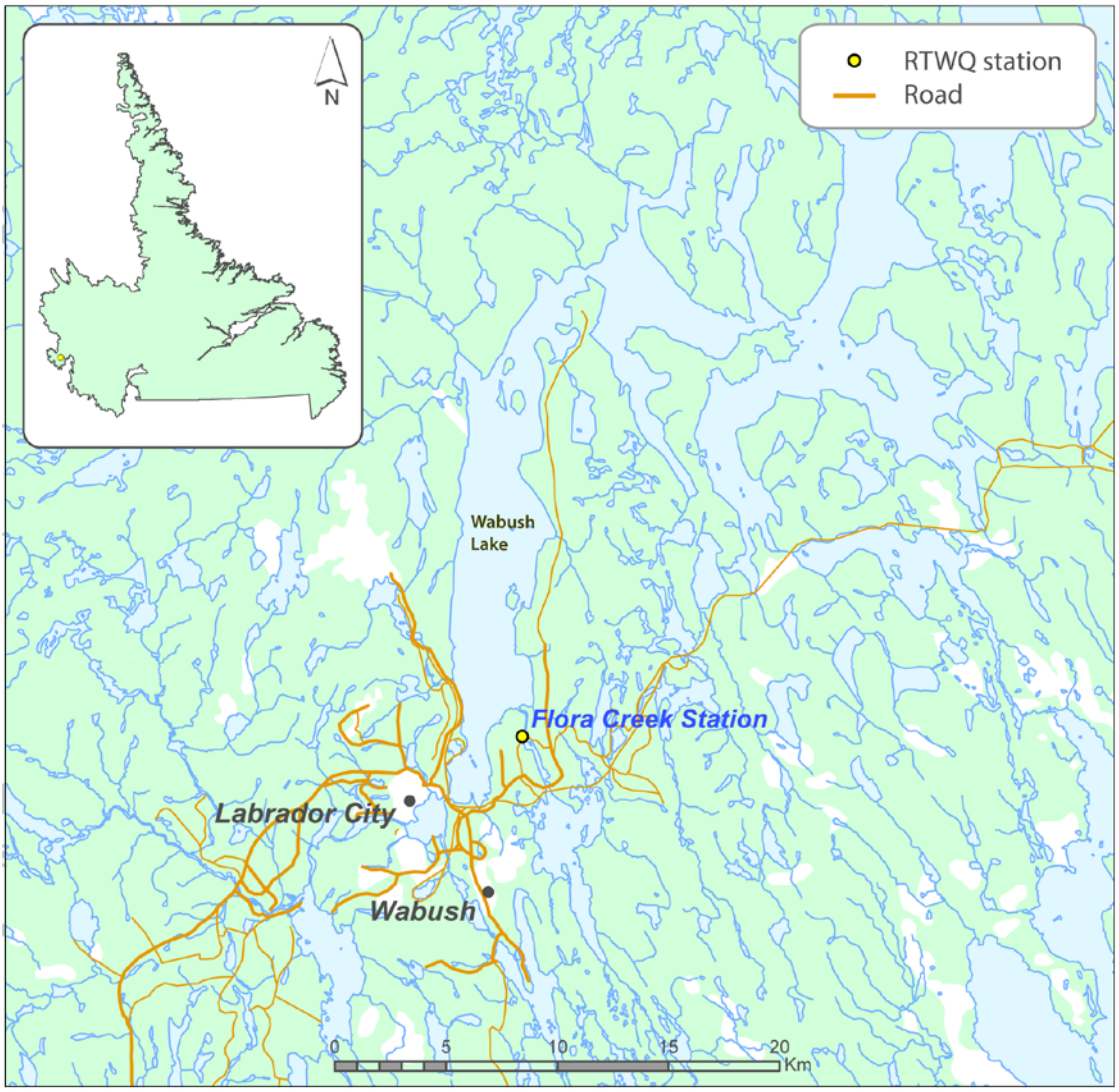


Figure 1: Map of Western Labrador area showing the RTWQ Flora Creek station.

- Initial deployment for this station was on June 7th, 2014. The instrument was removed for the winter season on October 15th. The following report depicts and discusses water quality events throughout this time period.
- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Cliffs Natural Resources, ENVC, EC, for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues. Therefore, mitigative measures can be implemented in a timely manner.
- ENVC provides Cliffs Natural Resources with monthly and annual deployment reports.
- Wabush Mines was in full operation when the Memorandum of Agreement to establish this station was signed. In February of 2014, it was announced that Wabush Mines would be idling its operations while a buyer was sought. The RTWQ instrument was deployed in June, while the mine was in its idling phase. In October 2014, after the instrument had been removed for the winter season, it was announced that Wabush Mines would be closed permanently. This station will remain in place during the closing/rehabilitation of the mine.

## Maintenance and Calibration

- To ensure accurate data collection, maintenance and calibration of the water quality instrumentation are performed preferably on a monthly basis.
- Maintenance includes a thorough cleaning of the instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, ENVC staff carefully calibrates each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity.
- Installation and removal dates for the 2014 season are summarized in the table below.

Table 1: Water quality instrument deployment start and end dates for 2014

| Installation | Removal | Deployment duration (days) |
|---|---|---|
| June 7 | July 8 | 31 |
| July 9 | August 6 | 28 |
| August 7 | September 4 | 28 |
| September 5 | October 15 | 40 |

## 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 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 QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 2).

**Table 2: Ranking classifications for deployment and removal**

| | Rank | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Excellent** | **Good** | **Fair** | **Marginal** | **Poor** |
| Temperature (°C) | <=+/-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 Flora Creek water quality station for the 4 deployment periods from June 7 to October 15, 2014, are summarized in Table 3.
- For additional information and explanations of ranking including “N/A” rankings, please refer to the monthly deployment reports.

- **Table 3: Comparison rankings for Flora Creek June 7 – October 15, 2014**

| | Date | | Instrument # | Temperature | pH | Specific Conductivity | Dissolved Oxygen | Turbidity |
|---|---|---|---|---|---|---|---|---|
| Flora Creek | 05-Jun-14 | Deployment | 13G101500 | Excellent | Excellent | Marginal | Excellent | N/A |
| | 08-Jul-14 | Removal | 13G101500 | Excellent | Fair | Fair | Excellent | Excellent |
| | 09-Jul-14 | Deployment | 13G101500 | Excellent | Good | Poor | Fair | Fair |
| | 06-Aug-14 | Removal | 13G101500 | N/A | N/A | N/A | N/A | N/A |
| | 07-Aug-14 | Deployment | 13G101500 | Excellent | Fair | Poor | Fair | Marginal |
| | 04-Sep-14 | Removal | 13G101500 | N/A | N/A | N/A | N/A | N/A |
| | 05-Sep-14 | Deployment | 13G101500 | Excellent | Fair | Poor | Good | Excellent |
| | 15-Oct-14 | Removal | 13G101500 | N/A | N/A | N/A | N/A | N/A |

## Data Interpretation

- The following graphs and discussion illustrate water quality-related events from June 7, 2014 to October 15th, 2014 at Flora Creek.
- 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.

**Flora Creek below TLH**

- Water temperature ranged from 5.74 to 23.73°C, during the 2014 deployment season. The median value was 15.02 °C (Figure 1).
- Water temperature increases at the beginning of the season and decreases during the later portion of the season; this is expected as ambient air temperature is warmer in the summer and cooler in the fall.

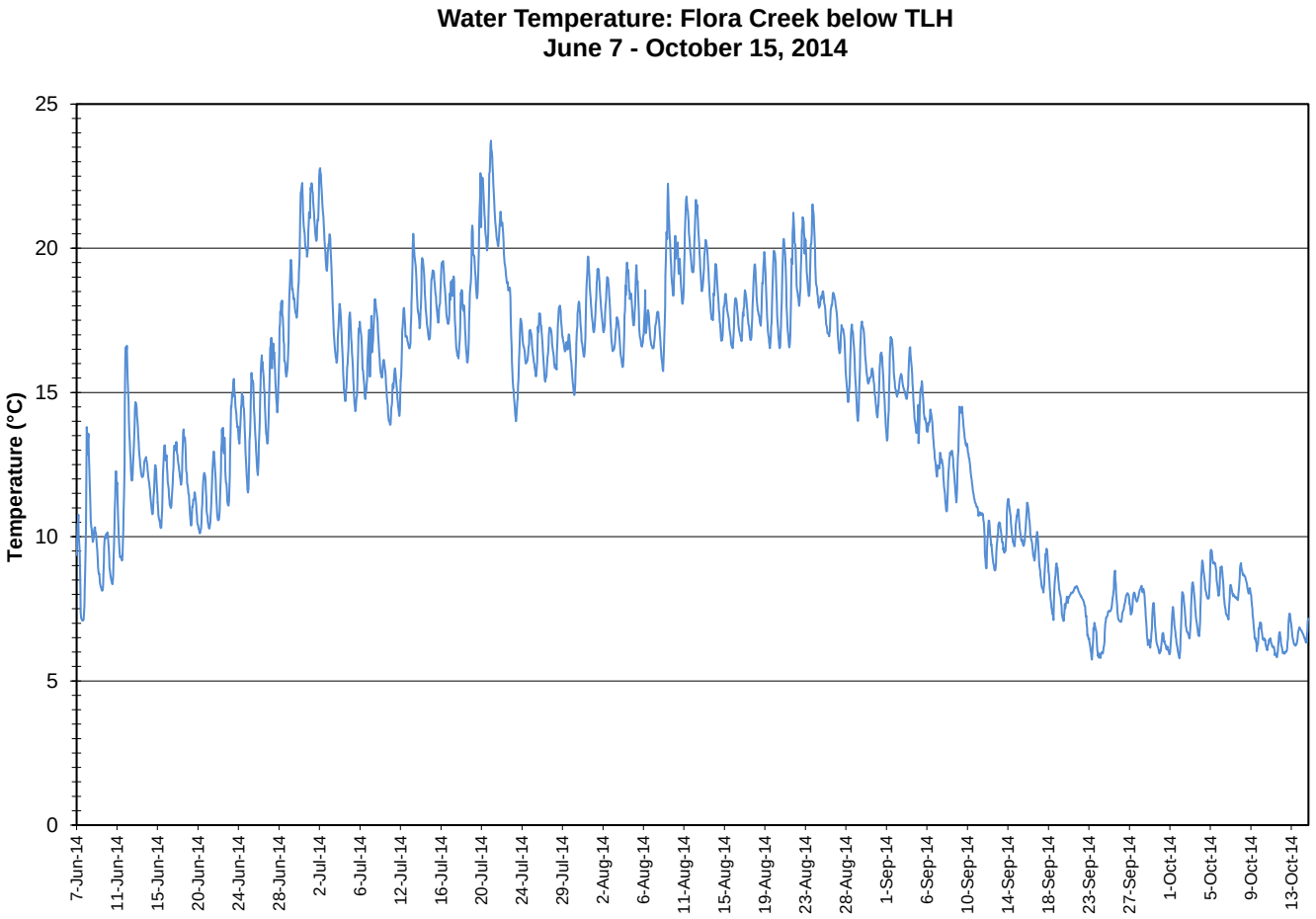


**Figure 1: Water temperature – Flora Creek below TLH**

- Water temperature values show a typical seasonal trend, warm in the summer and decreasing into the fall season. Water temperature fluctuations correspond moderately well with the ambient air temperature recorded by Environment Canada (Figure 2). It is important to note that weather data was collected from three different locations, Wabush, Churchill Falls and Happy Valley – Goose Bay, in order to obtain a full record covering the entire deployment season.

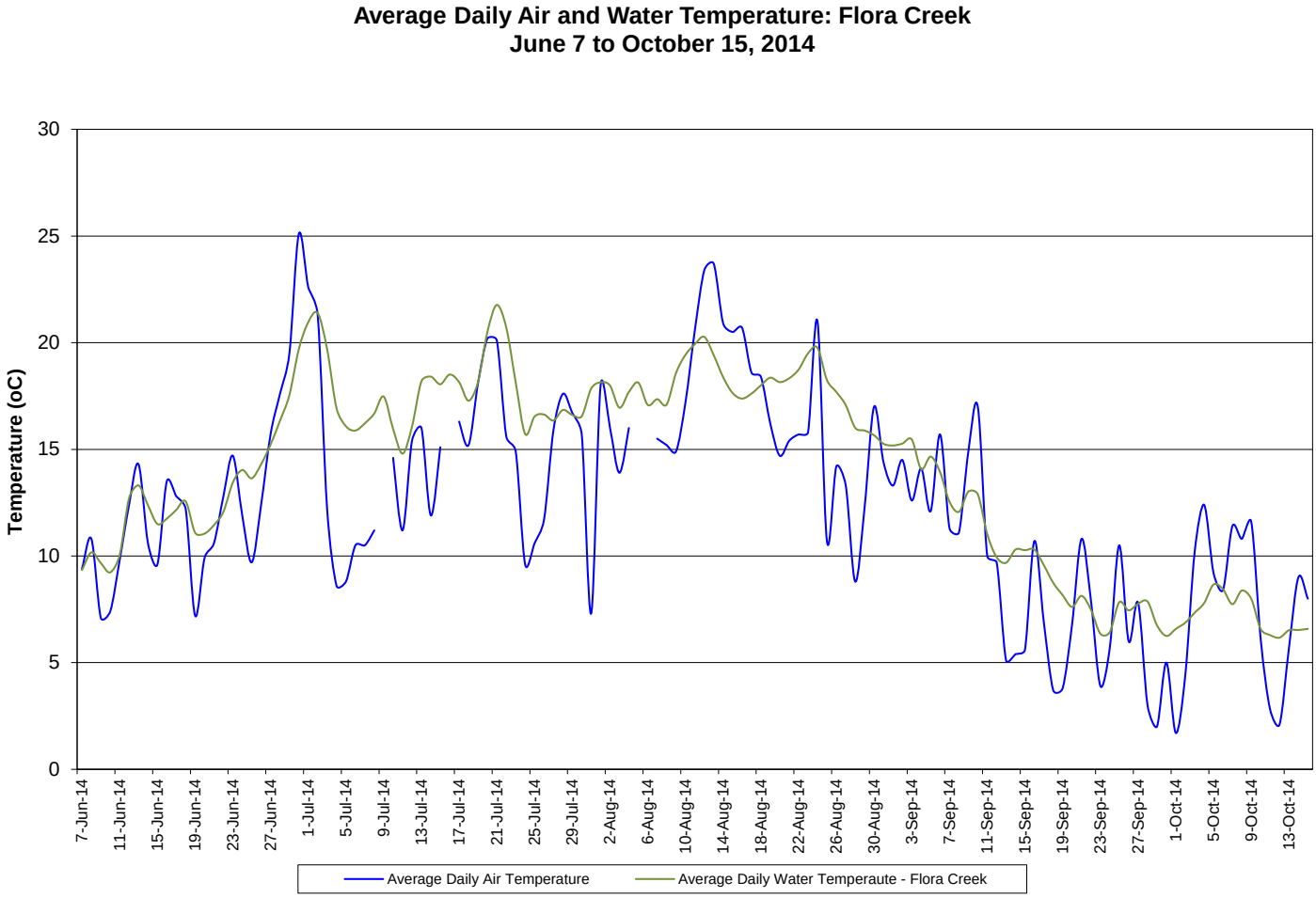


**Figure 2: Average daily air and water temperatures – Flora Creek below TLH**

**(Weather data collected at Labrador City, Churchill Falls and Happy Valley – Goose Bay)**

- pH ranges from 7.29 to 8.17 pH units at Flore Creek(Figure 3), throughout the 2014 deployment season. The median pH is 7.76.
- pH fluctuates daily. Peaks are observed during late afternoon, early evening.
- All values during the deployment are within the CCME Water Quality Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units).
- pH increases slightly during the beginning of the season, and then it is relatively stable until the end of the season.

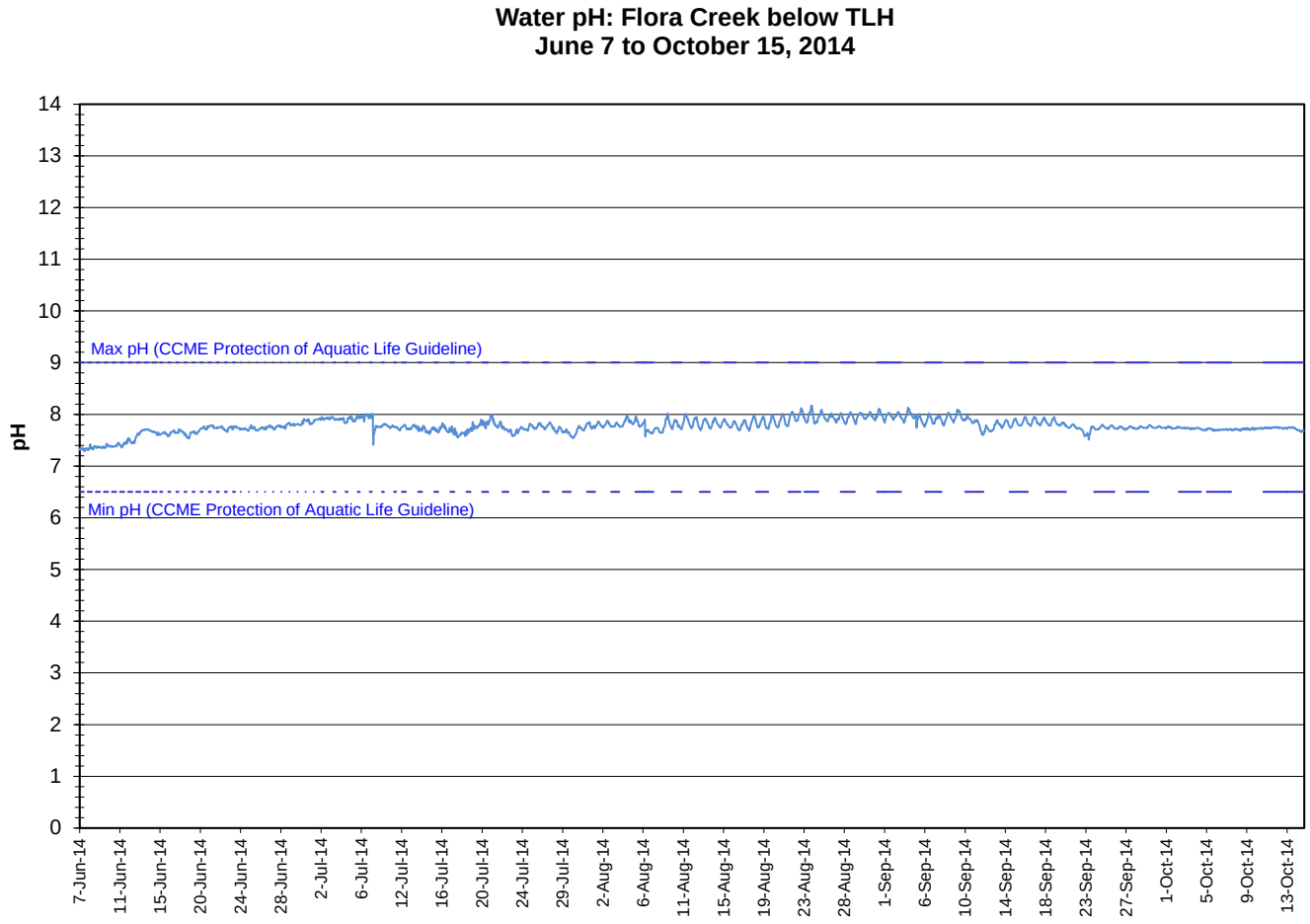


**Figure 3: pH – Flora Creek below TLH**

- Throughout the 2014 deployment season, specific conductivity ranged from 56.6 to 90.9 µs/cm at Flora Creek (Figure 4).
- The conductivity sensor on this instrument requires a substantial amount of time stabilize. During this deployment season, it was noted that it can take up to 12 hours for the sensor to stabilize. These instances are identified on the graph below in red.
- Conductivity increases during the beginning of the deployment season, it is then relatively stable for the remainder of the season with some fluctuations.

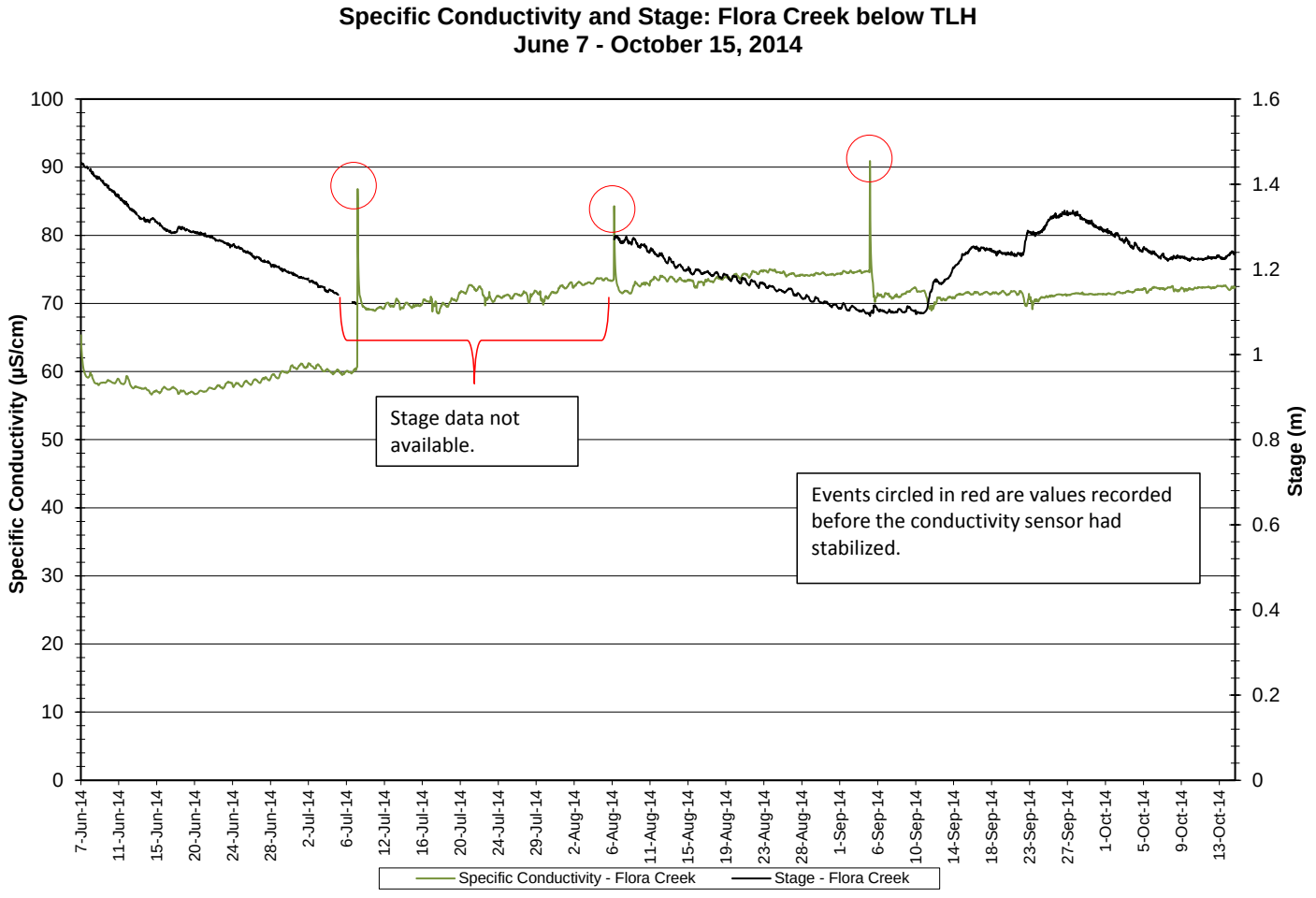


**Figure 4: Specific conductivity – Flora Creek below TLH**

- The saturation of dissolved oxygen ranged from 87.1 to 110.2% and a range of 7.99 to 12.00 mg/l was found in the concentration of dissolved oxygen with a median value of 9.72 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen decreases during the summer months throughout the time when water temperature is increasing, it then increases during the last deployment period of the season, when water temperature is decreasing in the fall.
- All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. Most values recorded were above the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.

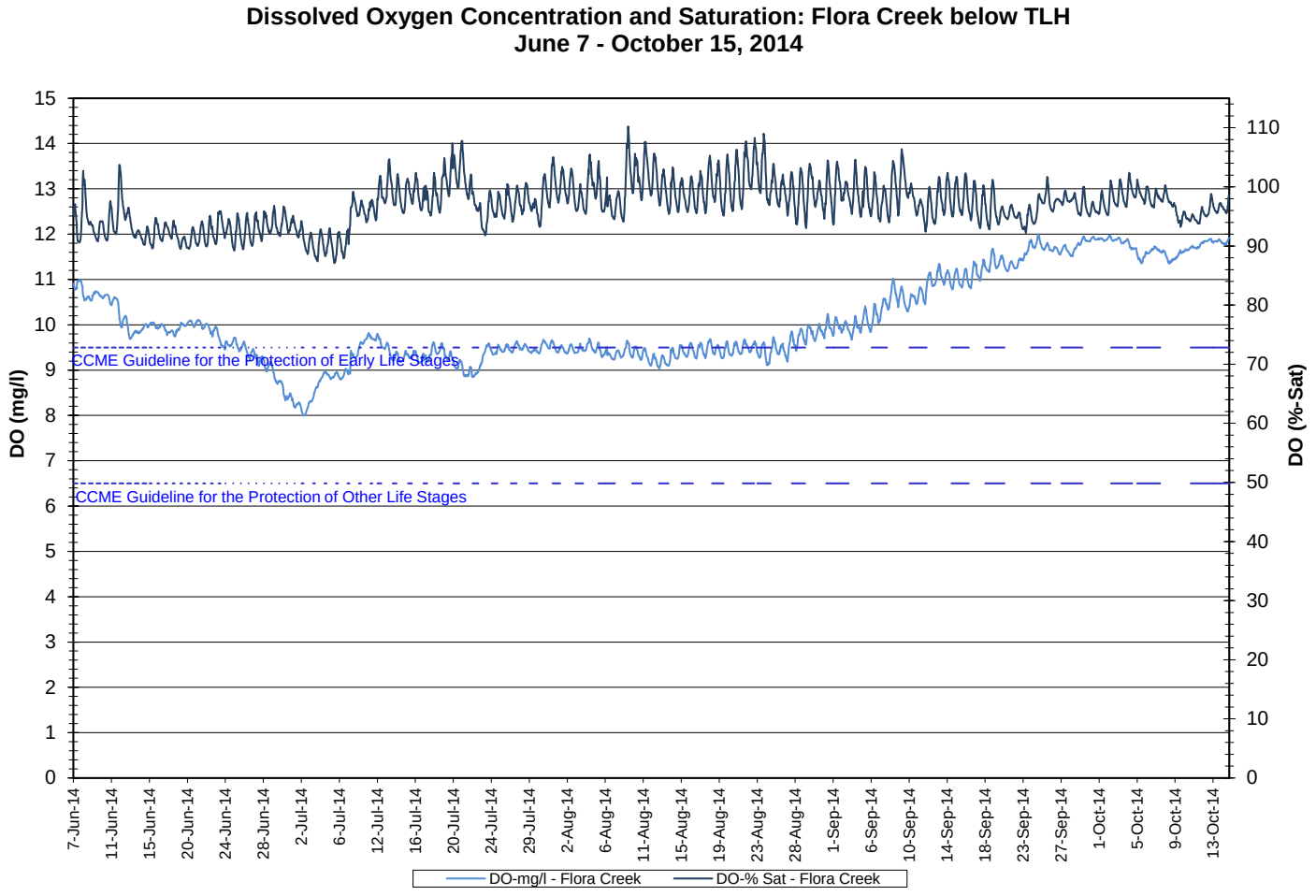


**Figure 5: Dissolved oxygen and percent saturation – Flora Creek below TLH**

- At the Flora Creek station, turbidity values range from 3.6 to 759.7 NTU with a median value of 45.0 NTU (Figure 6). This station was somewhat turbid for the entire season.
- Turbidity at the beginning of the season was very high and decreased over time; this was due to the late winter melt/freshet.
- After the significant decrease in the beginning of the season, turbidity readings >100NTU occur occasionally and for small periods of time. Turbidity spikes that correspond with precipitation at the time are identified on the graph in red. The cause of turbidity spikes on other days is unknown.

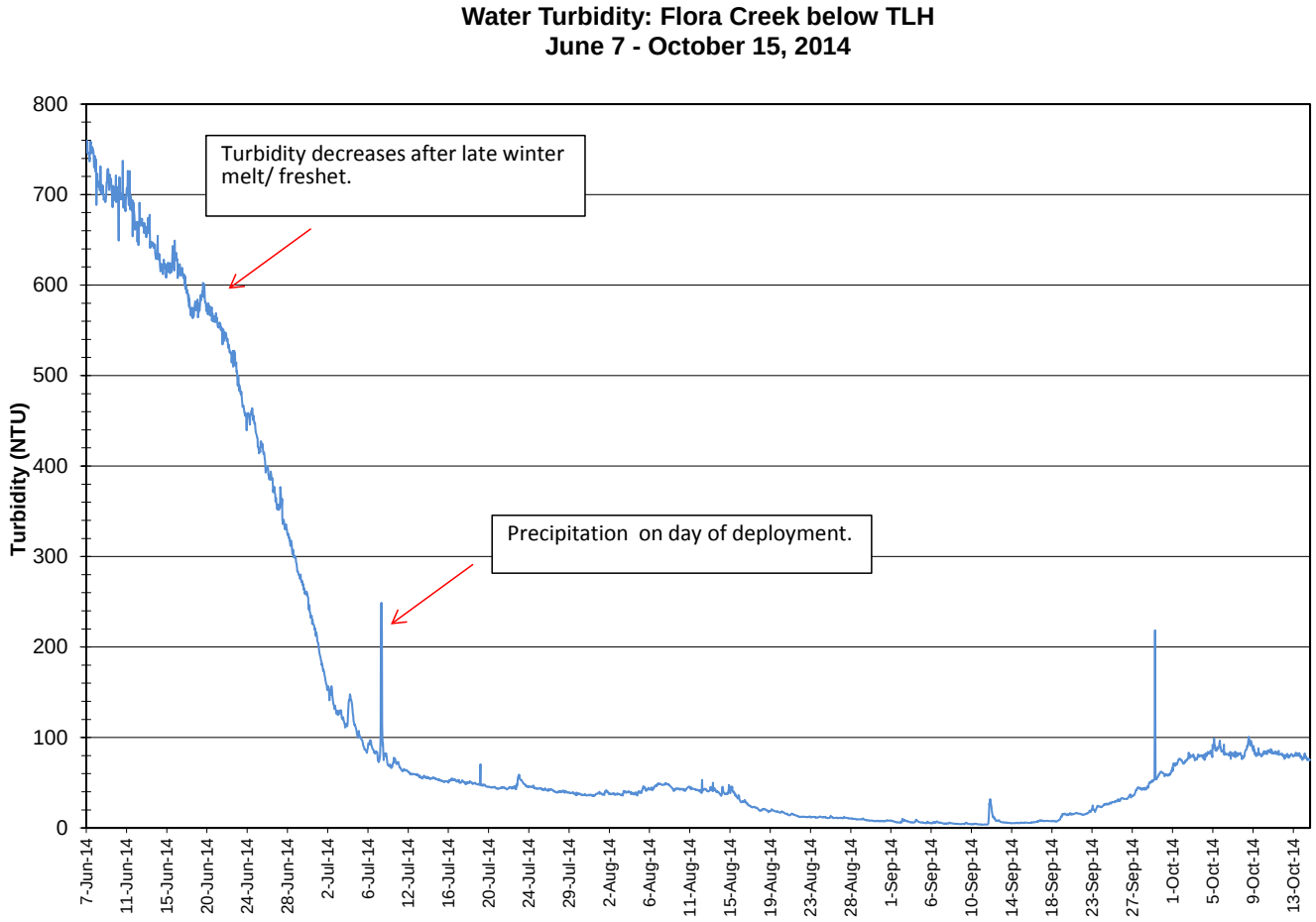


**Figure 6: Turbidity at Flora Creek below TLH**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Flora Creek (Figure 7).
- Stage data was not available for the beginning of the 2014 deployment season.
- Stage decreases slightly in the August deployment period before increasing and then stabilizing, with fluctuating precipitation levels.

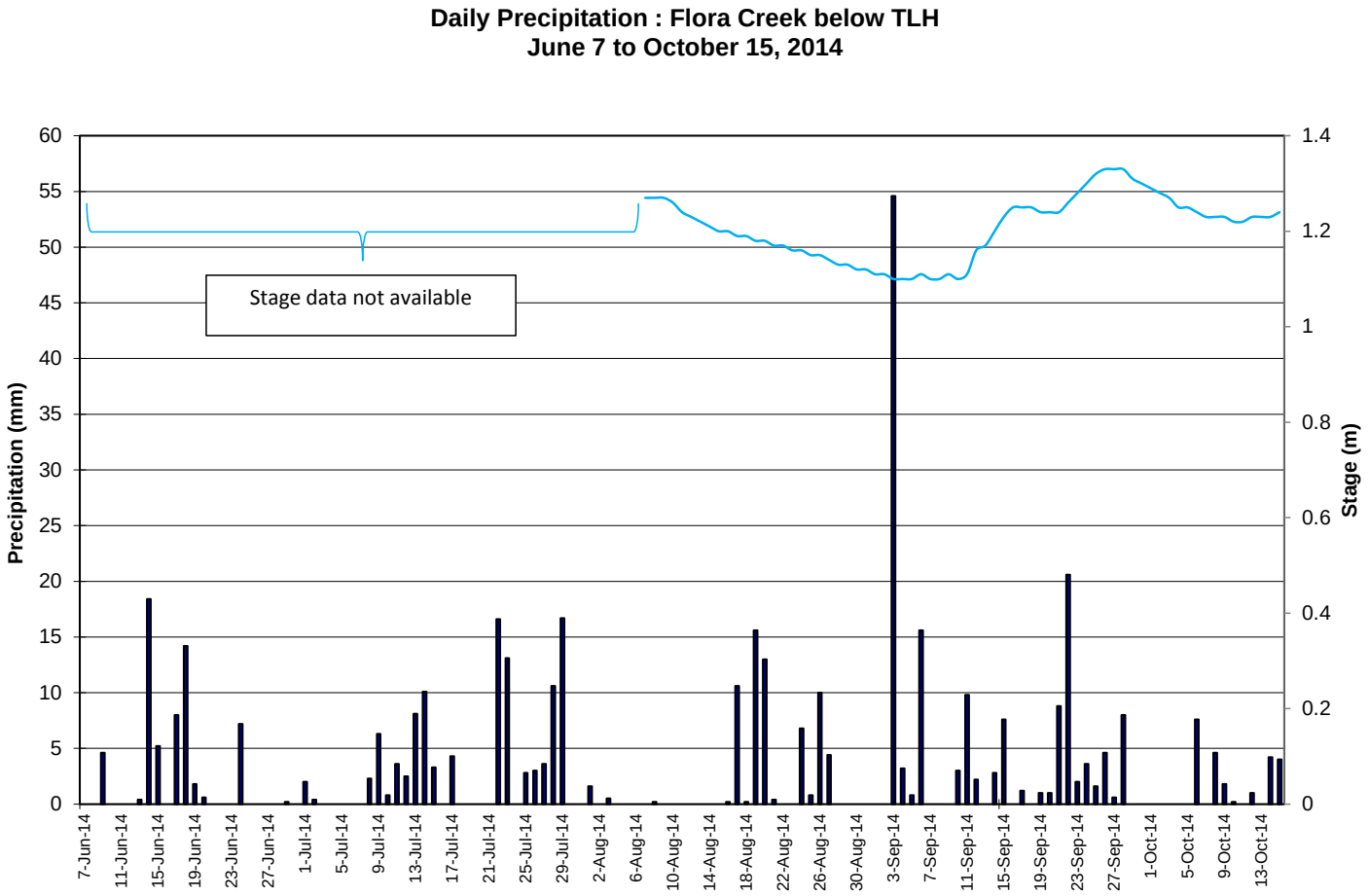


**Figure 7: Stage and precipitation at Flora Creek below TLH**

## Conclusions

- The instrument at the water quality monitoring station on Flora Creek was deployed for the first time on June 7, 2014 and removed on October 15th, 2014 for the winter season.
- Regular visits on a near 30 day deployment schedule have been adhered to for the most part. The last deployment period was somewhat longer at 40 days; this was done to collect as much data as possible before ice conditions were present.
- 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 Water Quality Guidelines for the Protection of Aquatic Life.
- The instrument performed well for the 2014 season with no issues. The station did not transmit data for the July deployment period; this was due to a power issue. Internally logged data was used for graphing purposes.
- Water temperature followed the seasonal trend of increasing during the summer and decreasing into the fall. Water temperature corresponded with air temperature.
- All pH values were within the acceptable range of the CCME Water Quality Guidelines for Protection of Aquatic Life.
- Specific conductivity increased after the first deployment period and then was relatively stable for the remainder of the season. It was noted that the conductivity sensor on this instrument requires substantial time to stabilize.
- In some cases, dissolved oxygen values were below the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold water Biota at Other Life Stages of 6.5 mg/l.
- This station tends to have high turbidity values. A decrease was noted after the late winter melt/freshet. Some turbidity spikes can be attributed to precipitation in the area at the time.

## Path Forward

- The field instrument will undergo proficiency testing and evaluation during the winter of 2014-2015. ENVC will inform Cliffs Natural Resources of any instrument performance issues.
- ENVC staff will deploy real time water quality instruments in spring 2015, when ice conditions allow and perform regular site visits throughout the 2015 deployment season for calibration and maintenance of the instruments.
- If necessary, deployment techniques will be evaluated and adapted the site, ensuring secure and suitable conditions for RTWQ monitoring.
- ENVC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.
- Open communication will continue to be maintained between ENVC, EC and Cliffs Natural Resources employees involved with the agreement, in order to respond to emerging issues on a proactive basis.
- Open communication will continue to be maintained between ENVC, EC and Cliffs Natural Resources in order to respond to and any significant water quality events in the form of email and/or monthly deployment reports, when the deployment season begins. Cliffs Natural Resources will also receive an annual report, summarizing the events of the deployment season.

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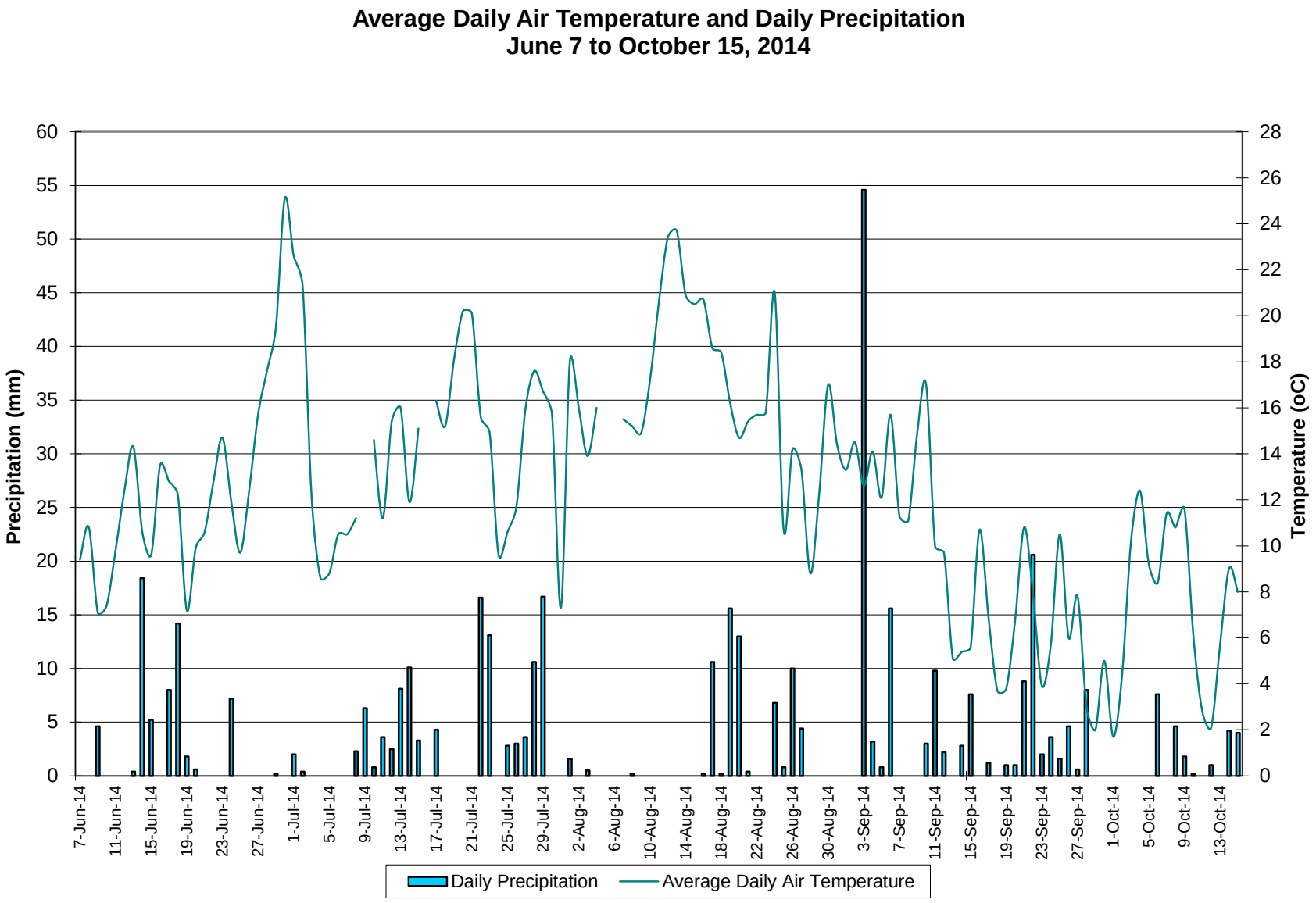
## Appendix 1


Average Daily Air Temperature and Daily Precipitation
June 7 to October 15, 2014
Precipitation (mm)
Temperature (oC)
0
5
10
15
20
25
30
35
40
45
50
55
60
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
7-Jun-14
11-Jun-14
15-Jun-14
19-Jun-14
23-Jun-14
27-Jun-14
1-Jul-14
5-Jul-14
9-Jul-14
13-Jul-14
17-Jul-14
21-Jul-14
25-Jul-14
29-Jul-14
2-Aug-14
6-Aug-14
10-Aug-14
14-Aug-14
18-Aug-14
22-Aug-14
26-Aug-14
30-Aug-14
3-Sep-14
7-Sep-14
11-Sep-14
15-Sep-14
19-Sep-14
23-Sep-14
27-Sep-14
1-Oct-14
5-Oct-14
9-Oct-14
13-Oct-14
Daily Precipitation
Average Daily Air Temperature