Real-Time Water Quality Deployment Report

Voisey's Bay Network

June 13 to
July 15, 2013

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

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Contents

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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, Tributary to Lower Reid Brook, Lower Reid Brook and Camp Pond Brook.
- On June 13, 2013, Vale Environment employees deployed real-time water quality monitoring instruments at the four real time stations in the Voisey's Bay network for a period of 32 days. Instruments were removed by Vale Environment and Water Resources Management staff on July 15.

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 June 13 to July 15, 2013 are summarized in Table 2.

Table 2: Comparison rankings for Voisey's Bay Network stations, June 13– July 15, 2013

Station Voisey's Bay	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Upper Reid Brook (62884)	Jun 13, 2013	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Jul 15, 2013	Removal	Good	Good	Excellent	Good	Excellent
Camp Pond Brook (62885)	Jun 13, 2013	Deployment	Excellent	Marginal	Excellent	Excellent	Excellent
	Jul 15, 2013	Removal	Excellent	Fair	Excellent	Good	Excellent
Tributary to L. Reid B. (62886)	Jun 13, 2013	Deployment	Excellent	Fair	Excellent	Good	Excellent
	Jul 15, 2013	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Lower Reid Brook (62887)	Jun 13, 2013	Deployment	Excellent	Excellent	Excellent	Fair	Excellent
	Jul 15, 2013	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

- At the station at Upper Reid Brook, all parameters ranked either 'good' or 'excellent' at deployment and removal.
- At the station on Camp Pond Brook, temperature, specific conductivity, dissolved oxygen and turbidity ranked either 'good' or 'excellent' at deployment and removal while pH ranked 'marginal' and 'fair' at deployment and removal, respectively. At deployment, the field instrument read a value of 6.00 for pH while the QAQC instrument read a value of 5.17. The QAQC instrument value is lower than expected for this station and may be a result of insufficient time to stabilize in the environment. At removal, the field instrument read a value of 6.51 while the QAQC instrument read a value of 7.04. This time the QAQC value is higher than the reporting value for this station. pH data will be examined for any notable drifting trends.
- At the station on the Tributary to Lower Reid Brook, temperature, specific conductivity, dissolved oxygen and turbidity ranked either 'good' or 'excellent' at deployment while pH ranked 'fair'. For pH, the field instrument read a value of 6.03 and the QAQC instrument read a value of 5.50. Similarly to the station at Camp Pond Brook, the QAQC instrument value is lower than expected for this station and may be a result of insufficient time to stabilize in the environment. At removal, all parameters ranked 'excellent'.
- At the station on Lower Reid Brook, temperature, pH, specific conductivity, and turbidity ranked 'excellent' at deployment while dissolved oxygen ranked 'fair'. For dissolved oxygen, the field instrument read a value of 12.12mg/l and the QAQC instrument read a value of 12.74mg/l, a difference of 0.60mg/l. At the time of the first transmission, the field instrument reads a value of 12.65mg/l which when compared to the QAQC instrument yields a comparison ranking of 'excellent'. At removal, all parameters ranked 'excellent'.
- 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 June 13 to July 15 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 1.10 ^{o}C to 10.00^{o}C during the deployment period (Figure 1).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring and summer seasons (Figure 2).
- Water temperature fluctuates diurnally. Average water temperature is 4.14°C for the deployment period.

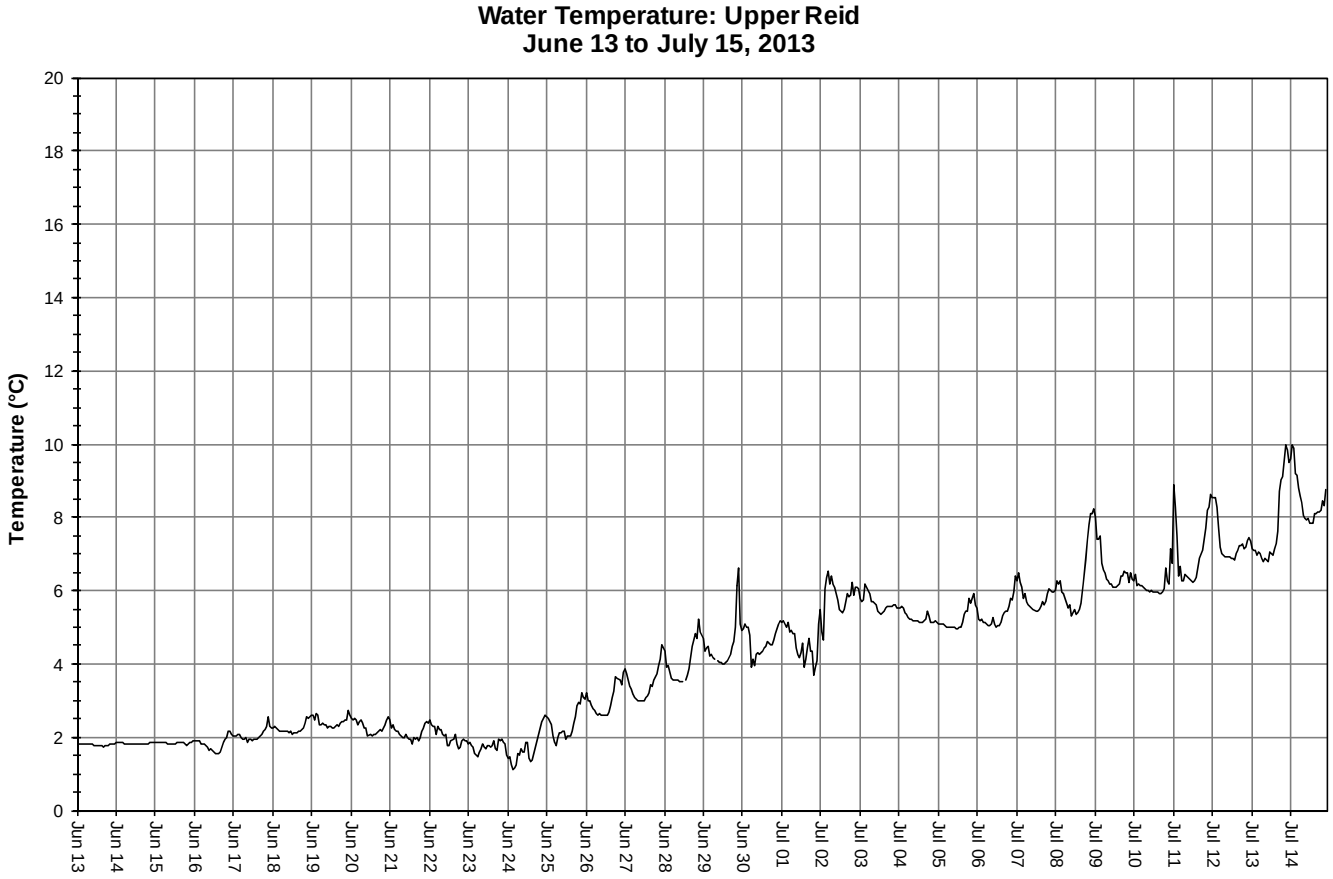


Figure 1: Water temperature at Upper Reid Brook

- Average daily air temperatures are fluctuating throughout the deployment period displaying a general increasing trend while average daily water temperatures increase consistently (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.

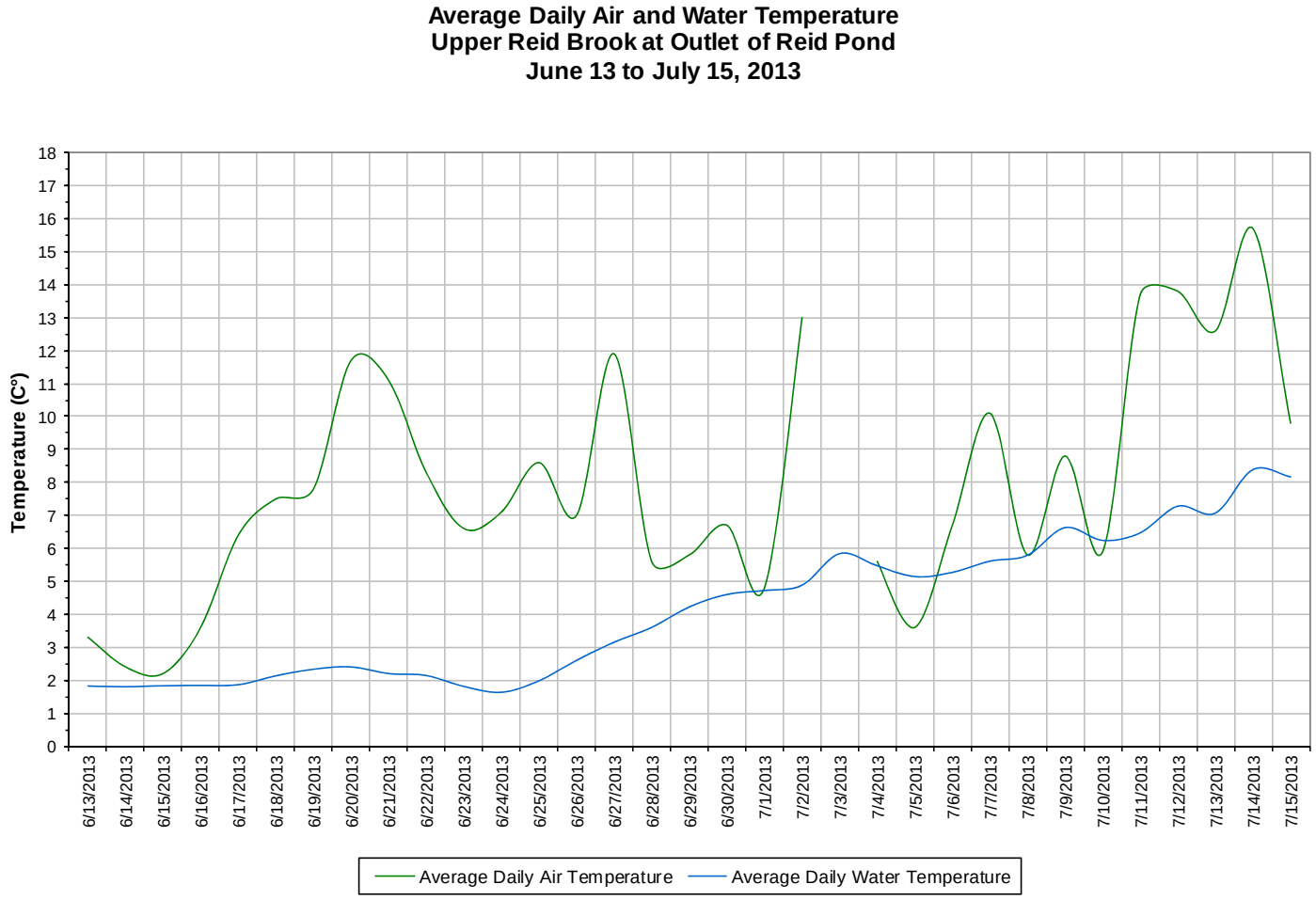


Figure 2: Average daily air and water temperatures at Upper Reid Brook

(weather data recorded at Nain)

- pH ranges between 6.41 and 6.82 pH units (Figure 3) and is increasing slightly throughout the deployment period.
- Most 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). At the beginning of the deployment period, pH levels are just below the minimum guideline value. Guidelines are indicated in blue on Figure 3.

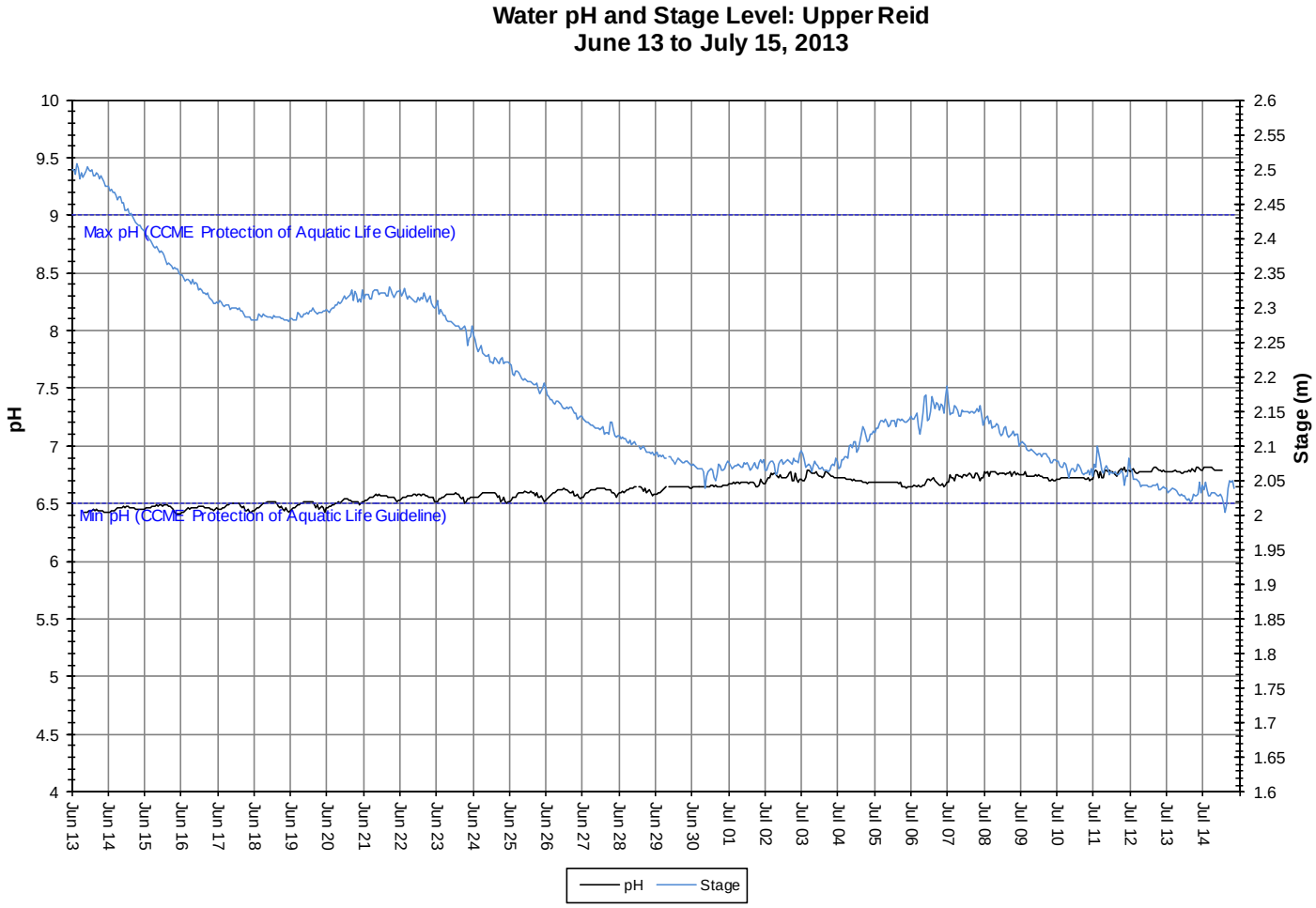


Figure 3: pH and stage level at Upper Reid Brook

- Specific conductivity values range from 10.2µS/cm to 11.9µS/cm during the deployment period (Figure 4).
- Specific conductivity remains very low and extremely stable throughout the deployment period regardless of the decreasing water level. This trend is expected as the flow from this station is directly from a stable lake environment.

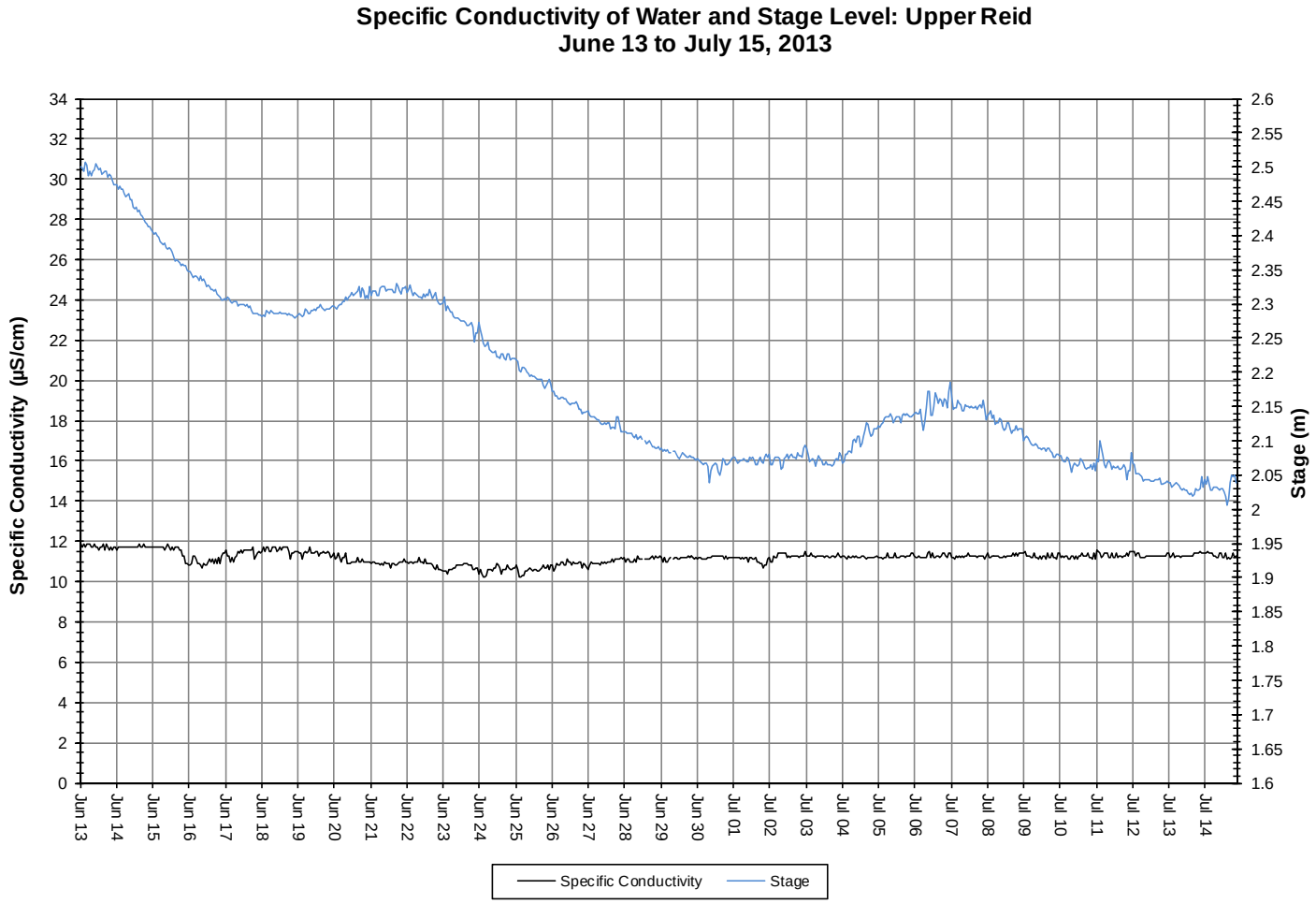


Figure 4: Specific conductivity and stage level at Upper Reid Brook

- Dissolved oxygen content ranges between 11.33mg/l and 12.65mg/l. The saturation of dissolved oxygen ranges from 87.3% to 102.8% (Figure 5).
- Dissolved oxygen content is decreasing slightly throughout the deployment period due to the increasing air and water temperatures (Figure 2). All values are well 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 12.30mg/l.

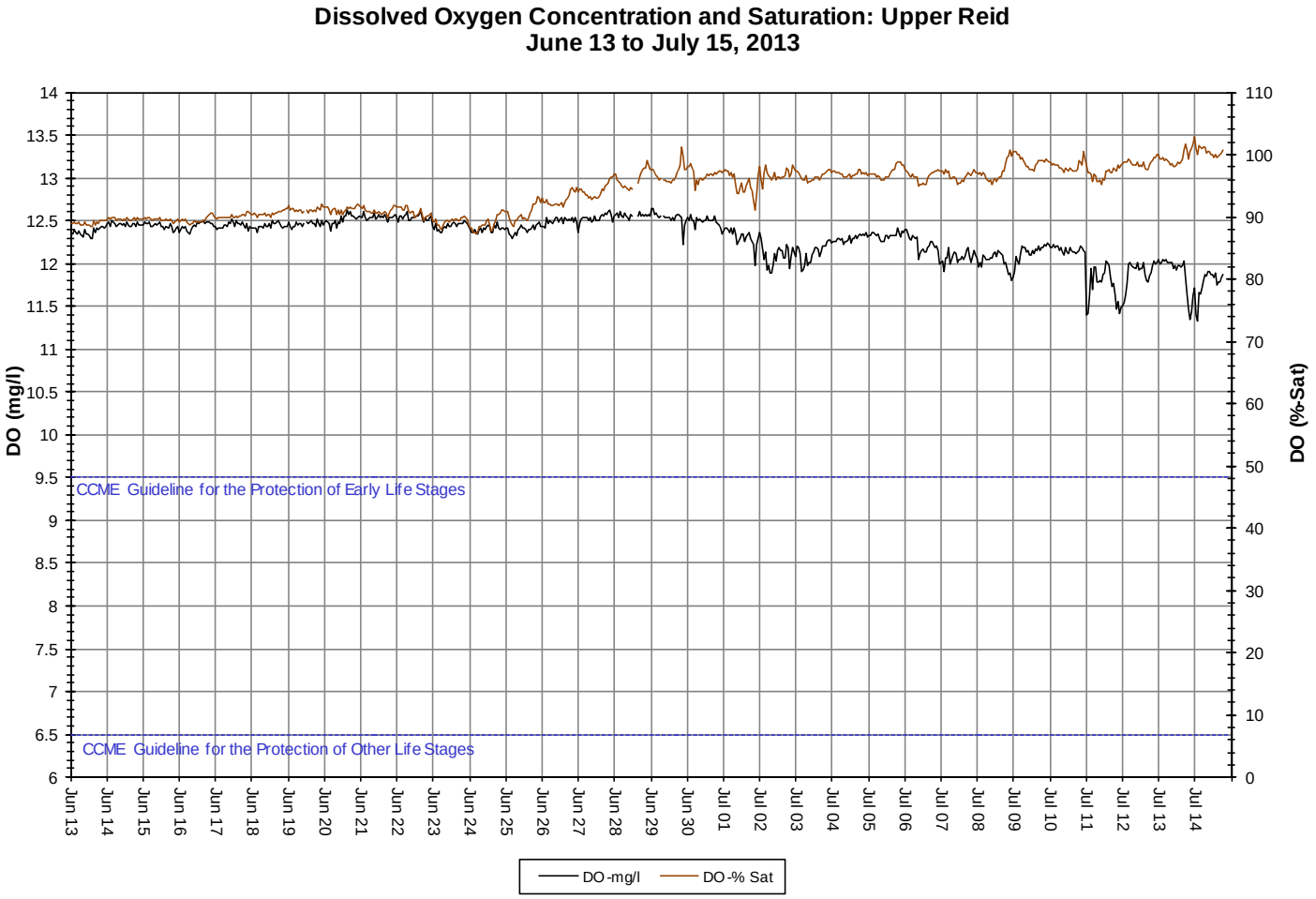


Figure 5: Dissolved oxygen and percent saturation at Upper Reid Brook

- Turbidity at this station remained at 0NTU for the entire deployment period except for two instances when turbidity reached 14.4NTU and 26.7NTU, each for a period of 1 hour (Figure 6). This trend is not unusual for this station as the water flowing from the lake is typically very clean, clear and cold.

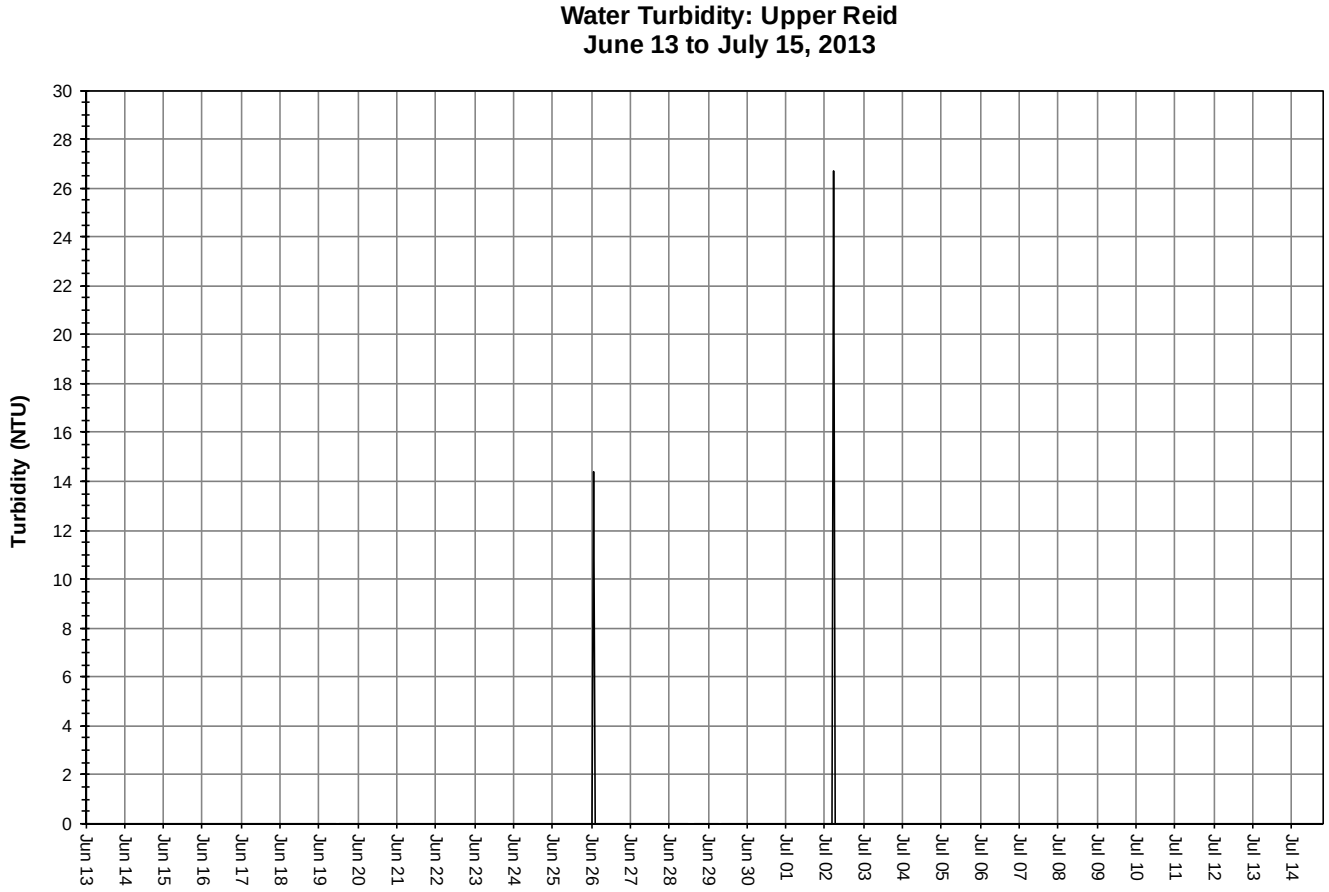


Figure 6: Turbidity at Upper Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is generally decreasing during the deployment period. Stage ranges from 2.01m to 2.51m, a difference of 0.50m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude.

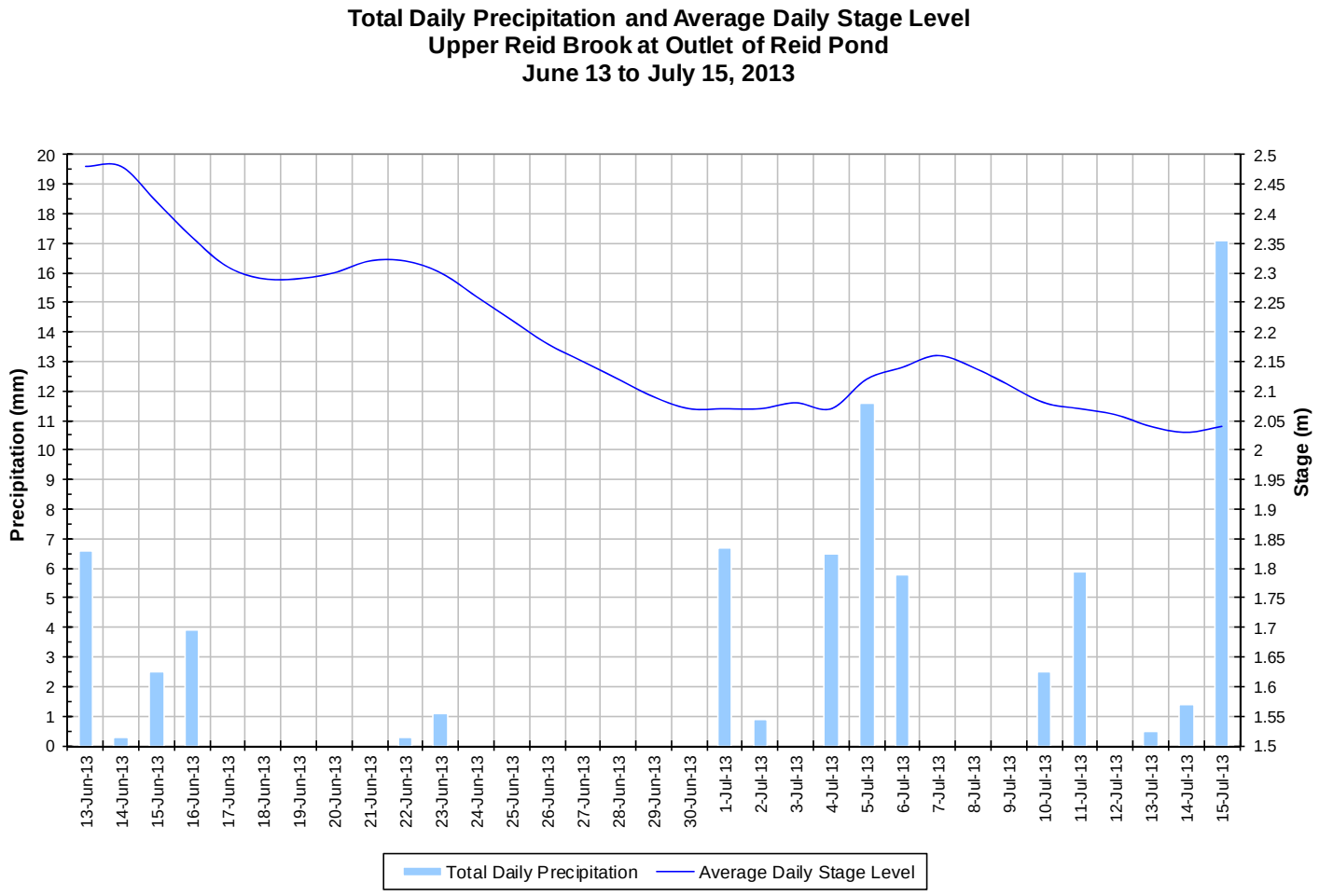


Figure 7: Daily precipitation and average daily stage level at Upper Reid Brook

(weather data recorded at Nain)

Camp Pond Brook

- Water temperature ranges from 4.20 °C to 18.28°C during the deployment period (Figure 8).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring and summer seasons (Figure 9).
- Water temperature fluctuates diurnally. Average water temperature is 10.83°C for the deployment period.
- This station typically has the highest water temperatures and greatest fluctuations when compared to the other stations in the network.

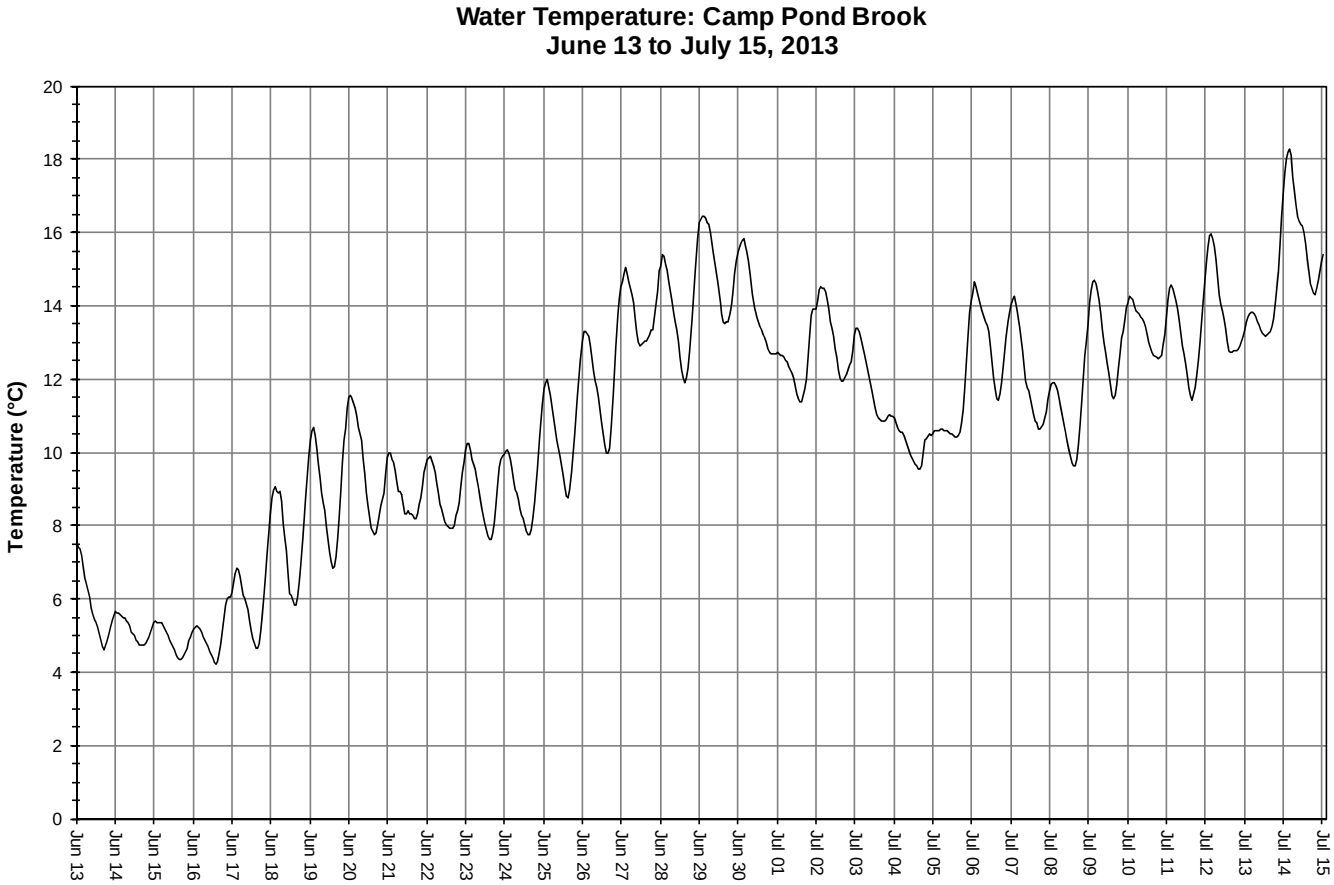


Figure 8: Water temperature at Camp Pond Brook

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

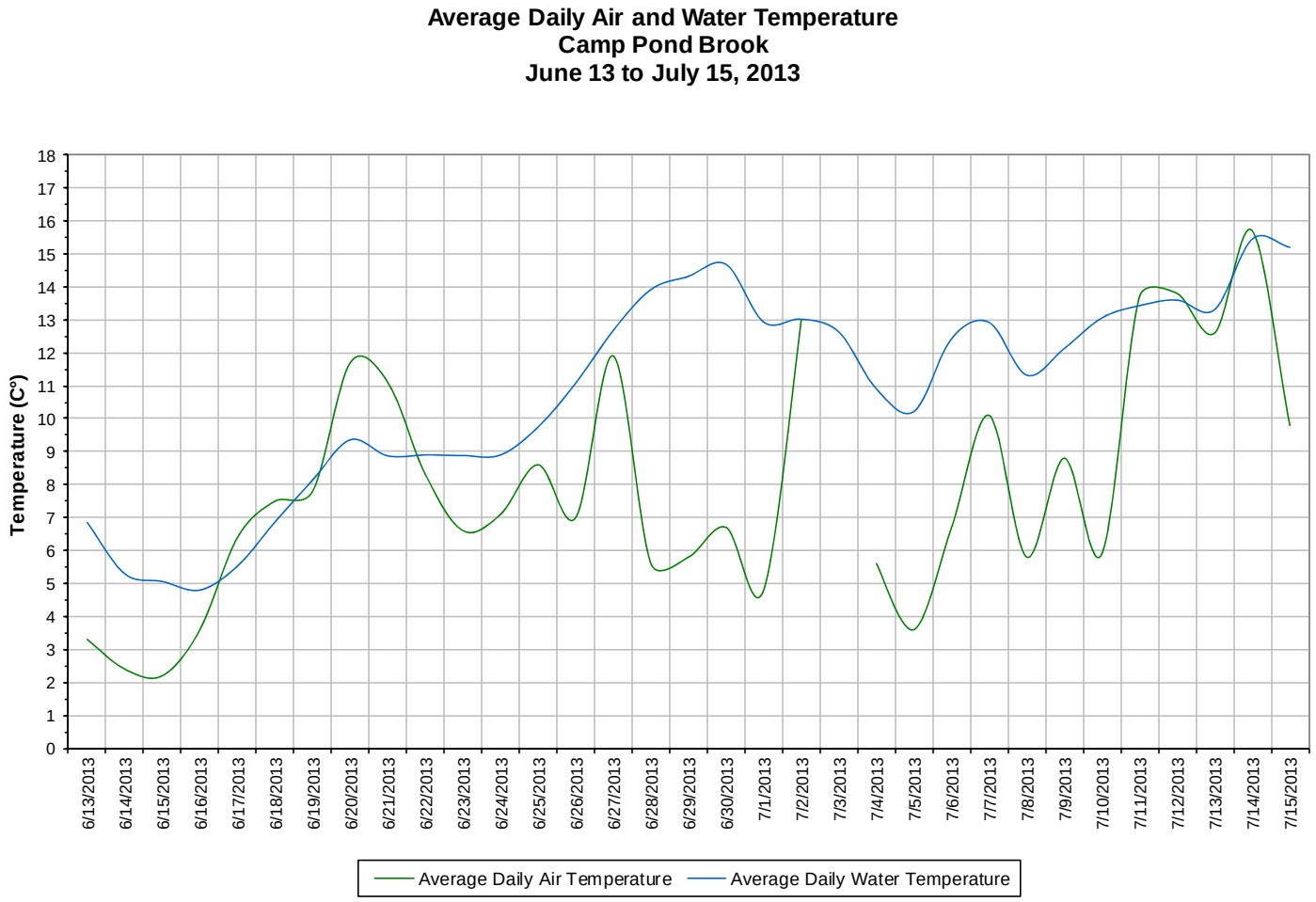


Figure 9: Average daily air and water temperatures at Camp Pond Brook

(weather data recorded at Nain)

- pH ranges between 6.20 and 6.71 pH units (Figure 10).
- pH values are increasing slightly at the beginning of the deployment period. Daily fluctuations are clearly visible around the last week of June and continue throughout the deployment period.
- Most values are within or just below 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.

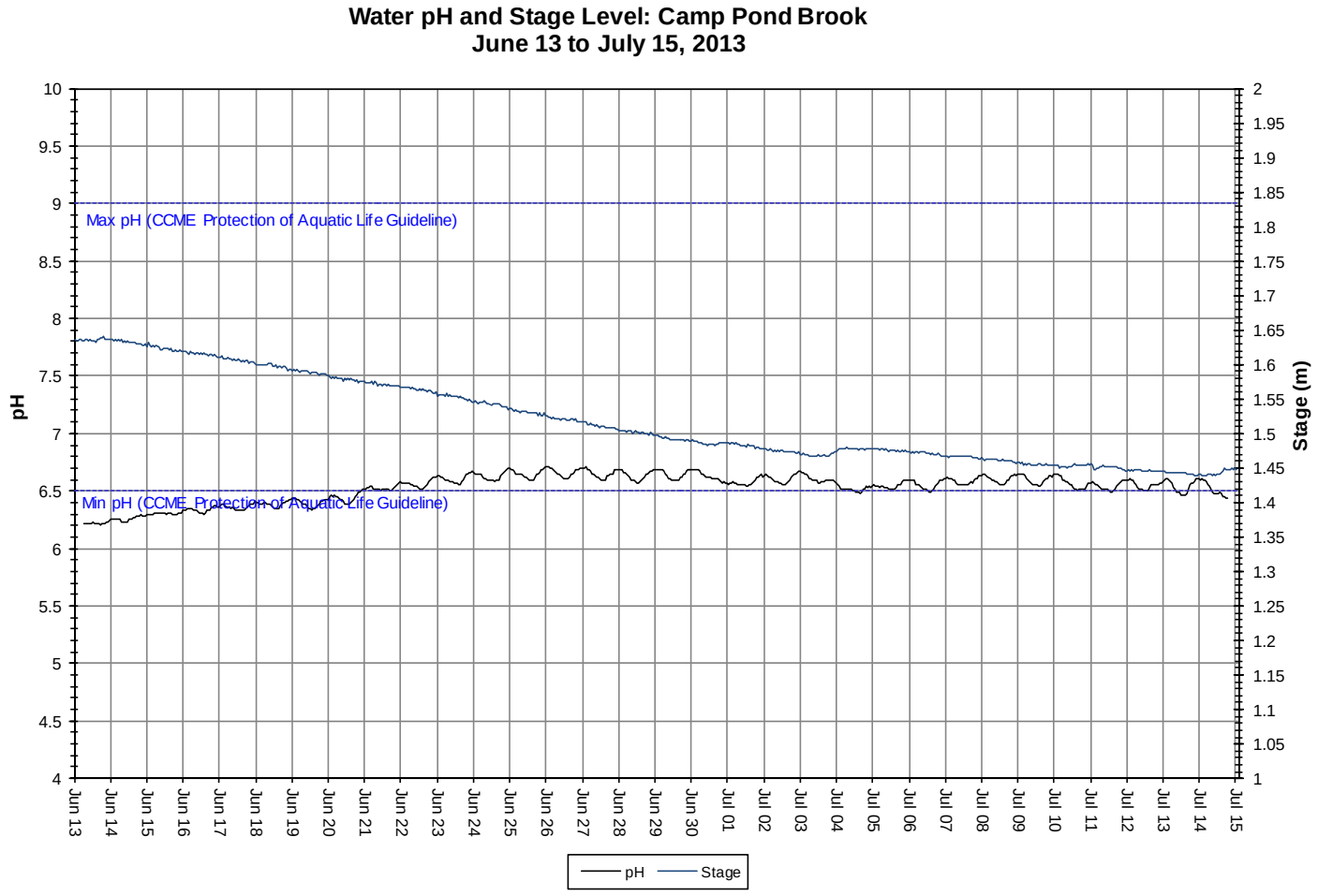


Figure 10: pH and stage level at Camp Pond Brook

- Specific conductivity ranges from 15.2µS/cm to 33.9µS/cm during the deployment period (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. The stage is decreasing consistently throughout the deployment period while the specific conductivity increases sharply at the beginning of the deployment period and fluctuates each day.

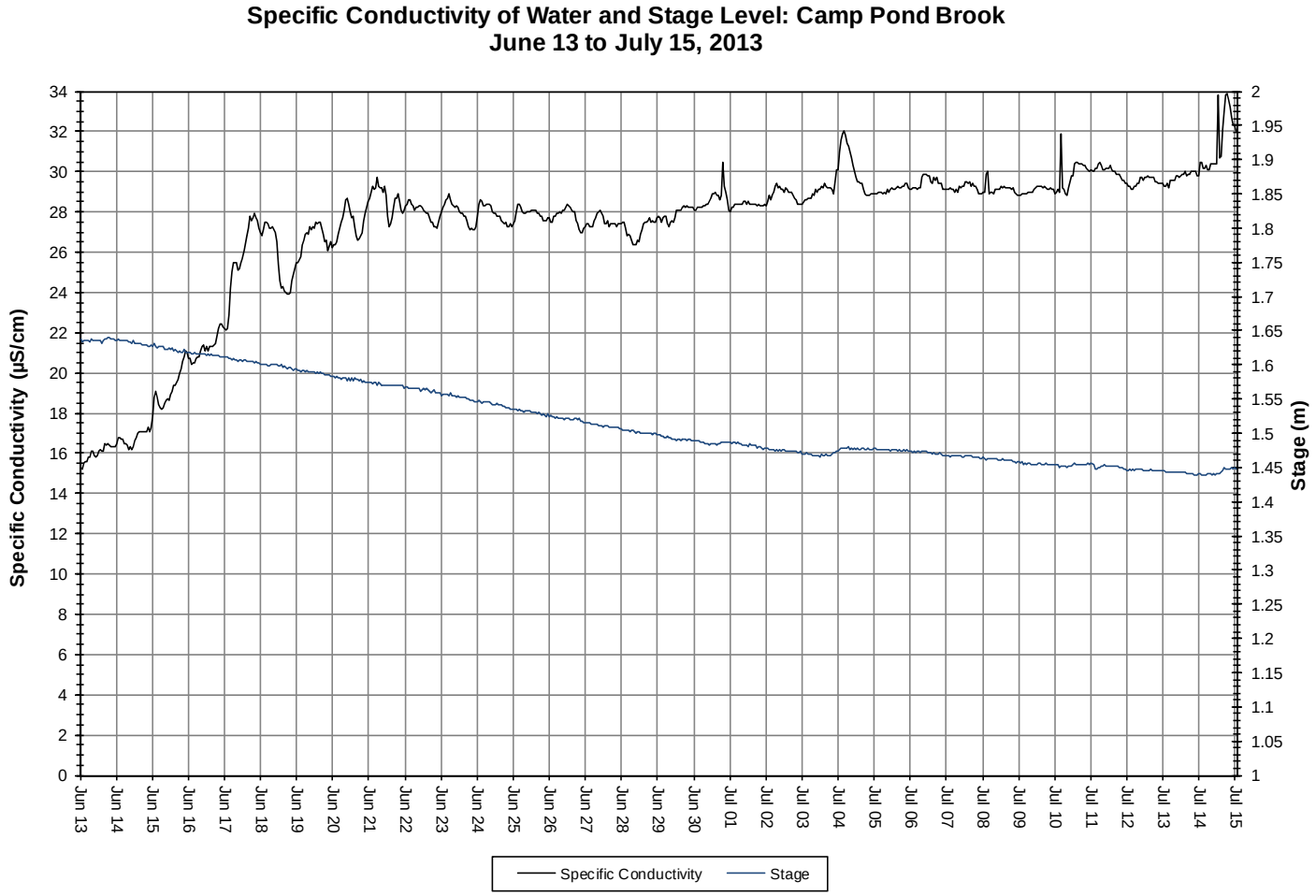


Figure 11: Specific conductivity and stage level at Camp Pond Brook

- Dissolved oxygen content ranges between 8.91mg/l and 11.66mg/l. The saturation of dissolved oxygen ranges from 85.6% to 100.0% (Figure 12).
- Dissolved oxygen content is decreasing throughout the deployment period. These decreases in dissolved oxygen correspond with increasing water temperatures (Figure 8).
- At the beginning of the deployment period, all values are well 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). Guidelines are indicated in blue on Figure 12. As the water temperatures increase, the oxygen content decreases below the minimum recommended guideline for the Protection of Aquatic Life at Early Life Stages about mid-way through the deployment. Average dissolved oxygen content is 10.27mg/l.

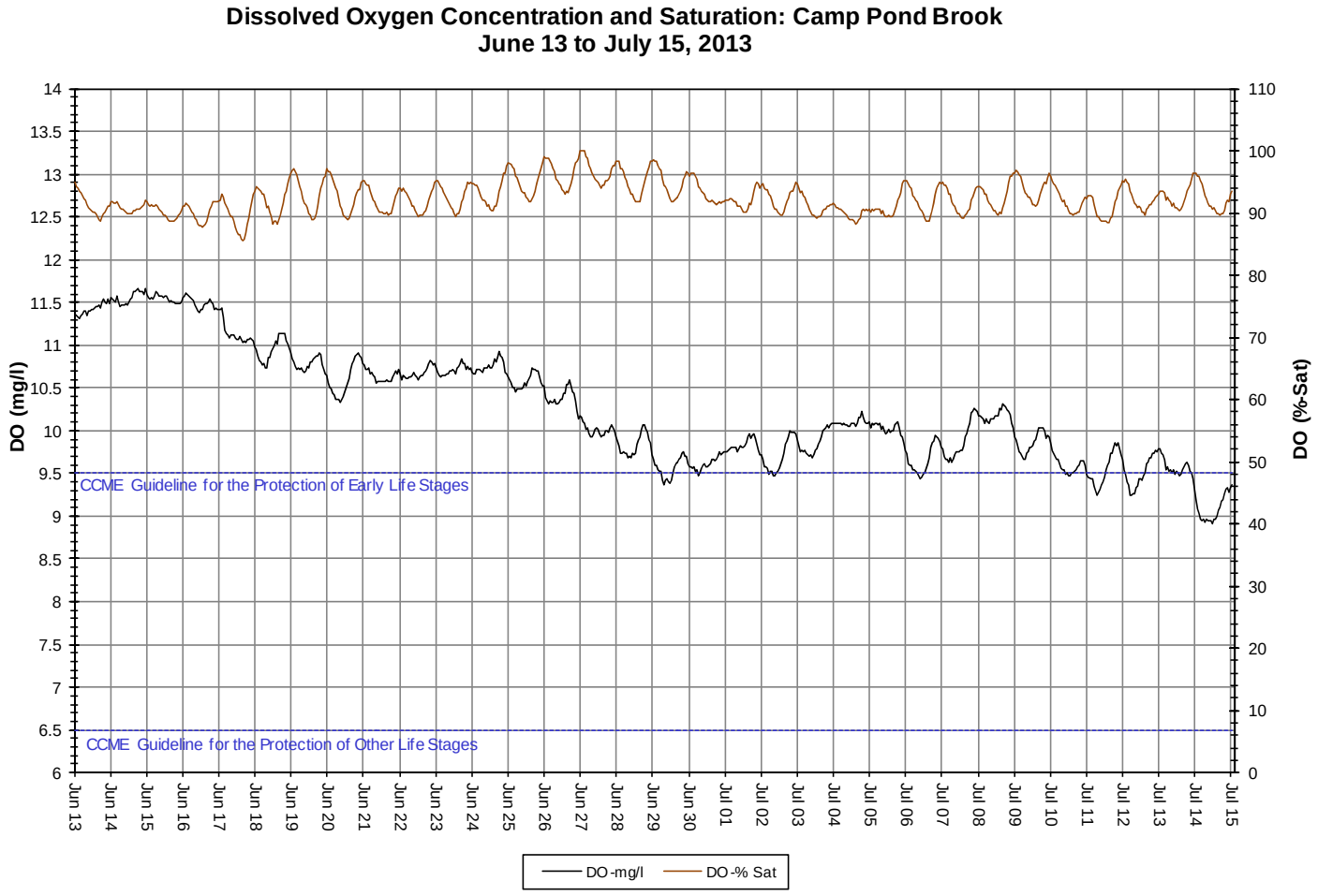


Figure 12: Dissolved oxygen and percent saturation at Camp Pond Brook

- Turbidity ranges between 0.0NTU to 16.7NTU (Figure 13). A median value of 0NTU indicates there is no natural background turbidity value at this station for this deployment period.
- Turbidity events at this station are generally short lived, often lasting 1-2 hours. On a couple of occasions, turbidity events last up to 7 hours. Rainfall events sometime correspond with these increases. The longer lasting turbidity events do correspond with rainfall events and are indicated on Figure 13.

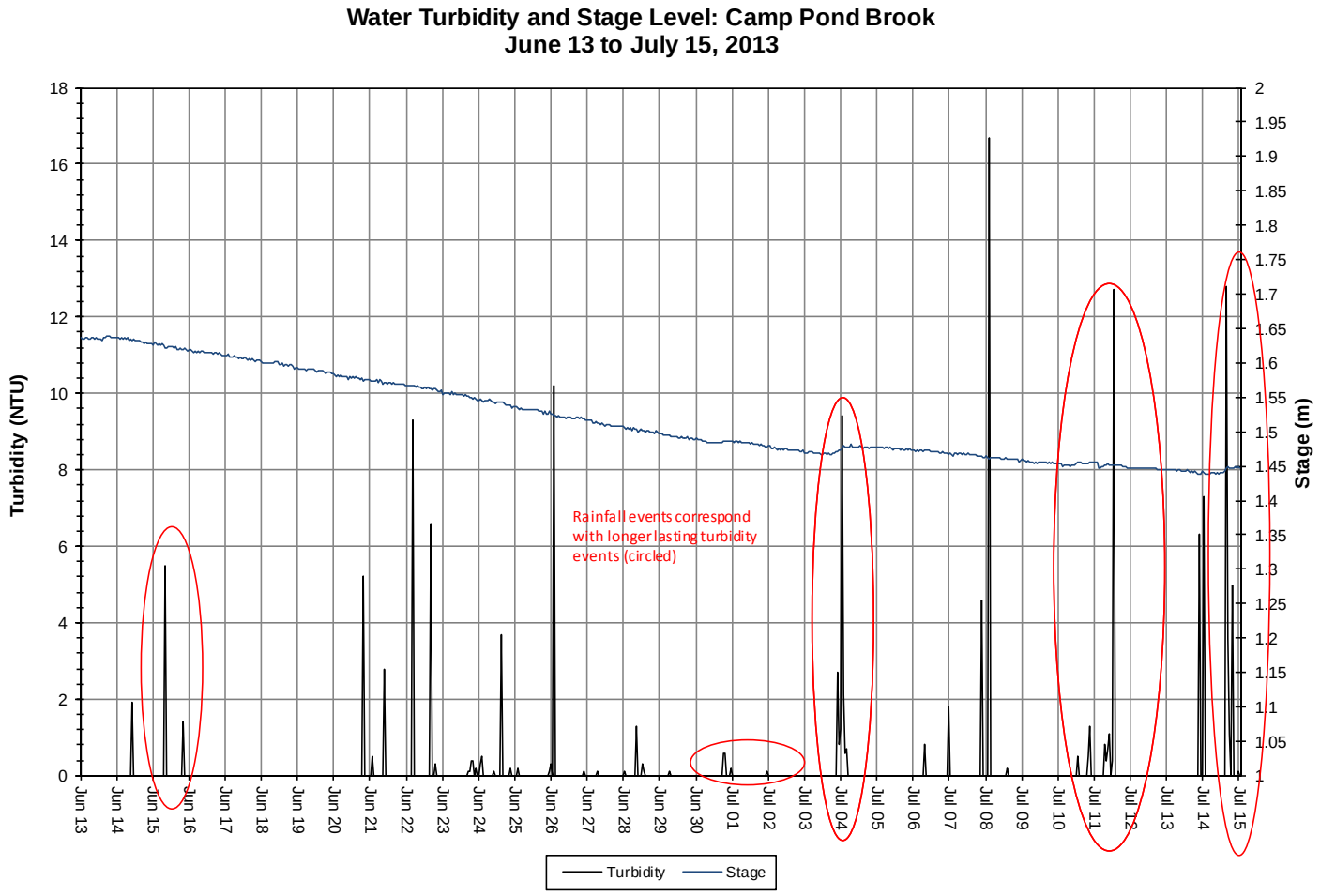


Figure 13: Turbidity and stage level at Camp Pond Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is decreasing very consistently during the deployment period. Stage level values range from 1.44 to 1.64m, a difference of 0.20m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude.

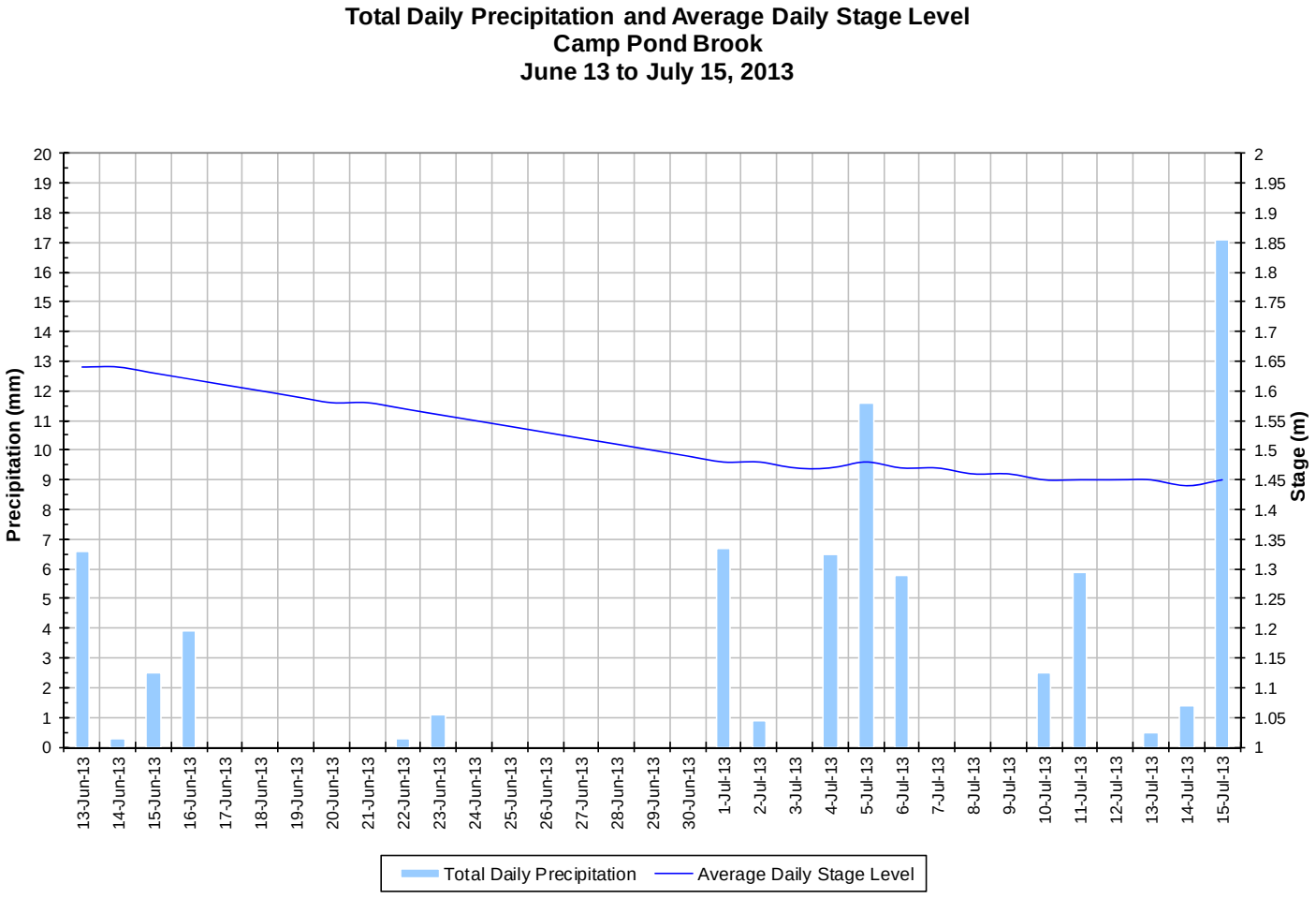


Figure 14: Daily precipitation and average daily stage level at Camp Pond Brook

(weather data recorded at Nain)

Tributary to Lower Reid Brook

- Data transmissions were intermittent throughout the deployment period. Log file data stored in the instruments internal memory has been used to supplement data transmission for a more complete data set.
- Water temperature ranges from 2.40°C to 14.46°C during the deployment period (Figure 15).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring and summer seasons (Figure 16)
- Water temperature fluctuates diurnally. Average water temperature is 8.32°C for the deployment period.

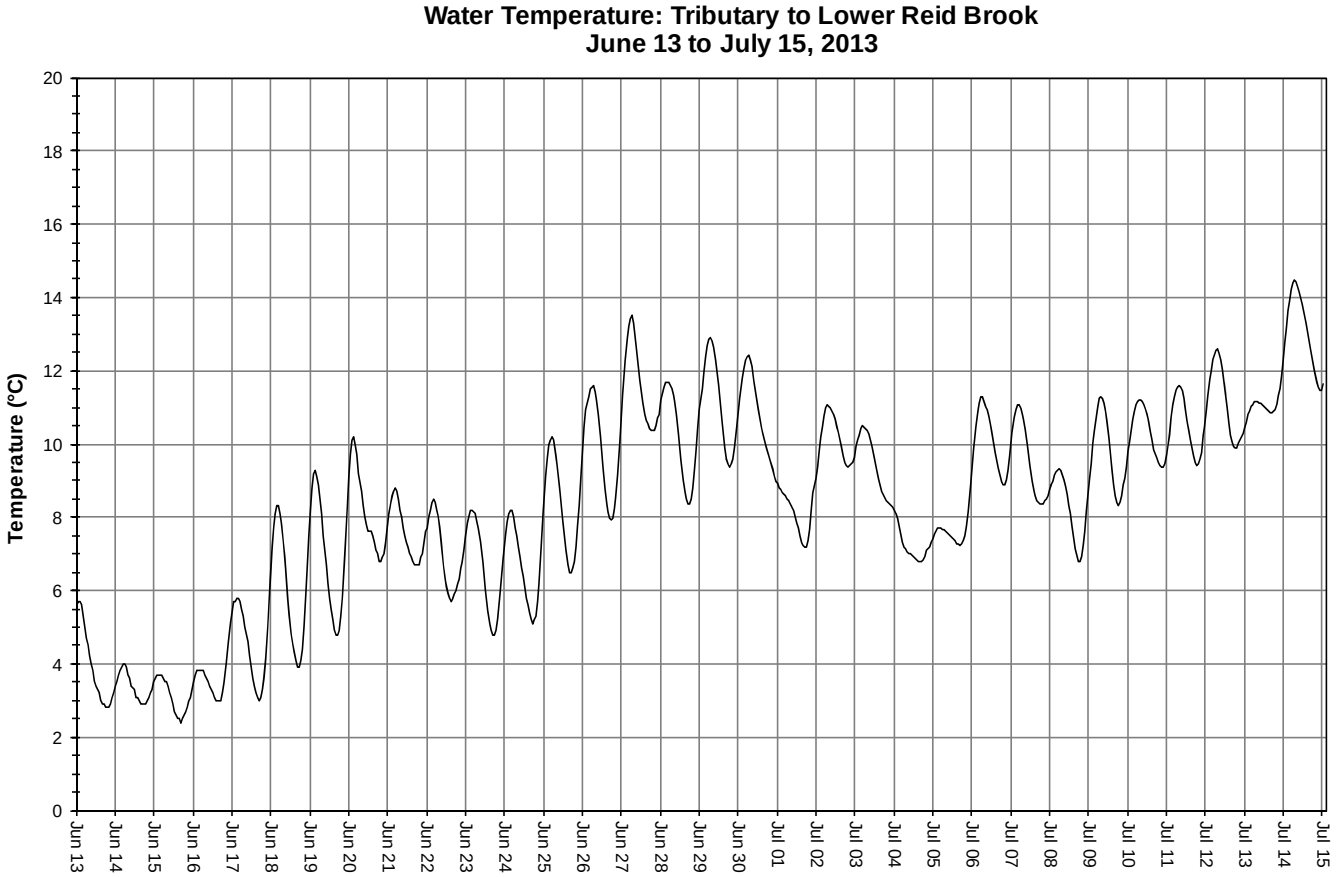


Figure 15: Water temperature at Tributary to Lower Reid Brook

- Average daily air and water temperatures fluctuate daily but show a general increasing trend 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.

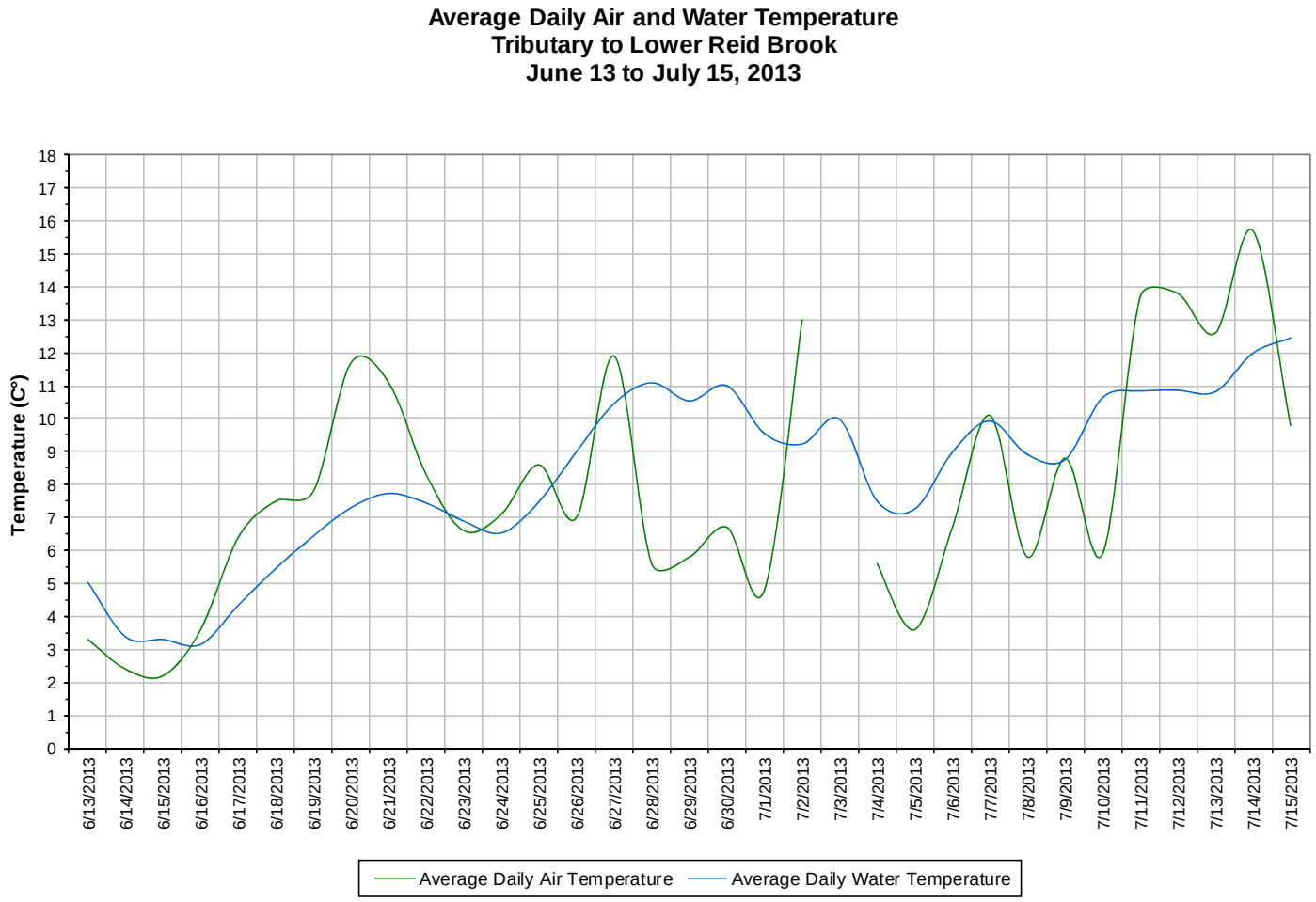


Figure 16: Average daily air and water temperatures at Tributary to Lower Reid Brook (weather data recorded at Nain)

- pH ranges between 6.48 and 6.96 pH units (Figure 17).
- Stage is included on Figure 17 to show the relationship between water level and pH. Stage appears to increase around July 4, even though data transmissions for stage are intermittent, the pattern can be inferred. During this stage increase, pH drops at this station on July 4. This decrease in pH also corresponds with changes in other water quality parameters including temperature (Figure 15) and specific conductivity (Figure 18). This event is highlighted in red on Figure 17.
- Most 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). At the beginning of the deployment period, pH values are just below the minimum guideline value. Guidelines are indicated in blue on Figure 17.

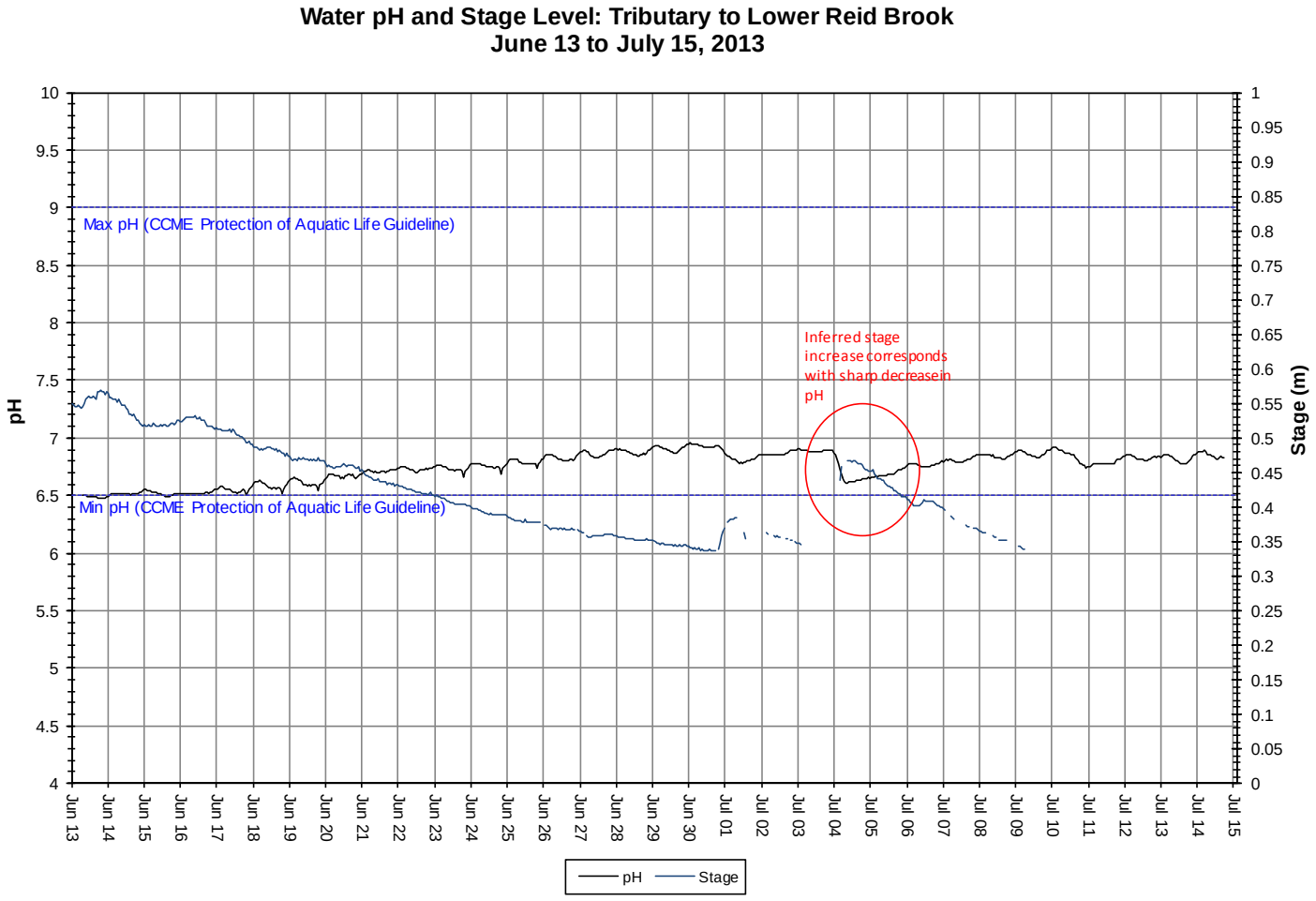


Figure 17: pH and stage level at Tributary to Lower Reid Brook

- Specific conductivity ranges between 16.0µS/cm and 30.0µS/cm and is increasing throughout the deployment period (Figure 18).
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period. 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 clear with the values collected from this station during the deployment period. This pattern is also clearly apparent at the station nearby on Lower Reid Brook. This trend is highlighted in red on Figure 18.

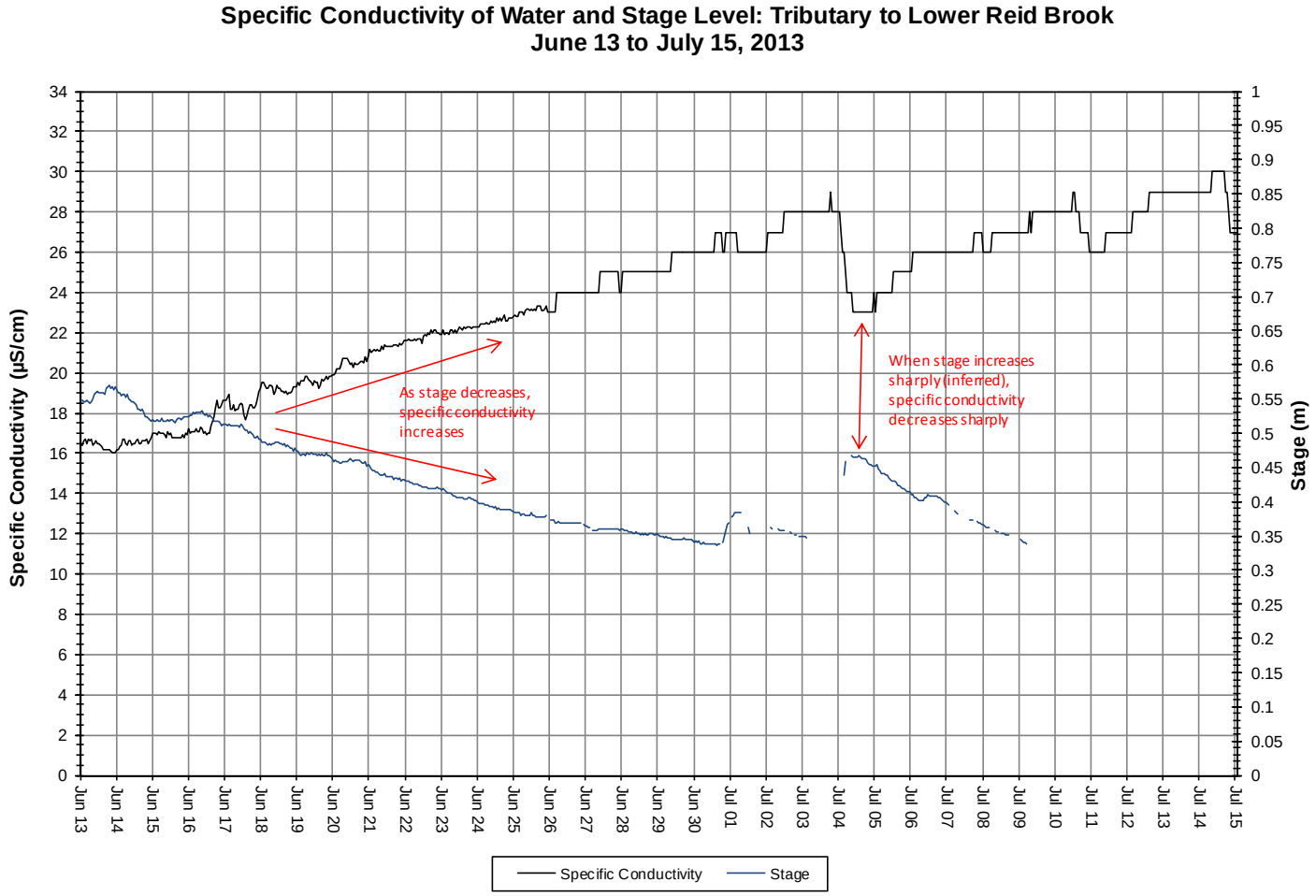


Figure 18: Specific conductivity and stage level at Tributary to Lower Reid Brook

- Dissolved oxygen content ranges between 9.78mg/l and 13.05mg/l. The saturation of dissolved oxygen ranges from 93.8% to 98.3% (Figure 19).
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures in the spring and summer seasons (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 was 11.34mg/l.

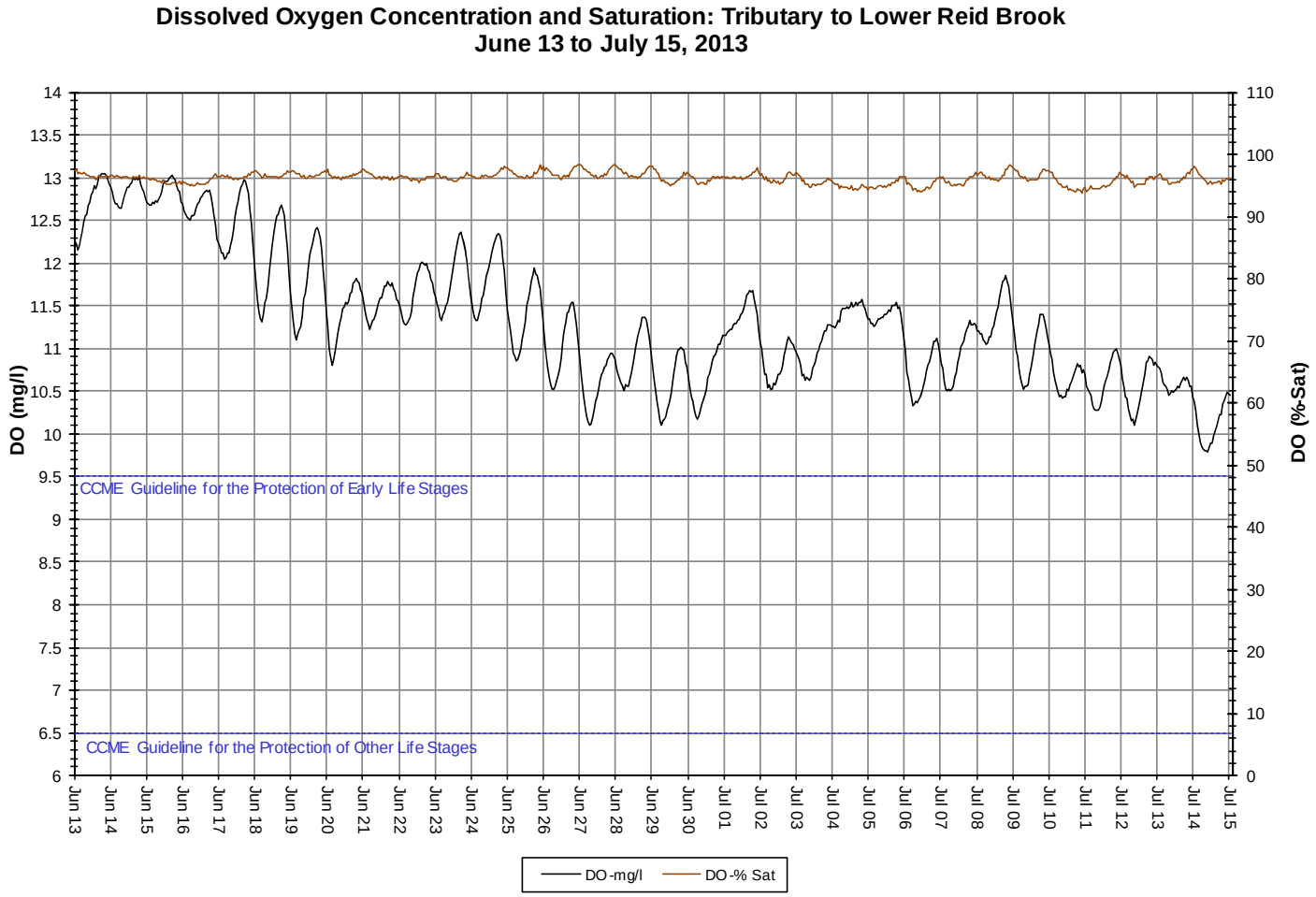


Figure 19: Dissolved oxygen and percent saturation at Tributary to Lower Reid Brook

- Turbidity ranges between 0NTU and 37.5NTU throughout the deployment period (Figure 20). A median value of 0NTU indicates there is no natural background turbidity value for this deployment period.
- Turbidity events at low magnitudes are normal for this station. There are a number of low magnitude rain fall events recorded in the area throughout the deployment period which correspond with some of these increases. These rainfall events occur on June 13-16, July 1-2, 4-6, 10-11 and 14-15.

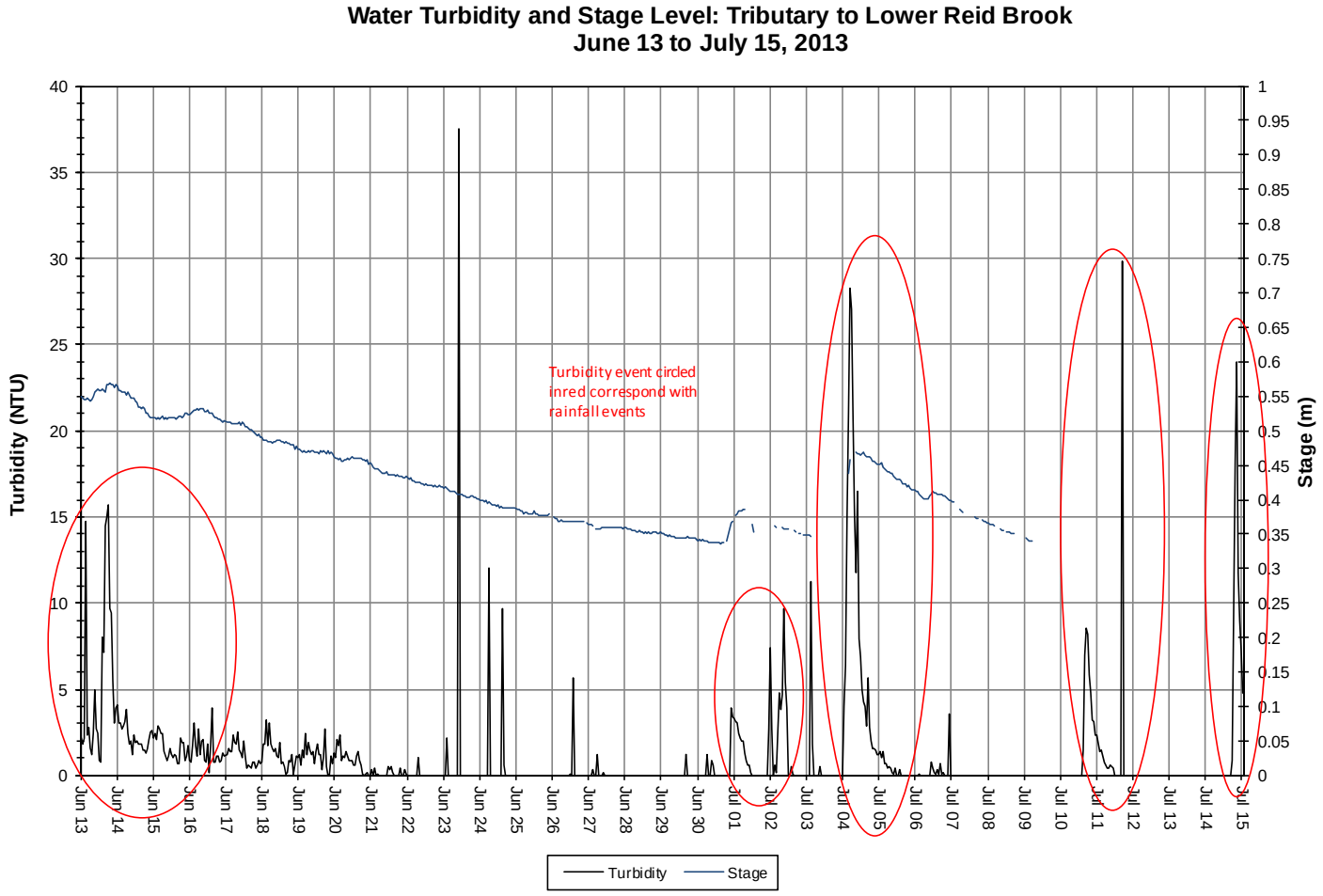


Figure 20: Turbidity and stage level at Tributary to Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is decreasing throughout most of the deployment period and increases slightly near the end. Stage ranges from 0.33m to 0.57m, a difference of 0.24m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude.

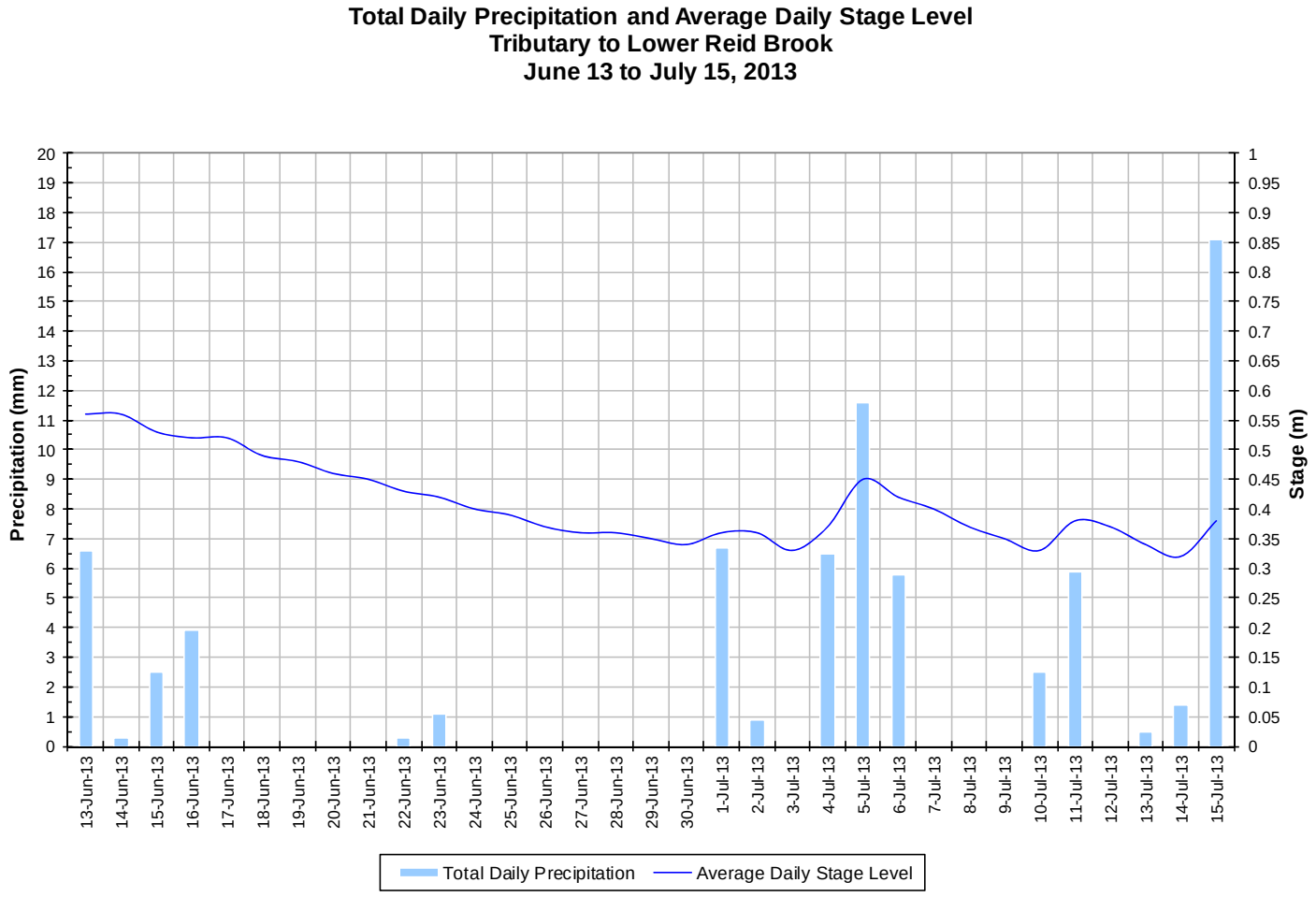


Figure 21: Daily precipitation and average daily stage at Tributary to Lower Reid Brook

(weather data recorded at Nain)

Lower Reid Brook

- Data transmissions were intermittent throughout the deployment period. Log file data stored in the instruments internal memory has been used to supplement data transmission for a more complete data set.
- Water temperature ranges from 2.53 ^{o}C to 14.57^{o}C during the deployment period (Figure 22).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring and summer seasons (Figure 23).
- Water temperature fluctuates diurnally. Average water temperature is 8.17°C for the deployment period.

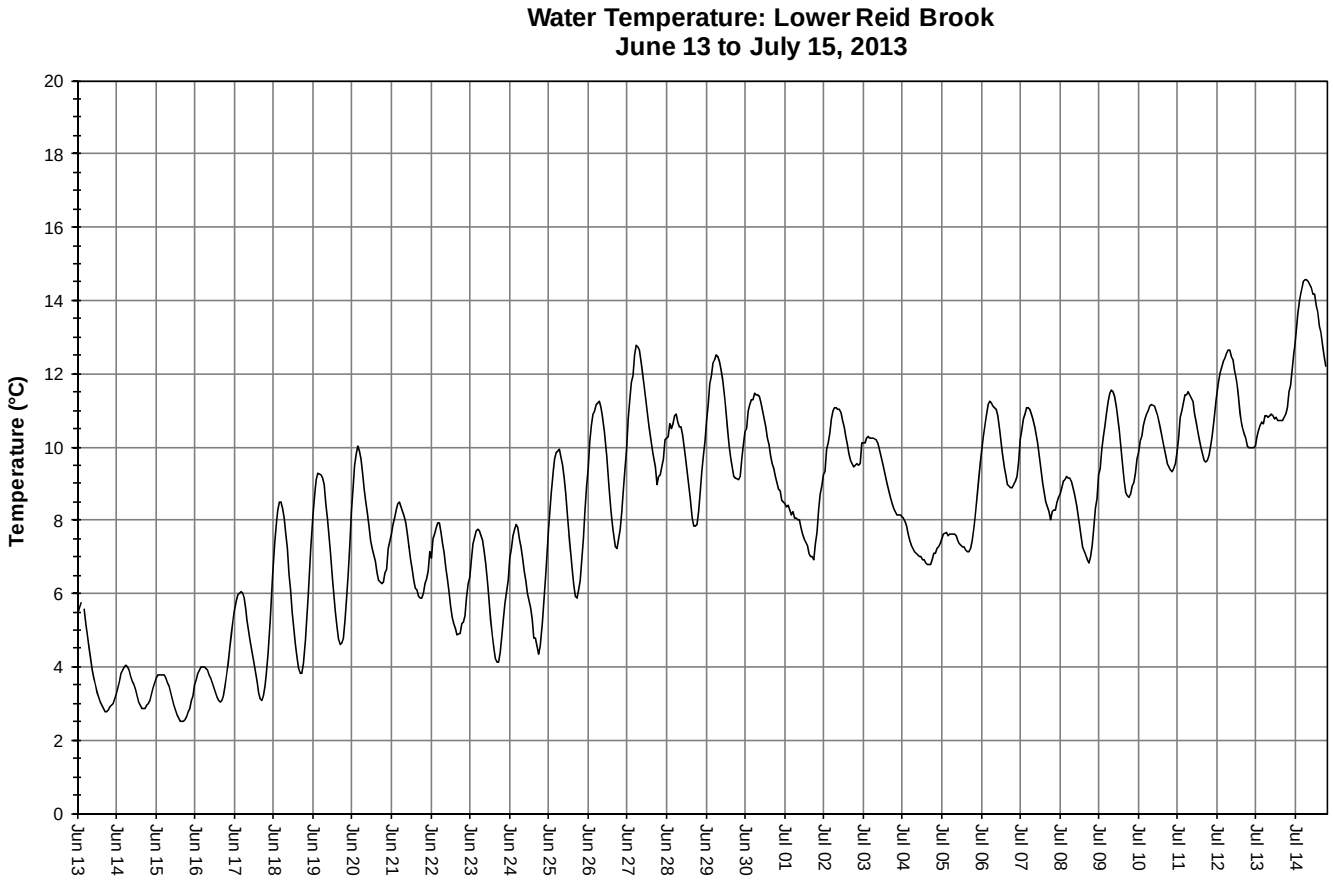


Figure 22: Water temperature at Lower Reid Brook

- Average daily air and water temperatures are generally increasing 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.

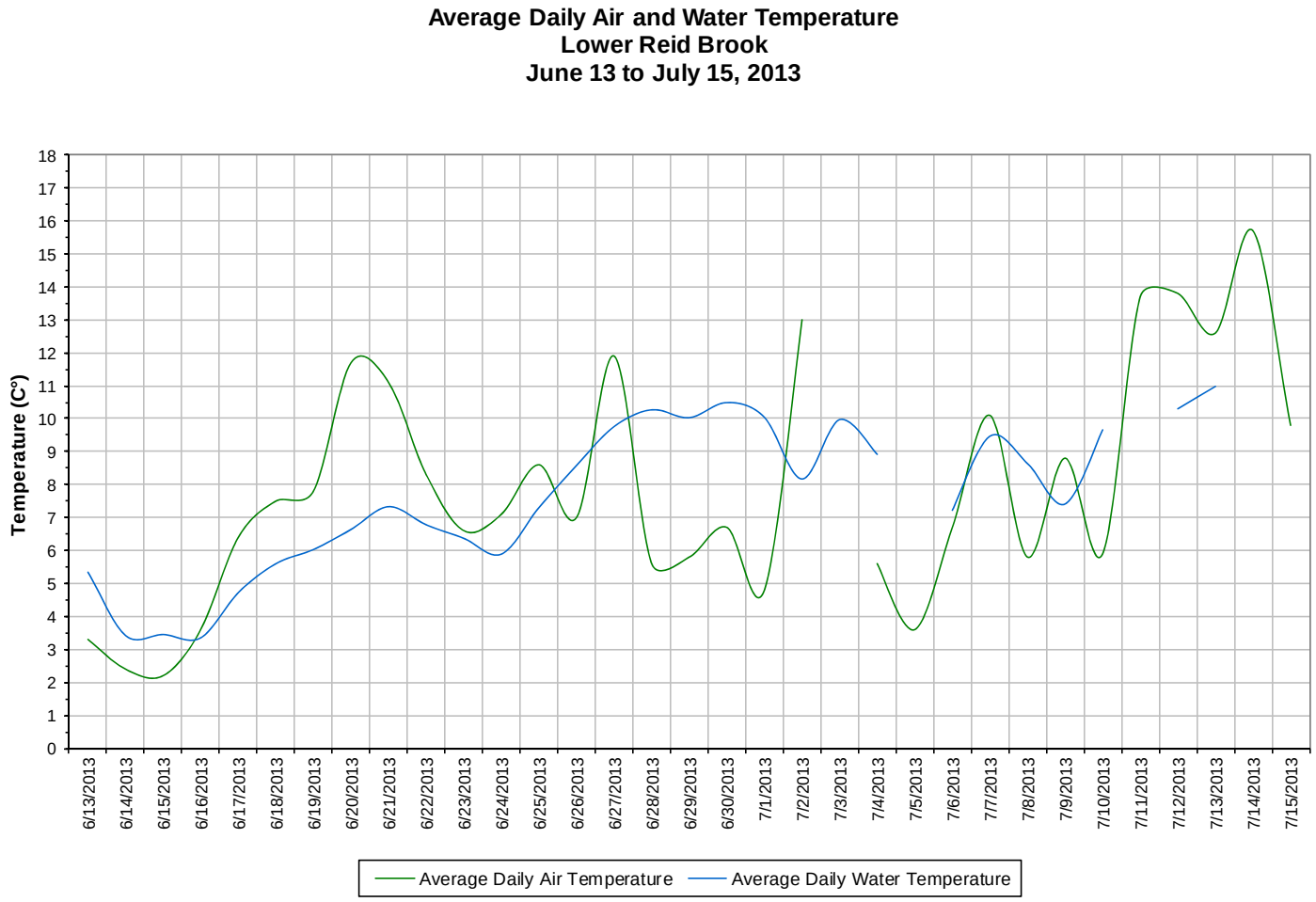


Figure 23: Average daily air and water temperatures at Lower Reid Brook

(weather data recorded at Nain)

- pH ranges between 6.61 and 7.25 pH units (Figure 24).
- Stage is included on Figure 24 to show the relationship between water level and pH. While stage data is not entirely available for illustration, an increase in stage is inferred around July 4. This increase in stage is seen at other stations in the network. This increase in stage corresponds with a decrease in pH as well as other water quality parameters (temperature, Figure 22; and specific conductivity, Figure 25). This event is indicated in red on Figure 24.
- All values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life. Guidelines are indicated in blue on Figure 24.

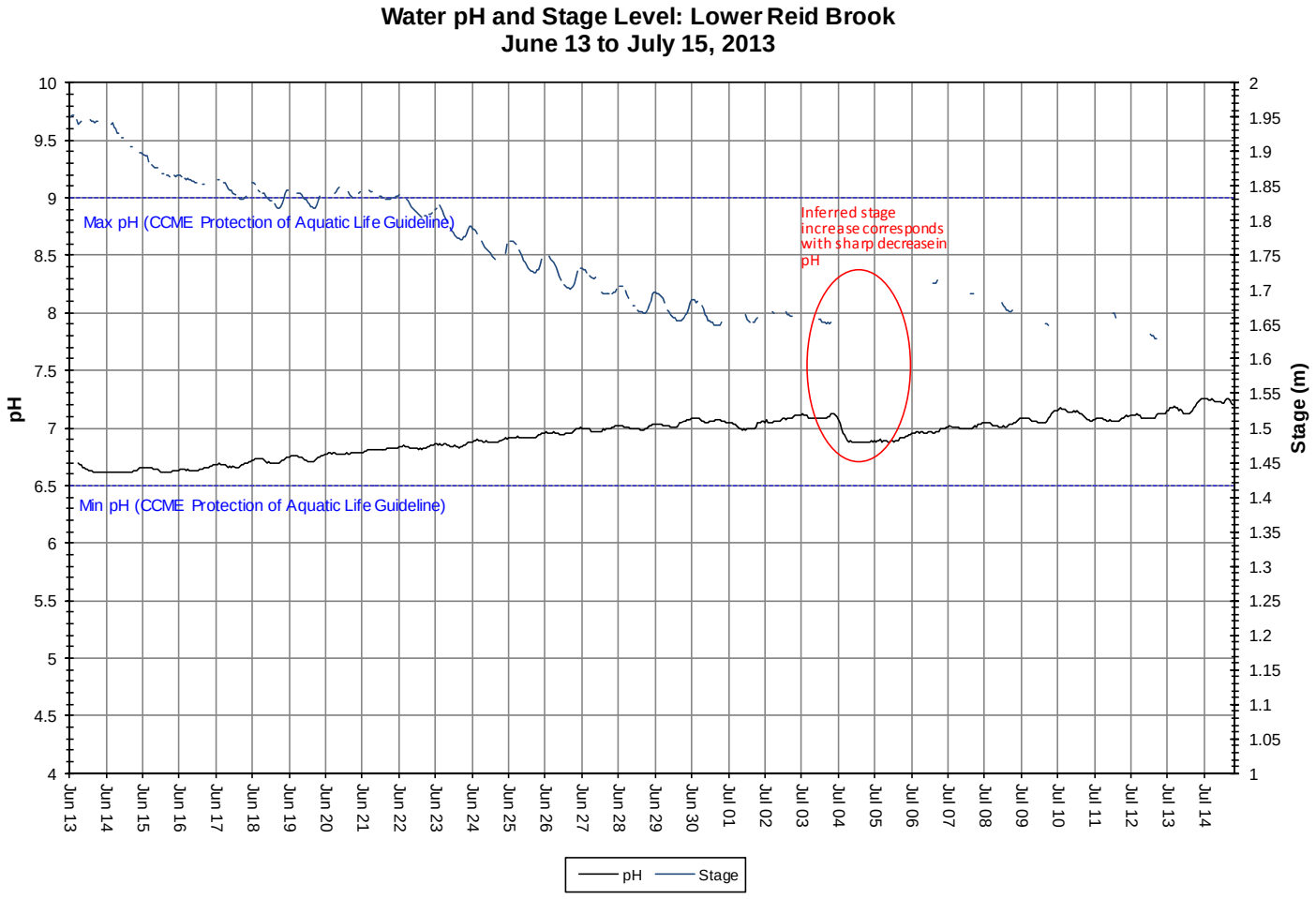


Figure 24: pH and stage level at Lower Reid Brook

- Specific conductivity ranges between 13.9µS/cm and 26.0µS/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.
- This trend is clear with the values collected from this station during the deployment period, regardless of the intermittent stage data. This trend is highlighted in red on Figure 25. This pattern is also clearly apparent at the station nearby on Tributary to Lower Reid Brook (Figure 18).

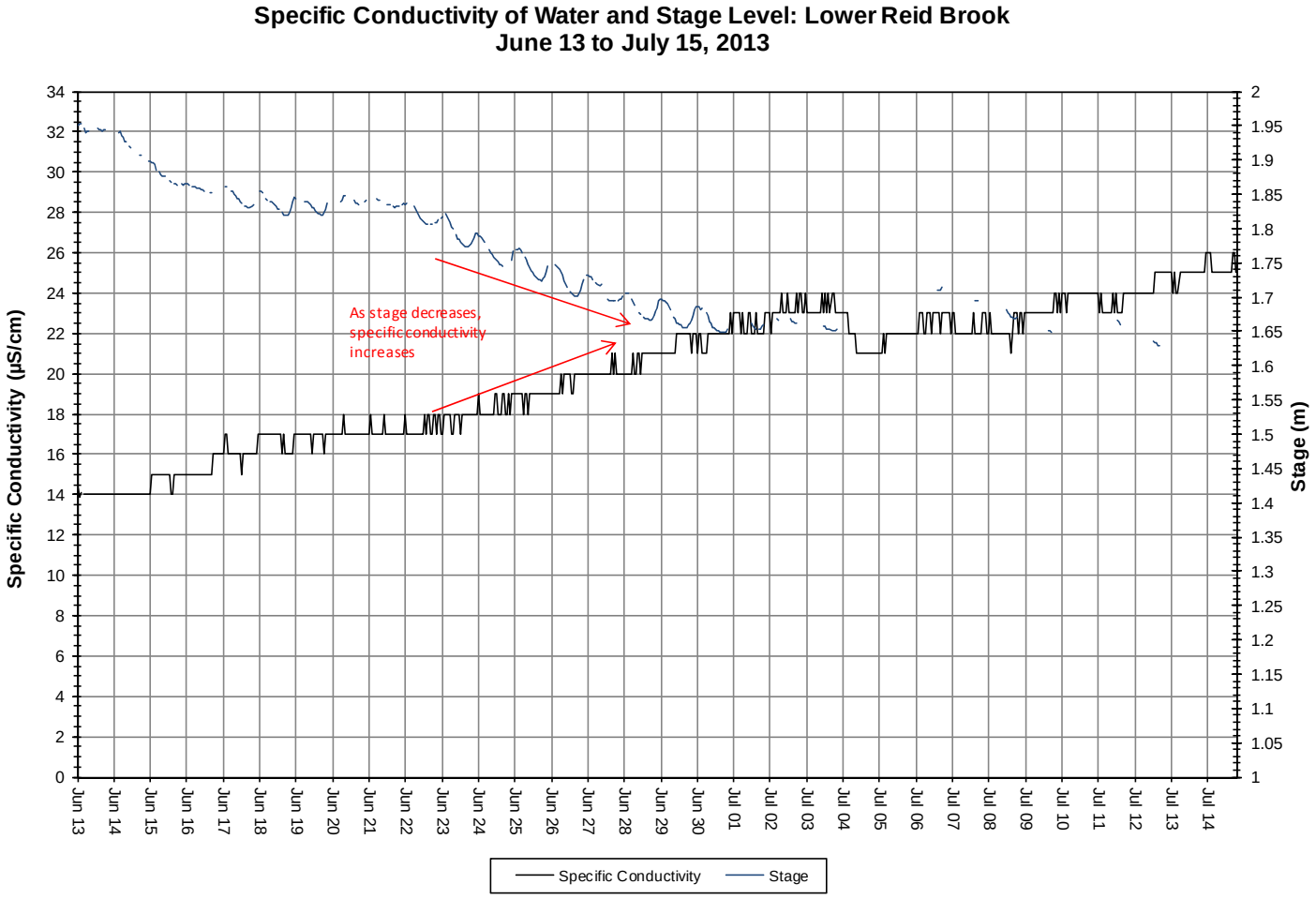


Figure 25: Specific conductivity and stage level at Lower Reid Brook

- Dissolved oxygen content ranges between 9.96mg/l and 13.36mg/l. The saturation of dissolved oxygen ranges from 95.8% to 101.6% (Figure 26).
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming 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 11.61mg/l.

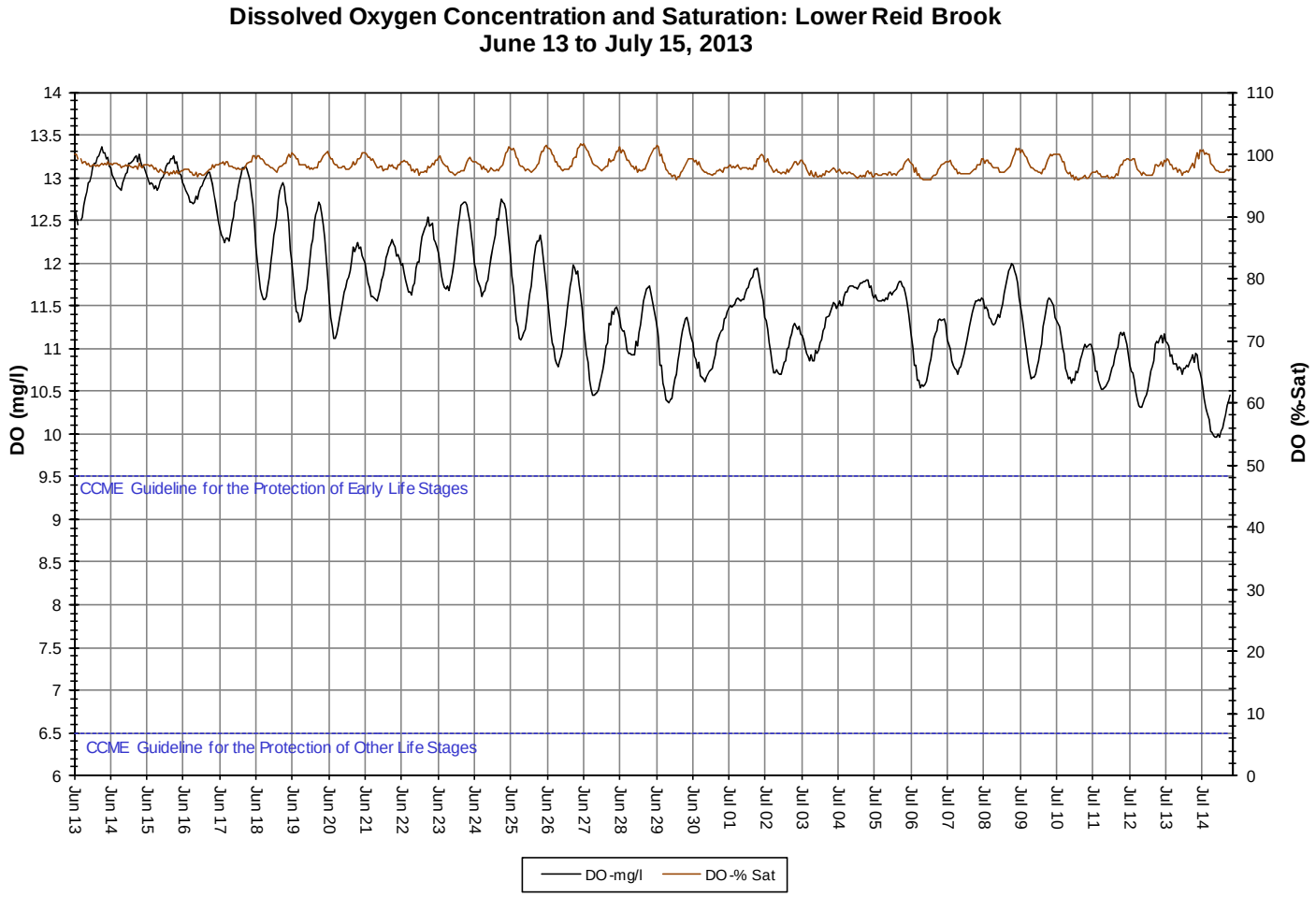


Figure 26: Dissolved oxygen and percent saturation at Lower Reid Brook

- Turbidity ranges between 0 and 42.1NTU 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 a number of low magnitude rain fall events recorded in the area throughout the deployment period which correspond with some of these increases. These rainfall events occur on June 13-16, July 1-2, 4-6, 10-11 and 14-15.

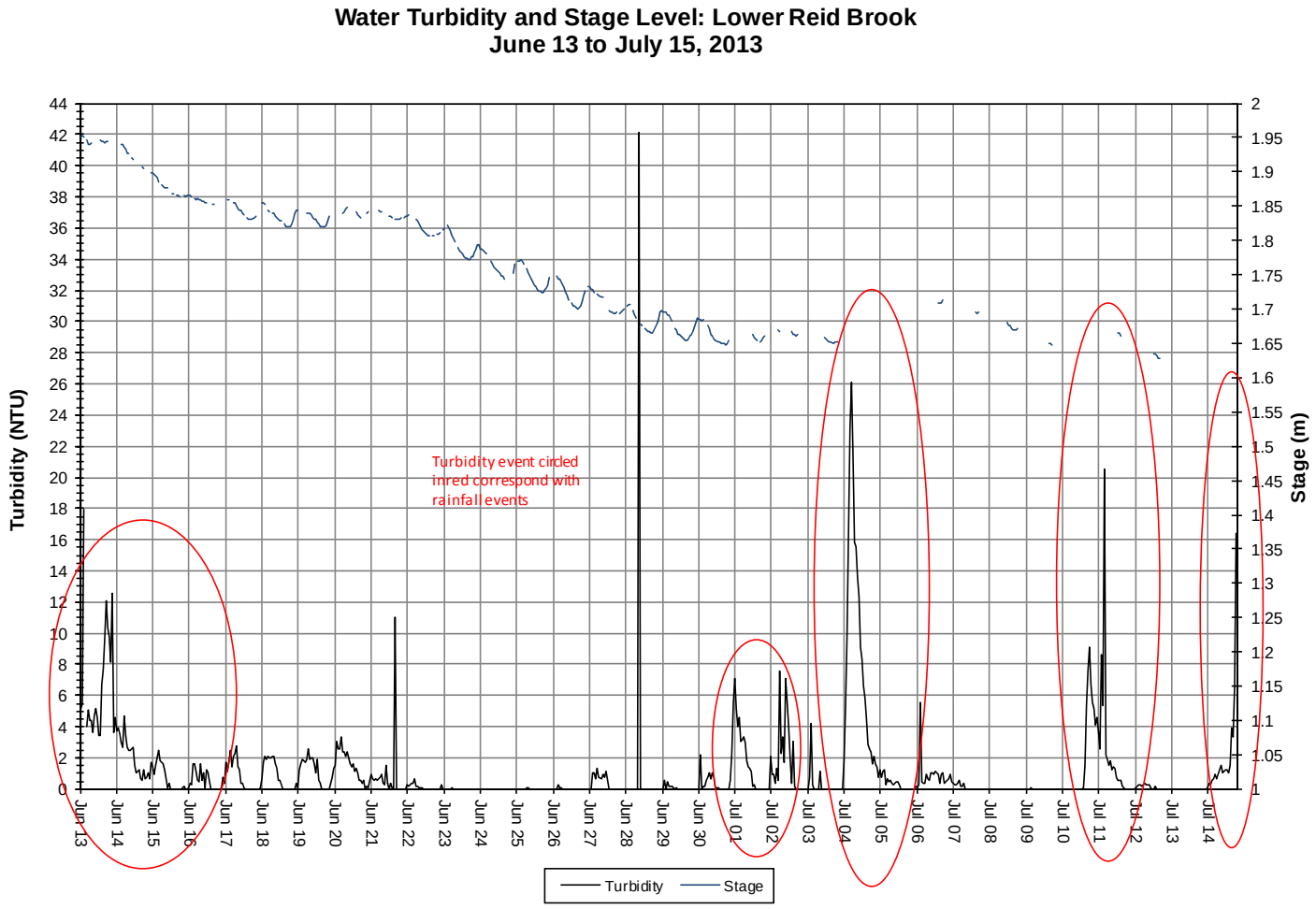


Figure 27: Turbidity and stage level at Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 28). Stage is decreasing consistently at this station throughout the deployment period. Stage ranges from 1.67 to 1.95m, a difference of 28m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude.

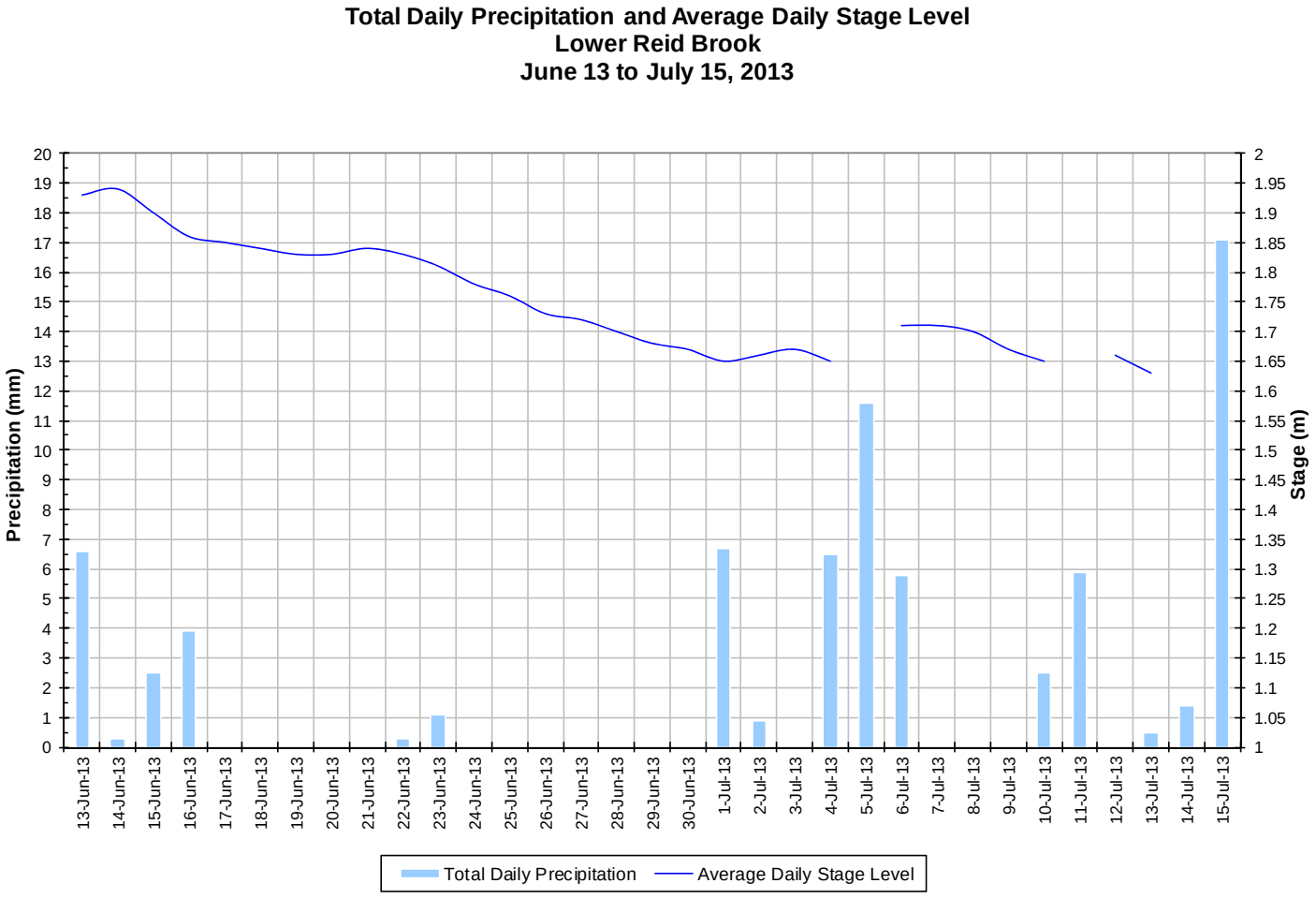


Figure 28: Daily precipitation and average daily stage level at Lower Reid Brook

(weather data recorded at Nain)

Conclusions

- Instruments at water quality monitoring stations in the Voisey's Bay Network were deployed from June 13 to July 15, 2013.

Summary by Station

- At Upper Reid Brook, water temperature increased and dissolved oxygen decreased throughout the deployment period. Specific conductivity was low and very stable which is normal for this station. pH values were neutral and increased slightly. Turbidity remained mostly at 0NTU. Stage levels decreased consistently throughout the deployment period.
- At Camp Pond Brook, water temperature increased and dissolved oxygen decreased. pH was neutral and increased slightly. Specific conductivity increased and fluctuated throughout the deployment period and did not portray a typical inverse relationship with stage level increases. Turbidity events were frequent and generally always short-lived (<7hours). Magnitude of events was low (<17NTU). There is no background turbidity at this station during the deployment. Stage data shows a decreasing trend throughout the deployment period.
- At Tributary to Lower Reid Brook, log file data was used to supplement transmitted data. Water temperature increased as dissolved oxygen content decreased. pH values were neutral and stable for the majority of the deployment period. There is a drop in pH during an inferred increase in stage (stage data is intermittent). Other water quality parameters also experience changes at this time (decreases in water temperature and specific conductivity). Turbidity events were frequent and sometimes corresponded with precipitation events. Events at this station closely resemble the events captured at the station nearby on Lower Reid Brook.
- At Lower Reid Brook, log file data was used to supplement transmitted data. Water temperature increased while dissolved oxygen decreased. pH values were generally stable except for a sharp decrease following an increase in stage. Other water quality parameters also experience changes at this time (decreases in water temperature and specific conductivity). Turbidity events were frequent and sometimes corresponded with precipitation events. Events at this station closely resemble the events captured at the station nearby on Tributary to Lower Reid Brook.

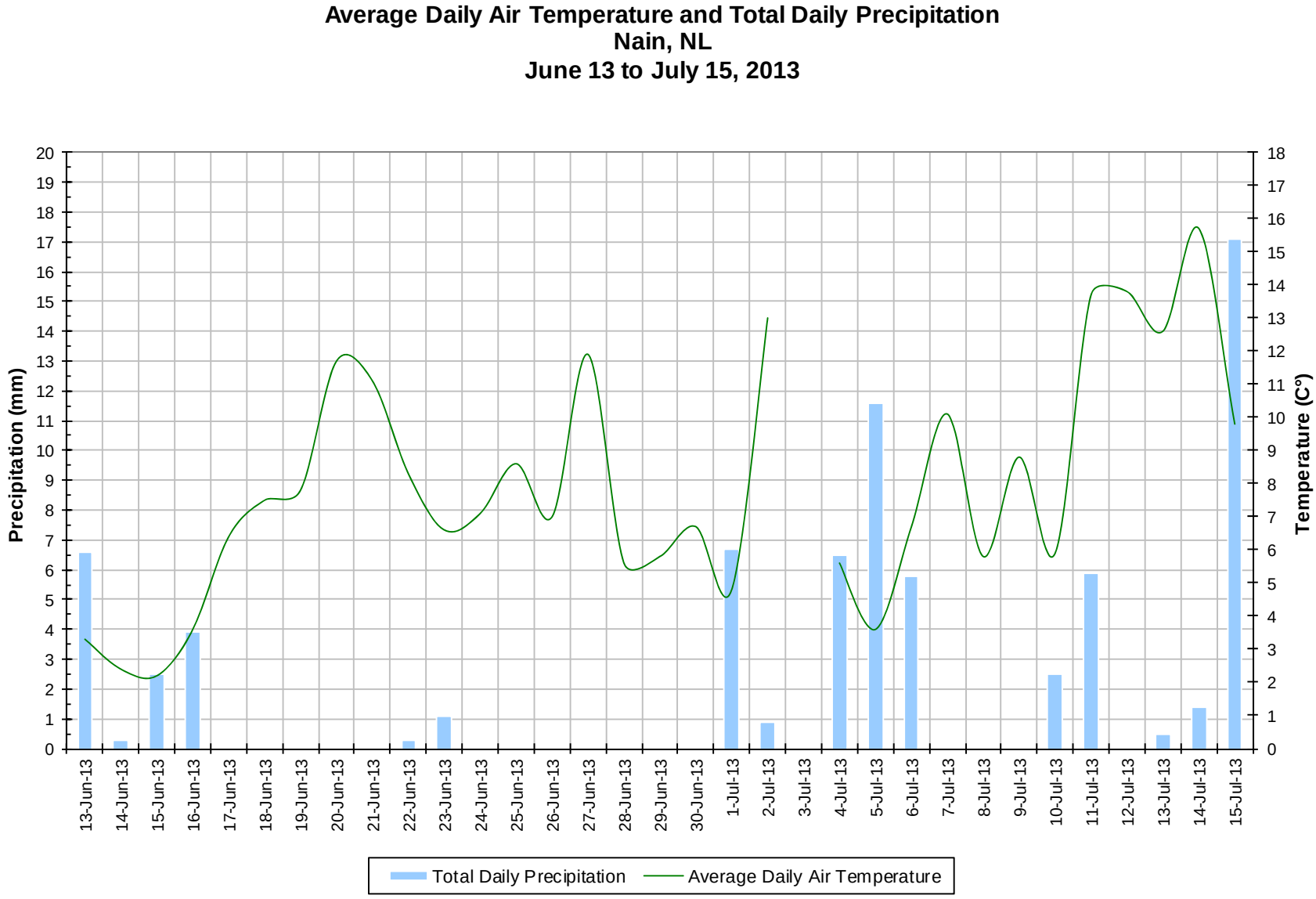
Summary by Parameter

- Temperature averaged between 4.14°C (Upper Reid Brook) and 10.83°C (Camp Pond Brook) at the 4 stations in the Voisey's Bay Network. Temperature increased at all stations throughout the deployment period in response to warm air temperatures. Water temperature is the coldest at this time of year and most stable at the Upper Reid Brook station because of the lake environment from which the water flows.
- pH values averaged between 6.50 (Camp Pond Brook) and 6.80 (Lower Reid Brook) pH units across the network. At Lower Reid Brook and Tributary to Lower Reid Brook, pH values decreased following a shrap increase in stage level on July 4. All values recorded at all stations were within or just below the recommended range as stated 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 22.2µS/cm (Tributary to Lower Reid Brook) and 27.2µS/cm (Camp Pond Brook). Values

at Upper Reid Brook were considerably lower averaging 11.2µS/cm. These lower values are expected from this pristine station at the outflow from Reid Pond. Values at this station tend not to fluctuate a lot even with changing stage levels. At Tributary to Lower Reid and Lower Reid Brook Stations, specific conductivity displayed a clear inverse relationship with stage level, with values decreasing when stage level increased. At Camp Pond Brook, specific conductivity did not relate to stage level in a clear relationship however this is typical for this station.

- Dissolved oxygen levels averaged between 10.27mg/l (Camp Pond Brook) and 12.30mg/l (Upper Reid Brook). 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). Most values were above or just below the minimum CCME Guideline for the Protection of Aquatic Life at Early Life Stages (9.5mg/l). Dissolved oxygen content decreased response to warming water temperatures at all stations throughout the deployment period. 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 are no turbidity events at Upper Reid Brook. At Camp Pond Brook, turbidity events are always short-lived (<7 hours) and low in magnitude (<17NTU). Turbidity events at the station on Tributary to lower Reid Brook and Lower Reid Brook are more frequent and slight longer lasting, some of which correspond with rainfall events.

Appendix 1: Weather Data – Environment Canada Historical Climate Database



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

2013-6309-00-SI-SP, Upper Reid Brook

2013-6310-00-SI-SP, Lower Reid Brook

2013-6311-00-SI-SP, Camp Pond Brook

2013-6312-00-SI-SP, Tributary to Lower Reid Brook

REPORT OF ANALYSIS

Lab Report Number: **1312570**

Cient:	Department of Environment	**COC Number:**	3304
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-07-02
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1035989	WS-S-0000 Upper Reid	2013-6309-00-SI-SP	2013-06-13

Comment:

Holding time for turbidity analysis was exceeded. Holding time for DOC analysis was exceeded for entire report.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	6
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	<1
Colour	TCU	2	9
Conductivity	uS/cm	5	15
Dissolved Organic Carbon	mg/L	0.5	2.3
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	7.12
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	2.3
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	0.1
Aluminum	mg/L	0.01	0.05
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

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Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035989	WS-S-0000 Upper Reid	2013-6309-00-SI-SP	2013-06-13	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	0.004
				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. Holding time for DOC analysis was exceeded for 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

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035990	WS-S-0000 Lower Reid	2013-6310-00-SI-SP	2013-06-13	Alkalinity as CaCO3	mg/L	5	6
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	1
				Colour	TCU	2	39
				Conductivity	uS/cm	5	18
				Dissolved Organic Carbon	mg/L	0.5	4.7
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				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	6.58
				Sulphate	mg/L	3	3
				Total Dissolved Solids (COND - CALC)	mg/L	1	12
				Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
				Total Organic Carbon	mg/L	0.5	4.8
				Total Phosphorus	mg/L	0.01	0.02
				Turbidity	NTU	0.1	0.9
				Aluminum	mg/L	0.01	0.19
				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	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Comment:

Holding time for turbidity analysis was exceeded.

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

APPROVAL:

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Laboratory Supervisor, Inorganics

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035990	WS-S-0000 Lower Reid	2013-6310-00-SI-SP	2013-06-13	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.46
				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	0.007
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	7

Comment:

Holding time for turbidity analysis was exceeded.

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Methods references and/or additional QA/QC information available on request.

APPROVAL:

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Laboratory Supervisor, Inorganics

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035991	WS-S-0000 Camp Pond Brook	2013-6311-00-SI-SP	2013-06-13	Alkalinity as CaCO3	mg/L	5	<5
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	1
				Colour	TCU	2	32
				Conductivity	uS/cm	5	18
				Dissolved Organic Carbon	mg/L	0.5	4.2
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				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	6.51
				Sulphate	mg/L	3	<3
				Total Dissolved Solids (COND - CALC)	mg/L	1	12
				Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
				Total Organic Carbon	mg/L	0.5	5.7
				Total Phosphorus	mg/L	0.01	0.01
				Turbidity	NTU	0.1	0.7
				Aluminum	mg/L	0.01	0.13
				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	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Comment:

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Methods references and/or additional QA/QC information available on request.

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035991	WS-S-0000	2013-6311-00-SI-SP	2013-06-13	Copper	mg/L	0.001	0.002
	Camp Pond Brook			Iron	mg/L	0.03	0.30
				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	<2
				Strontium	mg/L	0.001	0.007
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	0.01
				Total Suspended Solids	mg/L	2	2

Comment:

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Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035992	WS-S-0000 Tributary	2013-6312-00-SI-SP	2013-06-13	Alkalinity as CaCO3	mg/L	5	<5
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	1
				Colour	TCU	2	44
				Conductivity	uS/cm	5	18
				Dissolved Organic Carbon	mg/L	0.5	5.1
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				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	6.49
				Sulphate	mg/L	3	3
				Total Dissolved Solids (COND - CALC)	mg/L	1	12
				Total Kjeldahl Nitrogen	mg/L	0.10	0.13
				Total Organic Carbon	mg/L	0.5	5.8
				Total Phosphorus	mg/L	0.01	0.02
				Turbidity	NTU	0.1	0.7
				Aluminum	mg/L	0.01	0.14
				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	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Comment:

Holding time for turbidity analysis was exceeded.

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-06-25
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1035992	WS-S-0000 Tributary	2013-6312-00-SI-SP	2013-06-13	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	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.008
				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.

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Methods references and/or additional QA/QC information available on request.

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