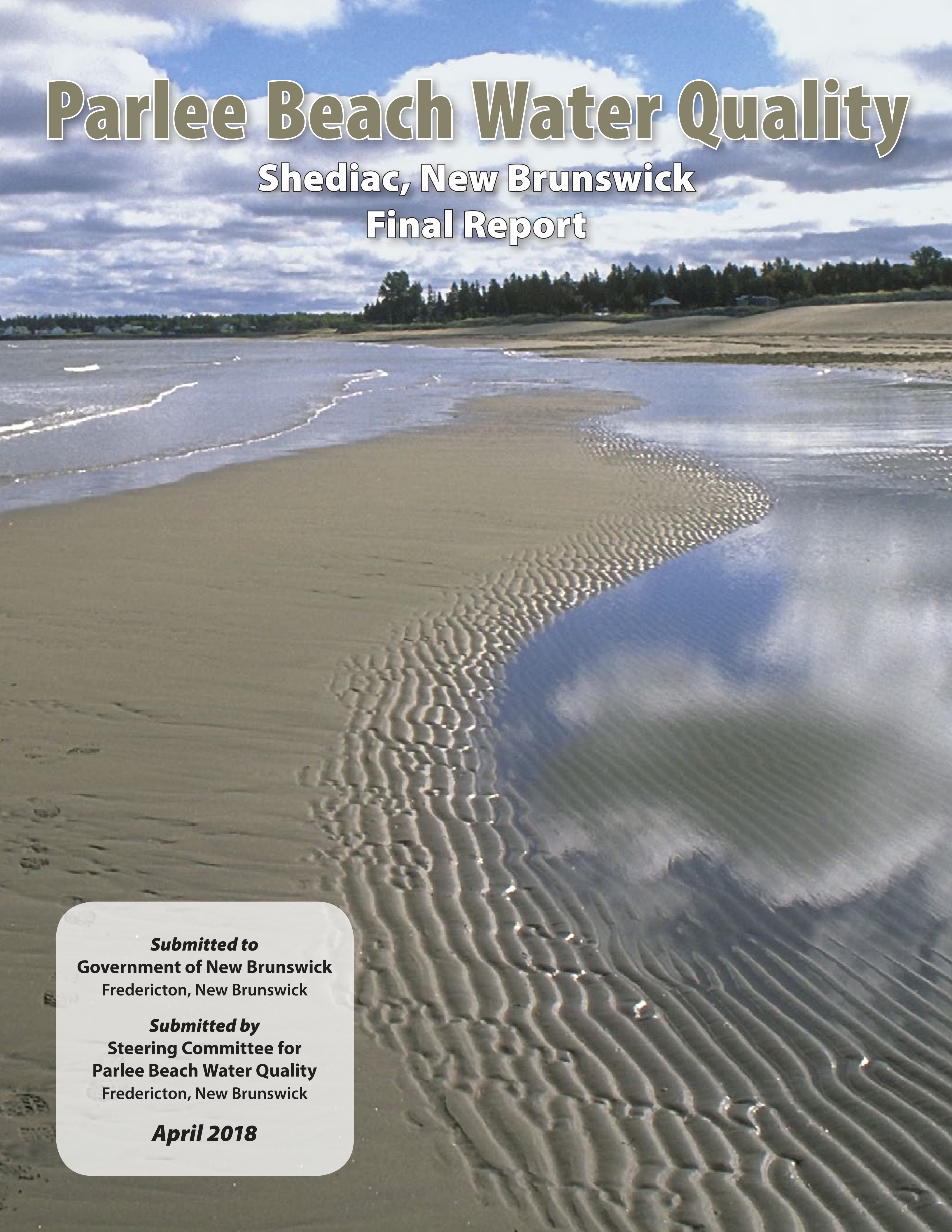


Parlee Beach Water Quality

Shediac, New Brunswick
Final Report

Submitted to
Government of New Brunswick
Fredericton, New Brunswick

Submitted by
Steering Committee for
Parlee Beach Water Quality
Fredericton, New Brunswick

April 2018

March 16, 2018

Hon. Serge Rousselle, Q.C.
Minister of Environment and Local Government
Attorney General
Minister of Service New Brunswick
Regional Minister for Northern New Brunswick
P.O. Box 6000
Fredericton, NB E3B 5H1

Dear Minister Rousselle,

Re: Final Report – Parlee Beach Water Quality, Shediac, NB

The Steering Committee for Parlee Beach Water Quality is pleased to present our final report summarizing the results of the pertinent studies, as well as our conclusions and recommendations.

Respectfully submitted,

Steering Committee for Parlee Beach Water Quality
Jacques Paynter, FEC, P. Eng., Project Manager
Kevin Gould, P. Eng., Department of Health
Don Fox, P. Geo., Department of Environment and Local Government
Sheila Lagacé, Department of Environment and Local Government
Alain Basque, Department of Tourism, Heritage and Culture
Andrew Foster, Department of Tourism, Heritage and Culture
Bruce Kinnie, P. Eng., P. Ag., Department of Agriculture, Aquaculture and Fisheries

Final Report

Parlee Beach Water Quality
Shediac, New Brunswick

Submitted to:
Government of New Brunswick
Fredericton, New Brunswick

Submitted by:
Steering Committee for Parlee Beach Water Quality
Fredericton, New Brunswick

April 2018

ISBN 978-1-4605-1488-7 (print edition)
ISBN 978-1-4605-1489-4 (PDF: English)
ISBN 978-1-4605-1490-0 (PDF: française)

11703

Table of Contents

1 Introduction . . . 1
1.1 Purpose . . . 1
1.2 Steering Committee Mandate . . . 1
1.3 Stakeholder Engagement . . . 1
1.4 Organization of Report . . . 2

2 Recreational Water Quality and Public Health . . . 3
2.1 Introduction . . . 3
2.2 New Water Monitoring Protocols at Parlee Beach and Murray Beach . . . 3

3 Water Quality Results at Parlee Beach and Murray Beach . . . 5
3.1 General Overview . . . 5
3.1.1 Water Quality . . . 5
3.1.2 Parlee Beach . . . 5
3.1.3 Murray Beach . . . 5
3.2 Detailed Results – Parlee Beach . . . 5
3.2.1 Data Collection . . . 6
3.2.2 Analysis . . . 6
3.2.2.1 Beachgoers and Air and Water Temperature . . . 6
3.2.2.2 Wind Speed and Geometric Mean of Bacteria Counts . . . 7
3.2.2.3 Beachgoers and Geometric Mean of Bacteria Counts . . . 8
3.2.2.4 Precipitation and Geometric Mean of Bacteria Counts . . . 9
3.2.2.5 Wind Direction and Geometric Mean . . . 12
3.2.2.6 Tidal Influence on Bacteria Counts . . . 16
3.2.3 Conclusions – Parlee Beach Water Quality . . . 17
3.3 Detailed Results – Murray Beach . . . 18

4 Watershed reconnaissance survey and water sampling program . . . 19
4.1 Monitoring Plan Design . . . 19
4.2 Results– ETF Sites . . . 21
4.2.1 Scoudouc Sites . . . 21
4.2.2 Shediac Sites . . . 22
4.2.3 Water Quality Sites . . . 22
4.2.4 Map of the Geometric Mean of Bacteria Counts for ETF Sites . . . 23
4.3 Results – WRP Sites . . . 24
4.3.1 Fresh Water Sites . . . 24
4.3.2 Water at Sediment Sites . . . 26
4.3.3 Sediment at Sediment Sites . . . 26
4.3.4 Effluent Sites . . . 27
4.3.5 Stormwater Sites . . . 27
4.3.6 Agriculture Sites . . . 28
4.3.7 Marine Sites . . . 28
4.3.8 Map of the Geometric Mean of Bacteria Counts at WRP Sites . . . 29
4.3.9 Greater Shediac Sewage Commission Lift Station Overflows . . . 30
4.3.10 Summary of Exceedances of the Guideline Values . . . 31
4.3.11 DNA Analysis . . . 32
4.4 Findings and Conclusions . . . 33

5 Scientific Work Plan . . . 34
5.1 Beach Sand Bacteria and Shallow Groundwater Flow Paths . . . 34
5.1.1 Objectives and Scope . . . 34
5.1.2 Synthesis of the report . . . 34
5.1.2.1 Brief Overview of Methods . . . 34
5.1.2.2 Findings and Conclusions . . . 35
5.2 Septic Systems Survey and Mapping . . . 35
5.2.1 Objectives and Scope . . . 35
5.2.2 Synthesis of the Report . . . 36
5.2.2.1 Study Areas . . . 36
5.2.3 Results . . . 37
5.2.4 Conclusions . . . 40
5.3 Coastal Hydrodynamic Modelling . . . 41
5.3.1 Objectives and Scope . . . 41
5.3.2 Synthesis of the Report . . . 41
5.3.2.1 Model Development . . . 41
5.3.2.2 Results . . . 41
5.3.3 Conclusions . . . 43
5.4 Cumulative Effects Assessment and Protocols Development . . . 44
5.4.1 Objectives and Scope . . . 44
5.4.2 Background . . . 44
5.4.3 Conclusions and Recommendations . . . 45
5.5 Beach Operations . . . 45
5.5.1 Beach Wrack Management . . . 45
5.5.1.1 Overview . . . 45
5.5.1.2 Management Options . . . 45
5.5.2 Beach Sand Management . . . 46
5.5.2.1 Overview . . . 46
5.5.2.2 Management Options . . . 46

6 Other Initiatives . . . 47
6.1 Dog Waste Management Program . . . 47
6.2 People-Powered Recreation Zone . . . 48
6.3 Marina Pump-Out Facilities . . . 48
6.4 Parlee Beach Sewage System . . . 49
6.5 Wetland Delineation Study . . . 49
6.5.1 Objectives and Scope . . . 49
6.5.1.1 Scope and Objectives . . . 49
6.5.1.2 Methods . . . 49
6.5.1.3 Results . . . 50
6.5.1.4 Conclusions . . . 50
6.6 State-of-the-Bay Report . . . 50
6.6.1 Scope and Objectives . . . 50

7 Conclusions and Recommendations . . . 51
7.1 Steering Committee Conclusions . . . 51
7.2 Steering Committee Recommendations . . . 51

Executive Summary . . . 54

List of Tables

Table 4.1 - DNA Analysis 32
Table 7.1 - Recommendations 51

List of Figures

Figure 1.1 Regional Setting 1
Figure 3.1 - Beachgoers and Temperature 6
Figure 3.2a - Wind Speed and Geometric Mean – June 7
Figure 3.2b - Wind Speed and Geometric Mean – July 7
Figure 3.2c - Wind Speed and Geometric Mean – August 8
Figure 3.2d - Wind Speed and Geometric Mean – September 8
Figure 3.3a - Beachgoers and Geometric Mean – June and July 9
Figure 3.3b - Beachgoers and Geometric Mean – August and September 9
Figure 3.4a - Precipitation and Geometric Mean – May 10
Figure 3.4b - Precipitation and Geometric Mean – June 10
Figure 3.4c - Precipitation and Geometric Mean – July 11
Figure 3.4d - Precipitation and Geometric Mean – August 11
Figure 3.4e - Precipitation and Geometric Mean – September 12
Figure 3.4f - Precipitation and Geometric Mean – October 12
Figure 3.5a - Historic Wind Distribution 13
Figure 3.5b - Wind Direction and Geometric Mean – June 14
Figure 3.5c - Wind Direction and Geometric Mean – July 14
Figure 3.5d - Wind Direction and Geometric Mean – August 15
Figure 3.5e - Wind Direction and Geometric Mean – September 15
Figure 3.5f - Wind Directions in Shediac Bay 16
Figure 3.5g - Tidal Height and Single-Sample Maximum 17
Figure 3.5h - Percentage Exceedance of Single-Sample Maximum for E. coli 18
Figure 3.5i - Percentage Exceedance of Single-Sample Maximum for E. coli 18
Figure 4.1a - ETF Sampling Sites 20
Figure 4.1b - WRP Sampling Sites 21
Figure 4.2a - Scoudouc Sites – Results 22
Figure 4.2b - Shediac Sites – Results 22
Figure 4.2c - Water Quality Sites – Results (WQ1 – WQ6) 23
Figure 4.2d - Water Quality Sites – Results (WQ7 – WQ11) 23
Figure 4.2e - ETF Sites Geometric Mean of E.coli Values by Sampling Location 24
Figure 4.3a - Fresh Water Sites (FW1 – FW5) 25
Figure 4.3b - Fresh Water Sites (FW6 – FW8) 25
Figure 4.3c - Fresh Water Sites (FW9 – FW11) 26
Figure 4.3d - Water at Sediment Sites 26
Figure 4.3e - Sediment at Sediment Sites 27

Figure 4.3f - Effluent Sites 27
Figure 4.3g - Stormwater Sites 28
Figure 4.3h - Agriculture Sites. 28
Figure 4.3i - Marine Sites 29
Figure 4.3j - WRP Sites Geometric Mean of E. coli Values by Sampling Location 30
Figure 4.3k - GSSC Lift Station Overflows - 2017 31
Figure 4.3l - Exceedances of Guideline Values. 32
Figure 4.3m - DNA Analysis Sampling Sites 33
Figure 5.1 - Sampling Locations 35
Figure 5.2a - Septic System Survey Study Areas 36
Figure 5.2b - Area of Concern 1C in Grand Barachois 38
Figure 5.2c - Area of Concern 1D in Grand Barachois 38
Figure 5.2d - Area of Concern 3-B in Shediac Bridge 39
Figure 5.2e - Areas of Concern Indicating Potential Issues with On-Site Septic Systems 40
Figure 5.3a - Modelled Residual Currents under Tides-only Forcing, Averaged over a Full Diurnal Cycle. 42
Figure 5.3b - Modelled Pollutant Concentrations 43
Figure 5.3c - Modelled Drogue Trajectories 43
Figure 6.1a - Dog Waste Station 47
Figure 6.1b - Station Locations 47
Figure 6.2 - People-Powered Recreation Zone 48
Figure 6.3 - Parlee Beach Sewage System Replacement 49
Figure 6.4 - Additional Wetland Delineation. 50

List of Acronyms

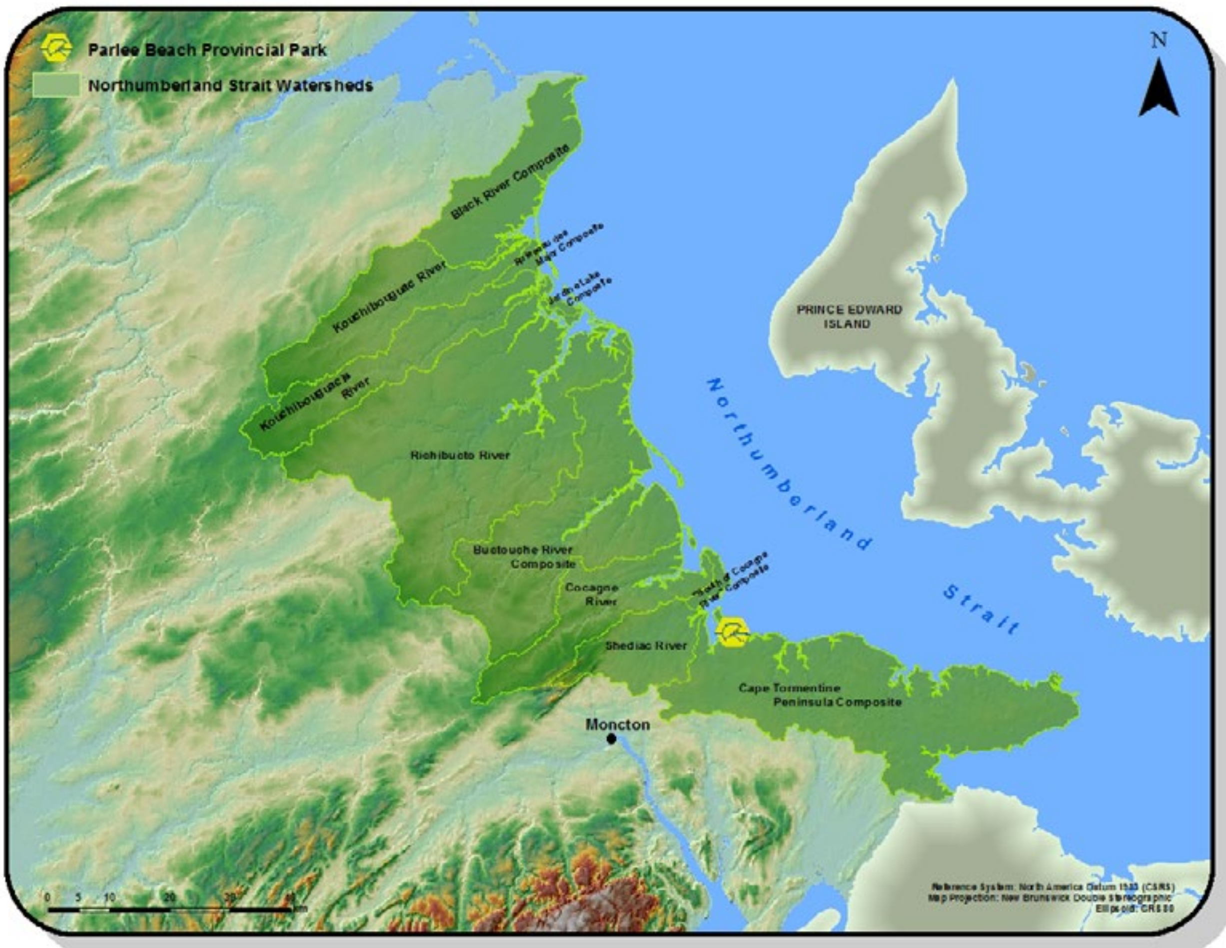
DAAF	New Brunswick Department Agriculture, Aquaculture and Fisheries
DH	New Brunswick Department of Health
DELG	New Brunswick Department of Environment and Local Government
ETF	Environmental Trust Fund
GSSC	Greater Shediac Sewage Commission
MOH	Medical Officer of Health
MPN	Most Probable Number
SBWA	Shediac Bay Watershed Association
THC	New Brunswick Department of Tourism, Heritage and Culture
WRP	Watershed Reconnaissance Program

1 Introduction

1.1 Purpose

This document presents the results of the Parlee Beach Water Quality project, including the water quality monitoring conducted at Parlee Beach and Murray Beach during 2017, as well as the findings and conclusions of the numerous studies conducted as part of the Scientific Work Plan. The project was managed by a Steering Committee comprised of representatives from four government departments: Health (DH); Environment and Local Government (DELG); Agriculture, Aquaculture and Fisheries (DAAF); and, Tourism, Heritage and Culture (THC).

Figure 1.1 Regional Setting



1.2 Steering Committee Mandate

The mandate of the Steering Committee was as follows:

- Develop and implement an updated water sampling and monitoring protocol at Parlee Beach.
- Develop and implement a public communication plan (public website, information kiosks, advisory signage, media).
- Develop and implement a technical work plan to identify point and non-point sources of contamination in the Shediac Bay Watershed.
- Prepare a report summarizing recommended actions to government.

1.3 Stakeholder Engagement

The Steering Committee identified and prepared a directory of stakeholders. All groups were contacted. Meetings were convened in Shediac and Pointe-du-Chêne during February 2017. The purpose of these meetings was to introduce the

Steering Committee, explain the Committee's mandate and determine how stakeholders wished to participate in the process. The Steering Committee asked stakeholders to identify their concerns and offer suggestions as to possible sources of bacteria, and provide documentation and data which might be pertinent.

These discussions resulted in many observations and anecdotal comments regarding potential sources of bacteria, as well as written submissions from several organizations.

The Steering Committee maintained ad hoc communications with various stakeholders throughout 2017.

1.4 Organization of Report

This report is organized into 7 chapters:

- Chapter 2 provides an overview of water quality and public health.
- Chapter 3 explains the Water Quality Monitoring Protocols implemented in 2017 and provides an analysis of the results of water quality testing and attempts to determine relationships between the different types of data that was collected.
- Chapter 4 presents the results of the water quality sampling and testing results for 57 sites distributed throughout the Shediac Bay Watershed.
- Chapter 5 provides brief summaries of the results of the studies conducted as part of the Scientific Work Plan.
- Chapter 6 outlines the other initiatives and mitigation measures initiated in early 2017.
- Chapter 7 provides the overall conclusions and recommendations of the Steering Committee.

2 Recreational Water Quality and Public Health

2.1 Introduction

It is not uncommon for bacteria like Escherichia coli (*E. coli*) and enterococci to be detected in recreational waters. Bacteria are living organisms and a natural part of our environment. Most of these bacteria are harmless, however some are pathogenic to humans (i.e., can make people sick). The bacteria (and other pathogens) that are harmful to humans are typically found in faecal matter.

Recreational waters, such as rivers, lakes and beaches, have the potential to be impacted by faecal matter from various point sources (such as sewage discharges from municipal and/or on-site septic systems) and non-point sources (such as from birds, wild and domesticated animals, and precipitation related storm-water runoff from agricultural or urban areas), as well as faecal shedding by swimmers themselves.

As a result, there is always a slight risk of health effects when swimming, just as there are risks associated with other common daily activities.

E. coli and enterococci are part of the normal intestinal flora of humans and animals and most strains are not in and of themselves harmful to humans. However, they are the most appropriate bacteriological indicators[1] of faecal contamination in recreational waters.

To help guide decisions by provincial and local authorities responsible for the management of recreational waters, the Guidelines for Canadian Recreational Water Quality have established guideline values for *E. coli* and enterococci. These guideline values are based on the analysis of epidemiological evidence relating concentrations of these indicator organisms to the incidence of swimming-associated gastrointestinal illness observed among swimmers.

E. coli		Enterococcus	
Single Sample Maximum	Geometric Mean of 5 most recent samples	Single Sample Maximum	Geometric Mean of 5 most recent samples
*400	*200	*70	*35

*All values are per 100 ml sample.

These values represent risk management decisions that strike a balance between potential health risks for the recreational water user and the benefits of recreational water use in terms of physical activity and enjoyment. Health Canada estimates that these guideline values will correspond to a seasonal gastrointestinal illness rate of approximately 1-2 per cent (10-20 illnesses per 1000 swimmers), and the Guidelines for Canadian Recreational Water Quality concluded that this is a tolerable and reasonable estimate of the risk of illness likely to be experienced by users engaged in a voluntary activity.

2.2 New Water Monitoring Protocols at Parlee Beach and Murray Beach

In 2017 new Water Quality Monitoring Protocols were put in place at Parlee Beach and Murray Beach. These Protocols are in accordance with the Guidelines for Canadian Recreational Water Quality (Canadian Guidelines) and replaced the Rating System that had previously been in place.

The purpose of these Protocols is to clearly outline roles and responsibilities for monitoring and reporting, and to ensure that a transparent recreational water monitoring process is in place so that the public is informed of any potential risk and had access to water quality information.

The protocols are available at the website:

1 They are 1) absent from non-polluted waters; 2) exclusively associated with animal and human faeces; 3) incapable of growth in the aquatic environment but able to survive for short periods of time; 4) their density can be related to a degree of swimmer-associated illnesses; and 5) detection and enumeration test methods should be relatively rapid, easy to perform, inexpensive, specific and sensitive.

http://www2.gnb.ca/content/dam/gnb/Departments/eco-bce/Promo/Parlee_Beach/parlee_beach_water_monitoring_protocol_document.pdf

Highlights of these protocols include:

- Developed in accordance with the recommendations contained in the Guidelines for Canadian Recreational Water Quality.
- Samples collected at five locations equally distributed along the beach.
- Samples transported to the accredited RPC laboratory in Fredericton and tested using standard methods.
- Test results transmitted electronically to Medical Officer of Health (MOH).
- Test results posted to website.
- Instructions issued by MOH regarding the issuance of swimming advisory.
- Appropriate signs posted at the beach by THC.

3 Water Quality Results at Parlee Beach and Murray Beach

3.1 General Overview

3.1.1 Water Quality

Based on the samples collected in 2017, concentrations of *E. coli* and enterococcus in Shediac Bay and at Parlee Beach are generally lower than the values contained in the Canadian Recreational Water Quality Guidelines. However, it is important to acknowledge that New Brunswick experienced an exceptionally dry summer in 2017 and some caution is therefore warranted in arriving at general conclusions based on the 2017 monitoring data. Additional water quality data are needed over a longer period and for a greater variety of weather conditions to support final conclusions.

Water quality results were compared to guideline values for both the geometric mean and single-sample maximum for *E. coli* and enterococcus. As stated by the Canadian Guidelines "The use of these dual limits allows for a better evaluation of water quality both in the short term and over the duration of the swimming season. The single-sample limit is helpful to identify immediate water quality issues, whereas the geometric mean[2] is helpful in identifying trends that may suggest a chronic contamination problem".

3.1.2 Parlee Beach

At Parlee Beach, water samples were collected daily from May 15 to Oct, 9, 2017, which covered a period of 148[3] days. During that time, "No Swimming" advisories were in place for 23 days, 15 of which were precautionary due to rainfall and eight due to an exceedance of a guideline value. Of the 15 days where precautionary "No Swimming" advisories were issued, only two (July 22 and July 23) corresponded with poor water quality results.

On four of the eight days when "No Swimming" advisories were issued due to an exceedance of a guideline value (Sept 20, Sept 2, Aug24 and July 8) only one of the 10 test results (five *for E. coli* and five for enterococcus) exceeded a single-sample maximum guideline value. Given that the overall water quality throughout the season was very good, these advisories may be viewed as conservative.

Of the remaining four advisory days, two of these, (July 22 and July 23) may be attributed to heavy rainfall.

3.1.3 Murray Beach

At Murray Beach, water samples were collected approximately every third day between May 29, 2017 and Oct. 9, 2017. This means that samples were collected on 58[4] days over a period of 134 days.

Only four sample days had values that exceeded guideline values. Because each "No Swimming" advisory remained in place until receipt of the results of the next scheduled samples, there were a total of nine days where a "No Swimming" advisory was in effect.

On two (June 26 and July 8) of these four days, only one of the 10 test results for each day exceeded a single-sample maximum guideline value. Given that the overall water quality throughout the season was very good, these advisories may be viewed as conservative.

Of the remaining two advisory days, one of them (July 22) may be attributed to a severe precipitation event.

3.2 Detailed Results – Parlee Beach

This section presents the results of the water quality sampling and testing at Parlee Beach. The water quality test results during the 2017 season were uploaded to the website at: http://beaches.gnb.ca/en/SamplingLocation/Details/5882

2 Since bacteria results can be different from location to location within an area of water, the results of any one sample do not represent the average concentration of bacteria in the water. For example, one single sample may demonstrate a concentration that is far above or far below the average. Therefore, the results of several samples must be combined in a way to ensure that one sample (high or low) does not unduly influence the true value.

3 Due to safety concerns (high wind and waves) of staff collecting samples only one of five samples was collected on May 15 and no samples were collected May 27 and Oct 2.

4 Due to safety concerns (high wind and waves) of staff collecting samples, no samples were collected on September 29 and on October 5, samples were collected from only three of five locations.

3.2.1 Data Collection

The following data were collected at Parlee Beach:

- Bacteria counts (*E. coli*. and Enteroccocus)
- Wind speed
- Wind direction
- Number of beachgoers
- Air temperature
- Water temperature
- Daily precipitation

The wind speed and direction were monitored by an on-site weather station. A manual rain gauge was used to collect precipitation data. The number of beachgoers was estimated by on-duty THC lifeguards who also monitored air and water temperature. Data were collected from May 15 to Oct. 9, 2017 resulting in approximately five months of data in total.

3.2.2 Analysis

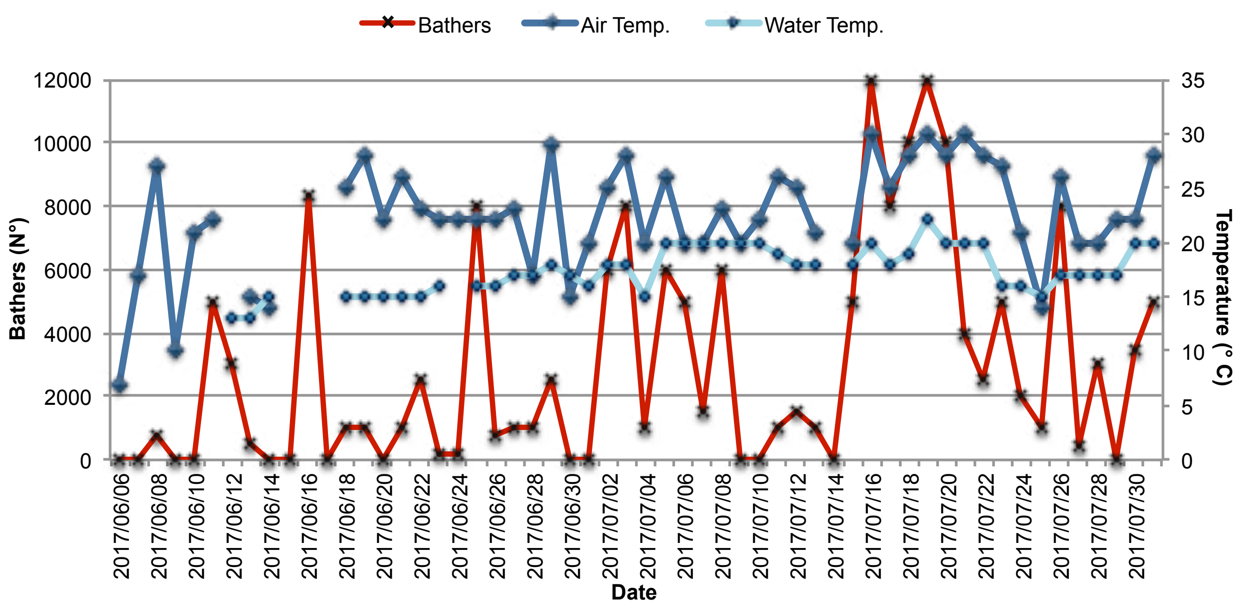
These data were analysed to determine if correlations between various parameters could be identified which might represent cause and effect relationships, and if a predictive model could be developed.

To enhance clarity and ease of understanding, the information is presented in a series of graphs indicating the relationship between several parameters and the geometric mean of the daily *E. coli* and enterococci sample results. These graphs are illustrative in nature and do not necessarily indicate precise data points[5].

3.2.2.1 Beachgoers and Air and Water Temperature

Figure 3.1 illustrates the relationship between the number of beachgoers (people at the beach) and the air and water temperature. Beachgoers are indicated by the red line; water temperature is a light blue line and air temperature is a dark blue line. The data presented spans the period from June 6 to July 30, 2017. As expected, there is a good correlation between these parameters and the number of beachgoers.

Figure 3.1 - Beachgoers and Temperature



5 The method used to conduct the laboratory analysis of marine waters has a detection limit of 10. This means that for a result of 10 Most Probable Number (MPN)/100ml the actual result can range from 0 (not detected) to 10.

3.2.2.2 Wind Speed and Geometric Mean of Bacteria Counts

Figures 3.2a to 3.2d illustrate the relationship between wind speed and the geometric mean of bacteria counts for the months of June to September 2017. Wind speed was measured hourly at the Parlee Beach weather station and averaged for any given day. Wind speed is indicated by the blue line in km/hr (right hand axis). The *E. coli* geometric mean is indicated by the green bar and the enterococci geometric mean is indicated by the yellow bar (left hand axis). There is no discernible correlation between these parameters for any of the four months.

Figure 3.2a - Wind Speed and Geometric Mean – June

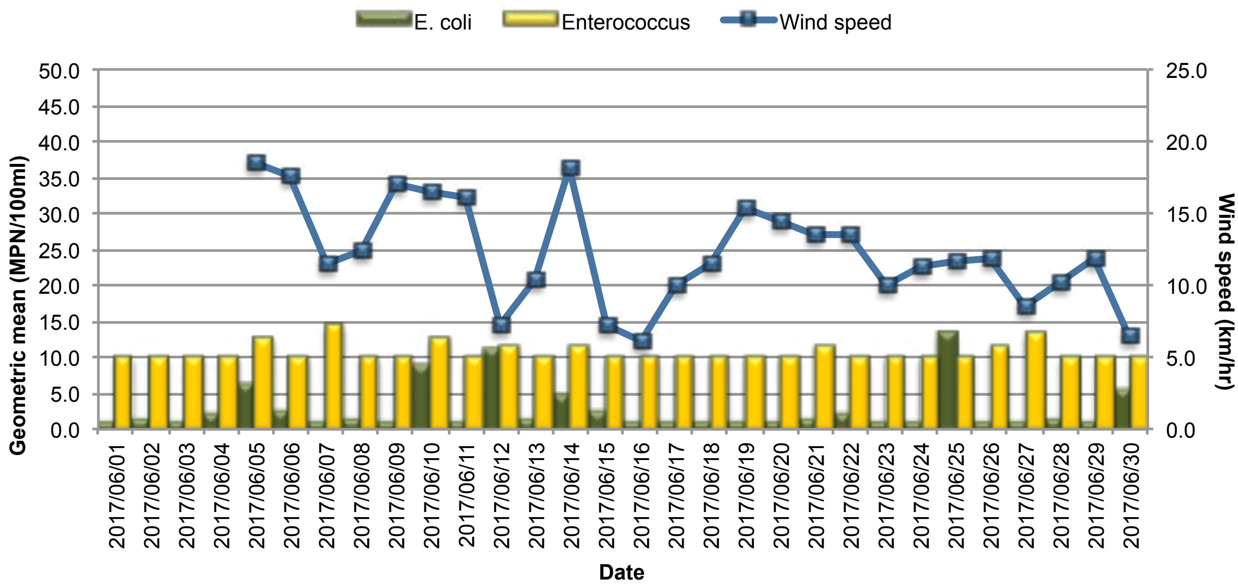


Figure 3.2b - Wind Speed and Geometric Mean – July

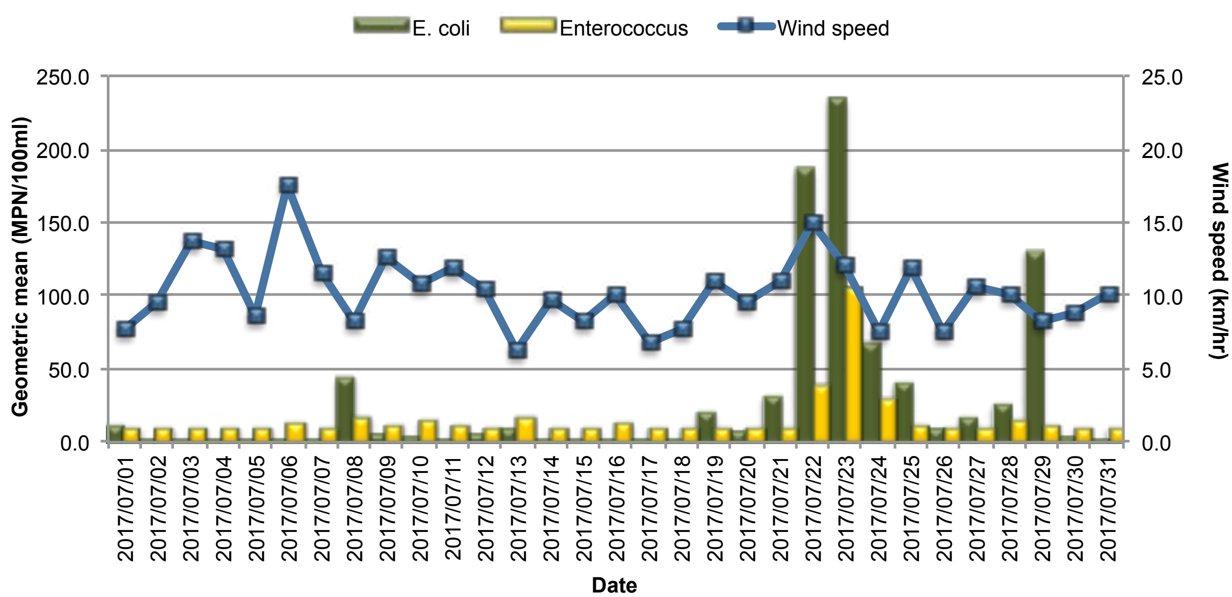


Figure 3.2c - Wind Speed and Geometric Mean – August

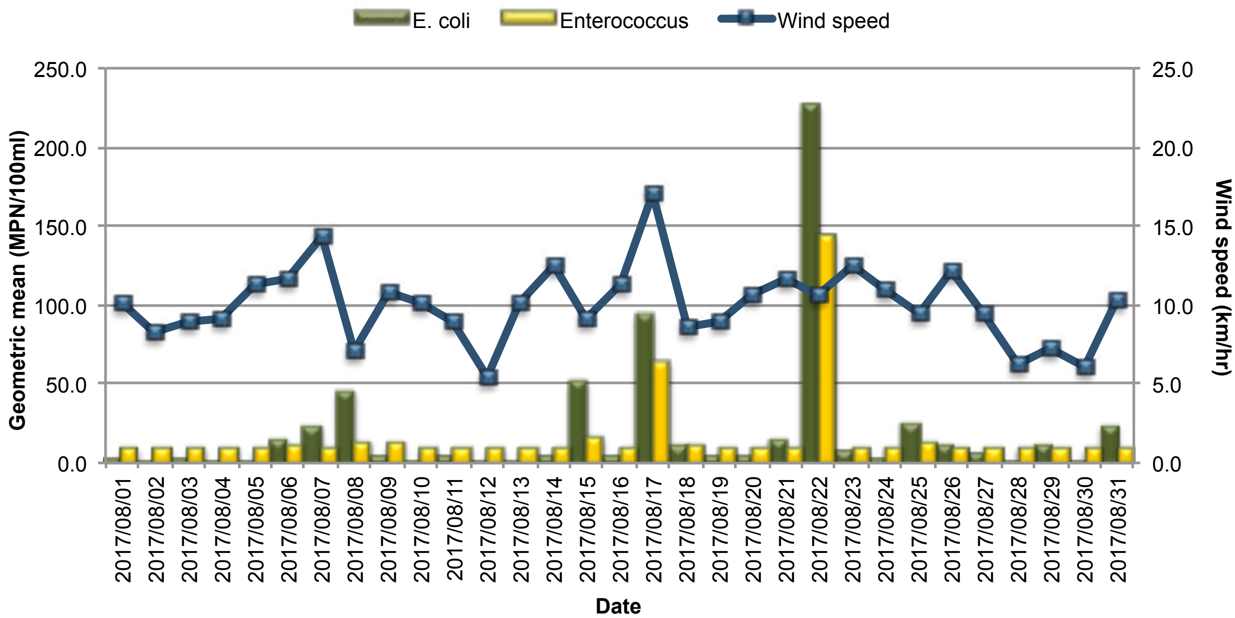
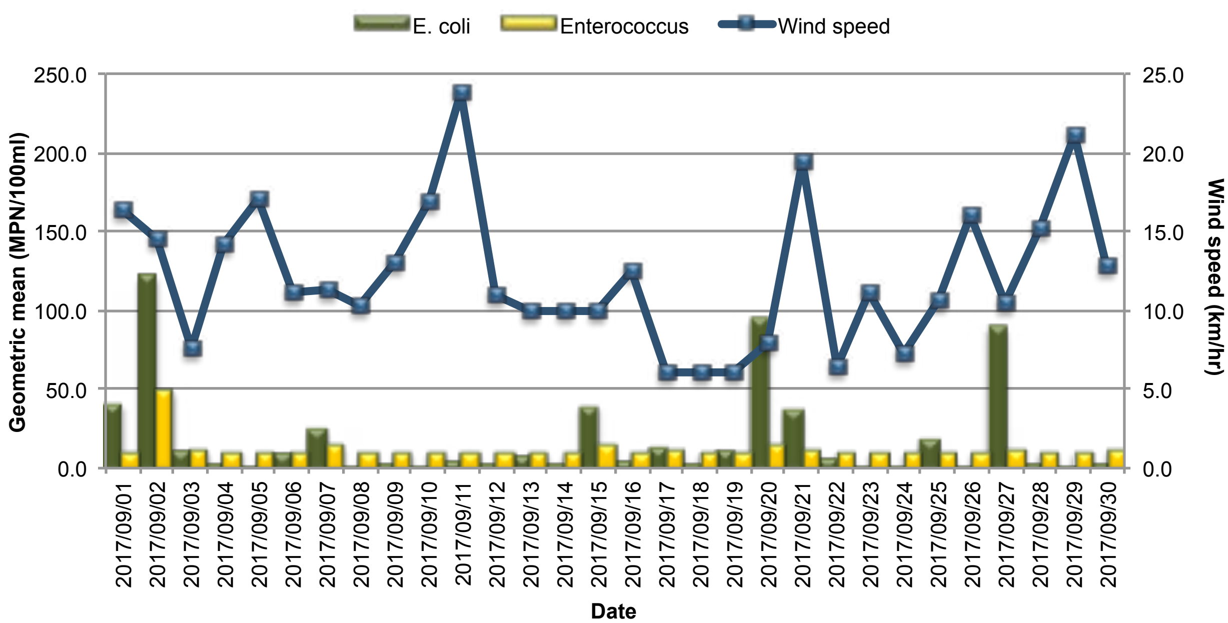


Figure 3.2d - Wind Speed and Geometric Mean – September



3.2.2.3 Beachgoers and Geometric Mean of Bacteria Counts

A review of the literature suggests that bather density can affect water quality at swimming beaches, as bathers themselves may act as a source of pollution. "Faecal shedding" is recognized in the World Health Organization (2003) guidelines as a major source of contaminants. In addition, the resuspension of bottom sediments due to disturbance by wading bathers can result in elevated turbidity levels and be a potential nonpoint source of contamination.

Figures 3.3a and 3.3b illustrate the relationship between the estimated number of beachgoers and the geometric mean of bacteria counts that were collected at Parlee Beach from June to September 2017. Bather density is a potential factor that can influence water quality, but, based on the daily geometric mean calculations from 2017, the number of beachgoers did not seem to have any predictable or lasting negative effect on the water quality of the following day.

Bacteria counts are highly dependent upon local conditions (water depth, tides, currents, temperatures, etc.). Locations with very little water movement may result in bacteria densities that increase with the number of beachgoers. At locations where there is significant wave action, bacteria shed into the water may be dispersed very rapidly, and the relationship between bacteria and the number of beachgoers would not be evident.

Figure 3.3a - Beachgoers and Geometric Mean – June and July

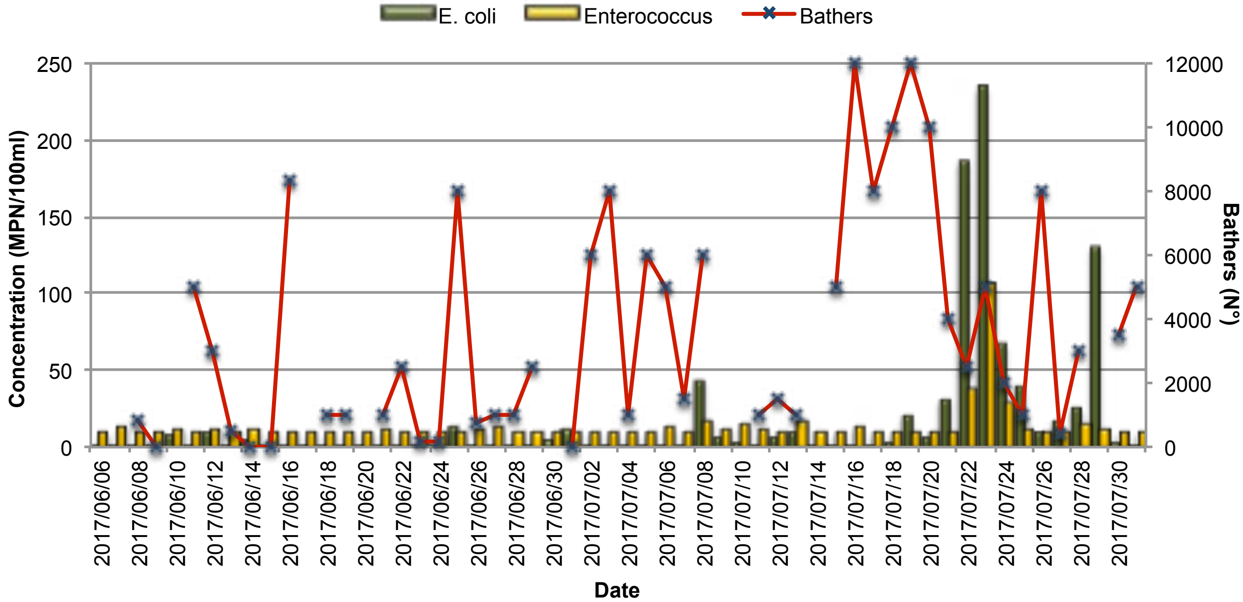
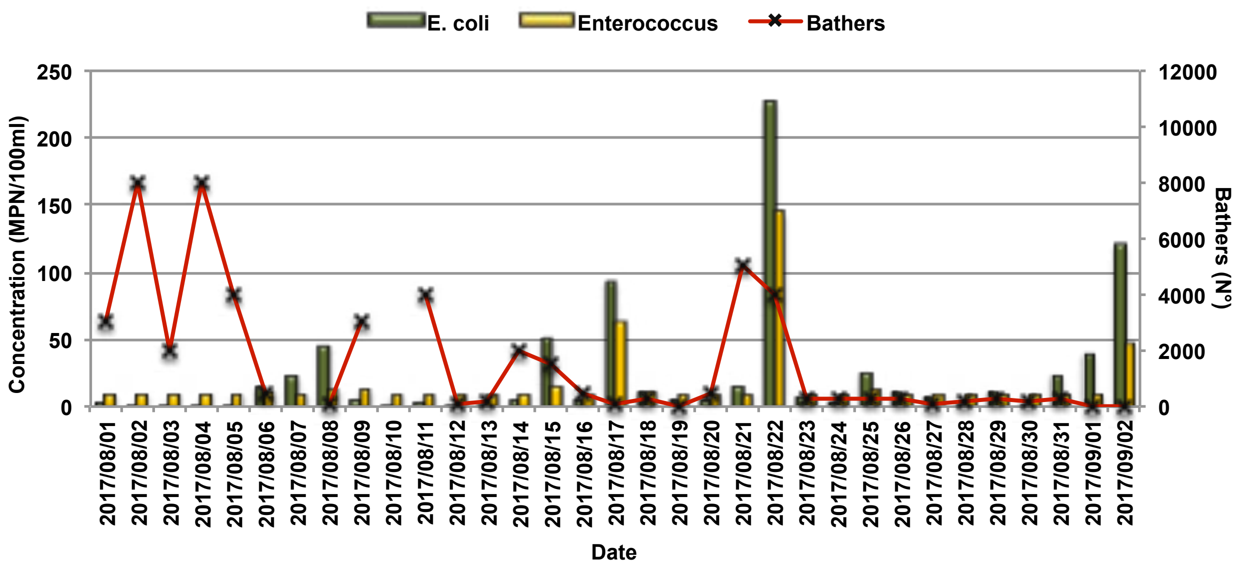


Figure 3.3b - Beachgoers and Geometric Mean – August and September



3.2.2.4 Precipitation and Geometric Mean of Bacteria Counts

A review of the literature suggests that intense rainfall events increase surface water runoff, which may negatively affect water quality at swimming beaches. Figures 3.4a to 3.4f illustrate the relationship between rainfall and the geometric mean of bacteria counts from June to the first nine days of October 2017. There is no consistent correlation between these parameters.

Figure 3.4a - Precipitation and Geometric Mean – May

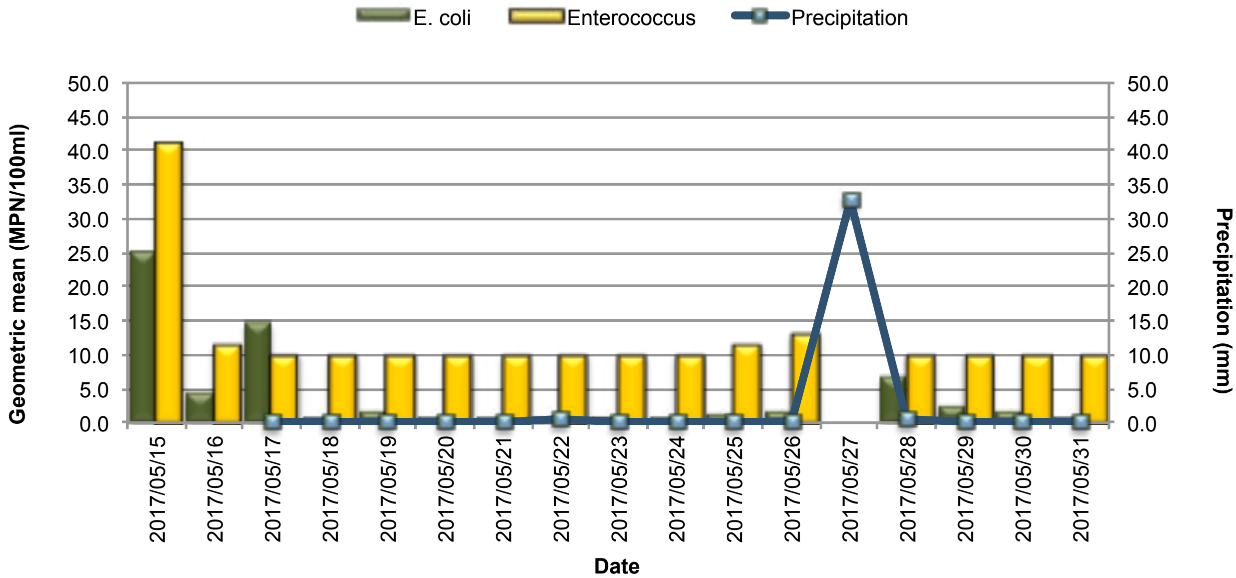


Figure 3.4b - Precipitation and Geometric Mean – June

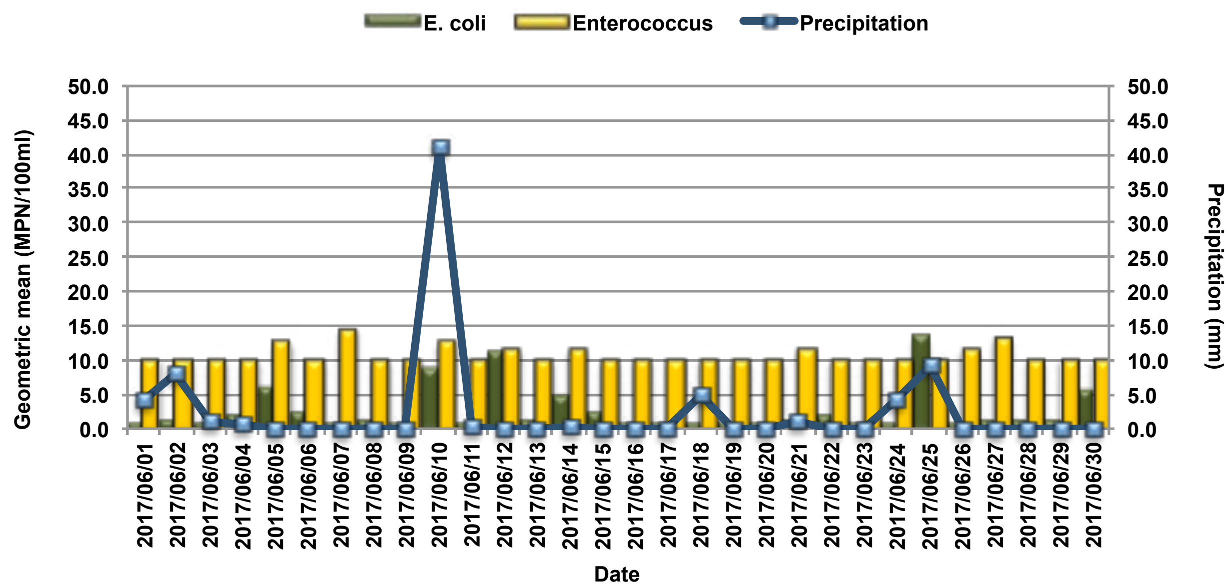


Figure 3.4c - Precipitation and Geometric Mean – July

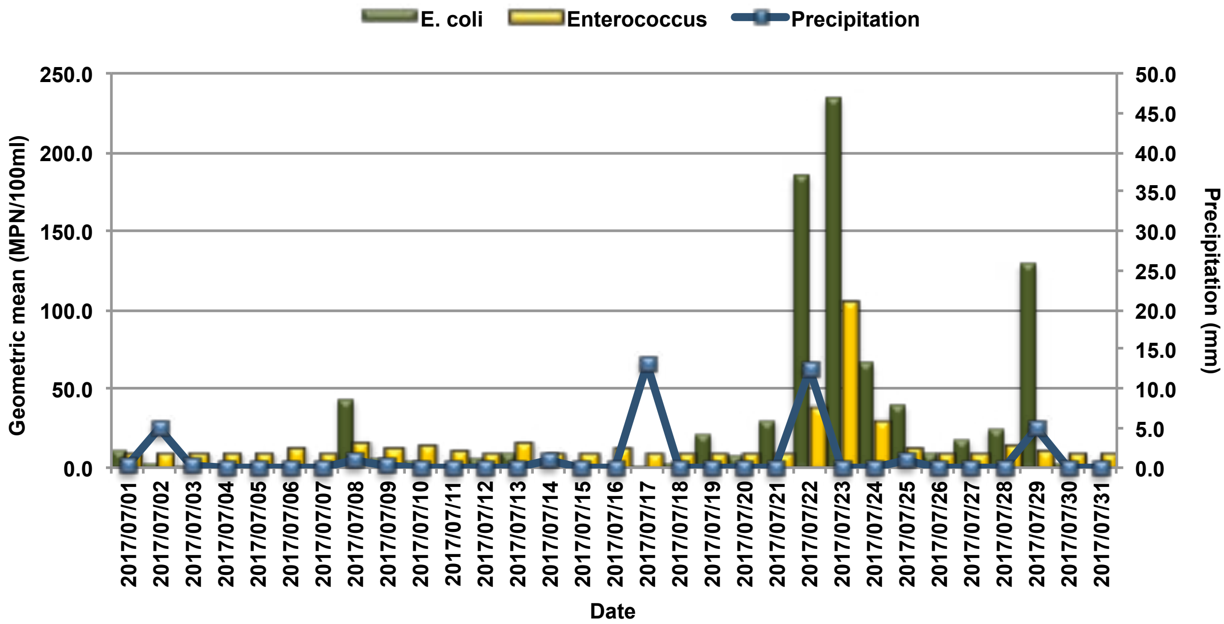


Figure 3.4d - Precipitation and Geometric Mean – August

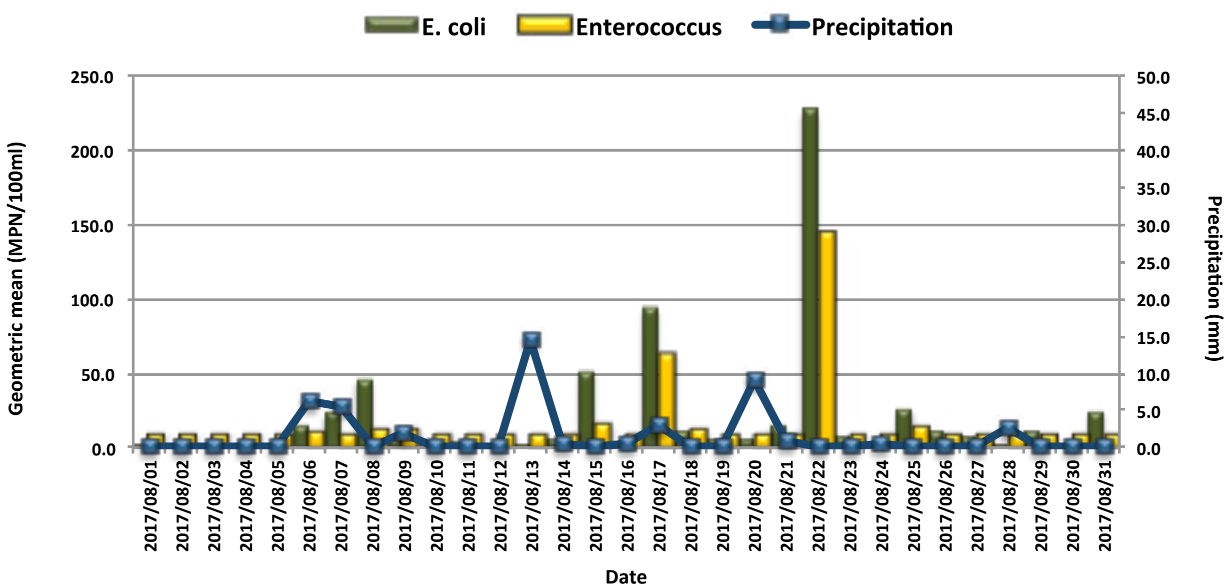


Figure 3.4e - Precipitation and Geometric Mean – September

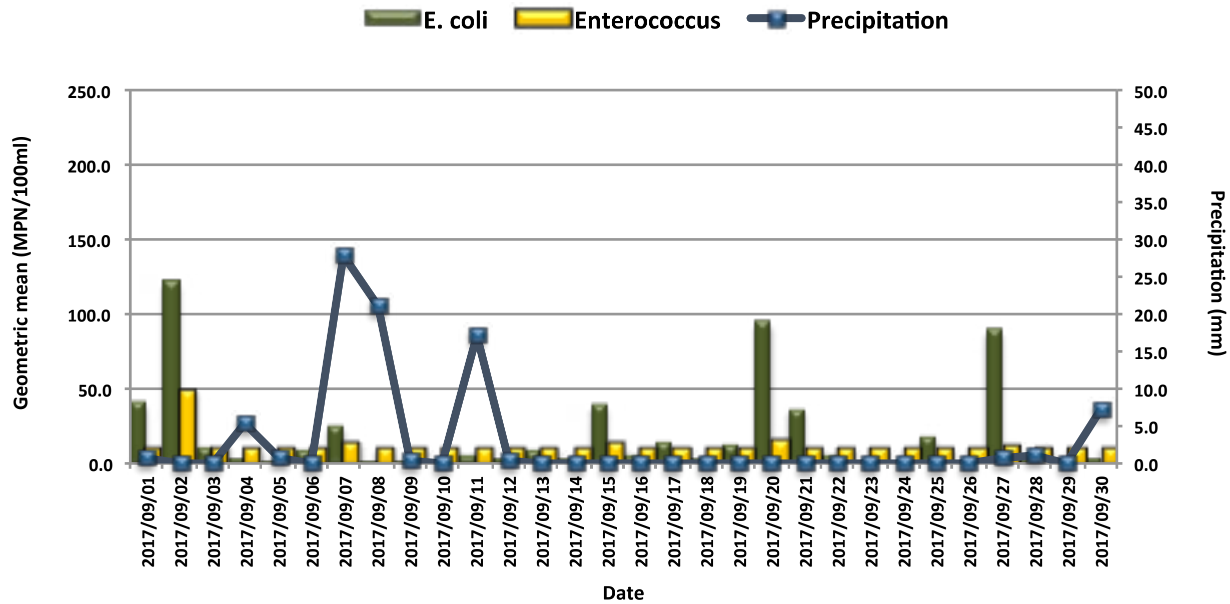
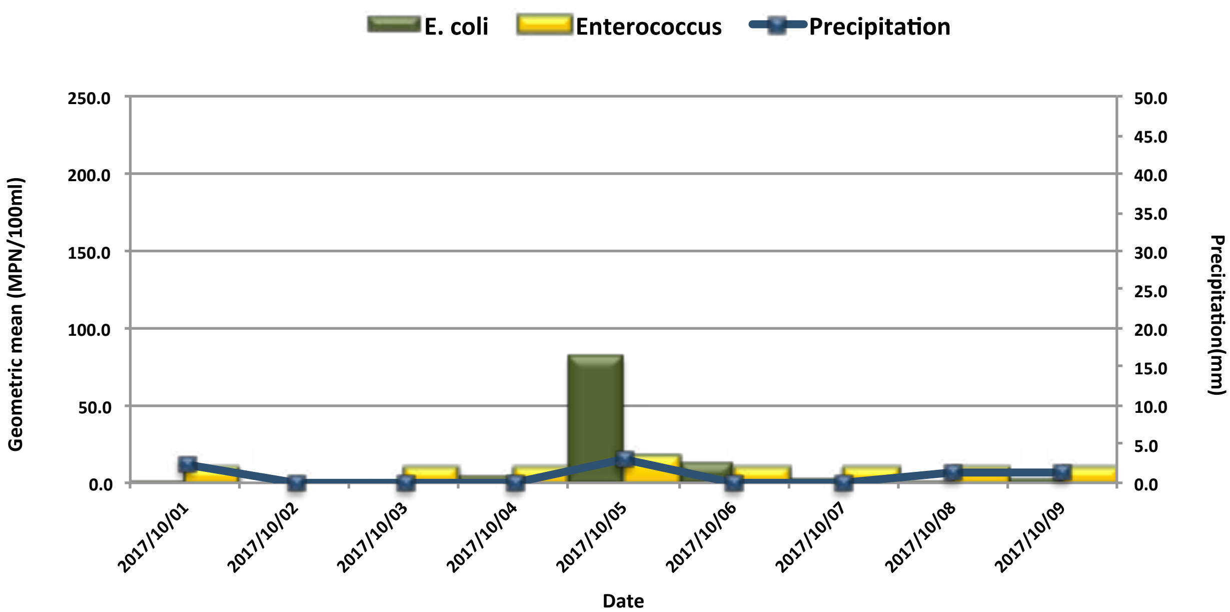


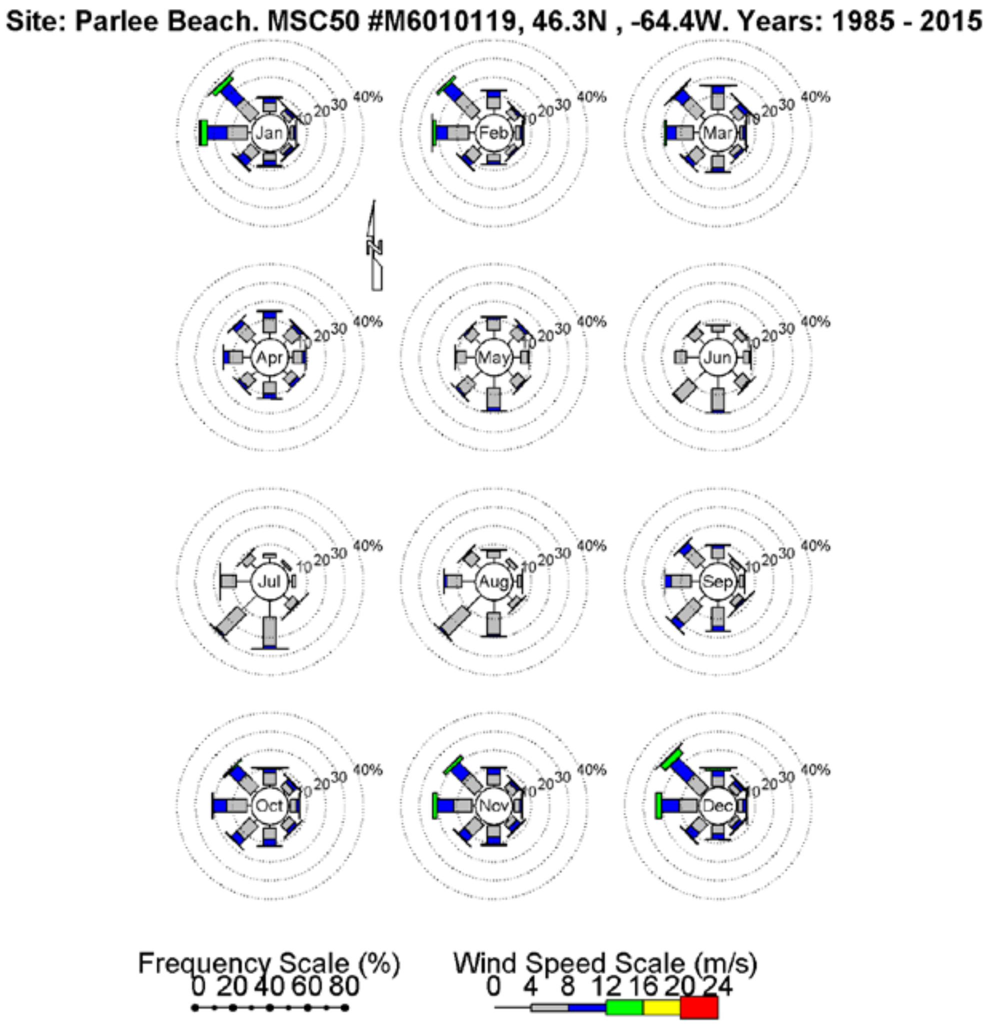
Figure 3.4f - Precipitation and Geometric Mean – October



3.2.2.5 Wind Direction and Geometric Mean

Figure 3.5a illustrates wind diagrams by month for 30 years of data over the period 1985 to 2015. During the swimming season (late May to early September), the prevailing winds come from the south and (primarily) the southwest. During the fall and winter months, winds from the northwest dominate. However, from time to time, the wind can blow from all directions.

Figure 3.5a - Historic Wind Distribution



Figures 3.5b to 3.5f illustrate the relationship between wind direction and the geometric mean of bacteria counts from June to the first nine days of October 2017. There appears to be a relatively consistent correlation between these parameters. These data suggest that when the wind is blowing from the southwest (between 180 and 270 degrees), water quality at Parlee Beach is acceptable. But when the wind shifts to the northwest (between 270 and 360 degrees) there is often an increase in test values.

Figure 3.5b - Wind Direction and Geometric Mean – June

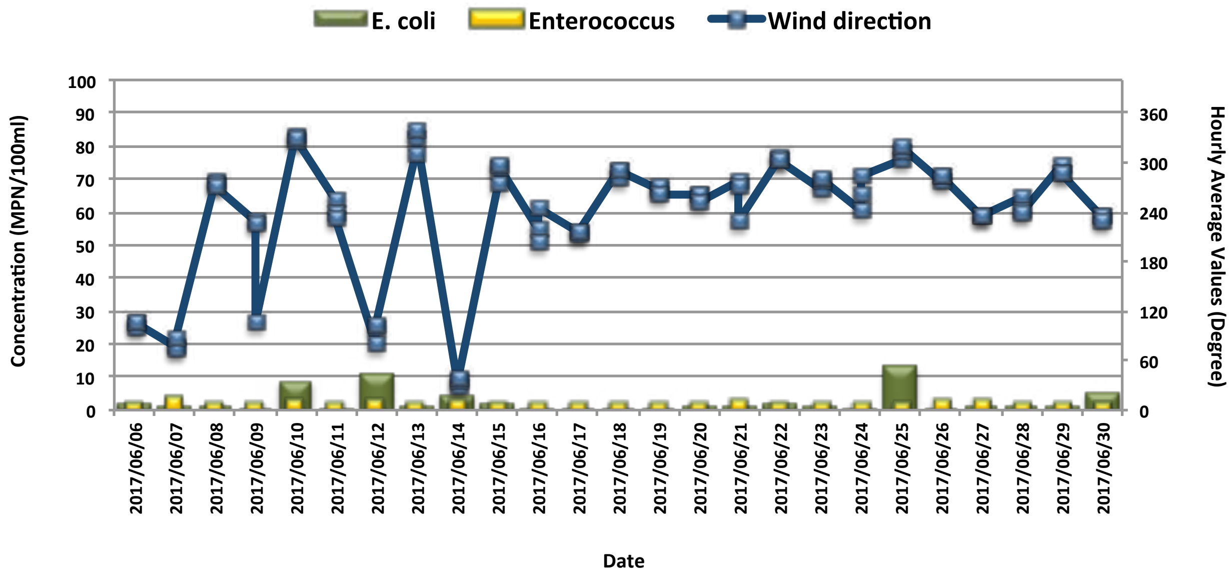


Figure 3.5c - Wind Direction and Geometric Mean – July

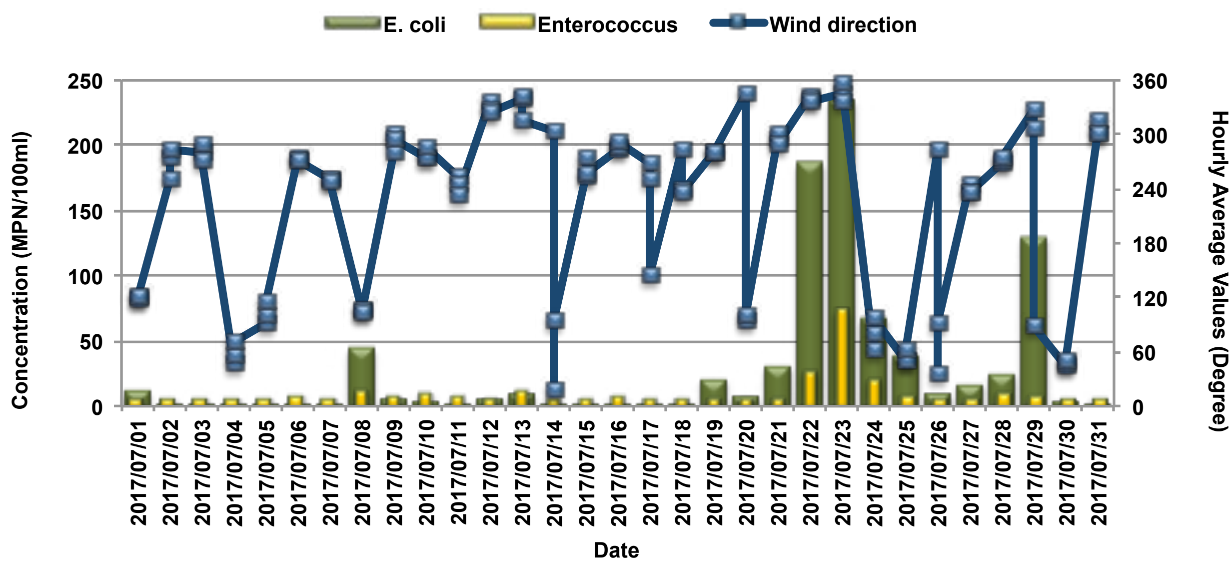


Figure 3.5d - Wind Direction and Geometric Mean – August

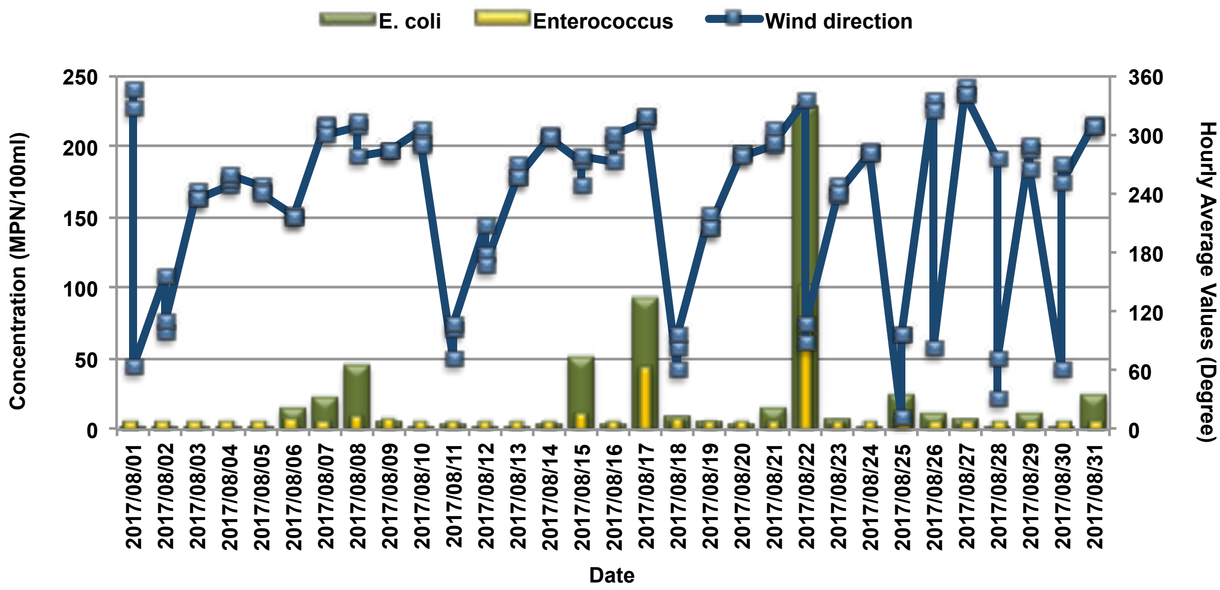


Figure 3.5e - Wind Direction and Geometric Mean – September

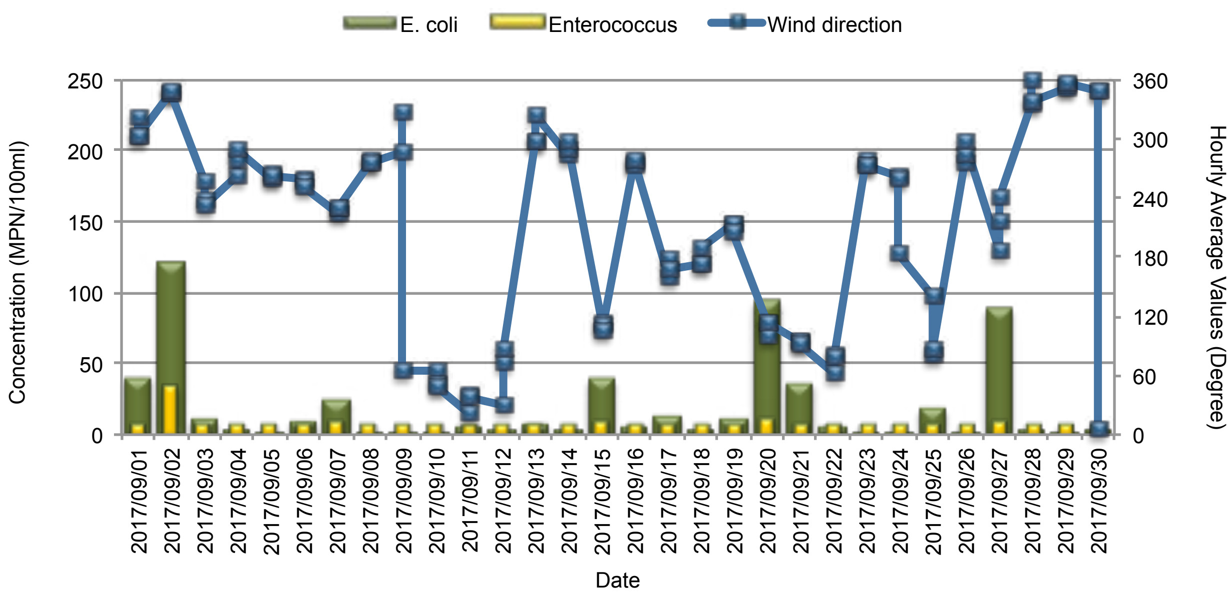


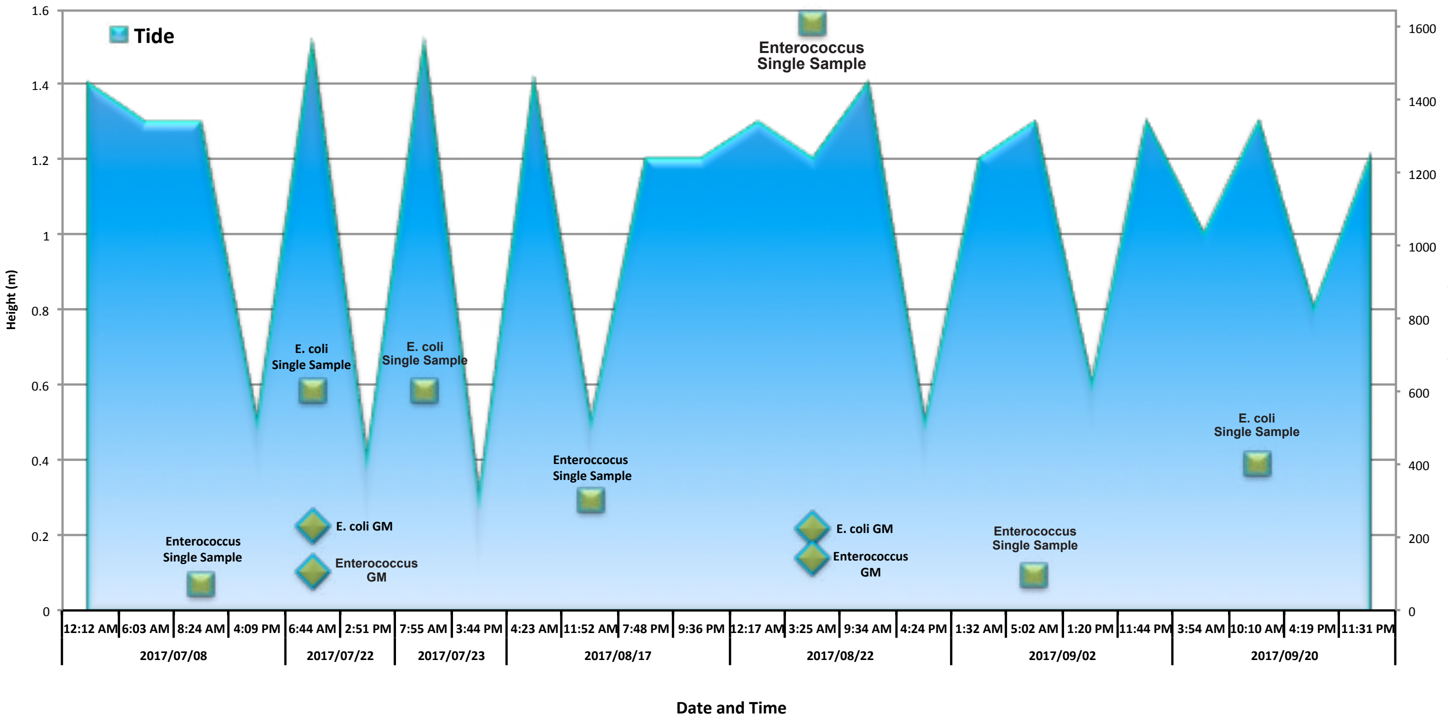
Figure 3.5f - Wind Directions in Shediac Bay

3.2.2.6 Tidal Influence on Bacteria Counts

Figure 5.5g shows an example of the relationship between tide height and bacteria for a selected seven days spread over July to September. The graph is not a continuous sequence of chronological days. In addition, the sample time does not match the time on the graph; it matches the day only.

Exceedances of the guideline value geometric mean of bacteria counts were noted on July 22 and August 22. The July 22 sample was collected on an ebbing tide; the August 22 sample was collected on a rising tide, as samples were collected at 10:30-11:00 am each day. Exceedances of the guideline value single-sample maximum occurred during each selected day; sometimes associated with sample collection time on a rising tide and sometimes on an ebbing tide. These are the only days during which the guideline values single-sample maximum or geometric mean were exceeded. For the other 140 days when samples were collected, many during high tide conditions, guidelines values were not exceeded. There is insufficient data to determine a conclusive relationship.

Figure 3.5g - Tidal Height and Single-Sample Maximum

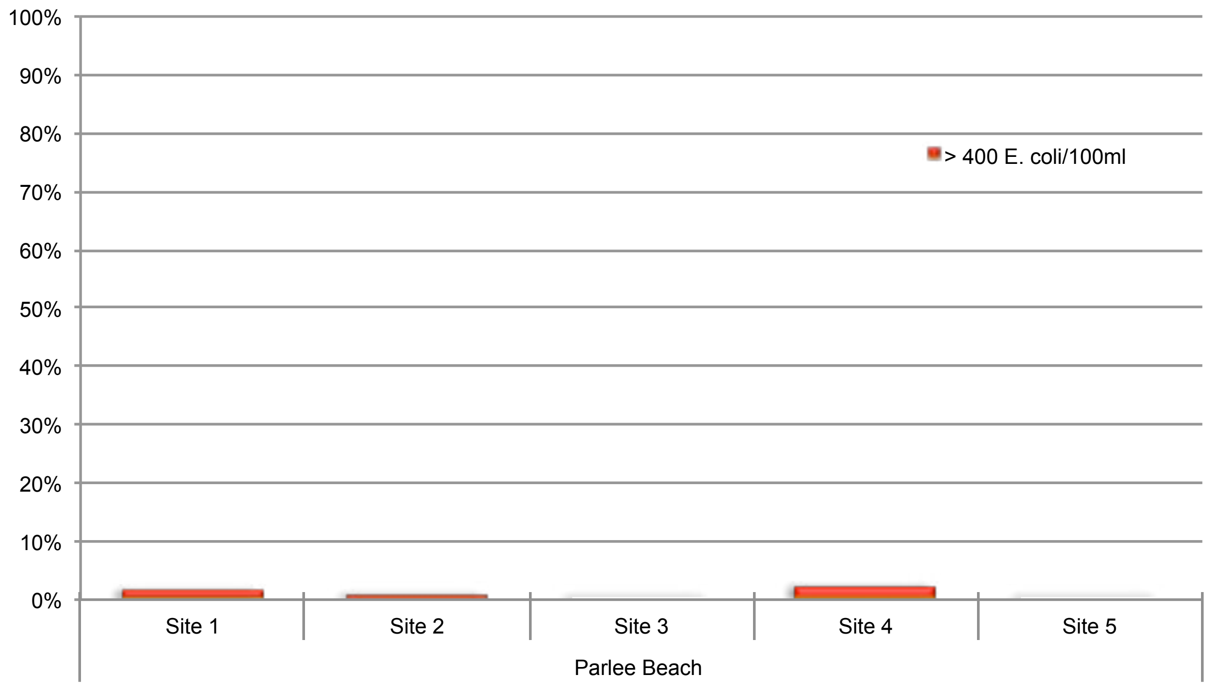


3.2.3 Conclusions – Parlee Beach Water Quality

- A review of the results indicates that most bacteria counts at Parlee Beach were lower than the limits established in the Guidelines for Canadian Recreational Water Quality. This suggests that any bacterial contamination of water at Parlee Beach is not chronic in nature, and the water quality is suitable for swimming.
- Guideline values were exceeded for less than three-per-cent of samples collected at three sampling sites and did not occur for samples obtained at the other two sites (see Figure 3.5h). (The sites are equidistant across the one km of beach and numbered one to five from west to east.) These occasional exceedances indicate that Parlee Beach is vulnerable to periodic episodes of poor water quality; likely due to sources of bacteria originating from within the watershed, that make their way to Parlee Beach under certain combinations of meteorological and oceanographic conditions.
- There does not appear to be a strong correlation between bacteria counts and most parameters, but information collected to date suggests that wind direction (and possibly tidal height) may be important factors.
- It is not possible to be conclusive as these observations are based on only five months' data, and rainfall during the 2017 summer was half the usual amount.
- These conclusions provide support for the development of a predictive model that would allow issuance of more timely[6] "No Swimming" advisories (when necessary) and potentially allow for a reduction in sampling frequency.

6 It currently takes approximately 48 hours to receive water quality results after a sample has been collected. This does not invalidate the data and is an industry-accepted process and timeframe. Water quality samples must be collected, correctly labelled, packed and transported to an accredited laboratory. Once received at the laboratory, the samples must be registered and prepared for analysis. The analysis itself takes approximately 24 hours. When analytical results are available, they must be properly documented and uploaded to a database. They are then reported to the Office of the Chief Medical Officer of Health.

Figure 3.5h - Percentage Exceedance of Single-Sample Maximum for E. coli

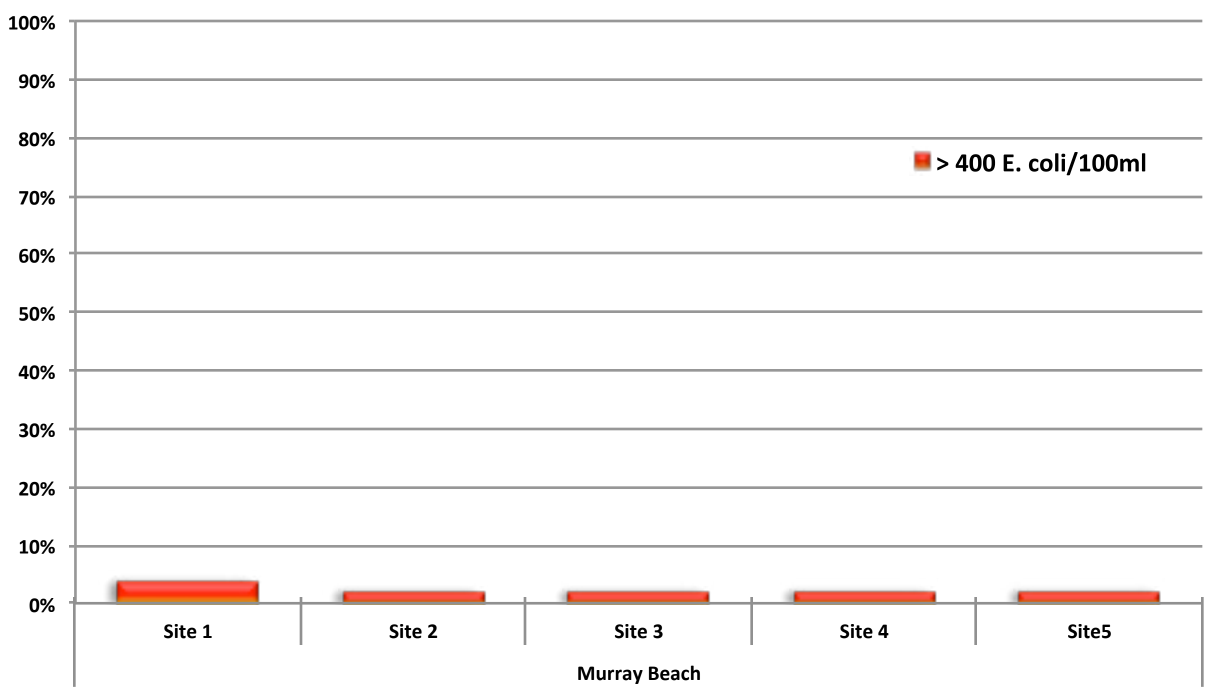


3.3 Detailed Results – Murray Beach

This section presents the results of the water quality sampling and testing process for Murray Beach. The water quality test results during the 2017 season were uploaded to a webpage at: http://beaches.gnb.ca/en/SamplingLocation/Details/5883

Water quality test results exceeded the guideline values on only four occasions. Exceedances of the single-sample maximum guideline value are less than three-per-cent of samples for all sampling sites as shown at Figure 3.5i.

Figure 3.5i - Percentage Exceedance of Single-Sample Maximum for E. coli



4 Watershed reconnaissance survey and water sampling program

4.1 Monitoring Plan Design

There are significant challenges in investigating bacterial contamination in a beach environment, including multiple potential sources and the need to understand movement and fate of bacteria. The purpose of this project was to gather water quality and related data that would support a more complete understanding of the sources that may be contributing to bacterial contamination in Shediac Bay and the bathing waters of Parlee Beach. This targeted monitoring program offered the potential of assembling a body of information that would improve understanding of bacterial dynamics and support improved decision-making.

The monitoring plan design was developed by Independent Environmental Services. The report entitled, "Parlee Beach Water Quality Monitoring Plan for 2017" is available upon request.

Monitoring took place at 36 sampling locations, identified and classified as follows:

- Effluent sites – facilities that operate under Certificates of Approval for wastewater discharge issued by DELG.
- Stormwater sites – small natural drainage channels and local stormwater drains.
- Freshwater sites – small local tributaries that may be influenced by a range of local bacteria sources such as small on-site sewage disposal systems, stormwater inputs, or runoff from fields.
- Agricultural sites – areas that might be influenced by livestock operations or horticultural activity.
- Marine sites – offshore locations in Shediac Bay near Parlee Beach.
- Sediment sites – locations adjacent to Parlee Beach that would provide useful information on whether the sediments contain bacteria.

The above described program was combined with sampling conducted at 21 sites by the Shediac Bay Watershed Association (SBWA) under an Environmental Trust Fund (ETF) project. The report entitled, "State of the Bay Water Quality Surveys for *E.coli* in the Shediac Bay Watershed 2000-2017: is available upon request.

The ETF sampling locations are identified and classified as follows:

- Water Quality sites – selected to be above tidal waters and on small streams that surround Shediac Bay.
- Scoudouc sites – freshwater locations distributed along the Scoudouc River.
- Shediac sites – various freshwater locations in the Shediac River watershed draining into Shediac Bay.

The sampling locations are illustrated in Figure 4.1a for the ETF sites, and in Figure 4.1b for the Watershed Reconnaissance Program (WRP) sites.

Figure 4.1a - ETF Sampling Sites

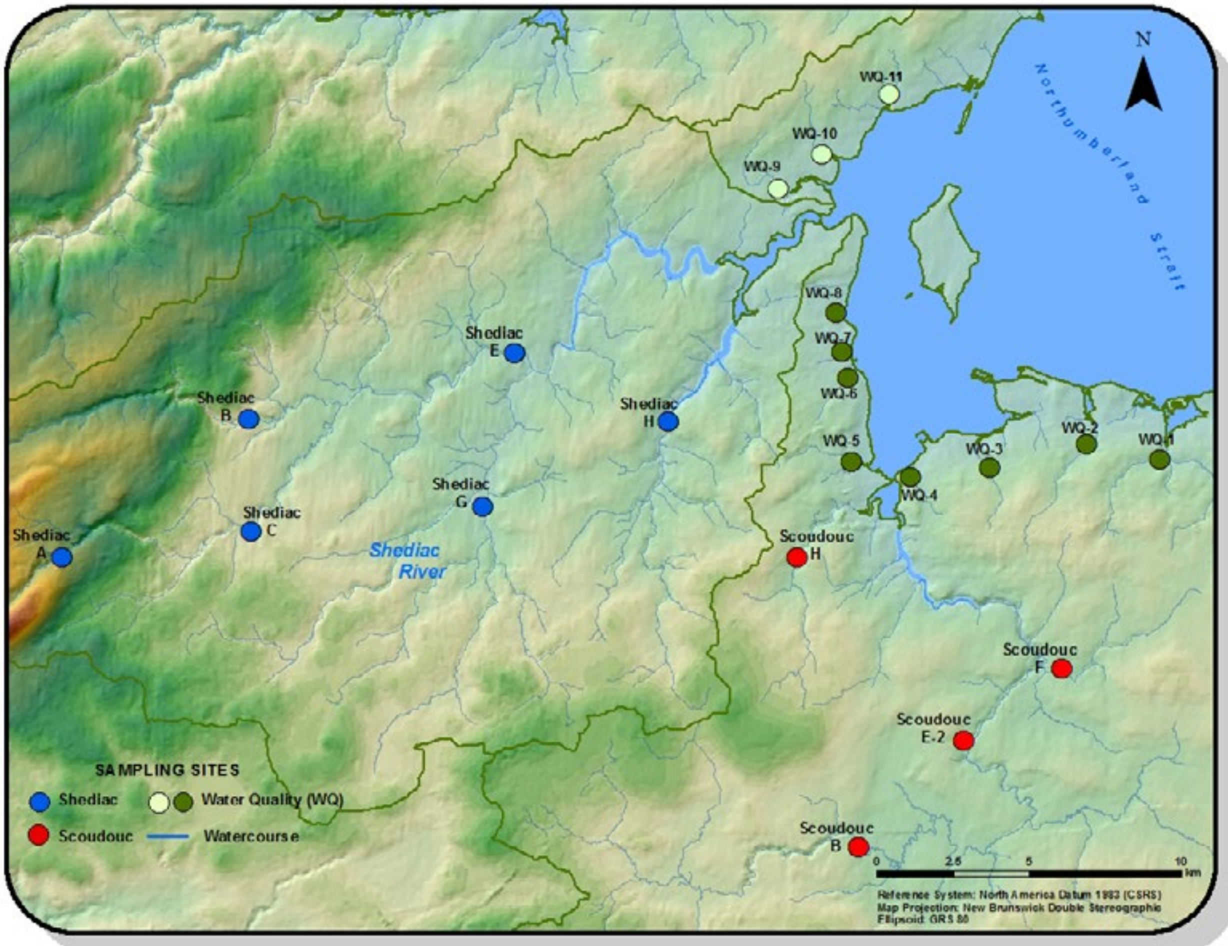
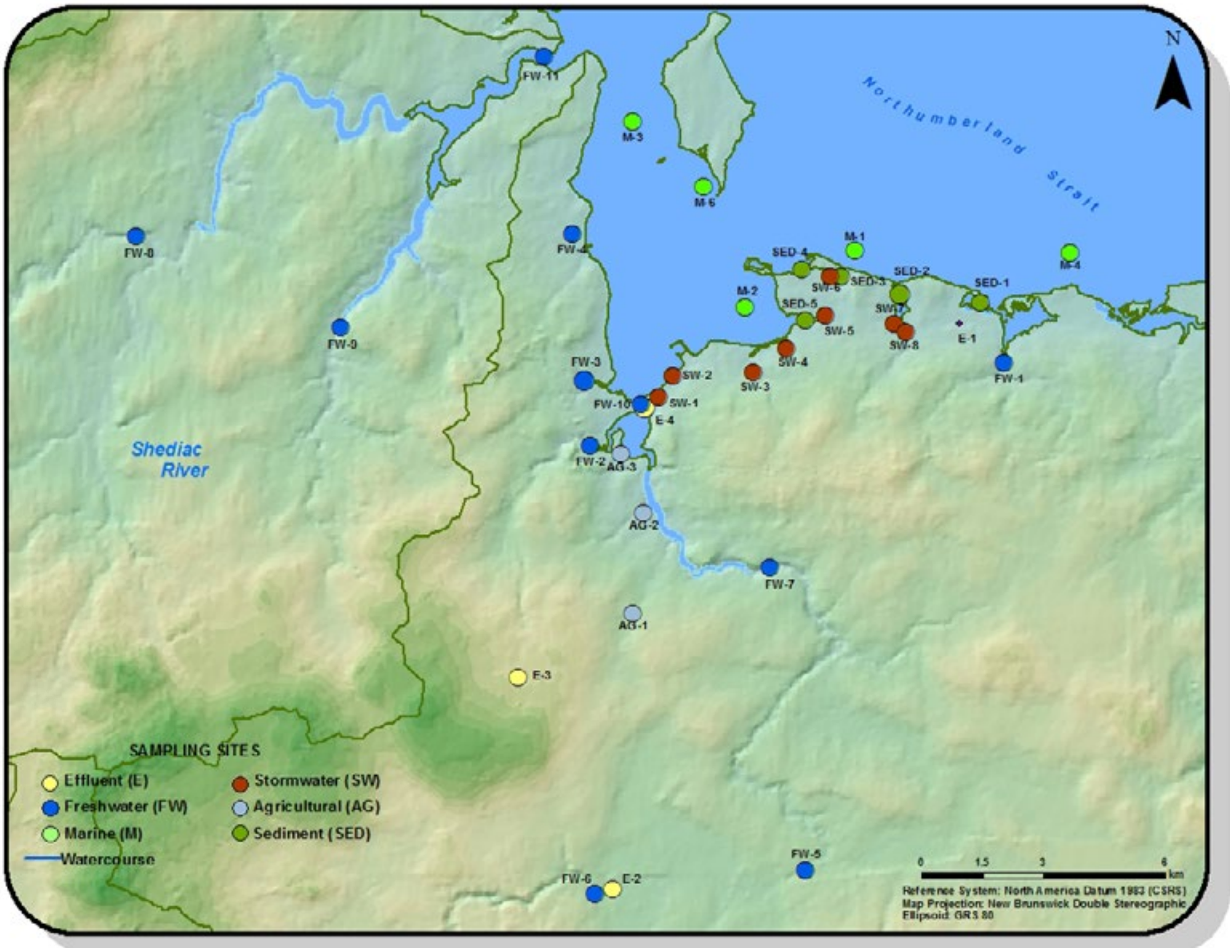


Figure 4.1b - WRP Sampling Sites

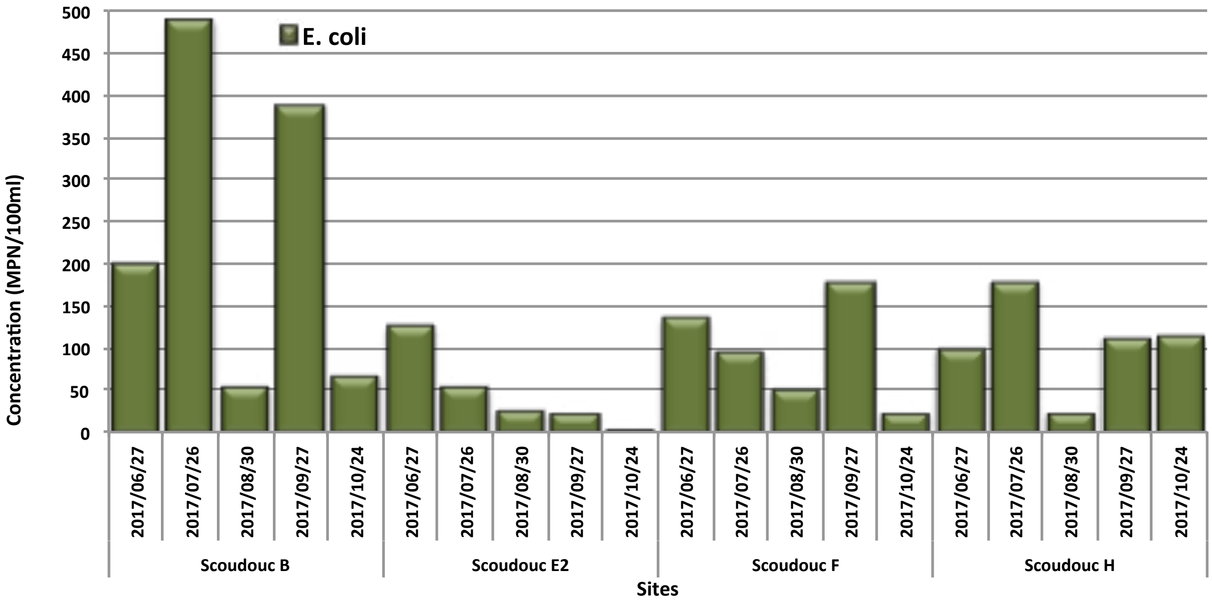


4.2 Results– ETF Sites

4.2.1 Scoudouc Sites

The test results for the four Scoudouc sites are shown at Figure 4.2a. Data were collected from June to October 2017. All *E. coli* sample results were under 200 MPN/100ml, except for two at Scoudouc B: one sample at about 380 MPN/100ml on Sept. 27, 2017; and one sample which exceeded the single-sample maximum guideline value of 400 MPN/100ml on July 26, 2017; possibly related to the approximate 12 mm of rain which fell on July 22.

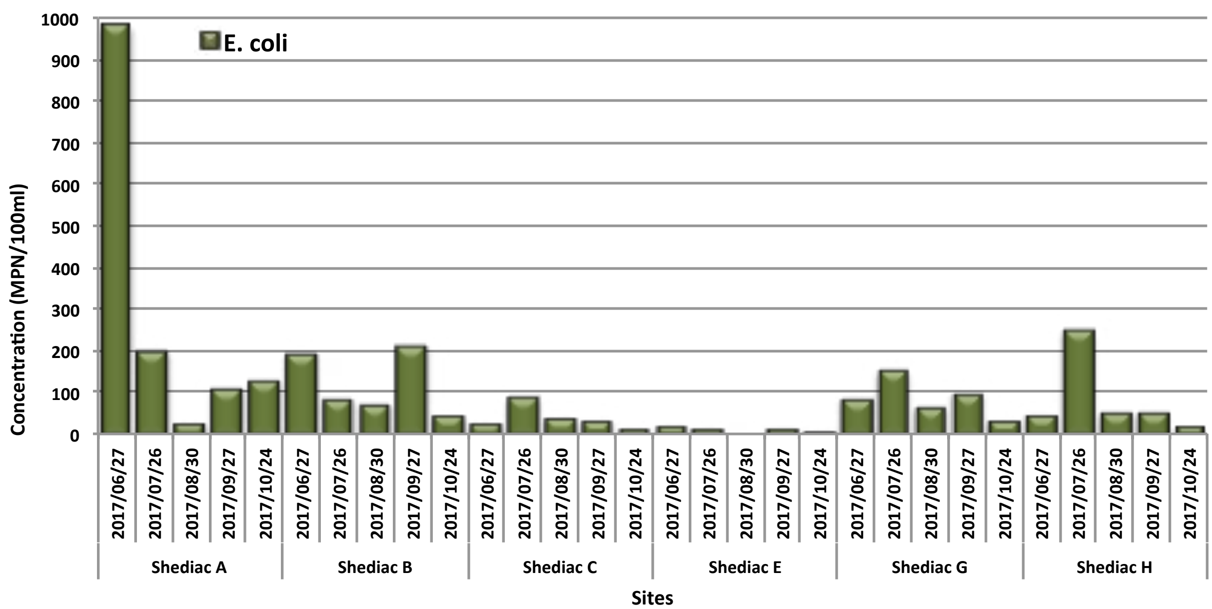
Figure 4.2a - Scoudouc Sites – Results



4.2.2 Shediac Sites

The test results for the six Shediac sites are shown at Figure 4.2b. Data was collected from June to October, 2017. All *E. coli* samples are under 250 MPN/100ml, except for one at Shediac A (in the upper reaches of the watershed), which was almost 1,000 MPN/100ml on June 27, 2017, which exceeded the single-sample maximum guideline value of 400 MPN/100ml.

Figure 4.2b - Shediac Sites – Results



4.2.3 Water Quality Sites

The test results for the eleven Water Quality sites are shown at Figure 4.2c (WQ1 – WQ6) and Figure 4.2d (WQ7 – WQ11). Data were collected from June to October, 2017. Several sites had *E. coli* values that exceeded the single-sample maximum guideline value of 400 MPN/100ml. These include WQ3 on July 19, WQ6 on July 19, WQ8 on July 19 and August 22, WQ10 on August 22 and September 20, and WQ11 on July 19, August 22, September 20, and October 18. These data indicate that WQ8, 10 and 11 are particularly problematic areas. These sites are located on Ruisseau Albert-Gallant in Shediac Bridge and two unnamed streams in Grand Digue.

Figure 4.2c - Water Quality Sites – Results (WQ1 – WQ6)

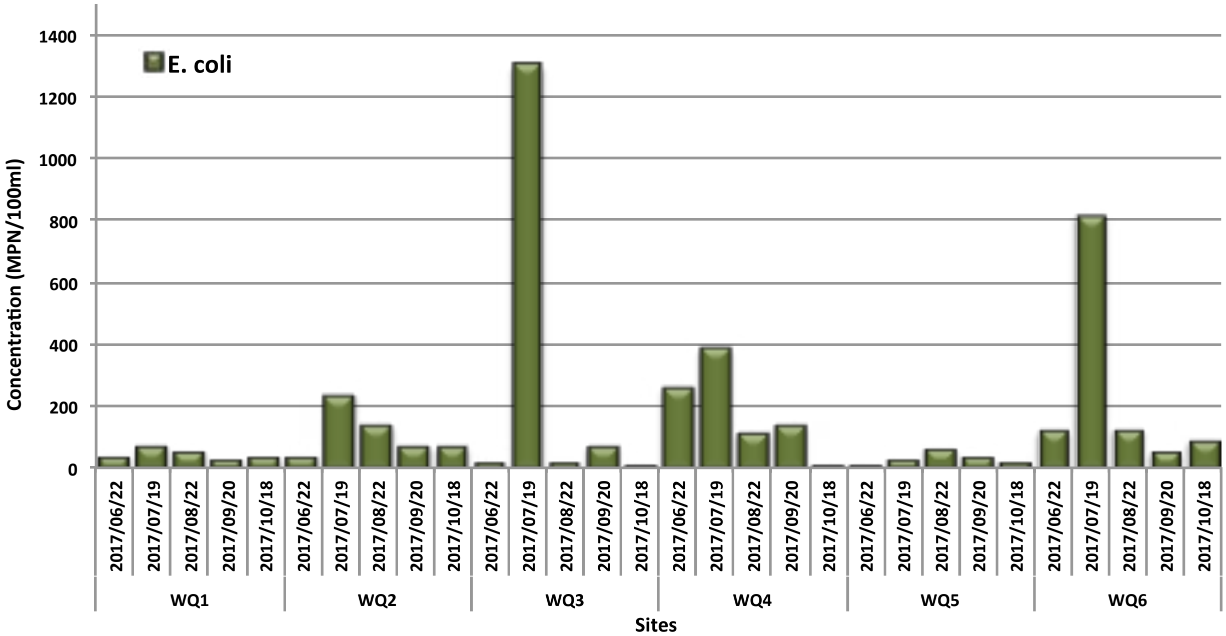
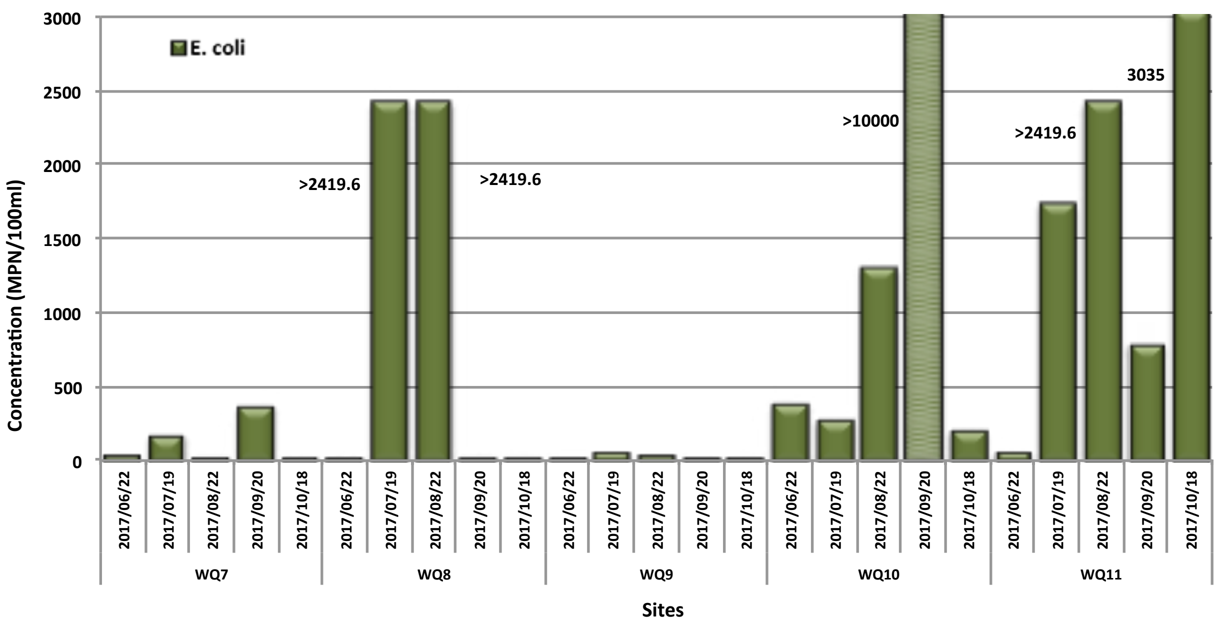


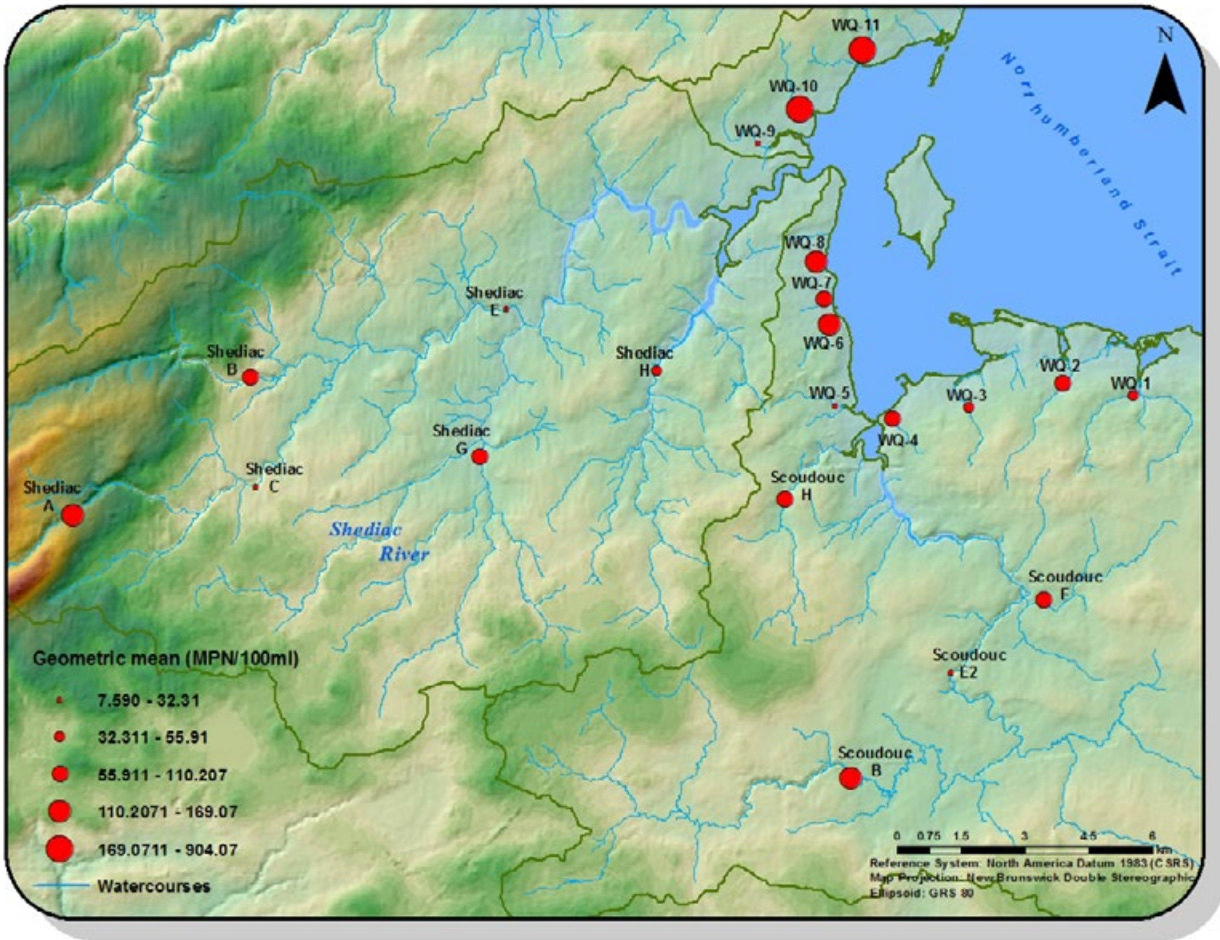
Figure 4.2d - Water Quality Sites – Results (WQ7 – WQ11)



4.2.4 Map of the Geometric Mean of Bacteria Counts for ETF Sites

The geometric mean of the *E. coli* samples collected at each sampling location was calculated and their spatial distribution was mapped as shown at Figure 4.2e. The size of the circle at each site is proportional to the geometric mean value, as indicated in the legend. The results indicate that sources of bacteria are distributed throughout the watershed, including the upper reaches at the Shediac A and Scoudouc B sites. However, only the sites WQ10 and WQ 11 (around Grand Digue, north of the Shediac River) are close to or exceed the geometric mean guideline value of 200 MPN/100ml.

Figure 4.2e - ETF Sites Geometric Mean of E.coli Values by Sampling Location



4.3 Results – WRP Sites

4.3.1 Fresh Water Sites

The test results for the eleven Fresh Water sites are shown on Figures 4.3a to 4.3c. Data were collected from July to October, 2017. Four *E. coli* samples exceeded the single-sample maximum guideline value of 400: FW2 at >10,000 MPN/100ml on September 7; FW3 at >10,000 MPN/100ml on August 21; FW6 at 2750 MPN/100ml on October 11; FW10 at >2400 MPN/100ml on July 27; and, FW11 at >10,000 MPN/100ml on September 7 (coincident with a precipitation event). For enterococcus, samples exceeded the single-sample maximum guideline value of 70 MPN/100ml at all sites. Highest values were exhibited at FW1, FW2, FW3, FW4 and FW11 with the highest value exhibited at FW11 at 7270 MPN/100ml on September 7.

Figure 4.3a - Fresh Water Sites (FW1 – FW5)

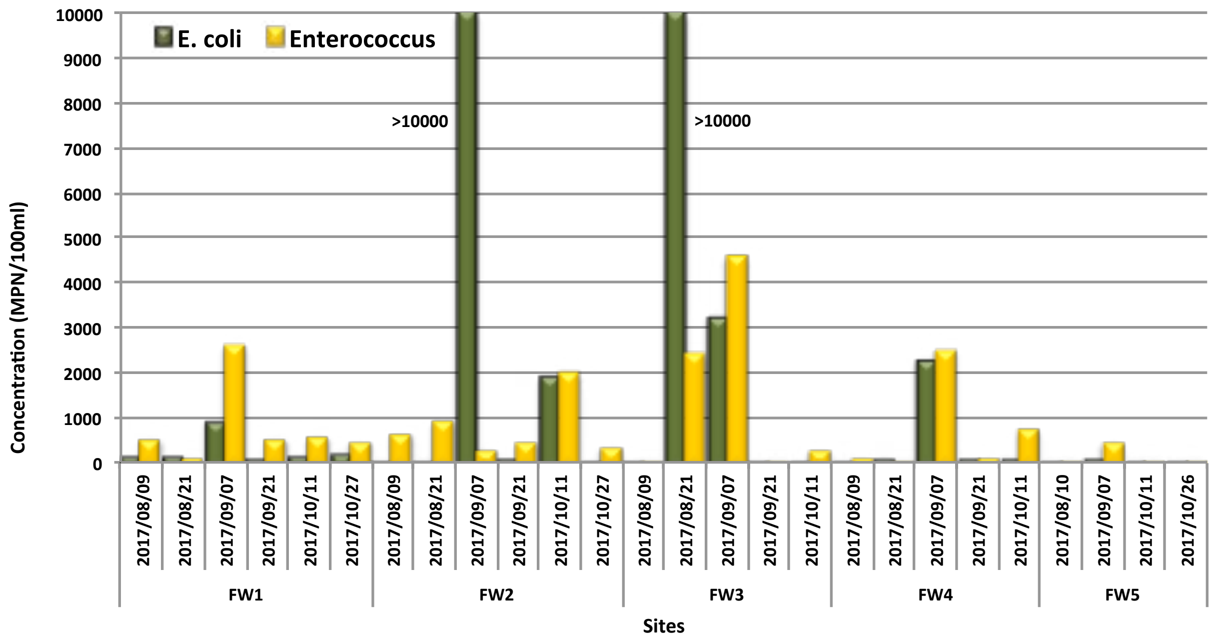


Figure 4.3b - Fresh Water Sites (FW6 – FW8)

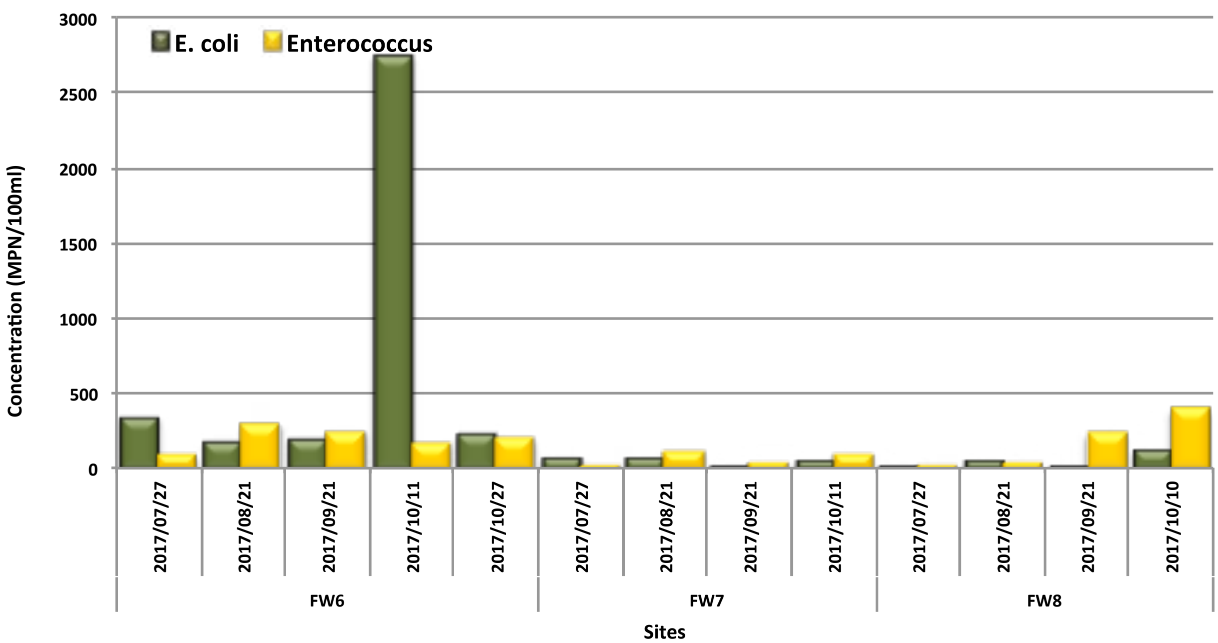
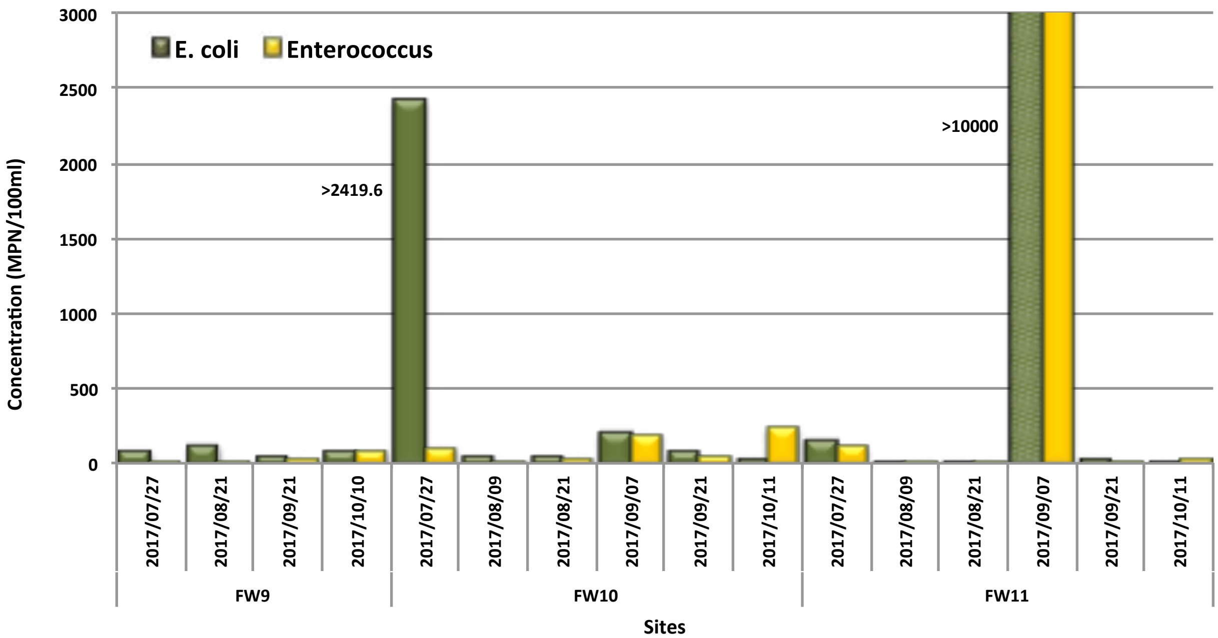


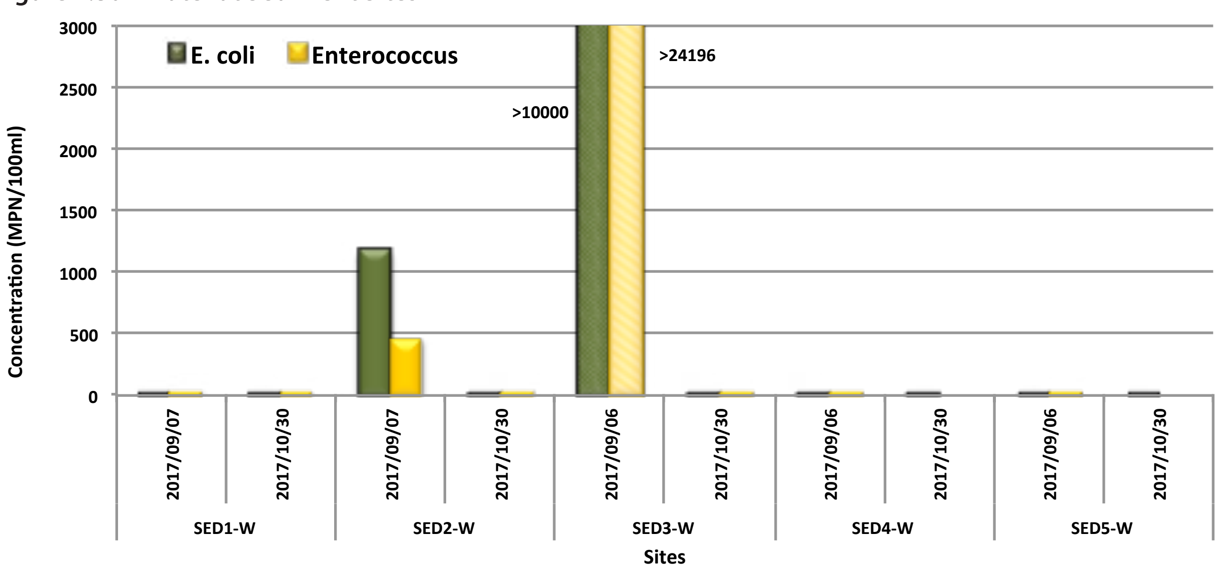
Figure 4.3c - Fresh Water Sites (FW9 – FW11)



4.3.2 Water at Sediment Sites

The test results for the five water samples collected at the Sediment sites are shown at Figure 4.3d. Data was collected in September and October, 2017. Two *E. coli* samples exceed the single-sample maximum guideline value of 400: SED2 at 1,174 MPN/100ml on September 7; and, SED3 ("pond" in Parlee Beach Provincial Park) at >10,000 MPN/100ml on September 6. For enterococcus, two samples exceeded the single-sample maximum guideline value of 70 MPN/100ml: SED2 at 450 MPN/100ml on September 7; and, SED3 at >24,196 MPN/100ml on September 6 (coincident with precipitation event).

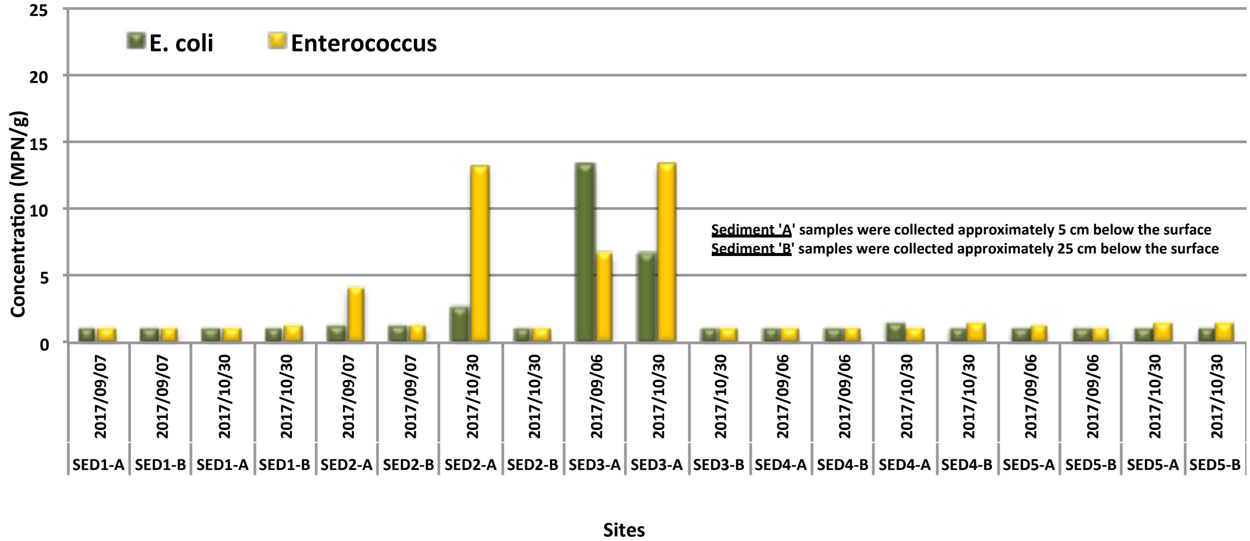
Figure 4.3d - Water at Sediment Sites



4.3.3 Sediment at Sediment Sites

The test results for the five sediment samples collected at Sediment sites are shown at Figure 4.3e. Data were collected in September and October. The A samples were collected 5 cm below the surface; the B samples were collected 25 cm below the surface. A majority of the 25 cm samples exhibit concentrations less than 2 MPN/g. Elevated *E. coli* values were exhibited at SED2 on October 30 and SED3 ("pond" in Parlee Beach Provincial Park) on September 6 and October 30 for 5 cm samples. For enterococcus, there were two concentrations of 13 MPN/g for 5 cm samples at SED2 and SED3 on October 30.

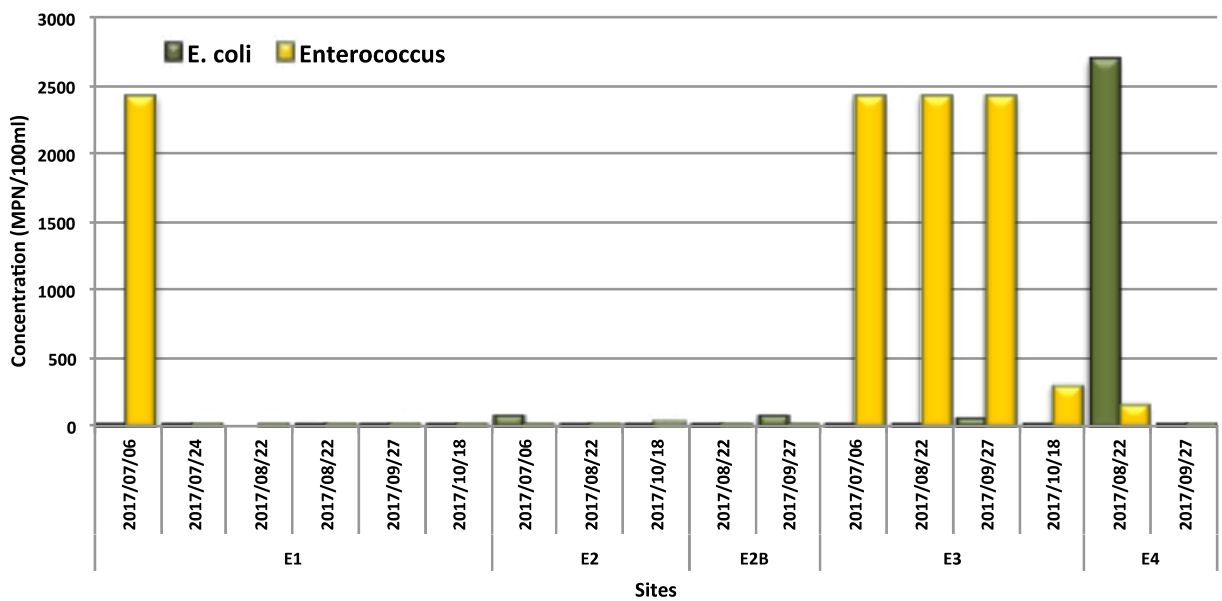
Figure 4.3e - Sediment at Sediment Sites



4.3.4 Effluent Sites

The test results for the four Effluent sites are shown at Figure 4.3f. Data were collected between July and October, 2017. One *E. coli* sample exceeds the single-sample maximum guideline value of 400: E4 at 2,700 MPN/100ml on August 22. For enterococcus, five samples exceeded the single-sample maximum guideline value of 70 M MPN/100ml: E1 at 2,400 MPN/100ml on July 6; E3 with three samples at 2400 MPN/100ml on July 6, August 22 and September 27; and, one sample at 307 MPN/100ml on October 18, and E4 with one sample at 155 MPN/100ml on August 22.

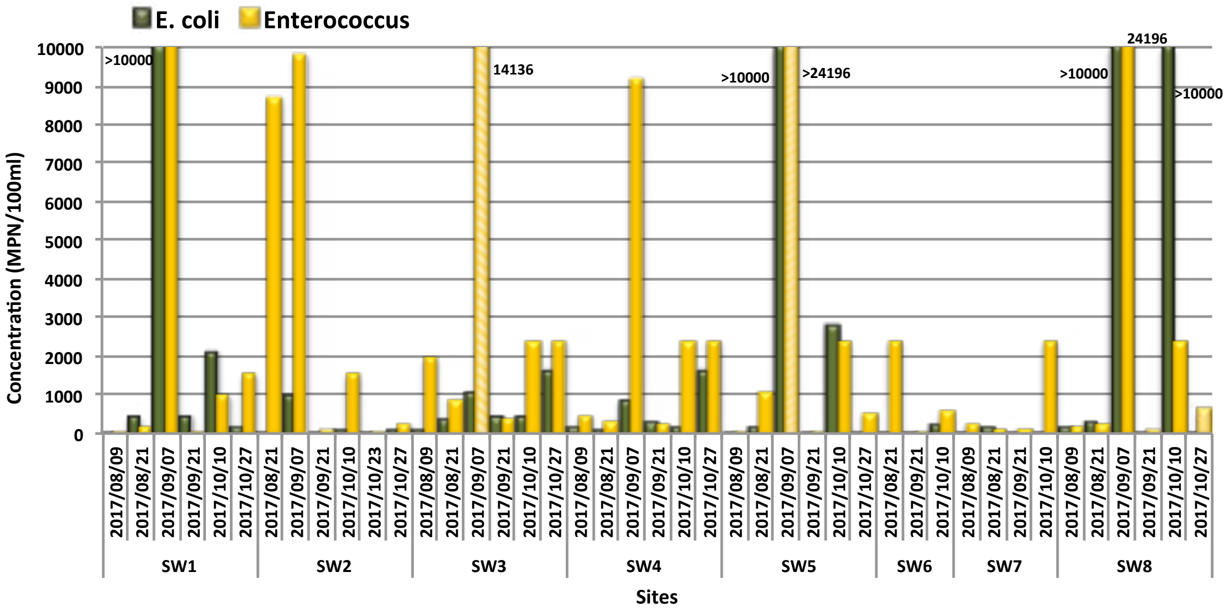
Figure 4.3f - Effluent Sites



4.3.5 Stormwater Sites

The test results for the eight Stormwater sites are shown at Figure 4.3g. Data were collected between August and October, 2017. The single-sample maximum guideline value of 400 MPN/100ml for *E. coli* was exceeded for some sampling events at all sites except SW6 and SW7. High values exceeding 10,000 MPN/100ml are exhibited at SW1, SW5, and SW8. For enterococcus, some samples at all sites exceeded the single-sample-maximum guideline value of 70 MPN/100ml. Very high values ranging from 10,000 MPN/100ml to 24,196 MPN/100ml are exhibited at all sites except SW6 and SW7. Many high values occurred on September 7 which coincided with a period of approximately 28 mm of precipitation on September 6 to 7. This suggests high bacterial counts are related to surface water runoff.

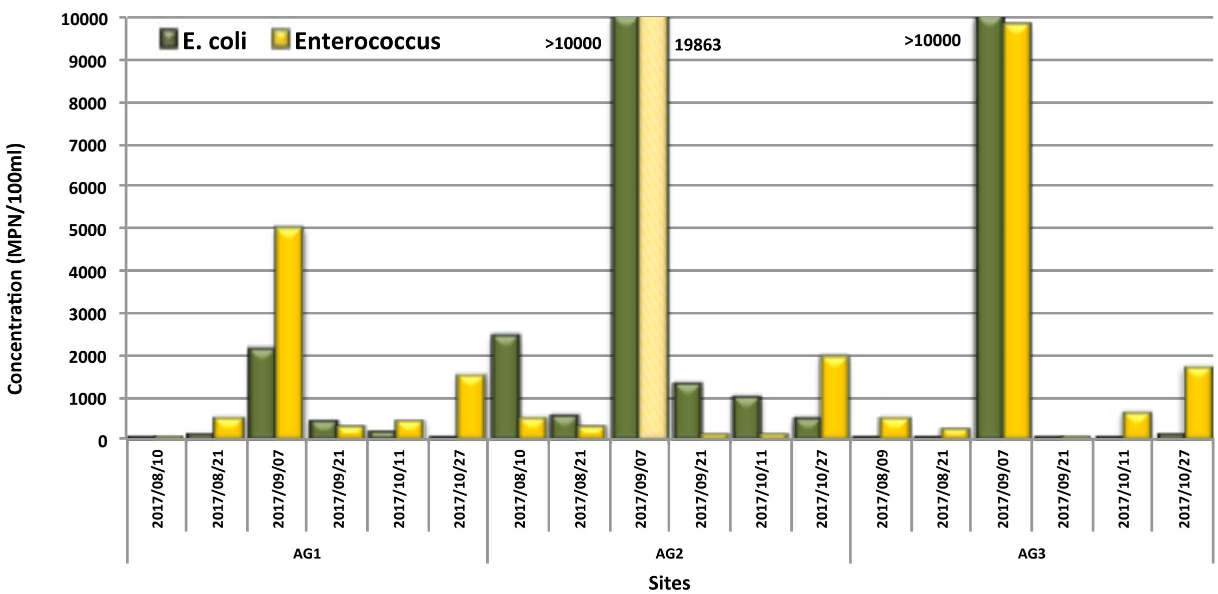
Figure 4.3g - Stormwater Sites



4.3.6 Agriculture Sites

The test results for the three Agriculture sites are shown at Figure 4.3h. Data was collected between August and October, 2017. The single-sample maximum guideline value of 400 MPN/100ml for *E. coli* was exceeded for some sampling events at all sites. For enterococcus, all sites exceeded the single-sample maximum guideline value of 70 MPN/100ml. Very high values occurred at all three sites on September 7. This coincides with a period of approximately 28 mm of precipitation which fell on September 6 to 7, suggesting the high bacterial counts are related to field runoff.

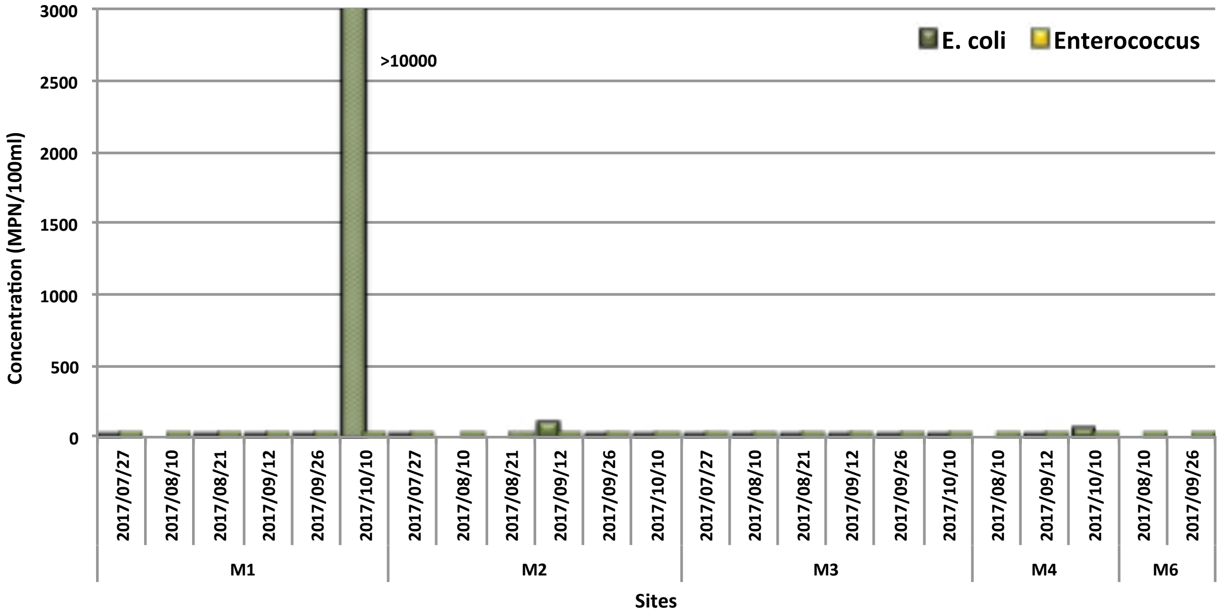
Figure 4.3h - Agriculture Sites



4.3.7 Marine Sites

The water quality test results for the five Marine sites are shown at Figure 4.3i. Data were collected between July and October, 2017. All *E. coli* and enterococcus samples are below the single-sample-maximum guideline value of 400 MPN/100ml, and 70 MPN/100ml, respectively. A high value of 10,000 MPN/100ml *E. coli* occurred at M1 (immediately north of Parlee Beach) on October 10. There was almost no rain on the nine days preceding this event, so this result does not appear to be related to precipitation.

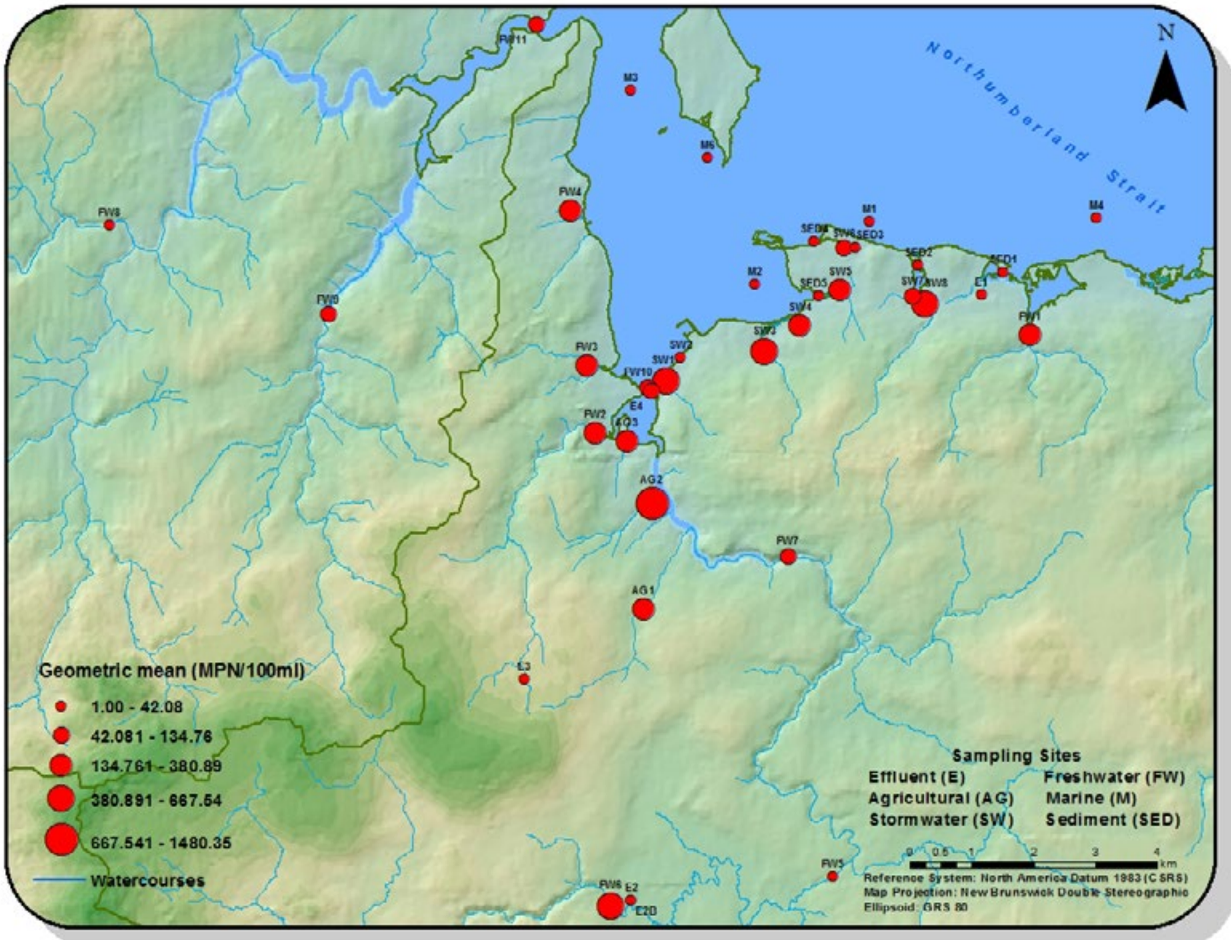
Figure 4.3i - Marine Sites



4.3.8 Map of the Geometric Mean of Bacteria Counts at WRP Sites

The geometric mean for *E. coli* of the samples collected at each sampling location was calculated and a spatial distribution was mapped as shown at Figure 4.3j. The size of the circle at each site is proportional to the geometric mean value as indicated in the legend. Sources of bacteria are distributed throughout the watershed, including in the upper reaches at sampling site Fresh Water 6. Many sites clustered around the Scoudouc River, and on the creeks draining into the Bay near Shediac and Pointe-du-Chêne, are close to or exceed the geometric mean guideline value of 200 MPN/100ml.

Figure 4.3j - WRP Sites Geometric Mean of E. coli Values by Sampling Location



4.3.9 Greater Shediac Sewage Commission Lift Station Overflows

Due to the relatively flat terrain in the Shediac and Pointe-du-Chêne area, the Greater Shediac Sewage Commission (GSSC) operates 24 lift stations to service the sewers in its jurisdiction. Occasionally these lift stations overflow during periods of intense precipitation or power outages. When this happens, the overflow pipes discharge directly into the environment and it is possible that diluted sewage reaches local creeks and swales, and, eventually enters Shediac Bay.

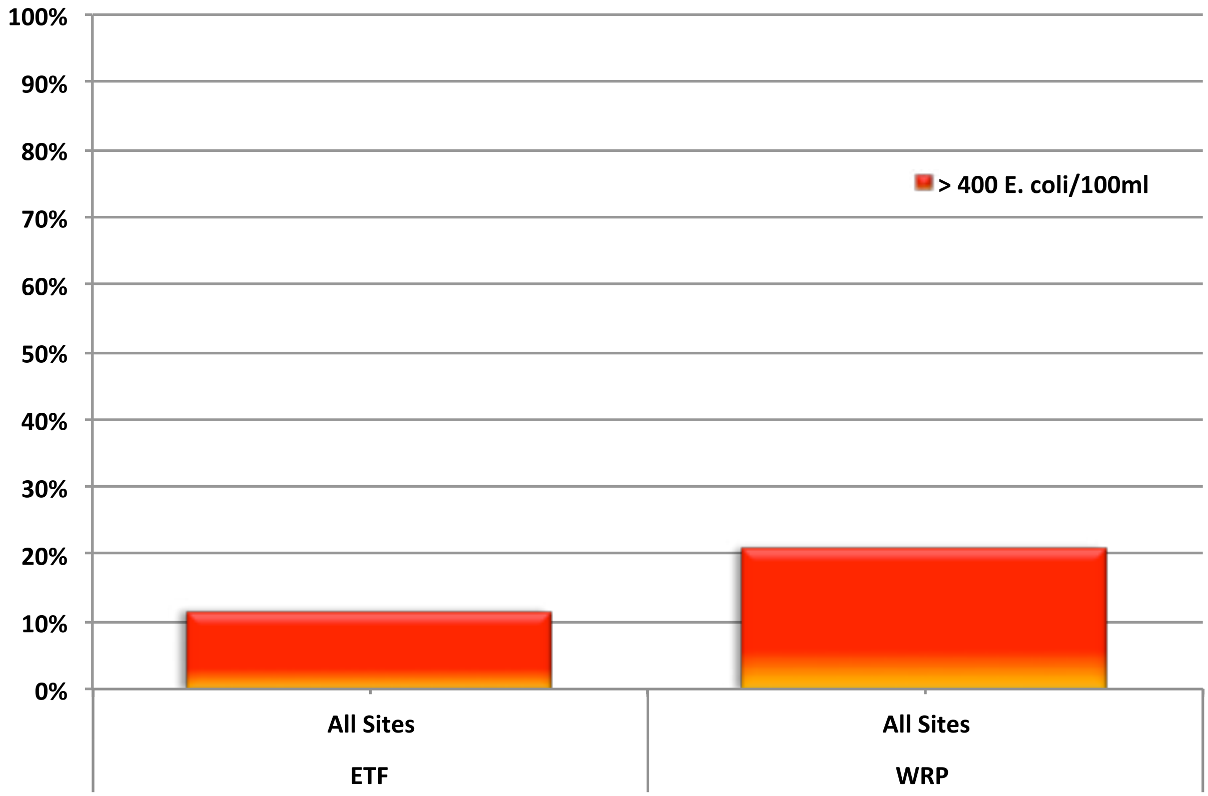
It is a regulated requirement that GSSC report all overflow occurrences. The dates and volumes of these events during 2017 are mapped in Figure 4.3k. The June 9/10 release at lift station 2 (LS#2) was the only overflow to occur during the swimming season, and involved a discharge of approximately 3,900 litres of diluted sewage. The wind for the next six days was generally from the northwest. This could explain the slight increase in geometric mean *E. coli* values at Parlee Beach that were exhibited on June 10 and June 12: 9 MPN/100ml, and 11 MPN/100ml, respectively (see Figure 4.3k), and may confirm the importance of a northwest wind in contributing to reduced water quality at Parlee Beach.

Figure 4.3k - GSSC Lift Station Overflows - 2017

4.3.10 Summary of Exceedances of the Guideline Values

Figure 4.3l presents the exceedances for the single-sample maximum values identified by the Guidelines for Canadian Recreational Water Quality for the ETF, and WRP sampling sites for *E. coli*. Exceedances occurred at about 12 per cent of the ETF sites, and about 20 per cent of the WRP sites. This indicates there are sources of bacteria distributed throughout the watershed.

Figure 4.3l - Exceedances of Guideline Values



4.3.11 DNA Analysis

In 2016, the SBWA collected samples at five sites (Figure 4.3m) and conducted DNA analysis to help identify the sources of bacteria. Table 4.1 presents the results which indicates:

- Human DNA was present at sites 1, 2, and 4.
- Ruminant DNA was present at sites 3, 4, and 5.
- Pig DNA was present at site 3.
- Canine DNA was present at sites 1 through 4 inclusive.
- Avian DNA was present at site 2.

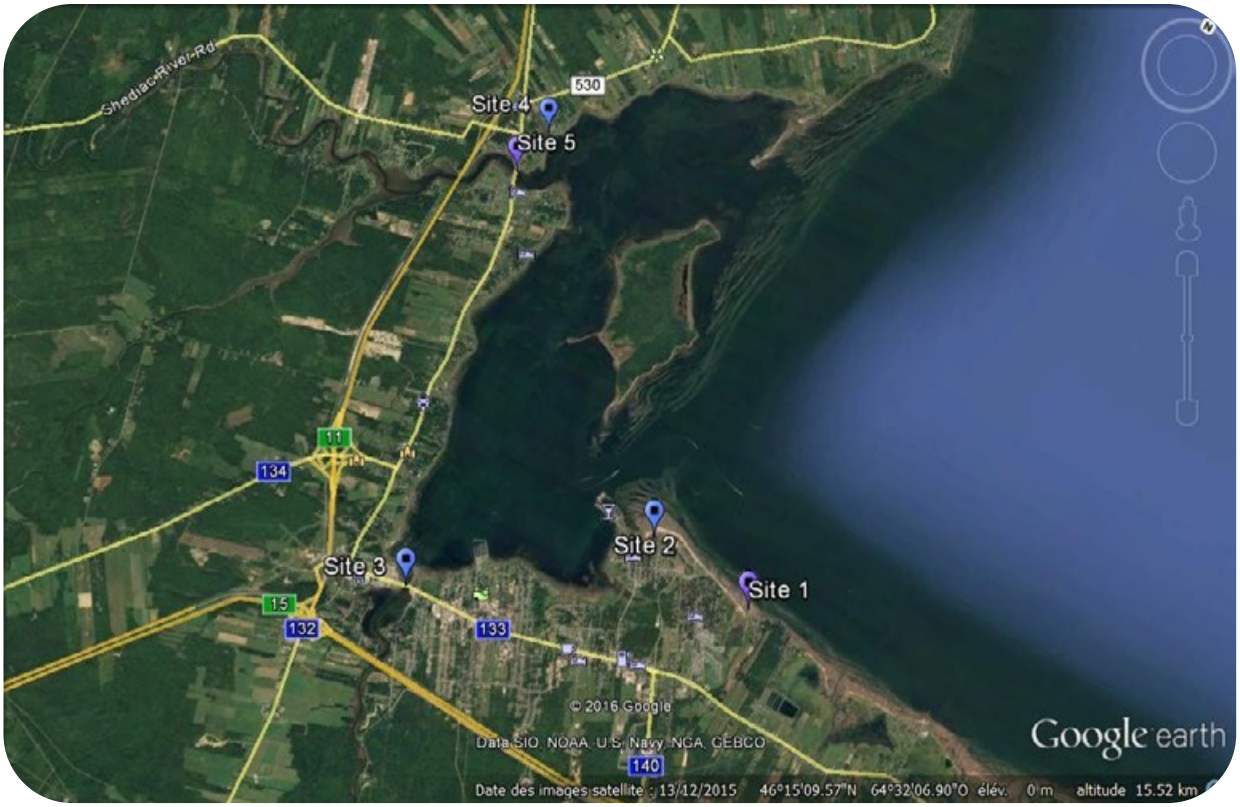
Sites 1 and 2 are in the immediate vicinity of Parlee Beach. These data indicate only that DNA were present and the information is helpful in providing some context to the potential sources of bacteria, but does not provide insight regarding relative or absolute concentrations.

Table 4.1 - DNA Analysis

	Human	Ruminants	Pig	Dog	Gull
1				√	
2	√			√	√
3		√	√	√	
4	√	√		√	
5		√		?	

Source: SBWA 2016

Figure 4.3m - DNA Analysis Sampling Sites



4.4 Findings and Conclusions

The results of the watershed monitoring programs are:

- The waters of Shediac Bay, in the vicinity of Parlee Beach, generally exhibit low concentrations of bacteria compared to the Guidelines for Canadian Recreational Water Quality.
- Sources of bacteria are found throughout the watershed.
- Rainfall contributes to elevated bacteria levels at sampling sites.
- A northwest wind appears to be a contributing factor to elevated bacteria levels at Parlee Beach.
- High *E. coli* numbers in streams do not necessarily result in high *E. coli* numbers in Shediac Bay.
- The likely sources of bacteria are:
  - stormwater run-off;
  - agricultural operations;
  - dogs; and
  - on-site sewage disposal systems.

5 Scientific Work Plan

This chapter provides a synthesis of the most pertinent studies that were conducted to assist in the identification of potential point and non-point sources of bacterial contamination in Shediac Bay and at Parlee Beach.

5.1 Beach Sand Bacteria and Shallow Groundwater Flow Paths

5.1.1 Objectives and Scope

This work was carried out by Stantec Consulting Ltd. The report, entitled "2017 Parlee Beach Sand Bacteria and Shallow Groundwater Flow Path Study" is available upon request.

The objectives of the assignment were to determine if the sand at Parlee Beach could potentially be a bacteria reservoir and act as a non-point source of contamination of the water; and, if possible, to identify sources of bacteria flowing in shallow groundwater discharges into Shediac Bay.

The consultant undertook the following scope of work:

- Analyze beach sand and pore water (i.e., groundwater migrating through pores in subsurface sand) for bacterial contamination.
- Establish local groundwater levels and regional groundwater flow patterns.
- Investigate tidal and/or groundwater fluctuations.
- Conduct a microbiological parameter and general chemistry scan of water samples.
- Conduct DNA fingerprinting of microbiological parameters.
- Identify any "hot-spots" of water quality concern in the near shore beach environment, including the tidally-influenced lagoon situated directly behind the beach bar system of the Parlee Beach complex.

5.1.2 Synthesis of the report

5.1.2.1 Brief Overview of Methods

Field activities were completed on September 1, and October 10, 2017. These included installing shallow groundwater monitoring stations, collecting samples of sand, pore water, and surface water for bacteria analysis, and characterizing groundwater flow dynamics.

Sampling for bacteria in beach sand and the associated pore water was completed using the "careful excavation" method. Six test pits were excavated at locations indicated by TP-1 to TP-6 at Figure 5.1. A total of nine surface water locations, indicated by HS-1 to HS-10, were sampled in both dry (August 30 to September 1, 2017) and wet (October 10, 2017) conditions.

To determine groundwater levels and flow dynamics at Parlee Beach, seven piezometers were installed between August 28 and 30, 2017 at locations DP-1 to DP-6 and DP-8.

Figure 5.1 - Sampling Locations

5.1.2.2 Findings and Conclusions

- For beach sand, the bacteria concentrations (*E. coli* and enterococci) were low (i.e., 4.1 MPN/g or less).
- For groundwater, the bacteria concentrations in all samples were below the Guidelines for Canadian Recreational Water Quality (for *E. coli*., 73 MPN/100ml or less; for enterococci, 52 MPN/100ml or less).
- For surface water, the bacteria concentrations were generally greater following a substantial rain event. The single-sample maximum concentration (Guidelines for Canadian Recreational Water Quality) was exceeded in three samples collected under wet conditions (HS-3, *E. coli*; HS1 and HS-9, enterococci).
- The overall concentration of DNA detected from all sources was relatively low, which is consistent with the low bacterial levels observed in the sand samples. The analysis indicates presence of human, ruminant, avian and dog DNA at various locations.
- The groundwater flow direction at Parlee Beach is from inland to Shediac Bay.
- The GSSC treatment plant may overflow through the drainage ditch at the northwest corner of the lagoon, resulting in a potential source for bacterial contamination after rainfall events.
- Although the GSSC treatment plant is unlikely to be a major and consistent point source of bacterial contamination, it may contribute some bacterial contamination to Shediac Bay under certain conditions.

5.2 Septic Systems Survey and Mapping

5.2.1 Objectives and Scope

This work was carried out by NATECH Environmental Services Inc. The report, entitled "Status Review of On-Site Effluent Disposal in the Un-serviced Areas near Parlee Beach" is available upon request.

The objectives of the assignment were to assess privately owned on-site sewage disposal systems in the areas outside the jurisdiction of the GSSC.

The consultant undertook the following scope of work:

- Delineate potential areas of interest.
- Consult with local installation contractors of on-site sewage disposal systems regarding soil conditions, preferred septic system technologies, and typical system failures.
- Consult with public health inspectors regarding policies with respect to septic system installations, typical failures of septic systems, and attempts to rectify the situation.
- Consult with selected stakeholders and community planners.
- Conduct site visits and perform visual inspections, collect water samples from the road ditches that discharge into Shediac Bay, and analyze for Faecal Coliforms and *E. coli*.
- Note indications of potentially failing septic systems (vegetation, soil moisture, smell, etc.).

5.2.2 Synthesis of the Report

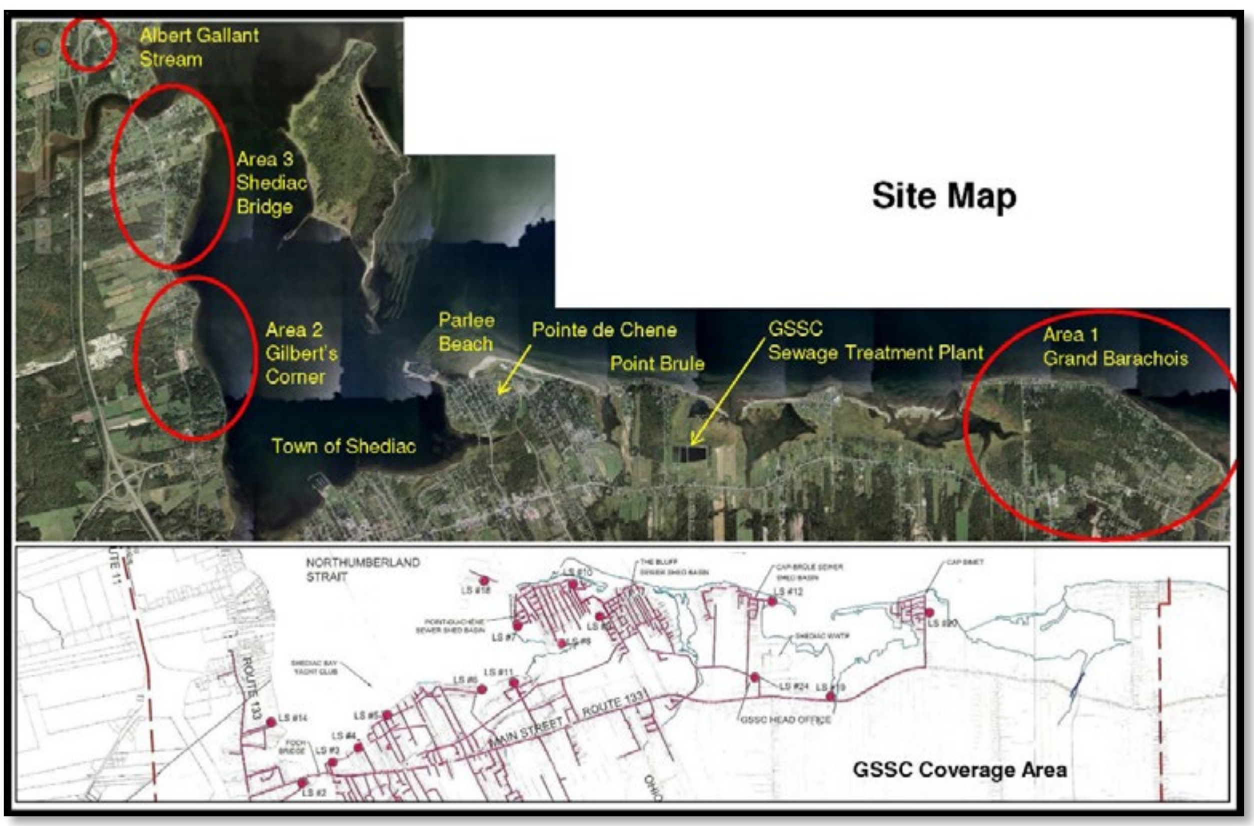
5.2.2.1 Study Areas

Three study areas were selected for investigation:

- Area 1: Grand Barachois.
- Area 2: Gilbert's Corner.
- Area 3: Shediac Bridge.

These areas are indicated on the aerial photo at Figure 5.2a, which also shows a map of the area serviced by the sewer system and treatment plant of the GSSC. At the suggestion of the Shediac Bay Watershed Association, the location at which Ruisseau Albert-Gallant crosses Route 134, was also investigated.

Figure 5.2a - Septic System Survey Study Areas



5.2.3 Results

The report summarizes the following:

- Approximate age of each development area;
- Number of developed lots with privately owned on-site sewage disposal systems;
- Lot sizes (minimum, maximum, and average);
- Typical on-site sewage disposal system characteristics (tank types and volumes, disposal technology used, disposal field sizes, proximity to water supplies, soils information, presence of privately owned systems with piped off-site discharges to surface water, etc.); and,
- Comparison of the existing situation with the NB Technical Guidelines for On-Site Sewage Disposal Systems.

The key findings are presented as follows:

A total of 1,190 lots occupied by 471 buildings were identified in the study area. The average residential lot size was approximately 700 m^2; however, lots were significantly smaller (less than 300 m^2) in the more densely populated areas. The New Brunswick Technical Guideline for On-Site Sewage Disposal Systems and the *Provincial Subdivision Regulation* both specify a minimum lot size of 4,000 m^2 for residential buildings, and a minimum depth from the road frontage of 38 m and a width of 54 m for properties with on-site sewage disposal systems. Within the study area, more than 85 per cent of the lots are smaller than 4,000 m^2, suggesting that most of the on-site sewage disposal systems in the study area are installed on substandard lots. The Guideline does not make a distinction between seasonally and year-round occupied lots.

Water samples were collected and analyzed for Total Coliforms, *E. coli* and Faecal Coliforms. The results were categorized into three contamination levels for *E. coli*. Of the 29 samples collected:

- 13 sample results were categorized as low – less than 100 MPN/100 ml.
- 11 sample results were categorized as medium – 100 MPN/100ml to less than or equal to 1000 MPN/ml.
- 5 sample results were categorized as high – greater than 1000 MPN/ml.

Three areas with suspected occasional seepages of partially treated effluent were identified by high test results and are shown at Figures 5.2b to 5.2c. On one occasion, the ditch in area 1-D had *E. coli* values greater than 200,000 MPN/100ml; possibly indicative of one or more seepages of insufficiently treated sanitary effluent from on-site sewage disposal systems.

The lack of precipitation during summer 2017 limited the number of samples that could be collected, as there was very little standing water within the study areas. Even during the follow-up inspection in November 2017, the ditches were mostly dry.

Figure 5.2b - Area of Concern 1C in Grand Barachois

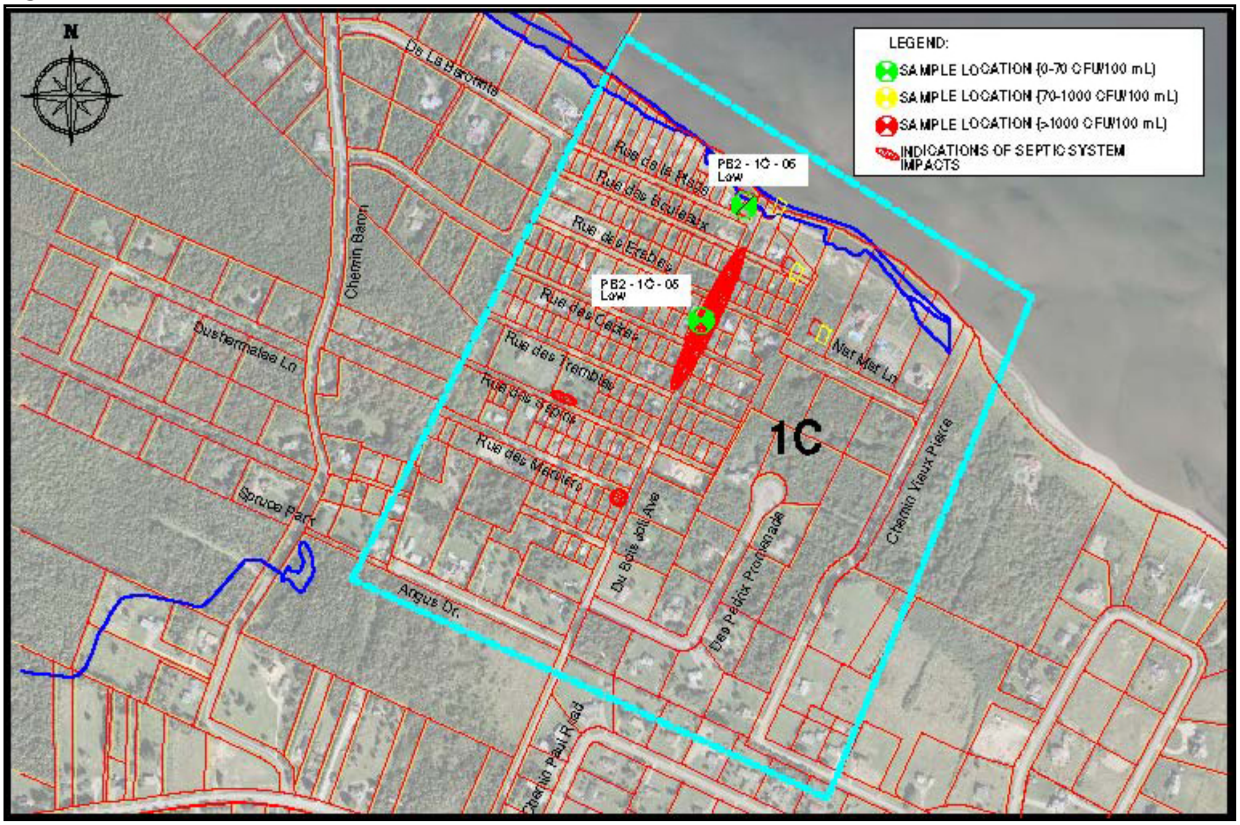


Figure 5.2c - Area of Concern 1D in Grand Barachois

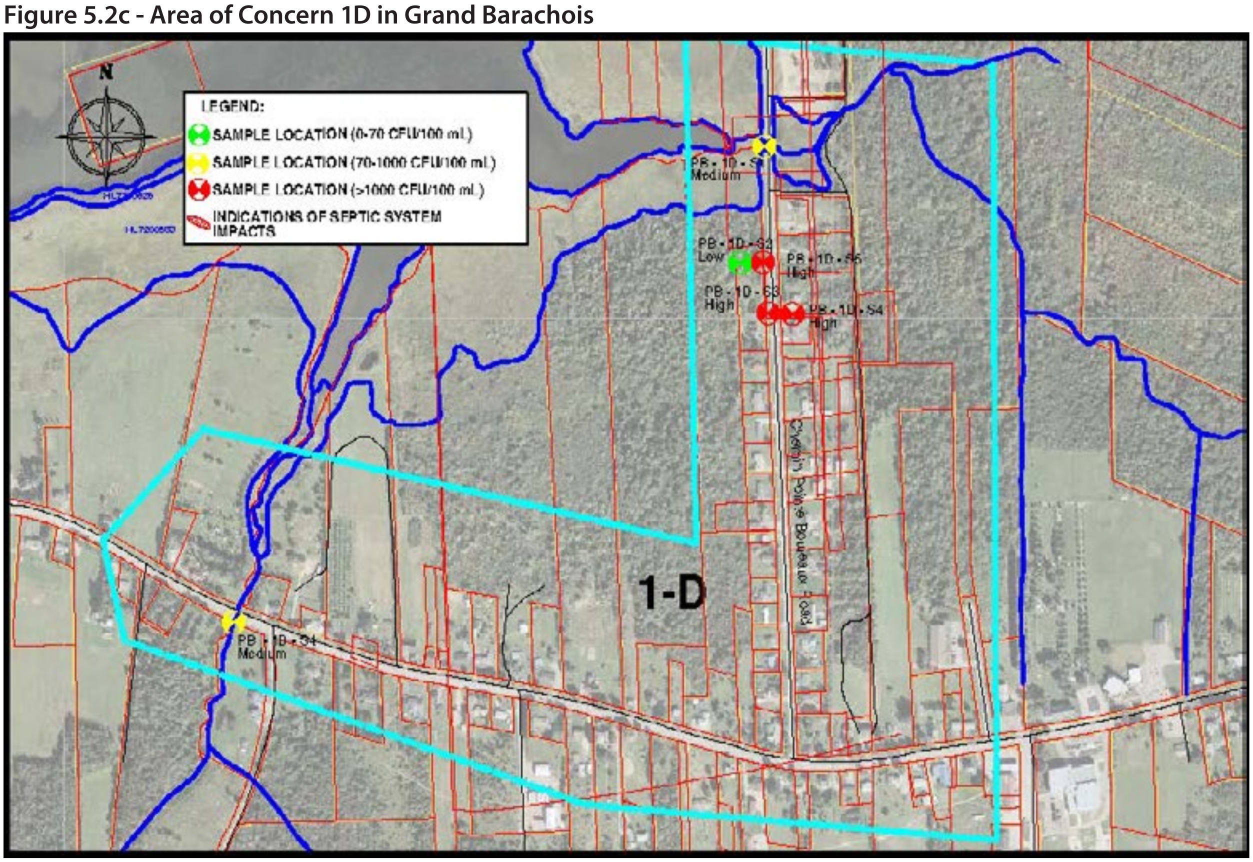
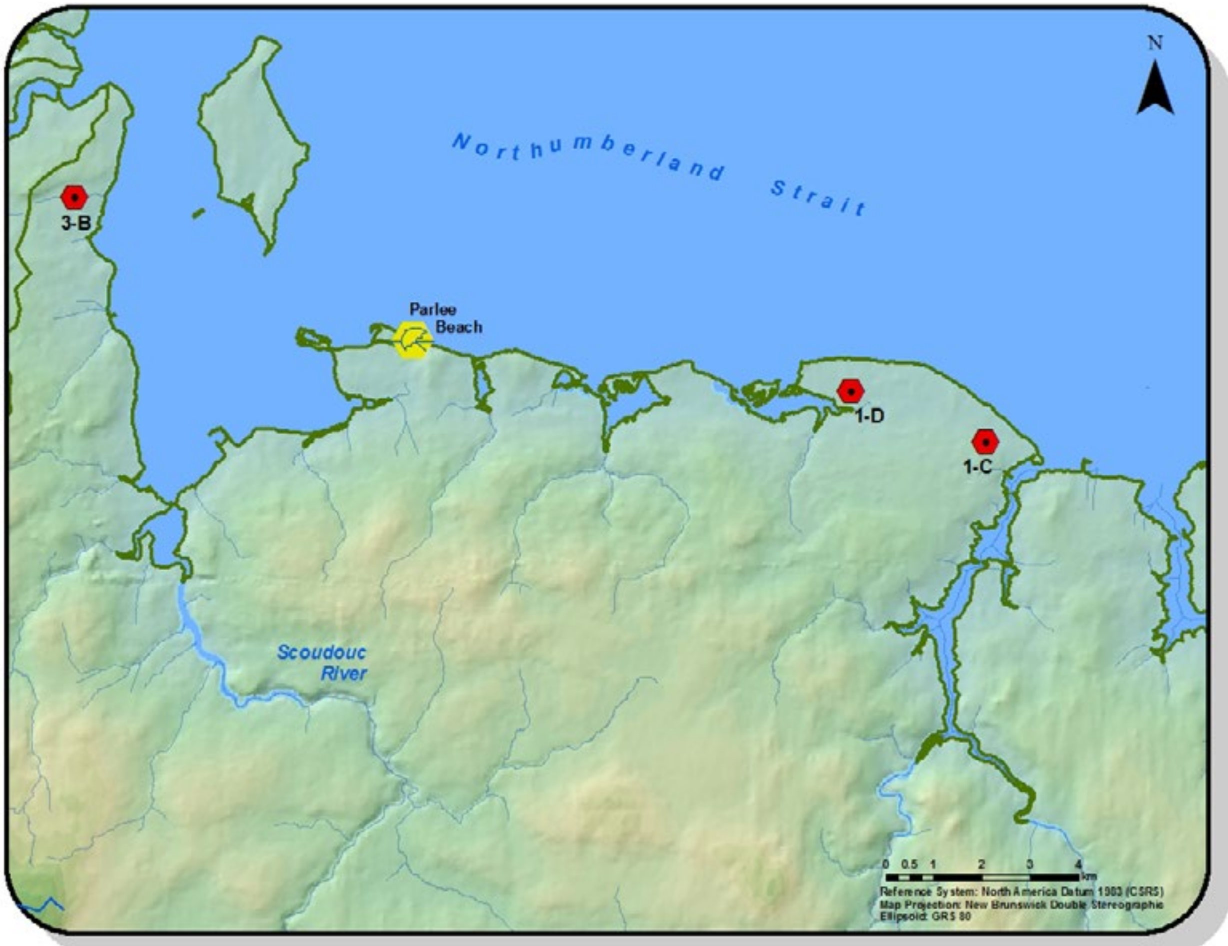


Figure 5.2d - Area of Concern 3-B in Shediac Bridge

To gain a regional perspective, the three areas of concern are shown on the map of Shediac Bay at Figure 5.2e.

Figure 5.2e - Areas of Concern Indicating Potential Issues with On-Site Septic Systems



5.2.4 Conclusions

This report concludes the following:

- There are a few properties within the GSSC jurisdiction that are not connected to the municipal system. However, there is no indication that their on-site sewage disposal systems are failing or that they contribute to the discharge of contaminated surface water into Shediac Bay.
- In general, there is no clear evidence of significant contribution from private on-site sewage disposal systems to water quality in Shediac Bay.
- No obviously failing on-site sewage disposal systems or discharges of untreated sewage were identified. However, potential problem areas, indicated in Figure 5.2e, are located as follows:
  - Two in Grand Barachois.
  - One in Shediac Bridge.
- There is potential for future surface water and groundwater quality problems related to the operation and maintenance of private on-site sewage disposal systems due to:
  - sub-standard building lots (average area 700 m2, 85% of lots non-compliant with Guideline), thus surface areas are likely too small to provide for adequate biological degradation of bacteria in disposal fields;
  - increasing flows to old on-site sewage disposal systems due to renovations and conversions (seasonal to year-round, addition of washing machines, extra bathrooms, etc.), thus exceeding original design capacity;
  - discharges from "semi-permanent" recreational vehicles (RVs) on individual lots, that do not have proper on-site sewage disposal systems;
  - although approvals are required to install new holding tanks, there is no process in place for monitoring existing holding tanks; and

- lack of inspection and enforcement of regulations pertaining to new on-site sewage disposal system installations.
- The report offers recommendations for improving the management of on-site sewage disposal systems in the un-serviced area surrounding Parlee Beach.

5.3 Coastal Hydrodynamic Modelling

5.3.1 Objectives and Scope

This work was carried out by Amec Foster Wheeler Environment and Infrastructure. The report, entitled "Parlee Beach and Shediac Bay Hydrodynamic Modelling Study" is available upon request.

The objectives were to:

- Develop a computer model of coastal circulation patterns in Shediac Bay accounting for the combined influence of tides, currents, winds and waves on water movement in Shediac Bay in general, and near Parlee Beach in particular;
- Simulate potential pollutant trajectories of particles and dissolved plumes to determine how released substances are transported through the environment; and,
- Investigate the potential contribution of various contaminant sources to water quality at Parlee Beach.

5.3.2 Synthesis of the Report

5.3.2.1 Model Development

The purpose of the model is to characterize the ocean circulation for a wide range of frequently occurring conditions, with a focus on average conditions during the swimming season.

The Delft3D modelling suite by Deltares is an ideal platform for coastal ocean studies of potential pollutant transport for idealized or historical conditions that could support the investigation of likely sources of contamination. The modelling scenarios were defined by:

- wind and wave climatology;
- ocean circulation and transport patterns; and
- wave-generated currents in the shallow surf zone.

5.3.2.2 Results

To characterize the widest range of average conditions contributing to bacteria transport in Shediac Bay and the vicinity of Parlee Beach, eight distinct scenarios were modelled with constant wind and wave conditions over a one-week period following the release of virtual substances, to assess the distinct patterns of transport by bulk motion and dispersion for each condition. The wind directions were as follows:

- Northwesterly winds
- Westerly winds
- Southwesterly winds
- Southerly winds
- Southeasterly winds
- Easterly winds
- Northeasterly winds
- Northerly winds

The report presents hypothetical releases of dissolved pollutants and "drogues" (virtual objects floating on the surface of the water) for a wide range of possible conditions. Hypothetical pollutants were released at two locations, approximately 3.5 km east of Parlee Beach, and approximately 3.5 km southwest of Parlee Beach. In addition, three sets of 25 drogues were virtually released at three distinct time periods (hours 0, 6 and 12) during the 8th day of the simulation.

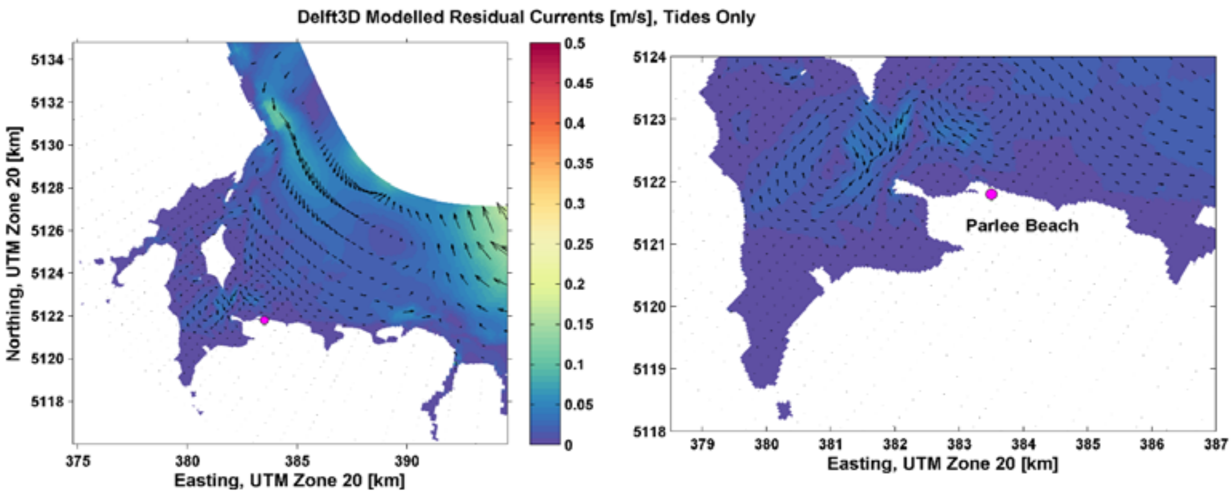
The report presents maps of the following scenarios:

- magnitudes and directions of the residual currents produced by wind and waves;
- 48-hour composite maximum pollutant concentrations; and
- drogue trajectories tracked over 24 hours.

Modelled Circulation Patterns

The results from the scenarios with wind and wave forcing indicate that distinct and persistent residual circulation patterns are expected to develop with the direction of the wind playing a dominant role in the local conditions within Shediac Bay and at Parlee Beach. The results also indicate that due to the L-shaped geometry of the coastline north and east of Shediac Bay, the circulation patterns can sometimes converge or diverge from the channel to the south of Shediac Bay, leading to varying patterns of the transport of pollutants from within the south part of Shediac Bay toward the coastal area of Parlee Beach (see Figure 5.3a).

Figure 5.3a - Modelled Residual Currents under Tides-only Forcing, Averaged over a Full Diurnal Cycle



Hypothetical Pollutant Transport Patterns near Parlee Beach

The modelled dissolved pollutant and drogue trajectory patterns produced distinct source signatures at the Parlee Beach location, with either the source in Shediac Bay (label P7) or the source east of Parlee Beach (label P12) (see Figure 5.3b). As the residual current maps and drogue trajectories indicate (see Figure 5.3c), the flow in the area to the west of Parlee Beach and the exchange with Shediac Bay exhibits complex patterns. Depending on the overall circulation patterns, and relative strength of the currents in the surf zone along the shore near Parlee Beach and the flow out of the channel south of Shediac Island, there is a range of possible outcomes and trajectories within Shediac Bay.

Figure 5.3b - Modelled Pollutant Concentrations

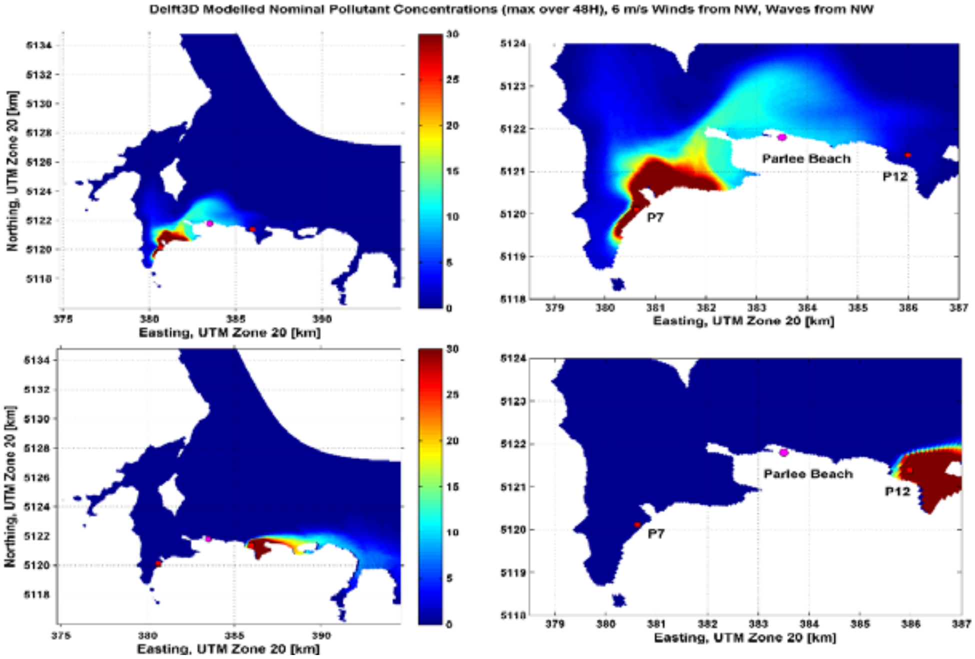
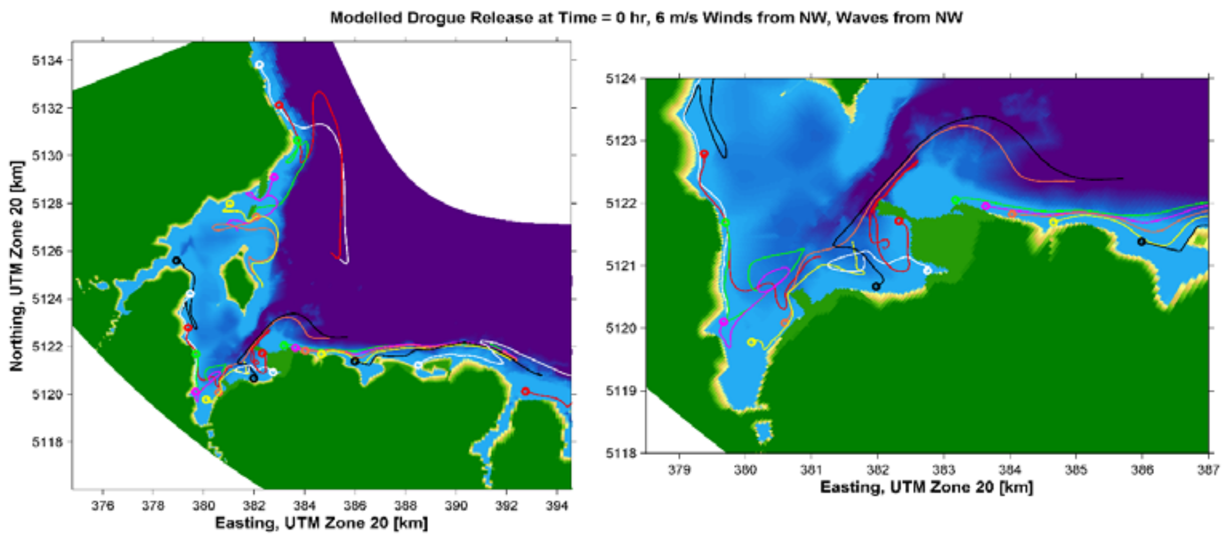


Figure 5.3c - Modelled Drogue Trajectories



The model results also indicate that the alongshore residual transport of any pollutant plumes (in either direction) is modulated by the influence of the tides, and therefore the same pollutant plume can result in multiple peaks of concentration at the same location over several days. The interpretation of these results should also consider that no decay (dilution) of pollutant was prescribed within the model. The absolute bacterial concentrations expected at any location and time will be strongly affected by the timing of the release, as well as the effective decay rates.

5.3.3 Conclusions

This report concludes the following:

- Wind plays a dominant role in local conditions within Shediac Bay and at Parlee Beach, in two ways: direct wind stress on the sea surface, as well as by developing waves which act further to drive currents in the shallow surf zone areas.
- The two most frequent wind directions during summer months, southwest and south, drive currents at Parlee Beach in opposite directions. The relative strength of the transport seems slightly weaker for winds from the south (westward transport) than from the southwest (eastward transport) for equivalent wind strength and forcing times.

- Sources southwest and east of Parlee Beach potentially contribute to bacteria concentrations at Parlee Beach under northwest and east wind and wave conditions, respectively. The relative importance of Shediac Bay versus east of Parlee Beach sources depends on the relative strength (rate and concentration) of any discharges, as well as the effective decay rates (no decay rates were applied in the present model).
- Relative dilution/dispersion of hypothetical contaminant plumes is rapid.
- Parlee Beach is particularly vulnerable to water quality conditions in the watershed. The model indicates that plumes are often transported efficiently along the shore by wind and wave-driven currents.
- The model presents a relatively efficient platform through which further questions and specific conditions could be investigated.

5.4 Cumulative Effects Assessment and Protocols Development

5.4.1 Objectives and Scope

This work was carried out by Amec Foster Wheeler Environment and Infrastructure. The report, entitled "A Guiding Principles Document to Assess Cumulative Effects in the Shediac Bay Area" is available upon request.

The objectives of the study were as follows:

- Identify the standard methods to adopt for situations where it is important to predict future development and possible environment effects;
- Determine how local planning bylaws are linked into possible cumulative effects on surface water quality within the Shediac Bay Watershed;
- Outline a process that can be used to consider cumulative effects of development; and,
- Identify the issues government should be aware of to address cumulative effects on surface water quality in the Shediac Bay Watershed.

5.4.2 Background

Cumulative effects assessment considers:

- combined impacts of multiple separate activities which effect the same environmental component; and,
- impacts in the past, present and the reasonably foreseeable future.

The standard methodology for cumulative effects assessment in Canada is described in the Cumulative Effects Assessment Practitioners Guide, (Canadian Environmental Assessment Agency 1999).

The principles of an effective cumulative effects assessment include:

- **Knowledge-based** – effective science and monitoring systems and networks provide the information needed to measure performance and support the development of outcomes and objectives.
- **Outcomes and environmental objectives-based** – driven by defined outcomes or objectives for the desired quality or state of air, water, land and biodiversity, now and in the future.
- **Future-focused** – considers the combined impacts of past, present, and reasonably foreseeable future human activities on the region's environmental objectives.
- **Place-based** – site-specific and intended to bring people and their activities together and build relationships among stakeholders to support shared stewardship within an area.
- **Collaborative** – amongst all interested parties.
- **Adaptive** – a shared responsibility to adapt and take corrective actions if outcomes or objectives are not being achieved.
- **Comprehensive** – uses both regulatory and non-regulatory approaches.

5.4.3 Conclusions and Recommendations

This report contains the following conclusions and recommendations:

- The Parlee Beach Scientific Work Plan meets most requirements for a cumulative effects assessment process, including: regional approach, collaborative relationships, scoping of issues and collection of required data.
- Two additional program needs for an effective cumulative effects assessment process are:
  - Geographic Information System Data Management System to integrate all the program data and enhance analysis (complex overlays and/or modelling) and presentation of results; and
  - A long-term sponsor and plan of execution.
- Future development should also be considered in the data collection, including:
  - Future regional development profile;
  - Community plans; and
  - Description of foreseeable planned projects.
- The cumulative effects assessment process should be integrated with regional water quality management and municipal planning by making the data/results accessible to decision-makers and stakeholders.
- The cumulative effects assessment process should integrate regional/local agents (Local Government Councils, LSD Advisory Committees, Regional Service Commissions, Planning Review and Adjustment Committees, building inspectors, etc.) to develop policy and by-laws that address potential cumulative impacts of future developments.

5.5 Beach Operations

5.5.1 Beach Wrack Management

5.5.1.1 Overview

Beach wrack is a naturally-occurring line or mat of debris that is pushed onshore by ocean tides and waves. It generally consists of a mixture of sea grass (vascular plants), seaweed (multi-cellular algae), reeds, driftwood, tree and plant seeds, shell and egg casings, trash and decomposing marine life. Once cast ashore, wrack can either be washed back into the ocean over subsequent tidal cycles or remain in the beach environment where it is either incorporated into physical beach processes such as dune formation or incorporated into terrestrial or marine food webs.

Beach cleaning (often referred to as beach grooming or raking) is the removal of beach wrack. Deciding to groom a beach requires the consideration of various factors:

- size of the beach;
- presence of endangered species and their habitats; and,
- aesthetic appeal.

5.5.1.2 Management Options

Beach wrack management practices that may be suitable for Parlee Beach include:

- Manage the scheduling of grooming (e.g., "as needed" basis, only during high tourism seasons, or before high use times).
- Educate beach visitors about the importance of wrack to help visitors gain an understanding about the ecosystem and its functions.
- Use low impact techniques, such as hand removal or hand raking.
- Remove as little sediment (sand, gravel, and cobble) as possible to minimize impacts and leave important substrate in place.
- Identify appropriate machinery access points that minimize damage to the foreshore and coastal vegetation. All machinery should be kept at least 3 to 5 metres seaward of dunes and vegetation to protect the stability and ecology of the area. Any cleaning closer to the dunes should be manual and selective.
- Avoid mechanical cleaning when strong winds are predicted.

- Do not remove wrack from areas below the low water line.
- Focus removal on the areas of significant accumulations of nuisance seaweed, leaving a sufficient wrack line on the beach to provide a seed source, nutrient source, and foraging habitat for shorebirds and to help build the beach and dunes.
- Remove by hand as soon as possible inorganic debris and materials considered hazardous to public health or safety.
- Install wildlife-proof garbage cans and institute a "carry in-carry out" policy for waste.
- Do not dump wrack material on top of dunes (where it can smother live plants, leading to dune erosion and destabilization), coastal vegetation or in other waterways, drains or gutters.
- Management practices should be reviewed on an annual basis with federal/provincial biologists and THC beach staff.

5.5.2 Beach Sand Management

5.5.2.1 Overview

Beach sand replenishment is a method of mitigating coastal storm damage or chronic erosion by deliberately replacing sand on an eroded beach. It involves extending a beach and the nearshore shallows seaward, by adding sand (usually from sources outside the eroding system). It is a common practice in North America.

Sand replenishment has reportedly taken place at Parlee Beach for more than 30 years. It appears that the supply of sand and sediment along New Brunswick's Northumberland coastline is limited because there are few large rivers discharging to the ocean. This means that the practice at Parlee Beach has been to recover sand that has been washed from the beach to the Chêne Bank, located between Parlee Beach and the Pointe-du-Chêne wharf.

5.5.2.2 Management Options

Based on the samples collected in 2017, the beach sand at Parlee Beach has very low concentration of bacteria. It can be concluded that the current beach sand management practice at Parlee Beach is acceptable.

6 Other Initiatives

This section briefly describes some of the major activities and studies, beyond the Scientific Work Plan, which were conducted during 2017.

6.1 Dog Waste Management Program

This work was undertaken by the Red Dot Association Inc. The report is available upon request. The literature suggests dogs can be a significant source of bacteria at beaches.

The objectives were to:

- Educate the public with respect to impact of dog waste on water quality.
- Coordinate a spring clean-up with the Pointe-du-Chêne LSD and Parlee Beach Provincial Park Manager.
- Request volunteers to do "gentle monitoring" of the beach, offering free dog waste bags to dog walkers.

Dogs are not permitted on Parlee Beach. Nevertheless, Provincial Park staff periodically patrolled the beach in the mornings and evenings during the operating season to discourage dog walking near the swimming area.

The results included:

- 12 dog waste stations were installed, including signage, litter containers, and dog waste bag dispensers (Figure 6.1a), located throughout Pointe-du-Chêne LSD and the wharf (Figure 6.1b).
- 1200 letters were mailed to Pointe-du-Chêne residents.
- 6,800 bags were distributed.
- 11,674 lbs. of waste (may include some beach trash) were collected.

This waste was primarily collected in Pointe-du-Chêne (not on Parlee Beach) and some of this waste would likely have been picked up by responsible dog owners even had this program not been in place. However, dog waste was identified from stakeholder feedback as a serious problem. This was a very successful program.

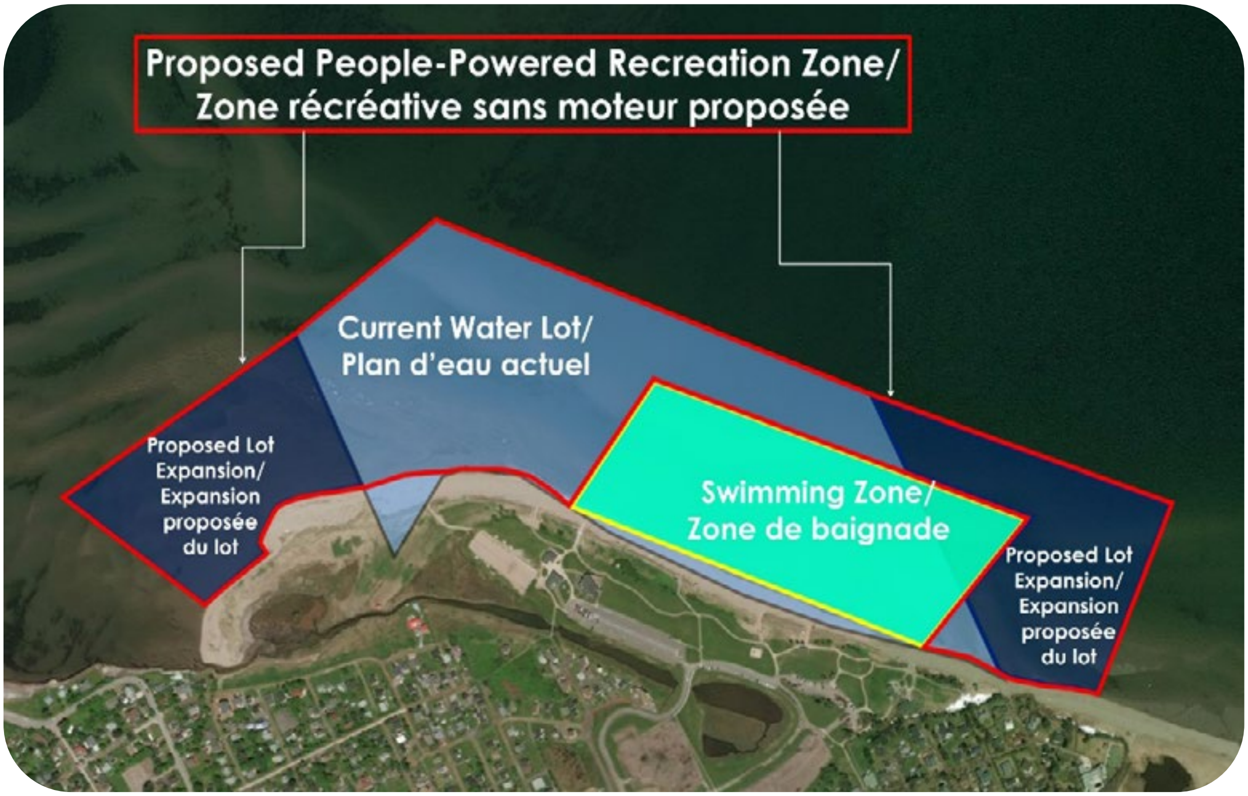
Figure 6.1a - Dog Waste Station

Figure 6.1b - Station Locations

6.2 People-Powered Recreation Zone

THC, in collaboration with Transport Canada, identified a zone at Parlee Beach where only human powered activity will be permissible. Public and stakeholder meetings were convened in Pointe-du-Chêne and Shediac during August 2017 to explain the purpose and spatial extent of the zone (Figure 6.2). This zone will be marked with appropriate buoys and signage and implemented in the 2018 season.

Figure 6.2 - People-Powered Recreation Zone



6.3 Marina Pump-Out Facilities

The waste pump out facilities at Shediac Yacht Club and Pointe-du-Chêne Harbour Authority were old and inconvenient to use. These were replaced with new equipment in early October 2017 and are now operational.

6.4 Parlee Beach Sewage System

An initiative to replace the Parlee Beach waste water collection system (restaurant, washrooms, showers), and to decommission the seasonally operated Parlee Beach Provincial Park lift station at the western extremity of the park was planned in 2017. This project will result in all Provincial park sewage being diverted to an upgraded GSSC lift station #10 (Figure 6.3) and treated at the GSSC treatment plant.

Figure 6.3 - Parlee Beach Sewage System Replacement

6.5 Wetland Delineation Study

6.5.1 Objectives and Scope

This work was carried out by the Atlantic Canada Conservation Data Centre. The report, entitled "Wetland Delineations near Shediac, New Brunswick" is available upon request.

6.5.1.1 Scope and Objectives

The objective of the study was as follows:

- Use standard field-based wetland delineation methods to improve the understanding of the spatial extent of wetlands in the Shediac – Pointe- du-Chêne area.

6.5.1.2 Methods

Wetland delineation was only undertaken where permission for access had been granted via contact between DELG and the landowner. Wetlands were delineated between June and October 2017 using the standard two primary parameters: dominance of hydrophytic vegetation, and visible signs of surface hydrology. A third parameter (hydric soil indicators) was used where wetland boundaries could not be clearly defined using the first two parameters. Efforts were also made, where possible, to delineate the upper boundary of dunes or other coastal features, which are not wetlands but are considered habitat of conservation concern, and to distinguish between coastal wetlands and non-coastal freshwater wetland. Coastal wetlands are considered Provincially Significant Wetland (PSW) under the New Brunswick Wetlands Conservation Policy. A person is exempt from the requirement to obtain a permit for alterations to a coastal wetland that is less than one hectare in area and is not contiguous to a watercourse.

Plot data supporting classification of sites as wetland or upland were recorded on standard data sheets in the field and was subsequently transferred to Excel spreadsheets. Spatial data were recorded by using hand-held GPS units and downloaded into ArcGIS and Google Maps for final analysis and transfer to DELG.

6.5.1.3 Results

Wetland delineations were conducted on sites representing 94 different property identification numbers (PIDs).

6.5.1.4 Conclusions

The study documented more wetland than is currently represented on GeoNB wetland layer. Figure 6.4 illustrates additional wetland delineations (pink lines).

6.6 State-of-the-Bay Report

This work was carried out by the SBWA. The report, entitled "State of the Bay Water Quality Surveys for *E. coli* in the Shediac Bay Watershed 2000-2017" is available upon request.

6.6.1 Scope and Objectives

The objectives of the report were:

- Summarize different projects and studies that have been accomplished by the Association and other partners.
- Better define water quality issues and the role of the different organizations regarding Shediac Bay.
- Prepare public presentation materials.

Most of the results of this report have been incorporated into Chapter 4 regarding the water quality sampling results for the ETF sites in the Shediac Bay Watershed.

Figure 6.4 - Additional Wetland Delineation

7 Conclusions and Recommendations

7.1 Steering Committee Conclusions

- Based on the samples collected in 2017, concentrations of *E. coli* and enterococcus in Shediac Bay and at Parlee Beach are generally lower than the values stated in the Guidelines for Canadian Recreational Water Quality.
- Based on the samples collected in 2017, high concentrations of *E. coli* and enterococcus have been identified throughout the Shediac Bay Watershed (the terrestrial basin which drains into Shediac Bay).
- These high concentrations of bacteria in the watershed may flow into Shediac Bay and, under certain oceanographic and meteorological conditions, may make their way to Parlee Beach. Wind direction, wave and tidal conditions appear to be determining factors.
- There are different types of sources of bacteria distributed throughout the Shediac Bay Watershed. Based on the samples collected in 2017 it is difficult to conclusively identify specific point and non-point sources. Surface water run-off from agriculture and urban areas, sewage system overflows, on-site sewage disposal systems, and birds, wild and domesticated animals are potential sources.
- To improve water quality in the Shediac Bay Watershed and reduce "No Swimming Advisories", at Parlee Beach, the bacteria sources which exist throughout the Watershed should be addressed.

7.2 Steering Committee Recommendations

The Steering Committee recommendations are presented in Table ES.1. These recommendations are presented with the understanding that:

- Water Quality Monitoring Protocols for Parlee Beach and Murray Beach will continue to be implemented in 2018.
- The "Water Strategy for New Brunswick 2018-2028" includes actions that could address some of the issues related to water quality at Parlee Beach.
- The presented costs are preliminary and would require further refinement depending on the mix of internal government resources and consulting services required to accomplish individual projects.

The rationale for each recommendation is presented in Sections 3, 4, 5 and 6 of the report.

Table 7.1 - Recommendations

Shediac Bay Watershed	Recommendation	Date to Initiate	Preliminary Cost Estimate	Potential Partners*
1	Enhance and continue watershed monitoring programs to gather additional data that will help identify specific sources of bacteria. Enhancements may include: increasing sampling frequency, additional collection sites, weather stations, conducting DNA testing (both at the beach and in the watershed), and sampling during wet conditions/rainfall events.	2018 and beyond	$150,000	DELG Shediac Bay Watershed Association Academic Community
2	Apply the hydrodynamic model to validate the transport paths related to actual discharges into the Bay (concentrations, volumes, weather conditions).	2018	$35,000	DELG Consultant
3	Conduct a targeted investigation in the high-density areas with sub-standard building lots, identified in the consultant's report, to verify if on-site sewage disposal systems are a potential source of bacteria.	2018	Internal to government	DH DELG JPS
4	Develop and implement a watershed management plan for Shediac Bay. Further details are included in Appendix C of the "Recommendations for Enhanced Watershed Management in New Brunswick". (Briefly the watershed management plan should cover water quality monitoring, assessment, reporting, public education, stakeholder engagement and stewardship initiatives.)	2018 and beyond	Internal to government	DELG (oversight) Southeast RSC Kent RSC Shediac Bay Watershed Association Other stakeholders

5	Conduct a hydraulic/hydrology study at the "pond" at Parlee Beach Provincial Park to identify any remedial action that may be necessary to mitigate poor water quality in the pond and drainage creek.	2018	To be determined	DELG THC DTI Consultant
Beaches	**Recommendation**	**Date to Initiate**	**Preliminary Cost Estimate**	**Potential Partners***
6	Develop and validate a tool for predicting water quality, based on relevant environmental and meteorological data, which could be used by the Medical Officer of Health (MOH) to issue "No Swimming Advisories" at Parlee Beach. A predictive tool would address concerns with the 48-hour delay related to analyzing water quality samples.	2018 and possibly beyond.	$25,000	DH DELG THC Consultant
7	Continue data collection by lifeguards (beachgoer numbers, air and water temperature, and boater numbers) to better understand the relationship between Parlee Beach activities and water quality.	2018 and possibly beyond	Internal to government	THC DELG
8	To enhance swimmer safety and mitigate potential effects of motorized boats near Parlee Beach, implement the "people-powered recreation zone" delineated during stakeholder and public consultations conducted in August 2017.	May 2018	Internal to government	THC Transport Canada
Surface Water Runoff	**Recommendation**	**Date to Initiate**	**Preliminary Cost Estimate**	**Potential Partners***
9	Continue the dog waste management/education program and expand to the entire Shediac Bay Watershed.	2018	$15,000	Red Dot Association Inc. THC DELG Shediac Bay Watershed Association
10	Identify examples of stormwater quality management methods that are appropriate for the Shediac Bay Watershed that could be implemented by local communities.	2018	$50,000 (initial project) excludes possible capital costs of implementation	DELG Town of Shediac Regional LSDs Shediac Bay Watershed Association Consultant
11	Engage the agricultural community to explore precautionary mitigative methods aimed at reducing the potential for bacteria from agricultural operations to enter Shediac Bay.	2018 and beyond	Internal to government (consultation only)	DAAF NB Agricultural Alliance Shediac Bay Watershed Association
Policy	**Recommendation**	**Date to Initiate**	**Preliminary Cost Estimate**	**Potential Partners***
12	Continue the boater education program and subsidize, for one year, the use of pump-out facilities at the Shediac Yacht Club and the Pointe-du-Chêne Harbour Authority and improve tracking of the frequency of use of these facilities.	May 2018.	$10,000	THC DELG Shediac Yacht Club Pointe-du-Chêne Harbour Authority Transport Canada

13	Develop an education program aimed at operating and maintaining on-site sewage disposal systems in the Shediac Bay Watershed.	2018	Internal to government	DH DELG SBWA Southeast RSC Kent RSC
14	Establish a Working Group to review the regulation and oversight of on-site sewage disposal systems, including inspection and enforcement, design standards, and options for ensuring that on-site sewage disposal systems are properly functioning and maintained.	2018	Internal to government	DELG JPS DH GSSC Southeast RSC Kent RSC

Note:* this list is not necessarily exhaustive and other partners may be included.

Executive Summary

Purpose

This document presents the results of the Parlee Beach Water Quality project, including the water quality monitoring conducted at Parlee Beach and Murray Beach during 2017, as well as the findings and conclusions of the numerous studies conducted as part of the Scientific Work Plan to identify sources of contamination. The project was managed by a Steering Committee comprised of representatives from four government departments: Health; Environment and Local Government; Agriculture, Aquaculture and Fisheries; and Tourism, Heritage and Culture.

The work of the Steering Committee was guided by a Project Charter which included the following mandate:

- Develop and implement a robust plan of technical work to identify point and non-point sources of contamination and possible remedial action.
- Complete sampling and monitoring.
- Prepare a report highlighting recommended actions to government.

This document is intended to be a stand-alone report that provides a fulsome understanding of the water quality conditions in Shediac Bay and at Parlee Beach. The supporting reports and studies are available upon request.

Steering Committee Conclusions

- Based on the samples collected in 2017, concentrations of *E. coli* and enterococcus in Shediac Bay and at Parlee Beach are generally lower than the values stated in the Guidelines for Canadian Recreational Water Quality.
- Based on the samples collected in 2017, high concentrations of *E. coli* and enterococcus have been identified throughout the Shediac Bay Watershed (the terrestrial basin which drains into Shediac Bay).
- These high concentrations of bacteria in the watershed may flow into Shediac Bay and, under certain oceanographic and meteorological conditions, may make their way to Parlee Beach. Wind direction, wave and tidal conditions appear to be determining factors.
- There are different types of sources of bacteria distributed throughout the Shediac Bay Watershed. Based on the samples collected in 2017 it is difficult to conclusively identify specific point and non-point sources. Surface water run-off from agriculture and urban areas, sewage system overflows, on-site sewage disposal systems, and birds, wild and domesticated animals are potential sources.
- To improve water quality in the Shediac Bay Watershed and reduce "No Swimming Advisories", at Parlee Beach, the bacteria sources which exist throughout the Watershed should be addressed.

Steering Committee Recommendations

The Steering Committee recommendations are presented in Table ES.1. These recommendations are presented with the understanding that:

- Water Quality Monitoring Protocols for Parlee Beach and Murray Beach will continue to be implemented in 2018.
- The "Water Strategy for New Brunswick 2018-2028" includes actions that could address some of the issues related to water quality at Parlee Beach.
- The presented costs are preliminary and would require further refinement depending on the mix of internal government resources and consulting services required to accomplish individual projects.

The rationale for each recommendation is presented in Sections 3, 4, 5 and 6 of the report.