

Bacteria Monitoring Results from Goose Creek and Rafuse Cove, Western Shore, NS

S. Fredericks

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Contributing Authors and Surveyors:

Blake McNeely, Watersheds & Water Quality Team Lead

Abby Maguire, Nova Action Cohort Member

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Coastal Action

45 School Street, Suite 403

Mahone Bay, N.S., B0J 2E0

Ph: (902) 634 9977

Email: info@coastalaction.org

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1.0 Introduction

The Municipality of Chester (MOC) contracted Coastal Action to conduct a water quality monitoring program in 2021 in Goose Creek (also known as Vaughans River) and Rafuse Cove, both located in Western Shore, NS, near Oak Island.

This program follows a similar small-scale program conducted in 2020 that investigated fecal bacteria conditions at the mouth of Goose Creek as well as marine sites in Rafuse Cove. Results of the 2020 monitoring identified a frequent source of bacteria contamination in Goose Creek; however, bacteria conditions in the marine environment were not determined to be a significant issue at the time.

The 2021 program focuses on monitoring a 600-m section of Goose Creek, from the ocean upstream to the Chester Connection Trail, to isolate and identify the location(s) where fecal bacteria pollution is entering the stream. Additional sampling occurred in the marine environment to investigate bacteria conditions in the immediate drainage area of Goose Creek and the bottom sediments of Rafuse Cove.

The objectives for this monitoring program were to:

1. Determine the source(s) and location(s) of fecal bacteria pollution in Goose Creek.
2. Determine if bottom sediments are acting as a reservoir for fecal bacteria in Rafuse Cove and investigate bacteria conditions in the marine discharge area of Goose Creek.
3. Monitor algal blooms in the Rafuse Cove area to determine if blooms contain cyanobacteria toxin (microcystin-LR) (Dependent on the occurrence and reporting of blooms in the area).

2.0 Program Methodology

The original program design included two rainfall-dependent and two drought-dependent sampling events, which were to occur in both the 600-m stretch of Goose Creek and the stream's marine discharge area in Rafuse Cove. All sampling events were conducted; however, multiple rainfall-dependent sample sets were lost due to equipment and procedural failures at the contracted laboratory, where samples were sent for analysis. Due to these unforeseen challenges, this report includes only one rainfall-dependent sampling event.

Supplementary data has been included from a similar study which was conducted in Goose Creek in 2021. Abby Maguire, a Park View Education Centre student, and a member of Coastal Action's Nova Action cohort, has been investigating the issue of fecal contamination in Goose Creek under the guidance of Coastal Action staff. The sample site locations and methodologies are identical to this study, allowing for the use of that data in this reporting.

Bacteria results are compared to Health Canada’s *Guidelines for Canadian Recreational Water Quality* (2012). Guidelines have been developed to indicate the safety of recreational waters for both primary (i.e., whole body or the face and trunk are frequently immersed or the face is frequently wetted by spray, and it is likely that some water will be swallowed) and secondary (i.e., only the limbs are regularly wetted and greater contact, including swallowing water, is unusual) types of water contact (Table 1).

Table 1. Health Canada guidelines for primary and secondary water-based recreation for Enterococci and E.coli bacteria.

	Enterococci bacteria	E. coli bacteria
Primary Contact	≤ 70 cfu/100 mL (single sample max.)	≤ 400 cfu/100 mL (single sample max.)
Secondary Contact	≤ 175 cfu/100 mL	≤ 1000 cfu/100 mL

* cfu = colony forming units

2.1 Goose Creek E. coli Sampling

Surface water samples were collected from multiple locations in Goose Creek, beginning at the mouth of the stream and travelling upstream as far as the Chester Connection Trail. Sample sites were placed between (i.e., upstream and downstream) residential properties and other potential contamination sources. Additional samples were collected when possible (i.e., when water was present/flowing) from a drainage ditch that runs parallel to Boehner Road and then flows through a forested wetland habitat along the northern and eastern sides of the Westermm Shore Sewage Treatment Plant fenceline before discharging into Goose Creek just upstream of Hwy 3 (Figure 1).



Figure 1. Bacteria sample sites on Goose Creek and a drainage channel near the Western Shore Sewage Treatment Plant.

Table 2. Description of sample sites located along a 600-m section of Goose Creek and drainage channel in Western Shore, NS.

Site Number	Description of bacteria sample sites
1	The mouth of Goose Creek before draining into the ocean
2	Upstream/downstream of residential properties
3	Upstream/downstream of residential properties
4	Downstream of Hwy 3 bridge
5	Drainage channel upstream of livestock property
6	Drainage channel downstream of livestock property (culvert outflow)
7	1 m downstream of the drainage channel
8	The mouth of the drainage channel before entering Goose Creek
9	1 m upstream of the drainage channel
10	The mouth of the Western Shore Sewage Treatment Plant effluent pipe
11	Upstream of Western Shore Sewage Treatment Plant
12	Upstream of residential property / downstream of Chester Connection Trail bridge
13	Mid-way along the Western Shore Sewage Treatment Plant property

2.2 Rafuse Cove Enterococci Water Sampling

Surface water samples were collected from three locations in Rafuse Cove on September 28, 2021 (Figure 2) and analyzed for enterococci bacteria, the recommended fecal indicator species in marine environments (Health Canada 2012). This sampling event occurred during drought conditions (i.e., > 48 hours without precipitation).

2.3 Rafuse Cove E. coli Sediment Sampling

Benthic sediment samples were collected from two locations in Rafuse Cove on September 28, 2021, and analyzed for E. coli bacteria (Figure 2). This sampling event occurred during drought conditions. Sediment samples were collected using a gravity corer. A gravity core of the top 10-20 cm of benthic sediment was collected and transferred to laboratory-provided, sterilized jars.



Figure 2. Water and sediment sample sites in Rafuse Cove, near the mouth of Goose Creek in Western Shore, NS.

3.0 Results

3.1 Goose Creek E. coli Results

E. coli concentrations displayed a marked difference following a heavy rainfall event on May 31, 2021 (Table 2). On this day, exceedances of Health Canada’s primary contact guideline were observed at sites 1-6 and site 11, while the remaining sites also showed elevated bacteria concentrations compared to drought conditions. No exceedances were observed during drought-dependent sampling events, indicating that bacteria contamination in Goose Creek is being caused mainly by runoff from land-based sources and not the frequent discharge of sewage treatment plant effluent.

Table 3. E. coli results from one rainfall-dependent and four drought-dependent sampling events in Goose Creek.

	Drought May 12, 2021	Drought May 20, 2021	Rainfall May 31, 2021	Drought August 18, 2021	Drought Sept. 28, 2021
Site 1	10	60	1200	230	20
Site 2	ND	44	640	60	80
Site 3	ND	42	680	30	40
Site 4	10	26	840	-	80
Site 5	ND	ND	480	-	30
Site 6	ND	ND	2100	-	-
Site 7	10	40	250	40	190
Site 8	ND	6	100	-	-
Site 9	ND	100	360	10	180
Site 10	ND	88	90	10	40
Site 11	ND	140	440	10	40
Site 12	-	-	-	20	40
Site 13	-	-	-	ND	-
	(ND = <10 cfu/100 mL)	(ND = <2.0 cfu/100 mL)	-	(ND = <10 cfu/100 mL)	-

* ND = Not Detected below the specified concentration.

* (-) indicates a site was not sampled due to lack of water flow or accessibility.

3.2 Rafuse Cove Enterococci Water Sample Results

Water samples collected from Rafuse Cove during drought conditions displayed low concentrations of enterococci bacteria at sites located in Rafuse Cove; however, one exceedance of Health Canada's primary contact enterococci guideline was observed near the marine discharge area of Goose Creek (Rafuse 3).

Table 4. Enterococci results for three marine sites in Rafuse Cove, collected during drought conditions on September 28, 2021.

Site Name	Enterococci Concentration (cfu/100 mL)
Rafuse 1	10
Rafuse 2	30
Rafuse 3	100

3.3 Rafuse Cove E. coli Sediment Sample Results

Benthic sediment samples collected from two locations in Rafuse Cove displayed low concentrations of E. coli bacteria. Health Canada does not currently have recreational guidelines for bacteria concentrations in beach sand or benthic sediments.

Table 5. *E. coli* concentrations in marine benthic sediment collected in Rafuse Cove during drought conditions on September 28, 2021.

Site Name	<i>E. coli</i> Concentration (MPN/g)
Rafuse Sediment 1	< 2.0
Rafuse Sediment 2	< 2.0

4.0 Discussion and Recommendations

4.1 Rafuse Cove

Based on the limited amount of data collected from Rafuse Cove during drought conditions, both the benthic sediment and overlying water column did not display elevated concentrations of fecal bacteria. Of the three marine water samples collected, the site located closest to the marine discharge area of Goose Creek was the only site to exceed Health Canada's primary contact guideline for enterococci bacteria. This may be attributed to the frequently contaminated waters of Goose Creek; however, other potential sources are present in this area (i.e., waterfowl, coastal shoreline properties in Rafuse Cove).

No algal blooms were reported and no water samples were collected for the analysis of microcystin-LR during the study period.

4.2 Goose Creek

Ground-truthing and monitoring results confirm that land-based sources of fecal bacteria within the catchment area of Goose Creek are contaminating this stream following rainfall events and during wetter periods of the year. Two residential properties have been identified as likely contributors to this problem; however, all properties within the stream's catchment area should be included in educational outreach initiatives (see section 4.3).

A residential property located immediately north of the Western Shore Sewage Treatment Plant (WSSTP) has a small fenced paddock where three horses and one goat are kept. A manure pile, which is not properly contained, is located next to this paddock. This paddock and manure pile slope directly towards a drainage ditch, located roughly 5 m from the manure. This drainage flows along the northern and eastern fenceline of the WSSTP, briefly running underground through a culvert then spreading throughout a wetland area before being funnelled back into a small drainage ditch that discharges into Goose Creek just upstream of Hwy 3.

For non-contained solid manure, the Nova Scotia Federation of Agriculture (NSFA) recommends separation distances of 20 m from a drainage ditch and 100 m from a watercourse. Solid manure should be contained within a walled concrete pad, and runoff should be managed to prevent leaching into the environment (Nova Scotia Federation of Agriculture 2006). The hobby farm-scale manure pile in question is located just 5 m from a drainage ditch and roughly 110 m from Goose Creek.

Sample sites were strategically placed in order to isolate the runoff from this property. Site 5 is located in the drainage ditch upstream of the livestock impacts. Site 6 is located immediately downstream of these impacts, and sites 7, 8, and 9 are placed along the drainage and leaching zone of this drainage channel where it joins Goose Creek.

Results from the rainfall-dependent sampling event presented in this report (May 31, 2021; Table 2) show elevated fecal bacteria at all sites downstream of this property in both the drainage ditch and Goose Creek.

Runoff from the property in question warrants an investigation from NS Environment, as the release of harmful substances, including manure, that results in the impairment of water quality is in violation of the *NS Environment Act* (Province of Nova Scotia 1995).

It should be noted; however, that additional sites upstream of this property, as well as sites located several hundred meters downstream of this property, have also displayed elevated bacteria conditions. A residential property located upstream of this property and the WSSTP, and just downstream of the Chester Connection Trail, also houses a small paddock and a poultry barn located immediately adjacent to the streambanks of Goose Creek and poses a similar risk of contamination if not properly managed. It is not known if these livestock/poultry structures were in use during the study period.

4.3 Recommendations

The intention of the monitoring program and this report is not to lay blame on individual properties for the fecal bacteria contamination issue in Goose Creek. The objectives are to confirm the persistent contamination issue and identify likely and potential sources for remediation. Next steps should focus on homeowner education, community stewardship, and remediation activities, along with continued rainfall-dependent monitoring. Coastal Action presents the following list of suggested next steps:

- Conduct a targeted outreach initiative with all property owners located within the catchment area of Goose Creek. This program could include educational resources regarding best practices for managing runoff and protecting water quality. Additional activities could include individual property assessments, recommendations, and resources (i.e., septic system maintenance, riparian buffers, water conservation/control techniques, etc.).
- Conduct one or more community stewardship days with volunteers to remove the significant amount of garbage observed within Goose Creek and throughout its riparian habitat.
- Maintenance and/or enhancement of the small wetland habitat located between the WSSTP and Hwy 3. This wetland is helping to filter the contaminated water currently flowing through it before it reaches Goose Creek (land ownership TBD).
- Continued rainfall-dependent bacteria monitoring is recommended to further confirm contamination areas in Goose Creek due to the issues with rainfall-dependent

monitoring events experienced in 2021. Continued monitoring would help to assess the before/after impacts of educational and remediation activities.

5.0 References

Health Canada. 2012. Guidelines for Canadian Recreational Water Quality, Third Edition. Water Air, and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. (Catalogue No H129-15/2012E).

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