# Omemee Beach Water Quality Report

# February 2020

KAWARTHA CONSERVATION

Discover · Protect · Restore

# Executive Summary

Kawartha Conservation plays a pivotal role in natural resource management within its 2600km$^2$ jurisdiction. Through the lake management planning process, a number of water quality issues have been identified. These can have lasting impacts on tourism, recreational opportunities and ecological health. The purpose of this study is to understand what inputs are contributing negatively to water quality and shoreline conditions which are resulting in swimming advisories or beach postings.

The objectives of this study are to determine where the greatest densities of *E.coli* occur at Omemee Beach and 3 upstream sites and attempt to establish any relationships between *E.coli* densities, water chemistry parameters and shoreline conditions. The study also quantifies foreshore *E.coli* densities. To look at all of these aspects a small scale study was carried out from June to the end of August in collaboration with the Haliburton, Kawartha Pine Ridge District Health Unit.

Water samples for *E.coli* were collected twice weekly (Monday & Wednesdays) from the beach site (OB) from the beginning of June to the end of August, approximately around 9:00am by HKPR and Kawartha Conservation Staff. Additional data was collected during daily sampling, which included air and water temperature, turbidity, beach user and bather density, presence of feces, wave type and wind direction, and potential pollution sources (i.e. waterfowl or wildlife presence, dogs on beach.

Water chemistry sampling was completed weekly on Wednesdays at approximately 9:00am at the beach site (OB), as well as one upstream sampling location (OBB) for the following: total phosphorus, nitrogen, and total suspended solids and chloride. Water samples for *E.coli* were also taken weekly (Wednesdays) for the upstream sampling site. General water quality data was collected for both sites (OB & OBB) using a handled multi probe unit, which included: water temperature, turbidity, pH, conductivity, and dissolved oxygen.

During the study period, there were 8 postings over the HKPR beach monitoring surveillance period (June-August). *E.coli* density results from upstream sites indicated that there were some similarities between sites, and it was unlikely that the water quality from the upstream location was a major influence on the beach area. Moreover it is likely that storm water runoff and geese populations are major drivers of the degraded water quality at Omemee Beach. Other important drivers such as water flow, fountain location and general park maintenance should be examined in the future.

Both sites lack a healthy riparian vegetative buffer to reduce storm water runoff including *E.coli* and nutrients. The Ministry of Natural Resources (MNRF) recommends a minimum of a 30m wide vegetated area to provide and protect aquatic habitats" (2012). Although the beach environment at site OB would not sustain a full riparian buffer there are areas adjacent to the sand beach that could benefit greatly from plantings by filtering run off and deterring geese roosting.

There are turtles nesting in this area and the utmost protection should take place. A turtle nesting cage program should be considered.

There is evidence of storm water runoff in different areas of the beach park which can be addressed though infrastructure (redirection) and raingardens.

This is a great opportunity for the community to become involved and rally around their beach. Additionally, it will be vital for improved communication between the community, Kawartha Conservation and the City of Kawartha Lakes moving forward.

# About Kawartha Conservation

## Who we are

We are a watershed-based organization that uses planning, stewardship, science, and conservation lands management to protect and sustain outstanding water quality and quantity supported by healthy landscapes.

## Why is watershed management important?

Abundant, clean water is the lifeblood of the Kawarthas. It is essential for our quality of life, health, and continued prosperity. It supplies our drinking water, maintains property values, sustains an agricultural industry, and contributes to a tourism-based economy that relies on recreational boating, fishing, and swimming. Our programs and services promote an integrated watershed approach that balance human, environmental, and economic needs.

## The community we support

We focus our programs and services within the natural boundaries of the Kawartha watershed, which extend from Lake Scugog in the southwest and Pigeon Lake in the east, to Balsam Lake in the northwest and Crystal Lake in the northeast – a total of 2,563 square kilometers.

## Our history and governance

In 1979, we were established by our municipal partners under the *Ontario Conservation Authorities Act*.

The natural boundaries of our watershed overlap the six municipalities that govern Kawartha Conservation through representation on our Board of Directors. Our municipal partners include the City of Kawartha Lakes, Region of Durham, Township of Scugog, Township of Brock, Municipality of Clarington, Municipality of Trent Lakes, and Township of Cavan Monaghan.


Kawartha Conservation

T: 705.328.2271

F: 705.328.2286

277 Kenrei Road, Lindsay ON  K9V 4R1

GenInfo@KawarthaConservation.com

KawarthaConservation.com

# Acknowledgements

This report was written by Debbie Balika, Water Quality Specialist, Kawartha Conservation. Peer editors include Brett Tregunno, Aquatic Biologist, Emma Collyer, Director, Integrated Watershed Management, and Richard Ovcharovich, Manager, Environmental Health, Bernie Mayer, Manager, Environmental Health, Haliburton Kawartha Pine Ridge District Health Department (HKPR). Others whom contributed to the development of this project include:

| | |
|---|---|
| Councillor Ron Ashmore | City of Kawartha Lakes |
| Pamela O’Brien | Public Health Ontario |
| Elmira Valor | HKPR |
| Emmeline Topping | HKPR |
| Neha Ghandi | HKPR |
| Nancy Aspden | Kawartha Conservation |
| Delanie Ashford | Kawartha Conservation |

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# Abbreviations

| | |
|---|---|
| CKL: | City of Kawartha Lakes |
| CWQG: | Canadian Water Quality Guideline |
| EC: | Environment Canada |
| *E.coli:* | *Escherichia coli* |
| masl: | Meters above sea level |
| OMNRF: | Ontario Ministry of Natural Resources and Forestry |
| MECP: | Ontario Ministry of the Environment, Conservation & Parks |
| PWQMN: | Provincial Water Quality Monitoring Network |
| PWQO: | Provincial Water Quality Objectives |
| PLMP: | Pigeon Lake Management Plan |
| TKN: | Total Kjeldahl Nitrogen |
| TN: | Total Nitrogen |
| TP: | Total Phosphorus |
| TSS: | Total suspended solids |
| TSW: | Trent Severn Waterway |

# Introduction

Kawartha Conservation plays a pivotal role in natural resource management within its 2600km$^2$ jurisdiction. Through the lake management planning process, a number of water quality issues have been identified. These can have lasting impacts on tourism, recreational opportunities and ecological health. The purpose of this study is to understand what inputs are contributing negatively to water quality and shoreline conditions which are resulting in swimming advisories or beach postings. Omemee Beach sits within the Pigeon Lake Management planning area and is a priority for the local community, as it is highly used. Over recent years there have been an increasing number of beach postings which means swimming advisories are put in place due to high *E.coli* concentrations in the water.   High *E. coli* concentrations are likely the result of a combination of factors including: excessive feces from birds, particularly Canada Geese, combined with urban runoff and pet feces following storm events, and/or shallow, warm waters with limited water circulation" (PLMP; 2019).

The objectives of this study are to determine where the greatest densities of *E.coli* occur at Omemee Beach and 3 upstream sites and attempt to establish any relationships between *E.coli* densities, water chemistry parameters and shoreline conditions. The study also quantifies foreshore *E.coli* densities. To look at all of these aspects a small scale study was carried out from June to the end of August in collaboration with the Haliburton, Kawartha Pine Ridge District Health Unit.

# Sampling methods and site characterization

## Study area

Omemee Beach is located on the Pigeon River system in the town of Omemee, Ontario **(Figure 1).** The beach is found within a residential area at the end of George Street at the bottom of a gentle slope. It is adjacent to the Omemee dam in a shallow wide waterway which sees a high density of users throughout the seasons **(Figure 2).** This waterbody is a very slow moving system and receives high spring inputs and continuous flows from the southwest end and exits in a northwest direction via a dam.

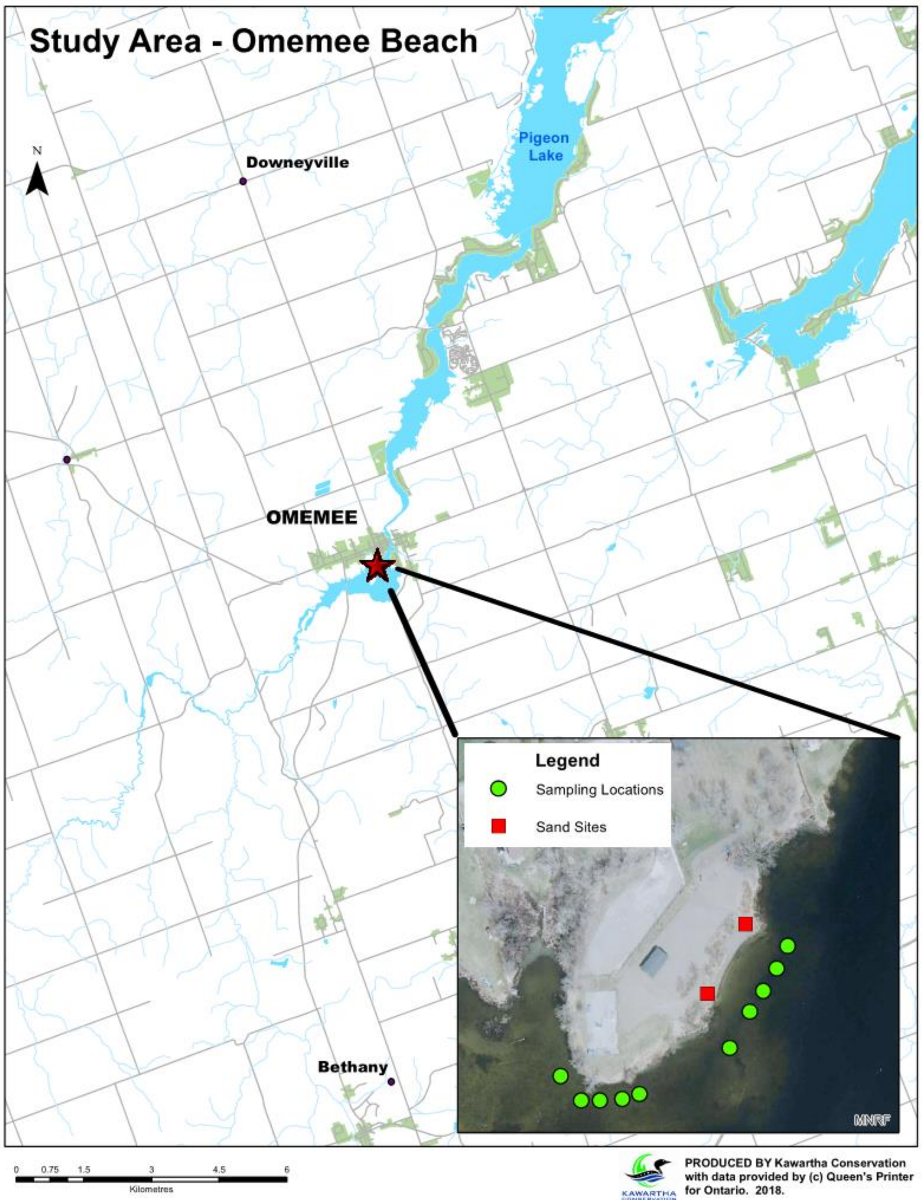



**Figure 1. Study area. Omemee Beach.**


**Figure 2. Water inputs and outputs at Omemee Beach.**

# Site characterization of Omemee Beach

Just offshore of Omemee beach a fountain was installed a number of years ago. It runs from 8:30am to 8:00PM **(Figure 3).** Often municipalities employ fountains in public beach settings as a method to deter geese or improve water circulation.

**Figure 3. The fountain located offshore of Omemee Beach.**

The park adjacent to the beach has recently been renovated with new play equipment and natural tree mulch as ground cover **(Figure 4).** There is an island of overgrown vegetation separating the large sandy area and the beach **(Figure 5).** There is a large parking lot to the north of the beach and a paved skate park to the east **(Figure 6).** Next to the skate park there is an ornamental grass area highly used by geese and anglers to access the water **(Figure 7).**

**Figure 4. New play area at Omemee Beach.**

**Figure 5. Vegetation islands.**

**Figure 6. Paved skate park adjacent to site OBB.**

**Figure 7. Ornamental grass south end of Omemee Beach Park (Site OBB)**

# Sampling Methods and Collection Regime

The Ministry of Health and Long-Term Care *Operational Approaches for Recreational Water Guideline* (2018) provides the monitoring protocol that was followed. The protocol states that five (5) water samples are to be taken, determined by the length of the beach, and sample collection 15 to 30cm below the water surface where the depth is 1 to 1.5m, or if less than 1m in depth, sampling will occur as far from the shore as possible within the bathing area **(Figure 8).**

Water samples for *E.coli* were collected twice weekly (Monday & Wednesdays) from the beach site (OB) from the beginning of June to the end of August, approximately around 9:00am by HKPR and Kawartha Conservation Staff **(Table 1).** Additional data was collected during daily sampling, which included air and water temperature, turbidity, beach user and bather density, presence of feces, wave type and wind direction, and potential pollution sources (i.e. waterfowl or wildlife presence, dogs on beach). For more details see Appendix A.

Water chemistry sampling was completed weekly on Wednesdays at approximately 9:00am at the beach site (OB), as well as one upstream sampling location (OBB) for the following: total phosphorus, nitrogen, and total suspended solids and chloride. Water samples for *E.coli* were also taken weekly (Wednesdays) for the upstream sampling site. General water quality data was collected for both sites (OB & OBB) using a hand-held multi probe unit, which included: water temperature, turbidity, pH, conductivity, and dissolved oxygen.

**Table 1. Sampling site conditions.**

| Site code | Water/ sand *E.coli* sample sites | Water chemistry | Vegetated buffer condition |
|---|---|---|---|
| OB | Water (2X weekly) | Weekly | Beach |
| OBB | Water | Weekly | Degraded/grass |
| OBS1 | Sand | NA | Beach |
| OBS2 | Sand | NA | Beach |

Beach sand samples were collected weekly (Wednesdays) at two different locations along a transect 3 metres up from the swash area (sand/water interface) **(Figure 9).** Sand was collected as composite samples comprised of 5 subsamples 30cm apart and 10cm deep with a sterilized spoon and placed in sterile amber glass bottles. Samples were sent to and analyzed by an outside accredited lab.

**Data analysis**

We used industry standards to assess the data we gathered. *E.coli* and water quality data was calculated and expressed as averages, medians, minimum and maximum values to understand the temporal changes of the beach. Relationships between parameters, such as water temperature vs *E.coli* densities, precipitation and E.coli densities were tested using the appropriate statistical analysis in order to determine if the relationship is statistically significant. This is described in more detail in Appendix B.

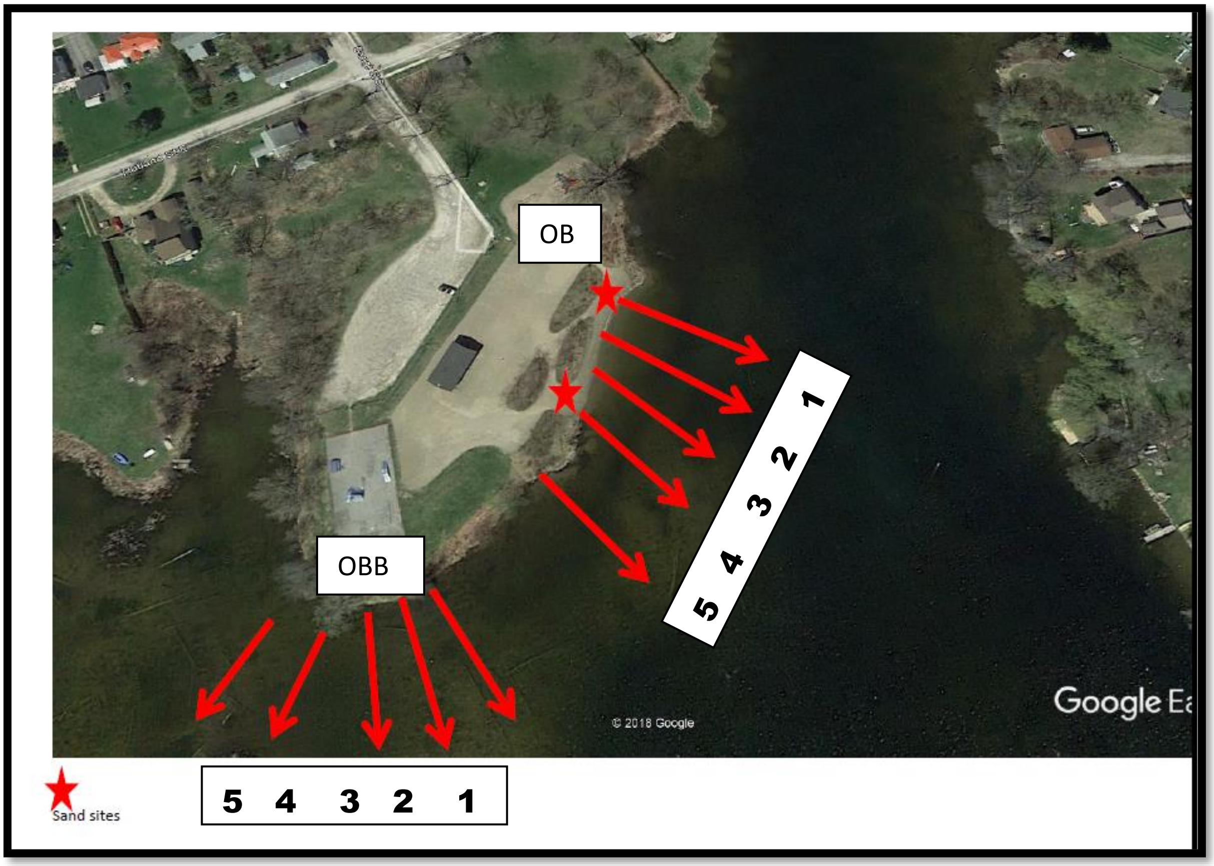



**Figure 8. Sampling locations at Omemee Beach**

**Figure 9. Swash zone at Omemee Beach.**

# Results/Conclusions

Surface water temperature affects aquatic ecosystems and the living organisms within it. Much like humans, aquatic organisms have optimal temperatures which help them carry out their life processes. They cannot carry out these processes if the temperatures are suboptimal and some processes stop if the temperature extreme is too much (hot or cold).

Surface water temperatures at all sites ranged from 20ºC to 26.7ºC during the study period. The highest temperature was recorded at site OB on July 24, 2019 while the lowest was also recorded at site OB on August 3, 2019 **(Table 2).** The average temperature at site OB was 24ºC. Water temperatures differed between sites throughout the study (Appendix B).

Dissolved oxygen (DO) measurements can indicate the health of a water body and the organisms that one could expect to live there. For example, some organisms have less oxygen requirements than others (i.e. trout need high dissolved oxygen whereas fish such as carp can live in very low concentrations). Almost all aquatic living organisms, from fish to microbes need dissolved oxygen to live **(Figure 10).**

Dissolved oxygen concentrations ranged from 3.9mg/L to 11.5mg/L **(Table 2).** Overall average dissolved oxygen concentrations were generally lower at the OBB site in comparison to the OB site calculated at 6.45mg/L and 7.73mg/L respectively.  Dissolved oxygen concentrations differed between sites throughout the study (Appendix B).

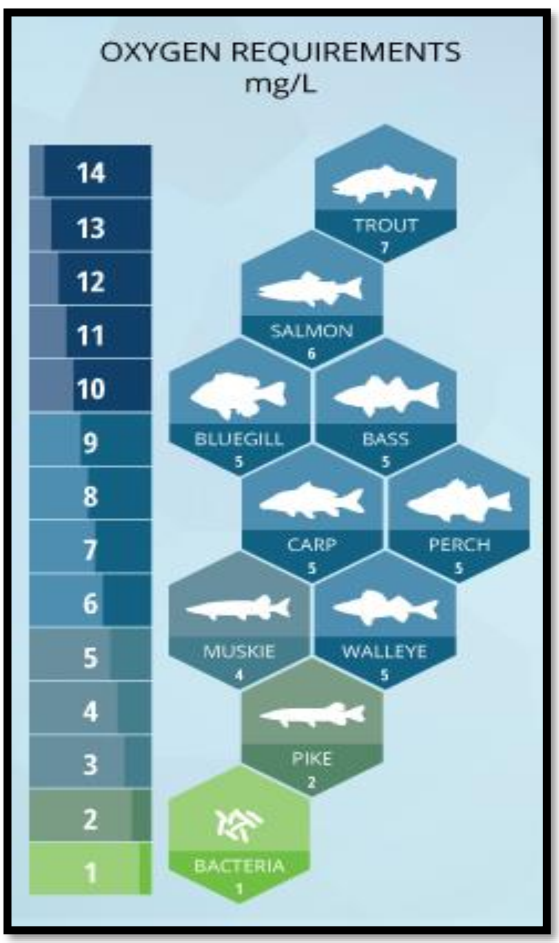


**Figure 10. Fish requirements of dissolved oxygen (Fondriest.com)**

Electrical conductivity is used to measure concentrations of various ions in water. It has a direct relationship with total dissolved solids and can be interpreted as measuring inorganic ions such as chlorides and sulfides. Conductivity measurements ranged from 275 µS to 302.6µS and differed significantly between the two sites over the study period. This could be the result of a wetland effect at Site OBB. (Appendix B). The average conductivity values were 324.20µS at site OB and 312.33 µS at site OBB **(Table 2).**

It is important to note that the data gathered data during this study should be considered to be baseline values as it has not been studied prior.

**Table 2. General water chemistry characteristics.**

| **Dissolved oxygen (mg/L)** | | | | | |
|---|---|---|---|---|---|
| Site | min | max | median | average | # of samples (n) |
| OB | 5.38 | 11.2 | 7.09 | 7.73 | 10 |
| OBB | 3.9 | 11.5 | 6.17 | 6.45 | 10 |
| | | | | | |
| **Water temperature (ºC)** | | | | | |
| Site | min | max | median | average | # of samples (n) |
| OB | 20 | 26.7 | 24.45 | 24.16 | 33 |
| OBB | 21 | 25.5 | 24 | 23.6 | 10 |
| | | | | | |
| **Conductivity (µS/cm)** | | | | | |
| Site | min | max | median | average | # of samples (n) |
| OB | 302.6 | 411.15 | 321 | 324.2 | 10 |
| OBB | 275 | 414.5 | 308.4 | 312.33 | 10 |
| | | | | | |

## Nutrients in the water

## Phosphorus

Phosphorus is one of the two primary nutrients required for the growth of aquatic plants and algae in streams and lakes. Even in elevated levels phosphorus is not considered toxic to plants and animals, but its high concentrations in water can cause the process of eutrophication, which results in excessive algal growth, and a corresponding depletion of dissolved oxygen in the water column. The Provincial Water Quality Objective (PWQO) for total phosphorus (TP) concentrations in watercourses is set at 0.03 mg/L, in order to prevent nuisance algae and aquatic plant growth (MOECC, 1994). The PWQO for TP concentrations in lakes is 0.020 mg/L and/or 0.010 mg/L for those lakes with a natural TP level below this value (MOECC, 1994). The PWQO value being considered for the Pigeon River at Omemee Beach (aka Mill pond) is 0.03mg/L.

The receiving waterbody, Pigeon Lake, is considered to have relatively good water quality in the northern portion of the lake, and exhibits some impairment in the southern end of the lake. It is designated as a mesotrophic (medium productivity) water body (PLMP 2019). According to Lake Partner Program (MECP) data for Pigeon Lake, total phosphorus concentrations are at or approaching the 0.02mg/L PWQO.

Average phosphorus concentrations over the entire study period at both the beach (OB) and upstream site (OBB) reached the PWQO and measured 0.03mg/L, however weekly single sampling results demonstrated some exceedances well above the PWQO **(Figure 11).**

During the sampling period site OB exceeded the PWQO 40% of the time, while site OBB exceeded the threshold 70% of the time.

Both sites, OB and OBB, followed the same general trend and did not differ significantly (Appendix B). We examined if there were any relationships or influences between the parameters studied. We combined the data from both sites and examined if there was a relationship between phosphorus and *E.coli* concentrations in the water. We found that when phosphorus concentrations increased in the water, *E.coli* concentrations increased as well (Appendix B). Examination of the data by each site revealed a slightly stronger positive correlation between phosphorus and *E.coli* at site OBB than site OB.

This may be a result of the variation between the sites (wetland versus beach). As mentioned above, the phosphorus concentrations were much higher at site OBB and exceeded the threshold 70% of the time within the study period. Wetlands are much more productive in terms of vegetation growing and dying off and using and releasing phosphorus. Land based activities such as run off and geese presence may have also contributed to the difference between sites.

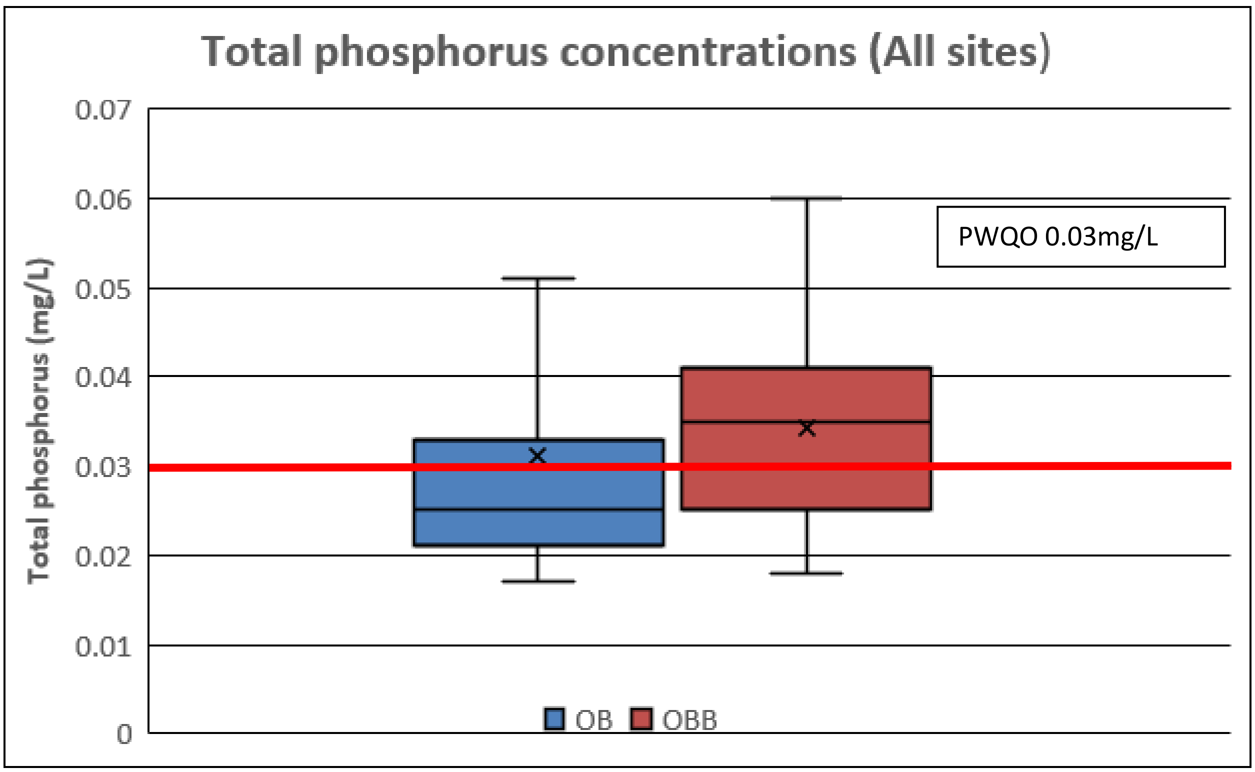



**Figure 11. Total phosphorus concentrations throughout study period (June to September 2019). The red line denotes the Provincial Water Quality Objective (0.03mg/L).** *Note: the box encapsulates the middle- 50% of the data (with the median represented as a solid line and the average as an X marker); the whiskers represent the maximum and minimum values without the more extreme outliers of the dataset; the points above and below the whiskers represent data at the 5th and 95th percentiles.*

## Nitrogen

Nitrogen is another key nutrient vital for the development of algae and aquatic plants. Nitrogen is present in surface water in several chemical forms such as free ammonia and ammonium, nitrite, nitrate and organic nitrogen. Nitrates are essential for plant growth in both terrestrial and aquatic ecosystems because they are highly soluble and mobile in water solutions and are the most available for plant consumption. Human mediated sources of nitrates include inorganic fertilizers, septic systems and wastewater treatment plants. Concentrations of total nitrates in surface water reflect general land use and anthropogenic pressure within the various parts of the watershed. Excessive nitrogen can have a negative impact on water quality and excessive growth of aquatic plants and algae. This excessive growth also decomposes and uses up dissolved oxygen taking it away from other organisms.

Total nitrogen (TN) includes both inorganic and organic forms of nitrogen. Total nitrogen concentrations were well within the interim PWQO of 1.0mg/L. All samples at both sites, OB and OBB fell below the PWQO. The average concentrations were 0.61mg/L and 0.62 mg/L at sites OB and OBB respectively.

## *Escherichia coli*-Water samples

*Escherichia coli* water samples were collected at 2 sites (OB & OBB) during the study period from June 26 to August 28, 2019. *E.coli* concentrations (water samples) ranged from 13cfu/100ml to 1000cfu/100ml over the duration of the study **(Figure 12).** The highest concentration (>1000-geomean) was found once during the study at site OB. The mean concentrations recorded at each site, over the duration of the study were: OB=196 cfu/100ml, OBB= 160 cfu/100ml, while median values were recorded as 99 cfu/100ml, and 120 cfu/100ml, respectively **(Table 3).**

**Table 3. *E.coli* characteristics of Omemee Beach (OB) and upstream site OBB.**

| Site | Mean | Median | # of samples (n) | # of exceedances | Rate of exceedance |
|---|---|---|---|---|---|
| OB | 196 | 99 | 18 | 4 | 22% |
| OBB | 160 | 120 | 11 | 4 | 37% |

Results indicated that there were several sampling events which exceeded the MOHLTC safe swimming threshold of 200cfu/100ml. Site OB experienced an exceedance rate of 22% while the upstream OBB site experienced a much higher rate of 37% **(Table 3).**

*Note: Site OB had more sample collection events than site OBB due to additional sample collection by HKPR staff.

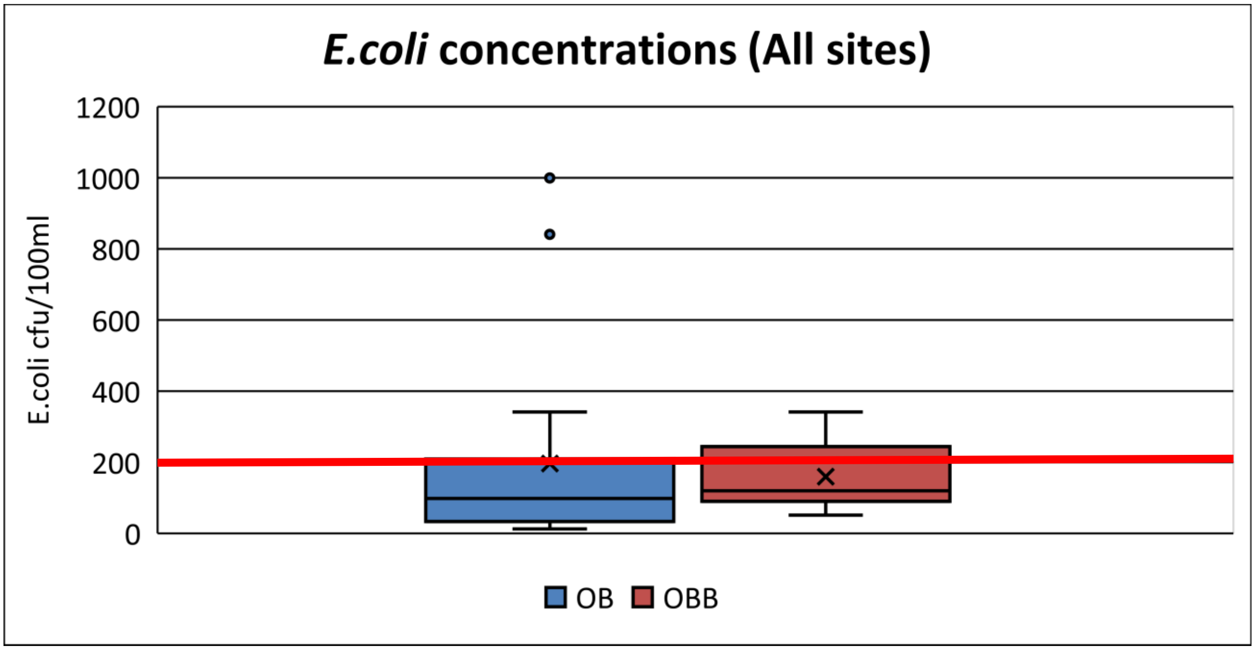



**Figure 12. *E.coli* concentrations throughout study period (June to September 2019). The red line denotes the Recreational Water Quality Objective (200cfu/100ml).** *Note: the box encapsulates the middle- 50% of the data (with the median represented as a solid line and the average as an X marker); the whiskers represent the maximum and minimum values without the more extreme outliers of the dataset; the points above and below the whiskers represent data at the 5th and 95th percentiles.*

At each sampling event 5 samples were collected which are equally, spatially distributed across the width of both sites (OB & OBB). The sample location #4 **(Figure 13)** within site OB, consistently had higher *E.coli* concentrations throughout the duration of the study. Overall this sample location exceeded the MOHLTC threshold (200cfu/100ml) 50% of the time **(Table 4).** Direct land use may be having an impact on this site and should be examined further.

**Table 4.** Highest consistent *E.coli* concentrations rates per sampling location

| Rate of Highest *E.coli* concentrations by sampling location | | | | | |
|---|---|---|---|---|---|
| Sample locations | 1 | 2 | 3 | 4 | 5 |
| % of sampling events | 12.5 | 8 | 33 | 50 | 33 |

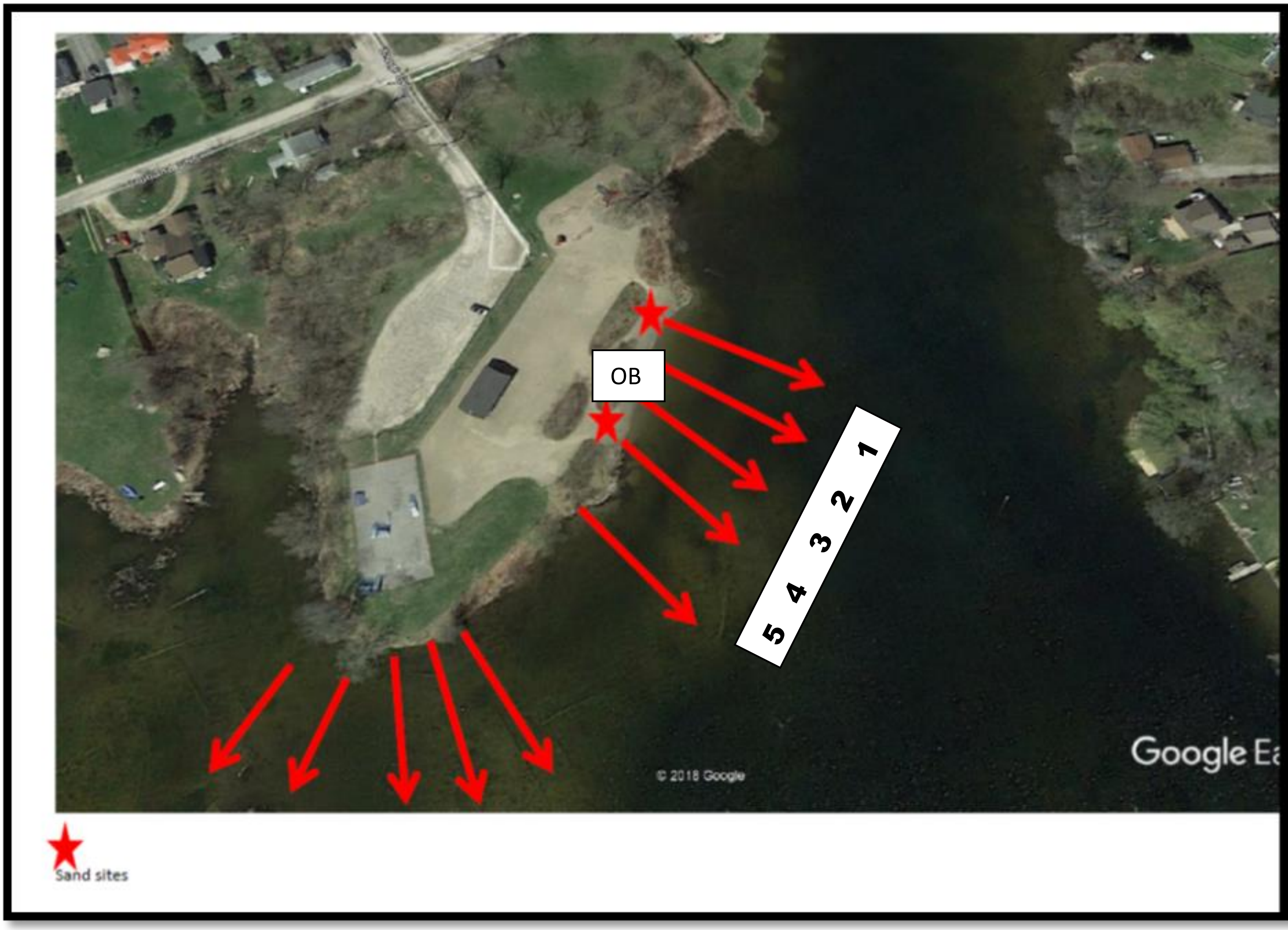



**Figure 13. Subsampling sites at both OB and OBB.**

The highest exceedance concentration was observed at Site OB on August 9, 2019 and the second highest was observed on July 17, 2019 **(Figure 14).** Both of these sampling dates corresponded with precipitation received 48-72hours prior, measuring 6.0ml & 12.80ml, respectively. The highest concertation of *E.coli* observed at Site OBB was on August 21, 2019 and also corresponded with precipitation measuring 12.20ml **(Figure 15).**

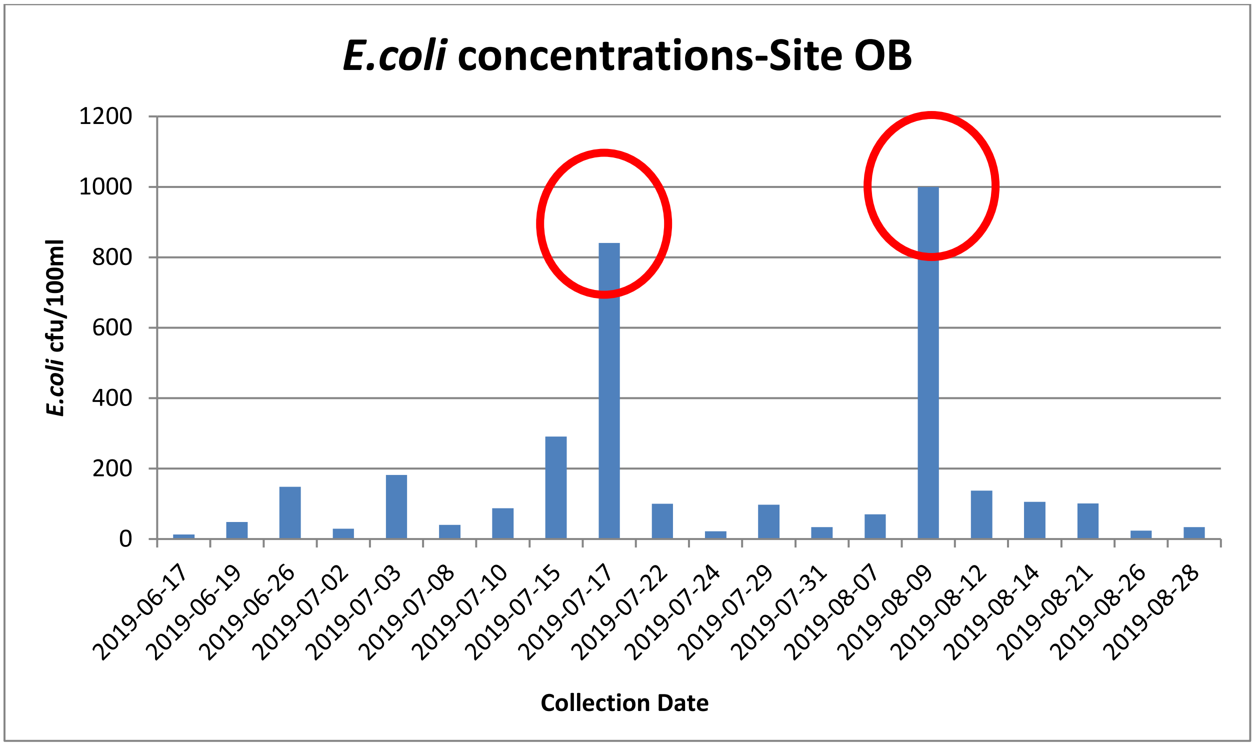



**Figure 14.** ***E.coli*** **concentrations by collection date at Site OB.**

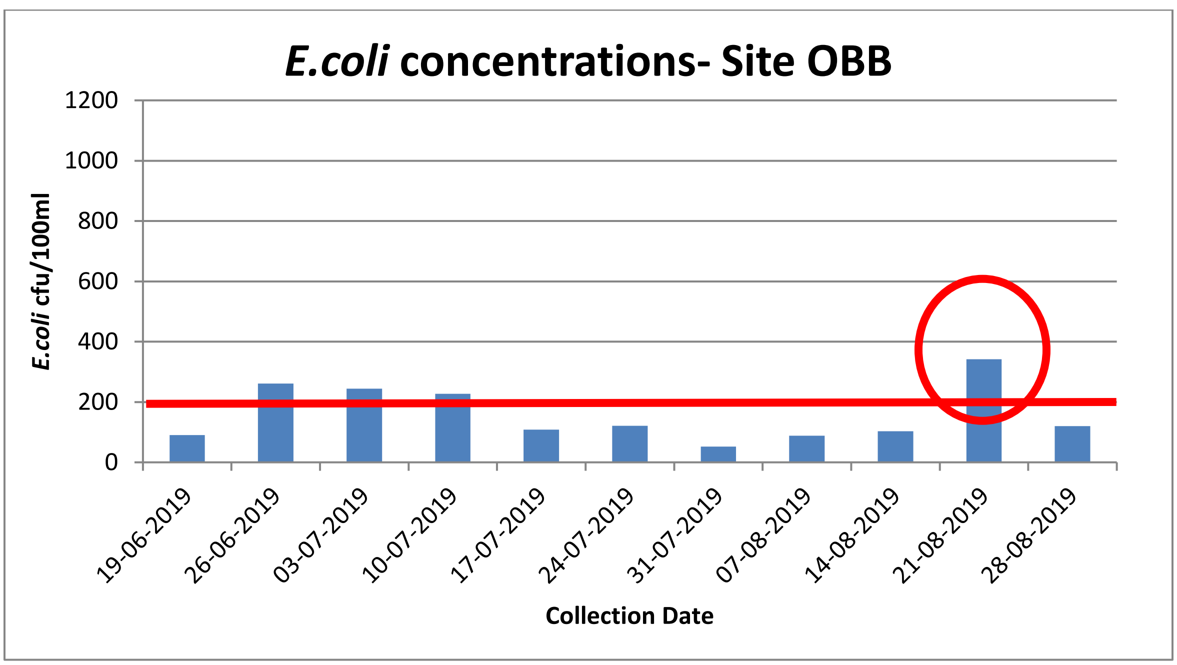



**Figure 15.** ***E.coli*** **concentrations by collection date at the upstream site at Omemee Beach (OBB).**

*E.coli* concentrations did not vary significantly between sites (Appendix B). There was a positive correlation between precipitation and *E.coli* concentrations for both OB and OBB. This means that when precipitation increased the concentrations of *E.coli* increased also.

## *Escherichia coli* (Sand samples)

Sand samples were collected once weekly in 2 different locations on the beach **(Figure 7).** OBS1 was located on the north sides of the beach, while OBS2 was located on the south side of the beach. There is no current guideline for *E.coli* concentrations in sand, however previous studies indicate that there is a natural presence as part of the ecosystem. Environment drivers such as warm temperatures can assist in the growth while precipitation can increase the colonization process through the flushing of bacteria to a localized area. *E.coli* concentrations in sand ranged from 9cfu/100ml to 65000 cfu/100ml (raw values) over the study period. The mean & median concentrations were 47106 cfu/100ml and 4250 cfu/100ml respectively (combined site data) **(Table 5).**

**Table 5. General characteristics of the sand *E.coli* dataset.**

| | **OBS1** | **OBS2** | **Combined sites** |
|---|---|---|---|
| **Ave** | 8826 | 85387 | 47106 |
| **Min** | 100 | 9 | 55 |
| **Max** | 43000 | 650000 | 346500 |
| **Median** | 3000 | 5500 | 4250 |

In order to understand the effect that the amount of precipitation may have on *E.coli* densities in the sand, data was combined from both sites and linear regression was performed on precipitation amount and *E.coli* densities. Linear regression is a way of testing (mathematically) whether relationships between 2 variables are real or perceived. Precipitation amounts (using rainfall (mm) 48-72 hours) before sand sampling events and combined site (OBS1 & OBS2) *E.coli* values demonstrated a weak positive correlation. This means that when the precipitation increased the *E.coli* concentrations also increased (Appendix B).

The next step was to examine the datasets by site (separately). We found that there was no relationship between precipitation and *E.coli* concentrations in the sand at site OBS1, however a small positive correlation was observed at site OBS2 (Appendix B). This result may help us identify the area of the beach to focus our efforts on, such as mitigating storm water channelization. It is important to note that the results were based on 8 samples/ site over 8 weeks.  Not every precipitation event was captured, but this gives us some ideas where we could mitigate or focus future studies

Over the study period the *E.coli* concentrations in sand increased and decreased the same at both sites, but in different magnitudes **(Figure 16).** For example on July 17, 2019, a rainfall amount of 6.0ml occurred and both sites exhibited an increase in *E.coli* concentrations; however the concentrations at OBS2 were significantly higher than OBS1.

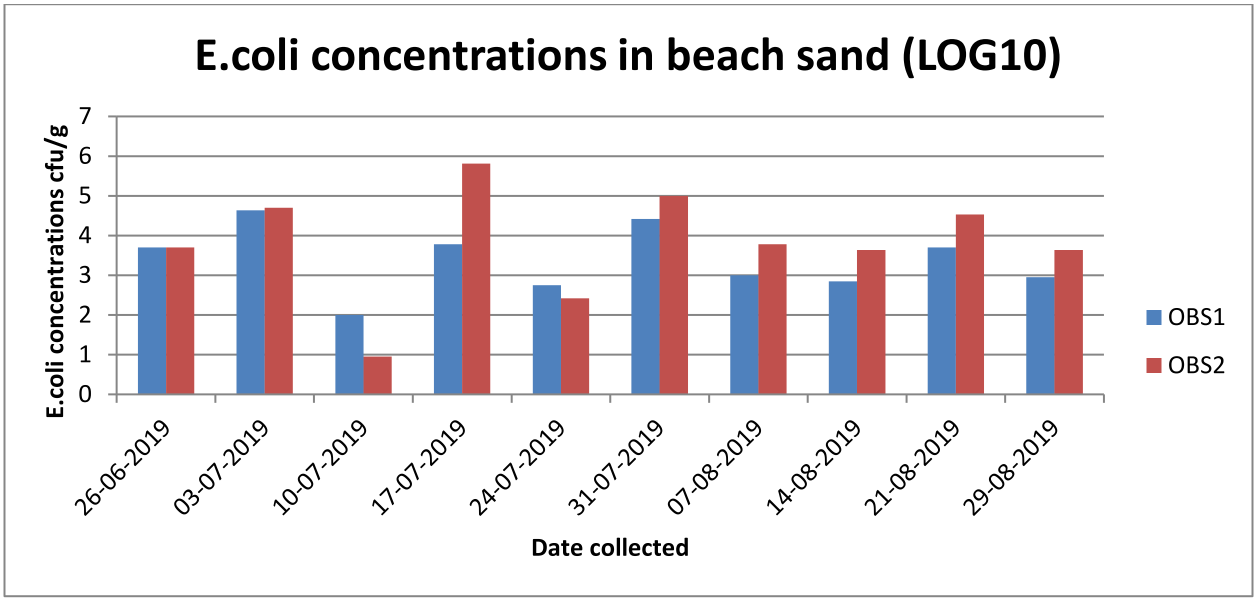



**Figure 16. *E.coli* concentrations in sand at sites OBS1 and OBS2 over the study period (June to September).**

The final analysis performed was to test the relationship of the concentrations of water *E.coli* in (site OB only) compared to the sand concentrations (sand samples were only taken form the beach (OB site). The sand *E.coli* data was combined (both sites) and results indicated a strong positive relationship, but not statistically significant (Appendix B). This means that there is a perceived correlation when the data from both sets are combined, but not a true relationship. The next step was to examine the data from each site separately. The results of testing the relationship of *E.coli* sand concentrations and *E.coli* water concentrations were very different. The linear regression results showed no relationship between the water *E.coli* concentrations (OB) and sand *E.coli* concentrations at the OBS1 site, while the results of the OBS2 site showed a strong statistically significant positive relationship (Appendix B).

The results indicate that when *E.coli* concentrations, in the sand increases, the concentrations in the water also increase. This is important as the sand could be influencing the *E.coli* concentrations as part of the storm water runoff and may be acting in conjunction with one another. Furthermore, this relationship supports the idea that the up shore area of OBS2 is impacting the site and adjacent water.

Additionally, previous studies have found that *E. coli* populations found in the sand adsorb tightly onto particles (sand/sediment) in moist nearshore areas as they can be protected from environmental elements such as solar radiance and ultimately cell death (Whitman et al: 2006). Whitman further indicates that large rainfall events could instigate a resuspension of sand *E.coli* lakeward to the nearshore areas.

## Waterfowl

The presence of waterfowl and geese in particular was noted during the study. When present, waterfowl were counted. When waterfowl was not present, evidence of waterfowl (feces and feathers) were documented. Observations determined that 33% of the time >20 geese were present (combined at both sites). Evidence of geese (feces & feathers) was present 71% of the time during the study period.

Due to the short distance between sites it is plausible that the geese use both sites/ areas at different times of the day. For example they may feed/graze at OBB then roost in the soft sand at site OB.

Mitigation efforts to reduce geese presence in the entire park are needed.

# Discussion/Conclusions

Concentrations of fecal indicator bacteria (FIB) such as *E.coli* have been used as a method to assess recreational water quality and the risk to human health. The province of Ontario uses the Ontario Public Health Standards, Beach Management Guidance Document (2018) to determine health risks applying the threshold of 200cfu/100ml using the geomean calculation (Public Health Ontario, 2018).Omemee Beach has experienced beach postings due to unsafe *E.coli* concentrations historically and on an ongoing basis.

During the study period, there were 8 postings over the HKPR beach monitoring surveillance period (June-August). *E.coli* density results from upstream sites indicated that there were some similarities between sites, and it was unlikely that the water quality from the upstream location was a major influence on the beach area. Moreover, it is likely that storm water runoff and geese populations are major drivers of the degraded water quality at Omemee Beach. Other important drivers such as water flow, fountain location and general park maintenance should be examined in the future.

Both sites lack a healthy riparian vegetative buffer to reduce storm water runoff including *E.coli* and nutrients. The Ministry of Natural Resources (MNRF), recommends a minimum of a 30m wide vegetated area to provide and protect aquatic habitats" (2012). Although the beach environment at site OB would not sustain a full riparian buffer there are areas adjacent to the sand beach that could benefit greatly from plantings that would filter run off and deterring geese roosting **(Figure 17).**

**Figure 17. A flock of geese roosting adjacent to the eroding/ degraded shoreline to the north of the beach.**

At site OBB the riparian area has degraded. There is evidence of earlier restoration work, but a lack of maintenance **(Figure 18).** Site OBB does not have a substantive amount of vegetation in order to promote good water quality. Additionally, the lack of vegetation and type of current vegetation (turf) is encouraging large congregations of waterfowl to converge for feeding and thus defecation and/or feeding and then roosting on the beach area **(Figure 19).**

**Figure 18. Ornamental grass as food source for geese.**

It is likely that the Omemee Beach is being influenced by storm water runoff and may be contributing to the *E.coli* densities in the beach sand. As mentioned previously, foreshore areas have a reservoir effect of FIB including E.coli (Vogel et al; 2017). It is postulated that contamination of the foreshore area can be due to water fowl, ground water, bacterial transfer from wrack (washed up debris), bather input and nonpoint storm water inputs (Nevers et al; 2016)**(Figure 19).**

**Figure 19. Aquatic vegetation accumulation up to the north of the beach.**

Storm water channelization was observed just upland of both of these sites. There is evidence of sheet flow from the parking lot area which was contributing to the channelization **(Figures 20a & b).** Earlier in the season there was a rain barrel installed upland of these sites which was vandalized continually over the period of study and flowed into the sites with the tap removed completely allowing water to flow out of the bottom and over the top (**Figures 21a & b).** The storm water from the rain barrel could have influenced water quality at both of these sites. Near the end of the study the rain barrel was removed and relocated in the park area. Through a spatial analysis, consistent high *E. coli* concentrations were found at in the sand at site OBS1 and the corresponding water collection sampling location #4 **(Figures 22a &b).** The high densities of *E.coli* found in the sand in relationship to the *E.coli* densities found in the water made it  clear that site OBS2 had a very significant strong positive relationship with the beach water collection site (OB) .

**Figures 20a and b. Stormwater channelization from upland draining into the beach area.**


**Figure 21a & b. Vandalized rain barrel.**


**Figures 22a and b. *E.coli* sampling location #4 adjacent to the storm water runoff channel. The red star represents the sand collection site.**

The results at Omemee Beach demonstrated that as rainfall amounts increased *E.coli* concentrations in the sand also increased. However, there was a stronger relationship observed at site OBS2. Although the mechanism for horizontal distribution is clear, the origin of *E.coli* populations within the sand is still unknown (Whitman et al: 2006).

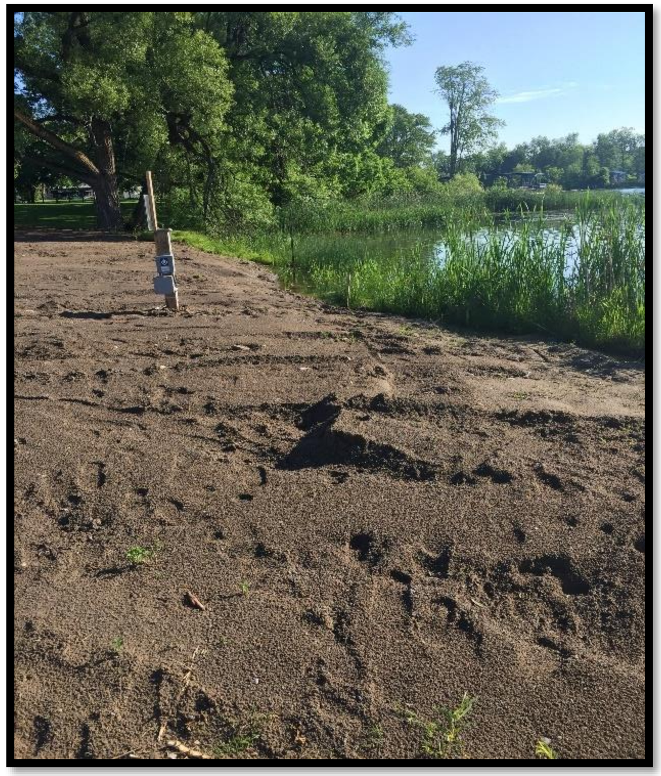
Evidence of storm water inputs was observed at Omemee Beach by way of channelization from the pathway into the unsaturated backshore of the beach area then into the water. The data strongly suggest that the south of the beach is being influenced by storm water runoff from the parking lot, the roof of the picnic shelter and the malfunctioning rain barrel collection system which was relocated in late August. Both the high exceedance rate of *E.coli* at sample location #4 and the elevated concentrations in the sand at site OBS2 provide good evidence for this. Plantings and storm water mitigation such as a French pipe should be considered to direct storm water away from the public beach area **(Figure 23a & b).** This will improve water quality through the mitigation and reduction of nutrients (TP & TN) and *E.coli* into the water body.

**Figures 23a and b. Storm water channelization and location of sheet flow.**

Both sampling locations (OB & OBB) lack healthy riparian buffers which could improve water quality through a filter effect. Site OB is 80% beach, however at the north end of the beach a shoreline naturalization project could occur here. Increased vegetation would also help deter the number of geese roosting in this area as discussed earlier.

It is important to note that during the study a number of native turtle species (snapper & painted) were laying eggs in the sand in this northern portion of the beach. A turtle nesting cage program, including a nursery area should be considered to help protect turtle eggs. All 7 species of turtles are considered a species at risk in Ontario. Park staff should be advised that turtle species nest here. Educational signage about turtles and turtle nesting areas could be posted in this area also **(Figures 24a & b).**

Site OBB is a wetland. Many species of birds and fish use this area. There were multiple centroid (bass) nests observed throughout the duration of the study. This area is rich with aquatic plants and important to protect. As mentioned, high geese populations and use were observed in this study. The current vegetative covering (i.e. turf) is conducive to large geese populations, and acts as a food source for them. We suggest a redesign for this area which would include better plant choices to deter geese. A riparian zone design would also address the access paths of the geese and the eroding shoreline. Finally, an improved riparian zone would act as a healthy buffer between the parking lot, skatepark and the waterbody.

**Figures 24a and b. Snapping turtle at Omemee Beach and observed turtle nesting area.**

## Invasive species

Some terrestrial invasive species were noted at the Omemee Beach Park. It would be of great benefit to perform an invasive plant survey. Mapping the results will allow for consistent information to be shared. Site OB has phragmites present **(Figure 25).** If addressed soon, this can be managed.

Other observations at site OB included a voracious colony(ies) of red biting ants which should be addressed.

**Figure 25. Phragmite regrowth just north of the main beach.**

## Park maintenance

Garbage on the beach and around the park was observed on each sampling event **(Figure 26).** Additionally, there was a general lack of maintenance on the beach and park overall. Floating, uprooted aquatic vegetation was floating in and building up along the shoreline of the beach (site OB) towards the end of August. As mentioned aquatic vegetation can sequester and aid in the growth of *E.coli*. A park maintenance plan including the removal of aquatic vegetation along the shoreline, garbage, daily maintenance and stewardship implementation projects should be communicated clearly and a plan put in place.  There was anecdotal evidence of a used syringe was found in the park by a community member. This should also be addressed.

**Figure 26. Canada Day firework celebration litter still present on July 24th, 2019.**

The community could also be a part of the maintenance, such as watering flowers/plants, picking up garbage, monitoring geese presence etc. We suggest that a public presentation about the health of Omemee Beach Park and next steps be considered for Spring 2020. This presentation should be co led by the City of Kawartha Lakes Parks and Recreation staff and Kawartha Conservation.

## Climate change considerations

Additional plantings and improving the shorelines combined with the removal of invasive species will increase biodiversity and aid in developing resiliency against climate change effects. One of the few mitigators against climate change is to build resiliency through a healthy biodiversity in plants and animals.

Current climate change modelling predicts an increase in high volume precipitation events which will assist in higher nutrient flushes from land into our waterways. Mitigating storm water through increased and strategic planting will help decrease those nutrient pulses into the waterbody in addition to reducing thermal pollution. Shoreline plantings will help with stabilization and reduce erosion.

# Summary/ Recommendations

Omemee Beach is a gem of a park for the community and tourists alike. One can view wildlife, swim and picnic at the park. However, Omemee Beach is in need of some improvements on the shoreline and park proper which will ultimately improve water quality and decrease the rate of beach postings.

This is a great opportunity for the community to become involved and rally around their beach. Additionally, it will be vital for improved communication between the community, Kawartha Conservation and the City of Kawartha Lakes moving forward.

Recommendations include:

- Shoreline naturalization (OB & OBB)
- Rain gardens and plantings along fence line to reduce runoff
- Infrastructure Storm water mitigation (i.e. French drain to assist move storm water north of the beach
- Community involvement (beach clean up)
- Turtle nesting cage program
- Invasive species monitoring and removal
- Park maintenance plan (aquatic vegetation raking/removal)
- Reshape/maintain vegetation islands for improved viewing experiences
- Remove red ant colonies
- Investigate the effect of the fountain on geese or other issues (is it having any positive effect?)
- Investigate in other technologies for water circulation
- Enhanced beach study (site OB) for water quality, including *E.coli* concentrations in 2020. This would provide a greater dataset and temporal influences such as any variation in precipitation and water levels.
- More research about the merits of grading/raking the sand should also be considered in light of the reported *E.coli* concentrations in the sand during the duration of this study, and could be added to the 2020 study regime.

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Appendix A: Beach Survey

HKPR District Health Unit 2019

# Beach Survey – Weekly Field Data Report

| | |
|---|---|
| Name of Beach: | Beach Code: |
| Surveyor Name: | Posted at Time of Sampling: ○ Yes ○ No |
| Date of Survey (mm/dd/yyyy): | Time of Sampling (hh:mm): ________ AM/PM |
| **General Beach Conditions** | |
| Air Temperature: ________°C | Dew Point Temperature: ________°C |
| Water Temperature†: ________°C | Relative Humidity: ________ % |
| Sky Conditions (cloud cover %):<br>○ Sunny (0%) ○ Mostly sunny (1-33%) ○ Partly cloudy (34-66%) ○ Mostly cloudy (67-99%) ○ Cloudy (100%) | |
| Wind Direction:<br>○ None ○ Away from shore ○ Toward shore ○ Parallel to shore | Wind Speed: ________ km/h |
| Wave Type:<br>○ Calm (no waves)<br>○ Wavy (soft waves, rolling, no white caps)<br>○ Choppy (white caps) | Wave Height: ________ cm |
| Rain Intensity:<br>○ None ○ Light (spitting; <2.5mm/h) ○ Medium (showers; 2.6-7.5mm/h) ○ Heavy (downpour; >7mm/h) | |
| Water Clarity:<br>○ <100 cm (cannot see feet) ○ >100 cm (can see feet) | Water Turbidity: ________ NTU |
| Approximate number of people observed in the water:<br>○ 0 (none) ○ 1 – 10 ○ 11 – 20 ○ >20 | Approximate number of people using the beach but not in the water at time of observation:<br>○ 0 (none) ○ 1 – 10 ○ 11 – 20 ○ >20 |

**Potential Pollutants**

| Type of Source | Source Present? | General Observations (e.g. approximate #) |
|---|---|---|
| Wildlife/waterfowl (e.g. turtles, geese, ducks) | ○ Yes ○ No | |
| Domestic animals (e.g. dogs) | ○ Yes ○ No | |
| Fecal matter (e.g. bird droppings) | ○ Yes ○ No | |
| Dead animals (e.g. fish*, frogs) | ○ Yes ○ No | |
| Wastewater discharges (e.g. boats, water treatment plant bypass*) | ○ Yes ○ No | |
| Stormwater/natural/urban/agricultural runoff* (e.g. water flowing from roads, nearby farms, debris*) | ○ Yes ○ No | |
| Watercraft access/boat dockage | ○ Yes ○ No | |
| Seasonal watercourse (new temporary stream) | ○ Yes ○ No | |
| Biochemical hazards* (e.g. chemical spill, needles) | ○ Yes ○ No | |
| Algal blooms*/pollen | ○ Yes ○ No | |
| Other | ○ Yes ○ No | |

| Part IV: Water Quality | | | |
|---|---|---|---|
| Sample Number | Sample Point | Parameter:<br>○ E. coli ○ Other (specify) | Comments |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| Geometric Mean Concentration (GMC): | | | |
| Additional Comments/Notes: | | | |
| Surveyor Signature: | | | |

† Water should not be entered if water temp is below 16°C due to personal safety reasons, therefore water clarity and wave height should not be assessed (instead enter "N/A" and record a note explaining in the additional notes section)
* If any potential hazards are present (heavy algae growth/blue green algae, debris, fish die off, waste water treatment plant bypass, chemical/oil/manure/sewage spill), call Bernie for instruction

**Appendix B- Technical Information**

**Background**

Concentrations of fecal indicator bacteria (FIB) such as E.coli have been used as a method to assess recreational water quality and the risk to human health. Human health risks are determined based the threshold of 200cfu/100ml. With the implementation of the Operational Approaches for Recreational Water Guideline (2018) from The Ministry of Health and Long Term Care (MHLTC), which replaced the Ontario Public Health Standards, Beach Management Guidance Document (2014), there was an increase in the maximum acceptable concentration of 100cfu per 100 mL to 200cfu per 100 mL of *Escherichia coli* using a geomean calculation.

Although, recreational water quality thresholds have been widely studied, there has been evidence that FIB in sand may act as a reservoir or source (sink) and play a role in water quality.  Previous studies have concluded that sand located near the shoreline at freshwater beaches demonstrated higher concentrations of E.coli than the adjacent shallow surface water and can be considered known reservoirs for E. coli (Kinzelman et al., 2004: Staley et al.,2015; Vogel et al 2016., Vogel et al 2017). The fecal concentration of foreshore sand is a result of contamination via wildlife (mostly shore birds), surface water (wave action), ground water and storm water runoff.

**Methodology**

*Escherichia coli* densities in sand are determined by membrane filtration technique. The sample is filtered by a vacuum through a 47mm diameter, 0.45µm pore size cellulose-ester gridded membrane filter. The bacterial cells trapped on the surface of the filter form colonies when placed on mFC Basal medium and are incubated inverted at 44.5oC +/- 0.5oC for 24 + 2 hours. The media uses the chromogenic substrate BCIG (5-bromo-6-cloro-3-indolyl-B-D-glucuronide) for quantitative recovery of Escherichia coli from aqueous, soil, and sludge samples. The BCIG gives visible blue colonies (SGS laboratories 2018).

General Water Quality data was collected using a handheld YSI ProDSS multiprobe unit, which included: water temperature, turbidity, PH, conductivity and dissolved oxygen

**Data Analysis**

*E.coli* values determined from water samples were calculated and recorded in GEOMEAN. *E.coli* values determined from sand samples were recorded in raw form.  All sand *E.coli* data was LOG transformed (a value of 1 was added to prior transformation to omit any zeros or negatives). The T test, paired means was used to determine significant variation between sites using both water and sand *E.coli* and surface water quality data. Linear regression analysis was performed to compare *E.coli* concentrations in sand and water with surface water quality parameters and precipitation amount.

**T-Test Results (Testing for variation between sites)**

| Statistical analyses | | | |
|---|---|---|---|
| **T-Test-Site OB vs OBB** | df | T-stat | P |
| E.coli concentrations (water) | 7 | -0.20939 | 0.420054 |
| E.coli concentrations (sand) | 9 | -1.20629 | 0.129228 |
| Water temperature | 9 | 2.482017 | 0.017438 |
| Dissolved oxygen | 9 | 2.286383 | 0.024029 |
| Conductivity | 9 | 2.463499 | 0.017976 |
| Total phosphorus | 7 | 0.277625 | 0.394661 |

**Regression Analysis Results**

| ***Regression Statistics*** | **R Square** | ***df*** | ***SS*** | ***MS*** | ***F*** | ***P* value** |
|---|---|---|---|---|---|---|
| **TP vs *E coli* (all sites)** | 0.03612 | 1 | 9.34229E-05 | 9.34E-05 | 0.524634 | 0.00 |
| ***E.coli* vs water temp (all sites)** | 0.003846 | 1 | 5389.279477 | 5389.279 | 0.096522 | 0.56 |
| **Water temp vs *E.coli* (Site OB)** | 0.00756 | 1 | 10190.68655 | 10190.69 | 0.137114 | 0.57 |
| **TP vs *.Ecoli* (Site OB)** | 0.104382 | 1 | 0.000200778 | 0.000201 | 0.699283 | 0.00 |
| **TP vs *E.coli* (Site OBB)** | 0.241107 | 1 | 0.000155484 | 0.000155 | 1.90625 | 0.03 |
| **Water temp vs *E.coli* (Site OBB)** | 0.003322 | 1 | 158.0801394 | 158.0801 | 0.016668 | 0.87 |

**Nitrogen Guidelines**

There is no provincial or federal guideline for total nitrogen concentrations in surface water. Alberta Environment has established a surface water quality guideline for total nitrogen at 1.0 mg/L (Alberta Environment, 1999). This guideline was used by Environment Canada for reporting on water quality in Lake Winnipeg (Environment Canada, 2013a, 2013b). It provides us with an opportunity to use the above-mentioned guideline as a nitrogen interim guideline for streams and lakes in the Kawartha Conservation watershed. Indirect toxic effects resulting from eutrophication may still occur at nitrate concentrations below the guideline value, depending on the total amount of nitrogen in water (CCME, 2007).