Severn Sound

Environmental Association

Status of Recreational Water Quality at Little Lake Park

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For: The Town of Midland

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Table of Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

CFU – colony forming units
EC – Environment Canada
E. coli – Escherichia coli
geomean – geometric mean
MOHLTC – Ministry of Health and Long Term Care
p – probability, referring to statistical tests
r^2 – correlation coefficient
SMDHU – Simcoe-Muskoka District Health Unit
SSEA – Severn Sound Environmental Association
SSRAP – Severn Sound Remedial Action Plan
WWTP – Wastewater treatment plant

Introduction

Some of the best public beaches in Simcoe County are within the Severn Sound watershed, and protecting beach quality is of great importance to the local municipalities who maintain them. One of the water use goals outlined in the Stage 2 report from the Severn Sound Remedial Action Plan (SSRAP) states that “water should be swimmable virtually everywhere in the Severn Sound watershed” (SSRAP 1993). To help achieve this goal, a beach monitoring program was developed in cooperation with the Simcoe-Muskoka District Health Unit (SMDHU) to monitor swimming water quality at beaches throughout the watershed, including Little Lake Park. In the Stage 2 report, one of the main concerns with respect to swimming water quality in the watershed is microbial contamination from fecal sources, and this is where beach monitoring efforts were focused.

Exposure to pathogenic microbes occurs primarily through the ingestion of water, but can also occur through contact with the skin or by entry of water through the ears, eyes, nose, or broken skin. Stomach disorders and minor skin, eye, ear, nose and throat infections have been associated with microbial contamination of recreational waters (MOHLTC 1998).

Sources of pathogenic bacteria, virus and protozoan contamination to recreational beaches can be both natural and anthropogenic. Natural streams, faulty or substandard private septic systems, and stormwater outfalls that discharge at or near a beach can represent significant sources, especially following storm events. Waterfowl and other animals, including pets, that frequent the immediate shoreline area represent localized sources. Beach users infected with water-borne illnesses can also be a source of pathogens. Large numbers of bathers can increase microbe densities from the bacteria that are naturally carried on their bodies, and by stirring up bottom sediments.

Aside from the presence of a source of pathogens, many other factors also influence recreational water quality. These include climate related variables such as wind, rainfall amount and intensity, and air temperature. Studies have shown that bacterial densities are often highest in the shallowest area of a beach, so heavy wave action from high winds can stir up beach sands and cause high concentrations of bacteria in the water. Particularly large and/or intense rainfall events increase the amount of natural and urban stormwater runoff reaching a beach, which often carries high concentrations of microbes. High water temperatures caused by hot summer days increase the rate at which microbes multiply, giving rise to greater densities. Characteristics of a beach itself also affect pathogen movement. For example, beaches that are sheltered, either naturally or by manmade barriers, lack the water circulation needed to flush out microbes, and can develop chronic contamination issues.

Of all pathogenic microbes, bacteria receive the most attention with respect to monitoring of recreational waters. There are many types of fecal bacteria that can be found in recreational waters, the most well known of which is *Escherichia coli* (*E. coli*). Although only a few strains are pathogenic, *E. coli* make good indicators since the bacteria are found only in the lower intestine of warm blooded mammals, including humans and waterfowl. Thus, their presence indicates evidence of fecal pollution, and potential risk from other pathogens. They are easy to sample and identify with standard methods, and have a long enough survival rate that allows samples to keep for analysis. It was once thought that *E. coli* were not normally found in soil and water, however recent studies have shown that the bacteria can accumulate in beach sands, and persist long enough to become a source during a subsequent rain event.

In 1992, under the Environmental Health Program Standards for Safe Water, the Ontario Ministry of Health and Long Term Care (MOHLTC) set the guideline for unsafe swimming conditions at a geometric mean (geomean) of 100 *E. coli* Colony Forming Units (CFU) per 100 ml of water. This geomean is calculated from samples taken at waist depth every 200 m across a beach on a given sampling day. The goal of this guideline is “to prevent or reduce the burden of water-borne illness and injury related to recreational water use” (MOHLTC 2009). If this level is exceeded, the Simcoe-Muskoka District Health Unit (SMDHU) issues a beach posting, which is then communicated to the public through the SMDHU website as well as signage by the municipality responsible for the beach. A posting indicates an advisory against swimming, and is different than a beach closure, which follows a more dangerous event such as a chemical or sewage spill, or toxic algae bloom.

Beach monitoring data are available for Little Lake Park from 1991 to present. Using this dataset and relevant environmental variables, our objectives for this report are to:

a) Determine the relative number of guideline exceedances in each swimming season at Little Lake Park, and whether it is changing over time;
b) Establish relationships between *E. coli* densities and environmental factors such as waterfowl abundance and local climate variables;
c) Determine where the greatest densities of *E. coli* occur, both lengthwise along the beach and widthwise with water depth.

Methods

Along with other beaches across the Severn Sound watershed, SSEA has sampled for *E. coli* in Little Lake Park since 2002, with support from the SMDHU. From 1991-2001, the Town of Midland was responsible for taking weekly samples. In 2011, monitoring was carried out by the SMDHU, and the data provided to SSEA. All organizations followed the Beach Management Protocol as detailed by the MOHLTC (MOHLTC, 1998).

Routine Sampling

Through the combined monitoring period, the public beach at Little Lake Park was sampled weekly throughout the bathing season (Mondays from mid-June to end of August, generally around 11:00 am). Ten samples were taken at 200 m intervals across the beach (**Figure 1**). Field personnel waded to 1-1.5 m depth before collecting samples 15-30 cm below the water surface into sterile bottles containing a sodium thiosulfate preservative (provided by the SMDHU). Water and air temperature data were also collected, and observations on weather, previous rainfall, bather density, approximate waterfowl abundance (Canadian geese, (*Branta Canadensis maxima*), gulls, and ducks recorded separately), and wave direction were noted. Water samples were kept on ice and sent to the Ontario Agency for Health Protection and Promotion Laboratory in Orillia on the same day of collection. A geomean was calculated for the ten samples, and compared to the MOHLTC guideline of 100 CFU/100 mL (see **Appendix A** for calculation of a geometric mean). If the MOHLTC guideline of 100 *E. coli* CFU/100 mL was exceeded, the beach was posted and re-sampled within the same week (usually by the Wednesday of the same week).

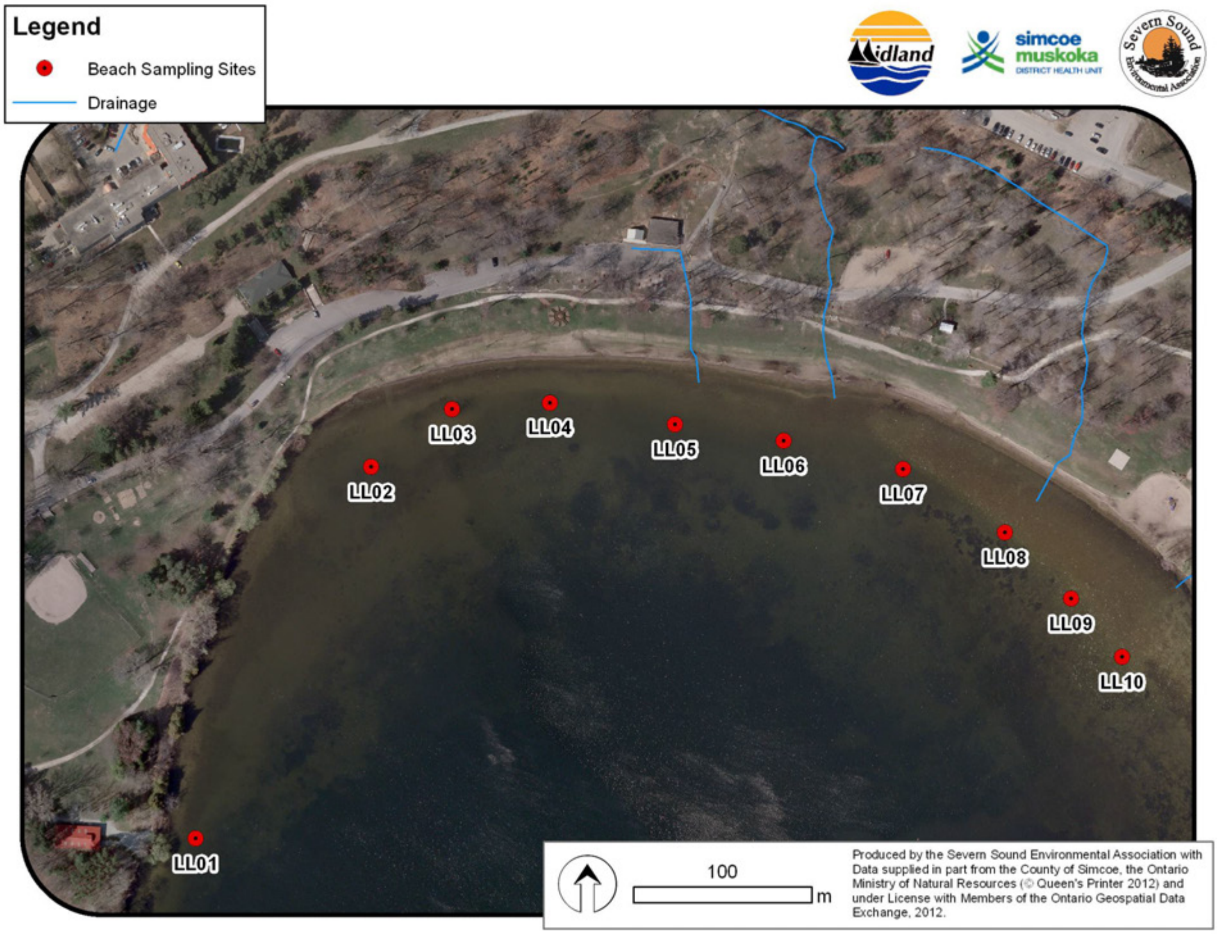

Figure 1. Sampling locations along the north shoreline within Little Lake park.

Variable Depth Sampling

In 2008, supplemental sampling was done four times over the summer at nine stations (rowing club dock station LL01 excluded) to determine what how bacterial densities vary with depth. In addition to routine samples taken at waist depth (1-1.5 m), samples were taken at knee (0.5 m) and ankle (0.15 m) depth in the water (**Figure 2**). Pits were also dug within the swash zone. As defined by Kon et al. (2007), the swash zone is “the portion of the beach face that is alternately being covered by incoming waves and exposed by the backrush.” Holes were dug to the depth of the water table, ensuring that lake water did not enter the hole, and the pore water that filled the pits was sampled.

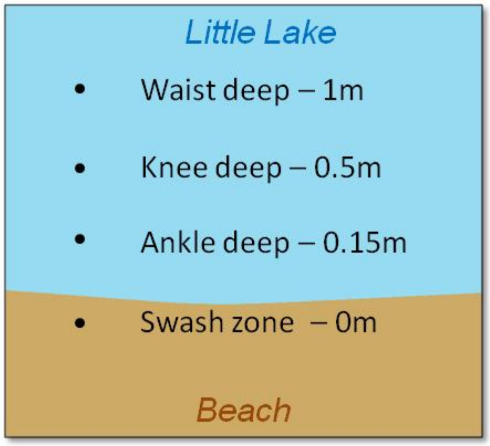

Figure 2. Depths for variable depth sampling done in Little Lake Park in 2008. All four depths were sampled at each station, except for LL01, on four separate dates.

Climate Data

Several data sources were used in modeling climatic influences on beach quality. Water and air temperature were collected on the day of sampling by field personnel. North-south (N-S) wind vectors (i.e. the component of the total wind speed occurring in a north to south direction) were calculated from Environment Canada data obtained from either the Beausoleil Island, Parry Sound or Western Island weather stations, depending on data availability. Overlapping data showed that wind speed and direction at these stations were similar, and measurements were thus assumed to be representative of conditions in Midland. Vectors were averaged from hourly data for the 12 h period prior to beach sampling (approx. 11:00 am). N-S vectors were used as opposed to east-west vectors because the beach is south-facing.

Rainfall data were summarized into three metrics: total rainfall during 24 and 48 h periods prior to sampling, and maximum hourly rainfall intensity during the 24 h period prior to sampling. The majority of the rain data was obtained from a SSEA-operated rain gauge located at the Huronia Airport (2005-2011). Data for 2002-2003 were obtained from a gauge located at Wye Marsh. Data for 2004 and part of 2006 were obtained from an Environment Canada (EC) gauge located at the Midland Wastewater Treatment Plant (WWTP). Following 2006, readings were no longer taken on weekends at the WWTP. Since beach samples were taken on Mondays, rainfall metrics could not be calculated using EC data after 2006, when data from the Airport was unavailable.

Statistical Analysis

Prior to analysis, all data were tested for normality using a Ryan-Joiner test, and were either square root or log transformed if necessary to achieve normality. Rainfall data and bather load required log transformation, however there were values equal to zero. Since a log(0) cannot be calculated, 1 was added to all data points before the transformation was done.

A Mann-Kendall trend test was used to determine whether or not the relative number of guideline exceedances changed over time. Linear regression analysis was used to examine the direct effects of waterfowl abundance and rainfall variables on *E. coli* densities. A Tukey-Kramer test was used to test for differences in bacterial density among sites to determine where the highest densities occur, and among 2-week periods of the sampling season to determine when the highest densities occur. A Tukey-Kramer test was also used to test for differences in bacterial density among the four depths sampled over four dates in 2008. Finally, a stepwise regression model was developed to examine the effect of multiple variables on *E. coli* densities. The modeling process included the following nine variables: waterfowl abundance (both goose only and total bird counts), water and air temperature, N-S wind vector, total rainfall within the previous 24 and 48 h, maximum rainfall intensity within the previous 24 h, and bather load. The F-statistic threshold for a variable to enter the model was set at four. This was the minimum value needed in order for each variable to explain a large enough amount of variation to be considered significant at an alpha level of 0.05.

Results

Over the years, geomeans were frequently above 100 CFU/100 mL at Little Lake Park. This has resulted in numerous beach postings, sometimes for close to or more than half of the swimmable season. The number of exceedances per season has fluctuated over the years, and the percentage of sampling runs where the guideline was exceeded has increased significantly since monitoring began (Mann Kendall test, p=0.008; **Figure 3**).

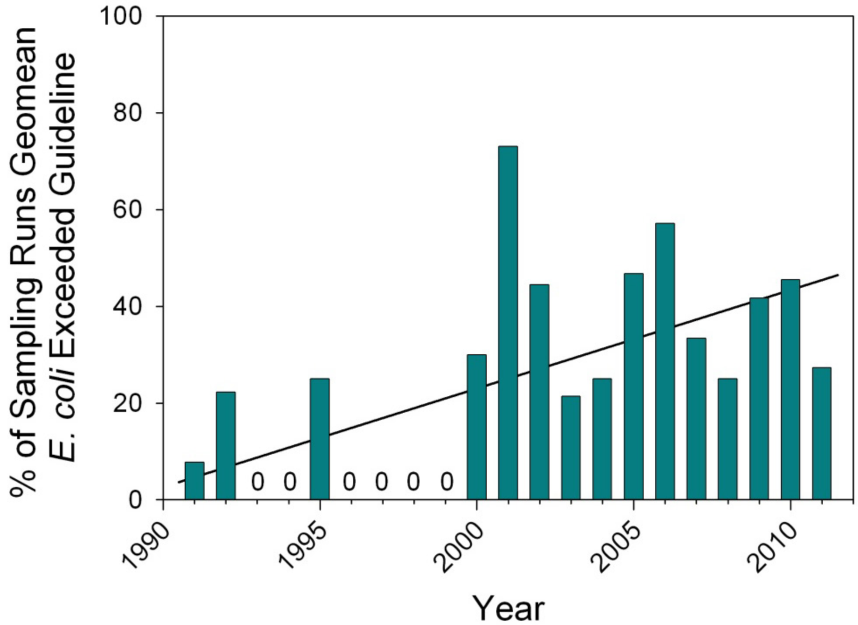

Figure 3. Percentage of sampling runs where geomean *E. coli* exceeded the MOHLTC guideline (100 CFU/100 mL) from 1991-2011.

In order to establish relationships between *E. coli* densities and environmental variables, several data analysis tools were used. First, we examined a plot of goose abundance over the swimmable season for each individual year (**Figure 4**). Visually, this plot shows that the abundance of geese increased dramatically by mid-July or the beginning of August during most years. A Tukey-Kramer test that grouped sample dates in 2 week periods showed that abundance was significantly higher (at $\alpha = 0.05$) in the second half of the season (from the beginning of August onward) than the first half of the season. A similar plot of *E. coli* densities over the season for each individual year shows that, aside from a few high early-season values in 2006 (due to heavy rain events), densities began exceeding guidelines at the beginning of August, and remained elevated for the remainder of the swimming season (**Figure 5**). Similarly to the test for goose abundance, a Tukey-Kramer showed that *E. coli* densities were indeed significantly higher in the second half of the season than the first half of the season.

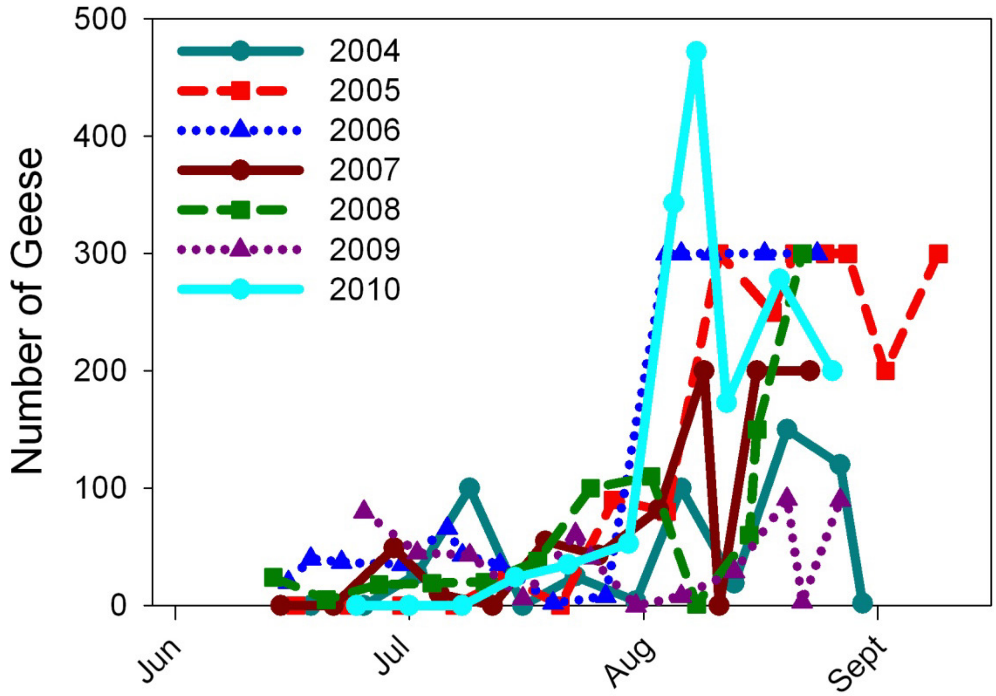

Figure 4. Abundance of Canadian geese observed during beach sampling at Little Lake Park from 2004-2010. Note, abundance data were not available for 2011.

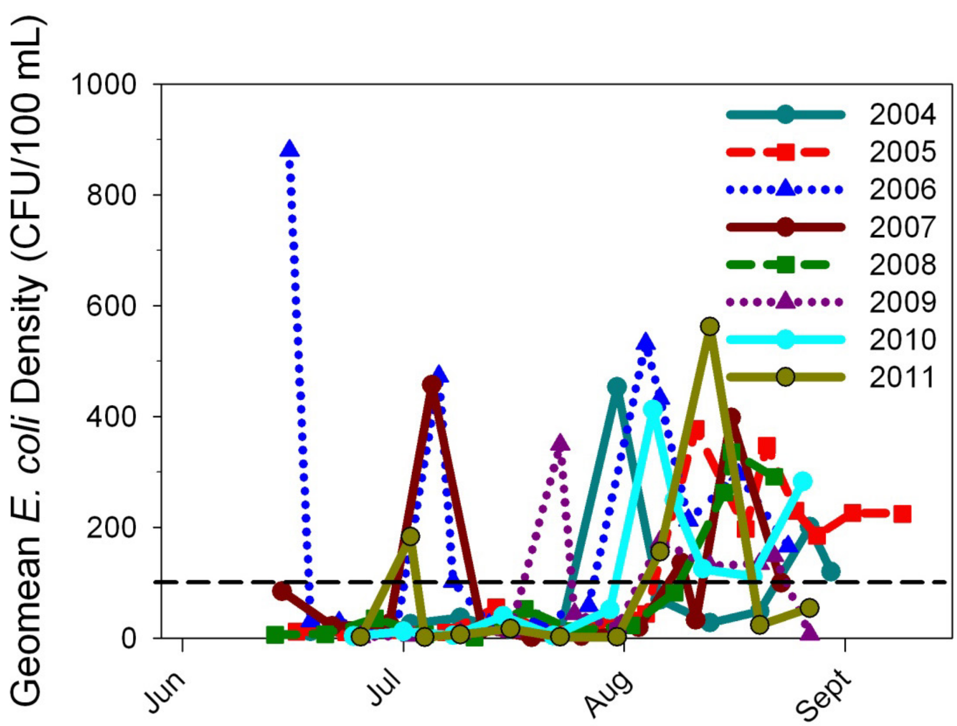

Figure 5. Seasonal geomean *E. coli* densities at Little Lake Park from 2004 to 2011. The dashed line indicates the MOHLTC guideline.

A linear regression of geomean *E. coli* densities and goose numbers using seven years of sampling data shows a significant relationship (p<0.0001, **Figure 6**). Goose counts explained 32% of the variability in *E. coli* density, which is high for data with such high variability. Goose abundance is shown here as opposed to total waterfowl abundance because there is greater potential for management of goose populations. The regression was also performed using total waterfowl abundance, and results were very similar, with a slightly lower correlation coefficient (r^2=0.29, or 29% of the variability explained).

Figure 6. Abundance of geese (square root transformed) versus geomean *E. coli* (log transformed) densities from 2004-2010.

A Tukey-Kramer test on all *E. coli* data points grouped by site showed that bacterial densities were significantly higher at the central sites (LL06 and LL07) than at the rowing club dock (LL01) (**Figure 7**). All other sites were not significantly different from each other. Referring to the sampling map (**Figure 1**), sites LL06 and LL07 correspond to the section of the beach most heavily used by bathers. The outlet for the Little Lake Park storm pond lies between these two sites, and is likely the source of elevated densities.

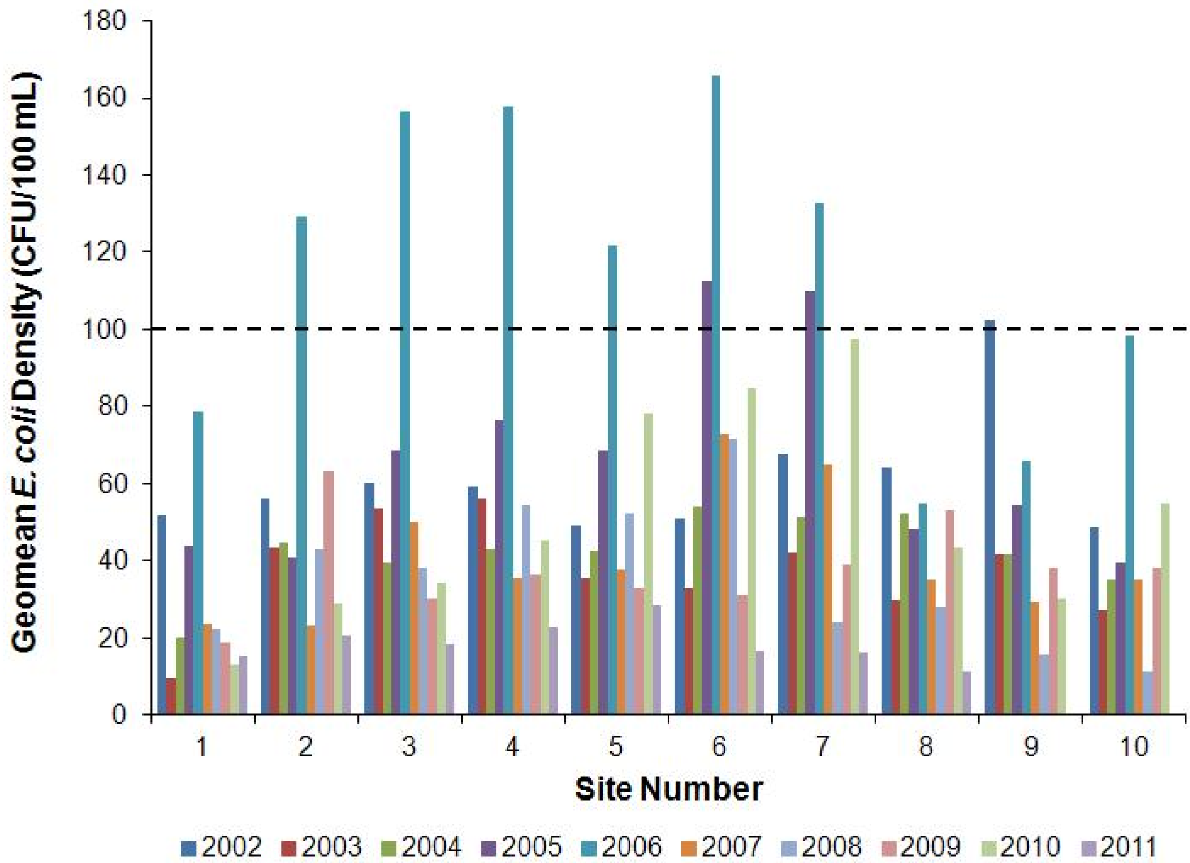

Figure 7. Geomean *E. coli* for each sampling site at Little Lake Park from 2002-11. The dashed line indicates the MOHLTC guideline.

While it is clear that the goose population has an impact on bacterial densities, **Figure 6** shows numerous data points where no geese were observed, yet densities were appreciable. Stepwise regression was used to assess the importance of other environmental variables. In addition to goose abundance, total bird abundance, water and air temperature, N-S wind vector, rainfall within the previous 24 and 48 h, maximum rainfall intensity within the previous 24 h, and bather load were used as predictor variables. The resulting model, shown below in **Equation 1**, indicated that in addition to goose abundance, maximum rainfall intensity within the previous 24 h and total rainfall within the previous 24 h were important in predicting *E. coli* density (**Table 1**). In total, the model explained 49% of the variation in *E. coli* density. An analysis of model residuals (actual-predicted *E. coli* density) showed that the model tended to underestimate actual *E. coli* density (57% of the time) but that the differences were not large (mean residual value was 38 CFU/100 mL). The model failed to predict *E. coli* density over 100 CFU/100 mL only 14% of the time. These results indicate a reasonable model fit. This model will be tested with data collected in future years to further assess its predictive capacity.

Equation 1:

Geomean *E. coli* = 0.96 + 0.08*(sqrt[# GEESE]) + 3*(log[24MAX INTENSITY]) - 2*(log24TOT RAIN)

Table 1. Results from a stepwise regression model using nine predictor variables. Shown in the table are the steps of this modeling process. The model included 68 observations from 10 years of monitoring. Bolded *p* values are statistically significant. Converted to a percentage, the individual variable r^2 values can be interpreted as the amount of additional variation in *E. coli* densities that can be explained by the given predictor variable. For example, in step 3, 24 h total rainfall explains an added 8% of the variation in *E. coli* densities compared to step 2 with goose abundance and rainfall intensity only. Step 3 represents the final model.

Step	Const.	sqrt#**Geese**		log**24MaxIntensity**		log**24TotRain**		Whole Model	
		coefficient	r^2	coefficient	r^2	coefficient	r^2	r^2	*p*
1	1.13	+0.07	0.30					0.30	**<0.001**
2	0.93	+0.08		+0.63	0.11			0.41	**<0.001**
3	0.96	+0.08		+3.00		-2.00	0.08	0.49	**<0.001**

According to the stepwise regression model, rainfall amount is negatively related to *E. coli* densities. That is, as rainfall amount increases, *E. coli* decreases. This is unlikely to be true in reality, and could simply be a result of the modeling process given that the amount of added variability that is explained by rainfall amount is low. Indeed, when examined individually using linear regression, both rainfall intensity and rainfall amount were significantly positively correlated to *E. coli* density, explaining 4 and 5% of the variation in *E. coli* density, respectively (*p*=0.03 for both regressions; **Figure 8**).

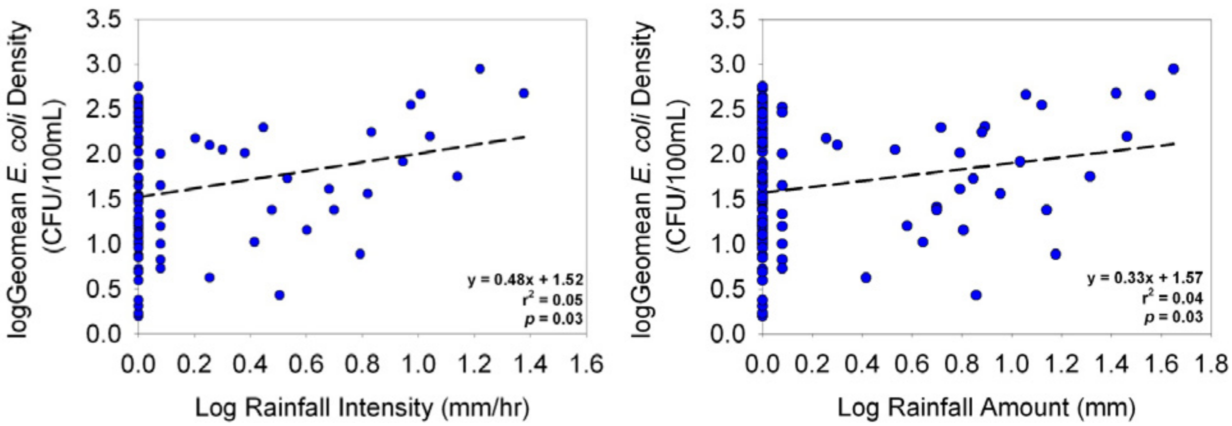

Figure 8. Maximum rainfall intensity (left) and total rainfall amount (right) within the 24 h period prior to sampling versus geomean *E. coli* densities for 2004-2011 at Little Lake Park (all variables log transformed).

In addition to understanding factors related to bacterial levels overall, we also wanted to know at what specific water depths densities were highest. A Tukey-Kramer test showed that over four different sample dates, there were significant differences among four depths sampled, and that densities were highest at the beach-water interface, or swash zone (**Figure 9**). This is where waves run up on shore, and water from lake has an opportunity to mix with any water seeping from the surrounding land. Bacterial densities at ankle depth were significantly greater than knee and waist depth, which were not different from each other.

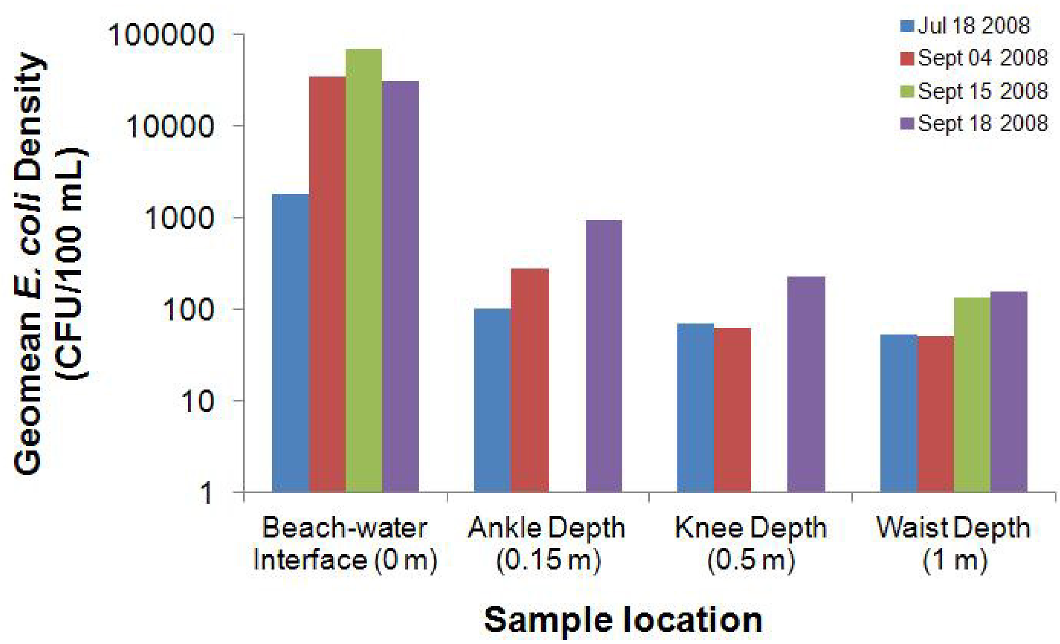

Figure 9. *E. coli* densities in water sampled at four different depths on four separate dates in 2008 in Little Lake Park. Note the Y-axis is shown as a logarithmic scale.

Discussion

The density of *E. coli* at the Little Lake Park beach has frequently exceeded the MOHLTC guideline for recreational beach quality since monitoring began in 1991, and the relative number of exceedances has increased over time. Unfortunately, goose abundance data is only available from 2004-2010, so it is not possible to determine whether an increase in bird abundance may be related to increased guideline exceedances. Examining data since 2004, there does not appear to be an increase in goose abundance. It should be noted that waterfowl counts are approximate, and the accuracy of these data vary with field personnel. There are also no temporal trends in rainfall that may have helped explain the increase in exceedances.

Results show that populations of waterfowl, and Canada Geese in particular, are an important factor in elevated *E. coli* densities. The timing of high bacterial densities coincides with when geese are foraging on the beach in the greatest numbers. Geese finish molting in mid-July, and following this flightless period, they travel with their young between foraging sites (beach area) and roosting sites (wetland opposite the beach) in preparation for the autumn migration. This results in large flocks congregating in the water, on the beach, and on the lawn adjacent to the beach during the height of the swimming season.

The Town has experimented with numerous goose management measures over the past five years. The goal of these measures is to eliminate geese from the park from June-September, and to have no more than 50 individuals at all other times of the year. Beginning in 2007, egg oiling has been used each year to reduce the survival rate of young geese. In 2008-09, the Town tried scare tactics using dogs. Beginning in 2010, birds were relocated to a property in Mallorytown, ON, and garlic spray was used on the grass to discourage grazing. In 2011, a scare pistol was used as well as Meeker's Magic fish compost and overseeding with rye grass as grazing deterrents. Unfortunately, to date, these management measures have not reduced goose abundance during late summer, when numbers can exceed 500 individuals.

In addition to goose abundance, intensity and amount of rainfall within the previous 24 h were also related to *E. coli* densities. Aside from the four inflows from Little Lake wetland, rainfall enters the lake mainly via urban drainage. There are 12 urban drains that discharge to the lake, three of which are outlets of permanent pool stormwater management ponds. One of these stormwater outlets discharges to the middle of the beach, and appears to be acting as a source of bacteria, given that the highest densities occur at the two sites adjacent to the outfall. In addition to providing increased flows during rain events, stormwater ponds elsewhere have been found to act as sources of indicator bacteria like *E. coli* (Hathaway et al. 2009). Residential lot level reduction of bacterial sources, such as pet excrement, will help lower the amount of bacteria delivered to Little Lake via stormwater.

While modeling is a useful exercise in identifying relationships between environmental variables and *E. coli* densities, it often doesn't tell the whole story. The strength of both linear and stepwise regressions were modest at best, as seen by low correlation coefficients, and this is likely due to the fact that *E. coli* can survive in upland soils, beach sand, lake sediment and water longer than previously thought (Ishii et al. 2006 and 2007). Wave action or heavy bather activity can re-suspend sediments back into the water, and result in high readings, even in the absence of recent rainfall and high waterfowl abundance.

Although recent rainfall does not always lead to *E. coli* densities greater than the guideline, it is still important to advise the general public to avoid swimming within 48 h of heavy rainfall. Of the sampling dates when *E. coli* densities were over the guideline, greater than 5 mm of rain fell within the previous 48 h 31% of the time. Additionally, more than 100 birds were present on 69% of the sampling dates when *E. coli* densities were over the guideline. Thus, it may be wise to advise the public to also avoid swimming when large numbers of birds are observed.

Variable depth sampling showed that *E. coli* densities are highest where the waves run up on the beach, and decrease with increasing water depth. This finding is supported by research on beaches in Tiny Township, and on Lakes Huron and Superior (Kon et al. 2007, Ishii et al. 2007). Given these findings, it may be prudent to educate beach users, especially parents whose children play in the swash zone and adjacent shallow waters, that the highest bacteria densities occur in the shallowest waters. A pamphlet for public use would be an excellent way to communicate findings of this report and offer guidance on reducing exposure to potentially harmful bacteria while using the beach at Little Lake Park.

With respect to sampling, it may not be necessary to re-sample when the guideline is exceeded after the beginning of August as long as bird abundances remain high. Data shows that from August onwards, densities remain elevated above the guideline. It would save the Town and SMDHU time and money if a posting was put up at the beginning of August and left for the remainder of the season. Re-samples are still recommended if the guideline is exceeded prior to August.

Summary

While Little Lake Park is an important asset to the Town of Midland and provides excellent recreational opportunities, the beach has chronic issues with high levels of the fecal indicator bacteria *E. coli*. The MOHLTC guideline of 100 CFU/100 mL is frequently exceeded, and the relative number of exceedances each year has increased over time. It was determined that waterfowl abundance, particularly Canada geese, is strongly related to *E. coli* densities. Maximum hourly intensity and amount of rainfall within the previous 24 h are also important factors. The timing of high bacterial densities coincides with when geese and their young are foraging on the beach from August onwards, and *E. coli* densities tend to be highest in the central area of the beach close to a stormwater outlet. In terms of water depth, densities are highest where the waves run up on the beach, and decrease with increasing water depth. In light of these findings, information should be communicated to the public on how to reduce exposure to potentially harmful bacteria.

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Appendices

Appendix A. Details on the calculation of the geometric mean.

Excerpt from the MOHLTC Beach Management Protocol, 1998
Adapted from notes by B. L. Miranda, Water Resources Branch, Ontario Ministry of Environment

Assessment of the bacterial quality of drinking water or bathing water, requires more than a single reading. Because of the uneven distribution of bacteria through a liquid medium, there is no reason to expect that the count of microorganisms in a single "grab sample" represents the average concentration in a lake or well, indeed, an occasional sample may be far above (or below) the average. Accordingly, to get an accurate estimate of the quality of recreational water, the results of a number of samples must be combined in such a way that the occasional unrepresentative sample will not unduly influence the average. For this reason, publications setting bacterial standards for water quality usually require either that a large proportion of the readings, say 90-95%, fall below a certain maximum permissible value, or that the geometric mean of all the samples fall below such a maximum. The Beach Management Protocol for bathing beaches of Ontario uses the latter approach.

The geometric mean, rather than the arithmetic average, is used in these calculations because it reduces the biasing effect of a single high reading. For instance, the arithmetic average of four counts of 10,000, 10,000, 10,000 and 1,000,000 is 257,500, while the geometric mean is about 31,600. In such a case, the single high reading may indicate an accident whose cause should be investigated, but a simple arithmetic average incorporating this reading gives an unrealistic estimate of average conditions.

The formula for the geometric mean G_x is:

$$G_x = {}^x1{}^x2{}^x3........{}^xn;$$

that is, the geometric mean of <u>n</u> readings is the <u>n</u>th root of their product.

This calculation, a cumbersome one in arithmetic terms, can be simplified considerably by means of logarithms (logs), as described below.

<u>Calculating the Geometric Mean</u>

The logarithm of the geometric mean is:

$$\log G_x = \frac{\log x1 + \log x2 + \log x3 + ... + \log xn}{n}$$

that is, to find the log of the geometric mean of a set of readings, add up the logs of all the readings and divide by the number of readings. The geometric mean will then be the antilog of log G_x.

Appendix B. *E. coli* density results, environmental variables, and beach observations in Little Lake, 2002-11. 2011 results provided by the SMDHU.

Data legend:

>100 resample n.d.=no data

2002

	Right Side									Left Side	*E. coli*
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Geomean**
17-Jun-02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
24-Jun-02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
2-Jul-02	40	10	20	20	10	40	10	10	20	20	**17.4**
8-Jul-02	40	70	50	10	20	30	80	20	70	30	**35.1**
15-Jul-02	10	10	10	10	10	10	10	10	10	10	**10.0**
22-Jul-02	20	20	10	20	10	10	20	60	10	10	**15.8**
29-Jul-02	**220**	**110**	**130**	**430**	30	70	60	60	**180**	90	**105.2**
6-Aug-02	10	20	20	50	80	**220**	**630**	**490**	**960**	10	**79.8**
12-Aug-02	80	**840**	60	**110**	**380**	**110**	n.d.	**190**	**130**	90	**151.2**
19-Aug-02	**200**	**170**	**1000**	**1000**	90	**160**	**140**	**470**	**1000**	**450**	**328.2**
26-Aug-02	**250**	**260**	**340**	**240**	90	30	**110**	60	**110**	**160**	**132.5**
29-Aug-02	50	50	50	20	**300**	**120**	**310**	60	**360**	**210**	**102.4**
18-Sep-02	n.d.	30	**140**	70	90	50	n.d.	n.d.	n.d.	n.d.	**66.7**
Geomean	**51.9**	**56.1**	**60.1**	**59.3**	**49.1**	**50.8**	**67.4**	**63.9**	**102.2**	**48.6**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
17-Jun-02	12	17	n.d.	n.d.	n.d.
24-Jun-02	17	22	n.d.	n.d.	n.d.
2-Jul-02	28	25	0	0	-12.35
8-Jul-02	25	24	0	0	-13.29
15-Jul-02	26	26	0	0	7.80
22-Jul-02	28	25	0	0	-20.49
29-Jul-02	26	25	0	0	-7.75
6-Aug-02	16	22	0	0	35.90
12-Aug-02	27	24	0	0	-20.08
19-Aug-02	17	23	0	0	-3.58
26-Aug-02	21	22	0	0	0.72
29-Aug-02	n.d.	n.d.	n.d.	n.d.	n.d.
18-Sep-02	n.d.	n.d.	n.d.	n.d.	n.d.

2003

	Right Side								Left Side	*E. coli*
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Geomean**
16-Jun-03	10	10	10	10	10	30	70	10	**140**	10	**17.7**
23-Jun-03	20	10	10	70	20	20	30	10	10	10	**16.7**
1-Jul-03	10	10	10	10	10	10	10	10	10	10	**10.0**
7-Jul-03	10	20	40	50	30	40	10	10	10	10	**18.5**
14-Jul-03	10	10	10	20	10	30	10	10	10	10	**12.0**
21-Jul-03	10	10	10	40	20	10	60	1	70	10	**14.2**
28-Jul-03	10	20	10	50	50	10	30	10	10	30	**18.4**
5-Aug-03	10	50	**120**	50	50	30	30	50	10	30	**33.9**
11-Aug-03	1	70	**110**	50	10	10	10	10	30	10	**16.1**
13-Aug-03	1	**150**	**290**	80	10	1	30	50	20	20	**21.5**
18-Aug-03	20	30	**150**	80	**160**	**180**	20	**240**	**120**	40	**73.8**
20-Aug-03	1	**840**	**880**	**380**	**460**	**1001**	**1001**	**1001**	**960**	**120**	**329.2**
25-Aug-03	70	**240**	**390**	**340**	**140**	**310**	**400**	**480**	**400**	**540**	**288.6**
27-Aug-03	**130**	**650**	**200**	**110**	**160**	**150**	**190**	**150**	**170**	**270**	**189.1**
Geomean	**9.3**	**43.3**	**53.5**	**56.3**	**35.4**	**33.0**	**41.9**	**29.8**	**41.6**	**27.3**	

Date	**Air Temp. (°C)**	**Water Temp. (°C)**	**Total Rain (mm) (last 24 h)**	**Max Intensity (mm/h) (last 24 h)**	**North-South Wind Vector (km/h)**
16-Jun-03	22	22	0	0	-1.21
23-Jun-03	24	25	0	0	-2.03
1-Jul-03	24	25	0.2	0.2	-0.11
7-Jul-03	24	26	0	0	-2.62
14-Jul-03	24	23	0	0	-3.00
21-Jul-03	21	20.9	5.4	3	1.69
28-Jul-03	23	23	0	0	1.73
5-Aug-03	23	25	0	0	0.71
11-Aug-03	26	26	0	0	2.56
13-Aug-03	23	24.6	0.2	0.2	0.12
18-Aug-03	23	24.6	0	0	0.60
20-Aug-03	27	24.1	0.2	0	-1.45
25-Aug-03	21	21.8	0.2	0	0.23
27-Aug-03	21	21.4	0	0	3.89

2004

	Right Side									Left Side	*E. coli*
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Geomean**
21-Jun-04	30	10	10	10	10	10	10	40	10	10	**12.8**
28-Jun-04	10	10	10	10	10	10	10	10	10	10	**10.0**
5-Jul-04	50	10	10	10	10	70	**110**	20	30	50	**25.5**
12-Jul-04	10	80	10	60	20	10	60	**1000**	30	30	**37.3**
19-Jul-04	10	30	20	30	20	30	10	10	10	10	**16.0**
26-Jul-04	10	10	30	10	10	10	10	10	10	10	**11.2**
3-Aug-04	10	**740**	**320**	**360**	**1000**	**1000**	**1000**	**1000**	**1000**	**430**	**453.3**
9-Aug-04	40	60	40	**200**	**160**	**110**	**200**	80	50	10	**69.7**
16-Aug-04	10	10	30	40	60	**140**	20	20	20	40	**28.2**
23-Aug-04	20	20	80	20	10	40	50	50	**470**	**270**	**49.1**
30-Aug-04	**180**	**310**	**320**	**190**	**290**	**250**	**260**	**160**	90	**120**	**201.5**
2-Sep-04	20	**1000**	**250**	**200**	**320**	**180**	**100**	40	70	40	**120.5**
13-Sep-04*	10	**200**	**270**	60	50	**170**	60	70	80	**300**	**88.0**
Geomean	**19.0**	**50.3**	**45.9**	**44.1**	**43.1**	**58.7**	**52.1**	**53.4**	**43.7**	**41.3**	

*sample was analyzed by the Central Ontario Analytical Laboratory in Orillia

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
21-Jun-04	21	20.5	0	n.d.	-6.70
28-Jun-04	19	20.5	0.2	n.d.	-2.96
5-Jul-04	15	22.1	4	n.d.	-11.42
12-Jul-04	25	26	0	n.d.	-0.04
19-Jul-04	23	26	2.8	n.d.	-1.34
26-Jul-04	20	22	0	n.d.	0.56
3-Aug-04	24	24	35	n.d.	-5.26
9-Aug-04	25	22	0	n.d.	-3.70
16-Aug-04	24	21	0	n.d.	-0.08
23-Aug-04	23	19	0	n.d.	n.d.
30-Aug-04	20	21	6.8	n.d.	n.d.
2-Sep-04	14	20	0	n.d.	n.d.
13-Sep-04	n.d.	n.d.	n.d.	n.d.	n.d.

	Bird Counts		
Date	Geese	Gulls	Ducks
21-Jun-04	0	100	0
28-Jun-04	0	13	0
5-Jul-04	27	10	0
12-Jul-04	100	100	0
19-Jul-04	0	15	0
26-Jul-04	25	25	0
3-Aug-04	4	20	0
9-Aug-04	100	25	0
16-Aug-04	19	6	0
23-Aug-04	150	50	0
30-Aug-04	120	0	1
2-Sep-04	2	6	0
13-Sep-04	n.d.	n.d.	n.d.

2005

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
20-Jun-05	10	10	20	10	10	20	10	10	20	10	**12.3**
27-Jun-05	10	20	10	10	10	10	10	10	10	10	**10.7**
4-Jul-05	30	10	10	10	20	30	30	10	10	10	**14.9**
11-Jul-05	10	20	40	30	20	20	10	1	20	1	**10.7**
18-Jul-05	**120**	**130**	40	30	10	**130**	**110**	10	**100**	**110**	**55.8**
25-Jul-05	1	10	10	10	20	20	20	20	10	10	**10.5**
1-Aug-05	50	20	9	90	20	40	30	10	30	10	**23.8**
8-Aug-05	30	1	60	80	60	**140**	**240**	50	n.d.	n.d.	**44.2**
15-Aug-05	50	20	**1001**	**1001**	**1001**	**1001**	**1001**	**1001**	60	**1001**	**378.5**
22-Aug-05	60	**170**	**370**	**250**	**470**	**440**	**530**	**140**	90	70	**197.7**
25-Aug-05	**220**	**200**	**150**	**340**	**820**	**520**	**170**	**600**	**580**	**460**	**348.0**
29-Aug-05	**260**	**130**	**170**	**190**	**130**	**150**	**300**	**380**	**520**	**330**	**230.1**
1-Sep-05	**190**	**140**	**620**	**410**	**130**	**250**	**380**	**160**	90	40	**185.4**
6-Sep-05	**400**	**110**	**230**	**110**	**140**	**480**	**760**	**260**	**110**	**220**	**226.6**
13-Sep-05	60	**980**	**150**	**390**	**400**	**830**	**1100**	**130**	**100**	20	**224.6**
Geomean	**43.8**	**40.7**	**68.6**	**76.6**	**68.6**	**112.7**	**109.8**	**48.1**	**54.3**	**39.2**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
20-Jun-05	21.5	20	0	0	-4.63
27-Jun-05	25.6	26	0	0	-2.55
4-Jul-05	26.4	24	0	0	n.d.
11-Jul-05	26.1	27	0	0	-1.05
18-Jul-05	26.3	29	19.6	12.8	-9.44
25-Jul-05	25.9	24	3.4	1.6	-0.84
1-Aug-05	24.6	25	12.8	4	-4.61
8-Aug-05	24.6	25	0	0	-1.78
15-Aug-05	26.3	24	0	0	2.72
22-Aug-05	18.3	20	4.2	1.8	n.d.
25-Aug-05	20	21	0	0	n.d.
29-Aug-05	26.1	23.5	0	0	n.d.
1-Sep-05	24	23.2	0	0	n.d.

6-Sep-05	24.3	20.5	0	0	n.d.
13-Sep-05	26	21.5	0	0	n.d.

	Bird Counts		
Date	**Geese**	**Gulls**	**Ducks**
20-Jun-05	0	1	0
27-Jun-05	0	15	0
4-Jul-05	0	9	0
11-Jul-05	0	11	0
18-Jul-05	24	6	0
25-Jul-05	0	4	8
1-Aug-05	90	10	0
8-Aug-05	80	20	0
15-Aug-05	>300	0	0
22-Aug-05	230	20	0
25-Aug-05	>300	20	0
29-Aug-05	>300	20	12
1-Sep-05	80	14	0
6-Sep-05	200	12	0
13-Sep-05	>300	10	0

2006

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
19-Jun-06	**280**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**880.5**
22-Jun-06	10	70	70	90	20	40	40	30	10	20	**31.1**
26-Jun-06	10	**120**	**100**	80	20	10	70	10	10	30	**28.9**
4-Jul-06	30	10	10	10	20	10	40	40	10	10	**15.8**
10-Jul-06	**420**	**1001**	**1001**	**880**	**850**	**1001**	**800**	10	n.d.	n.d.	**473.4**
12-Jul-06	60	90	20	**140**	**100**	**150**	**270**	**180**	**190**	60	**102.3**
17-Jul-06	20	30	50	10	20	10	10	30	20	**240**	**24.8**
24-Jul-06	30	30	**100**	50	40	90	50	10	10	10	**31.0**
31-Jul-06	50	60	60	**130**	50	**100**	40	30	n.d.	n.d.	**58.7**
8-Aug-06	**1001**	**1001**	**1001**	**1001**	**630**	**1001**	**340**	30	n.d.	n.d.	**532.4**
10-Aug-06	**240**	**100**	**550**	**380**	**800**	**1001**	**1001**	**230**	420	600	**433.3**
14-Aug-06	**530**	**310**	**370**	**450**	**1001**	**1001**	80	30	50	60	**213.6**
21-Aug-06	**140**	**200**	**330**	**410**	**190**	**1001**	**280**	**270**	**230**	**410**	**295.8**
28-Aug-06	30	**140**	**190**	**150**	60	**220**	**140**	**200**	**560**	**660**	**166.5**
Geomean	**78.5**	**129.0**	**156.7**	**158.1**	**121.7**	**165.9**	**132.5**	**54.7**	**66.0**	**98.4**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
19-Jun-06	26	23.5	43.6	15.6	n.d.
22-Jun-06	23	23	0	0	-18.05
26-Jun-06	25.6	24	0	0	5.74
4-Jul-06	20.5	24	0.2	0.2	-14.07
10-Jul-06	20.5	23.5	25.2	22.8	-11.42
12-Jul-06	20.5	24.3	5.2	1.4	-0.11
17-Jul-06	26.2	27	0	n.d.	-17.43
24-Jul-06	23.5	23.5	0	n.d.	-13.11
31-Jul-06	24.8	25	0	n.d.	-11.54
8-Aug-06	18.6	24.5	0	n.d.	20.44
10-Aug-06	24.5	23.8	0	n.d.	11.21
14-Aug-06	20.2	22	0	n.d.	-27.75
21-Aug-06	19.5	23	0	n.d.	7.81
28-Aug-06	22	21.5	0	n.d.	0.36

		Bird Counts		
Date	**Water Clarity**	**Geese**	**Gulls**	**Ducks**
19-Jun-06	clear	20	3	38
22-Jun-06	clear	40	8	22
26-Jun-06	clear	37	9	0
4-Jul-06	clear	35	33	0
10-Jul-06	clear	66	12	0
12-Jul-06	clear	43	43	0
17-Jul-06	clear	35	32	0
24-Jul-06	clear	2	0	0
31-Jul-06	clear	8	4	0
8-Aug-06	clear	>300	4	0
10-Aug-06	clear	>300	12	20
14-Aug-06	murky	>300	20	0
21-Aug-06	murky	>300	45	2
28-Aug-06	clear	>300	10	12

2007

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
18-Jun-07	**120**	**150**	**430**	**390**	**200**	**110**	50	30	20	10	**85.1**
25-Jun-07	50	10	20	20	30	30	40	60	1	60	**21.9**
3-Jul-07	1	**190**	**150**	**110**	**150**	70	**160**	30	1	1	**26.3**
9-Jul-07	40	**1001**	**1001**	**1001**	**1001**	**1001**	**1001**	10	**1001**	**1001**	**457.7**
16-Jul-07	20	1	40	20	10	10	20	**110**	30	30	**17.8**
23-Jul-07	1	1	1	1	1	10	1	10	1	1	**1.6**
30-Jul-07	10	1	30	10	10	30	1	1	1	1	**3.9**
7-Aug-07	10	50	50	10	30	30	30	1	30	40	**19.5**
13-Aug-07	**220**	**100**	**150**	**210**	**170**	**220**	**160**	50	70	**150**	**136.1**
15-Aug-07	10	1	1	1	1	**150**	**1000**	**1000**	**1000**	**1000**	**32.9**
20-Aug-07	**170**	**300**	**520**	**350**	**230**	**270**	**970**	**690**	**1000**	**260**	**398.2**
27-Aug-07	**150**	50	40	30	80	**120**	**190**	**160**	**310**	**130**	**100.6**
Geomean	**23.4**	**23.0**	**50.0**	**35.3**	**37.8**	**72.8**	**65.0**	**34.9**	**29.2**	**35.2**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
18-Jun-07	20.1	21	n.d.	n.d.	-4.43
25-Jun-07	22.3	18	n.d.	n.d.	-1.84
3-Jul-07	18.6	18.5	n.d.	n.d.	-1.87
9-Jul-07	26	22	10.4	9.2	-3.39
16-Jul-07	17.7	17.5	0	0	-3.23
23-Jul-07	21.1	20	0	0	-0.99
30-Jul-07	19.8	21	0	0	0.17
7-Aug-07	21.7	21.5	0	0	-3.68
13-Aug-07	22	20	0	0	5.36
15-Aug-07	18.9	19	0	0	3.33
20-Aug-07	14.4	17	0	0	-0.23
27-Aug-07	20.9	19	0.2	0.2	-1.95

		Bird Counts		
Date	**Water Clarity**	**Geese**	**Gulls**	**Ducks**
18-Jun-07	clear	0	4	0
25-Jun-07	clear	0	12	0
3-Jul-07	clear	49	8	0
9-Jul-07	murky	10	9	0
16-Jul-07	clear	0	0	0
23-Jul-07	clear	55	20	0
30-Jul-07	clear	43	18	0
7-Aug-07	murky	82	35	6
13-Aug-07	clear	>200	30	0
15-Aug-07	clear	0	20	7
20-Aug-07	clear	>200	50	0
27-Aug-07	clear	>200	20	5

2008

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
16-Jun-08	1	10	10	10	10	20	30	30	1	1	**6.7**
23-Jun-08	20	30	30	1	20	20	10	10	1	1	**7.7**
30-Jun-08	50	20	10	10	20	90	30	70	**130**	80	**36.3**
7-Jul-08	10	1	10	40	10	70	10	20	1	1	**7.5**
14-Jul-08	1	1	1	10	1	1	1	1	20	1	**1.7**
21-Jul-08	20	**200**	**230**	**1001**	**1001**	**1001**	10	1	1	20	**53.3**
28-Jul-08	1	10	10	50	10	10	10	30	30	40	**13.4**
5-Aug-08	**340**	**260**	90	**180**	**260**	**160**	1	1	1	1	**23.9**
11-Aug-08	30	50	**120**	**130**	**210**	70	**100**	90	90	50	**82.1**
18-Aug-08	**160**	**340**	**140**	**150**	**430**	**1001**	**1001**	**1001**	**160**	20	**262.9**
19-Aug-08	60	**1001**	**1001**	**1001**	**540**	**480**	**270**	**350**	**180**	70	**336.4**
25-Aug-08	**760**	**750**	90	**100**	80	**130**	**140**	**600**	**1000**	**1000**	**291.8**
Geomean	**22.3**	**43.0**	**38.1**	**54.6**	**52.2**	**71.4**	**23.9**	**28.1**	**15.6**	**11.3**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
16-Jun-08	17	23	0.2	0.2	-3.85
23-Jun-08	22	22	14	5.2	-2.43
30-Jun-08	16	24	8	5.6	-1.26
7-Jul-08	23	25	0	0	-6.00
14-Jul-08	26	23	0	0	-3.77
21-Jul-08	14	22	6	2.4	-0.42
28-Jul-08	21	19	0	0	-3.26
5-Aug-08	24	23	0	0	-3.00
11-Aug-08	16	19	9.8	7.8	6.61
18-Aug-08	24	21	0	0	-7.93
19-Aug-08	14	19	0	0	6.17
25-Aug-08	15	21	0	0	9.30

		Bird Counts		
Date	**Water Clarity**	**Geese**	**Gulls**	**Ducks**
16-Jun-08	clear	24	6	2
23-Jun-08	clear	5	10	0
30-Jun-08	clear	18	21	0
7-Jul-08	clear	19	40	0
14-Jul-08	clear	20	34	0
21-Jul-08	murky	38	36	0
28-Jul-08	clear	100	18	0
5-Aug-08	clear	110	32	5
11-Aug-08	clear	1	43	5
18-Aug-08	clear	60	63	0
19-Aug-08	clear	150	66	1
25-Aug-08	clear	>300	20	0

2009

Date	Right Side 1	2	3	4	5	6.00	7	8	9	Left Side 10	*E. coli* Geomean
29-Jun-09	1	10	10	10	1	1.00	20	1	1	1	**2.7**
6-Jul-09	10	40	1	1	10	n.d.	n.d.	n.d.	n.d.	n.d.	**5.3**
13-Jul-09	1	**100**	20	10	10	1.00	1	20	30	30	**9.0**
20-Jul-09	10	40	1	40	10	10.00	30	10	20	10	**12.5**
27-Jul-09	**1000**	**1000**	**1000**	**110**	90	40.00	70	**1000**	**1000**	**1000**	**350.2**
29-Jul-09	80	**250**	**280**	**280**	80	40.00	20	30	1	10	**44.4**
4-Aug-09	10	10	1	**100**	70	**190.00**	**110**	60	10	1	**19.7**
10-Aug-09	30	**110**	**110**	60	**190**	**270.00**	**540**	**200**	**320**	**680**	**174.6**
17-Aug-09	90	**100**	**200**	**160**	**440**	**150.00**	**140**	**230**	40	60	**130.8**
24-Aug-09	**100**	**430**	**540**	**490**	10	**110.00**	70	**140**	**110**	**150**	**135.1**
26-Aug-09	10	**210**	90	90	**200**	**100.00**	**640**	**200**	**350**	**360**	**149.3**
31-Aug-09	10	1	10	1	20	20.00	1	20	80	n.d.	**7.4**
Geomean	**19.0**	**63.1**	**30.3**	**36.3**	**33.0**	**31.2**	**38.9**	**53.0**	**38.0**	**38.2**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
29-Jun-09	22.8	21.8	6.2	2.2	-4.89
6-Jul-09	20.7	20.7	0	0	n.d.
13-Jul-09	20.3	21.5	0	0	n.d.
20-Jul-09	22.6	22.7	0	0	-9.78
27-Jul-09	22.1	22.2	12.2	8.4	-6.45
29-Jul-09	21.1	22.1	0.2	0.2	-7.62
4-Aug-09	22.9	23	0	0	-27.05
10-Aug-09	23.2	23.6	6.6	5.8	-3.07
17-Aug-09	26.8	27	0	0	-20.67
24-Aug-09	23.2	23.2	0	0	7.25
26-Aug-09	22.3	22.3	0.8	0.6	24.67
31-Aug-09	22.3	19.8	0	0	n.d.

		Bird Counts		
Date	**Water Clarity**	**Geese**	**Gulls**	**Ducks**
29-Jun-09	clear	80	10	0
6-Jul-09	clear	45	10	0
13-Jul-09	clear	43	27	0
20-Jul-09	clear	6	27	0
27-Jul-09	clear	61	12	0
29-Jul-09	clear	41	6	0
4-Aug-09	clear	0	16	0
10-Aug-09	clear	8	13	0
17-Aug-09	clear	29	55	0
24-Aug-09	clear	91	16	0
26-Aug-09	clear	3	4	1
31-Aug-09	clear	>90	4	0

2010

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
28-Jun-10	30	1	1	1	10	30	20	1	1	10	**4.2**
5-Jul-10	10	10	1	20	30	10	30	10	30	20	**12.7**
12-Jul-10	10	1	40	1	10	10	10	1	1	50	**5.4**
19-Jul-10	1	40	40	**150**	**100**	70	**130**	70	20	40	**40.6**
26-Jul-10	1	1	1	1	10	10	40	20	10	10	**4.9**
3-Aug-10	90	**500**	**430**	**410**	**310**	**140**	40	10	1	1	**51.7**
9-Aug-10	70	**270**	**170**	**210**	**300**	**700**	**1001**	**1001**	**1001**	**1001**	**412.4**
12-Aug-10	50	90	**160**	**360**	**1001**	**1001**	**910**	**240**	**410**	40	**249.4**
16-Aug-10	20	40	**110**	**210**	70	**120**	**320**	**260**	**200**	**370**	**125.3**
23-Aug-10	**110**	**200**	**130**	**150**	90	**120**	40	**150**	50	**220**	**111.8**
30-Aug-10	1	**310**	**290**	**550**	**380**	**540**	**530**	**820**	**740**	**1001**	**282.8**
Geomean	**13.2**	**29.0**	**34.3**	**45.2**	**78.2**	**84.7**	**97.7**	**43.6**	**30.1**	**54.7**	

Date	Air Temp. (°C)	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
28-Jun-10	25	21	1.6	0.8	-3.80
5-Jul-10	30	24	0	0	-10.15
12-Jul-10	23	26	0.2	0.2	-4.68
19-Jul-10	23	25	5.2	3.8	4.20
26-Jul-10	26	25	0	0	0.55
3-Aug-10	30	26	0	0	-5.80
9-Aug-10	27	24	0	0	-0.69
12-Aug-10	24	25	0	0	0.47
16-Aug-10	24	25	1	0.8	-4.05
23-Aug-10	25	22	2.4	1	5.83
30-Aug-10	30	24	0	0	0.37

		Bird Counts				
Date	**Water Clarity**	**Geese**	**Gulls**	**Ducks**	**Swans**	**Other**
28-Jun-10	clear	0	40	0	0	4
5-Jul-10	clear	0	40	0	0	0
12-Jul-10	clear	0	15	0	0	0
19-Jul-10	clear	24	0	0	0	0
26-Jul-10	clear	35	30	0	0	0
3-Aug-10	clear	53	2	0	0	0
9-Aug-10	clear	343	12	0	0	0
12-Aug-10	clear	472	23	5	0	0
16-Aug-10	clear	173	31	3	0	0
23-Aug-10	clear	278	10	0	0	0
30-Aug-10	clear	200	30	0	0	0

2011

Date	Right Side 1	2	3	4	5	6	7	8	9	Left Side 10	*E. coli* Geomean
29-Jun-11	1	10	10	1	1	10	1	1	n.d.	n.d.	**2.4**
6-Jul-11	**120**	**150**	**200**	90	**180**	**480**	**230**	**200**	n.d.	n.d.	**183.5**
8-Jul-11	10	1	1	30	1	1	1	1	n.d.	n.d.	**2.0**
13-Jul-11	10	10	10	30	20	1	10	1	n.d.	n.d.	**7.0**
20-Jul-11	30	30	30	30	30	30	1	10	n.d.	n.d.	**17.1**
27-Jul-11	1	10	1	1	10	1	10	1	n.d.	n.d.	**2.4**
4-Aug-11	1	1	1	1	40	1	1	20	n.d.	n.d.	**2.3**
10-Aug-11	**190**	**150**	**210**	**140**	**150**	**100**	**150**	**190**	n.d.	n.d.	**156.4**
17-Aug-11	50	**470**	**1000**	**1000**	**780**	**840**	**1000**	**650**	n.d.	n.d.	**562.4**
24-Aug-11	40	30	20	30	20	80	90	1	n.d.	n.d.	**23.8**
31-Aug-11	80	30	30	80	90	30	70	70	n.d.	n.d.	**54.4**
Geomean	**15.3**	**20.6**	**18.3**	**22.7**	**28.2**	**16.7**	**16.3**	**11.2**			

Date	Air Temp. (°C)*	Water Temp. (°C)	Total Rain (mm) (last 24 h)	Max Intensity (mm/h) (last 24 h)	North-South Wind Vector (km/h)
29-Jun-11	10.71	n.d.	0	0	4.54
6-Jul-11	17.73	n.d.	134	116	-2.07
8-Jul-11	20.97	n.d.	0	0	0.04
13-Jul-11	18.86	n.d.	0	0	4.46
20-Jul-11	22.46	n.d.	0	0	-4.48
27-Jul-11	20.64	n.d.	0	0	1.21
4-Aug-11	20.64	n.d.	n.d.	n.d.	1.07
10-Aug-11	16.31	n.d.	28	10	-0.44
17-Aug-11	15.83	n.d.	0	0	-2.94
24-Aug-11	17.09	n.d.	4	2	-10.45
31-Aug-11	18.54	n.d.	0	0	n.d.

*data from a SSEA temperature logger installed at the Huronia Airport

Appendix C. Percentage of samples that exceeded the MOHLTC guideline from 1991-2011 in Little Lake. Raw bacteria count data from 1991-2001 could not be located, however reports provided the summary information below.

Year	Samples Exceeding Guideline	Total Number of Samples	% Over Guideline
1991	1	13	8
1992	2	9	22
1993	0	10	0
1994	0	6	0
1995	1	4	25
1996	0	4	0
1997	0	5	0
1998	0	10	0
1999	0	9	0
2000	3	10	30
2001			73
2002	4	9	44
2003	3	14	21
2004	3	12	25
2005	7	15	47
2006	8	14	57
2007	4	12	33
2008	3	12	25
2009	5	12	42
2010	5	11	45
2011	3	11	27

Appendix D. *E. coli* counts (CFU/100 mL) and geomeans from variable depth sampling done in 2008 at Little Lake Park.

		Depth			
Date	**Station**	**Swash Zone (0 m)**	**Ankle (0.15 m)**	**Knee (0.5 m)**	**Waist (1-1.5 m)**
18-Jul-08	LL2	200	42	25	14
	LL3	4400	22	28	64
	LL4	3000	90	162	72
	LL5	30000	64	138	60
	LL6	50000	400	88	60
	LL7	2600	300	86	148
	LL8	210	130	200	146
	LL9	100	300	10	30
	LL10	1200	58	200	24
	Geomean	**1855**	**104**	**71**	**54**
4-Sep-08	LL2	50000	800	44	20
	LL3	70000	300	100	28
	LL4	40000	100	52	56
	LL5	30000	136	84	72
	LL6	50000	300	56	64
	LL7	60000	600	60	68
	LL8	70000	500	52	64
	LL9	30000	96	80	88
	LL10	3800	408	60	40
	Geomean	**35960**	**283**	**63**	**51**
15-Sep-08	LL2	190000	n.d.	n.d.	336
	LL3	27000	n.d.	n.d.	90
	LL4	300000	n.d.	n.d.	164
	LL5	200000	n.d.	n.d.	196
	LL6	120000	n.d.	n.d.	80
	LL7	35000	n.d.	n.d.	100
	LL8	33000	n.d.	n.d.	240
	LL9	300000	n.d.	n.d.	40
	LL10	4000	n.d.	n.d.	196
	Geomean	**71875**			**135**
18-Sep-08	LL2	1700	2300	272	176
	LL3	14000	900	320	172

LL4	300000	1300	236	148
LL5	300000	1100	212	192
LL6	85000	800	356	216
LL7	37000	2300	276	188
LL8	15000	438	216	136
LL9	200000	188	128	92
LL10	1500	1500	160	136
Geomean	**31475**	**957**	**231**	**157**