Real-Time Water Quality Deployment Report

Voisey's Bay Network

September 27 to November 7, 2013

Newfoundland Labrador

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

Real-Time Water Quality Deployment Report

Voisey's Bay Network

September 27 to November 7, 2013

Contents

Prepared by:
Grace de Beer
Department of Environment and Conservation
Water Resources Management Division
T: 709.896.5542
F: 709.896.9566
E: gracedebeer@gov.nl.ca

Real Time Water Quality Monitoring

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at four stations in the Voisey's Bay Network; Upper Reid Brook, Camp Pond Brook, Tributary to Lower Reid Brook, and Lower Reid Brook.
- On September 27, 2013, Vale Environment staff deployed real-time water quality monitoring instruments at the four real time stations in the Voisey's Bay network for a period of 39-41 days. Instruments were removed by Vale Environment staff on November 5, 6, & 7.

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 Instrument is temporarily deployed along side the Field Instrument. 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 Instrument and QAQC Instrument 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 instrument 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 instrument the entire instrument 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 Voisey's Bay Network stations deployed from September 27 to November 5, 6, & 7, 2013 are summarized in Table 2.

Table 2: Comparison rankings for Voisey's Bay Network stations, September 27– November 5, 6, & 7, 2013

Station Voisey's Bay	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Upper Reid Brook (62884)	Sep 27, 2013	Deployment	Good	Fair	Excellent	n/a*	n/a*
	Nov 6, 2013	Removal	Poor	Poor	Excellent	n/a*	n/a*
Camp Pond Brook (62885)	Sep 27, 2013	Deployment	Excellent	Good	Excellent	n/a*	n/a*
	Nov 7, 2013	Removal	Excellent	Poor	Good	n/a*	n/a*
Tributary to L. Reid B. (62886)	Sep 27, 2013	Deployment	Excellent	Marginal	Excellent	n/a*	n/a*
	Nov 5, 2013	Removal	Excellent	Poor	Good	n/a*	n/a*
Lower Reid Brook (62887)	Sep 27, 2013	Deployment	Excellent	Fair	Excellent	n/a*	n/a*
	Nov 5, 2013	Removal	Excellent	Poor	Excellent	n/a*	n/a*

* The dissolved oxygen and turbidity sensor on the QAQC instrument 62829 was not functioning correctly on September 27 or November 5, 6, or 7.

- At the station at Upper Reid Brook, temperature, and specific conductivity rank 'good' and 'excellent' while pH ranks 'fair' at deployment. For pH, the field instrument read a value of 6.73 and the QAQC instrument read a value of 6.11, a difference of 0.62. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At removal, specific conductivity ranks 'excellent' while temperature and pH rank 'poor'. For temperature, the field instrument read a value of 3.67°C and the QAQC instrument read a value of 4.93°C. This difference is likely due to the positioning of the instruments in the stream at the time of the comparison readings. If the field instrument were slightly deeper in the water, the temperature may have actually been colder. For pH, the field instrument read a value of 6.99 and the QAQC instrument read a value of 5.27, a difference of 0.84. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At the station on Camp Pond Brook, temperature, pH and specific conductivity rank either 'good' or 'excellent' at deployment. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At removal, temperature and specific conductivity rank 'excellent' and 'good' while pH ranks 'poor'. For pH, the field instrument read a value of 7.15 and the QAQC instrument read a value of 5.08, a difference of 2.07. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At the station on the Tributary to Lower Reid Brook, temperature and specific conductivity rank 'excellent' at deployment while pH ranks 'marginal'. For pH, the field instrument read a value of 6.10 and the QAQC instrument read a value of 7.05, a difference of 0.95. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.

- At removal, temperature and specific conductivity rank 'excellent' and 'good' while pH ranks 'poor'. For pH, the field instrument read a value of 6.56 and the QAQC instrument read a value of 4.18, a difference of 2.38. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At the station on Lower Reid Brook, temperature and specific conductivity rank 'excellent' at deployment while pH ranks 'fair'. For pH, the field instrument read a value of 6.70 and the QAQC instrument read a value of 7.21, a difference of 0.51. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- At removal, temperature and specific conductivity rank 'excellent' at deployment while pH ranks 'poor'. For pH, the field instrument read a value of 7.07 and the QAQC instrument read a value of 5.11, a difference of 1.96. This discrepancy may in part be due to insufficient time for stabilization or either the field or QAQC instruments. Dissolved oxygen and turbidity are not ranked due to sensor malfunction.
- Grab samples were taken at each of the stations at the time of the deployment. The results are attached in Appendix 2.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from September 27 to November 7 in the Voisey's Bay Real Time Water Quality Monitoring Network.
- 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.

Upper Reid Brook (Outlet from Reid Pond)

- Water temperature ranges from 2.86°C to 9.96°C during the deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall season (Figure 2).
- Average water temperature is 6.77°C for the deployment period.

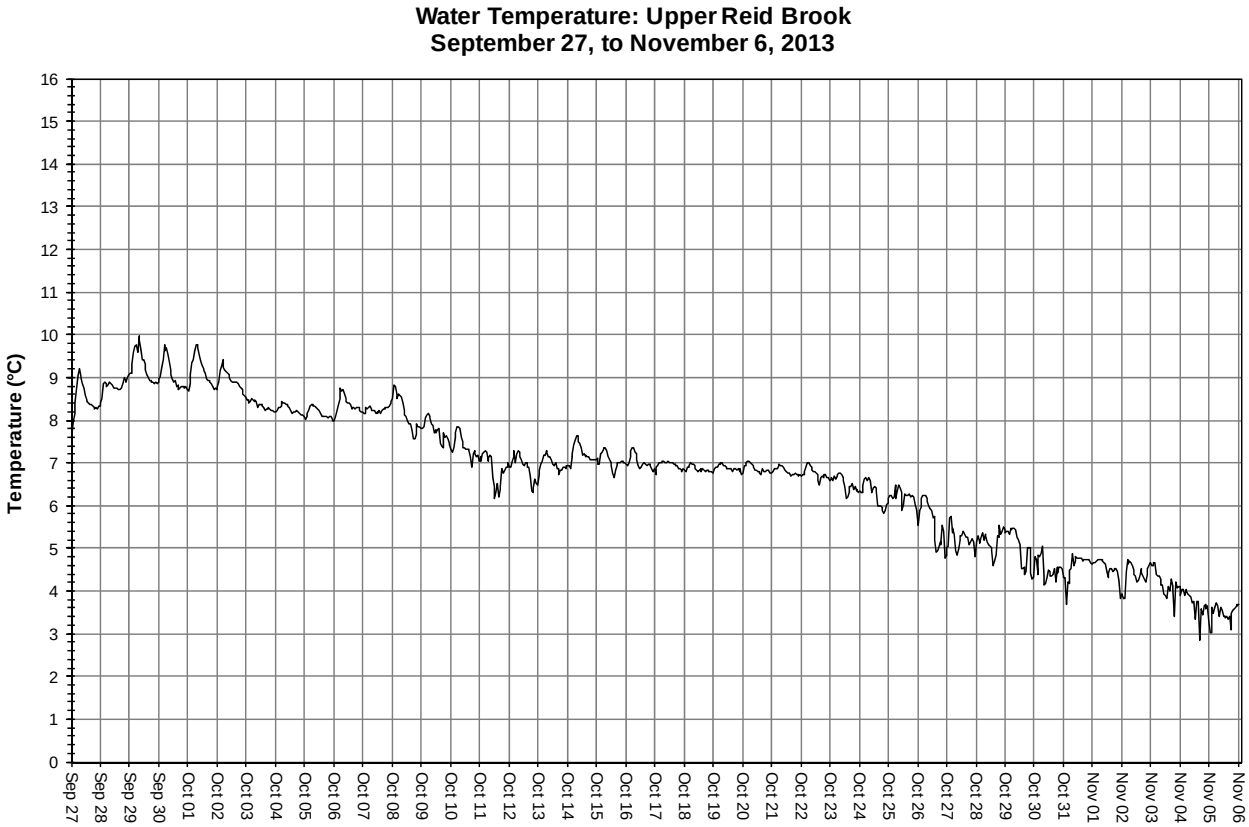


Figure 1: Water temperature at Upper Reid Brook

- Average daily air and water temperature are decreasing throughout the deployment period (Figure 2). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

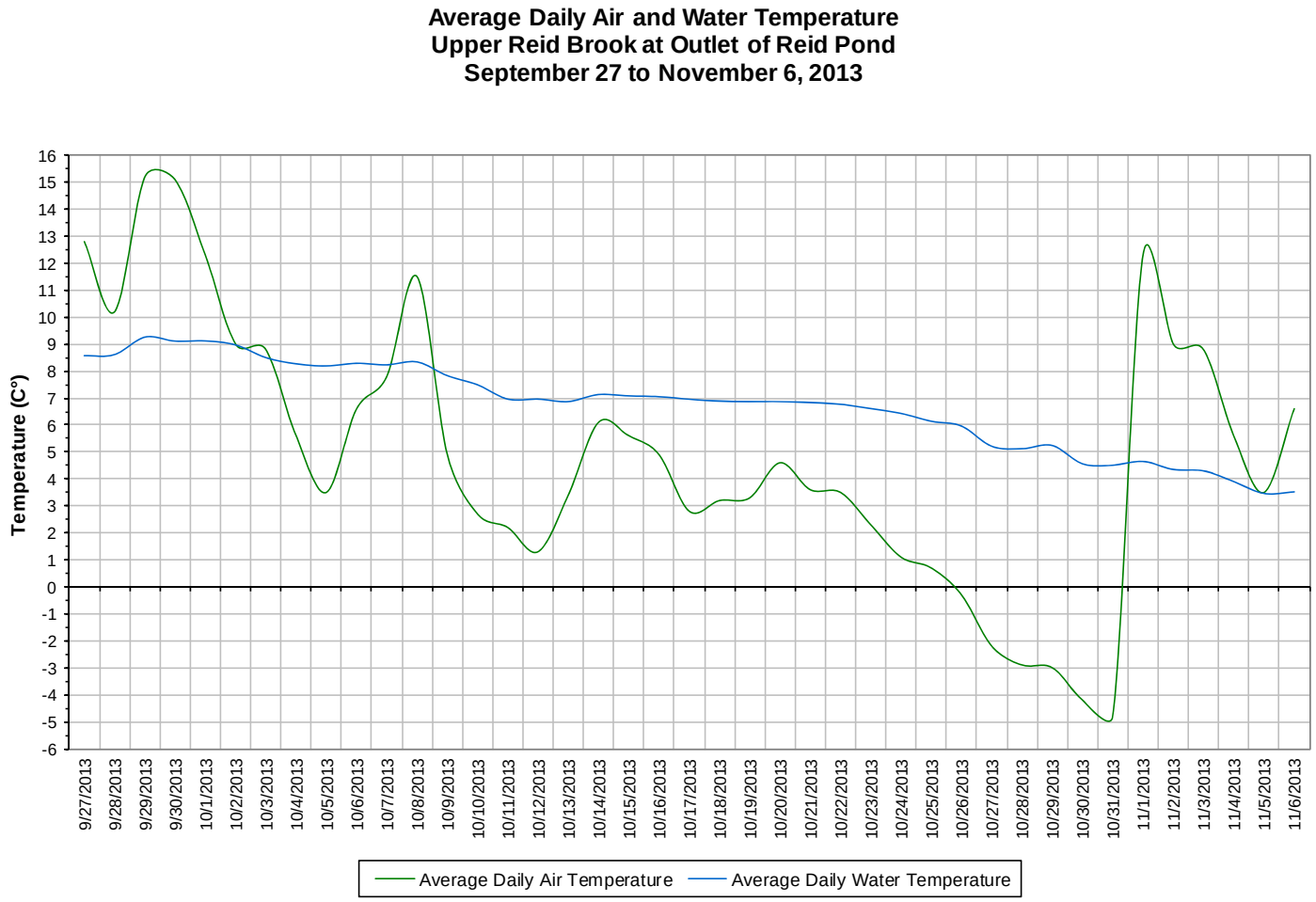


Figure 2: Average daily air and water temperatures at Upper Reid Brook

(weather data recorded at Nain)

- pH ranges between 6.74 and 7.10 pH units (Figure 3).
- All values are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (> 6.5 and <9.5 pH units). Guidelines are indicated in blue on Figure 3.

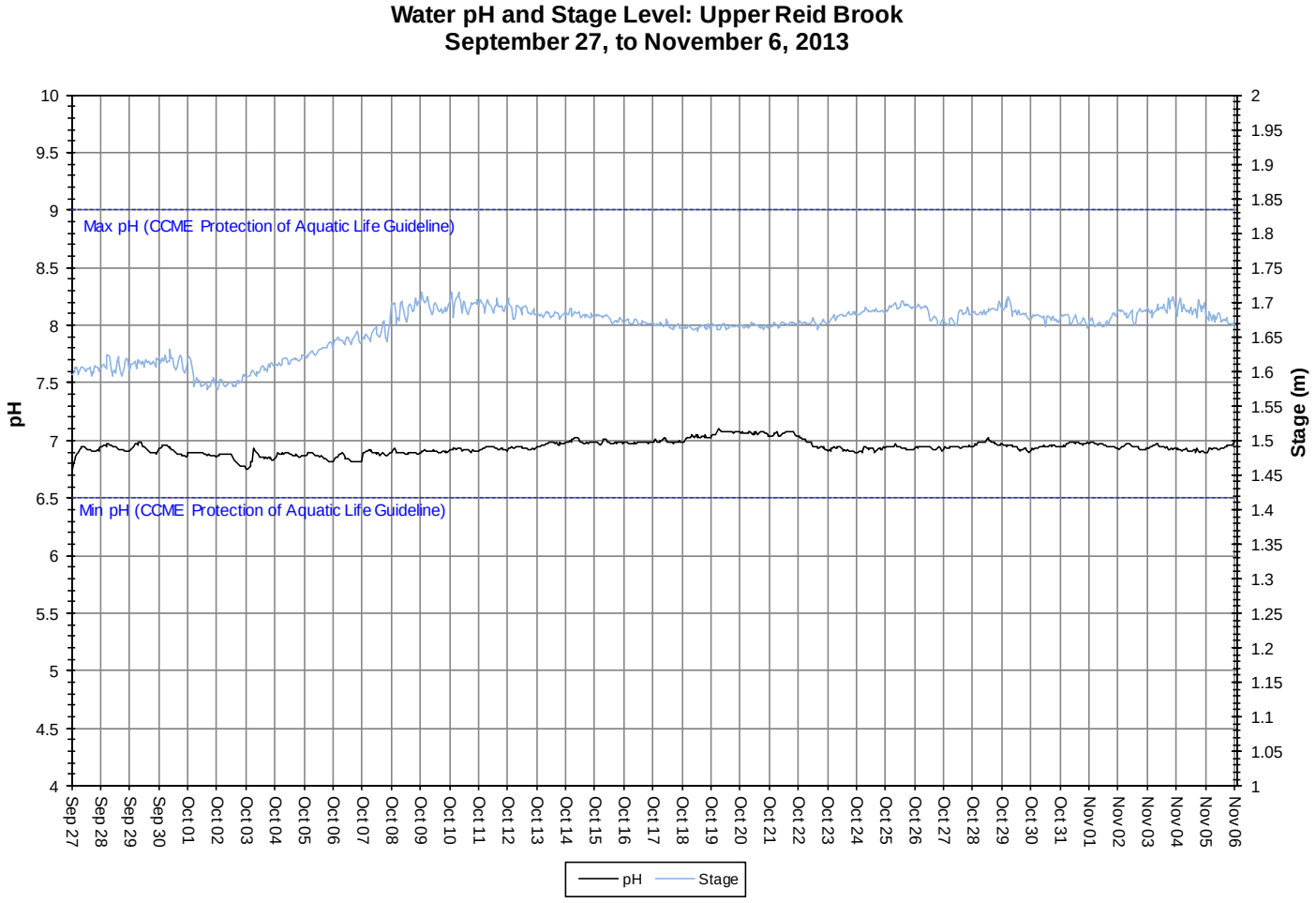


Figure 3: pH and stage level at Upper Reid Brook

- Specific conductivity values range from 11.5µS/cm to 12.4µS/cm during the deployment period, averaging 11.9µS/cm (Figure 4).
- Specific conductivity remains very low and very stable throughout the deployment period. This trend is expected as the flow from this station is directly from a stable lake environment.

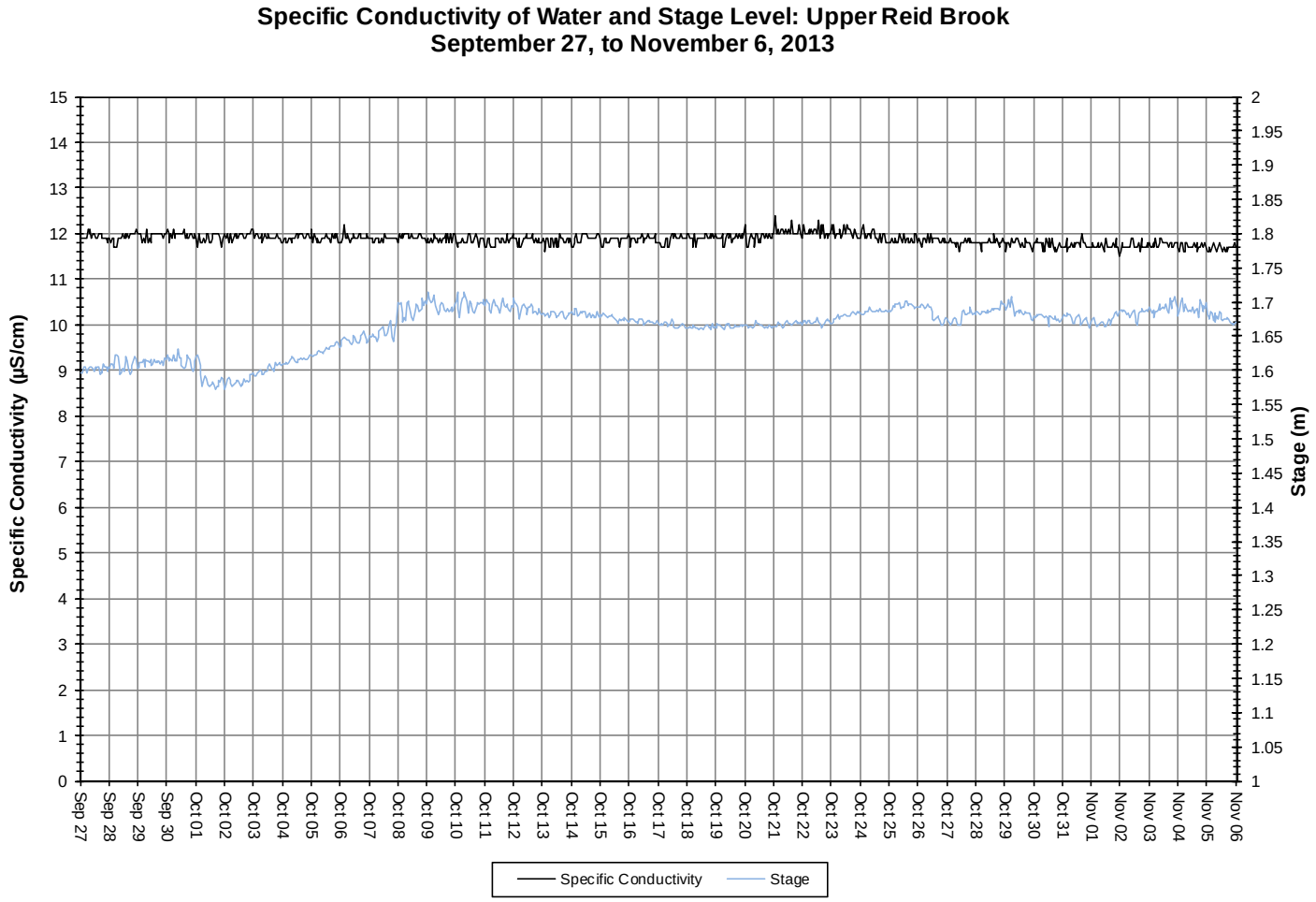


Figure 4: Specific conductivity and stage level at Upper Reid Brook

- Dissolved oxygen content ranges between 10.93mg/l and 12.48mg/l. The saturation of dissolved oxygen ranges from 88.5% to 99.1% (Figure 5).
- Dissolved oxygen content is increasing throughout the deployment period due to the decreasing air and water temperatures (Figure 2).
- All values are above both of the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l). The guidelines are indicated in blue on Figure 5. Average dissolved oxygen content is 11.41mg/l.

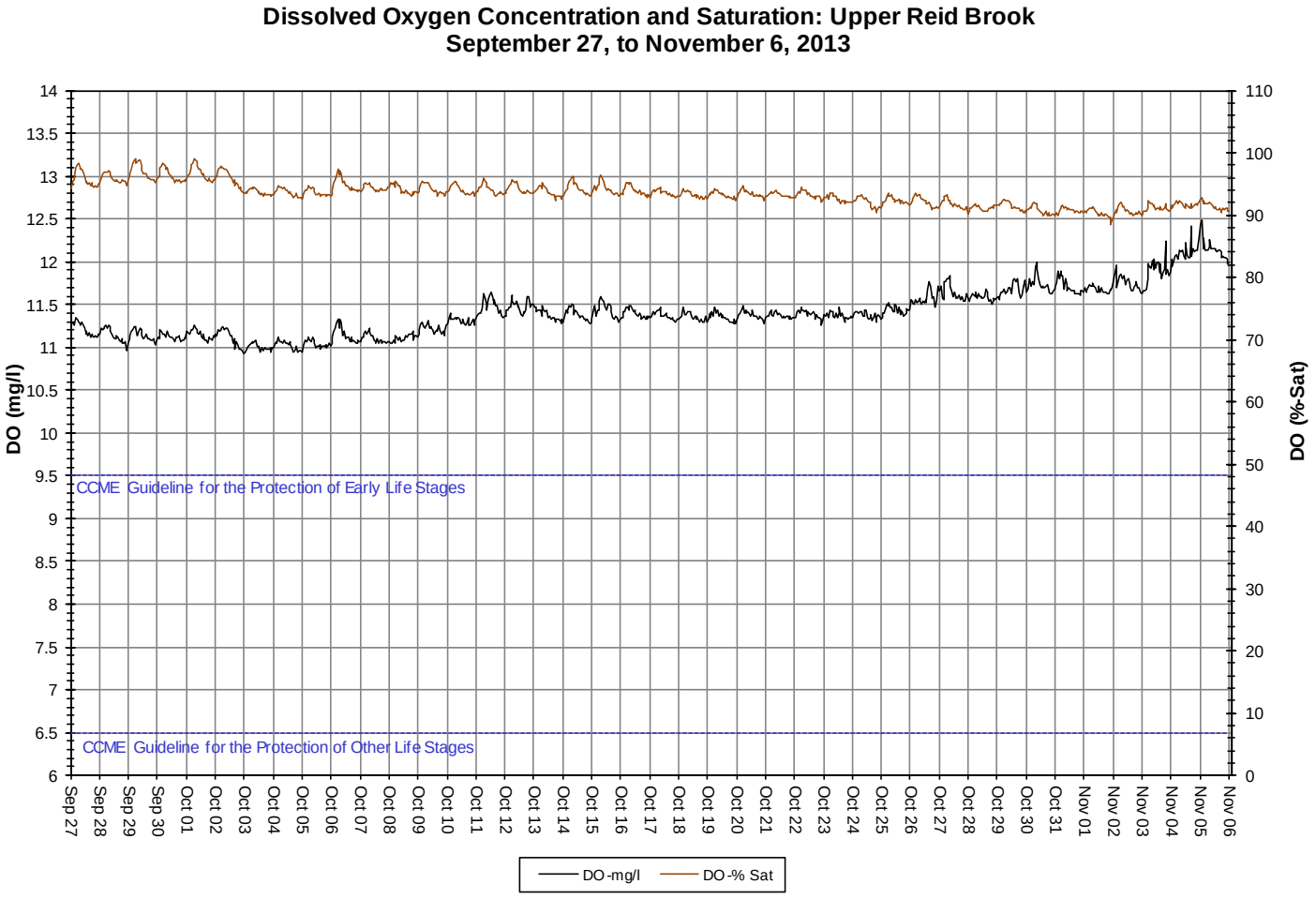


Figure 5: Dissolved oxygen and percent saturation at Upper Reid Brook

- Turbidity at this station remained at 0NTU for the majority of the deployment period. This trend is not unusual for this station as the water flowing from the lake is typically very clean, clear and cold. The turbidity increase on October 9 lasts for 2 hours and should not be considered a water quality event.

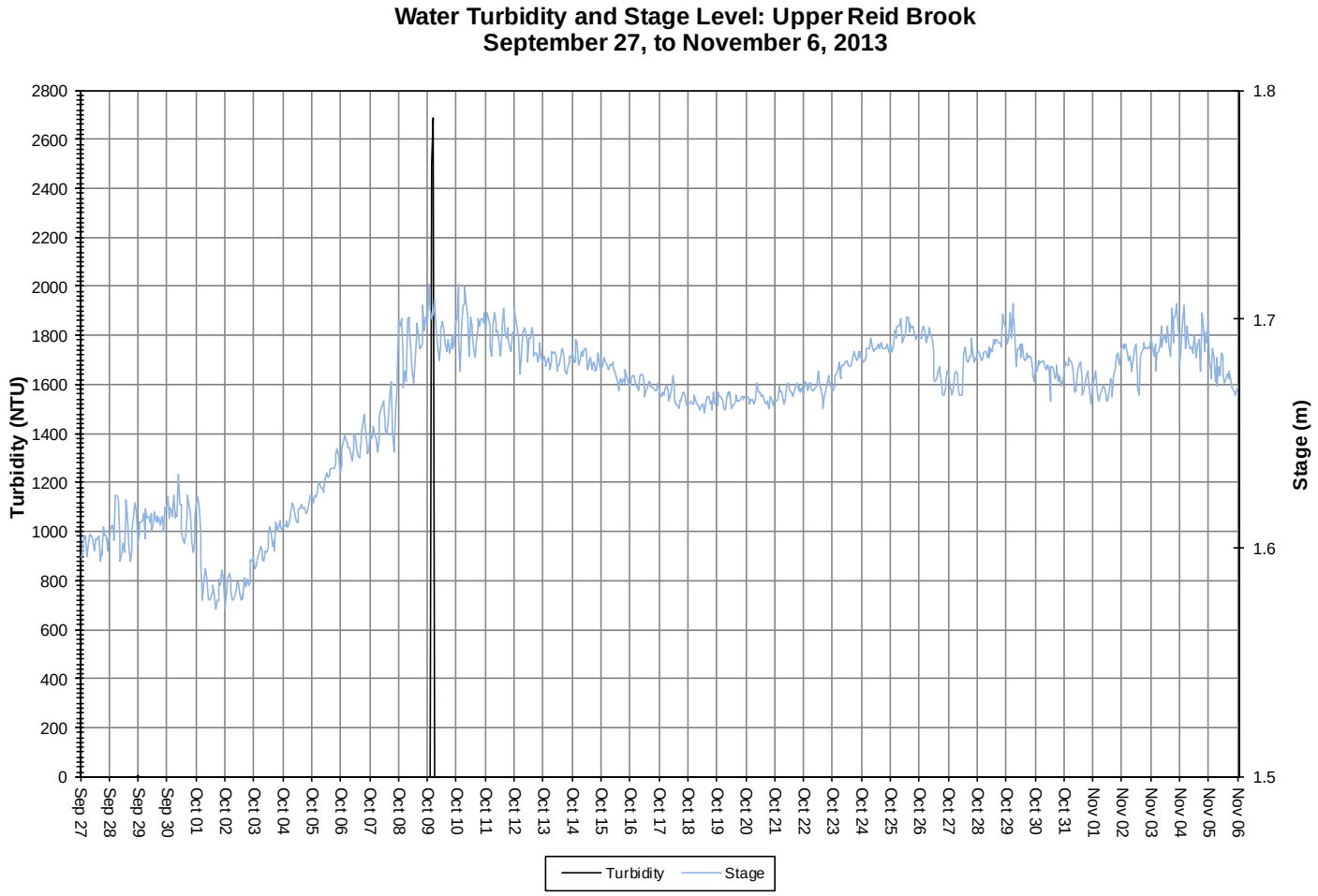


Figure 6: Turbidity and stage level at Upper Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is relatively stable throughout the deployment period. Stage ranges from 1.57m to 1.72m, a difference of 0.15m.
- Precipitation events occur about 50% of the time and are low in magnitude.

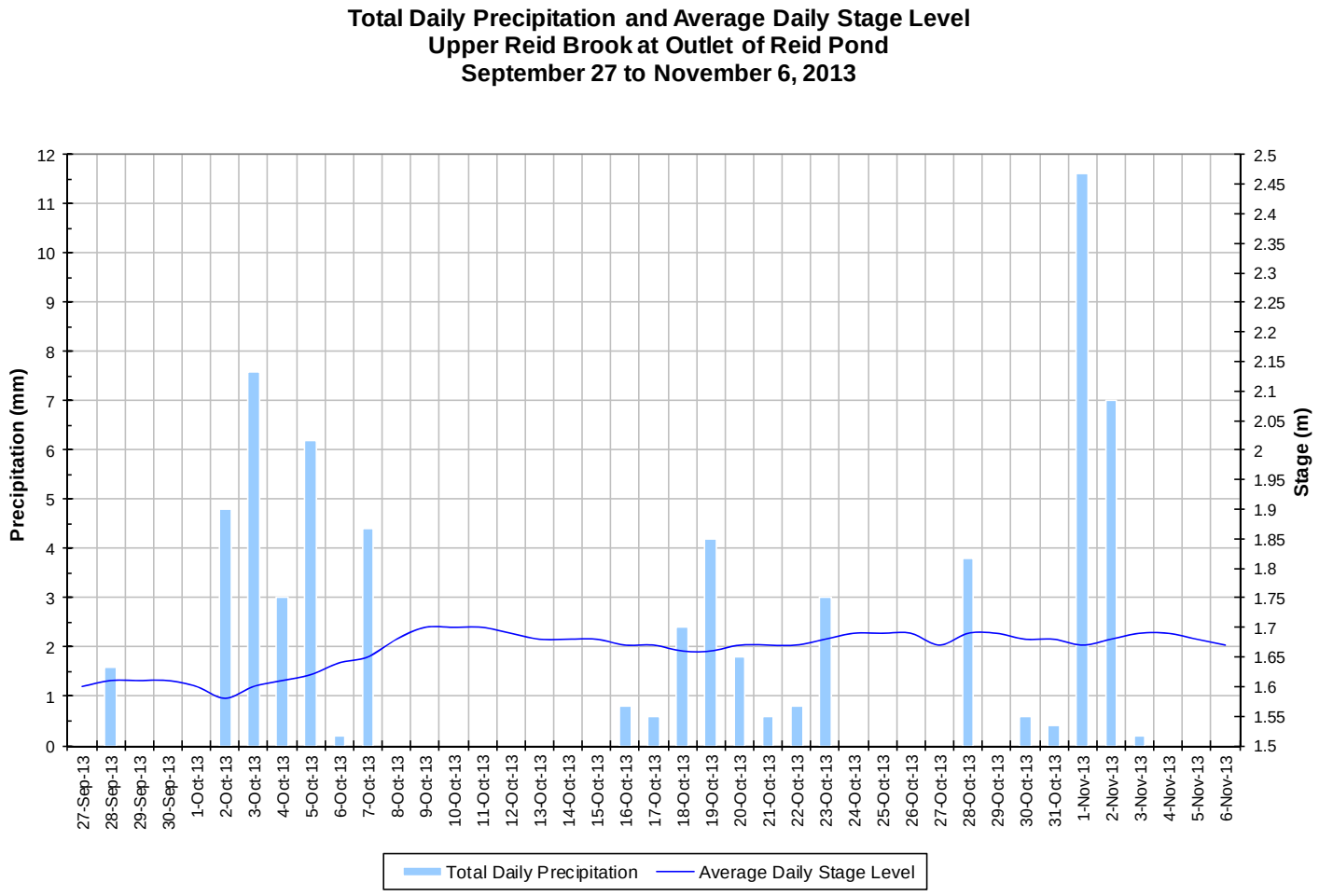


Figure 7: Daily precipitation and average daily stage level at Upper Reid Brook

(weather data recorded at Nain)

Camp Pond Brook

- Water temperature ranges from 0.03°C to 12.34°C during the deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. The trend is expected given the cooling ambient air temperatures in the fall season (Figure 9). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- Average water temperature is 4.49°C for the deployment period. On November 4, water temperature reaches 0.0°C and remains at or near that temperature until the end of the deployment period.
- This station typically has the highest water temperatures and greatest fluctuations when compared to the other stations in the network.

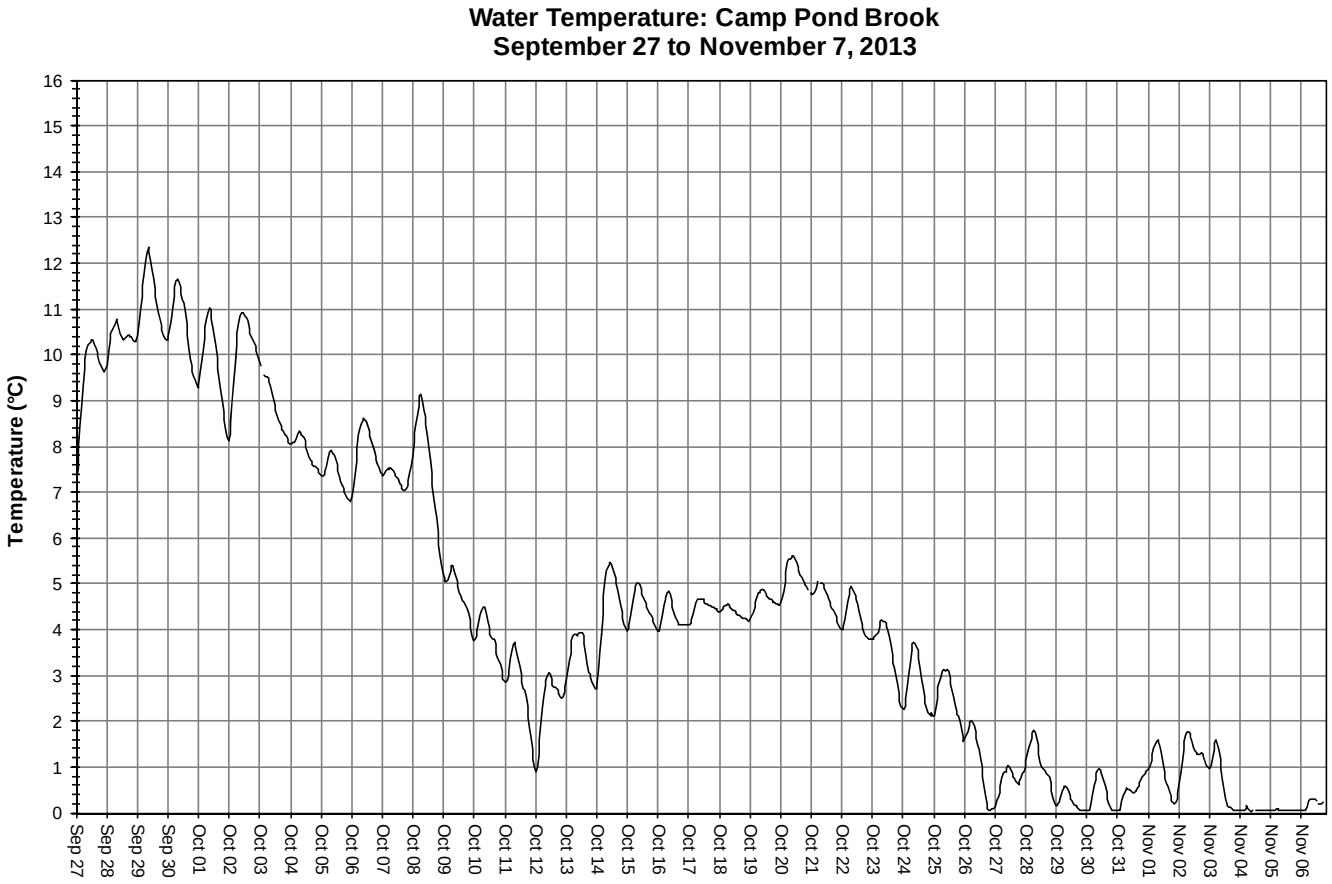


Figure 8: Water temperature at Camp Pond Brook

- Average daily air and water temperatures are decreasing throughout the deployment period (Figure 9). Fluctuations in average daily air temperatures are reflected by changes in water temperature. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

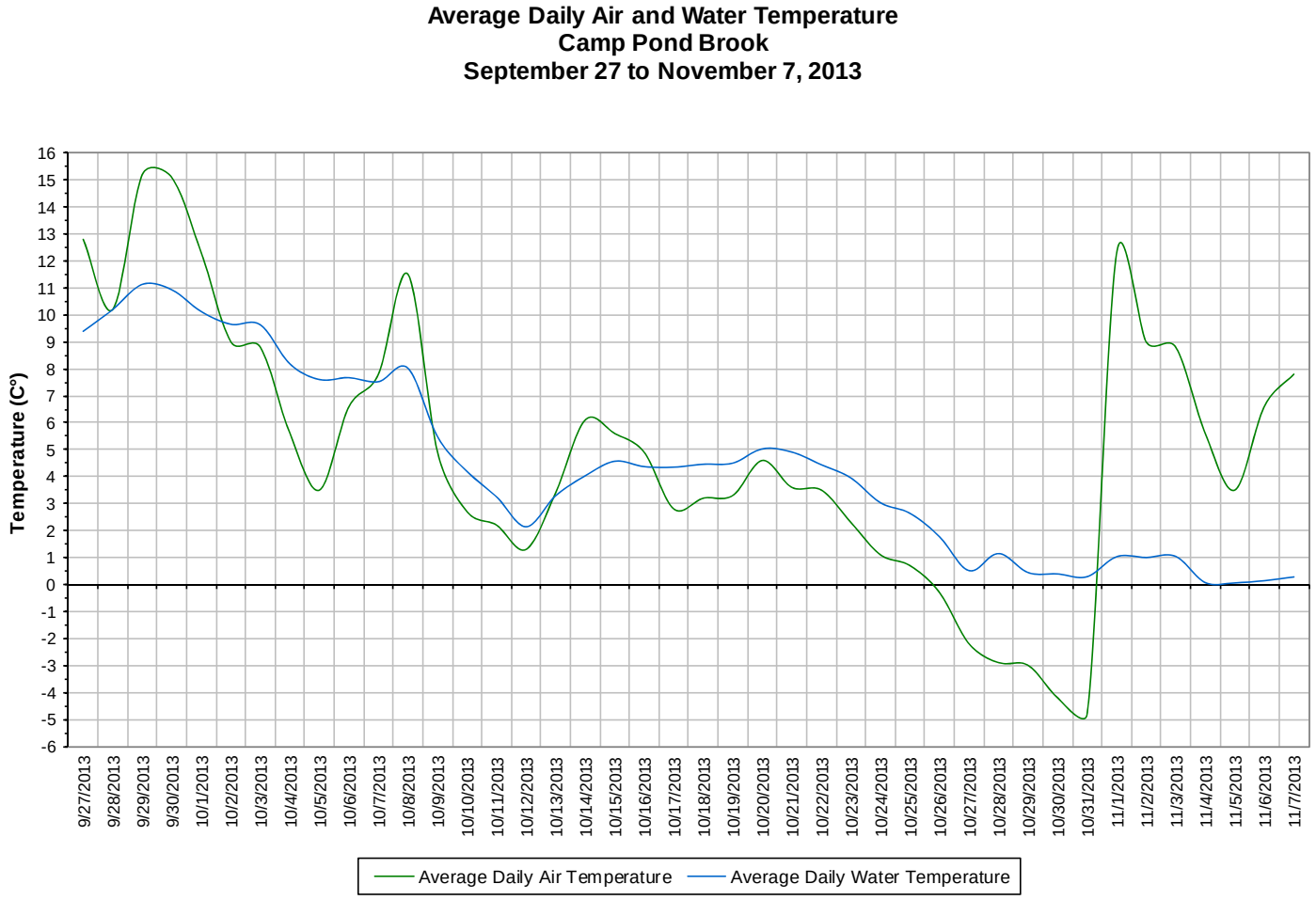


Figure 9: Average daily air and water temperatures at Camp Pond Brook

(weather data recorded at Nain)

- pH ranges between 6.90 and 7.21 pH units (Figure 10).
- pH values are very stable, fluctuating diurnally throughout the deployment period.
- All values are within the recommended guidelines for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). Guidelines are indicated in blue on Figure 10.
- Near the end of the deployment period, there are some increases in stage that correspond with decreases in pH. These events are highlighted in red on Figure 10. There are changes in other parameters during these events as well.

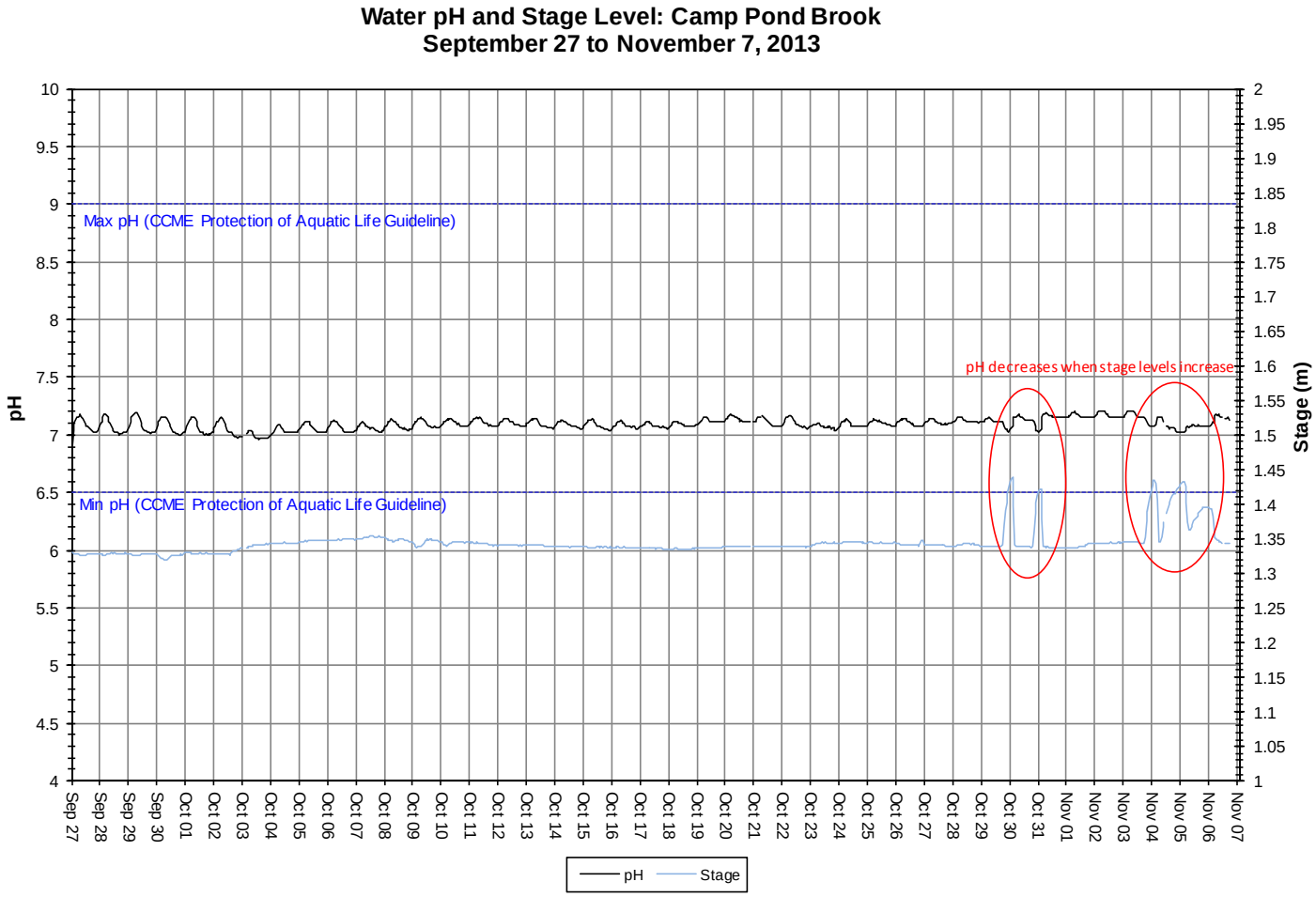


Figure 10: pH and stage level at Camp Pond Brook

- Specific conductivity ranges from 14.9µS/cm to 47.5µS/cm during the deployment period, averaging 39.7µS/cm (Figure 11).
- Stage data is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Typically, as stage level decreases, the specific conductivity of the water increases because of the increase in concentration of dissolved solids present in the water column. Inversely, as stage levels increase, specific conductivity generally decreases as the dissolved solids become more diluted in the water column. This trend is not typically experienced at this station. Instead, there is usually a positive relationship between water level and specific conductance.
- In this case, there is actually a typical inverse relationship with stage level and specific conductivity. Stage levels increase and specific conductivity decreases. This trend is unusual for this station. There are also other simultaneous changes in other water quality parameters during these stage increases.

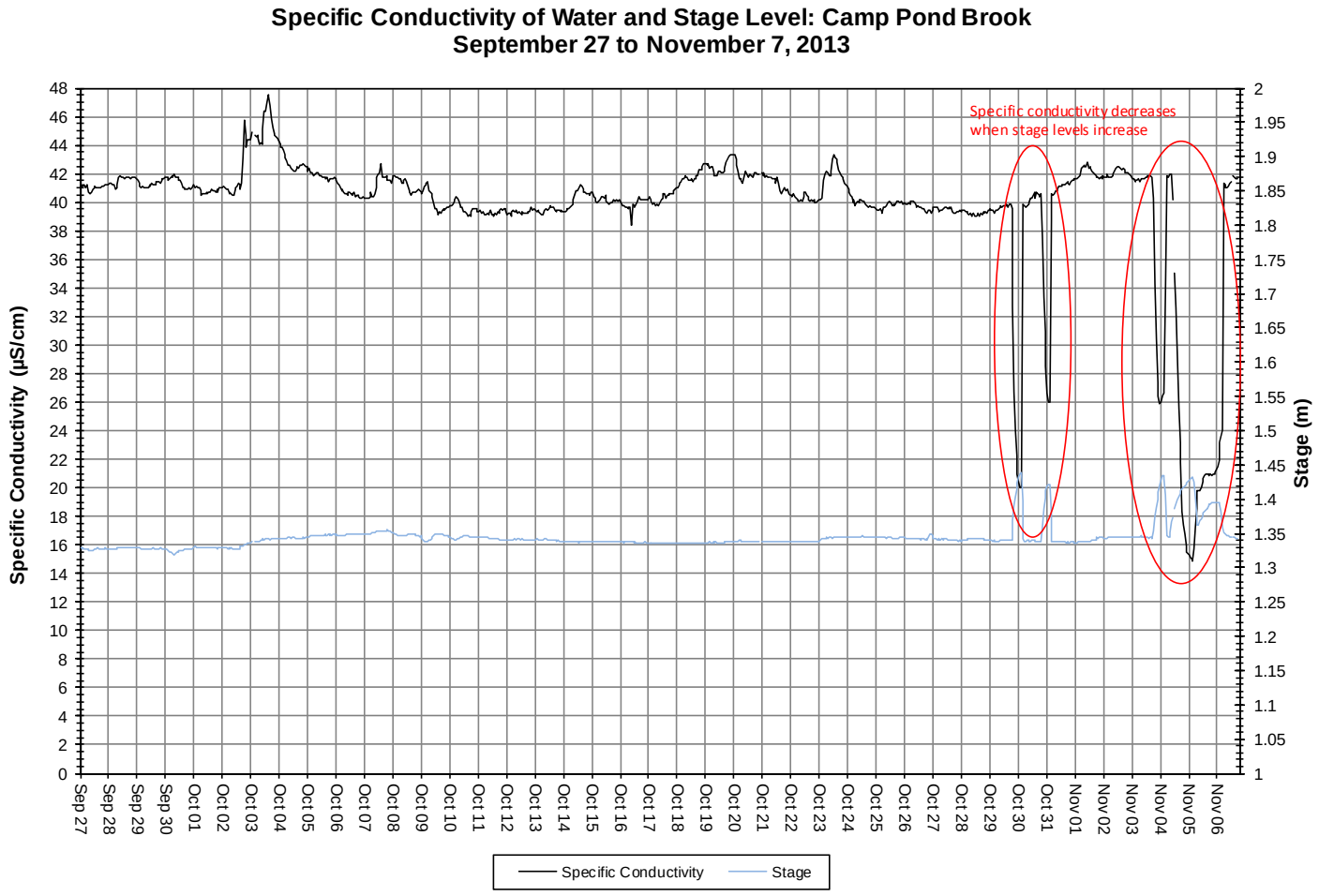


Figure 11: Specific conductivity and stage level at Camp Pond Brook

- Dissolved oxygen content ranges between 9.92mg/l and 13.72mg/l. The saturation of dissolved oxygen ranges from 88.8% to 99.2% (Figure 12).
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decreasing air and water temperatures (Figure 9).
- All values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and at Early Life Stages (9.5mg/l). Guidelines are indicated in blue on Figure 12. Average dissolved oxygen content is 12.09mg/l.

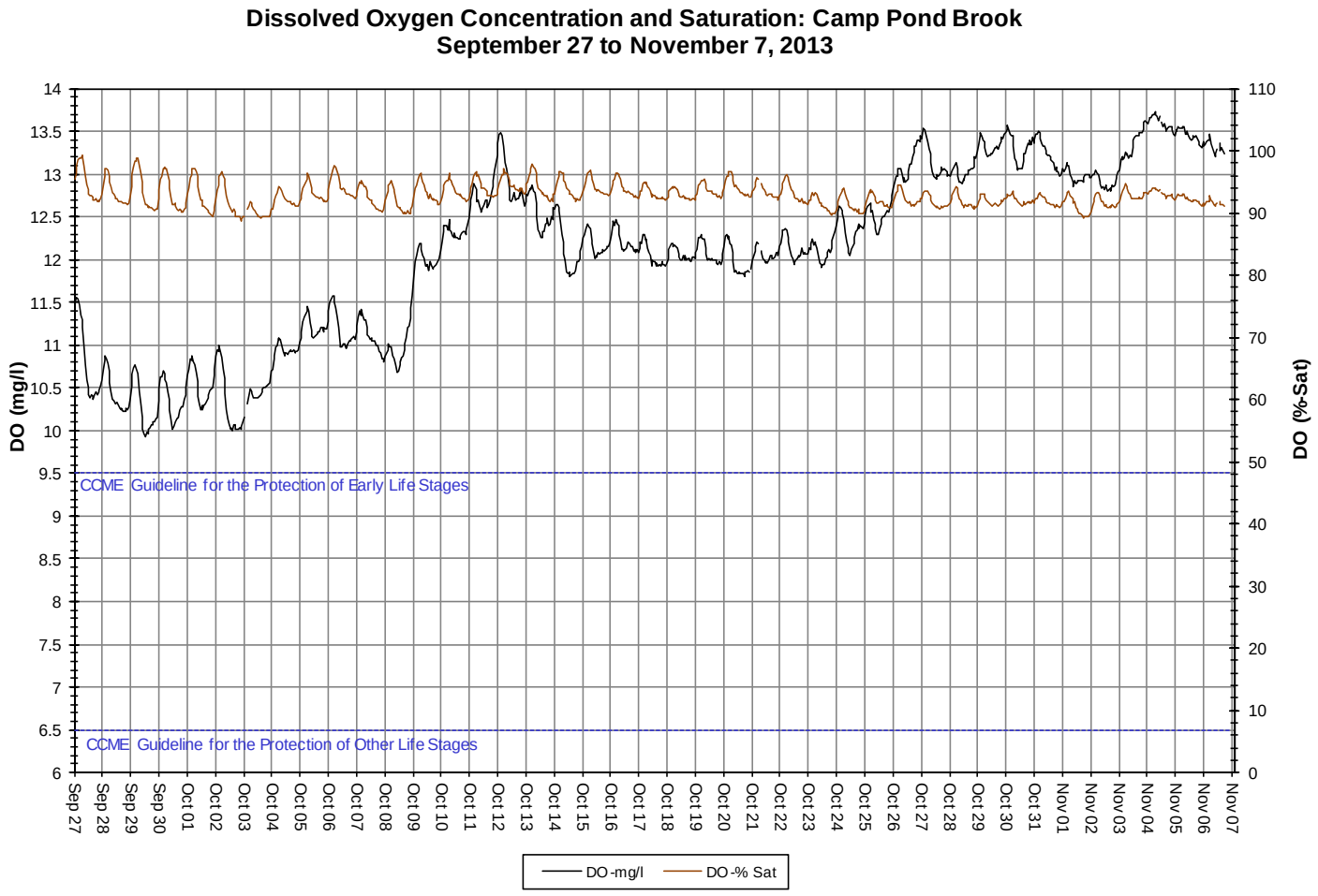


Figure 12: Dissolved oxygen and percent saturation at Camp Pond Brook

- Turbidity values range between 0NTU and 61.4NTU (Figure 13). A median value of 0.0NTU indicates there is no natural background turbidity at this station for this deployment period.
- There are a number of low magnitude turbidity events at this station lasting from between 1 and 36 hours. This trend is typical for this station. Some of these events (indicated in red on Figure 13) correspond with rainfall events.

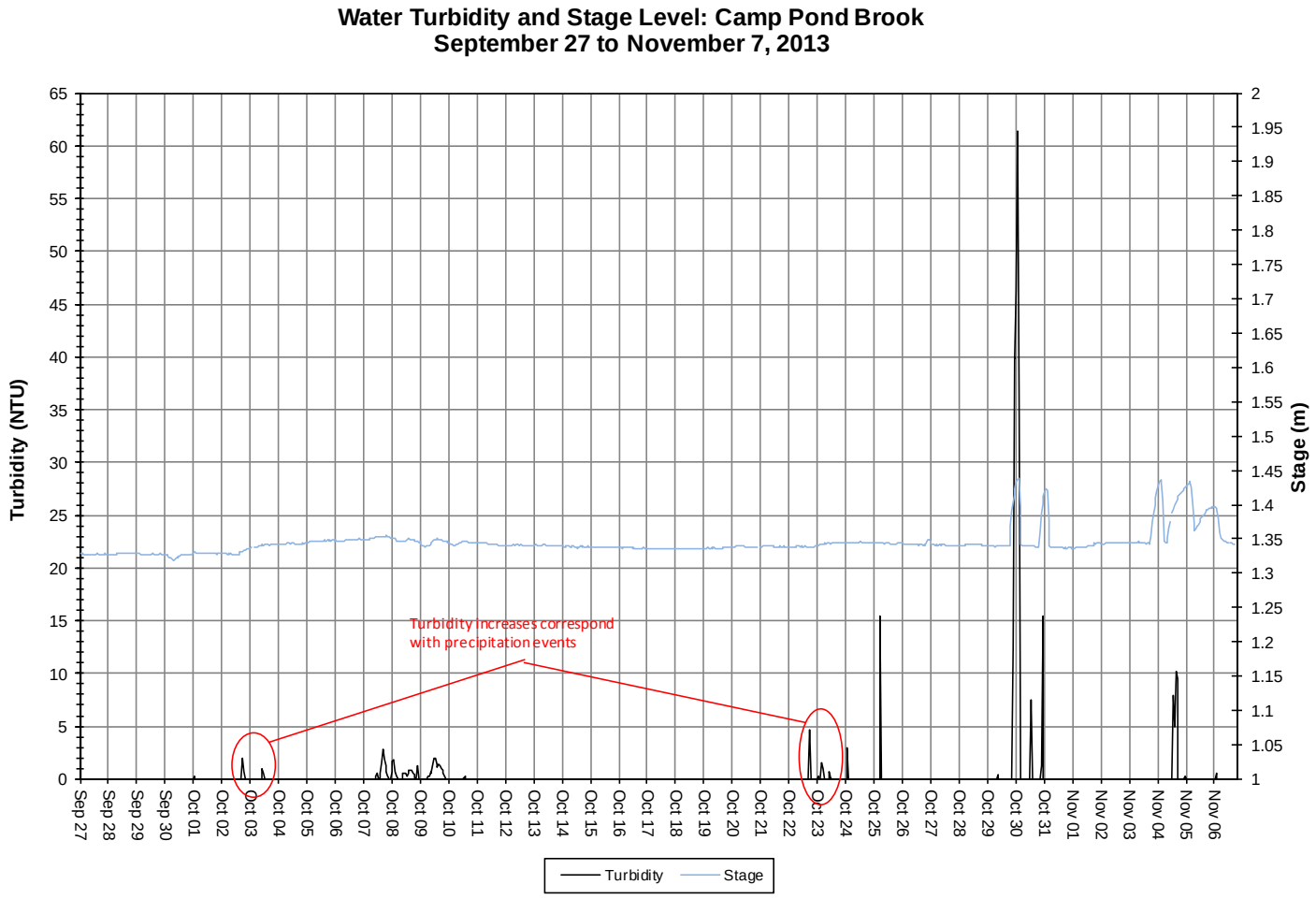


Figure 13: Turbidity and stage level at Camp Pond Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is generally very stable and consistent throughout the deployment period. Stage level values range from 1.32 to 1.44m, a difference of 0.12m.
- Precipitation events occur about 50% of the time and are low in magnitude.

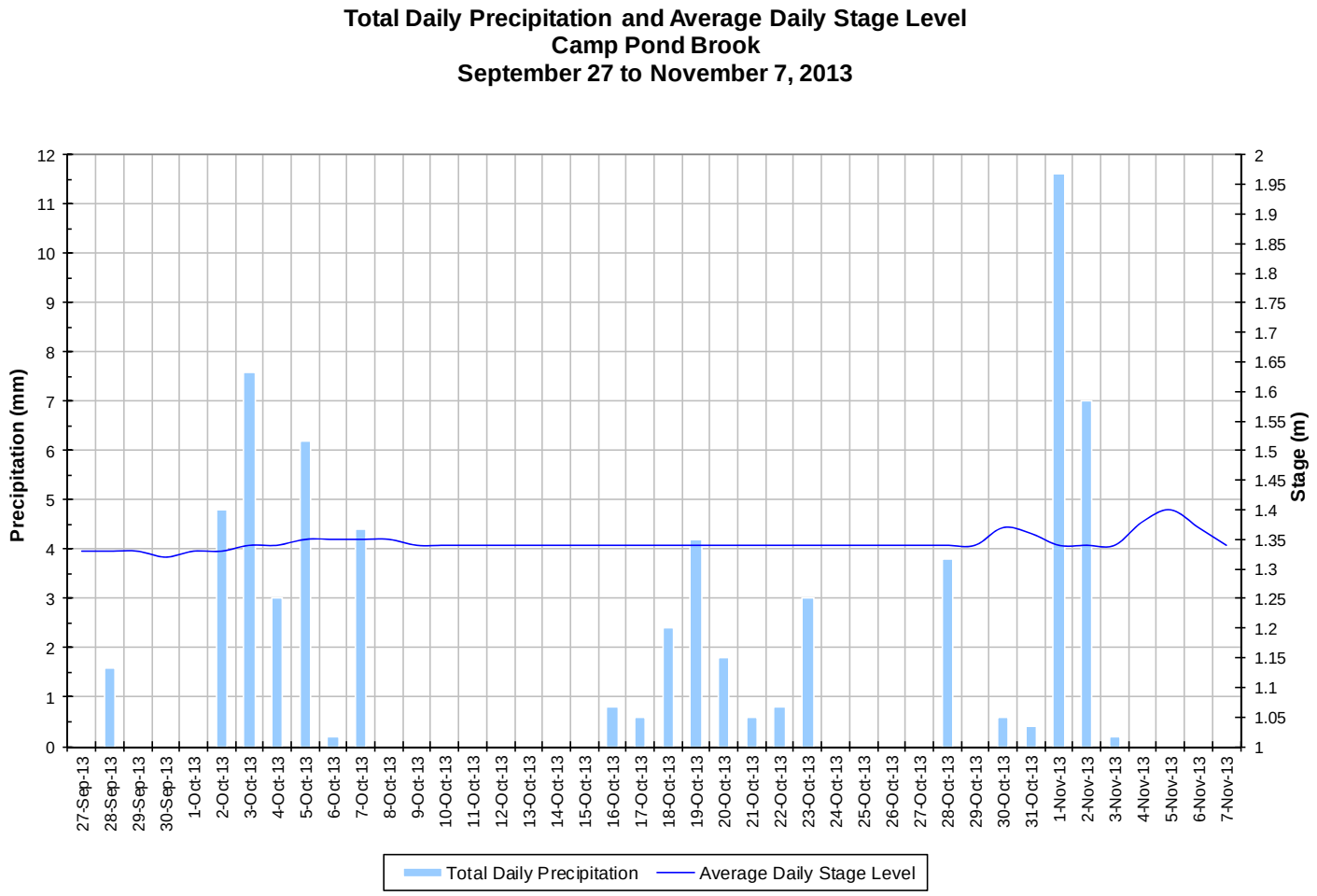


Figure 14: Daily precipitation and average daily stage level at Camp Pond Brook

(weather data recorded at Nain)

Tributary to Lower Reid Brook

- Water temperature ranges from 0.0°C to 9.30°C during the deployment period (Figure 15).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall season (Figure 16). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- On October 28, water temperature reaches 0.0°C and remains at or near that temperature until the end of the deployment period.
- Average water temperature is 3.56°C for the deployment period.

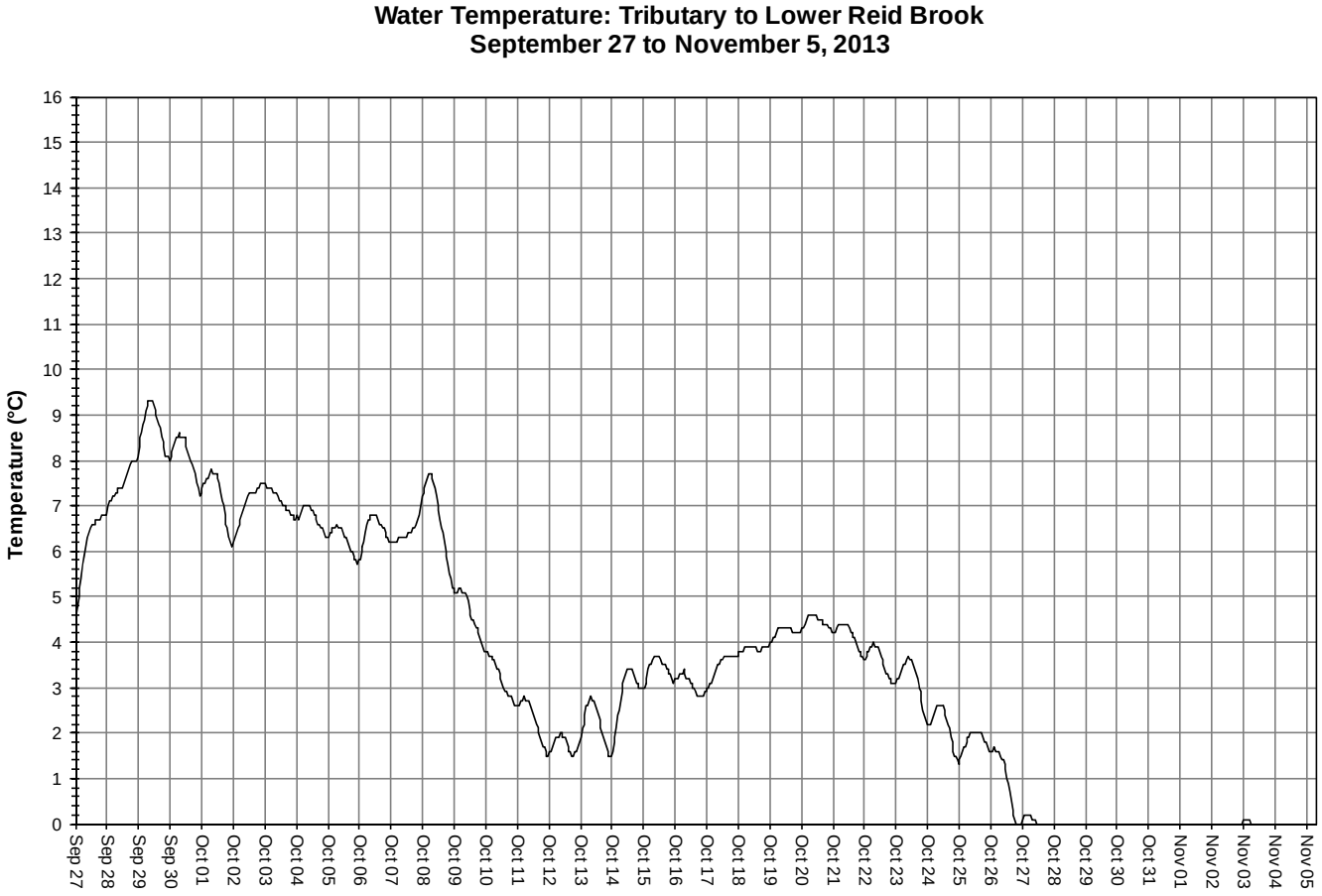


Figure 15: Water temperature at Tributary to Lower Reid Brook

- Average daily air and water temperatures are decreasing throughout the deployment period (Figure 16). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

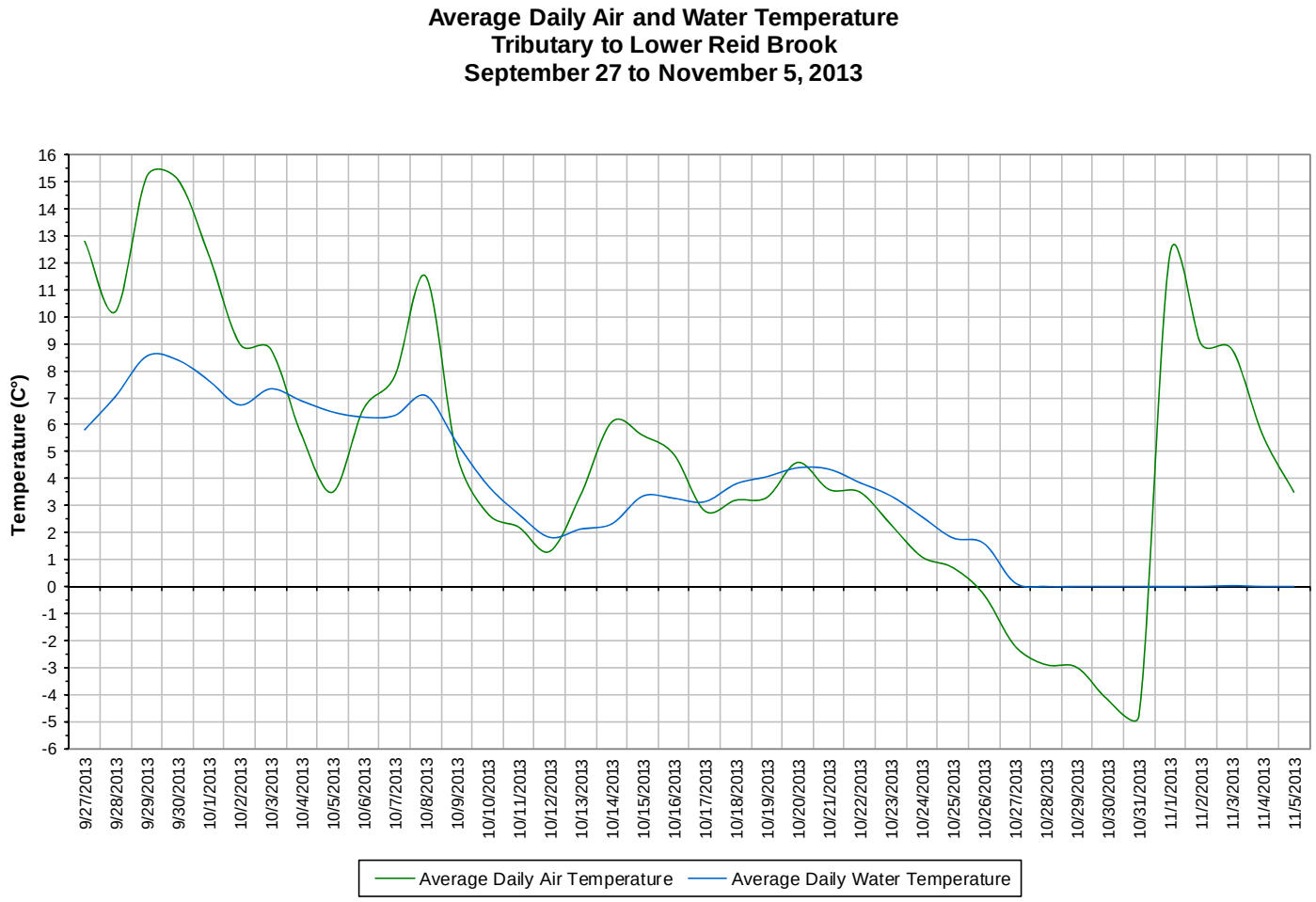


Figure 16: Average daily air and water temperatures at Tributary to Lower Reid Brook (weather data recorded at Nain)

- pH ranges between 6.65 and 7.03 pH units (Figure 17).
- pH is generally stable throughout the deployment period with a slight decrease in the final week of deployment during a stage level increase. These events are highlight in red on Figure 17.
- All values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). Guidelines are indicated in blue on Figure 17.

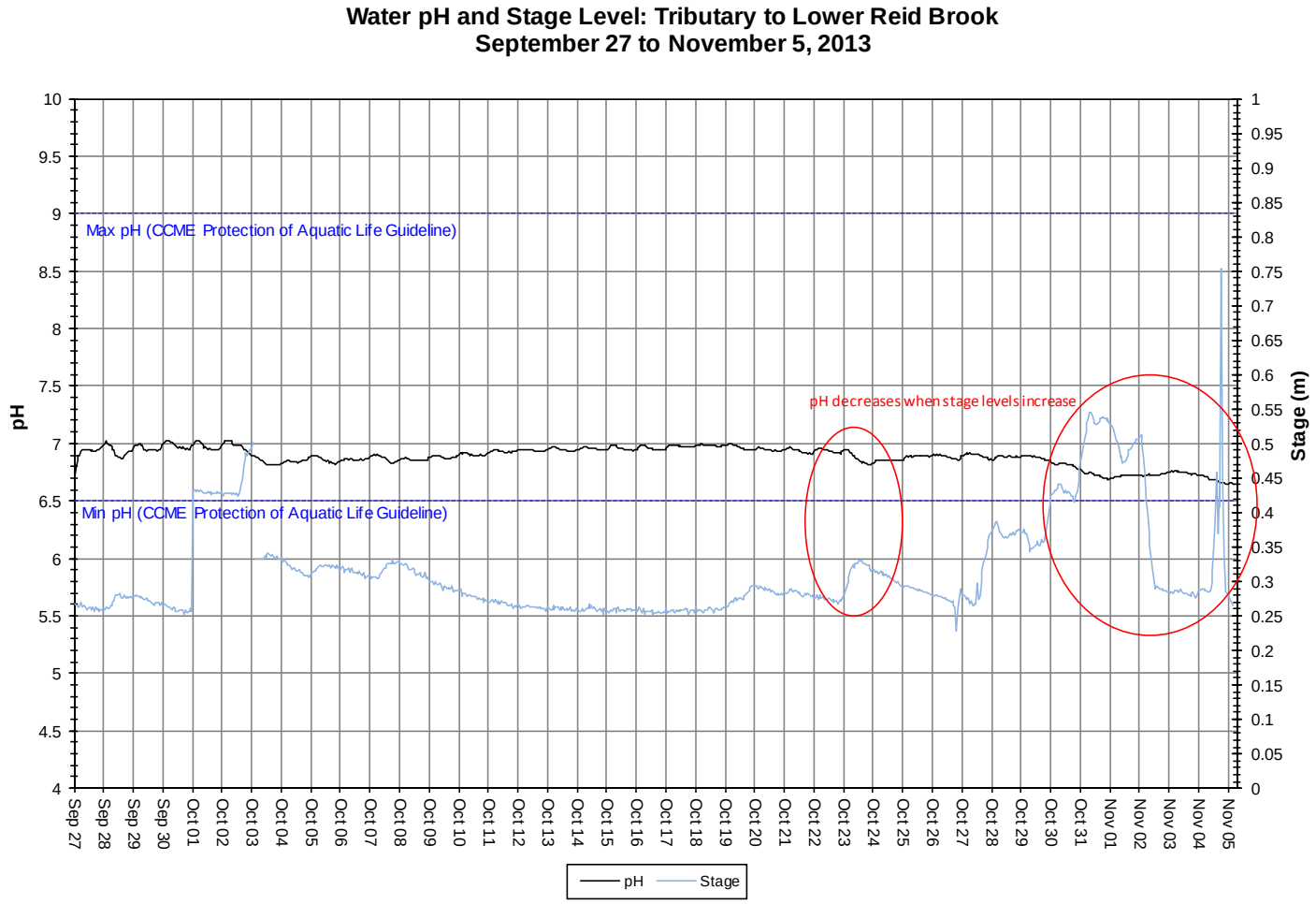


Figure 17: pH and stage level at Tributary to Lower Reid Brook

- Specific conductivity ranges between 38.8µS/cm and 56.6µS/cm during the deployment period, averaging 45.6µS/cm (Figure 18).
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Specific conductivity changes with the varying water level. As stage decreases, specific conductivity generally increases due to the increase in concentration of dissolved solids in the water column. Inversely, as stage increases, specific conductivity decreases as the concentration of dissolved solids is diluted.
- This trend is not clear with the values collected from this station during the deployment period. Instead, there is a positive relationship between specific conductivity and stage level. As stage level goes up, specific conductivity also increases. This trend is highlighted in red on Figure 18.

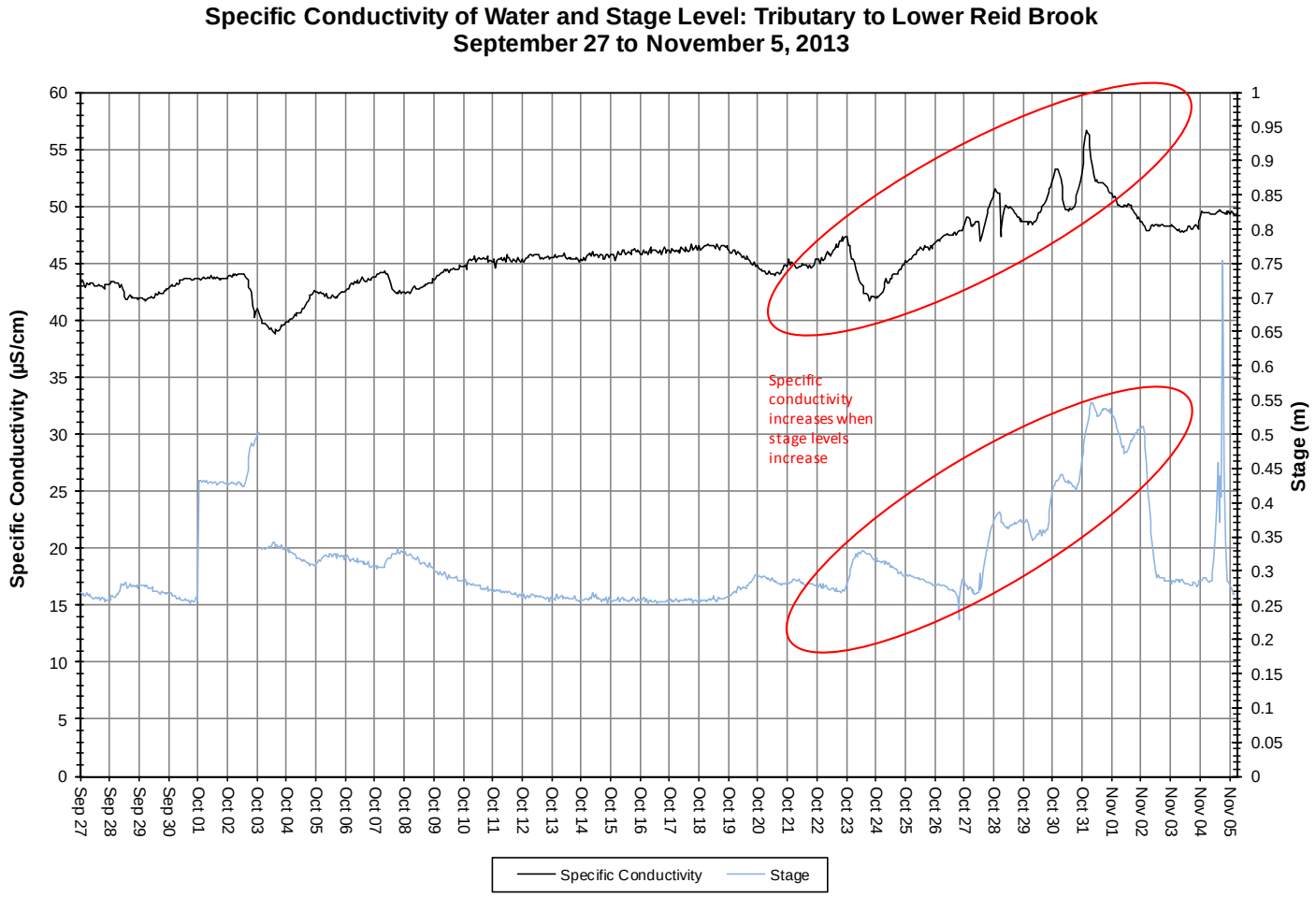


Figure 18: Specific conductivity and stage level at Tributary to Lower Reid Brook

- Dissolved oxygen content ranges between 10.79mg/l and 13.96mg/l. The saturation of dissolved oxygen ranges from 89.8% to 98.1% (Figure 19).
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 16).
- All values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l). The guidelines are indicated in blue on Figure 19. Average dissolved oxygen value is 12.57mg/l.

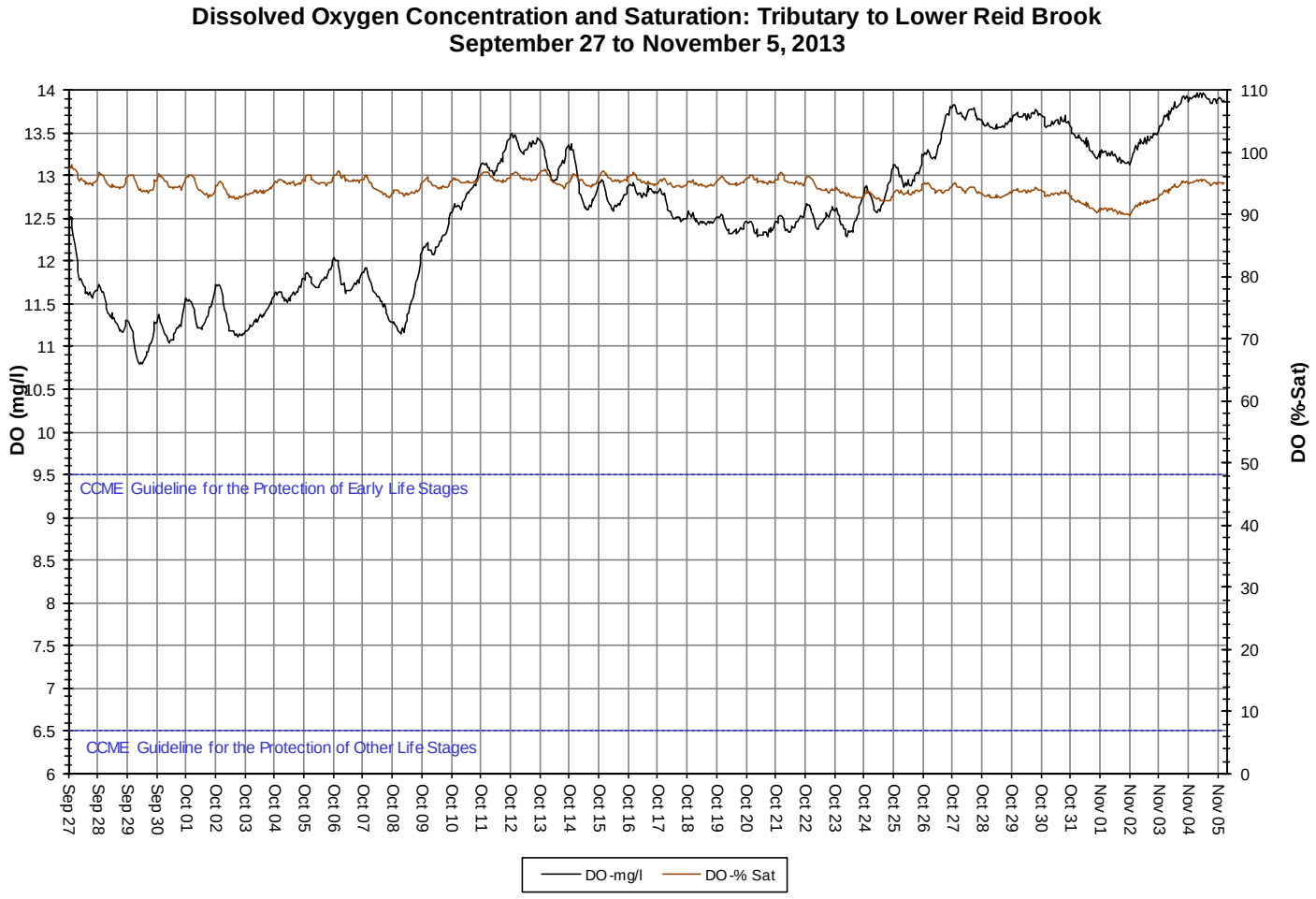


Figure 19: Dissolved oxygen and percent saturation at Tributary to Lower Reid Brook

- Turbidity ranges between 0NTU and 22.3NTU from September 27 to October 9 (Figure 20). A median value of 0NTU indicates there is no natural background turbidity value for this deployment period.
- Turbidity begins to increase above background levels (0NTU) on October 10. This data has been deemed invalid and have been removed from the data set. The sensor is likely to have been affected by sand or silt around the sensor window.

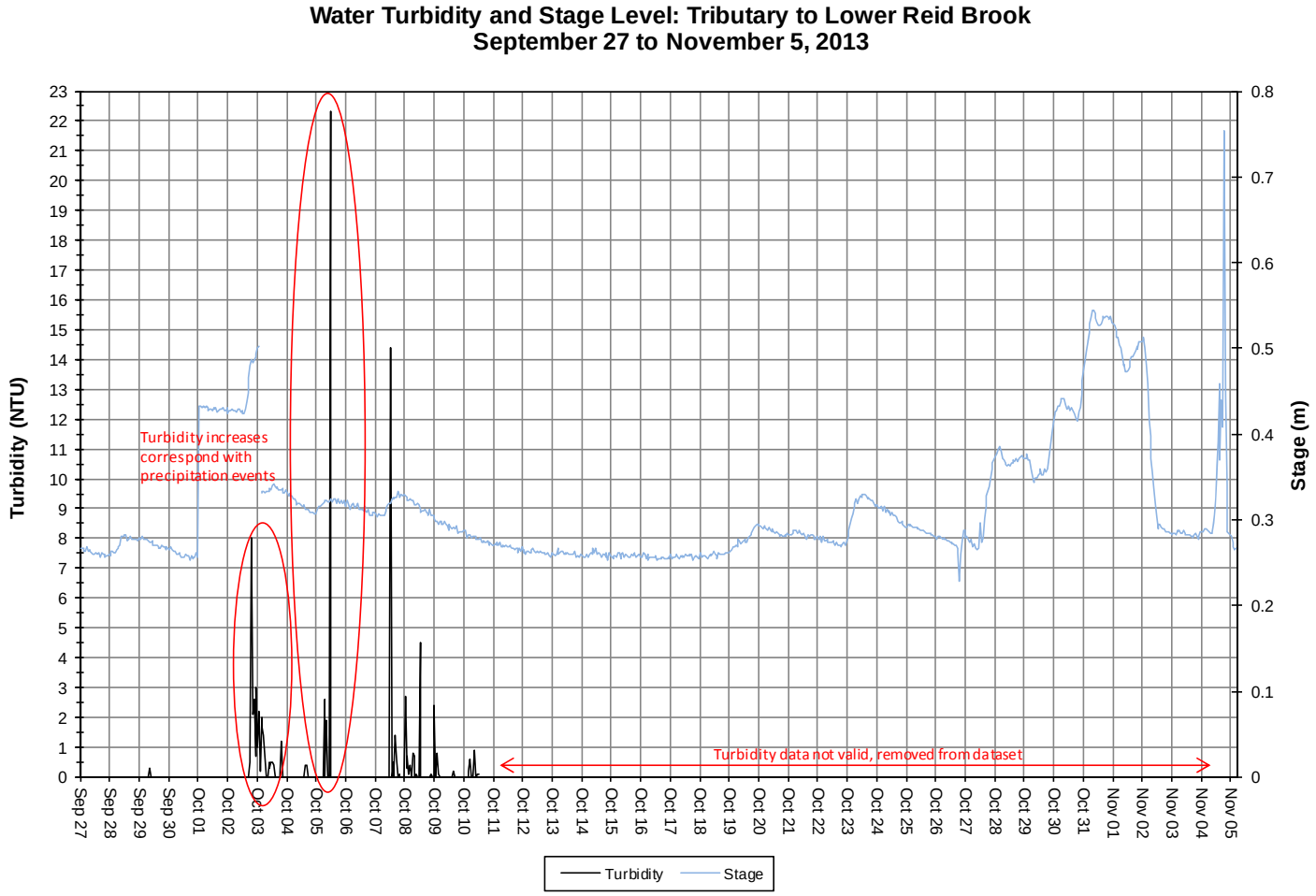


Figure 20: Turbidity and stage level at Tributary to Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is increasing and decreasing throughout the deployment period. Stage ranges from 0.23m to 0.35m, a difference of 0.12m.
- Precipitation events occur about 50% of the time and are low in magnitude.

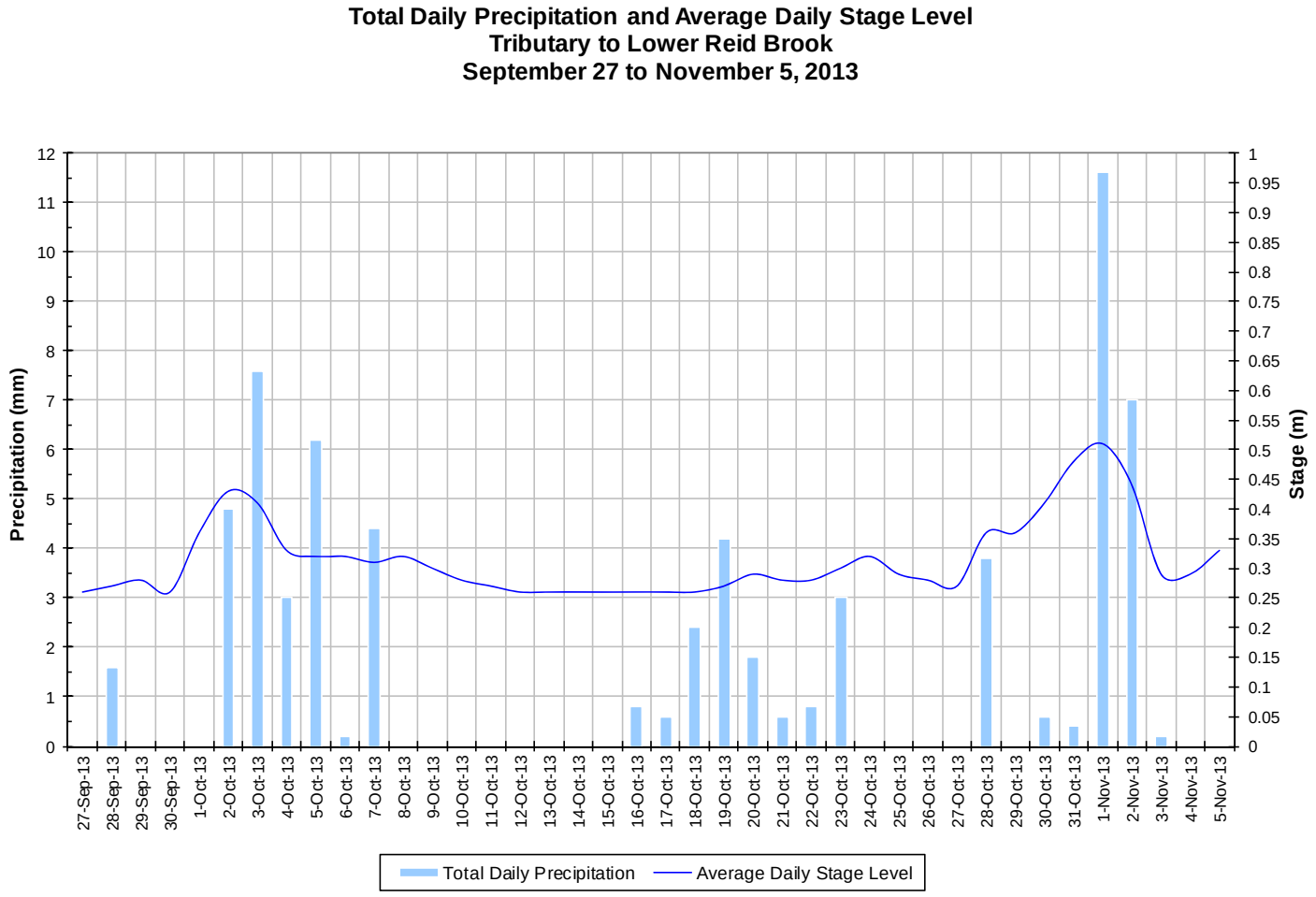


Figure 21: Daily precipitation and average daily stage at Tributary to Lower Reid Brook (weather data recorded at Nain)

Lower Reid Brook

- Water temperature ranges from 0.19°C to 10.33°C during the deployment period (Figure 22).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall season (Figure 23). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- On October 28, water temperature reaches 0.0°C and remains near or at that temperature until the end of the deployment period.
- Average water temperature is 3.82°C for the deployment period.

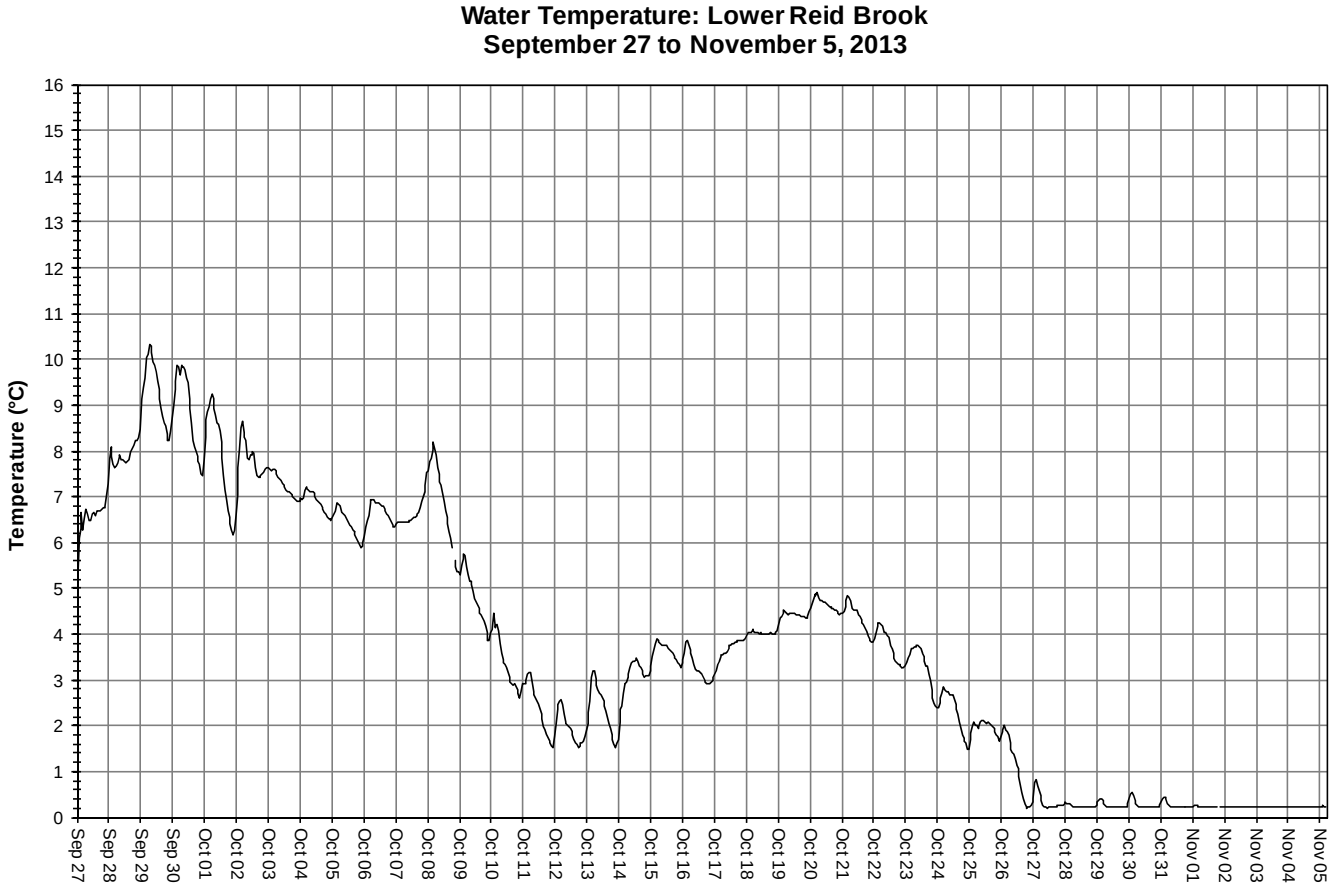


Figure 22: Water temperature at Lower Reid Brook

- Average daily air and water temperatures are decreasing throughout the deployment period (Figure 23). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

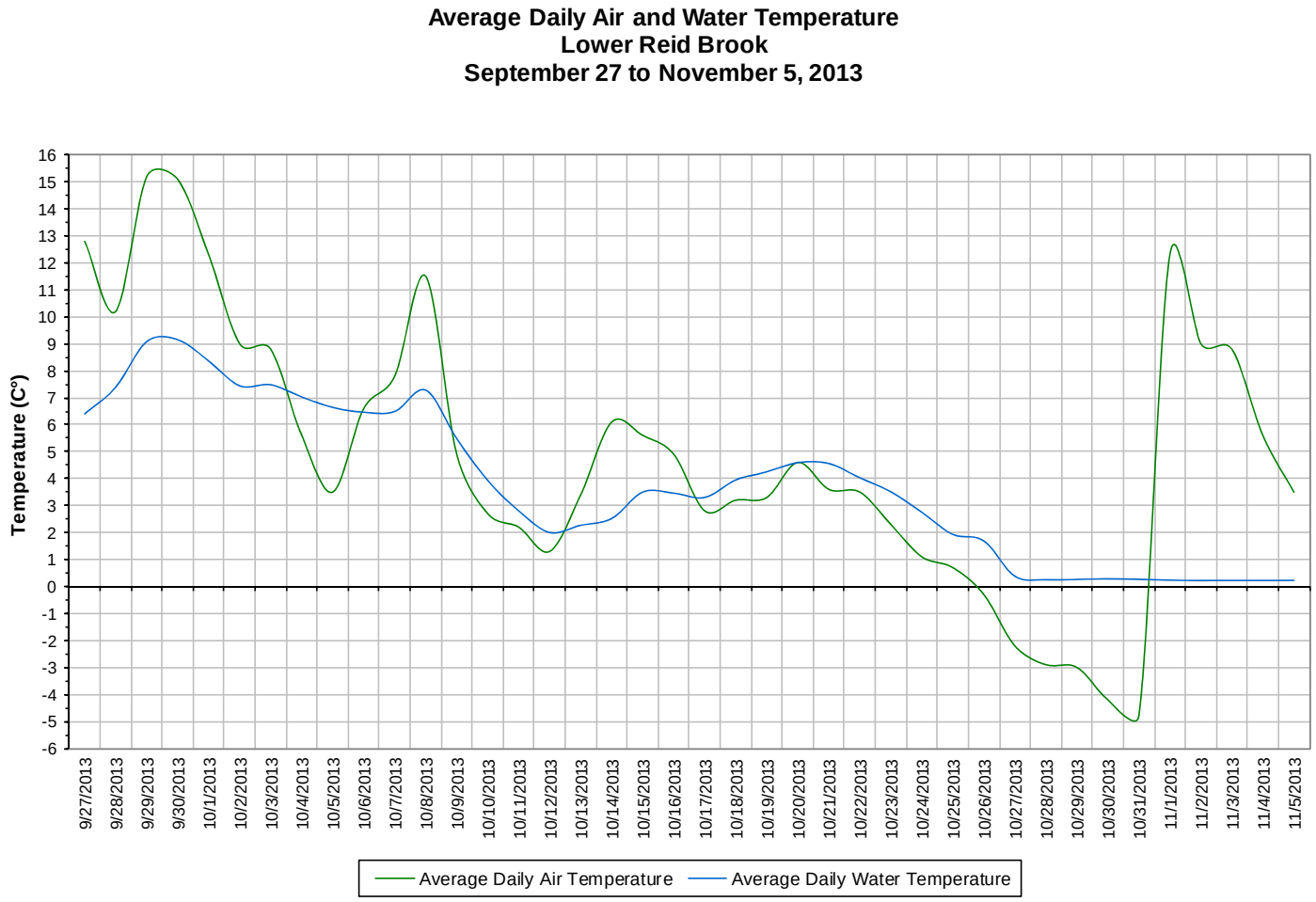


Figure 23: Average daily air and water temperatures at Lower Reid Brook

(weather data recorded at Nain)

- pH ranges between 6.88 and 7.24 pH units (Figure 24).
- pH is generally stable and fluctuates diurnally. pH decrease slightly on October 27 following an increase in stage. This event is highlighted in Figure 24.
- All values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). Guidelines are indicated in blue on Figure 24.

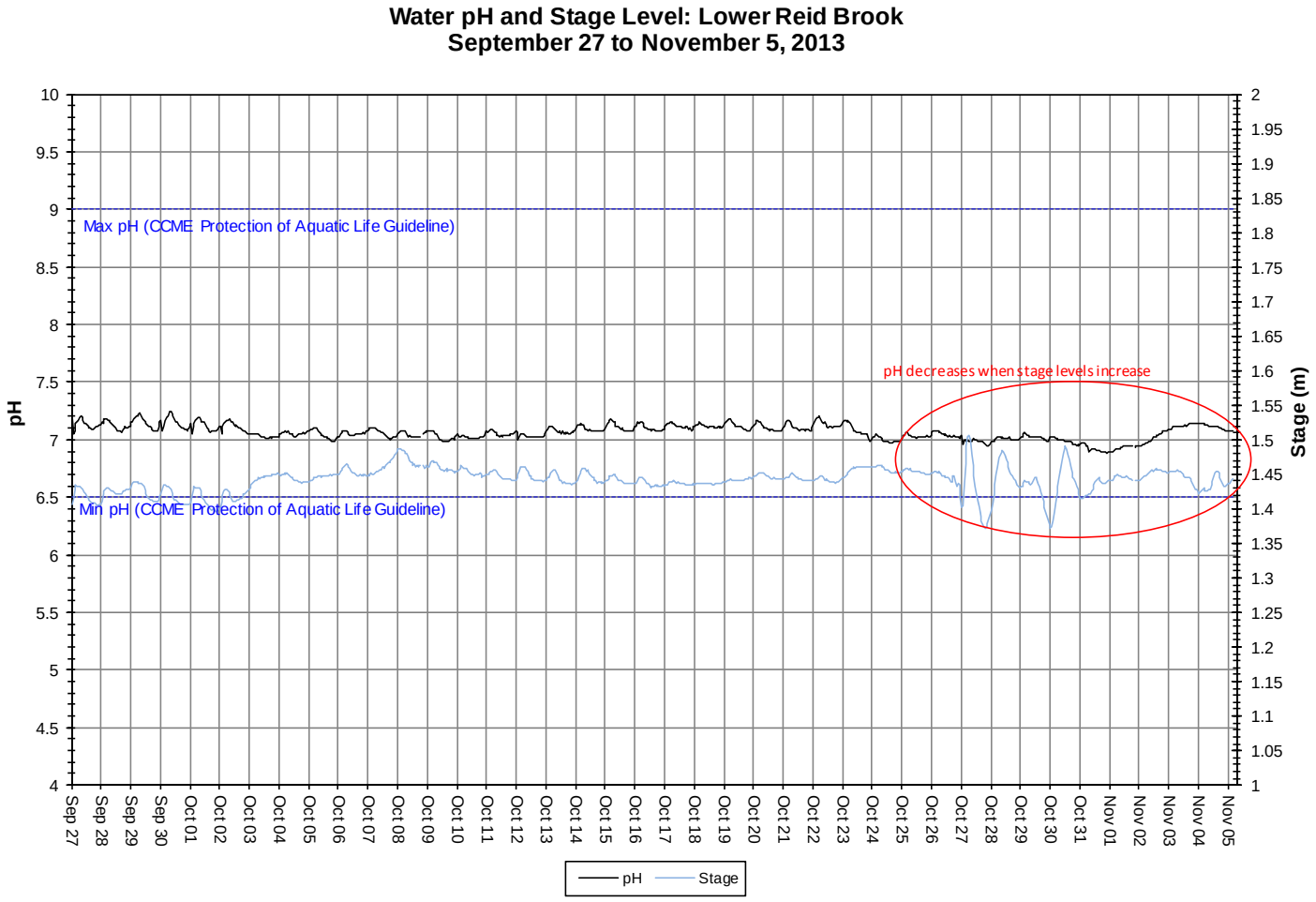


Figure 24: pH and stage level at Lower Reid Brook

- Specific conductivity ranges between 36.0µS/cm and 52.5µS/cm, averaging 41.4µS/cm (Figure 25).
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. As stage decreases, specific conductivity increases because of the increased concentration of dissolved solids. Inversely, as stage increases, specific conductivity decreases due to the dilution of dissolved solids in the water column.
- Near the end of the deployment period, there is some fluctuation in the stage levels which corresponds with increases and decreases in specific conductivity. This inverse relationship is highlighted in red on Figure 25.

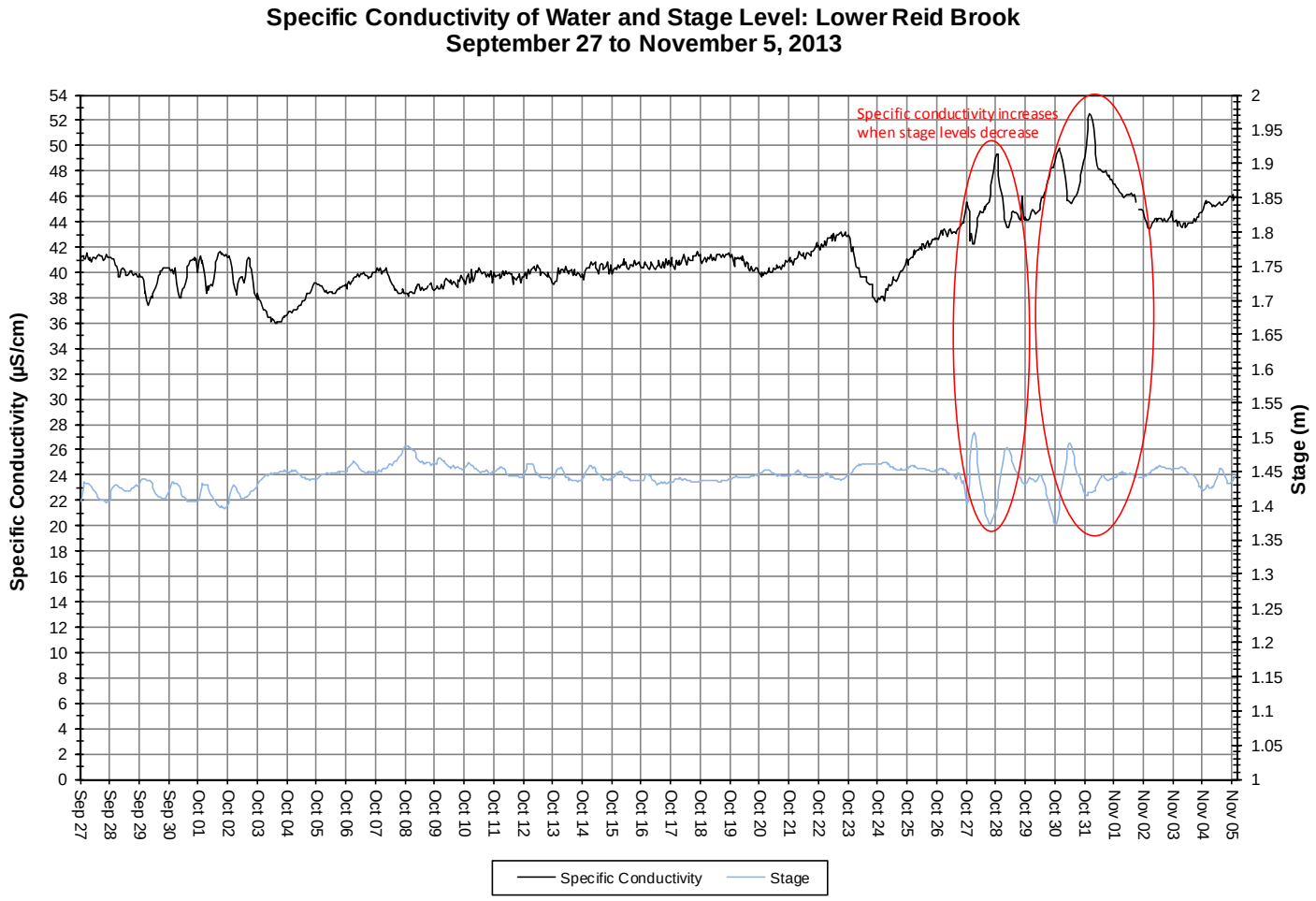


Figure 25: Specific conductivity and stage level at Lower Reid Brook

- Dissolved oxygen content ranges between 10.82mg/l and 13.89mg/l. The saturation of dissolved oxygen ranges from 89.7% to 101.2% (Figure 26).
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the decreasing air and water temperatures (Figure 23).
- All values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5 mg/l). The guidelines are indicated in blue on Figure 26. Average dissolved oxygen content is 12.57mg/l.

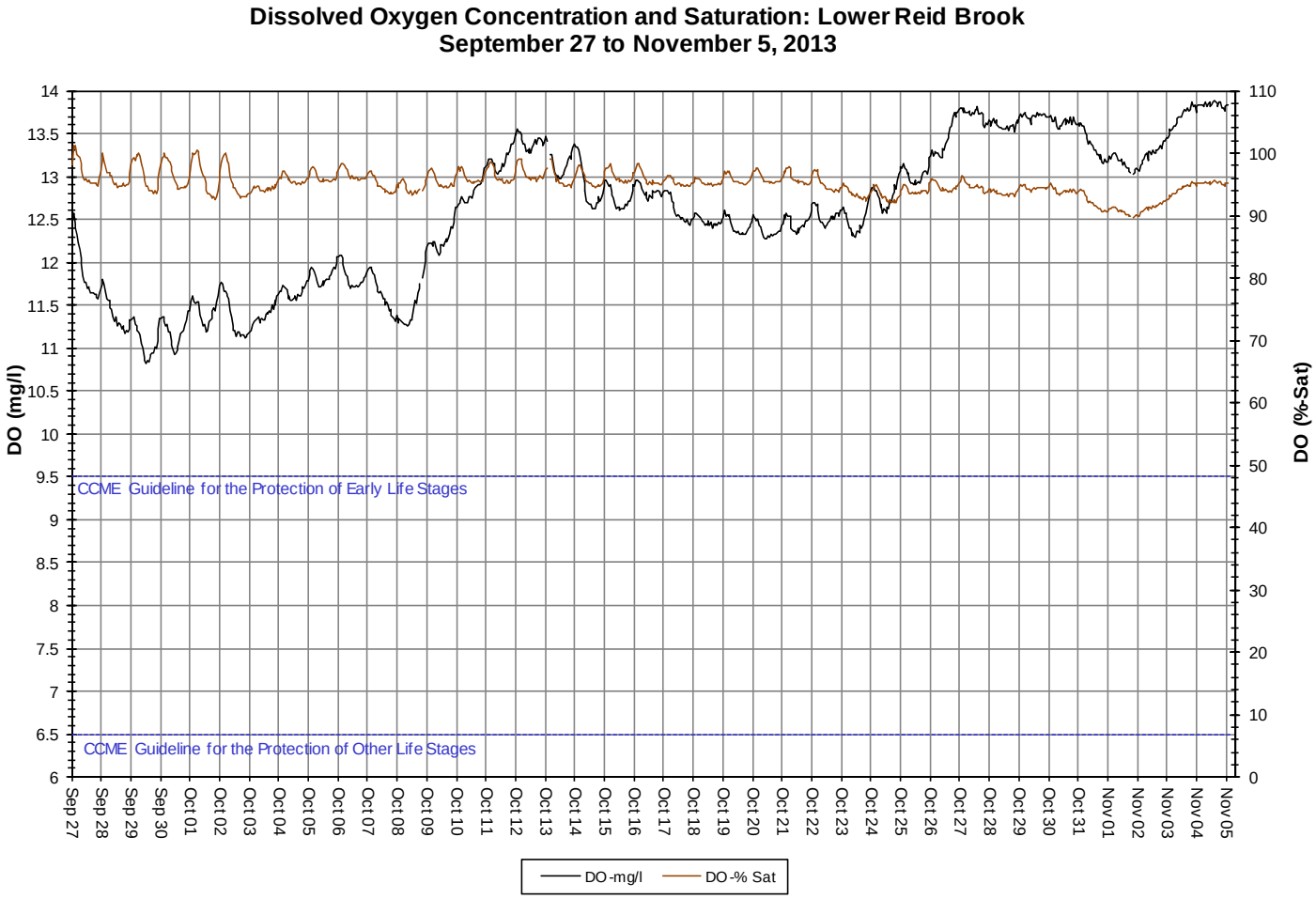


Figure 26: Dissolved oxygen and percent saturation at Lower Reid Brook

- Turbidity ranges between 0NTU and 259NTU throughout the deployment period (Figure 27). A median value of 0.0NTU indicates there is no natural background turbidity data for this deployment period.
- Turbidity events at low magnitudes are normal for this station. There are very few turbidity increases captured during the deployment period, all of which only last 1-2 hours. There is one increase up to 259NTU however this increase is also short-lived and should not be considered significant.

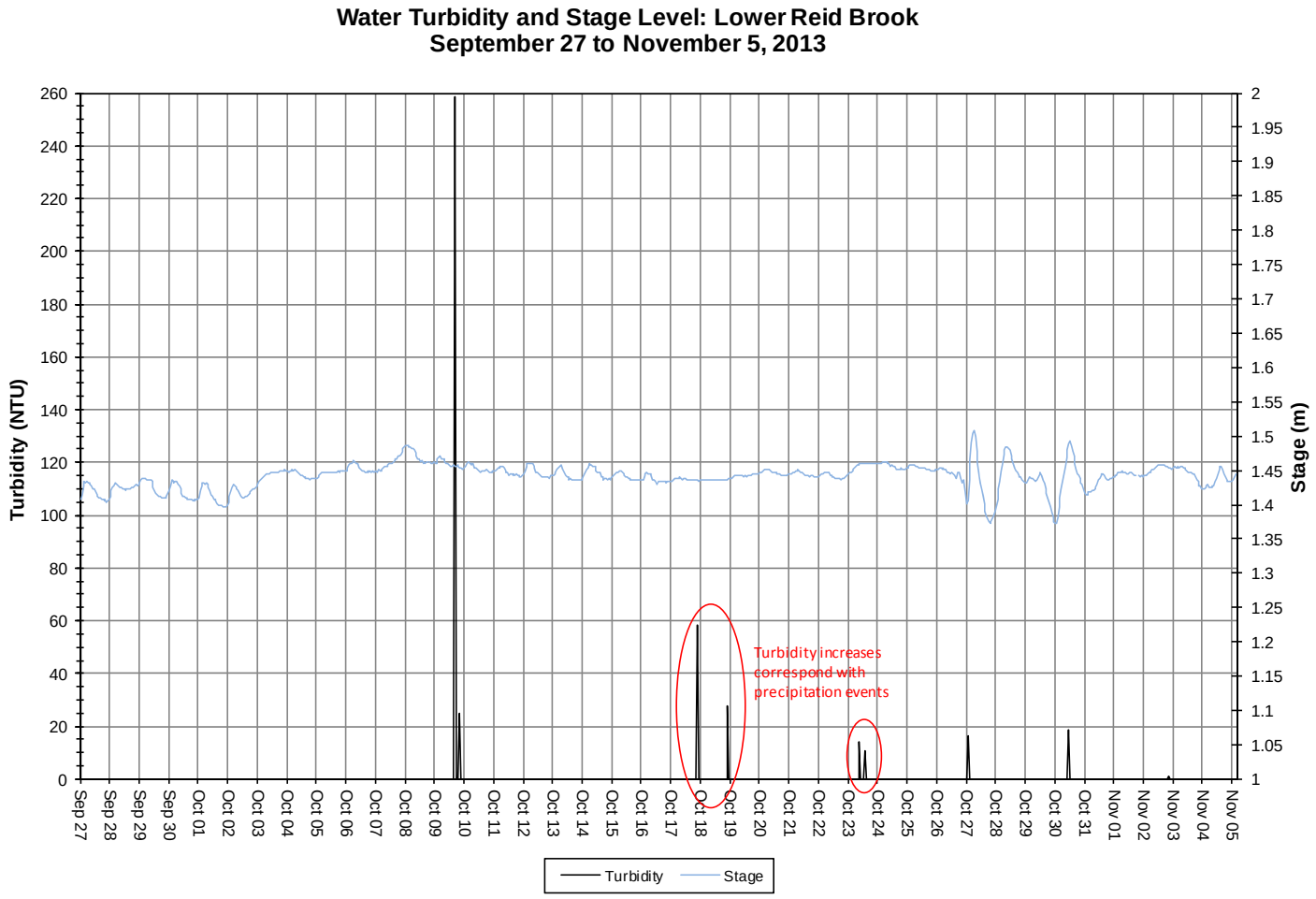


Figure 27: Turbidity and stage level at Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and stage level (Figure 28). Stage is very stable at this station throughout the deployment period. Stage ranges from 1.37 to 1.51m, a difference of 0.14m.
- Precipitation events occur about 50% of the time and are low in magnitude.

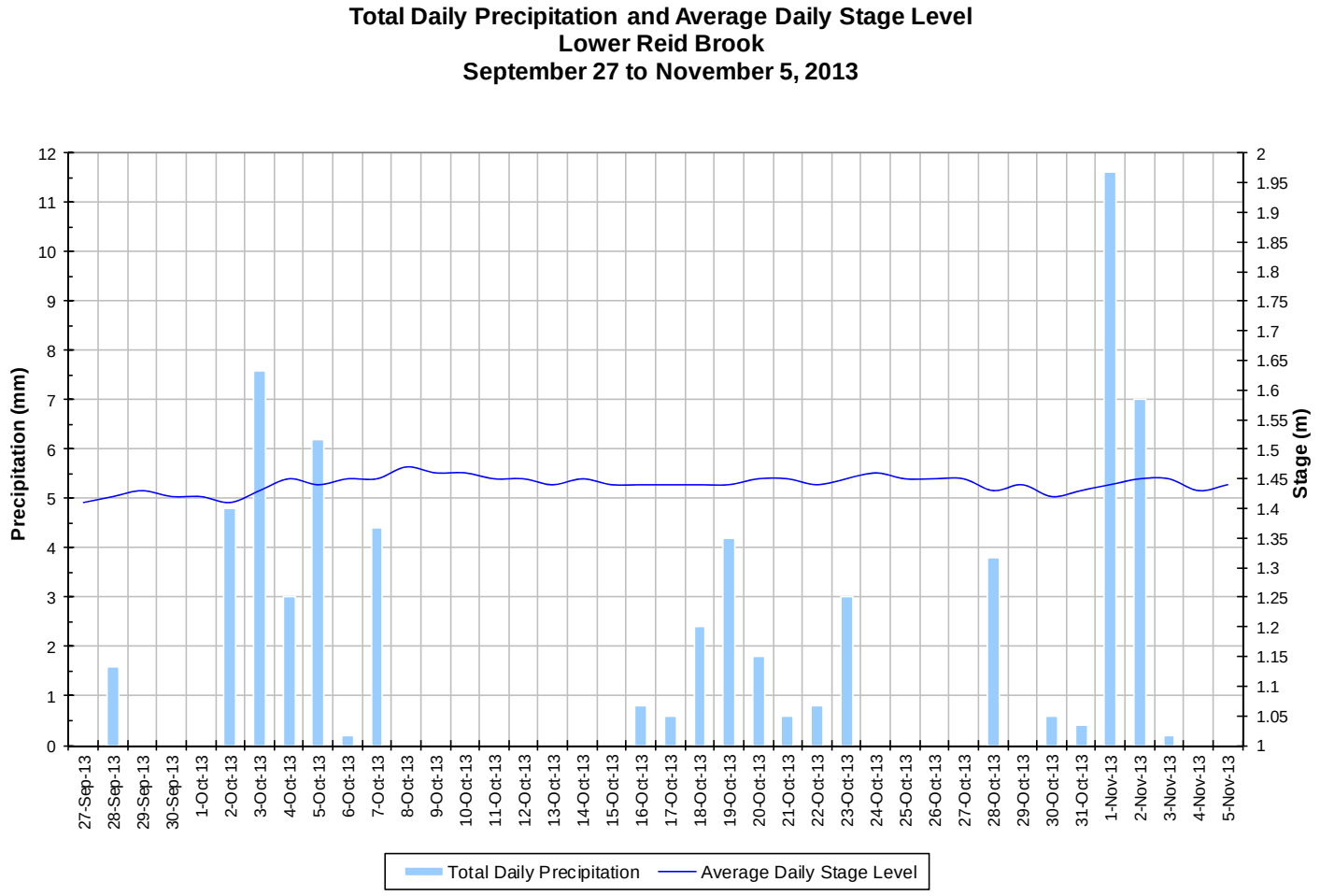


Figure 28: Daily precipitation and average daily stage level at Lower Reid Brook (weather data recorded at Nain)

Conclusions

- Instruments at water quality monitoring stations in the Voisey's Bay Network were deployed from September 27 to November 7, 2013.

Summary by Station

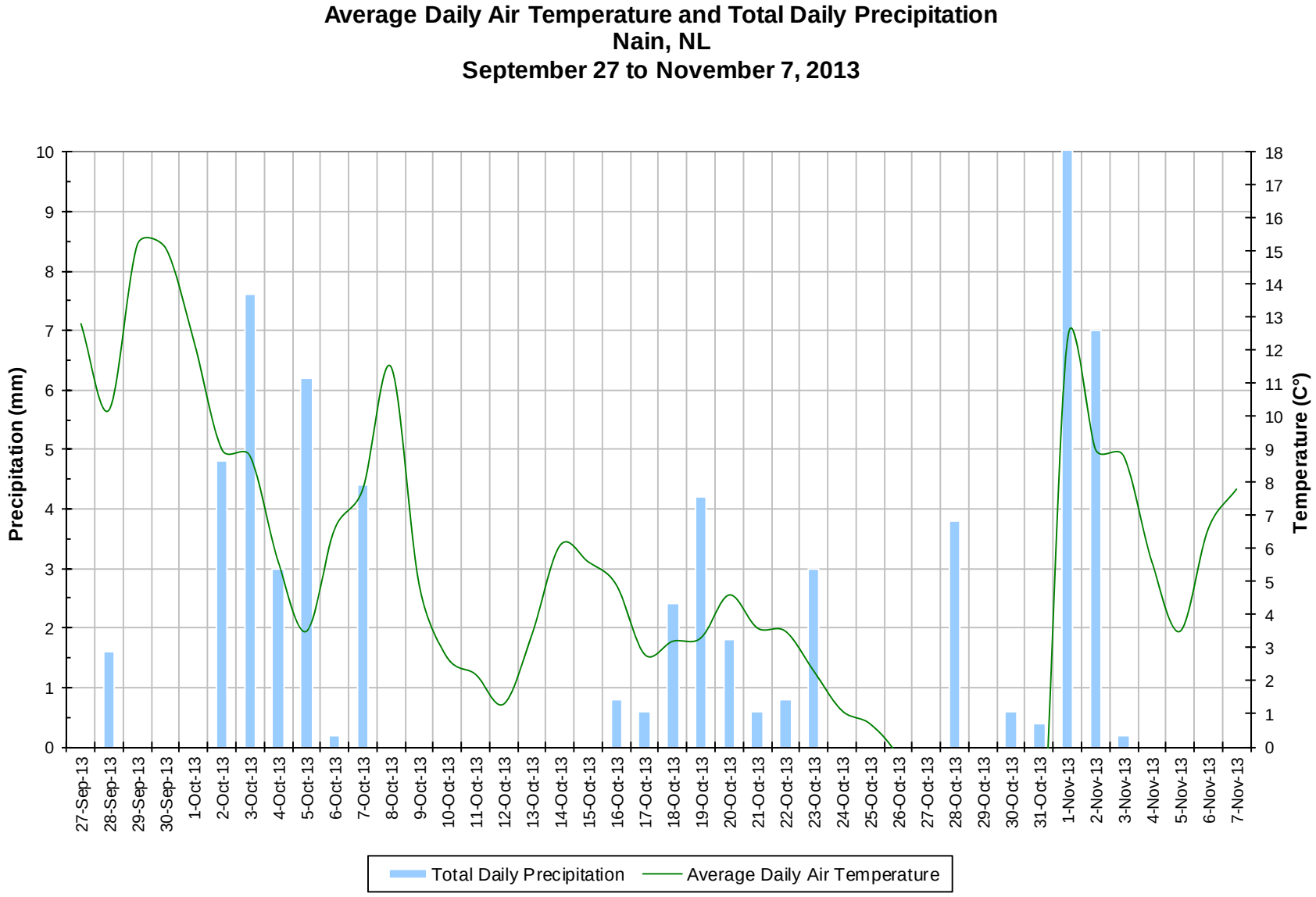
- At Upper Reid Brook, water temperature decreased slightly while dissolved oxygen increased slightly throughout the deployment period. Specific conductivity was low and very stable which is normal for this station. pH values were neutral and consistent for the majority of the deployment period before decreasing slightly in the final week. Turbidity remained at 0NTU. Stage levels increased slightly throughout the deployment period.
- At Camp Pond Brook, water temperature decreased to 0°C on November 4 and dissolved oxygen increased throughout the deployment period. pH was neutral and consistent until near the end of the deployment period when there was a decrease in pH which corresponded with an increase in stage. Specific conductivity decreased following increases in stage level. Turbidity events were infrequent and low in magnitude.
- At Tributary to Lower Reid Brook, water temperature decreased to 0°C on October 27 while dissolved oxygen increased. pH values were generally neutral and stable with the exception of decreases that took place following an increase in stage level near the end of the deployment period. Specific conductivity increases near the end of the deployment period following increase in stage. Turbidity data was removed from the data set for the majority of the deployment period due to sensor failure after the first week.
- At Lower Reid Brook, water temperature decreased and dissolved oxygen increased. pH values were neutral and consistent throughout the most of the deployment period. pH and specific conductivity decreased following an increase in stage level. Turbidity events were minimal and short lived.

Summary by Parameter

- Temperature averaged between 3.56°C (Tributary to Lower Reid) and 6.77°C (Upper Reid) at the 4 stations in the Voisey's Bay Network. Water temperature was decreasing at all stations and fluctuated throughout the deployment period depending on the weather conditions. The stations on Camp Pond Brook, Tributary to Lower Reid Brook and Lower Reid Brook are more sensitive to changes in the ambient air temperatures. These three stations also leveled out at 0°C near the end of the deployment period.
- pH values ranged between 6.65 (Tributary) and 7.24 (Lower Reid) pH units across the network. At Camp Pond Brook, Tributary to Lower Reid Brook and Lower Reid Brook, pH values decreased following stage level increase in the final week of the deployment period. All values recorded at all stations were within the recommended range as suggested by the CCME Guideline for the Protection of Aquatic Life.
- At Tributary to Lower Reid Brook, Lower Reid Brook and Camp Pond Brook stations, specific conductivity averaged between 39.7µS/cm (Camp Pond) and 45.6µS/cm (Tributary to Lower Reid). Values at Upper Reid Brook were considerably lower averaging 11.9µS/cm. These lower values are expected from this pristine station at the outflow from Reid Pond. At Camp Pond Brook and Lower Reid Brook stations, specific conductivity displayed an inverse relationship with stage level at the end of the deployment period. At Tributary to Lower Reid, specific conductivity displayed a positive relationship to stage level.

- Dissolved oxygen levels averaged between 11.41mg/l (Upper Reid) and 12.57mg/l (Tributary to Lower Reid and Lower Reid). All values recorded at all stations were above the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l). Dissolved oxygen content was increasing at all stations which is expected given the seasonably cooling air and water temperatures. Dissolved oxygen content at Upper Reid Brook is more stable due to the lake from which the water flows.
- Median turbidity values are 0NTU at all stations indicating there is generally no background turbidity in these streams. There were minimal turbidity events at relatively low magnitudes at the stations at Upper Reid Brook, Camp Pond Brook and Lower Reid Brook. Some of the events correspond with precipitation Turbidity data at the station on the Tributary to Lower Reid Brook was removed from the dataset following sensor malfunction one week into the deployment period.

Appendix 1: Weather Data – Environment Canada Historical Climate Database



Appendix 2: Grab Sample Results: Report of Analysis – Exova Accutest

2013-6343-00-SI-SP, Camp Pond Brook

2013-6348-00-SI-SP, Tributary to Lower Reid Brook

2013-6349-00-SI-SP, Lower Reid Brook

2013-6350-00-SI-SP, Upper Reid Brook

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1062809	WS-S-0000 Camp Pond Brk	2013-6343-00-SI-SP	2013-09-27

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis. Holding time for DOC analysis was exceeded for the entire report.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	13
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	2
Colour	TCU	2	18
Conductivity	uS/cm	5	43
Dissolved Organic Carbon	mg/L	0.5	3.4
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	14
N-NH3 (Ammonia)	mg/L	0.02	0.03
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.61
Sulphate	mg/L	3	6
Total Dissolved Solids (COND - CALC)	mg/L	1	28
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	4.5
Total Phosphorus	mg/L	0.01	0.02
Turbidity	NTU	0.1	0.6
Aluminum	mg/L	0.01	0.06
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	4
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1062809	WS-S-0000 Camp Pond Brk	2013-6343-00-SI-SP	2013-09-27	Copper	mg/L	0.001	0.002
				Iron	mg/L	0.03	0.28
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	1
				Manganese	mg/L	0.01	0.02
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.015
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	3
				Strontium	mg/L	0.001	0.019
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis. Holding time for DOC analysis was exceeded for the entire report.

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1062810	WS-S-0000 Tributary 1	2013-6348-00-SI-SP	2013-09-27

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	13
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	3
Colour	TCU	2	29
Conductivity	uS/cm	5	45
Dissolved Organic Carbon	mg/L	0.5	3.9
Fluoride	mg/L	0.10	0.13
Hardness as CaCO3	mg/L	1	14
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.67
Sulphate	mg/L	3	5
Total Dissolved Solids (COND - CALC)	mg/L	1	29
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	4.1
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	0.8
Aluminum	mg/L	0.01	0.06
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	4
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1062810	WS-S-0000 Tributary 1	2013-6348-00-SI-SP	2013-09-27	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.47
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	1
				Manganese	mg/L	0.01	0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.007
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	3
				Strontium	mg/L	0.001	0.023
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1062811	WS-S-0000 LWR. Reid Brk	2013-6349-00-SI-SP	2013-09-27

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	14
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	3
Colour	TCU	2	24
Conductivity	uS/cm	5	43
Dissolved Organic Carbon	mg/L	0.5	4.3
Fluoride	mg/L	0.10	0.13
Hardness as CaCO3	mg/L	1	14
N-NH3 (Ammonia)	mg/L	0.02	0.04
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.67
Sulphate	mg/L	3	4
Total Dissolved Solids (COND - CALC)	mg/L	1	28
Total Kjeldahl Nitrogen	mg/L	0.10	0.19
Total Organic Carbon	mg/L	0.5	6.6
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	0.8
Aluminum	mg/L	0.01	0.07
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	4
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1062811	WS-S-0000 LWR. Reid Brk	2013-6349-00-SI-SP	2013-09-27	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.67
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	1
				Manganese	mg/L	0.01	0.02
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.006
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	3
				Strontium	mg/L	0.001	0.021
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	2

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1062812	WS-S-0000 Upper Reid Brook	2013-6350-00-SI-SP	2013-09-27

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	7
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	<1
Colour	TCU	2	8
Conductivity	uS/cm	5	16
Dissolved Organic Carbon	mg/L	0.5	1.8
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	2
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.45
Sulphate	mg/L	3	<3
Total Dissolved Solids (COND - CALC)	mg/L	1	10
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	2.6
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	0.2
Aluminum	mg/L	0.01	0.04
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	1
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics

REPORT OF ANALYSIS

Lab Report Number: **1321800**

Cient:	Department of Environment	**COC Number:**	1464
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-10-11
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-10-03
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1062812	WS-S-0000 Upper Reid Brook	2013-6350-00-SI-SP	2013-09-27	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	<0.03
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.005
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for turbidity analysis was exceeded. Sample was subcontracted for DOC and TOC analysis.

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Lorna Wilson
Laboratory Supervisor, Inorganics