Water Quality Monitoring in the Tantramar River Watershed

2018 Water Quality Report

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- Mount Allison University for loaning sampling equipment to assist in our long-term water quality monitoring program
- And countless others for supporting EOS in establishing the Chignecto Watersheds Committee and starting up a long-term water quality monitoring program

Executive Summary

The EOS Eco-Energy long-term water quality monitoring program started in the Tantramar River Watershed. Water samples were collected from 12 sites across the Tantramar River Watershed from June to September and sent to the RPC Laboratory in Moncton for analysis. In addition, in-situ measurements were taken (pH, temperature, conductivity, dissolved oxygen, total dissolved solids, salinity) from the 12 sites from May to October using a Hanna Multiparameter Meter. This water quality report compiles and summarizes these results which will be used as a baseline of water quality moving forward.

The objective of this report is to establish a baseline of water quality in the Tantramar River Watersheds, with the intention to continue with a long-term water quality monitoring program. This data will help us gain a better understanding of our watersheds and could lead to the undertaking of any necessary restoration or protection activities, ultimately ensuring healthy watersheds, sustainable ecosystems and resilient communities. This knowledge could also be used to educate the public on local watershed issues and how they connect to climate change in our region.

The Tantramar River Watershed is focused around the Tantramar River whose headwaters start northwest of Cookville and wind down to the Highway 2 (TCH) near Sackville, New Brunswick. The watershed also has another > 4th order river, the Aulac River. Both rivers ultimately flow into the Cumberland Basin of the Inner Bay of Fundy. The rest of our watershed is made up of a series of brooks and creeks.

Water samples were collected from 12 sites across the Tantramar River Watershed from June to September which resulted in 52 samples being collected. Samples were analyzed at the RPC Laboratory in Moncton. The lab analyzed the samples for 58 parameters for each sample resulting in 3016 data points. In addition to water samples, in-situ measurements were collected using a Hanna Multiparameter Meter from the 12 sites from May to October resulting in 432 additional data points, for a total of 3448 data points collected over the course of the field season.

The water quality results were compared to provincial water quality guidelines, CCME water quality guidelines for the protection of aquatic health, and Health Canada Guidelines for Recreational Activities. While we could speculate on some of the potential causes for variations between sites and fluctuation in parameter concentrations, this is just the first year of data collection in our monitoring program. More years of data are required to look at trends and relationships within the water quality data.

The summer of 2018 was warm and dry (Appendix 1 & 2), resulting in water levels being generally low across sites. This likely led to the higher water temperatures that exceeded the CCME guidelines of 20oC we saw in July to September. Generally, we saw the temperatures exceeding the guideline in our more impacted waterways. In-situ water pH

was within CCME guidelines (6.5 – 9) for the most part, with the exception of East Brook with was below the CCME guideline from May to October. Dissolved oxygen was below the New Brunswick guideline (6.5 mg/L) in June to September which could correspond with the high temperatures as DO decreases with increased temperature. There are no water quality guidelines for conductivity, TDS, and salinity. However, all three were typically higher in our more impacted rivers and creeks, with the exception of Harper Brook. All three were also significantly higher in our Aulac River site. E. coli levels only surpassed the Health Canada Recreational Guidelines on 4 occasions. From June to September total phosphorus levels frequently exceeded the New Brunswick guideline (0.03 mg/L) 63.8% of the time (30 samples exceeding the guideline and only 17 coming out below the guideline). Most of our sites are considered eutrophic. Surface water metals were well below the detection limits, aside from iron and aluminum which were both above the CCME guidelines for 7 of the sites.

Overall, EOS had a very successful first year of water quality monitoring that provided us with valuable baseline data that can be used to ensure the health of our watershed. Alongside this it has given us the opportunity to better understand our watershed and the opportunity to have it documented. This project was a great first step towards building a long-term water quality monitoring program within the watershed. As we continue to collect more data we will be able to see trends in the water quality and develop a better understanding of what the “normal” water quality is in our waterways as well as how climate change may impact them.

EOS Eco-Energy believes that this long-term water monitoring program should extend to the Cape Tormentine Peninsula Watershed in 2019-2020 to obtain information about the current state of water quality within that watershed in our region. EOS recommends that the knowledge gaps in our watersheds continue to be addressed through our long-term water quality monitoring plan. We would also like to expand our knowledge of our watersheds through the collection of CABIN data, hydrological data, riparian health data, and fish & habitat data.

Introduction

EOS Eco-Energy is an environmental not-for-profit organization based out of Sackville, New Brunswick. EOS Eco-Energy is dedicated to community-based solutions to reducing and adapting to climate change in the Tantramar region of southeast New Brunswick. In 2017 EOS formed the Chignecto Watersheds Committee, a committee dedicated to the long-term sustainability and resiliency of our local environment and preparing our communities for the combined impacts of climate and land use change by promoting watershed awareness through public education, conducting long-term inland water monitoring, and performing subsequent restoration and protection activities. Members include representatives of Ducks Unlimited Canada, NatureNB, professors & research groups from Mount Allison University, the local planning commission, Fort Folly Habitat Recovery, Petitcodiac Watershed Alliance, and Chignecto Soil & Crop Association. This wide range of expertise provides the capacity, mentorships, partnerships, networks, and volunteer bases to be successful in establishing a long-term monitoring program. Having a long-term monitoring program will help us maintain healthy, productive aquatic environments that will continue to ensure dependable, safe, high quality water to recreational, agricultural, municipal, and industrial users. Thus, this project will ultimately contribute to the overall health of the environment and quality of life of New Brunswickers.

Our long-term water quality monitoring program started in the Tantramar River Watershed. Water samples were collected from 12 sites across the Tantramar River Watershed from June to September and sent to the RPC Laboratory in Moncton for analysis. In addition, in-situ measurements were taken (pH, temperature, conductivity, dissolved oxygen, total dissolved solids, salinity) from the 12 sites from May to October using a Hanna Multiparameter Meter. This water quality report compiles and summarizes these results which will be used as a baseline of water quality moving forward.

Objective

The objective of this report is to establish a baseline of water quality in the Tantramar River Watersheds, with the intention to continue with a long-term water quality monitoring program. This data will help us gain a better understanding of our watersheds and could lead to the undertaking of any necessary restoration or protection activities, ultimately ensuring healthy watersheds, sustainable ecosystems and resilient communities. This knowledge could also be used to educate the public on local watershed issues and how they connect to climate change in our region.

Methodology

Last year the EOS Chignecto Watersheds Committee worked together to choose sample sites throughout the Tantramar River Watershed based off of maps, existing data, and advice given from other watershed groups and the NB Department of Environment and Local Government. Initial site visits were conducted in May 2018 to finalize the 12 sample sites.

Water quality samples were collected from 12 sampling sites throughout the Tantramar River Watershed once a month from June to September 2018. The water sampling was performed according to the New Brunswick Department of Environment and Local Government protocols. Water samples were sent to RPC Laboratory Moncton for surface water quality parameters and *E. Coli* analysis. Sterile sample bottles were provided by RPC prior to sampling to ensure no sample contamination occurred. Collected samples were stored in a cooler at ~ 4^{o}C until they were transported to RPC at the end of the sampling day.

In-situ water quality parameters (pH, temperature, dissolved oxygen, conductivity, salinity, and total dissolved solids) were collected using a Hanna Multiparameter Meter from the 12 sampling sites from May to October 2018. The Hanna Meter was calibrated prior to each field outing.

Study Area

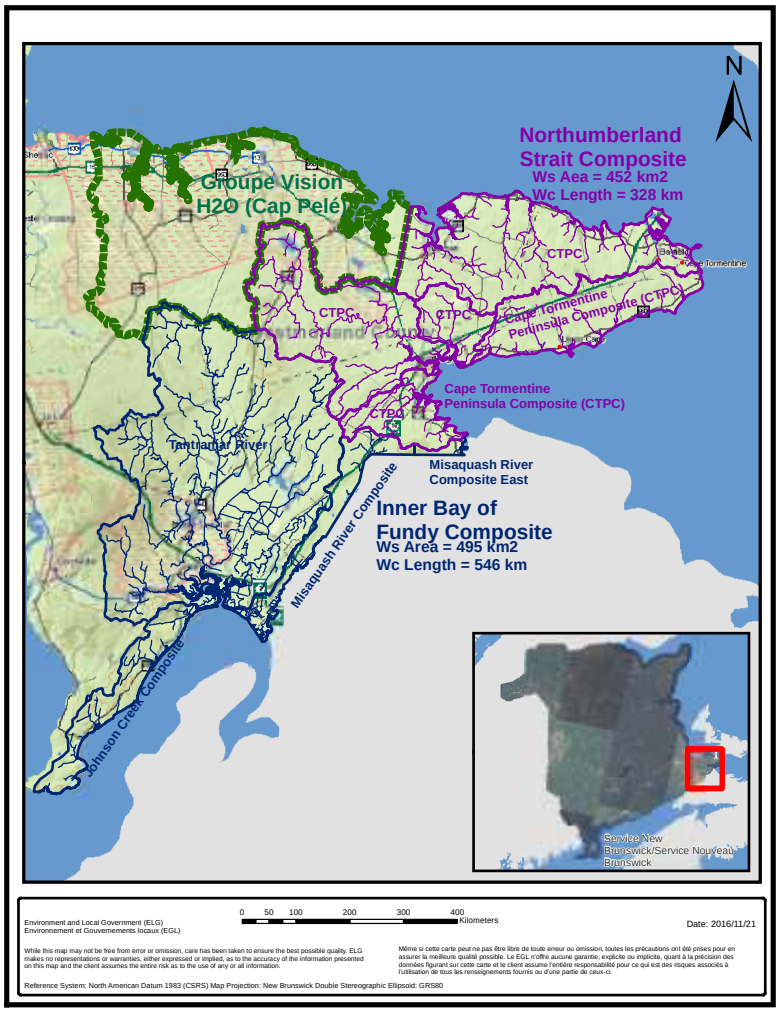

Figure 1: Map of Chignecto Watersheds

The Inner Bay of Fundy Composite covers 495 km^2 of land area and has a total watercourse length of 546 km (Figure 1). This watershed is comprised of three watersheds: the Tantramar River Watershed, the Johnson Creek Watershed, and the Misaquash River Watershed (which crosses over the New Brunswick & Nova Scotia border). The Tantramar River Watershed is the largest watershed in this composite, covering 410.4 km^2 of the land area. The watershed boundaries the Cape Tormentine Peninsula Watershed and the watersheds covered by VisionH2O in Cap-Pele to the north, the Misaquash River Watershed to the east, and the Johnson Creek and Memramcook River Watersheds to the southwest.

The Tantramar River Watershed is focused around the Tantramar River whose headwaters start northwest of Cookville and wind down to the Highway 2 (TCH) near Sackville, New Brunswick. The watershed also has another > 4th order river, the Aulac

River. Both rivers ultimately flow into the Cumberland Basin of the Inner Bay of Fundy. The rest of our watershed is made up of a series of brooks and creeks.

Land-use in the Tantramar River Watershed include agricultural and forestry activities, residential and commercial developments, municipal sewage lagoons and private wells, and the Tintamarre National Wildlife Area (Figure 2). The watershed is also a part of the UNESCO World Heritage Site, the Fundy Biosphere Reserve.

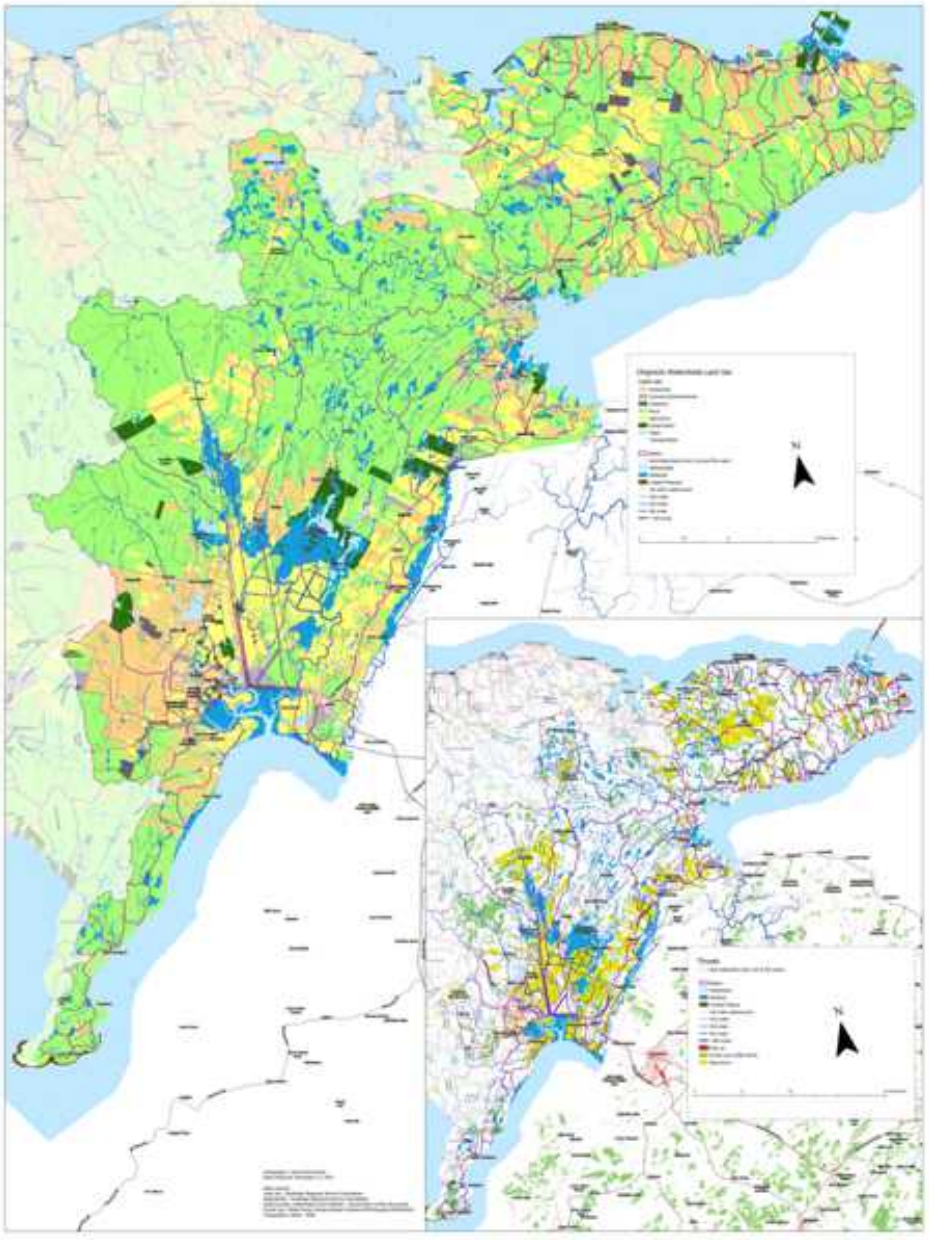

Figure 2: Land-use Map of the Chignecto Watersheds (Source: James Bornemann)

Sampling Sites

Water quality samples were collected from 12 sampling sites throughout the Tantramar River Watershed once a month from June to September 2018 (Table 1).

Table 1: Water Quality Sampling Sites

Station Name	Latitude	Longtitude	Elevation (m)	Location Description
East Brook on Route 940	46.06894	-64.28004	39	North on Route 940 between Centre Village and Anderson Settlement
Harper Brook on Route 940	46.02615	-64.28512	24	North on Route 940 aprox 3 km from dirt road turnoff unto Cookvile Rd
Tantramar River on Cookville Road	46.03093	-64.32698	6	Aprox. 4km from Cookville Rd turnoff from Route 940. First left before Cookvile Loop Rd
Missaquash Brook on Towse Road	46.02343	-64.35143	7	Towse Rd. between Upper Aboujagane Rd and Cookville Rd
Tantramar River off Route 940 (Double Culvert)	45.95750	-64.32759	7	2km SW of Ogdens Lake on Route 940
Joe Brook off Mt. View Road	45.94858	-64.37636	9	End of NW arm of Silver Lake. Just before Art Mill Lane heading towards Stanley Dr.
Silver Lake Outflow below bridge on Main Street	45.92694	-64.35554	7	Southern end of Silver Lake, before Church St.
Tantramar River at Covered Bridge on High Marsh Road	45.93181	-64.33044	2	SE on High Marsh Rd. before Goose Lake Rd.
La Coupe River off High Marsh Road	45.91642	-64.26049	2	NE on High Marsh Rd. aprox. 0.5 km before Carter Cross Rd.
Aulac River off Troop Valley Road	45.93230	-64.23455	4	Aprox. 0.5 km SE from Jolicure Rd.
Robinson Brook off Brooklyn Road	46.00071	-64.23603	23	NE on Brooklyn Rd. Just after Oulton Rd.
Reservoir Brook off Fairfield Road	45.90105	-64.43252	39	4.5 km west on Fairfield Rd.
Morice Creek at Folkins Drive	45.91105	-64.35526	4	Aprox. 1 km NE on Folkins Dr.

Note: purple site was changed to the yellow site halfway through the sampling season

As this was our first year of monitoring, we learned many lessons along the way. Mid-way through our field season, one of our sample sites had very low water levels (Figure 2, **purple site)** and had become a watering hole for livestock which would have not given us consistent conditions for comparing our results. Thus, we started sampling another site of interest that was indicated during the planning phase, but cut out due to not having received sufficient funding for our desired sites of interest (Figure 2, **yellow site**). We now know for next year's monitoring to try our best to do initial site research to ensure that water levels are sufficient for testing all season long and that there are no projected land-use changes during our sampling season. Also, it doesn't hurt to visit additional sample sites while ground truthing, as they could always be used for future monitoring.

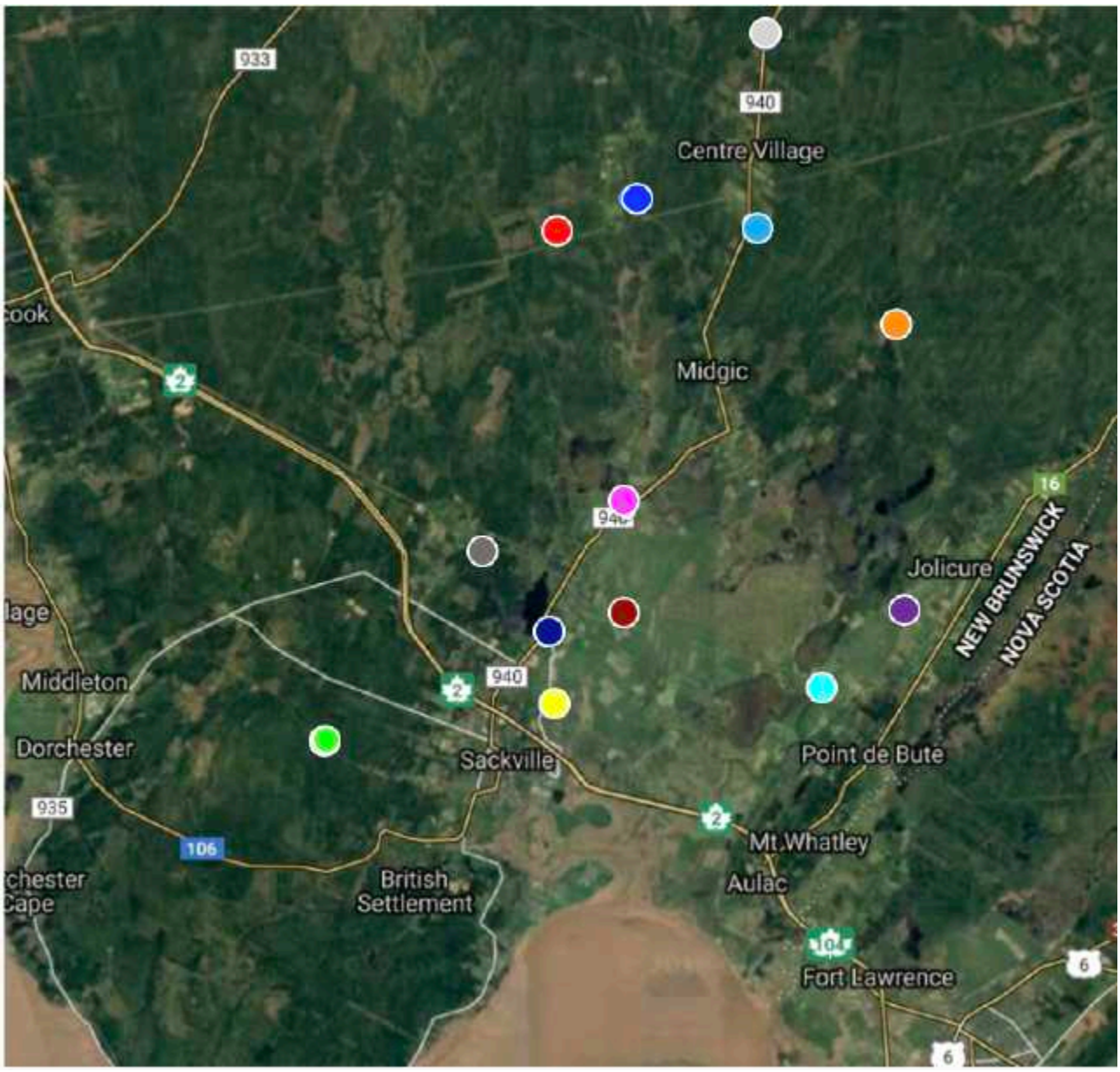

Figure 3: Tantramar River Sampling Sites (see Table 1 for Site Name)

Site Descriptions

East Brook off of Bridge on Route 940

Wetlands to the east of Rte 940 between Centre Village and Anderson Settlement drain into a Ducks Unlimited Canada wetland restoration site where it then forms East Brook. This narrow watercourse meanders south-west through agricultural land, transmission line right-of-way and forested areas. The brook then runs under the Cookville Road before joining the Tantramar River. The sample site is located on Rte 940 directly off the west side of the bridge near the Ducks Unlimited pond.

Photo 1: East Brook, downstream of Ducks Unlimited site in August

Harper Brook on Route 940

Harper Brook drains wetlands to the east of Rte 940 between Midgic and Centreville. The brook forms and then quickly crosses to the west of Rte 940 through a single culvert, before re-crossing near a cattle pasture a short distance downstream. It then travels south-west through a relatively undisturbed area before again crossing Rte 940 through a single culvert where it then flows into a wetland with Patterson Lake to the north. Agricultural disturbance negates any natural confluence of Harper Brook and the Tantramar River. Samples were taken on the east side of Rte 940, upstream of the most northern culvert crossing. The sample site looks to be used for swimming, has light undercutting at the banks, and a cattle crossing downstream.

Photo 2: Harper Brook sampling site on Route 940 in August

Musquash Brook on Towse Road

Musquash Brook drains wetlands north of Sackville Parish and flows through wooded and agricultural areas south-east into the Tantramar River. Samples were taken directly upstream of where the brook meets Towse Rd. The site has considerable bank erosion, lots of vegetation and deciduous trees, and a rocky bottom.

Photo 3: Musquash Brook, downstream of sampling site in August

Tantramar River on Cookville Road

This site was chosen as it represents a comparatively natural portion of the Tantramar River that was also very accessible. Samples were taken upstream on the western end of the wooden bridge on Cookville Road. The site is quite deep and is a popular fishing and swimming spot. There is a diversity of vegetation along low sloped banks and a large riparian buffer.

Photo 4: Tantramar River, upstream of bridge on Cookville Rd. in August

Tantramar River Double Culvert Under Route 940

The site is downstream of the “Tantramar River on Cookville Rd.” sampling site with approximately 10 km of watercourse between the two points. It flows predominantly south with slight meandering through mostly wetlands near Cookville, with increasing rural and agricultural land downstream. Samples were collected directly upstream of and on the eastern side of the double culverts under the 940. The area around the sample site shows significant streambank erosion likely due to a lack of deep rooted vegetation.

Photo 5: Tantramar River at double culvert on 940, upstream in August

Tantramar River at Covered Bridge on High Marsh Road

This site is located approximately 3 km south along the Tantramar River from the "Tantramar River Double Culvert" site. The river runs south through predominantly agricultural land with deep channeling of the banks. The site was chosen as it was previously sampled for surface water quality by the DELG on October 3, 2006. The site was also easily accessible and would best capture a highly impacted portion of the river without being too tidally influenced. The site is also slightly downstream of the Goose Creek and Tantramar River confluence. The area surrounding the site has steep banks with little root mass protection.

Photo 6: Tantramar River upstream of covered bridge on High Marsh Road sampling site. Goose Creek joining from the south-west.

Joe Brook at Mount View Road

Joe Brook runs north-west under Mount View Rd. and flows into the north-western arm of Silver Lake. It runs through mostly rural, forested land upstream of the sample site and then becomes more residential downstream. Samples were collected upstream and to the east of the bridge on Mount View Rd. The site is a popular fishing spot.

Photo 7: Joe Brook, upstream of bridge on Mount View Rd. in August

Silver Lake Outflow Below Bridge on Main Street

Silver Lake is located within Middle Sackville and was originally created as a mill pond. It is now used for recreational activities such as fishing, boating and swimming with moderate residential development surrounding it. There is a supervised freshwater beach at the southern end of the lake near Route 940. The site was chosen as it represents unique factors in the assessment of the watershed and for the strong public interest in the health of Silver Lake. Samples were gathered at the outflow point of the lake, upstream of the bridge on the 940. The area surrounding the sample site has rocky banks with little vegetation.

Photo 8: Looking north-west of Silver Lake outflow sampling site in June

Morice Creek at Folkins Drive

Morice Creek forms at the outflow of Silver Lake where it heavily meanders south-east through agricultural and conservation land before meeting the Tantramar River. The site is also downstream of the Middle Sackville sewage lagoon. Samples were collected upstream of the bridge on the south side. The site area was quite deep, had remanence of an old bridge, and grassy banks.

Photo 9: Morice Creek, upstream of sample site on Folkins Dr.

Robinson Brook upstream of Brooklyn Road

The site is located between the northern arm of Big Jolicure Lake on Brooklyn road past the Luciphy road intersection. It was chosen as it was previously sampled by ECCC for CABIN on September 16, 2010 and would capture information on a relatively undisturbed portion of the Tantramar watershed which flows into the Tintamarre National Wildlife Area. The shallow brook runs south through mainly rural, forested land.

Photo 10: Sampling Robinson Brook in July

Aulac River off Troop Valley Road

Aulac River runs parallel to and approximately 1.5 km to the south-east of La Coupe River before the two rivers meet and flow into Cumberland Basin. Aside from the Tantramar River, Aulac River is the only other large order river of the Tantramar River watershed that releases directly into the Bay of Fundy. During our sampling season significant water level drops at the site contributed to the sample site being abandoned and an alternate site on La Coupe River was chosen. During the initial site visit to Aulac River in May, a group of sizable fish were seen swimming upstream of the sample site in low levels of water (the species of the fish is unknown).

The sampling site is on Troop Valley Road, approximately 0.5 km from Jolicure road. Samples were collected downstream of Troop Valley Road and on the south side of the river. The sampling site showed slight bank erosion, a silty substrate, algae on shoreline, turbid water due to sediment disturbance, and signs of cattle who frequent a man-made watering hole close by and downstream to the sampling location.

Photo 11: Aulac River during initial site visits in May

La Coupe River off High Marsh Road

The headwaters of La Coupe River are the Jolicure Lakes within the Tintamarre National Wildlife Area. The river runs south-west, takes a sharp turn east downstream and joins the Aulac River where it continues on to be dispersed on the intertidal mudflats of Cumberland Basin. Upon exiting the wetlands of the protected wildlife area, the river runs through mostly agricultural land to the west and rural land to its east. The site was chosen to be sampled as it was the only accessible site in close proximity to the Aulac River. Samples were collected within the riparian area on the north side of the river. The area surrounding the sample site had grassy banks with a gradual slope and a flooded riparian zone. There was also algae lining the shores and possible cattle crossing downstream.

Photo 12: La Coupe River, upstream of sampling site in August

Reservoir Brook off Fairfield Road

Reservoir Brook flows southeast through mainly wooded areas west of Sackville. It eventually flows into Carters Brook and into the Tantramar River. Samples were collected upstream and to the east of the large culvert on Fairfield Road. At the sample site, algae is evident on the rocky substrate with plenty of deciduous and conifer trees, shrubs and grasses.

Photo 13: Samples being collected by volunteers at the Reservoir Brook site in August

Results & Discussion

Water samples were collected from 12 sites across the Tantramar River Watershed from June to September which resulted in 52 samples being collected. Samples were analyzed at the RPC Laboratory in Moncton. The lab analyzed the samples for 58 parameters for each sample resulting in 3016 data points. In addition to water samples, in-situ measurements were collected using a Hanna Multiparameter Meter from the 12 sites from May to October resulting in 432 additional data points, for a total of 3448 data points collected over the course of the field season.

We compared our current baseline results to water quality guidelines used in New Brunswick (Table 2) and the CCME guidelines for the protection of aquatic life (http://st-ts.ccme.ca/en/index.html).

Table 2:Water quality guidelines used in New Brunswick

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	1
Arsenic	total	5 µg/L	2
Chloride	total	120 mg/L	2
Copper	total	2 µg/L for hardness < 90 mg [$CaCO_3$]/L $0.2*e^{0.8545*\ln[\text{hardness}]-1.465}$ µg/L for hardness > 90 mg [$CaCO_3$]/L	1
Iron	total	0.3 mg/L	1
Nitrate	total	2.9 mg N/L	1
Oxygen	dissolved	6.5 mg/L	2
pH	n/a	between 6.5 and 9	2
Phosphorus	total	0.03 mg/L	1
Turbidity	n/a	10 NTU (SSG[A])	2
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [$CaCO_3$]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [$CaCO_3$]/L	1

Note: n/a = not applicable.
[A] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

New Brunswick Water Quality Guideline Sources:

1 Government of Canada (2008) Technical Guidance Document for Water Quality Index Practitioners Reporting Under the Canadian Environmental Sustainability Indicators (CESI) Initiative 2008. Environment and Climate Change Canada and Statistics Canada. Retrieved on September 20, 2018.

2 Canadian Council of Ministers of the Environment (2016) Canadian Water Quality Guidelines for the Protection of Aquatic Life Summary Table. Retrieved on September 20, 2018.

In-Situ Water Quality Measurements

In-situ water quality measurements were collected using a Hanna Multiparameter Meter from the 12 sites for two additional months (May & October) than the RPC lab sampling due to funding constraints. For this reason, we have decided to present our in-situ water quality measurements as a monthly comparison across sites to capture seasonal variation of spring to fall.

Temperature

Water temperature is dependent on a number of factors including geographic location, season, time of day, velocity, width and depth of the waterbody, riparian vegetative cover, and anthropogenic impacts. Temperature is also a very important water quality parameter as it impacts a number of other chemical, biological, and physical processes in the aquatic environment. For example, higher temperature water means less oxygen can be dissolved. The summer of 2018 was warm (Appendix 1) and dry (Appendix 2) and water levels were generally low across sites.

Water temperature of all sites experienced typical seasonal variation, with an increase in temperature during the warmer, summer months (July-September), and a cooling in October with daily temperatures more characteristic of fall (Table 3). There was also a dip in water temperature between May and June for some of our smaller streams, which could be attributed to the low temperatures from the late frost that we saw into June this year (see Appendix 1).

According to the CCME guidelines, water temperatures of salmonid species (e.g. trout found in our watershed) prefer cool water (< 20°C). Long-term exposure to temperatures greater than 24^{o}C is lethal to salmonid species. There is also a CCME guideline that states that human activity should not induce temperature changes of +/- 1^{o}C from natural levels. Water temperature remained below the recommended CCME guideline of 20°C across all sites in May, June and October. In July 3 sites exceeded the recommended temperature of 20°C, 7 sites exceeded in August, and 7 in September.

All of the Tantramar River sites were consistently above the CCME temperature guidelines from July to September (ranging from 20.57^{o}C to 23.77^{o}C) (Table 3). This could be attributed to the limited riparian cover of the river, as well as the slower water velocity. It is also quite turbid which can increase temperature. There were also visual observations of dead fish in the river which could be explained by this high temperature.

The LaCoupe River off of High Marsh Rd. (tributary of the Aulac River) and the Silver Lake Outflow were also above the guidelines from July to September. Similar to the Tantramar River, the LaCoupe River has limited riparian vegetation to help shade the water and is a slow flowing river. Silver Lake is a shallow lake that doesn't experience thermal mixing so the outflow is expected to stay warm.

Morice Creek at Folkins Drive was over temperature guidelines. This site is downstream of Silver Lake Outflow (which also had consistently high readings these months) and the Middle Sackville Wastewater Lagoon which could cause an increase in temperature of the river.

In general, there were higher water temperatures in our impacted waterways than in our less impacted waterways. This is illustrated with the temperature of the Tantramar River sites consistently exceeding the CCME guideline for July – September, while the Tantramar River tributaries (East Brook, Harper Brook, and Musquash Brook) all have lower water temperatures prior to entering the river. Similarly, Joe Brook has lower temperatures feeding into Silver Lake than the temperature at the outflow of the lake, and the temperature of La Coupe River is higher than Robinson Brook after spending time in the Jolicure lakes area.

Table 3: Monthly Water Temperature Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	14.75	13.91	19.41	21.92	19.36	4.94
Harper Brook on Route 940	11.23	6.55	13.7	17.19	15.98	5.19
Musquash Brook on Towse Road	11.97	8.42	14.87	18.15	16.75	5.01
Tantramar River on Cookville Road	11.23	13.39	23.52	23.77	21.31	5.08
Tantramar River on Route 940	14.39	14.54	21.41	22.91	20.68	4.9
Tantramar River at Covered Bridge	15.07	14.96	21.6	23.26	20.57	5.19
Joe Brook off Mt. View Rd.	12.49	8.24	14.44	17.22	16.13	4.99
Silver Lake Outflow below bridge on Main St.	13.98	15.55	21.6	23.82	21.06	6.85
Morice Creek at Folkins Dr.	-	-	-	23.11	20.43	6.85
Robinson Brook upstream of Brooklyn Rd.	13.28	12.67	19.13	19.21	16.93	5.22
La Coupe River off High Marsh Rd.	-	14.36	22.75	22.89	20.46	6.35
Aulac River off Troop Valley Rd.	13.81	13.54	-	-	-	-
Reservoir Brook off Fairfield Rd.	14.56	9.19	14.94	17.56	15.28	5.46

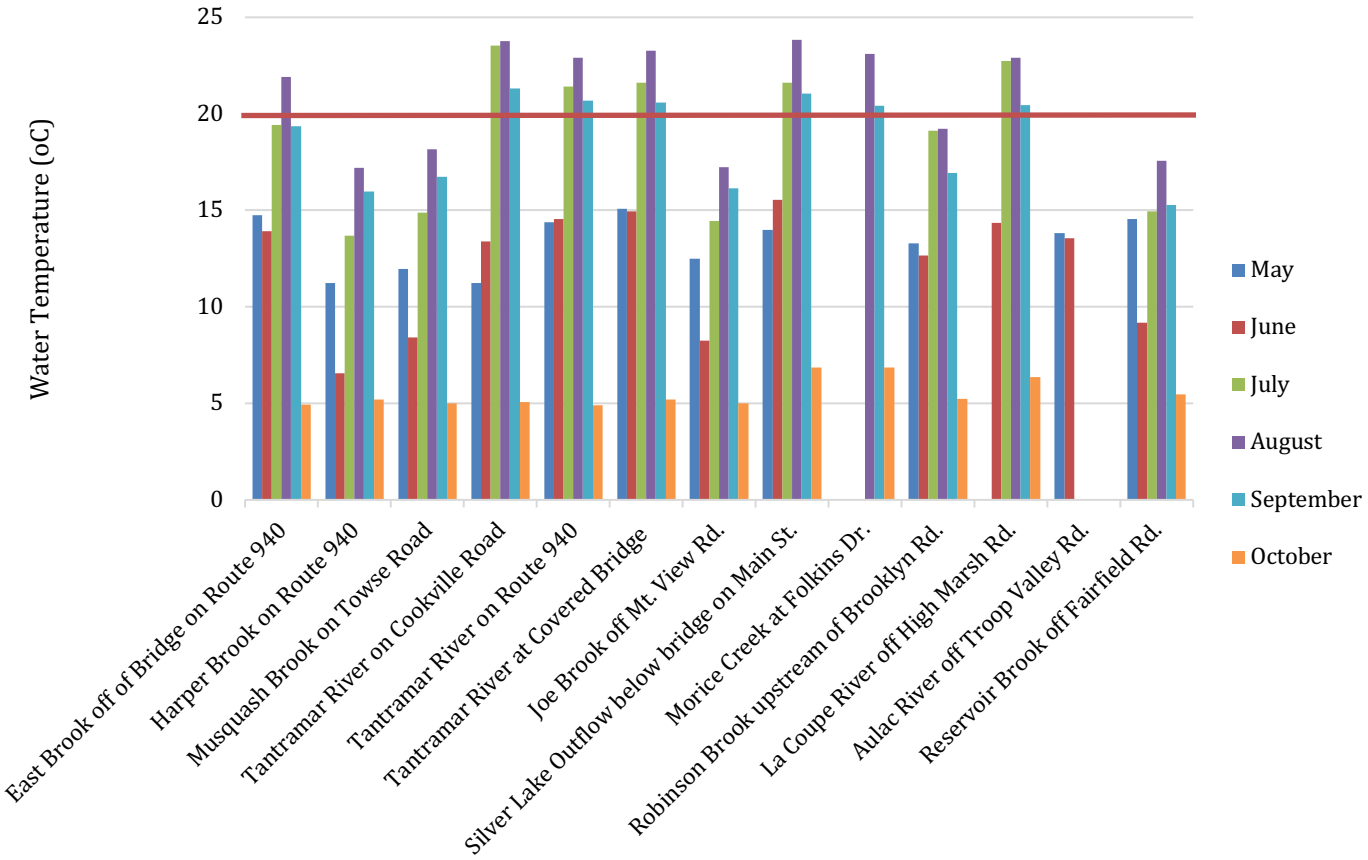

Figure 4: Monthly In-Situ Water Temperature. Red line indicates CCME maximum recommended temperature for cold water fish species.

pH

pH is a measure of acidity or alkalinity of the water. It is a logarithmic measurement of free hydrogen ions in solution. The pH scale is from 0 to 14, with a pH of 7 being neutral, < 7 acidic, and > 7 basic. According to the CCME guidelines, the ideal pH for surface water to support aquatic life is between 6.5 and 9.0. According to Health Canada's Recreational Guidelines, the recommended pH is 5.0 to 9.0. pH of surface water can be influenced by a number of factors including surficial geology, acid rain, wastewater effluent, sewer overflows from septic tanks, and agricultural runoff.

East Brook off of Route 940 had the lowest pH (ranging 5.62 to 6.34), with pH consistently below the recommended CCME guidelines over all the months (Table 4). This low pH could be attributed to the sample site being located downstream of the wwetlands to the east of Route 940 between Centre Village and Anderson Settlement drain into a Ducks Unlimited restoration site which can have lower pH due to the acidity of peat deposits in the wetlands.

In May, the Tantramar River Cookville Road site (6.43), Musquash Brook (6.35), and Robinson Brook (6.48) were slightly more acidic & below the CCME guideline (Table 4). LaCoupe River pH was below the CCME guideline in July (6.37) & August (6.36). Robinson Brook flows into the Tintamarre National Wildlife Area (NWA) which the LaCoupe River originates from. The NWA protects large raised bogs characterized by deep peat deposits which can lower pH levels of the soil. The pH results observed at the LaCoupe River are generally lower than the pH of Robinson Brook. Perhaps this could be due to passing through the lower pH wetlands in the NWA. It would be interesting to sample the Goose Creek outflow of the NWA in future sampling seasons to compare results and see if there are similarities.

In October, a number of sites in addition to East Brook were below the CCME pH guideline, including Harper Brook (6.48), Musquash Brook (6.37), Tantramar River at Route 940 (6.33), Robinson Brook (6.35), and Morice Creek (6.24). It should be noted that Silver Lake Outflow was within the Health Canada Recreational Guidelines across all months, indicating that it was safe for swimming, boating, etc.

Table 4: Monthly Water pH Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	5.62	6.09	6.34	6.12	6.09	6.05
Harper Brook on Route 940	7.13	7.57	7.51	6.92	6.86	6.48
Musquash Brook on Towse Road	6.35	6.97	7.02	7.19	7.02	6.37
Tantramar River on Cookville Road	6.43	6.78	6.84	7.03	6.97	6.54
Tantramar River on Route 940	6.82	6.95	6.73	6.74	6.74	6.33
Tantramar River at Covered Bridge	6.59	7.02	7.1	6.72	6.92	6.6
Joe Brook off Mt. View Rd.	6.81	7.14	7.08	7.14	7.08	6.74
Silver Lake Outflow below bridge on Main St.	6.93	7.37	7.31	7.20	7.07	6.86
Morice Creek at Folkins Dr.	-	-	-	6.95	6.88	6.24
Robinson Brook upstream of Brooklyn Rd.	6.48	7.37	7.13	7.09	6.96	6.35
La Coupe River off High Marsh Rd.	-	6.7	6.37	6.36	6.73	6.6
Aulac River off Troop Valley Rd.	7.48	7.47	-	-	-	-
Reservoir Brook off Fairfield Rd.	7	7.28	7.32	7.32	7.17	6.79

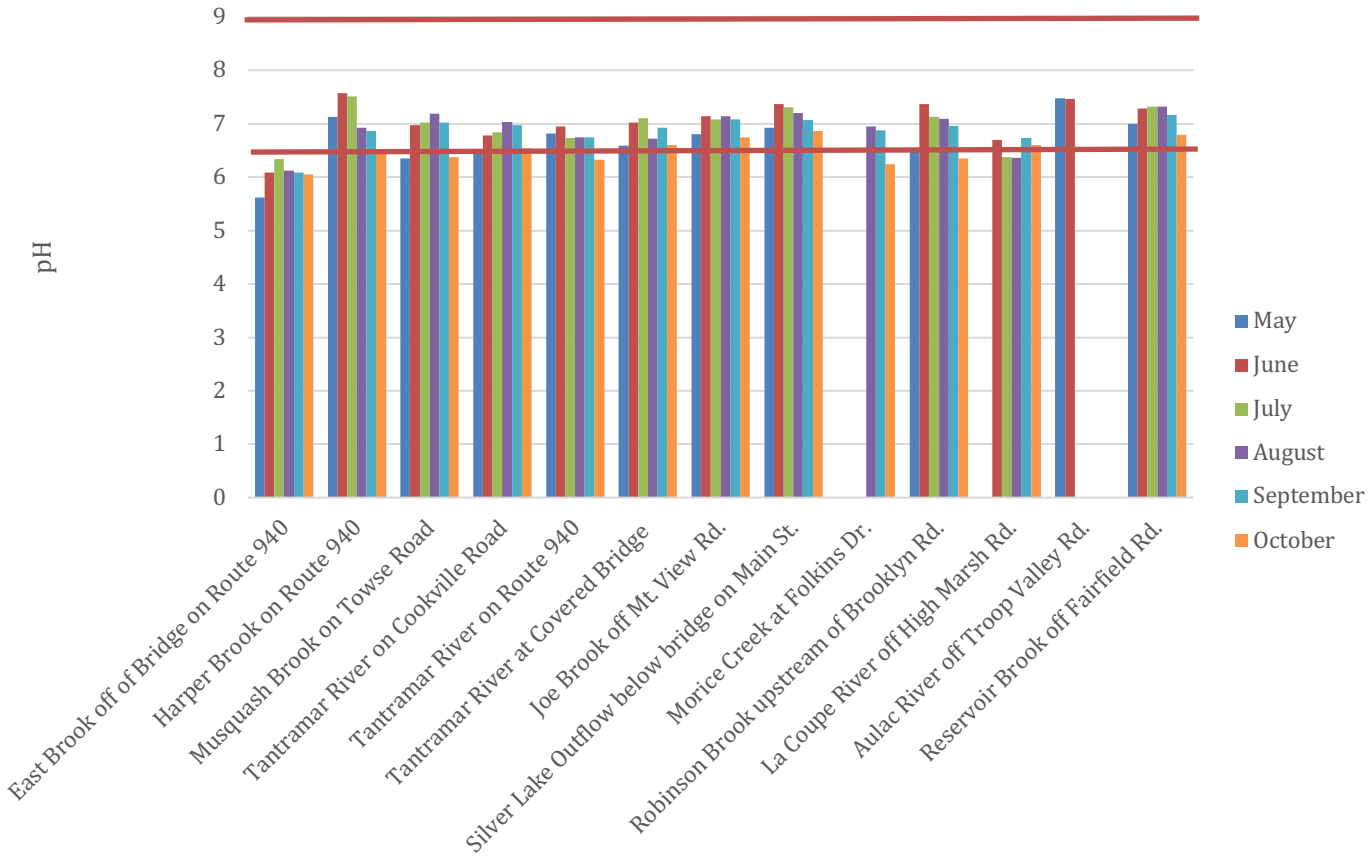

Figure 5: Monthly pH Measured In-Situ Using Hanna Multiparameter Meter

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is the amount of oxygen dissolved in the water that is available for aquatic life. New Brunswick has a water quality guideline of 6.5 mg/L DO for the protection of aquatic life (Table 2). As the temperature of a waterbody increases, the amount of dissolved oxygen in the water decreases. This is evident in our results with higher DO levels in May and October when the seasonal water temperatures were lower (Table 3). East Brook (ranging from 0 – 5.02 mg/L), Tantramar River off Cookville Road (ranging 4.45 – 4.38 mg/L), and La Coupe River (0 – 5.32 mg/L) all had DO levels below the recommended level for the protection of aquatic life from June to September when water temperatures were higher (Table 5). Low DO concentrations can also be due to slow moving or stagnant water, which can explain why these particular waterbodies have low DO as they are all slow-moving rivers & brooks. East Brook is also quiet small which leads to an even higher increase of temperature that can mean lower DO.

Concentrations of DO below 3 mg/L are considered hypoxic conditions, while water with DO < 0.5 mg/L is considered anoxic. Anoxic conditions can lead to an increase in release of phosphorus from sediments, resulting in algae blooms. Both East Brook (0 mg/L DO in

July) and La Coupe River (0 mg/L DO in August) experienced anoxic conditions throughout the sampling season. In addition, East Brook was hypoxic in August (1.53 mg/L DO) and September (1.02 mg/L), and La Coupe River was hypoxic in July (1.37 mg/L DO) (Table 5). We also saw leeches at the East Brook site which can be an indicator of low DO.

The Tantramar River at the Route 940 and at the Covered Bridge was also below the DO guideline for June, August, and September ranging from 5.25 mg/L to 6.47 mg/L (Table 5). Harper Brook was below in August (5.65 mg/L). The Silver Lake Outflow was slightly below for July (6.48 mg/L DO) and August (6.31 mg/L DO).

Table 5:Monthly Dissolved Oxygen (mg/L) Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	8.48	5.02	0	1.53	1.02	9.88
Harper Brook on Route 940	9.6	11.4	8.24	5.65	7.03	11.43
Musquash Brook on Towse Road	9.5	10.37	7.84	6.95	8.62	11.32
Tantramar River on Cookville Road	8.52	6.38	4.45	4.95	5.37	10.32
Tantramar River on Route 940	7.24	6.07	7.87	5.53	5.67	9.46
Tantramar River at Covered Bridge	7.21	5.83	8.24	5.25	6.47	9.58
Joe Brook off Mt. View Rd.	10.66	12.19	10.13	8.35	9.32	12.01
Silver Lake Outflow below bridge on Main St.	10.46	9.25	6.48	6.31	7.79	11.6
Morice Creek at Folkins Dr.	-	-	-	6.58	7.08	11.04
Robinson Brook upstream of Brooklyn Rd.	8.93	10.21	8.29	6.65	7.82	10.82
La Coupe River off High Marsh Rd.	-	5.32	1.37	0	4.94	7.68
Aulac River off Troop Valley Rd.	10.32	11.6	-	-	-	-
Reservoir Brook off Fairfield Rd.	13.96	11.55	10.33	8.02	9.93	11.44

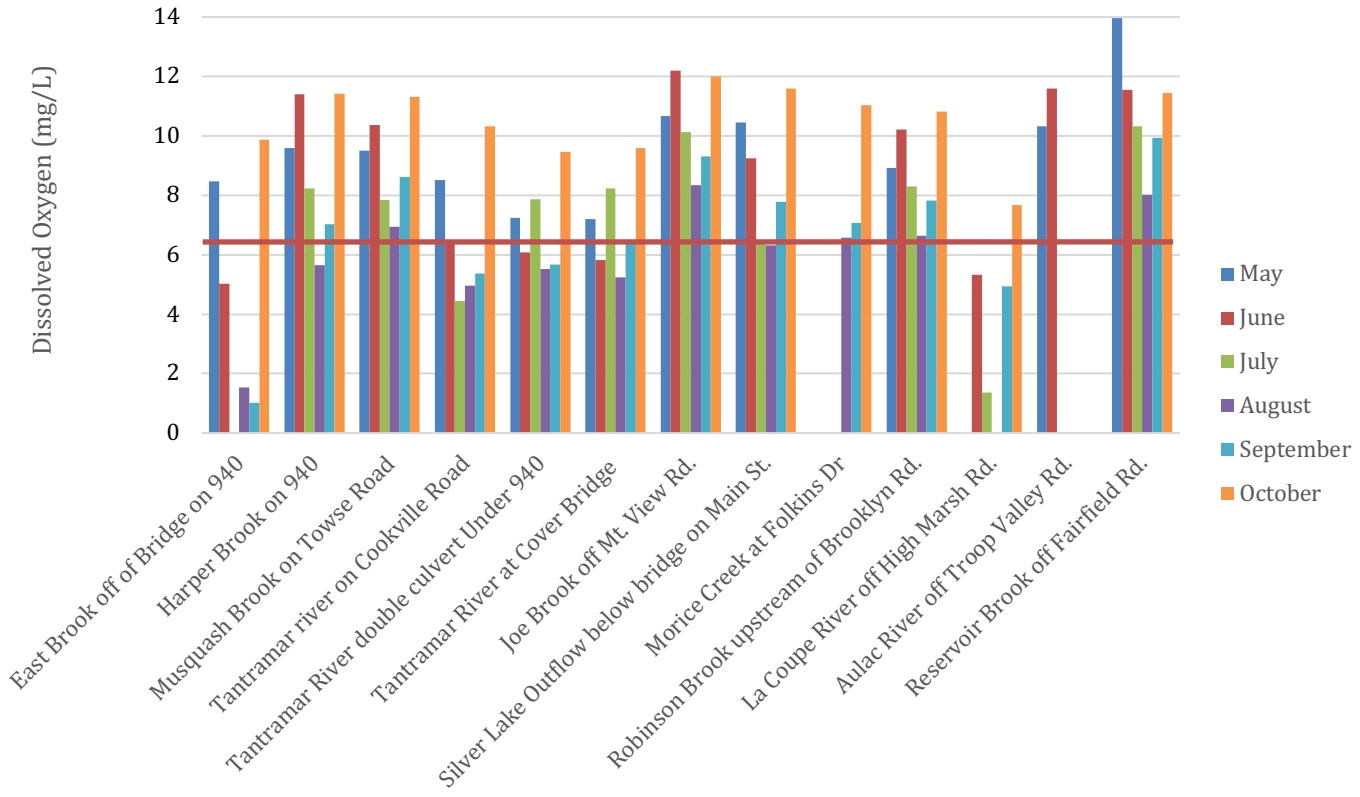

Figure 6:Monthly Dissolved Oxygen (mg/L)

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) is a measure of the quantity of dissolved solids within the water. TDS occurs naturally in water from sources such as algae, dead organic matter, and particulates from rock or soil. Since the dissolved solids are typically ions, TDS is directly related to conductivity. New Brunswick does not have a TDS guideline for water quality and CCME also does not have a recommended guideline for the protection of aquatic life. However, high levels of TDS can impact turbidity, clarity and colour of water, which when increased can lead to low DO levels (sometimes even anoxic conditions) due to the turbidity preventing sunlight from reaching aquatic plants.

Aulac River had the highest TDS values (267 – 270 ppm) in May and June (Table 6). This could be due to this being a tidally influenced river so naturally higher concentrations of ions. Morice Creek had the second highest TDS concentrations on average (103 ppm average) with an increase in September (Table 6). This site could have higher ions due to being downstream of a sewage lagoon. East Brook and Reservoir Brook had the lowest TDS concentrations, with East Brook seeing an increase in concentration in July (43 ppm) with a decrease of TDS into the fall, and Reservoir Brook seeing an increase in August (33 ppm) with a decrease in September (Table 6). In general, there seemed to be a trend of an increase in TDS during the summer months and decreasing in the fall (Figure 7)

Also, the less impacted sites tended to have lower TDS results, with the exception of Harper Brook which exhibited higher TDS on average (Figure7).

Table 6: Monthly In-Situ Total Dissolved Solids (ppm)

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	21	25	43	34	35	25
Harper Brook on Route 940	71	96	93	99	96	71
Musquash Brook on Towse Road	21	28	36	37	76	29
Tantramar River on Cookville Road	29	58	66	63	79	36
Tantramar River on Route 940	35	66	97	109	97	42
Tantramar River at Covered Bridge	44	87	121	103	112	59
Joe Brook off Mt. View Rd.	31	42	46	49	49	40
Silver Lake Outflow below bridge on Main St.	47	55	56	58	53	60
Morice Creek at Folkins Dr.	-	-	-	96	121	92
Robinson Brook upstream of Brooklyn Rd.	29	40	52	44	55	32
La Coupe River off High Marsh Rd.	-	94	119	79	51	87
Aulac River off Troop Valley Rd.	267	270	-	-	-	-
Reservoir Brook off Fairfield Rd.	28	29	29	33	34	25

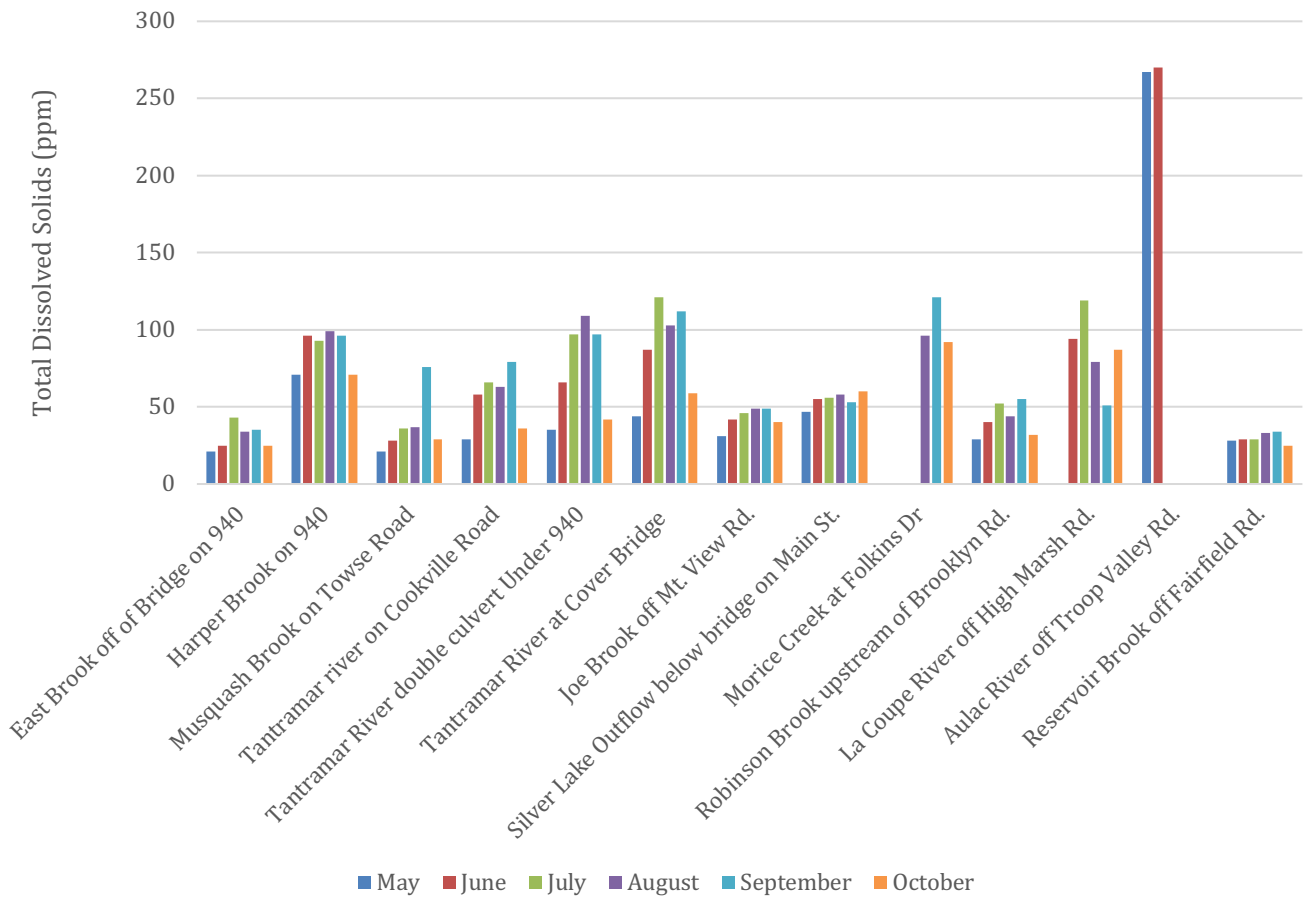

Figure 7: Monthly In-Situ Total Dissolved Solids (ppm)

Specific Conductivity

Specific conductivity (uS/cm) is a measure of the ability of water to carry an electrical current. As mentioned in the TDS section, conductivity is dependent on the quantity of dissolved inorganic solids (ions, e.g. sodium, chloride, nitrate, phosphate, etc.) and temperature. Conductivity in streams is typically based off of the surficial geology. The Tantramar River Watershed has fine-textured soils resulting from a combination of glacial till and marine deposits that are well suited to farming. Intertidal plains and salt marshes have clay, silt, some fine sand, minor peat and organic sediments; all of which can increase conductivity, TDS, and salinity in our waterways. Specific conductivity means that the conductivity is adjusted as if the sample had been taken at a reference temperature (usually 25^{o}C) so that conductivity can be compared across samples taken at different water temperatures. Similar to TDS, there is no water quality guideline for conductivity.

Aulac River had the highest conductivity out of the sites with 533 uS/cm in May and 539 uS/cm in June (Table 7, Figure 8). The RPC surface water chemistry lab results (Table 38) showed high concentrations of ions such as sodium, calcium, and chloride which

would increase the conductivity. Aulac River also has a tide gate that sometimes allows the river to be tidally influenced which would lead to high conductivity due to an increase in salinity and TDS.

Otherwise, generally our less impacted sites had lower conductivity results, with the exception of Harper Brook which exhibited higher conductivity on average (175 uS/cm) (Table 7, Figure 8). Impacted streams are expected to have higher conductivities due to storm water runoff or sewage discharges. The conductivity results also appear to be lowest in May and October, and higher from June to September (Figure 8).

Table 7: Monthly In-Situ Specific Conductivity (uS/cm)

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	41	50	87	68	70	51
Harper Brook on Route 940	141	193	187	198	191	141
Musquash Brook on Towse Road	41	56	72	74	72	58
Tantramar River on Cookville Road	58	115	130	126	157	72
Tantramar River on Route 940	71	131	194	218	195	84
Tantramar River at Covered Bridge	88	171	243	205	223	118
Joe Brook off Mt. View Rd.	62	83	92	98	97	80
Silver Lake Outflow below bridge on Main St.	93	110	112	115	106	120
Morice Creek at Folkins Dr.	-	-	-	197	243	185
Robinson Brook upstream of Brooklyn Rd.	58	80	104	88	109	64
La Coupe River off High Marsh Rd.	-	188	238	159	103	175
Aulac River off Troop Valley Rd.	533	539	-	-	-	-
Reservoir Brook off Fairfield Rd.	56	59	59	66	67	50

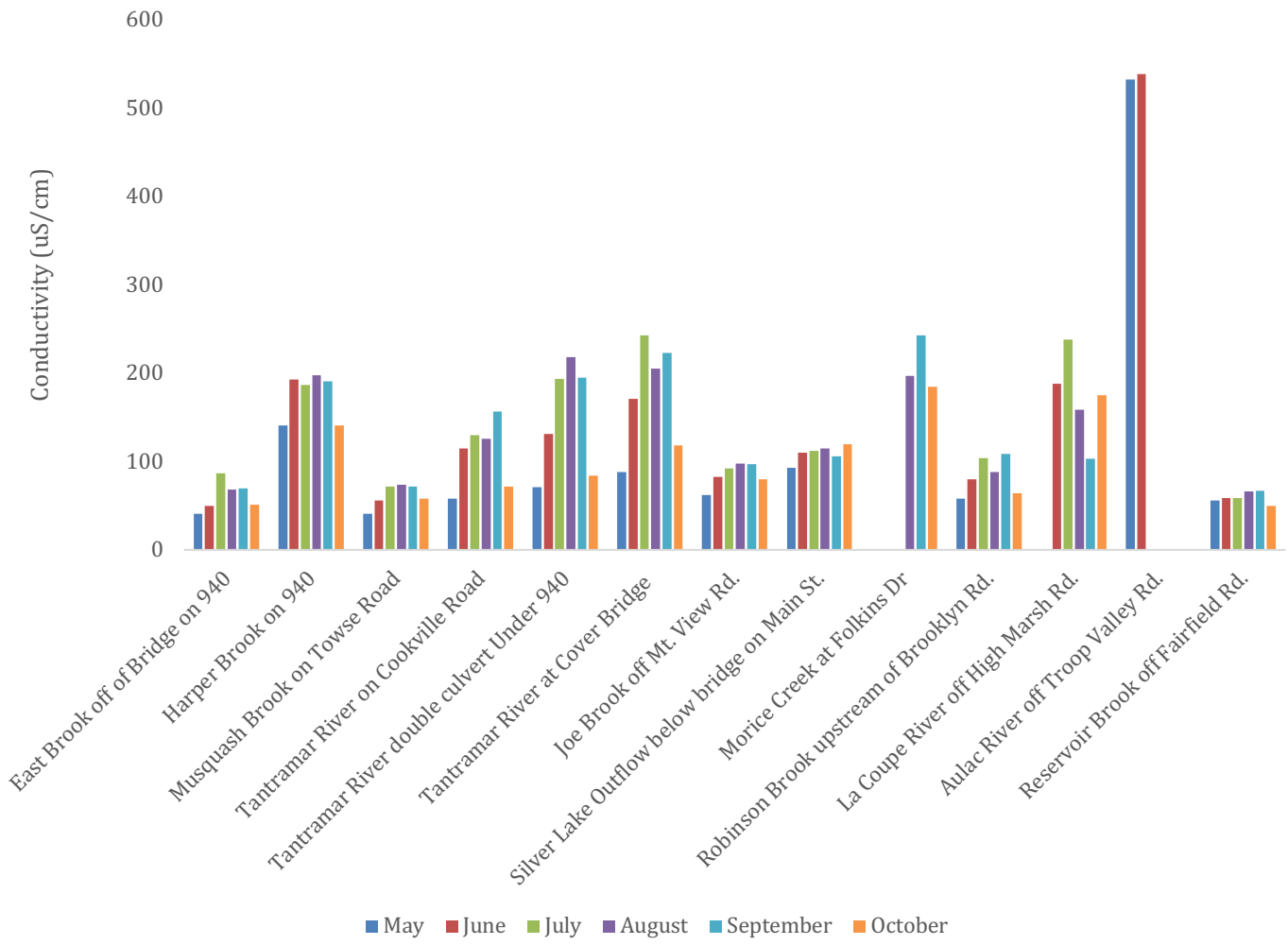

Figure 8: Monthly In-Situ Specific Conductivity (uS/cm)

Salinity

Salinity is the concentration of dissolved salt ions (e.g. salt, NaCl, dissolved into a sodium ion (Na) and chloride ion (Cl)). As it is related to conductivity and TDS, there are no water quality guidelines to compare our results too and the potential sources of salinity are the same as TDS and conductivity. We also found that the results followed the same patterns with Aulac River having the highest salinity (0.24 ppm), and our less impacted sites having lower salinity concentrations than our more impacted sites (Table 8, Figure 9).

Table 8: Monthly In-Situ Salinity (ppm)

Sample Site	May	June	July	August	September	October
East Brook off of Bridge on Route 940	0.02	0.02	0.04	0.03	0.03	0.02
Harper Brook on Route 940	0.07	0.09	0.09	0.09	0.09	0.07
Musquash Brook on Towse Road	0.02	0.03	0.03	0.03	0.03	0.03
Tantramar River on Cookville Road	0.07	0.05	0.06	0.06	0.07	0.03
Tantramar River on Route 940	0.03	0.06	0.09	0.1	0.09	0.04
Tantramar River at Covered Bridge	0.04	0.08	0.11	0.1	0.11	0.05
Joe Brook off Mt. View Rd.	0.03	0.04	0.04	0.05	0.05	0.04
Silver Lake Outflow below bridge on Main St.	0.04	0.05	0.05	0.05	0.05	0.06
Morice Creek at Folkins Dr.	-	-	-	0.09	0.12	0.09
Robinson Brook upstream of Brooklyn Rd.	0.03	0.04	0.05	0.04	0.05	0.03
La Coupe River off High Marsh Rd.	-	0.09	0.11	0.07	0.05	0.08
Aulac River off Troop Valley Rd.	0.26	0.26	-	-	-	-
Reservoir Brook off Fairfield Rd.	0.03	0.03	0.03	0.03	0.03	0.02

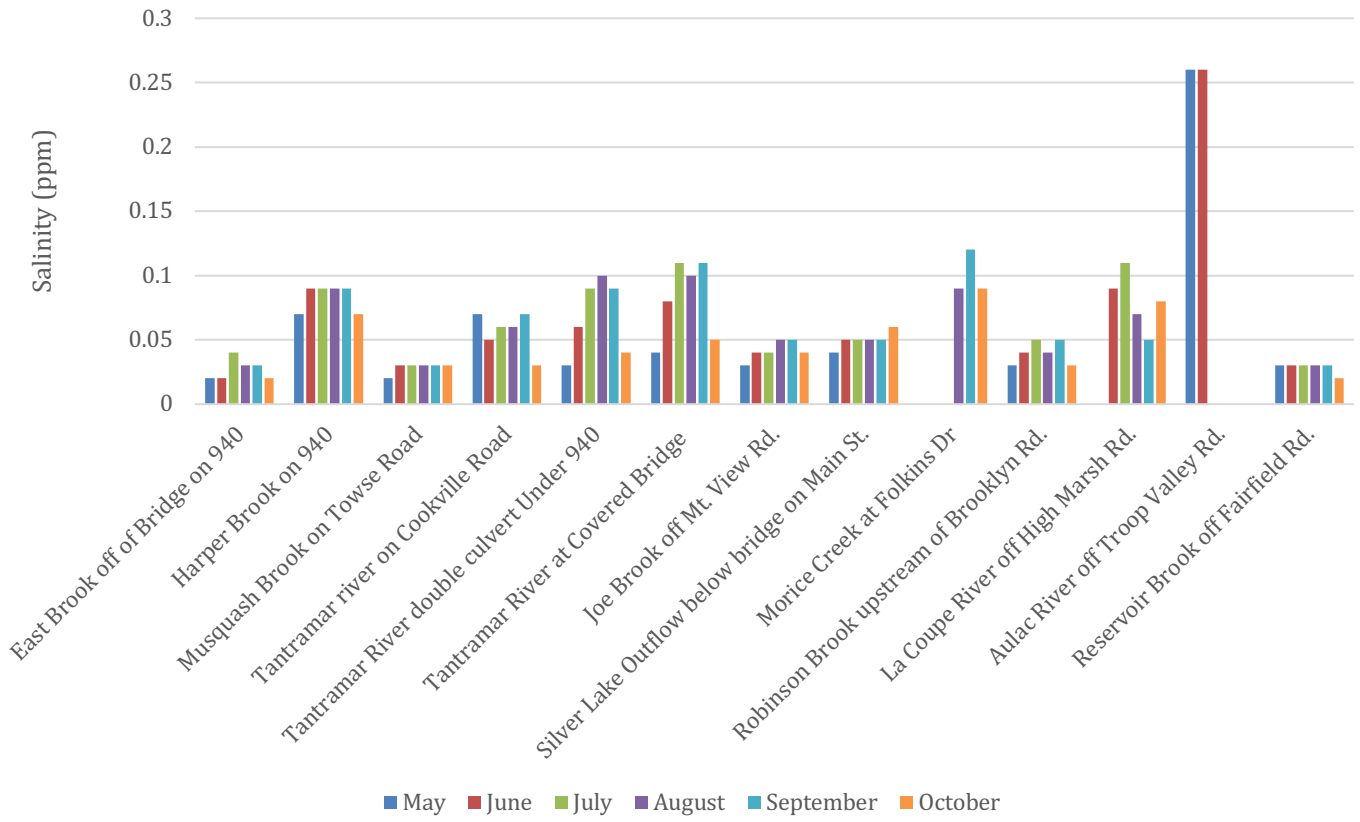

Figure 9: Monthly In-Situ Salinity (ppm)

RPC Surface Water Chemistry Results by Sample Site

In addition to our in-situ measurements, water quality grab samples were taken to be analyzed at RPC Moncton. This section of the results provides a by site description of the surface water quality results from RPC. We have chosen to also highlight E. Coli and nutrients (total phosphorus and total nitrates) through graphical representation as they are a concern in our area due to the large percentage of agricultural land within our watershed.

E.Coli

Escherichia coli (E. coli) is the most appropriate indicator of faecal contamination in fresh recreational waters. The presence of these fecal indicators could mean there are other disease-causing pathogens present, such as bacteria, viruses, and parasites. Although many strains of coliform bacteria are harmless, certain strains (e.g. *E. coli* 0157:H7) may cause illness. The results were then compared to the Guidelines for Canadian Recreational Water Quality. Water is safe for swimming when bacteria levels are below the guidelines, which Health Canada based off of risk management decisions which evaluated the potential health risks and the benefits of recreational water use for physical activity and enjoyment. For the case of our sampling, a single-sample was taken at each location from June to September, so we compared samples to the single-sample maximum guidelines (see table 9 below). **Every time you take a water sample it is just a snapshot of the water quality at that location at that point in time. This is why an average of multiple samples taken from different locations along a beach is typically used for evaluating water quality. This is also why long-term monitoring is valuable as you can look at the natural variations in water quality and see the trends over time to get an idea of what is expected.**

Table 9: Canadian Recreational Water Quality Guidelines

Enterococci	***E. coli***
A geometric mean of most recent five samples equal to or less than 35 enterococci/100 ml	A geometric mean of most recent five samples equal to or less than 200 E. coli/100 ml
A single-sample maximum equal to or less than 70 enterococci/100 ml	A single-sample maximum equal to or less than 400 E. coli/100 ml

For the most part E. Coli was below the single-sample maximum according to the Canadian Recreational Water Quality Guidelines (Table 36, Figure 10). With the exception of La Coupe River exceeding the guideline in August (435.2 MPN/100mL) and September (2092.4 MPN/100mL); Harper Brook (1226.2 MPN/100mL) and Morice Creek (976.8 MPN/100mL) also exceeded the guideline in September.

Table 10: Monthly E. Coli (MPN/100mL)

Sample Site	June	July	August	September
East Brook off of Bridge on Route 940	193.5	44.1	62	111.2
Harper Brook on Route 940	1	9.8	137.4	1226.2
Musquash Brook on Towse Road	20.1	7.5	39.9	21.8
Tantramar River on Cookville Road	38.9	145.5	98.4	48.2
Tantramar River on Route 940	35.9	104.3	235.9	139.4
Tantramar River at Covered Bridge	135.4	36.4	107.1	186.4
Joe Brook off Mt. View Rd.	8.5	22.8	-	-
Silver Lake Outflow below bridge on Main St.	<1	2	2	40.2
Morice Creek at Folkins Dr.	-	-	29.2	976.8
Robinson Brook upstream of Brooklyn Rd.	40.4	35	24.3	21.8
La Coupe River off High Marsh Rd.	32.7	107.1	435.2	2092.4
Aulac River off Troop Valley Rd.	64.5	--	-	-
Reservoir Brook off Fairfield Rd.	13.2	6.3	29.2	61.8

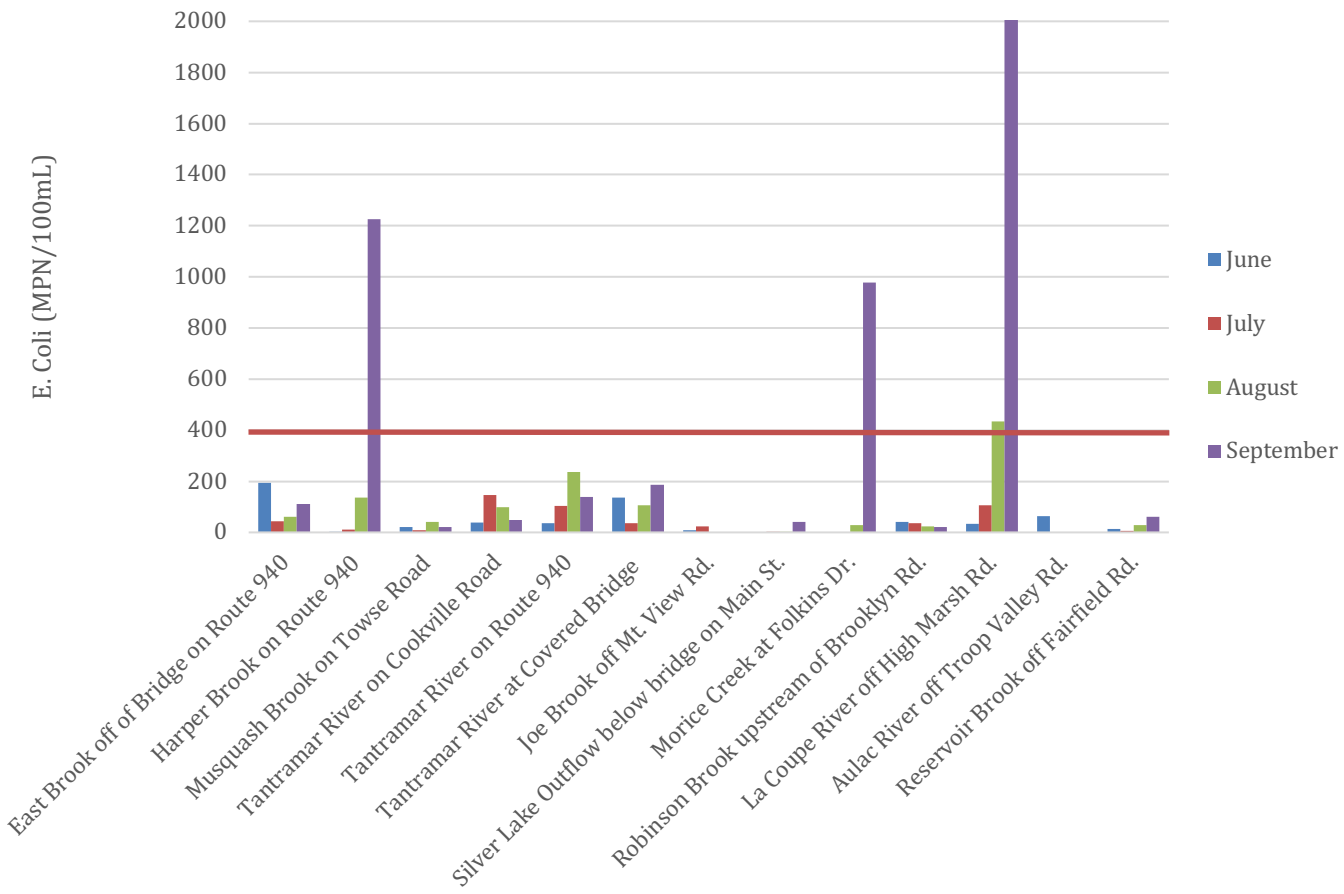

Figure 10: Monthly E. Coli (MPN/100mL)

Total Phosphorus (TP)

The New Brunswick total phosphorus limit for protection of aquatic life is < 0.03 mg/L (Table 2). Phosphorus is a component of many important nutrient compounds used by plants, such as phosphates. Phosphorus is also the limiting nutrient for algal growth which can lead to eutrophication. Total phosphorus can range to ultra-oligotrophic (very low, < 0.004 mg/L TP) to hyper-eutrophic very high, (> 0.1 mg/L TP) (Table 37). Total phosphorus measures both organic and inorganic phosphates in the surface water. Phosphorus can be present naturally due to geological formations or decomposing organic matter. It is usually adsorbed by sediments. Phosphorus can also enter waterways from runoff from fertilizer, manure storage, wastewater treatment effluent, and septic systems leaching.

Table 11: Total phosphorus trigger ranges for Canadian lakes and rivers (Source: CCME)

Trophic Status	Canadian Trigger Ranges Total phosphorus ($\mu g \cdot L^{-1}$)
Ultra-oligotrophic	< 4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	> 100

Many of our samples exceeded the NB total phosphorus guideline (0.03 mg/L) for the protection or aquatic life and were in eutrophic (0.035 – 0.100 mg/L) states, with even the September sample from Morice Creek being hyper-eutrophic (>0.100 mg/L) (table 38, figure 11).

East Brook, the Tantramar River at all 3 sites (Cookville Road, Route 940, Covered Bridge), and La Coupe River exceeded the guideline from June to September. The La Coupe River had the highest total phosphorus sample in August with 0.17 mg/L. July had the most samples over the limit (9/10 sample sites), with the addition of Harper Brook (0.038 mg/L), Joe Brook (0.073 mg/L), Silver Lake Outflow (0.043 mg/L), and Robinson Brook (0.082 mg/L) exceeding the limit. Robinson Brook also exceeded the limit in August and September. The Morice Creek site exceeded the limit both months when it was sampled (0.072 mg/L in August & 0.112 mg/L in September). Aulac River also exceeded the limit the one time it was sampled (0.079 mg/L).

Table 12: Total Phosphorus (mg/L)

Sample Site	June	July	August	September
East Brook off of Bridge on Route 940	0.058	0.065	0.035	0.06
Harper Brook on Route 940	0.022	0.038	0.019	0.02
Musquash Brook on Towse Road	0.009	0.023	0.015	0.018
Tantramar River on Cookville Road	0.043	0.069	0.053	0.058
Tantramar River on Route 940	0.035	0.07	0.101	0.072
Tantramar River at Covered Bridge	0.034	0.051	0.064	0.076
Joe Brook off Mt. View Rd.	0.008	0.073	0.01	0.01
Silver Lake Outflow below bridge on Main St.	0.022	0.043	0.02	0.03
Morice Creek at Folkins Dr.	-	-	0.071	0.112
Robinson Brook upstream of Brooklyn Rd.	0.022	0.082	0.061	0.055
La Coupe River off High Marsh Rd.	0.066	0.096	0.17	0.079
Aulac River off Troop Valley Rd.	0.079	-	-	-
Reservoir Brook off Fairfield Rd.	0.007	0.026	0.024	0.016

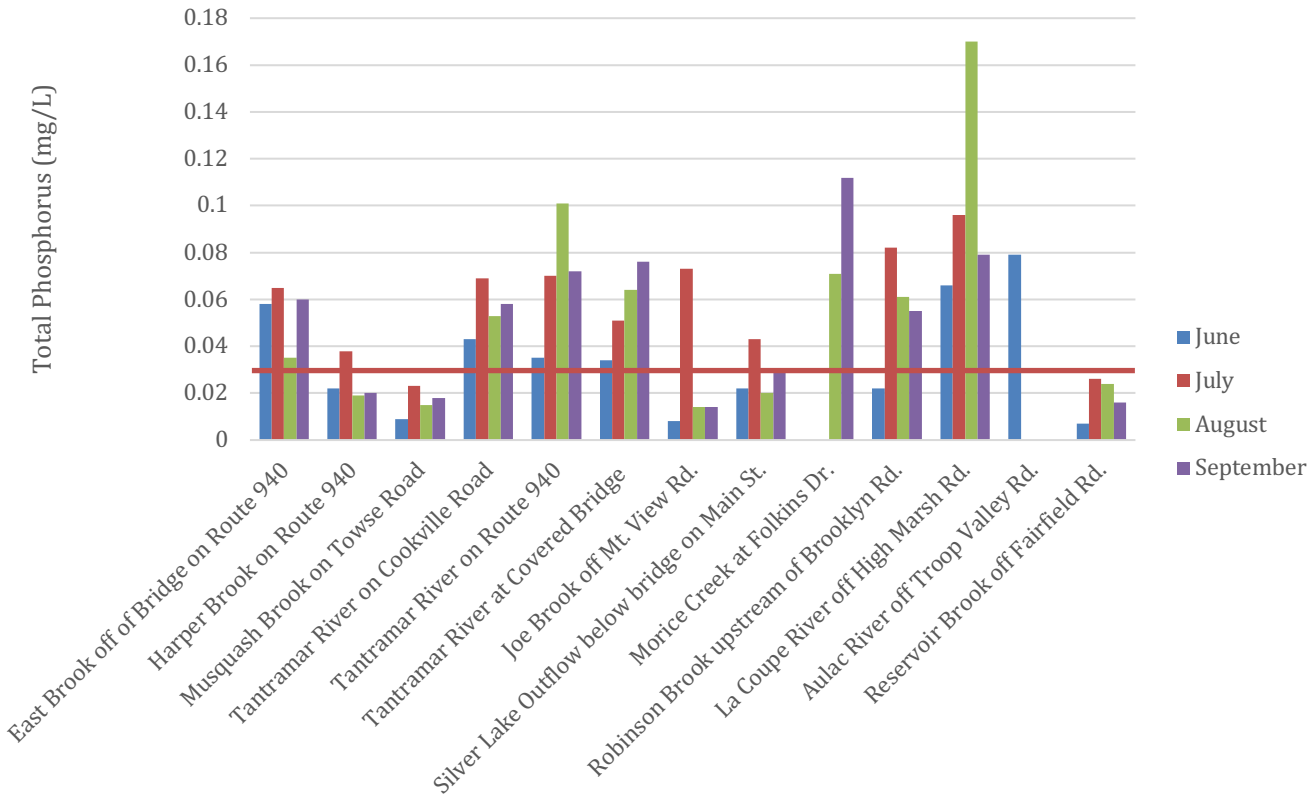

Figure 11:Monthly Total Phosphorus (mg/L)

Total Nitrates

Nitrate (NO_3) is another important nutrient that can act as a limiting factor of plant growth. Increased nitrogen levels can be due to agricultural and urban runoff, wastewater treatment effluent, leeching from septic systems, and storm sewer overflows. The New Brunswick total nitrate concentration in freshwater for the protection of aquatic life is 2.9 mg/L (Table 2). All of our samples were below the recommended total nitrate guideline, with a majority of sites being below the detection limit (< 0.05 mg/L) (Table 39, Figure 12).

Harper Brook had the highest concentrations of total nitrates (0.3 – 0.47 mg/L, Figure 12) which decreased from June to September. Morice Creek followed the same trend with decreasing concentrations of total nitrates from August to September (0.1-0.23 mg/L). Musquash Brook, Joe Brook, and Reservoir Brook saw an increase in total nitrate concentrations during the summer months (June to August) and then a slight decrease in September, with the exception of Robinson Brook which remained the same concentration in September.

Table 13: Monthly Total Nitrates (mg/L) Results from RPC

Sample Site	June	July	August	September
East Brook off of Bridge on Route 940	< 0.05	< 0.05	< 0.05	< 0.05
Harper Brook on Route 940	0.47	0.38	0.34	0.3
Musquash Brook on Towse Road	< 0.05	0.16	0.2	0.1
Tantramar River on Cookville Road	0.08	< 0.05	< 0.05	0.07
Tantramar River on Route 940	< 0.05	< 0.05	< 0.05	< 0.05
Tantramar River at Covered Bridge	< 0.05	< 0.05	< 0.05	< 0.05
Joe Brook off Mt. View Rd.	< 0.05	0.08	0.09	< 0.05
Silver Lake Outflow below bridge on Main St.	< 0.05	< 0.05	< 0.05	< 0.05
Morice Creek at Folkins Dr.	-	-	0.1	0.23
Robinson Brook upstream of Brooklyn Rd.	< 0.05	0.08	0.12	0.12
La Coupe River off High Marsh Rd.	< 0.05	< 0.05	< 0.05	< 0.05
Aulac River off Troop Valley Rd.	< 0.05	-	-	-
Reservoir Brook off Fairfield Rd.	< 0.05	0.08	0.11	0.07

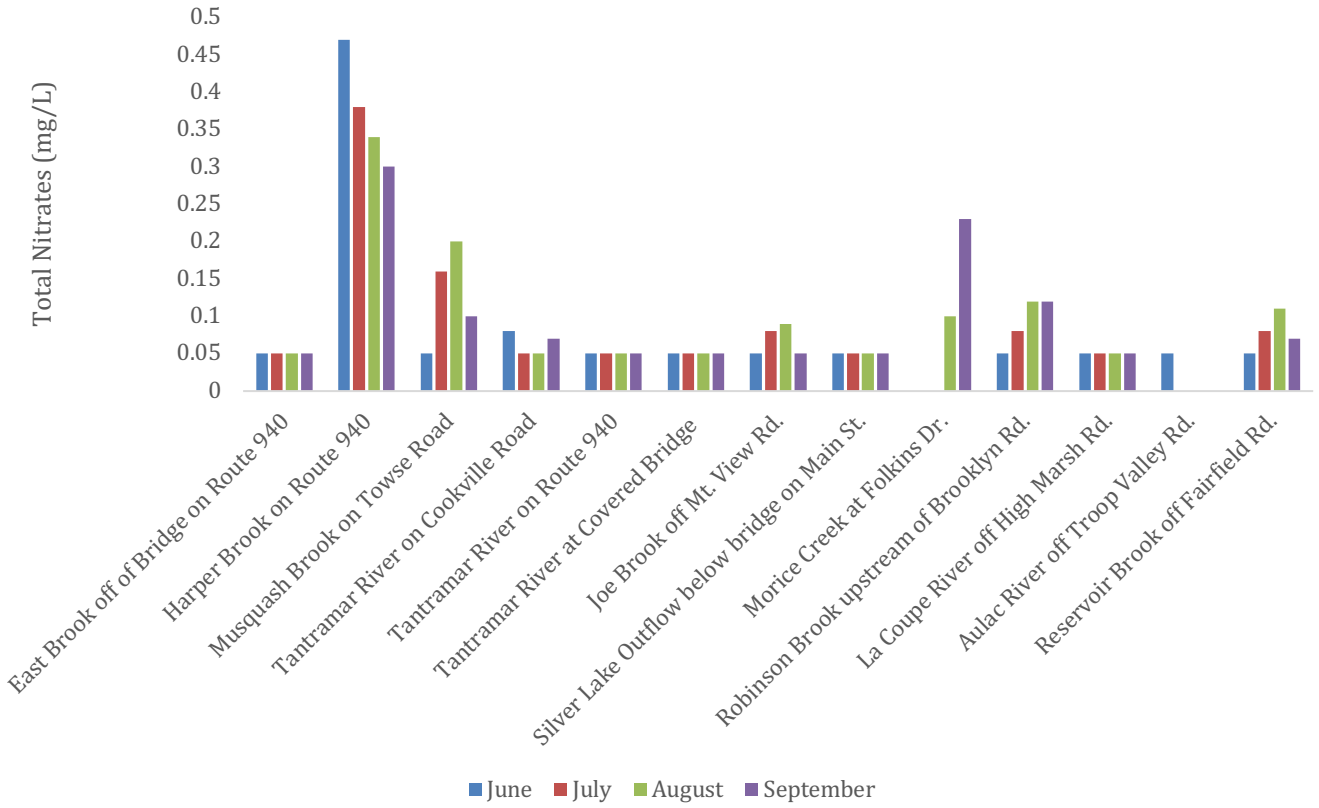

Figure 12: Monthly Total Nitrates (mg/L)

Surface Water Quality by Sample Site

Tantramar River off Cookville Road

Total phosphorus exceeded New Brunswick 0.03 mg/L guideline for total phosphorus under the Canadian Environmental Sustainability Indicator, with the concentration increasing from June (0.034 mg/L) to September (0.076 mg/l) (Table 9). According to the CCME Canadian Trigger Ranges, this means that the Tantramar River is eutrophic (0.035 – 0.1 mg/L).

The concentration of Aluminum (Al) exceeded the CCME guideline for the protection of aquatic life of 100 µg/L for surface water with a pH ≥ 6.5 in June (134 µg/L), July (121 µg/L) and September (101 µg/L) (Table 10). The province of New Brunswick is known to have higher levels of naturally occurring Al. Therefore, with runoff, rain events, or snow melt can cause Al to leach into the waterways from the soils. This site also exceeded the New Brunswick guideline for iron (Fe) 300 µg/L for the protection of aquatic life across all months (530 – 880 µg/L) (Table 10). Similar to Al, Fe would enter the river through runoff from naturally occurring Fe in the watershed rocks or soils. Iron can also enter waterbodies through anthropogenic sources such as urban runoff or wastewater effluent.

Table 14: Tantramar River off Cookville Road Surface Water Chemistry

TANTRAMAR RIVER ON COOKVILLE ROAD: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	7.00	0.55	9.45	0.80	20	13.5	220	2	0.07	70	< 1	0.6	80	< 50	80	0.043	15.6	125	92	7.0	2.8	20.0	0.019	26.9	0.7	47	9.0	-2.04
2018-07-16	8.81	0.69	12.3	1.06	29	16.9	240	< 1	0.10	60	< 1	0.5	< 50	< 50	< 50	0.069	18.0	148	113	7.0	3.0	29.0	0.027	35.1	0.5	59	8.8	-1.77
2018-08-15	7.93	0.88	11.5	1.04	26	14.6	180	4	0.08	< 50	< 1	0.9	< 50	< 50	< 50	0.053	16	91	108	7.2	2.3	26.0	0.039	33.0	0.9	57	8.8	-1.65
2018-09-04	11.1	0.78	13.9	1.20	30	23.1	200	< 1	0.14	70	< 1	0.7	70	< 50	70	0.058	20	144	138	7.1	1.8	30.0	0.036	39.6	0.8	70	8.7	-1.61

Table 15: Tantramar River off Cookville Road Surface Water Metals

TANTRAMAR RIVER ON COOKVILLE ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	134	< 0.1	< 1	125	< 0.1	< 1	5	0.02	9450	< 1	0.2	< 1	590	0.2	0.8	800	256	< 0.1	< 1	550	1.1	< 1	< 0.1	7000	81	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-07-16	121	< 0.1	1	153	< 0.1	< 1	7	0.01	12300	< 1	0.2	< 1	880	0.4	1	1060	400	0.1	< 1	690	1.8	< 1	< 0.1	8810	107	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-08-15	53	< 0.1	< 1	150	< 0.1	< 1	8	< 0.01	11500	< 1	< 0.1	< 1	530	0.2	0.9	1040	160	0.1	< 1	880	2	< 1	< 0.1	7930	102	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-09-04	101	< 0.1	1	198	< 0.1	< 1	7	0.01	13900	< 1	0.2	< 1	770	0.3	1.4	1200	446	0.1	< 1	780	2	< 1	< 0.1	11100	145	< 0.1	< 0.1	< 0.1	0.1	< 1	2

Tantramar River off Route 940

Moving further south down Tantramar River, we see a continuation with the New Brunswick guideline for total phosphorus (0.03 mg/L) being exceeded across all months, with an increase from June to August (0.035 – 0.101 mg/L), and a slight decrease to 0.072 mg/L total phosphorus in September (Table 11). According to the CCME Canadian Trigger Ranges, this means that the Tantramar River is hyper-eutrophic in August (> 0.1 mg/L) and eutrophic (0.035 – 0.1 mg/L) in June, July, and September.

Again, the concentrations of Al exceeded the CCME guideline for the protection of aquatic life (100 µg/L Al for surface water with a pH ≥ 6.5) with similar numbers of Al to further upstream at the Tantramar River at Cookville Road: June (128 µg/L), July (100 µg/L), and September (113 µg/L) exceeding the guideline, and a decrease in the Al concentration in August (51 µg/L)(Table 12). This site also exceeded the New Brunswick guideline for Fe (300 µg/L) across all months (790-1460 µg/L) (Table 12). These concentrations of Al are slightly higher than further upstream.

Table 16: Tantramar River off Route 940 Surface Water Chemistry

TANTRAMAR RIVER DOUBLE CULVERT UNDER 940: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	10.6	0.58	7.57	1.43	19	19.9	210	2	0.08	< 50	< 1	0.5	< 50	< 50	< 50	0.035	13.9	119	106	7.0	3.7	19.0	0.018	24.8	0.5	55	9.2	-2.16
2018-07-16	17.5	0.73	10.9	2.31	29	32.1	230	< 1	0.15	< 50	< 1	0.7	< 50	< 50	< 50	0.07	16.8	137	160	7.1	5.4	29.0	0.034	36.7	0.7	83	8.8	-1.74
2018-08-15	19.2	1.65	14.1	2.38	33	38.5	190	3	0.19	< 50	< 1	1.3	< 50	< 50	< 50	0.101	13	82	198	7.1	8.4	33.0	0.039	45.0	1.3	100	8.7	-1.58
2018-09-04	18.6	0.90	11.0	2.42	28	34.7	240	< 1	0.17	110	< 1	0.9	< 50	< 50	< 50	0.072	21	160	174	7.1	4.9	28.0	0.033	37.4	0.9	87	8.8	-1.75

Table 17: Tantramar River off Route 940 Surface Water Metals

TANTRAMAR RIVER DOUBLE CULVERT UNDER 940: SURFACE WATER METALS																														
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	128	< 0.1	< 1	70	< 0.1	< 1	15	0.01	7570	< 1	0.2	< 1	790	0.3	0.8	1430	245	< 0.1	< 1	580	1	< 1	< 0.1	10600	53	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-07-16	100	< 0.1	2	99	< 0.1	< 1	15	< 0.01	10900	< 1	0.2	< 1	1460	0.4	1.2	2310	321	0.1	< 1	730	1.5	< 1	< 0.1	17500	91	< 0.1	< 0.1	0.2	< 0.1	1	2
2018-08-15	51	< 0.1	1	137	< 0.1	< 1	15	< 0.01	14100	< 1	0.2	< 1	810	0.2	1.3	2380	202	0.1	< 1	1650	2.8	< 1	< 0.1	19200	132	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-09-04	113	0.1	1	111	< 0.1	< 1	14	0.01	11000	< 1	0.2	< 1	1380	0.4	1.3	2420	293	< 0.1	< 1	900	1.7	< 1	< 0.1	18600	95	< 0.1	< 0.1	< 0.1	< 0.1	1	4

Tantramar River by Covered Bridge

The trend in total phosphorus continues at our last site on the Tantramar River at the Covered Bridge off of Highmarsh Road. The New Brunswick guideline for total phosphorus (0.03 mg/L) is exceeded for all samples taken, with an increase in concentration of total phosphorus from June to September (0.034 – 0.076 µg/L) (Table 13). According to the CCME Canadian Trigger Ranges, this means that the Tantramar River eutrophic (0.035 – 0.1 mg/L).

Unlike further upstream, the concentration of Al only exceeded the CCME guideline (100 µg/L Al for surface water with a pH ≥ 6.5) in June (115 µg/L). However, the concentration of Fe remained very similar exceeding the CCME guideline of 300 µg/L from June to September with concentrations of Al ranging from 660 to 1360 µg/L (Table 14).

Table 18: Tantramar River by Covered Bridge Surface Water Chemistry

TANTRAMAR RIVER AT COVERED BRIDGE: SURFACE WATER CHEMICALS																														
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	12.8	0.70	6.73	1.95	20	22.1	190	3	0.08	< 50	< 1	0.5	< 50	< 50	< 50	0.034	12.3	104	118	7.0	3.8	20.0	0.019	24.8	0.5	60	9.2	-2.19
2018-07-16	27.0	1.07	12.1	3.32	34	47.3	210	< 1	0.20	60	< 1	0.8	< 50	< 50	< 50	0.051	15.1	123	225	7.3	6.4	33.9	0.064	43.9	0.8	113	8.7	-1.43
2018-08-15	20.2	1.18	11.0	2.75	29	38.6	190	4	0.16	< 50	< 1	0.9	< 50	< 50	< 50	0.064	14	101	191	7.0	4.8	29.0	0.027	38.8	0.9	97	8.8	-1.84
2018-09-04	23.4	1.10	9.72	3.20	32	41.2	180	< 1	0.17	110	< 1	0.7	100	< 50	< 50	0.076	18	141	202	7.2	5.8	31.9	0.048	37.4	0.8	100	8.8	-1.65

Table 19: Tantramar River by Covered Bridge Surface Water Metals

TANTRAMAR RIVER AT COVERED BRIDGE: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	115	< 0.1	< 1	61	< 0.1	< 1	13	0.01	6730	< 1	0.2	< 1	660	0.3	1	1950	123	< 0.1	< 1	700	0.9	< 1	< 0.1	12800	38	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1
2018-07-16	85	< 0.1	2	104	< 0.1	< 1	21	< 0.01	12100	< 1	0.2	< 1	1360	0.4	1.6	3320	278	0.1	< 1	1070	1.5	< 1	< 0.1	27000	89	< 0.1	< 0.1	0.1	0.2	1	2
2018-08-15	60	< 0.1	1	105	< 0.1	< 1	20	0.01	11000	< 1	0.2	< 1	920	0.3	1.5	2750	184	0.1	< 1	1180	1.7	< 1	< 0.1	20200	84	< 0.1	< 0.1	< 0.1	< 0.1	1	2
2018-09-04	92	< 0.1	1	93	< 0.1	< 1	22	< 0.01	9720	< 1	0.2	< 1	1270	0.4	1.5	3200	197	< 0.1	< 1	1100	1.5	< 1	< 0.1	23400	63	< 0.1	< 0.1	< 0.1	0.1	1	2

East Brook

The total phosphorus in East Brook exceeded the New Brunswick guideline (0.03 mg/L) and was considered eutrophic according to the CCME Canadian Trigger Ranges from June to September with concentrations of total phosphorus ranging between 0.035 to 0.065 mg/L (Table 15). The RPC laboratory pH also fell outside of the CCME guidelines for the protection of aquatic life (pH between 6.5 and 9) in June (6.5) and July (6.2), however the pH increased to 6.6 for August and September (Table 15). Similarly, the in-situ pH was below the CCME pH guideline from May to October with the pH ranging from 5.62 to 6.34 (Table 4).

The concentration of Aluminum (Al) exceeded the CCME guideline for the protection of aquatic life of 100 µg/L for surface water with a pH ≥ 6.5 across all months with concentrations falling between 220 and 364 µg/L (Table 16). The iron (Fe) concentrations also exceeded the New Brunswick guideline (300 µg/L) across all months with concentrations ranging from 690 to 1870 µg/L (Table 16). The September water sample also had a 9 µg/L concentration of zinc (Zn) (Table 21) which exceeds the New Brunswick guideline of 7.5 µg/L for surface water with a hardness less than or equal to 90 mg/L (East Brook hardness ranges from 11.1 – 20.5 mg/L, Table 20).

Table 20: East Brook Surface Water Chemistry

EAST BROOK OFF OF BRIDGE ON 940: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	3.31	0.15	3.59	0.51	7	5.1	260	1	0.02	< 50	< 1	0.8	< 50	< 50	< 50	0.058	22	195	36	6.3	9.7	7.0	0.001	11.1	0.8	19	9.9	-3.59
2018-07-16	3.82	0.30	5.92	0.76	15	5.3	350	1	0.05	< 50	< 1	1.1	< 50	< 50	< 50	0.065	27	247	49	6.2	3.0	15.0	0.002	17.9	1.1	30	9.3	-3.15
2018-08-15	3.99	0.22	5.96	0.82	15	5.6	240	3	0.04	< 50	< 1	1.1	< 50	< 50	< 50	0.035	29	185	52	6.6	1.6	15.0	0.006	18.3	1.1	30	9.3	-2.74
2018-09-04	3.81	0.34	6.85	0.83	15	5.7	300	< 5	0.04	< 50	< 1	1.2	< 50	< 50	< 50	0.060	35	276	52	6.6	2.7	15.0	0.006	20.5	1.2	30	9.3	-2.68

Table 21: East Brook Surface Water Metals

EAST BROOK OFF OF BRIDGE ON 940: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	364	< 0.1	< 1	40	< 0.1	< 1	4	0.02	3590	< 1	0.3	< 1	690	0.6	0.5	510	137	< 0.1	< 1	150	0.6	< 1	< 0.1	3310	15	< 0.1	< 0.1	< 0.1	< 0.1	< 1	4
2018-07-16	259	< 0.1	1	69	< 0.1	< 1	6	0.03	5920	< 1	1.5	< 1	1680	0.6	0.5	760	1380	< 0.1	1	300	1	< 1	< 0.1	3820	26	< 0.1	< 0.1	< 0.1	< 0.1	< 1	7
2018-08-15	220	< 0.1	< 1	61	< 0.1	< 1	6	0.02	5960	< 1	0.6	< 1	950	0.3	0.6	820	400	< 0.1	< 1	220	0.8	< 1	< 0.1	3990	27	< 0.1	< 0.1	< 0.1	< 0.1	< 1	6
2018-09-04	347	< 0.1	1	73	< 0.1	< 1	4	0.04	6850	< 1	1.3	< 1	1870	0.7	0.7	830	1000	< 0.1	1	340	1.2	< 1	< 0.1	3810	29	< 0.1	< 0.1	< 0.1	0.1	1	9

Harper Brook

Harper Brook was one of our most minimally impacted sample sites, so it was comforting to see that the only guideline exceeded was the New Brunswick guideline for total phosphorus (0.03 mg/L) in July with a concentration of 0.038 mg/L deeming it slightly eutrophic (0.035 – 0.1 mg/L) by the CCME guidelines (Table 22). Otherwise, the brook was mesotrophic (0.010 – 0.020 mg/L) in August (0.019 mg/L), borderline mesotrophic and meso-eutrophic (0.020 – 0.035 mg/L) in September, and meso-eutrophic in June (0.022 mg/L) (Table 22).

Table 22: Harper Brook Surface Water Chemistry

HARPER BROOK ON 940: SURFACE WATER CHEMICALS																													
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	7.64	0.71	22.8	1.42	63	8.2	140	4	0.03	< 50	< 1	0.2	470	< 50	470	0.022	2.9	9	166	7.6	0.6	62.7	0.235	62.8	0.7	86	8.2	-0.59
2018-07-16	8.91	0.90	22.7	1.43	69	7.1	140	4	0.04	< 50	< 1	0.2	380	< 50	380	0.038	1.3	7	169	7.5	0.8	68.8	0.205	62.6	0.6	89	8.2	-0.65
2018-08-15	10.2	1.08	23.1	1.44	63	11.6	120	6	0.04	< 50	< 1	0.2	340	< 50	340	0.019	2.5	14	179	7.5	1.1	62.8	0.187	63.6	0.6	94	8.2	-0.68
2018-09-04	8.52	1.45	23.1	1.53	72	6.8	100	3	0.03	< 50	< 1	0.2	300	< 50	300	0.020	2.3	18	171	7.5	1.0	71.8	0.213	64.0	< 0.2	90	8.1	-0.63

Table 23: Harper Brook Surface Water Metals

HARPER BROOK ON 940: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	20	< 0.1	1	188	< 0.1	< 1	7	0.01	22800	< 1	< 0.1	< 1	90	< 0.1	0.7	1420	97	0.3	< 1	710	1	< 1	< 0.1	7640	75	< 0.1	< 0.1	< 0.1	0.2	< 1	1
2018-07-16	19	< 0.1	1	240	< 0.1	< 1	11	< 0.01	22700	< 1	< 0.1	< 1	130	< 0.1	1.1	1430	161	0.6	< 1	900	1.4	< 1	< 0.1	8910	89	< 0.1	< 0.1	< 0.1	0.2	< 1	< 1
2018-08-15	11	< 0.1	1	250	< 0.1	< 1	12	< 0.01	23100	< 1	< 0.1	< 1	170	< 0.1	1.1	1440	173	0.7	< 1	1080	2	< 1	< 0.1	10200	90	< 0.1	< 0.1	< 0.1	0.2	< 1	1
2018-09-04	12	< 0.1	1	268	< 0.1	< 1	12	< 0.01	23100	< 1	< 0.1	< 1	140	< 0.1	1.1	1530	94	0.6	< 1	1450	2.4	< 1	< 0.1	8520	89	< 0.1	< 0.1	< 0.1	0.2	< 1	2

Musquash Brook

Musquash Brook was another one of our less impacted sites. Based on the total phosphorus CCME guidelines, the brook was oligotrophic (0.04-0.01 mg/L) in June (0.009 mg/L), meso-eutrophic in July (0.023 mg/L), and mesotrophic in August (0.015 mg/L) and September (0.018 mg/L) (Table 24). The iron (Fe) concentrations exceeded the New Brunswick guideline (300 µg/L) from July to September with concentrations ranging from 340 to 480 µg/L (Table 25).

Table 24: Musquash Brook Surface Water Chemistry

MUSQUASH BROOK ON TOWSE ROAD: SURFACE WATER CHEMICALS																											
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	2.66	0.25	4.39	0.57	12	3.8	150	2	0.02	< 50	< 1	0.2	< 50	< 50	< 50	0.009	6.7	40	41	7.0	0.5	12.0	0.011	13.3	0.2	21	9.6	-2.56
2018-07-16	3.18	0.43	6.52	0.87	20	3.9	170	< 1	0.04	< 50	< 1	0.3	160	< 50	160	0.023	6.6	36	57	7.1	0.9	20.0	0.024	19.9	0.5	29	9.2	-2.08
2018-08-15	3.21	0.56	6.85	0.98	20	4.0	150	2	0.04	< 50	< 1	0.4	200	< 50	200	0.015	8.4	52	59	7.3	1.1	20.0	0.038	21.1	0.6	31	9.2	-1.86
2018-09-04	2.98	0.47	6.80	0.85	20	3.2	130	2	0.04	< 50	< 1	0.2	100	< 50	100	0.018	7.4	39	56	7.3	1.3	20.0	0.038	20.5	0.3	30	9.2	-1.87

Table 25: Musquash Brook Surface Water Metals

MUSQUASH BROOK ON TOWSE ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	64	< 0.1	1	48	< 0.1	< 1	5	0.03	4390	< 1	< 0.1	< 1	210	< 0.1	0.3	570	86	< 0.1	< 1	250	0.6	< 1	< 0.1	2660	14	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-07-16	49	< 0.1	1	73	< 0.1	< 1	8	0.06	6520	< 1	0.2	< 1	350	0.2	0.4	870	262	< 0.1	< 1	430	1.4	< 1	< 0.1	3180	23	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-08-15	31	< 0.1	1	68	< 0.1	< 1	7	0.03	6850	< 1	0.1	< 1	480	0.1	0.4	980	158	< 0.1	< 1	560	1.9	< 1	< 0.1	3210	26	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-09-04	30	< 0.1	1	65	< 0.1	< 1	8	0.03	6800	< 1	0.1	< 1	340	< 0.1	0.4	850	111	< 0.1	< 1	470	1.5	< 1	< 0.1	2980	25	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2

Robinson Brook

Robinson Brook is one of our most pristine sites, flowing into the Tintamarre National Wildlife Area and being previously used as an ECCC CABIN reference site. The total phosphorus was 0.022 mg/L in June, making it meso-eutrophic (Table 26). The total phosphorus concentrations quadrupled in July (0.082 mg/L) exceeding the New Brunswick guideline (0.03 mg/L) and making the brook eutrophic. The brook remained above the New Brunswick total phosphorus guideline and classified as eutrophic for August (0.061 mg/L) and September (0.055 mg/L), however there was a slight decrease in concentration each month (Table 26).

Aluminum concentrations exceeded the CCME guideline (100 µg/L Al for surface water with a pH ≥ 6.5) from June to August (115-114 µg/L), however in September it was below the guideline with a concentration of 78 µg/L (Table 27). The concentrations of iron exceeded the CCME guideline (300 µg/L) from June to September ranging from 410 – 1420 µg/L (Table 27).

Table 26: Robinson Brook Surface Water Chemistry

ROBINSON BROOK UPSTREAM OF BROOKLYN ROAD: SURFACE WATER CHEMICALS																											
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	3.24	0.35	7.95	1.33	21	5.0	230	2	0.03	< 50	< 1	0.5	< 50	< 50	< 50	0.022	14.2	121	62	7.2	0.8	21.0	0.031	25.3	0.5	34	9.1	-1.88
2018-07-16	3.66	0.64	11.5	1.87	36	5.4	340	< 1	0.04	80	< 1	0.7	80	< 50	80	0.082	12.7	92	87	7.2	2.8	35.9	0.053	36.4	0.8	50	8.7	-1.50
2018-08-15	3.35	0.59	9.71	1.50	27	4.9	270	3	0.04	60	< 1	1.0	120	< 50	120	0.061	23	168	72	7.2	1.6	27.0	0.040	30.4	1.1	42	8.9	-1.69
2018-09-04	3.47	0.80	11.4	1.86	34	4.4	230	2	0.05	90	< 1	0.6	120	< 50	120	0.055	17	122	84	7.2	2.1	33.9	0.051	36.1	0.2	47	8.7	-1.53

Table 27: Robinson Brook Surface Water Metals

ROBINSON BROOK UPSTREAM OF BROOKLYN ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	115	< 0.1	< 1	80	< 0.1	< 1	6	0.01	7950	< 1	0.2	< 1	410	0.1	0.6	1330	178	< 0.1	< 1	350	0.7	< 1	< 0.1	3240	26	< 0.1	< 0.1	< 0.1	0.1	< 1	2
2018-07-16	115	< 0.1	1	169	< 0.1	< 1	6	0.02	11500	< 1	1.8	< 1	1420	0.4	0.8	1870	2420	< 0.1	< 1	640	1.5	< 1	< 0.1	3660	41	< 0.1	< 0.1	< 0.1	0.2	1	5
2018-08-15	114	< 0.1	< 1	109	< 0.1	< 1	6	< 0.01	9710	< 1	0.3	< 1	890	0.2	0.7	1500	299	< 0.1	< 1	590	1.6	< 1	< 0.1	3350	34	< 0.1	< 0.1	< 0.1	0.1	< 1	3
2018-09-04	78	< 0.1	< 1	111	< 0.1	< 1	6	< 0.01	11400	< 1	0.3	< 1	820	0.2	0.8	1860	208	< 0.1	< 1	800	2	< 1	< 0.1	3470	39	< 0.1	< 0.1	< 0.1	0.1	1	2

Reservoir Brook

Reservoir Brook ranged from oligotrophic in June (0.007 mg/L) to meso-eutrophic in July (0.026 mg/L) and August (0.024 mg/L), and mesotrophic in September (0.016 mg/L) based on the CCME total phosphorus guidelines (Table 28)

The CCME guidelines for the protection of aquatic life states that the guideline for long-term exposure to cadmium (Cd) is 0.04 µg/L Cd for water with a hardness of < 17 mg/L. Reservoir Brook has a hardness ranging from 9.5 to 13 mg/L (all < 17 mg/L), and the concentration of Cd is 0.04 µg/L in July and August (Table 29).

Table 28: Reservoir Brook Surface Water Chemistry

RESERVOIR BROOK OFF FAIRFIELD ROAD: SURFACE WATER CHEMICALS																											
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	3.84	0.48	2.47	0.80	9	6.0	110	3	0.02	< 50	< 1	0.1	< 50	< 50	< 50	0.007	2.6	18	43	7.0	0.3	9.0	0.008	9.5	< 0.2	22	9.9	-2.94
2018-07-16	3.83	0.56	3.02	0.89	10	5.2	120	2	0.03	< 50	< 1	0.1	80	< 50	80	0.026	1.9	11	46	7.1	1.0	10.0	0.012	11.2	< 0.2	22	9.8	-2.71
2018-08-15	4.45	0.65	3.23	1.05	12	5.6	110	3	0.03	< 50	< 1	0.2	110	< 50	110	0.024	2.9	18	52	7.2	1.5	12.0	0.018	12.4	0.3	26	9.7	-2.50
2018-09-04	4.20	0.64	3.53	1.02	14	5.5	100	< 1	0.03	< 50	< 1	0.1	70	< 50	70	0.016	2.6	18	52	7.1	0.7	14.0	0.017	13.0	0.2	24	9.6	-2.50

Table 29: Reservoir Brook Surface Water Metals

RESERVOIR BROOK OFF FAIRFIELD ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	45	< 0.1	< 1	100	< 0.1	< 1	4	0.02	2470	< 1	< 1	< 1	100	< 0.1	0.8	800	58	< 0.1	< 1	480	0.7	< 1	< 0.1	3840	24	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-07-16	52	< 0.1	< 1	126	< 0.1	< 1	5	0.04	3020	< 1	0.2	< 1	190	0.3	1	890	149	< 0.1	< 1	560	0.9	< 1	< 0.1	3830	30	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-08-15	70	< 0.1	< 1	141	< 0.1	< 1	6	0.04	3230	< 1	0.4	< 1	280	0.4	1.2	1050	198	< 0.1	< 1	650	1.2	< 1	< 0.1	4450	34	< 0.1	< 0.1	< 0.1	< 0.1	< 1	5
2018-09-04	29	< 0.1	< 1	124	< 0.1	< 1	6	0.02	3530	< 1	< 1	< 1	160	0.1	1.2	1020	53	< 0.1	< 1	640	1.2	< 1	< 0.1	4200	34	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2

Joe Brook

Joe Brook runs into Silver Lake. In June the brook is oligotrophic (0.008 mg/L) based off CCME guidelines for total phosphorus, in July the concentration increases to 0.073 mg/L and exceeds the New Brunswick guideline of 0.03 mg/L making it eutrophic (Table 30). The concentration decreases in August and September and is considered mesotrophic (0.014 mg/L) (Table 30).

The CCME guidelines for the protection of aquatic life states that the guideline for long-term exposure to cadmium (Cd) is 0.04 µg/L Cd for water with a hardness of < 17 mg/L. In June, Joe Brook has a cadmium concentration of 0.13 µg/L at a hardness of 17 mg/L, so we highlighted it as a potential exceedance of the guideline (Table 30, Table 31). The June to August samples also exceeds the New Brunswick guideline of zinc (7.5 µg/L) for surface water with a hardness less than or equal to 90 mg/L (Joe Brook hardness ranges from 17 – 23.9 mg/L, Table 30).

Table 30: Joe Brook Surface Water Chemistry

JOE BROOK OFF MT. VIEW ROAD: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	5.06	0.43	5.13	1.02	13	8.8	170	5	0.03	< 50	< 1	0.1	< 50	< 50	< 50	0.008	4.7	39	64	7.1	0.5	13.0	0.015	17.0	< 0.2	34	9.5	-2.38
2018-07-16	5.80	0.55	6.25	1.23	18	7.9	150	4	0.03	< 50	< 1	< 0.1	80	< 50	80	0.073	2.3	22	76	7.1	0.6	18.0	0.021	20.7	< 0.2	38	9.3	-2.15
2018-08-15	5.84	0.64	7.19	1.44	19	7.9	170	5	0.04	< 50	< 1	0.2	90	< 50	90	0.014	4.9	37	82	7.2	0.5	19.0	0.028	23.9	0.3	41	9.2	-1.97
2018-09-04	5.77	0.60	7.17	1.33	21	10.9	130	4	0.04	< 50	< 1	< 0.1	< 50	< 50	< 50	0.014	2.9	23	79	7.2	0.5	21.0	0.031	23.4	< 0.2	43	9.1	-1.93

Table 31: Joe Brook Surface Water Metals

JOE BROOK OFF MT. VIEW ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	63	< 0.1	< 1	101	< 0.1	< 1	4	0.13	5130	< 1	< 0.1	< 1	180	0.2	1	1020	119	< 0.1	< 1	430	0.7	< 1	< 0.1	5060	34	< 0.1	< 0.1	< 0.1	< 0.1	< 1	16
2018-07-16	21	< 0.1	< 1	129	< 0.1	< 1	5	0.09	6250	< 1	< 0.1	< 1	160	0.1	1.2	1230	122	< 0.1	< 1	550	0.9	< 1	< 0.1	5800	48	< 0.1	< 0.1	< 0.1	< 0.1	< 1	9
2018-08-15	31	< 0.1	< 1	134	< 0.1	< 1	6	0.08	7190	< 1	< 0.1	< 1	230	0.2	1.4	1440	148	< 0.1	< 1	640	1.2	< 1	< 0.1	5840	57	< 0.1	< 0.1	< 0.1	< 0.1	< 1	9
2018-09-04	20	< 0.1	< 1	121	< 0.1	< 1	6	0.06	7170	< 1	< 0.1	< 1	180	0.2	1.4	1330	125	< 0.1	< 1	600	1.1	< 1	< 0.1	5770	55	< 0.1	< 0.1	< 0.1	< 0.1	< 1	7

Silver Lake Outflow

June the lake outflow starts off as mesotrophic with a total phosphorus concentration of 0.022 mg/L (Table 32). Similar to the incoming Joe Brook, we see an increase in total phosphorus in July (0.043 mg/L), exceeding the New Brunswick guideline for total phosphorus (0.03 mg/L) and making it eutrophic (Table 32). In August the total phosphorus decreases back to a mesotrophic state (0.018 mg/L) and increases again to meso-eutrophic in September (0.028 mg/L) (Table 32).

The concentration of Aluminum (Al) in June slightly exceeded the CCME guideline for the protection of aquatic life (100 µg/L Al for surface water with a pH ≥ 6.5) with a concentration of 101 µg/L (Table 33).

Table 32: Silver Outflow Surface Water Chemistry

SILVER LAKE OUTFLOW BELOW BRIDGE ON MAIN STREET: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	9.05	0.71	5.86	0.91	12	15.4	140	5	0.03	< 50	< 1	0.2	< 50	< 50	< 50	0.022	5.9	38	91	7.2	3.5	12.0	0.018	18.4	0.2	45	9.5	-2.26
2018-07-16	9.59	0.78	6.28	1.02	16	17.4	160	3	0.03	< 50	< 1	0.3	< 50	< 50	< 50	0.043	7.3	39	96	7.2	1.9	16.0	0.024	19.9	0.3	48	9.3	-2.11
2018-08-15	9.98	0.87	5.97	1.19	15	19.1	160	5	0.04	< 50	< 1	0.4	< 50	< 50	< 50	0.018	6.1	29	99	7.2	1.2	15.0	0.022	19.8	0.4	52	9.4	-2.16
2018-09-04	8.93	0.90	5.79	1.08	15	16.2	150	< 1	0.03	< 50	< 1	0.3	< 50	< 50	< 50	0.028	9.5	51	89	7.2	1.8	15.0	0.022	18.9	0.3	43	9.4	-2.17

Table 33: Silver Lake Outflow Surface Water Metals

SILVER LAKE OUTFLOW BELOW BRIDGE ON MAIN STREET: SURFACE WATER METALS																														
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	101	< 0.1	< 1	102	< 0.1	< 1	5	0.04	5860	< 1	< 0.1	< 1	270	0.4	0.8	910	124	< 0.1	< 1	710	1.1	< 1	< 0.1	9050	30	< 0.1	< 0.1	< 0.1	< 0.1	< 1	7
2018-07-16	51	< 0.1	< 1	101	< 0.1	< 1	6	0.02	6280	< 1	< 0.1	< 1	230	0.2	0.9	1020	136	< 0.1	< 1	780	1.3	< 1	< 0.1	9590	37	< 0.1	< 0.1	< 0.1	< 0.1	< 1	4
2018-08-15	25	< 0.1	< 1	100	< 0.1	< 1	7	< 0.01	5970	< 1	< 0.1	< 1	180	0.2	0.9	1190	146	0.1	< 1	870	1.5	< 1	< 0.1	9980	40	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-09-04	49	< 0.1	< 1	112	< 0.1	< 1	7	0.01	5790	< 1	< 0.1	< 1	240	0.3	0.9	1080	153	0.1	< 1	900	1.6	< 1	< 0.1	8930	36	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3

Morice Creek

Morice Creek didn't start being monitored until August, so we only have 2 months' worth of data. The sample site is downstream from Silver Lake Outflow and the Middle Sackville Sewage Lagoon and ultimately flows out into the Tantramar River. Both months that the creek was sampled exceeded the New Brunswick guideline for total phosphorus (0.03 mg/L), with eutrophic conditions in August (0.071 mg/L) and hyper-eutrophic conditions in September (0.112 mg/L) according to CCME guidelines (Table 34).

The aluminum concentration doubled from August (44 µg/L) to September (106 µg/L), with September exceeding the CCME guideline for the protection of aquatic life (100 µg/L Al for surface water with a pH ≥ 6.5) (Table 35). This site also exceeded the New Brunswick guideline for Fe (300 µg/L) for both August (340 µg/L) and September (480 µg/L) (Table 35).

Table 34: Morice Creek Surface Water Chemistry

MORICE CREEK AT FOLKINS DRIVE: SURFACE WATER CHEMICALS																													
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12																													
2018-07-16																													
2018-08-15	20.2	1.36	8.85	1.87	22	36.9	170	7	0.07	120	< 1	0.6	100	< 50	100	0.071	6.3	33	177	7.2	2.7	22.0	0.033	29.8	0.7	91	9.0	-1.85
2018-09-04	25.7	2.42	10.8	2.41	28	42.8	180	7	0.10	180	0.001	0.6	230	< 50	230	0.112	9.1	50	223	7.2	6.5	28.0	0.042	36.9	0.8	110	8.9	-1.67

Table 35: Morice Creek Surface Water Metals

MORICE CREEK AT FOLKINS DRIVE: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12																															
2018-07-16																															
2018-08-15	44	< 0.1	< 1	105	< 0.1	< 1	14	0.01	8850	< 1	0.1	< 1	340	0.2	1.1	1870	219	0.2	< 1	1360	1.9	< 1	< 0.1	20200	50	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2018-09-04	106	< 0.1	< 1	124	< 0.1	< 1	18	0.02	10800	< 1	0.2	1	480	0.5	1.4	2410	221	0.1	< 1	2420	2.6	< 1	< 0.1	25700	56	< 0.1	< 0.1	< 0.1	0.2	1	4

La Coupe River

La Coupe River flows out of Tintamarre National Wildlife Area and into Aulac River. The total phosphorus concentrations exceeded the New Brunswick guideline of 0.03 mg/L from June to September, with eutrophic status for June (0.066 mg/L), July (0.096 mg/L), and September (0.079 mg/L); and hyper-eutrophic in August (0.170 mg/L) (Table 36).

Aluminum concentrations exceeded the CCME guideline (100 µg/L Al for surface water with a pH ≥ 6.5) from June to September (ranging from 121-192 µg/L) (Table 37). The concentrations of also iron exceeded the CCME guideline (300 µg/L) from June to September ranging from 940 – 2220 µg/L (Table 37).

Table 36: La Coupe River Surface Water Chemistry

LA COUPE RIVER OFF HIGH MARSH ROAD: SURFACE WATER CHEMICALS																											
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	11.1	0.61	4.49	2.02	13	17.4	210	5	0.07	< 50	< 1	0.7	< 50	< 50	< 50	0.066	14.2	132	97	6.9	4.8	13.0	0.010	19.5	0.7	50	9.5	-2.65
2018-07-16	23.9	0.96	5.69	3.55	18	45.6	200	< 1	0.16	< 50	< 1	0.8	< 50	< 50	< 50	0.096	16.9	140	188	6.5	5.6	18.0	0.005	28.8	0.8	93	9.3	-2.82
2018-08-15	16.4	1.31	5.18	3.10	18	28.8	220	7	0.12	170	< 1	1.3	< 50	< 50	< 50	0.170	21	182	142	6.8	6.0	18.0	0.011	25.7	1.3	76	9.4	-2.56
2018-09-04	8.69	0.61	5.06	1.65	18	14.5	180	3	0.07	80	< 1	0.8	< 50	< 50	< 50	0.079	17	139	84	7.0	6.4	18.0	0.017	19.4	0.8	46	9.3	-2.35

Table 37: La Coupe River Surface Water Metals

LA COUPE RIVER OFF HIGH MARSH ROAD: SURFACE WATER METALS																														
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	192	< 0.1	< 1	20	< 0.1	< 1	16	< 0.01	4490	< 1	0.4	< 1	940	0.5	1.4	2020	127	< 0.1	< 1	610	0.8	< 1	< 0.1	11100	20	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2018-07-16	121	< 0.1	1	26	< 0.1	< 1	20	< 0.01	5690	< 1	0.5	< 1	1540	0.4	1.1	3550	175	< 0.1	< 1	960	0.9	< 1	< 0.1	23900	35	< 0.1	< 0.1	< 0.1	< 0.1	1	2
2018-08-15	123	< 0.1	1	22	< 0.1	< 1	28	< 0.01	5180	< 1	0.9	< 1	2220	0.4	2.3	3100	311	< 0.1	1	1310	1.5	< 1	< 0.1	16400	30	< 0.1	< 0.1	< 0.1	< 0.1	1	5
2018-09-04	143	< 0.1	< 1	28	< 0.1	< 1	14	< 0.01	5060	< 1	0.5	< 1	1420	0.5	0.9	1650	244	< 0.1	< 1	610	1.2	< 1	< 0.1	8690	22	< 0.1	< 0.1	< 0.1	< 0.1	1	2

Aulac River

In June, Aulac River exceeded the total phosphorus guideline for New Brunswick (0.03 mg/L) with a concentration of 0.079 mg/L, classifying it as eutrophic according to the CCME guidelines (table 38). We did not continue sampling Aulac River for the remainder of the season. The iron concentration (790 ug/L) also exceeded the CCME guideline of 300 ug/L (Table 39).

Table 38: Aulac River Surface Water Chemistry

AULAC RIVER OFF TROOP VALLEY ROAD: SURFACE WATER CHEMICALS																												
Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl- (mg/L)	F- (µg/L)	SO_4 (mg/L)	Br (µg/L)	Ammonia (as N (µg/L)	Ammonia Un-ionized @ 20ºC (µg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate and Nitrite (as N) (µg/L)	NO2 (as N) (µg/L)	NO3 (as N) (µg/L)	P-Total (mg/L)	DOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH (units)	Turbitity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	Nitrogen - Total (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2018-06-12	52.1	1.87	39.4	5.56	110	87.3	230	10	0.16	< 50	< 1	0.7	< 50	< 50	< 50	0.079	9.7	43	513	7.7	6.4	109.	0.516	121	0.7	265	7.8	-0.07
2018-07-16																												
2018-08-15																												
2018-09-04																												

Table 39: Aulac River Surface Water Metals

AULAC RIVER OFF TROOP VALLEY ROAD: SURFACE WATER METALS																															
Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Ca (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	K (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Na (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2018-06-12	88	< 0.1	< 1	109	< 0.1	< 1	26	< 0.01	39400	< 1	0.2	< 1	790	0.2	1.7	5560	186	0.2	< 1	1870	1.9	< 1	< 0.1	52100	102	< 0.1	< 0.1	< 0.1	0.8	< 1	< 1
2018-07-16																															
2018-08-15																															
2018-09-04																															

Conclusions and Recommendations

In conclusion, this past year has given us the opportunity to collect water quality data from 12 sites throughout the Tantramar River Watershed. The water quality results were compared to provincial water quality guidelines, CCME water quality guidelines for the protection of aquatic health, and Health Canada Guidelines for Recreational Activities. While we could speculate on some of the potential causes for variations between sites and fluctuation in parameter concentrations, this is just the first year of data collection in our monitoring program. More years of data are required to look at the natural variations in water quality and to see trends over time to get an idea of what is expected. As mentioned previously, every time you take a water sample it is just a snapshot of the water quality at that location at that point in time. This is also why long-term monitoring is so important.

The summer of 2018 was warm and dry (Appendix 1 & 2), resulting in water levels being generally low across sites. This likely led to the higher water temperatures that exceeded the CCME guidelines of 20^{o}C we saw in July to September. Generally, we saw the temperatures exceeding the guideline in our more impacted waterways (all Tantramar River sites, Silver Lake Outflow, Morice Creek, La Coupe River). We also observed high temperatures at East Brook which could be attributed to low water levels where it is a smaller brook. For the Tantramar and LaCoupe Rivers, the high temperatures could be attributed to the limited riparian cover of the rivers, as well as the slower water velocity. In the future, these sites will continue to be monitored for changes over time. EOS has some temperature loggers we could set up for more detailed temporal Temperature data. Other recommendations could include a riparian health assessment of the La Coupe River (EOS has already assessed the Tantramar River: https://eosecoenergy.com/en/wp-content/uploads/2018/11/EOS-NBWTF-Final-Report-2018.pdf). EOS would also like to engage with community members and landowners to promote watershed best management practices and improve riparian buffer zones.

In-situ water pH was within CCME guidelines (6.5 – 9) for the most part, with the exception of East Brook with was below the CCME guideline from May to October. La Coupe River was below the CCME limit in July and August. There were also a number of other sites slightly below the recommended pH limit in May and October. Comparing the in-situ pH results to the RPC laboratory pH results, only East Brook fell below the CCME guidelines in June and July. This could indicate a problem with our Hanna pH probe. We did have to replace our pH probe in August, so this could explain some of the variation between the in-situ and lab results.

Dissolved oxygen was below the New Brunswick guideline (6.5 mg/L) in June to September which could correspond with the high temperatures as DO decreases with increased temperature. It was also lowest at sites with low flows (Tantramar River, La Coupe River, East Brook) or with more stagnant water (Silver Lake Outflow).

There are no water quality guidelines for conductivity, TDS, and salinity. However, all three were typically higher in our more impacted rivers and creeks, with the exception of Harper Brook. All three were also significantly higher in our Aulac River site.

E. coli levels only surpassed the Health Canada Recreational Guidelines on 4 occasions. Once in La Coupe River in August; and Harper Brook, Morice Creek, and La Coupe River again in September. There was light rain on the day that we sampled (5.1 mm) in September after a dry spell which may have mobilized (Appendix 2, Figure 13).

From June to September total phosphorus levels frequently exceeded the New Brunswick guideline (0.03 mg/L) 63.8% of the time (30 samples exceeding the guideline and only 17 coming out below the guideline). Most of our sites are considered eutrophic. Morice Creek, and the Tantramar and La Coupe River were classified as hyper-eutrophic in September and August respectively. As a key nutrient that can lead to an increase in algae growth and decrease in DO in our waterways, this is a parameter that we would like to look into further. Two of our less impacted sites remained continuously under the total phosphorus guideline, Musquash Brook and Reservoir Brook. These brooks, as well as Joe Brook, started off the field season in June in the oligotrophic range, but increased to mesotrophic or meso-eutrophic as the summer progressed. For the most part our total nitrate levels were below the detection limit, aside from Harper Brook, Musquash Brook, and Morice Creek which still fell below the water quality guidelines for nitrates.

Surface water metals were well below the detection limits, aside from iron and aluminum which were both above the CCME guidelines for 7 of the sites (all Tantramar River sites, East Brook, Robinson Brook, Morice Creek, and La Coupe River). Musquash Brook and Aulac River only exceeded iron CCME guidelines. Silver Lake only exceeded aluminum guidelines in June. East Brook also exceeded the CCME guideline for zinc in September. Joe Brook also exceeded the CCME guideline for zinc in the summer months (June – August), and also exceeded the cadmium CCME guideline in June. This brook is a popular fishing spot so it would be good to further investigate the source of these metals. Reservoir Brook also exceeded the cadmium CCME guideline in July and August.

Overall, EOS had a very successful first year of water quality monitoring that provided us with valuable baseline data that can be used to ensure the health of our watershed. Alongside this it has given us the opportunity to better understand our watershed and the opportunity to have it documented. This project was a great first step towards building a long-term water quality monitoring program within the watershed. As we continue to collect more data we will be able to see trends in the water quality and develop a better understanding of what the “normal” water quality is in our waterways as well as how climate change may impact them.

EOS believes that this program should extend to the Cape Tormentine Peninsula Watershed in 2019-2020 to obtain information about the current state of water quality within the watershed. The Chignecto Watersheds Committee have selected sample sites to collect monthly water quality samples from June to September within the Cape Tormentine Peninsula Watershed based off of data collected from our 2018 citizen science monitoring blitzes, land-use maps, site accessibility, and advice from other watershed groups. This is our next step in building a long-term water quality monitoring program within the Inner Bay of Fundy and Cape Tormentine Watersheds.

EOS Eco-Energy recommends that the knowledge gaps in our watersheds continue to be addressed through our long-term water quality monitoring plan. We would also like to expand our knowledge of our watersheds through the collection of CABIN data, hydrological data, riparian health data, and fish & habitat data.

References

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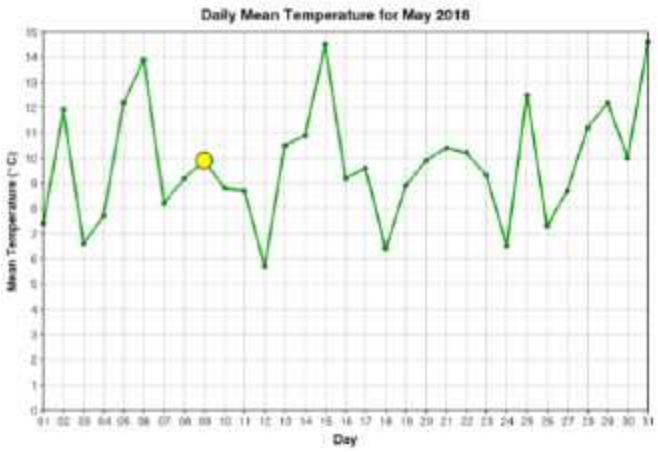
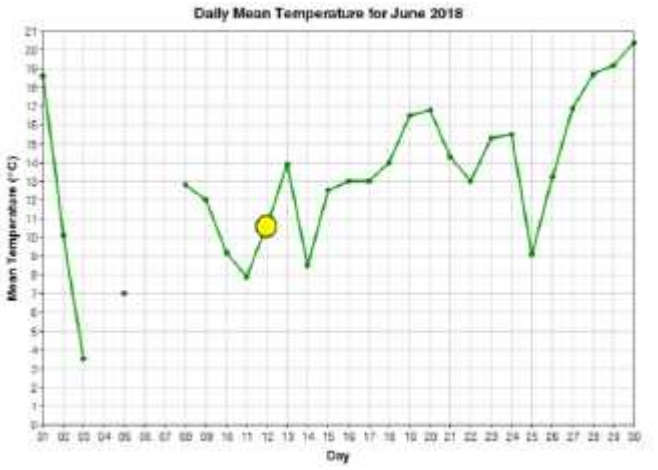
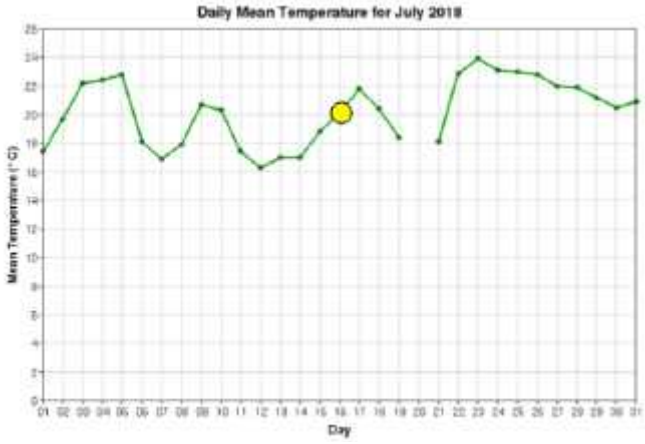
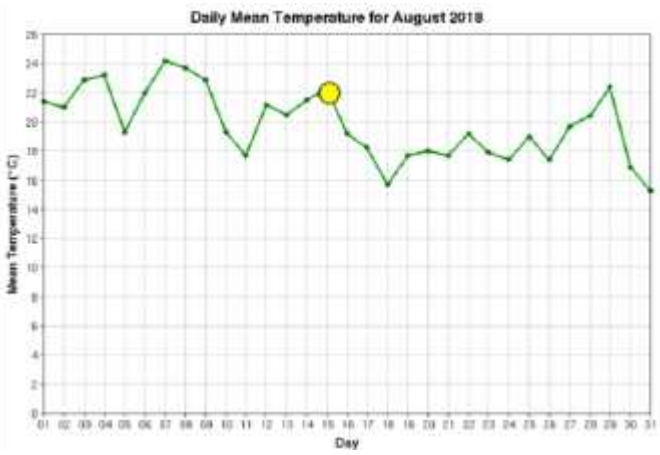
Appendix 1 – Daily Mean Temperatures During Sampling Season

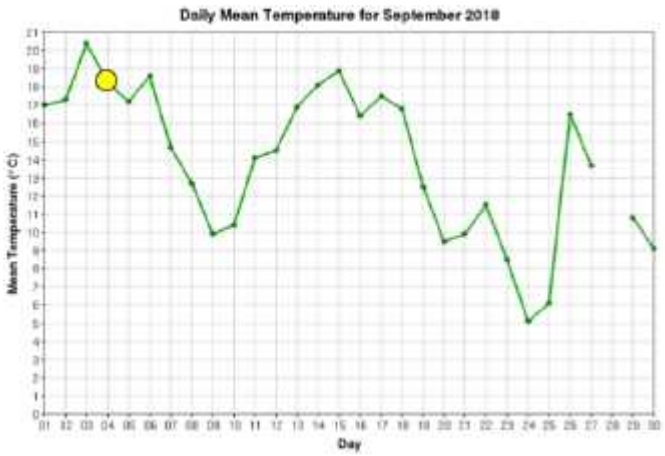
Note: yellow dots indicate sampling day. Data was sourced from Nappan, NS weather station (the closest one to Sackville/the Tantramar River Watershed).

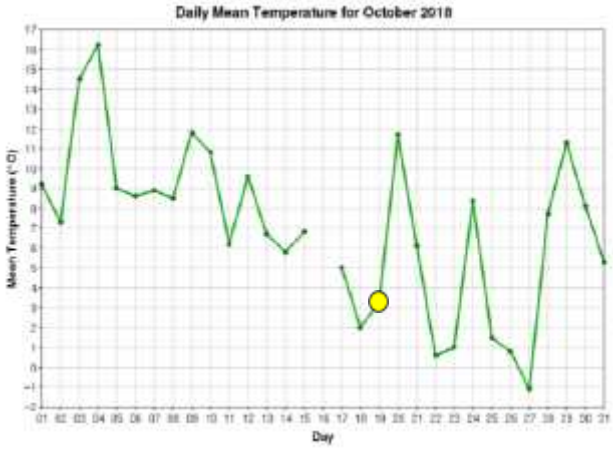












Appendix 2 – Daily and Total Monthly Sackville Precipitation

Table 40: Sackville Monthly Total Precipitation (mm) for 2018 from CoCoRaHS Site: CAN-NB-58

Month	Total Precipitation (mm)
May	82.3
June	160.1
July	38.5
August	162.7
September	90.1
October	181.2

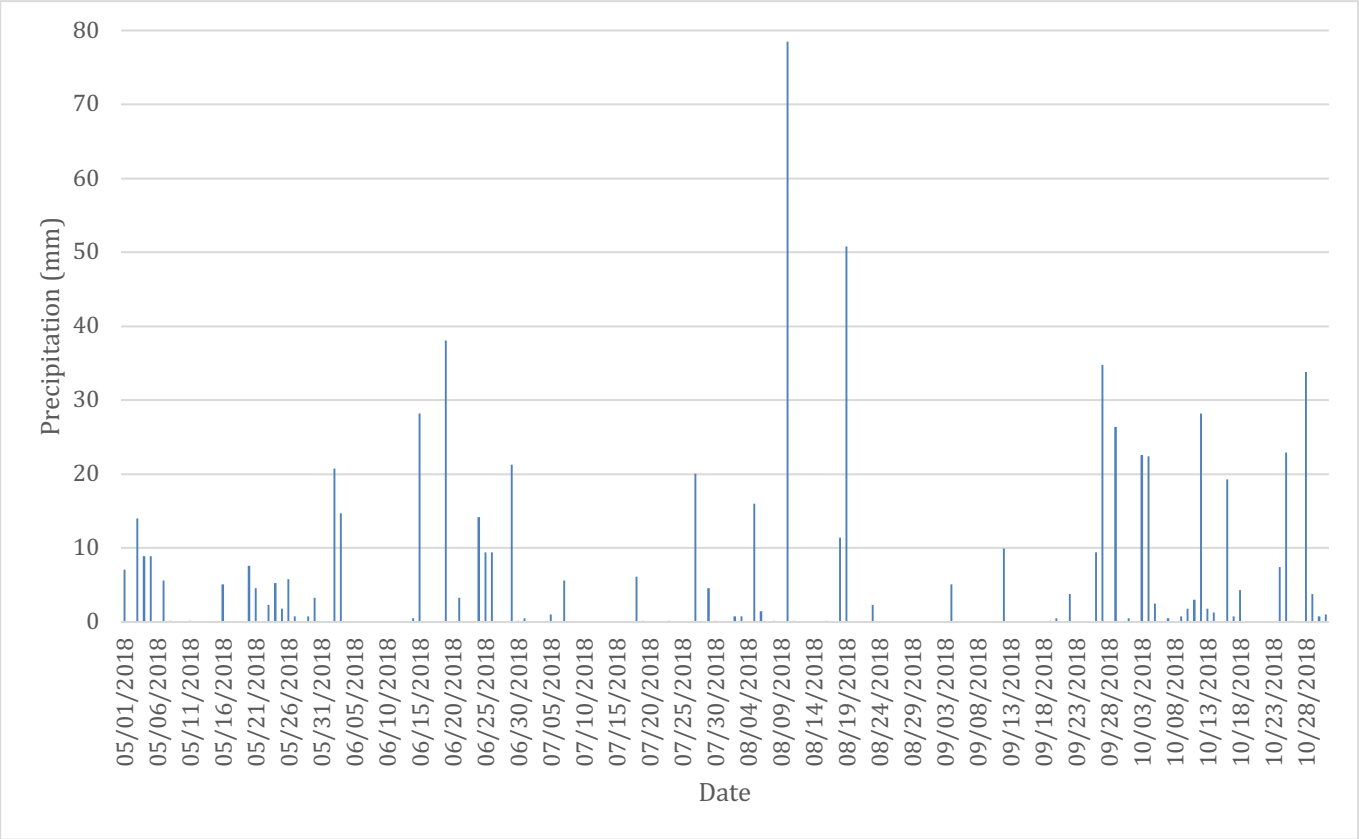


Figure 13: Daily Precipitation (mm) from Sackville CoCoRaHS Site CAN-NB-58