Evaluation of Risk from Houseboat Greywater discharges to Recreational Water Users on Shuswap Lake Beaches

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Introduction

Houseboats have been gaining popularity in recent years in British Columbia. Shuswap Lake accommodates the highest houseboat numbers on an inland waterbody in the Province, which earned Sicamous the name "Houseboat Capital of the World". Most houseboats used on the lake during the summer are rental boats that provide running water in fully equipped kitchens and bathrooms (toilet, shower, sink). All rental boats prevent blackwater (toilet wastewater) from entering the lake by collecting it in onboard tanks that are pumped out into land based sewage systems after each journey. However, very few boats provide the same for household greywater (kitchen and bathroom sinks, showers, bath tubs). The greywater of most boats is directly discharged into Shuswap Lake, although provincial legislation prohibits the discharge of greywater into inland waters.

With the high houseboat densities in Shuswap Lake and large numbers of boats docking at BC Parks Beaches, such as Nielson Beach, Marble Point and Hungry Cove, there is concern that greywater discharges, particularly from showers, may result in a health risk for swimmers. This concern is supported by various studies (Casanova et al, 2001; Rose et al, 1991; Birks et al, 2004) that show persistence of pathogens in greywater and fecal bacteria concentrations close to those in untreated sewage.

Study Objective

- **Identify whether Provincial and Canada wide health guidelines for recreation are exceeded near BC Parks Beaches at which houseboats overnight frequently.**
- **Evaluate whether these exceedances are likely due to boat greywater discharges adjacent to these beaches.**

Please note that although real controls exist only in laboratory environments (and not in this study), the word ‘control’ has been used interchangeably with ‘reference sites’ in some of the tables of this document.

Study Description and Methods

Correspondence with BC Parks staff and houseboat companies as well as a pilot study in 2008 indicated that the highest densities of beached houseboats in Shuswap Lake occurred in July and August at Nielson Beach, Marble Point and Hungry Cove (popular beaches of BC Marine Parks). In comparison, houseboat rentals are practically none-existent from October to March.

In 2009, weekly water samples were collected over a five week period in July and August (test period) and again in October and November (reference period) at each of the above beaches and three similar reference sites that were not suitable for houseboat beaching (Figure 1). At each beach (test and reference), surface samples were taken near shore in 1m deep water and about 30-70m offshore in 20m deep water to reflect water potentially used by swimmers. At the test beaches, samples were collected in the centre of the cluster of parked boats as well as 50m up- and 50m down-beach from this site. Due to the low numbers of boats at Marble Point, sample sites were reduced to mid beach only for four of five sample events. A duplicate sample of pure greywater was also gathered from a houseboat with a greywater tank. During each sampling event, weather observations, surface water temperature, number

of houseboats per beach and presence of birds or other potentially influencing factors were noted. In addition, BC Parks provided numbers of houseboats per beach on each day of July and August.

Water samples were analysed for bacteria that live in the intestinal tract of warm blooded animals (fecal coliforms, E.coli, and bacteriodes) and that are thus indicators of animal or human fecal contamination. Those samples with high bacteria concentrations were tested further for the presence of musks (fragrances of personal care products of which some are endocrine disruptors) as a tracer of greywater in the lake. In addition, a bacteria source tracking technique was employed to identify the host of fecal indicator bacteria. The method was developed and adapted from the published articles by Dr. Katharine Field (Oregon State University) (Field et al, 2003) and is a genetic assay that detects 16-S ribosomal genomic DNA from the host-specific intestinal bacterial group *Bacteroides*. So far, detection for the following host species has been developed: Human, ruminant, dog, pig, elk, and horse. For this study the method was employed for samples with high fecal coliform or E.coli levels from August 05 to August 19, 2009.

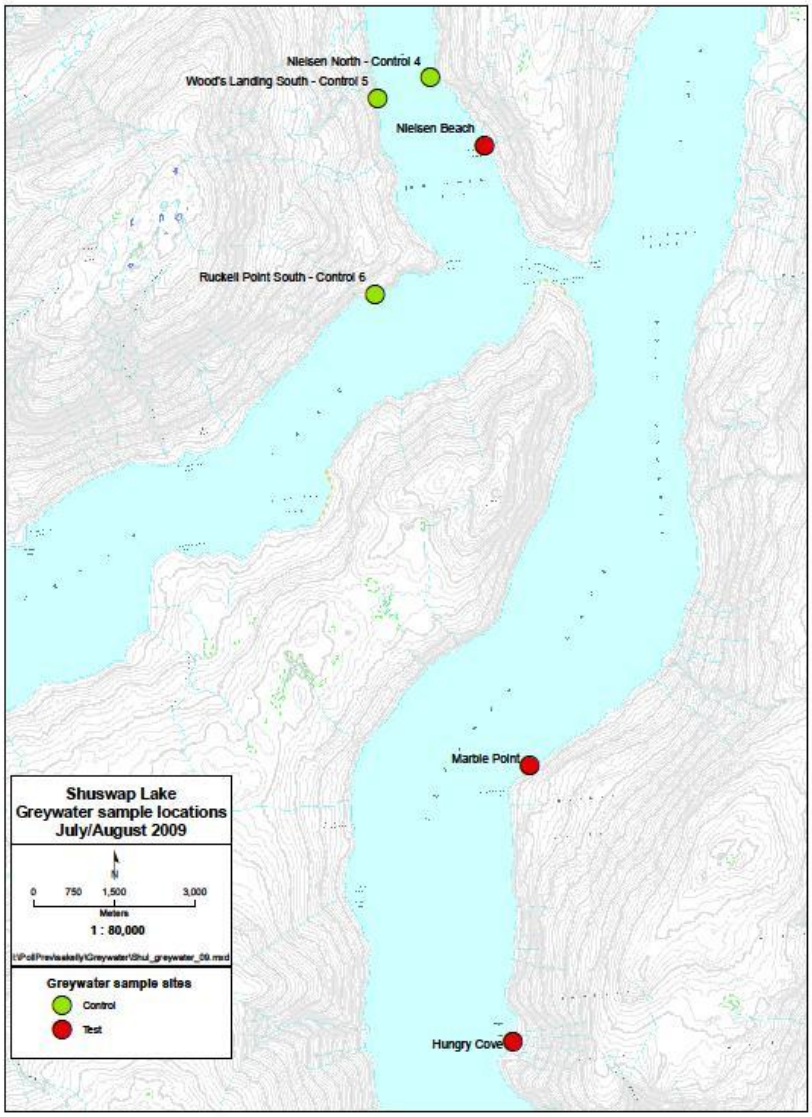

Figure 1: 2009 Sample Sites

Two logistic regression models were defined to model the association of E.coli and fecal coliform presence with potentially influential variables of interest. These variables include: Number of houseboats on a sample beach, water temperature, and test versus reference sites. The wildlife and waterfowl observations were too sporadic to be useful in a statistical test.

This method was chosen to accommodate the high number of analysis results below the detection level as recommended by Huston & Juarez-Colunga (2009). It determines how the probability for detection of E.coli and fecal coliforms is related to differences in the above variables of interest. A deviance goodness of fit test confirmed whether the model fit the data well.

Results and Discussion

Sample dates and analysis results are summarized in Table A and B in Appendix I. A list of analysis and field measurement (variables of interest) results by site and date are shown in Appendix II.

According to BC Parks logs, the minimum number of houseboats anchored at any of the test beaches per day from mid July to the end of August was 5, the maximum 103. Houseboats near reference beaches were not counted on a daily basis. However, an anchored or slow moving houseboat was observed close to a control beach twice during sampling events. No houseboats were observed in visible distance to the study beaches during the sample events during the reference period in October and November. Houseboat rental companies informed us that no houseboats were rented during this period.

Comparison to BC and Health Canada Guidelines

In order to determine whether bacteria concentrations near Park beaches are safe for recreational use, particularly swimming, the geometric mean of all weekly concentrations were compared to the provincial and Health Canada Guidelines for secondary contact recreation. Figure 2 and 3 show that neither the BC, nor the Health Canada guidelines were exceeded at most sites, with the exception of Nielsen Beach, where the geometric mean for fecal coliform numbers were 1.3-1.9 times higher than the provincial guideline at two sites (Figure 2 & 3).

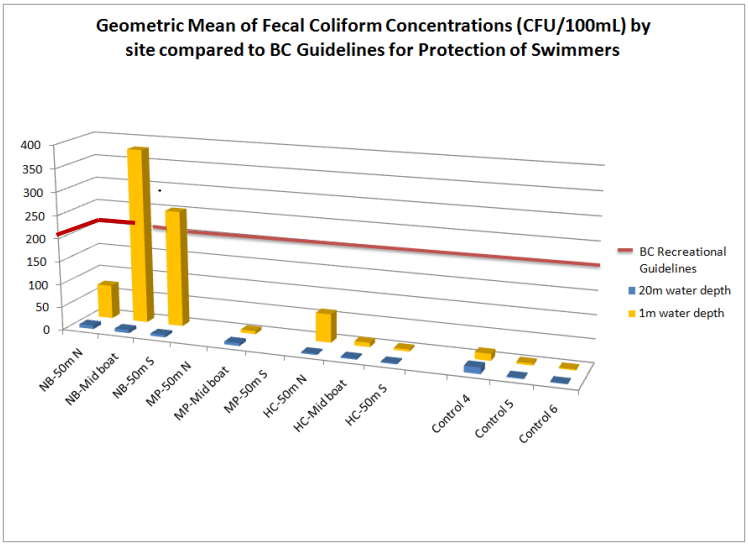

Figure 2: Geometric Mean of Fecal Coliform Concentrations in Surface Samples at each sample site between July 22 and August 26, 2009. NB=Nielson Beach, MP=Marble Point, HC=Hungry Cove.

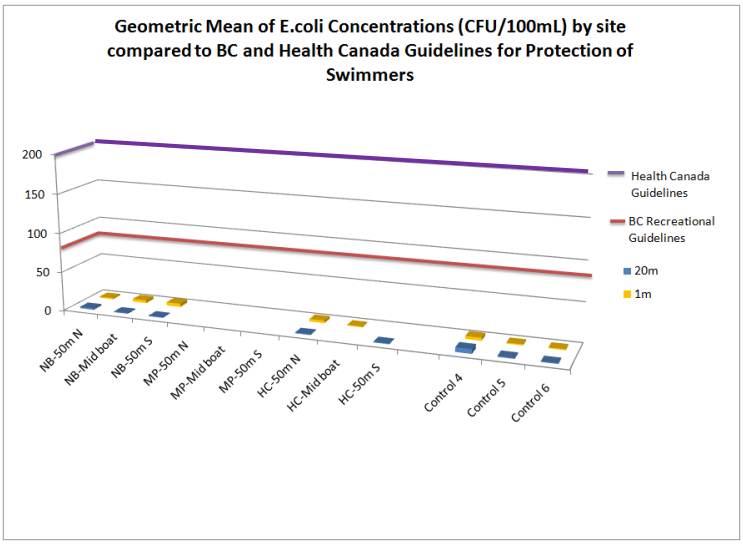

Figure 3: Geometric Mean of E.coli Concentrations in Surface Samples at each sample site between July 22 and August 26, 2009. NB=Nielson Beach, MP=Marble Point, HC=Hungry Cove.

No Health Canada guideline exists for fecal coliforms. According to the BC Criteria for Microbial Indicators - Technical Appendix (Warrington, 1988), fecal coliforms are an index of the sanitary quality of the recreational waters, but do not correlate well with the risk of gastrointestinal diseases and do not quantify the risk of non-enteric infections. E.coli is generally seen as the more appropriate indicator for risk for the above diseases.

The relatively low E.coli concentrations detected around houseboats in 2009 may be due to a lower E.coli count in the discharged greywater. The duplicate collected from one houseboat greywater tank in 2009 indicated fecal coliform numbers 4-5 orders of magnitude (1,600,000 CFU/100mL) above the E.coli counts (22 and 140 CFU/100mL) (Appendix I). The 2008 pilot study showed a 1-3 orders of magnitude difference between the two groups in samples from two different greywater tanks (Dennis Einarson – Internal Memo, results summarized in Appendix III). The fecal coliform concentrations reported for greywater by Casanova et al (2001) were about 2 orders of magnitude above the E.coli values found in greywater by Birks et al (2004). A typically longer survival of fecal coliforms (other than E.coli) compared to E.coli in the lake water (Kimberly et al, 2005; Gordon et al, 1978) could also play a role in this unbalance.

In spite of the above difference between E.coli and fecal coliform concentrations in pure greywater, E.coli concentrations detected at Nielson Beach during one of the two sample events of the pilot study in August 2008 (Aug 28) were substantially higher than those detected in 2009 and up to 80% of the fecal coliform concentrations (Appendix III). It is unclear if these concentrations were due to greywater discharge; particularly since data from August 03, 2008 (after the long weekend with high number of boats) showed E.coli levels as low as those of 2009.

Since the 2008 sampling was conducted on only two discrete dates with high houseboat numbers, it is not comparable to the systematic midweek sampling in 2009. Although, the manager of one of the houseboat companies indicated that he requested clients in 2009 not to shower near beaches, the effect of this request on customer behaviour and greywater release at the beaches cannot be estimated and will not be discussed in the scope of this study.

It is similarly unclear, what role the inactivation from sunlight (specifically during the very hot summer of 2009) plays.

Bacteria Sources

The Study employed three tools to help identify whether greywater discharges from houseboats likely contributed to the detected bacteria levels in the lake.

1. Logistic Regression Model to test for significant evidence of associations between fecal coliform / E.coli presence and variables of interest, such as houseboat numbers at the sample beach, water temperature and reference versus test sites.
2. Analysis of lake water for typical greywater tracers, such as musks (fragrances of personal care products).
3. Bacteria source (host) tracking.

While bacteria concentrations at Nielson Beach, Hungry Cove and Marble Point were often one and sometimes two orders of magnitude above the detection limit, bacteria levels at the three control sites remained mostly below or near the threshold for detection, with the exception of August 05 at Control 4 and August 12 at all three reference sites (Figure 4, 5 and 6; Appendix A). Observation of signs of wildlife at Control 4 on August 5 may provide some hints for potential causes for the high fecal coliform and E.coli levels (2800 and 2400 CFU/100mL, respectively). On August 12, a houseboat parking near and then passing Control 4, murky runoff from a creek into Control 5 and organic foam at Control 6 were observed as potentially influencing factors.

Logistic Regression Model:

A Logistic Regression Model was used to determine whether or not there is significant evidence to suggest an association between houseboat numbers at a beach (and other factors) and fecal coliform or E.coli presence. Results of the Logistic Regression Model are summarized in Table 1 for E.coli and Table 2 for fecal coliforms. The data and associated variables used in the model are summarized in Appendix II.

Table 1: Results of Logistic Regression Model for presence of E.coli associated with Variables of Interest

	Estimate	**Std. Error**	**Z value**	**Pr (>IzI)**
(Intercept)	-5.417	1.4230	-380	0.0001
Number of Boats	0.0667	0.0297	2.25	0.0245
Water Temperature	0.2163	0.0682	3.17	0.0015
Test vs. Reference beach	-1.1441	0.6318	-1.81	0.0702

Deviance (likelihood-ratio) Chi-square = 47.12, df=3, P≤0.0001

Deviance goodness of fit = 148.2119, df = 198, P = 0.9967

Table 2: Results of Logistic Regression Model for presence of Fecal Coliforms associated with Variables of Interest

	Estimate	Std. Error	Z value	Pr (>Izl)
(Intercept)	-6.3851	1.0260	-6.22	0.0000
Number of Boats	0.1300	0.0415	3.13	0.0017
Water Temperature	0.3071	0.0543	5.66	0.0000

Deviance (likelihood-ratio) Chi-square = 47.12, df=3, P≤0.0001
Deviance goodness of fit = 148.2119, df = 198, P = 0.9999

Table 1 indicates that the likelihood of detecting E.coli is significantly associated with the number of houseboats present and with water temperature. The odds for bacteria detection increase by 1.069 (=$e^{0.067}$=$e^{\text{estimate for number of boats in table 1}}$) for every additional boat and by 1.24 (=$e^{0.216}$=$e^{\text{estimate for water temp. in table 1}}$) for every degree Celsius of water temperature. The results also show a clear difference of detection between test and reference sites; however, not significant at the 5% level.

Table 2 shows a similar picture for fecal coliforms with the odds for detection increasing by 1,139 (=$e^{0.130,}$ from Table 2) with every additional boat present and by 1.360 (=$e^{0.307}$, from Table 2) with every degree Celsius of water temperature. The test versus reference site information failed to contribute any additional explanatory power to the model, meaning that the likelihood for detection is similar between test and reference sites. For that reason, it was removed from the test.

It appears contradictory that the probability for fecal coliform detection is positively affected by houseboat numbers, but is not significantly higher at test versus reference sites. Latter may be due to the facts that a few houseboats were observed near reference sites, a number of reference site values were above the detection level and that all data (test and reference period) were included in this analysis. During the reference period, detection of bacteria was very similar between test and reference sites (by far most non-detect). It should also be noted that the statistical test used applied exclusively to chance of detection, but not to differences in detected concentrations. Concentration based tests were not possible for this data base; the proportion of data below the detection level were too high.

The increasing probability for detection with rising temperatures cannot be explained by bacteria survivability in relation to temperature. McFeters & Stuart (1972) showed decreasing survivability of E.coli in water with rising temperatures (test range: 5 – 25 ^{o}C). Darakas (2001) states that the optimal temperature for E.coli survival in the environment is 10^{o}C (similar to the low fall temperatures in our study), with survival decreasing at higher or lower temperatures. Based on this, we suspect that this association is reflecting other factors that are associated with water temperature as reasons for this association, such as the lack of fecal bacteria sources from houseboats or other recreation during colder temperatures in the fall.

In summary, the statistics suggest a close connection between increasing houseboat numbers and increasing likelihood for fecal coliform and E.coli detection.

Greywater Tracer Analysis:

While the greywater tracers, galaxolide and tonalide, were found in pure greywater from a houseboat collection tank at levels one order above the detection limit, only one of the ten receiving water samples analysed for musks tested positive for galaxolide and none for tonalide. The musk concentrations in the greywater tank (0.4 and 0.24 µg/L for galaxolide and 0.16 and 0.10 µg/L for tonalide) were five to 20 times above the concentration detected at Nielson Beach (0.02 µg/L) (Table A, Appendix I). Due to the small margin between the concentration of these tracers in greywater and the detection limit (0.01 µg/L), musks may be suboptimal as tracers for this study, where receiving water dilution was high. However, the fact that galaxolide has been detected at Nielson Beach once, indicates presence of greywater in the lake at Nielson Beach and that the concentrations can vary.

Bacteria Host Tracking:

Five samples with high bacteria values collected in shallow areas were analysed to determine fecal bacteria hosts. Significantly high fecal indicator concentrations occurred on August 5th at all three test beaches and Control 4, and on August 12th at Nielson Beach and Control 4 and 5.

Table 3: Identified intestinal bacteria host species by site and date. (grey fill indicates no analysis for bacteria hosts of the water sample collected at this site/date, because fecal coliform concentrations were too low or budget for this work had not been approved).

Host Species	1 m Water Depth					
	2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26
Nielsen Beach - mid boat			human	incon-clusive	incon-clusive	
Marble Point - mid boat			human, ruminant			
Hungry Cove mit boat			human, ruminant			
Control 4 NB North			Unknown Animal	human, ruminant		
Control 5 Woods Landing S.				incon-clusive		
Control 6 Ruckel Point S.						

As shown in Table 3, results specify that high fecal coliform concentrations at Nielson Beach on August 5th co-occur with bacteriodes from human hosts, indicating human waste as a detectable source for the fecal contamination. At Marble Point and Hungry Cove human and ruminant waste are both identified sources, pointing to ungulate wildlife or upstream livestock as additional sources beside greywater or sewage discharges. The very high E.coli and fecal coliform concentrations on August 5th at Control 4 are neither from human, nor ruminant, pig, dog or elk hosts, but an unknown warm-blooded wildlife species. The observed signs for wildlife at the beach may be associated with the host species.

The identification of human and ruminant waste as sources for bacteria at Control 4 on August 12th points to wildlife and human origin. Latter was likely either due to contaminant drift from Nielson Beach, which is located about 1km south of Control 4 or from the houseboat that was observed anchoring near and then slowly passing the site shortly before sampling.

No clear host could be determined for Nielson Beach bacteria on August 12 and 19th and Control 5 on August 12. The markers were faint and not precise, thus cannot be interpreted as clear indicators for specific hosts.

Conclusions

The above study results provide the following answers to the questions reflecting the study objectives:

Does a health risk to swimmers exist at BC Parks beaches with docked houseboats?

- E.coli remained well below provincial and Health Canada Guidelines to protect swimmers at all sites during the sampling period in 2009.
- The same is true for fecal coliforms at most sites, except for Nielson Beach, where the provincial guideline was exceeded by 125 and 190 % at two sites. Since the provincial guideline technical document cautions that fecal coliforms are an index of the sanitary quality of the recreational waters, but do not correlate well with the risk of non-enteric infections, the exceedance of the provincial recreational guideline does not automatically imply a health risk.
- Actual health risk will have to be determined by the Interior Health Authority in part based on the results summarized in this report.

Are houseboat greywater discharges the likely causes for recreational guideline exceedances?

- A logistic regression model showed that the likelihood for detection of fecal coliform and E.coli is significantly associated and rising with houseboat numbers and water temperature. (A test using bacteria concentrations was not possible due to the high number of results below the detection limit).
- The association with water temperature is not likely based on survivability of the two fecal indicator groups, since survivability studies (McFeters & Stuart, 1972; Darakas, 2001) demonstrate an opposite relationship. Other, temperature related factors, such as the lack of bacteria sources from houseboats and recreationists during colder temperatures in the Fall, may be the reason for this association.
- The selected greywater tracers (musks) were found to be unsuitable due to the high detection level and high dilution in the receiving water; however, they confirmed greywater presence on one occasion.
- The bacteria host tracking results showed human waste as a consistent sources of fecal bacteria around houseboats. However, wildlife was identified as another host for detected bacteria at test and reference beaches. Although wildlife were found to cause very high bacteria concentrations near a reference beach, those occasions are less frequent than elevated bacteria concentrations near houseboats.
- The significant association between houseboat numbers and the chance for fecal bacteria detection as well as the confirmation of humans as a consistent host of detected fecal indicators near houseboats provide a strong indication for houseboats as fecal bacteria sources that may have significantly contributed to guideline exceedances.

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APPENDIX I

2009 Fecal Bacteria Concentrations, Musk Concentrations and Bacteria Source Tracking Results

Table A: Bacteria and greywater tracer concentrations as well as bacteria source tracking analysis results for July/August 2009 samples (Test Period)

FECAL COLIFORMS (CFU/100mL)		20 meters						geo	1 meter						geo	
		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26	mean	2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26	mean	2009-08-30
Nielsen Beach	50m N	34	2	6	64	<1		8	210	-	230	200	3		73	
	Mid boat	45	2	4	47	1		7	58	270	290 / 510**	1400 / 2400	410 / 12		379	
	50m S	4	2	14	40	<1		5	400	320	520	900	17		252	
Marble Point	50m N	6							5							
	Mid boat	4	<1	18	38	4		6	<1	1	43	38	8		7	
	50m S	1							4							
	Mid beach			2							47					
Hermit Bay	50m N		-	9	2	1	3	3		140	790	3	98	27	61	
	Mid boat		4	8	4	<1	<1	3		45	400	4	<1	1 / 1	9	
	50m S		4	9	1	<1	2	2		16	120	1	1	<1	5	
Control 4	Nielsen Beach North	<1	12	2400	220	<1	1	14	<1	3	2800	240	<1	<1	15	
Control 5	Woods Landing South	<1	<1	6	31	<1	-	2	<1	4	6	52	<1	-	4	
Control 6	Ruckell Point South	<1	<1	1	4	2	<1	1	1	2	2	10	3	<1	2	
Field Blank									<1			<1	<1	<1		
Greywater Sample																1,600,000
Greywater Replicate																1,600,000

E. COLI (CFU/100mL)		20 meters						geo	1 meter						geo	
		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26	mean	2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26	mean	2009-08-30
Nielsen Beach	50m N	<1	<1	2	18	<1		2	30		3	<1	<1		2	
	Mid boat	2	<1	1	<1	<1		1	1	2	290 / 240	<1 / <1	<1 / <1		4	
	50m S	<1	<1	1	<1	<1		1	1	6	73	1	3		4	
Marble Point	50m N	<1							<1							
	Mid boat	<1	<1	<1	<1	<1			<1	<1	<1	<1	<1			
	50m S	<1							2							
	Mid beach															
Hermit Bay	50m N		-	1	1	<1	1	1		<1	<1	<1	10	<1	3	
	Mid boat		<1	<1	<1	<1	<1			2	<1	1	<1	<1 / <1	1	
	50m S		<1	1	<1	<1	<1	1		<1	<1	<1	<1	<1		
Control 4	Nielsen Beach North	<1 *	<1	2400	15	<1	<1	6	1 *	<1	2800	<1	<1	<1	4	
Control 5	Woods Landing South	<1	<1	4	1	<1	-	1	<1	4	1	1	<1	-	1	
Control 6	Ruckell Point South	<1	<1	1	<1	<1	<1	1	1	2	<1	<1	2	<1	1	
Field Blank									<1			<1	<1	<1		
Greywater Sample																22
Greywater Replicate																140

Table A (continuing)

Bacteriodes Source Tracking		20 meters							1 meter							
		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26		2009-08-30
Nielsen Beach - M	Bacteriodes detected										Yes	Yes	Yes			
Mid boat	Host species determination										human	incon-clusive	incon-clusive			
	Replicate										human					
Marble Point	Bacteriodes detected										Yes					
Mid boat****	Host species determination										human, ruminant					
	Replicate										human, ruminant					
Hermit Bay	Bacteriodes detected										Yes					
(Hungry Cove) Mid beach	Host species determination										human, ruminant					
Control 4	Bacteriodes detected										Yes	Yes				
Nielsen Beach North	Host species markers detected										Unknown Animal	human, ruminant				
Control 5	Bacteriodes detected											Yes				
Woods Landing South	Host species determination											incon-clusive				
Control 6 Ruckel Point South																
Field Blank																

Table A (continuing)

Musks (µg/L)		20 meters							1 meter							
		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26		2009-07-22	2009-07-29	2009-08-05	2009-08-12	2009-08-19	2009-08-26		2009-08-30
Nielsen Beach - M	Musks detected								**No**	**Yes**	**No**	**No**	**No**			
Mid boat	Specific Musk / concentration								N/A	**Galaxolide /0.02ug/L**	N/A	N/A	N/A			
	Replicate										**No**					
Marble Point	Musks detected										**No**					
Mid boat****	Specific Musk / concentration										N/A					
	Replicate															
Hermit Bay	Musks detected										**No**					
(Hungry Cove) Mid beach	Specific Musk / concentration										N/A					
Control 4	Musks detected										**No**					
Nielsen Beach North	Specific Musk / concentration										N/A					
Control 5	Musks detected									**No**						
Woods Landing South	Specific Musk / concentration									N/A						
Control 6	Musks detected								**No**							
Ruckel Point South	Specific Musk / concentration								N/A							
Field Blank																
Greywater	Musks detected															**Yes**
Sample	Specific Musk / concentration								N/A							**Galaxolide/0.4; Tonalide /0.16**
	Replicate															**Galaxolide/0.24; Tonalide /0.10**

Table B: Bacteria concentrations for October/November Samples (Reference Period)

FECAL COLIFORMS		20 meters					geo	1 meter					geo
		2009-10-14	2009-10-20	2009-10-28	2009-11-04	2009-11-09	mean	2009-10-14	2009-10-20	2009-10-28	2009-11-04	2009-11-09	mean
Nielsen Beach	50m N	1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
	Mid beach	<1	<1	<1	<1	<1	**<1**	<1/<1	<1/1	<1/<1	<1/<1	<1/<1	**<1**
	50m S	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Marble Point	Mid beach	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Hermit Bay	50m N	<1	<1	<1	<1	<1	**<1**	1	<1	<1	<1	<1	**<1**
	Mid beach	<1	<1	<1	<1	<1	**<1**	<1	2	1	<1	<1	**1**
	50m S	<1	2	<1	<1	<1	**<1**	1	<1	<1	<1	<1	**<1**
Control 4	Nielsen Beach North	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Control 5	Woods Landing Soutl	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Control 6	Ruckell Point South	1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Field Blank								<1	<1	<1	<1	<1	**<1**
E. COLI		20 meters					geo	1 meter					geo
		2009-10-14	2009-10-20	2009-10-28	2009-11-04	2009-11-09	mean	2009-10-14	2009-10-20	2009-10-28	2009-11-04	2009-11-09	mean
Nielsen Beach	50m N	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
	Mid beach	<1	<1	<1	<1	<1	**<1**	<1/<1	<1/1	<1/<1	<1/<1	<1/<1	**<1**
	50m S	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Marble Point	Mid beach	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Hermit Bay	50m N	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
	Mid beach	<1	<1	<1	<1	<1	**<1**	<1	2	1	<1	<1	**1**
	50m S	<1	2	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Control 4	Nielsen Beach North	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Control 5	Woods Landing Soutl	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Control 6	Ruckell Point South	<1	<1	<1	<1	<1	**<1**	<1	<1	<1	<1	<1	**<1**
Field Blank								<1	<1	<1	<1	<1	**<1**

APPENDIX II

Fecal Bacteria Concentrations and associated Field Variables

Table A: Fecal coliform Concentration with associated Field Variables

FC cen.	FC (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	Signs of Wildlife
FALSE	210	NB	N	**2009-07-22**	1	0	31	182	1	22.2	9.58	10	0	FALSE
FALSE	58	NB	mid	**2009-07-22**	1	0	31	182	1	22.3	9.75	10	0	FALSE
FALSE	400	NB	S	**2009-07-22**	1	0	31	182	1	22.4	9.92	10	0	FALSE
TRUE	<1	MP	mid	**2009-07-22**	1	0	11	107	1	23.4	10.75	0	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	1	1500	0	0	1	22.2	9.17	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	1	1800	0	0	1	22.4	9.33	10	0	FALSE
FALSE	1	Control	mid	**2009-07-22**	1	3100	0	0	1	21.7	8.67	10	8	FALSE
FALSE	270	NB	mid	**2009-07-29**	1	0	28	171	1	23.2	10.92	7	0	FALSE
FALSE	320	NB	S	**2009-07-29**	1	0	28	171	1	23.2	11	7	0	FALSE
FALSE	1	MP	mid	**2009-07-29**	1	0	9	89	1	22.3	9.58	7	0	FALSE
FALSE	140	HC	N	**2009-07-29**	1	0	12	96	1	22.5	10.08	7	0	FALSE
FALSE	45	HC	mid	**2009-07-29**	1	0	12	96	1	22.5	10.25	7	0	FALSE
FALSE	16	HC	S	**2009-07-29**	1	0	12	96	1	22.5	10.42	7	0	FALSE
FALSE	3	Control	mid	**2009-07-29**	1	1500	0	0	1	22.5	11.17	7	0	FALSE
FALSE	4	Control	mid	**2009-07-29**	1	1800	0	0	1	22.6	11.33	7	0	FALSE
FALSE	2	Control	mid	**2009-07-29**	1	3100	0	0	1	22.8	11.83	7	0	FALSE
FALSE	230	NB	N	**2009-08-05**	1	0	28	273	1	22.5	9.42	95	0	FALSE
FALSE	290	NB	mid	**2009-08-05**	1	0	28	273	1	22.5	9.58	95	0	FALSE
FALSE	520	NB	S	**2009-08-05**	1	0	28	273	1	22.5	9.75	95	0	FALSE
FALSE	43	MP	mid	**2009-08-05**	1	0	19	128	1	23	10.42	95	0	FALSE
FALSE	790	HC	N	**2009-08-05**	1	0	14	92	1	22.7	8.75	95	0	FALSE
FALSE	400	HC	mid	**2009-08-05**	1	0	14	92	1	22.7	8.92	95	0	FALSE
FALSE	120	HC	S	**2009-08-05**	1	0	14	92	1	22.7	9.08	95	0	FALSE
FALSE	2800	Control	mid	**2009-08-05**	1	1500	0	0	1	22.5	9.75	95	0	TRUE
FALSE	6	Control	mid	**2009-08-05**	1	1800	0	0	1	22.3	9.92	95	0	FALSE
FALSE	2	Control	mid	**2009-08-05**	1	3100	0	0	1	22.5	10.08	95	0	FALSE
FALSE	200	NB	N	**2009-08-12**	1	0	23	177	1	21.5	9.08	20	1	FALSE
FALSE	1400	NB	mid	**2009-08-12**	1	0	23	177	1	21.5	9.25	20	0	FALSE
FALSE	900	NB	S	**2009-08-12**	1	0	23	177	1	21.5	9.42	20	0	FALSE
FALSE	38	MP	mid	**2009-08-12**	1	0	17	116	1	22.2	10.25	50	0	FALSE
FALSE	3	HC	N	**2009-08-12**	1	0	11	85	1	22.2	9.75	40	0	FALSE
FALSE	4	HC	mid	**2009-08-12**	1	0	11	85	1	22.2	9.92	40	0	FALSE
FALSE	1	HC	S	**2009-08-12**	1	0	11	85	1	22.2	10.08	40	0	FALSE
FALSE	240	Control	mid	**2009-08-12**	1	1500	1	1	1	21.4	10.75	5	0	FALSE
FALSE	52	Control	mid	**2009-08-12**	1	1800	0	0	1	21.5	10.92	5	0	FALSE
FALSE	10	Control	mid	**2009-08-12**	1	3100	0	0	1	21.2	11.08	2	0	FALSE
FALSE	3	NB	N	**2009-08-19**	1	0	16	145	1	21.7	9.67	0	0	FALSE
FALSE	410	NB	mid	**2009-08-19**	1	0	16	145	1	21.6	9.83	0	0	FALSE
FALSE	17	NB	S	**2009-08-19**	1	0	16	145	1	21.6	10.00	0	0	FALSE
FALSE	8	MP	mid	**2009-08-19**	1	0	8	198	1	20.9	8.67	0	0	FALSE
FALSE	98	HC	N	**2009-08-19**	1	0	5	93	1	20.8	9.00	0	0	TRUE
TRUE	<1	HC	mid	**2009-08-19**	1	0	5	93	1	20.8	9.17	0	0	TRUE
FALSE	1	HC	S	**2009-08-19**	1	0	5	93	1	20.8	9.33	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	1	1500	0	0	1	21.6	10.80	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	1	1800	0	0	1	21.9	10.17	0	0	FALSE
FALSE	3	Control	mid	**2009-08-19**	1	3100	0	0	1	22	10.33	0	0	FALSE
FALSE	27	HC	N	**2009-08-26**	1	0	5	87	1	20.5	9.50	90	0	FALSE
FALSE	1 / 1	HC	mid	**2009-08-26**	1	0	5	87	1	20.6	9.33	90	0	FALSE
TRUE	<1	HC	S	**2009-08-26**	1	0	5	87	1	20.6	9.17	90	1	FALSE
TRUE	<1	Control	mid	**2009-08-26**	1	1500	0	0	1	20.5	10.25	40	0	FALSE
TRUE	<1	Control	mid	**2009-08-26**	1	3100	0	0	1	20.4	10.50	15	0	FALSE
TRUE	<1	NB	N	**2009-10-14**	1	0	0	0	0	12.8	13.67	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-14**	1	0	0	0	0	12.8	13.50	100	0	FALSE
TRUE	<1	NB	S	**2009-10-14**	1	0	0	0	0	12.8	13.33	100	0	FALSE

Table A (continuing)

FC cen.	FC (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	Signs of Wildlife
TRUE	<1	MP	mid	**2009-10-14**	1	0	0	0	0	13.1	14.33	100	0	FALSE
TRUE	<1	HC	N	**2009-10-14**	1	0	0	0	0	13.1	14.58	100	0	FALSE
TRUE	<1	HC	mid	**2009-10-14**	1	0	0	0	0	13.1	14.75	100	0	FALSE
FALSE	1	HC	S	**2009-10-14**	1	0	0	0	0	13.1	14.92	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	1500	0	0	0	12.9	13.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	1800	0	0	0	12.9	14.00	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	3100	0	0	0	12.8	14.17	100	0	FALSE
TRUE	<1	NB	N	**2009-10-20**	1	0	0	0	0	12.3	9.92	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-20**	1	0	0	0	0	12.3	9.75	100	0	FALSE
TRUE	<1	NB	S	**2009-10-20**	1	0	0	0	0	12.3	9.58	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-20**	1	0	0	0	0	12.5	12.92	45	0	FALSE
TRUE	<1	HC	N	**2009-10-20**	1	0	0	0	0	12.5	13.00	40	0	FALSE
FALSE	2	HC	mid	**2009-10-20**	1	0	0	0	0	12.5	13.17	40	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	1	1500	0	0	0	12.3	10.08	100	0	TRUE
TRUE	<1	Control	mid	**2009-10-20**	1	1800	0	0	0	12.3	10.25	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	1	3100	0	0	0	12.3	10.42	100	0	FALSE
TRUE	<1	NB	N	**2009-10-28**	1	0	0	0	0	12.2	11.25	95	0	FALSE
TRUE	<1	NB	mid	**2009-10-28**	1	0	0	0	0	12.2	11.42	95	0	FALSE
TRUE	<1	NB	S	**2009-10-28**	1	0	0	0	0	12.2	11.58	95	0	FALSE
TRUE	<1	MP	mid	**2009-10-28**	1	0	0	0	0	12.3	11.75	95	0	FALSE
TRUE	<1	HC	N	**2009-10-28**	1	0	0	0	0	12.3	11.92	80	0	FALSE
FALSE	1	HC	mid	**2009-10-28**	1	0	0	0	0	12.3	12.08	80	0	FALSE
TRUE	<1	HC	S	**2009-10-28**	1	0	0	0	0	12.3	12.25	80	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	1	1500	0	0	0	12.3	11.08	95	0	TRUE
TRUE	<1	Control	mid	**2009-10-28**	1	1800	0	0	0	12.3	10.92	95	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	1	3100	0	0	0	12.2	10.75	95	0	FALSE
TRUE	<1	NB	N	**2009-11-04**	1	0	0	0	0	9.8	11.25	90	0	FALSE
TRUE	<1	NB	mid	**2009-11-04**	1	0	0	0	0	9.8	11.42	90	0	FALSE
TRUE	<1	NB	S	**2009-11-04**	1	0	0	0	0	9.9	11.58	90	0	FALSE
TRUE	<1	MP	mid	**2009-11-04**	1	0	0	0	0	10.1	11.75	90	2	FALSE
TRUE	<1	HC	N	**2009-11-04**	1	0	0	0	0	10	11.92	90	0	FALSE
TRUE	<1	HC	mid	**2009-11-04**	1	0	0	0	0	10	12.08	90	0	FALSE
TRUE	<1	HC	S	**2009-11-04**	1	0	0	0	0	10	12.25	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	1500	0	0	0	9.6	11.08	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	1800	0	0	0	9.7	10.92	80	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	3100	0	0	0	9.3	10.75	80	2	FALSE
TRUE	<1	NB	N	**2009-11-09**	1	0	0	0	0	8.5	10.83	100	0	FALSE
TRUE	<1	NB	mid	**2009-11-09**	1	0	0	0	0	8.5	11.00	100	0	FALSE
TRUE	<1	NB	S	**2009-11-09**	1	0	0	0	0	8.5	11.17	100	0	FALSE
TRUE	<1	MP	mid	**2009-11-09**	1	0	0	0	0	8.2	11.33	100	0	FALSE
TRUE	<1	HC	N	**2009-11-09**	1	0	0	0	0	8.4	11.50	100	0	FALSE
TRUE	<1	HC	mid	**2009-11-09**	1	0	0	0	0	8.4	11.67	100	0	FALSE
TRUE	<1	HC	S	**2009-11-09**	1	0	0	0	0	8.4	11.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	1500	0	0	0	8.4	10.67	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	1800	0	0	0	8.5	10.50	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	3100	0	0	0	8.7	10.33	100	0	FALSE
FALSE	34	NB	N	**2009-07-22**	20	0	31	182	1	22.2	9.50	10	0	FALSE
FALSE	45	NB	mid	**2009-07-22**	20	0	31	182	1	22.3	9.67	10	0	FALSE
FALSE	4	NB	S	**2009-07-22**	20	0	31	182	1	22.4	9.83	10	0	FALSE
FALSE	4	MP	mid	**2009-07-22**	20	0	11	107	1	23.4	10.67	0	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	1500	0	0	1	22.2	9.17	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	1800	0	0	1	22.4	9.33	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	3100	0	0	1	21.7	8.67	10	8	FALSE
FALSE	2	NB	N	**2009-07-29**	20	0	28	171	1	23.2	10.58	7	0	FALSE

Table A (continuing)

FC cen.	FC (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	Signs of Wildlife
FALSE	2	NB	mid	**2009-07-29**	20	0	28	171	1	23.2	10.75	7	0	FALSE
FALSE	2	NB	S	**2009-07-29**	20	0	28	171	1	23.2	10.92	7	0	FALSE
TRUE	<1	MP	mid	**2009-07-29**	20	0	9	89	1	22.3	9.67	7	0	FALSE
FALSE	4	HC	mid	**2009-07-29**	20	0	12	96	1	22.5	10	7	0	FALSE
FALSE	4	HC	S	**2009-07-29**	20	0	12	96	1	22.5	10.17	7	0	FALSE
FALSE	12	Control	mid	**2009-07-29**	20	1500	0	0	1	22.5	10.33	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	20	1800	0	0	1	22.6	11.25	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	20	3100	0	0	1	22.8	11.75	7	0	FALSE
FALSE	6	NB	N	**2009-08-05**	20	0	28	273	1	22.5	9.33	95	0	FALSE
FALSE	4	NB	mid	**2009-08-05**	20	0	28	273	1	22.5	9.50	95	0	FALSE
FALSE	14	NB	S	**2009-08-05**	20	0	28	273	1	22.5	9.67	95	0	FALSE
FALSE	18	MP	mid	**2009-08-05**	20	0	19	128	1	23	10.33	95	0	FALSE
FALSE	9	HC	N	**2009-08-05**	20	0	14	92	1	22.7	8.67	95	0	FALSE
FALSE	8	HC	mid	**2009-08-05**	20	0	14	92	1	22.7	8.83	95	0	FALSE
FALSE	9	HC	S	**2009-08-05**	20	0	14	92	1	22.7	9.00	95	0	FALSE
FALSE	2400	Control	mid	**2009-08-05**	20	1500	0	0	1	22.5	9.67	95	0	FALSE
FALSE	6	Control	mid	**2009-08-05**	20	1800	0	0	1	22.3	9.83	95	0	FALSE
FALSE	1	Control	mid	**2009-08-05**	20	3100	0	0	1	22.5	10.00	95	0	FALSE
FALSE	64	NB	N	**2009-08-12**	20	0	23	177	1	21.5	9.00	20	1	FALSE
FALSE	47	NB	mid	**2009-08-12**	20	0	23	177	1	21.5	9.17	20	0	FALSE
FALSE	40	NB	S	**2009-08-12**	20	0	23	177	1	21.5	9.33	20	0	FALSE
FALSE	38	MP	mid	**2009-08-12**	20	0	17	116	1	22.2	10.17	50	0	FALSE
FALSE	2	HC	N	**2009-08-12**	20	0	11	85	1	22.2	9.67	40	0	FALSE
FALSE	4	HC	mid	**2009-08-12**	20	0	11	85	1	22.2	9.83	40	0	FALSE
FALSE	1	HC	S	**2009-08-12**	20	0	11	85	1	22.2	10.00	40	0	FALSE
FALSE	220	Control	mid	**2009-08-12**	20	1500	0	0	1	21.4	10.67	5	0	FALSE
FALSE	31	Control	mid	**2009-08-12**	20	1800	0	0	1	21.5	10.92	5	0	FALSE
FALSE	4	Control	mid	**2009-08-12**	20	3100	0	0	1	21.2	11.00	2	0	FALSE
TRUE	<1	NB	N	**2009-08-19**	20	0	16	145	1	21.7	9.58	0	0	FALSE
FALSE	1	NB	mid	**2009-08-19**	20	0	16	145	1	21.6	9.75	0	0	FALSE
TRUE	<1	NB	S	**2009-08-19**	20	0	16	145	1	21.6	9.92	0	0	FALSE
FALSE	4	MP	mid	**2009-08-19**	20	0	8	198	1	20.9	8.58	0	0	FALSE
FALSE	1	HC	N	**2009-08-19**	20	0	5	93	1	20.8	8.92	0	0	TRUE
TRUE	<1	HC	mid	**2009-08-19**	20	0	5	93	1	20.8	9.08	0	0	TRUE
TRUE	<1	HC	S	**2009-08-19**	20	0	5	93	1	20.8	9.25	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	20	1500	0	0	1	21.6	10.00	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	20	1800	0	0	1	21.9	10.08	0	0	FALSE
FALSE	2	Control	mid	**2009-08-19**	20	3100	0	0	1	22	10.25	0	0	FALSE
FALSE	3	HC	N	**2009-08-26**	20	0	5	87	1	20.5	9.50	90	0	FALSE
TRUE	<1	HC	mid	**2009-08-26**	20	0	5	87	1	20.6	9.33	90	0	FALSE
FALSE	2	HC	S	**2009-08-26**	20	0	5	87	1	20.6	9.17	90	1	FALSE
FALSE	1	Control	mid	**2009-08-26**	20	1500	0	0	1	20.5	10.17	40	0	FALSE
TRUE	<1	Control	mid	**2009-08-26**	20	3100	0	0	1	20.4	10.42	15	0	FALSE
FALSE	1	NB	N	**2009-10-14**	20	0	0	0	0	12.8	13.58	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-14**	20	0	0	0	0	12.8	13.42	100	0	FALSE
TRUE	<1	NB	S	**2009-10-14**	20	0	0	0	0	12.8	13.25	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-14**	20	0	0	0	0	13.1	14.83	100	0	FALSE
TRUE	<1	HC	N	**2009-10-14**	20	0	0	0	0	13.1	14.50	100	0	FALSE
TRUE	<1	HC	mid	**2009-10-14**	20	0	0	0	0	13.1	14.67	100	0	FALSE
TRUE	<1	HC	S	**2009-10-14**	20	0	0	0	0	13.1	14.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	20	1500	0	0	0	12.9	13.75	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	20	1800	0	0	0	12.9	13.58	100	0	FALSE
FALSE	1	Control	mid	**2009-10-14**	20	3100	0	0	0	12.8	14.08	100	0	FALSE
TRUE	<1	NB	N	**2009-10-20**	20	0	0	0	0	12.3	9.83	100	0	FALSE

Table A (continuing)

FC cen.	FC (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	Signs of Wildlife
TRUE	<1	NB	mid	**2009-10-20**	20	0	0	0	0	12.3	9.67	100	0	FALSE
TRUE	<1	NB	S	**2009-10-20**	20	0	0	0	0	12.3	9.50	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-20**	20	0	0	0	0	12.5	12.75	45	0	FALSE
TRUE	<1	HC	N	**2009-10-20**	20	0	0	0	0	12.5	12.92	40	0	FALSE
TRUE	<1	HC	mid	**2009-10-20**	20	0	0	0	0	12.5	13.08	40	0	FALSE
FALSE	2	HC	S	**2009-10-20**	20	0	0	0	0	12.5	13.25	40	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	20	1500	0	0	0	12.3	10.00	100	0	TRUE
TRUE	<1	Control	mid	**2009-10-20**	20	1800	0	0	0	12.3	10.17	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	20	3100	0	0	0	12.3	10.33	100	0	FALSE
TRUE	<1	NB	N	**2009-10-28**	20	0	0	0	0	12.2	11.17	95	0	FALSE
TRUE	<1	NB	mid	**2009-10-28**	20	0	0	0	0	12.2	11.33	95	0	FALSE
TRUE	<1	NB	S	**2009-10-28**	20	0	0	0	0	12.2	11.50	95	0	FALSE
TRUE	<1	MP	mid	**2009-10-28**	20	0	0	0	0	12.3	11.67	95	0	FALSE
TRUE	<1	HC	N	**2009-10-28**	20	0	0	0	0	12.3	11.83	80	0	FALSE
TRUE	<1	HC	mid	**2009-10-28**	20	0	0	0	0	12.3	12.00	80	0	FALSE
TRUE	<1	HC	S	**2009-10-28**	20	0	0	0	0	12.3	12.17	80	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	20	1500	0	0	0	12.3	11.00	95	0	TRUE
TRUE	<1	Control	mid	**2009-10-28**	20	1800	0	0	0	12.3	10.83	95	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	20	3100	0	0	0	12.2	10.67	95	0	FALSE
TRUE	<1	NB	N	**2009-11-04**	20	0	0	0	0	9.8	11.17	90	0	FALSE
TRUE	<1	NB	mid	**2009-11-04**	20	0	0	0	0	9.8	11.33	90	0	FALSE
TRUE	<1	NB	S	**2009-11-04**	20	0	0	0	0	9.9	11.50	90	0	FALSE
TRUE	<1	MP	mid	**2009-11-04**	20	0	0	0	0	10.1	11.67	90	2	FALSE
TRUE	<1	HC	N	**2009-11-04**	20	0	0	0	0	10	11.83	90	0	FALSE
TRUE	<1	HC	mid	**2009-11-04**	20	0	0	0	0	10	12.00	90	0	FALSE
TRUE	<1	HC	S	**2009-11-04**	20	0	0	0	0	10	12.17	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	1500	0	0	0	9.6	11.00	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	1800	0	0	0	9.7	10.83	80	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	3100	0	0	0	9.3	10.67	80	2	FALSE
TRUE	<1	NB	N	**2009-11-09**	20	0	0	0	0	8.5	10.75	100	0	FALSE
TRUE	<1	NB	mid	**2009-11-09**	20	0	0	0	0	8.5	10.92	100	0	FALSE
TRUE	<1	NB	S	**2009-11-09**	20	0	0	0	0	8.5	11.08	100	0	FALSE
TRUE	<1	MP	mid	**2009-11-09**	20	0	0	0	0	8.2	11.25	100	0	FALSE
TRUE	<1	HC	N	**2009-11-09**	20	0	0	0	0	8.4	11.42	100	0	FALSE
TRUE	<1	HC	mid	**2009-11-09**	20	0	0	0	0	8.4	11.58	100	0	FALSE
TRUE	<1	HC	S	**2009-11-09**	20	0	0	0	0	8.4	11.75	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	1500	0	0	0	8.4	10.58	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	1800	0	0	0	8.5	10.42	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	3100	0	0	0	8.7	10.25	100	0	FALSE

Table B: E.coli Concentration with associated Field Variables

E.coli cen.	E.coli (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	# Signs for land animals
FALSE	30	NB	N	**2009-07-22**	1	0	31	182	1	22.2	9.58	10	0	FALSE
FALSE	1	NB	mid	**2009-07-22**	1	0	31	182	1	22.3	9.75	10	0	FALSE
FALSE	1	NB	S	**2009-07-22**	1	0	31	182	1	22.4	9.92	10	0	FALSE
TRUE	<1	MP	mid	**2009-07-22**	1	0	11	107	1	23.4	10.75	0	0	FALSE
FALSE	1	Control	mid	**2009-07-22**	1	1500	0	0	1	22.2	9.17	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	1	1800	0	0	1	22.4	9.33	10	0	FALSE
FALSE	1	Control	mid	**2009-07-22**	1	3100	0	0	1	21.7	8.67	10	8	FALSE
FALSE	2	NB	mid	**2009-07-29**	1	0	28	171	1	23.2	10.92	7	0	FALSE
FALSE	6	NB	S	**2009-07-29**	1	0	28	171	1	23.2	11	7	0	FALSE
TRUE	<1	MP	mid	**2009-07-29**	1	0	9	89	1	22.3	9.58	7	0	FALSE
TRUE	<1	HC	N	**2009-07-29**	1	0	12	96	1	22.5	10.08	7	0	FALSE
FALSE	2	HC	mid	**2009-07-29**	1	0	12	96	1	22.5	10.25	7	0	FALSE
TRUE	<1	HC	S	**2009-07-29**	1	0	12	96	1	22.5	10.42	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	1	1500	0	0	1	22.5	11.17	7	0	FALSE
FALSE	4	Control	mid	**2009-07-29**	1	1800	0	0	1	22.6	11.33	7	0	FALSE
FALSE	2	Control	mid	**2009-07-29**	1	3100	0	0	1	22.8	11.83	7	0	FALSE
FALSE	3	NB	N	**2009-08-05**	1	0	28	273	1	22.5	9.42	95	0	FALSE
FALSE	290	NB	mid	**2009-08-05**	1	0	28	273	1	22.5	9.58	95	0	FALSE
FALSE	73	NB	S	**2009-08-05**	1	0	28	273	1	22.5	9.75	95	0	FALSE
TRUE	<1	MP	mid	**2009-08-05**	1	0	19	128	1	23	10.42	95	0	FALSE
TRUE	<1	HC	N	**2009-08-05**	1	0	14	92	1	22.7	8.75	95	0	FALSE
TRUE	<1	HC	mid	**2009-08-05**	1	0	14	92	1	22.7	8.92	95	0	FALSE
TRUE	<1	HC	S	**2009-08-05**	1	0	14	92	1	22.7	9.08	95	0	FALSE
FALSE	2800	Control	mid	**2009-08-05**	1	1500	0	0	1	22.5	9.75	95	0	TRUE
FALSE	1	Control	mid	**2009-08-05**	1	1800	0	0	1	22.3	9.92	95	0	FALSE
TRUE	<1	Control	mid	**2009-08-05**	1	3100	0	0	1	22.5	10.08	95	0	FALSE
TRUE	<1	NB	N	**2009-08-12**	1	0	23	177	1	21.5	9.08	20	1	FALSE
TRUE	<1	NB	mid	**2009-08-12**	1	0	23	177	1	21.5	9.25	20	0	FALSE
FALSE	1	NB	S	**2009-08-12**	1	0	23	177	1	21.5	9.42	20	0	FALSE
TRUE	<1	MP	mid	**2009-08-12**	1	0	17	116	1	22.2	10.25	50	0	FALSE
TRUE	<1	HC	N	**2009-08-12**	1	0	11	85	1	22.2	9.75	40	0	FALSE
FALSE	1	HC	mid	**2009-08-12**	1	0	11	85	1	22.2	9.92	40	0	FALSE
TRUE	<1	HC	S	**2009-08-12**	1	0	11	85	1	22.2	10.08	40	0	FALSE
TRUE	<1	Control	mid	**2009-08-12**	1	1500	1	1	1	21.4	10.75	5	0	FALSE
FALSE	1	Control	mid	**2009-08-12**	1	1800	0	0	1	21.5	10.92	5	0	FALSE
TRUE	<1	Control	mid	**2009-08-12**	1	3100	0	0	1	21.2	11.08	2	0	FALSE
TRUE	<1	NB	N	**2009-08-19**	1	0	16	145	1	21.7	9.67	0	0	FALSE
TRUE	<1	NB	mid	**2009-08-19**	1	0	16	145	1	21.6	9.83	0	0	FALSE
FALSE	3	NB	S	**2009-08-19**	1	0	16	145	1	21.6	10.00	0	0	FALSE
TRUE	<1	MP	mid	**2009-08-19**	1	0	8	198	1	20.9	8.67	0	0	FALSE
FALSE	10	HC	N	**2009-08-19**	1	0	5	93	1	20.8	9.00	0	0	TRUE
TRUE	<1	HC	mid	**2009-08-19**	1	0	5	93	1	20.8	9.17	0	0	TRUE
TRUE	<1	HC	S	**2009-08-19**	1	0	5	93	1	20.8	9.33	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	1	1500	0	0	1	21.6	10.80	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	1	1800	0	0	1	21.9	10.17	0	0	FALSE
FALSE	2	Control	mid	**2009-08-19**	1	3100	0	0	1	22	10.33	0	0	FALSE
TRUE	<1	HC	N	**2009-08-26**	1	0	5	87	1	20.5	9.50	90	0	FALSE
TRUE	<1	HC	mid	**2009-08-26**	1	0	5	87	1	20.6	9.33	90	0	FALSE
TRUE	<1	HC	S	**2009-08-26**	1	0	5	87	1	20.6	9.17	90	1	FALSE
TRUE	<1	Control	mid	**2009-08-26**	1	1500	1	1	1	20.5	10.25	40	0	FALSE
TRUE	<1	Control	mid	**2009-08-26**	1	3100	0	0	1	20.4	10.50	15	0	FALSE
TRUE	<1	NB	N	**2009-10-14**	1	0	0	0	0	12.8	13.67	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-14**	1	0	0	0	0	12.8	13.50	100	0	FALSE
TRUE	<1	NB	S	**2009-10-14**	1	0	0	0	0	12.8	13.33	100	0	FALSE

Table B (continuing)

E.coli cen.	E.coli (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	# Signs for land animals
TRUE	<1	MP	mid	**2009-10-14**	1	0	0	0	0	13.1	14.33	100	0	FALSE
TRUE	<1	HC	N	**2009-10-14**	1	0	0	0	0	13.1	14.58	100	0	FALSE
TRUE	<1	HC	mid	**2009-10-14**	1	0	0	0	0	13.1	14.75	100	0	FALSE
TRUE	<1	HC	S	**2009-10-14**	1	0	0	0	0	13.1	14.92	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	1500	0	0	0	12.9	13.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	1800	0	0	0	12.9	14.00	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	1	3100	0	0	0	12.8	14.17	100	0	FALSE
TRUE	<1	NB	N	**2009-10-20**	1	0	0	0	0	12.3	9.92	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-20**	1	0	0	0	0	12.3	9.75	100	0	FALSE
TRUE	<1	NB	S	**2009-10-20**	1	0	0	0	0	12.3	9.58	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-20**	1	0	0	0	0	12.5	12.92	45	0	FALSE
TRUE	<1	HC	N	**2009-10-20**	1	0	0	0	0	12.5	13.00	40	0	FALSE
FALSE	2	HC	mid	**2009-10-20**	1	0	0	0	0	12.5	13.17	40	0	FALSE
TRUE	<1	HC	S	**2009-10-20**	1	0	0	0	0	12.5	13.33	40	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	1	1500	0	0	0	12.3	10.08	100	0	TRUE
TRUE	<1	Control	mid	**2009-10-20**	1	1800	0	0	0	12.3	10.25	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	1	3100	0	0	0	12.3	10.42	100	0	FALSE
TRUE	<1	NB	N	**2009-10-28**	1	0	0	0	0	12.2	11.25	95	0	FALSE
TRUE	<1	NB	mid	**2009-10-28**	1	0	0	0	0	12.2	11.42	95	0	FALSE
TRUE	<1	NB	S	**2009-10-28**	1	0	0	0	0	12.2	11.58	95	0	FALSE
TRUE	<1	MP	mid	**2009-10-28**	1	0	0	0	0	12.3	11.75	95	0	FALSE
TRUE	<1	HC	N	**2009-10-28**	1	0	0	0	0	12.3	11.92	80	0	FALSE
FALSE	1	HC	mid	**2009-10-28**	1	0	0	0	0	12.3	12.08	80	0	FALSE
TRUE	<1	HC	S	**2009-10-28**	1	0	0	0	0	12.3	12.25	80	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	1	1500	0	0	0	12.3	11.08	95	0	TRUE
TRUE	<1	Control	mid	**2009-10-28**	1	1800	0	0	0	12.3	10.92	95	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	1	3100	0	0	0	12.2	10.75	95	0	FALSE
TRUE	<1	NB	N	**2009-11-04**	1	0	0	0	0	9.8	11.25	90	0	FALSE
TRUE	<1	NB	mid	**2009-11-04**	1	0	0	0	0	9.8	11.42	90	0	FALSE
TRUE	<1	NB	S	**2009-11-04**	1	0	0	0	0	9.9	11.58	90	0	FALSE
TRUE	<1	MP	mid	**2009-11-04**	1	0	0	0	0	10.1	11.75	90	2	FALSE
TRUE	<1	HC	N	**2009-11-04**	1	0	0	0	0	10	11.92	90	0	FALSE
TRUE	<1	HC	mid	**2009-11-04**	1	0	0	0	0	10	12.08	90	0	FALSE
TRUE	<1	HC	S	**2009-11-04**	1	0	0	0	0	10	12.25	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	1500	0	0	0	9.6	11.08	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	1800	0	0	0	9.7	10.92	80	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	1	3100	0	0	0	9.3	10.75	80	2	FALSE
TRUE	<1	NB	N	**2009-11-09**	1	0	0	0	0	8.5	10.83	100	0	FALSE
TRUE	<1	NB	mid	**2009-11-09**	1	0	0	0	0	8.5	11.00	100	0	FALSE
TRUE	<1	NB	S	**2009-11-09**	1	0	0	0	0	8.5	11.17	100	0	FALSE
TRUE	<1	MP	mid	**2009-11-09**	1	0	0	0	0	8.2	11.33	100	0	FALSE
TRUE	<1	HC	N	**2009-11-09**	1	0	0	0	0	8.4	11.50	100	0	FALSE
TRUE	<1	HC	mid	**2009-11-09**	1	0	0	0	0	8.4	11.67	100	0	FALSE
TRUE	<1	HC	S	**2009-11-09**	1	0	0	0	0	8.4	11.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	1500	0	0	0	8.4	10.67	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	1800	0	0	0	8.5	10.50	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	1	3100	0	0	0	8.7	10.33	100	0	FALSE
TRUE	<1	NB	N	**2009-07-22**	20	0	31	182	1	22.2	9.50	10	0	FALSE
FALSE	2	NB	mid	**2009-07-22**	20	0	31	182	1	22.3	9.67	10	0	FALSE
TRUE	<1	NB	S	**2009-07-22**	20	0	31	182	1	22.4	9.83	10	0	FALSE
TRUE	<1	MP	mid	**2009-07-22**	20	0	11	107	1	23.4	10.67	0	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	1500	0	0	1	22.2	9.17	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	1800	0	0	1	22.4	9.33	10	0	FALSE
TRUE	<1	Control	mid	**2009-07-22**	20	3100	0	0	1	21.7	8.67	10	8	FALSE

Table B (continuing)

E.coli cen.	E.coli (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	# Signs for land animals
TRUE	<1	NB	N	**2009-07-29**	20	0	28	171	1	23.2	10.58	7	0	FALSE
TRUE	<1	NB	mid	**2009-07-29**	20	0	28	171	1	23.2	10.75	7	0	FALSE
TRUE	<1	NB	S	**2009-07-29**	20	0	28	171	1	23.2	10.92	7	0	FALSE
TRUE	<1	MP	mid	**2009-07-29**	20	0	9	89	1	22.3	9.67	7	0	FALSE
TRUE	<1	HC	mid	**2009-07-29**	20	0	12	96	1	22.5	10	7	0	FALSE
TRUE	<1	HC	S	**2009-07-29**	20	0	12	96	1	22.5	10.17	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	20	1500	0	0	1	22.5	10.33	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	20	1800	0	0	1	22.6	11.25	7	0	FALSE
TRUE	<1	Control	mid	**2009-07-29**	20	3100	0	0	1	22.8	11.75	7	0	FALSE
FALSE	2	NB	N	**2009-08-05**	20	0	28	273	1	22.5	9.33	95	0	FALSE
FALSE	1	NB	mid	**2009-08-05**	20	0	28	273	1	22.5	9.50	95	0	FALSE
FALSE	1	NB	S	**2009-08-05**	20	0	28	273	1	22.5	9.67	95	0	FALSE
TRUE	<1	MP	mid	**2009-08-05**	20	0	19	128	1	23	10.33	95	0	FALSE
FALSE	1	HC	N	**2009-08-05**	20	0	14	92	1	22.7	8.67	95	0	FALSE
TRUE	<1	HC	mid	**2009-08-05**	20	0	14	92	1	22.7	8.83	95	0	FALSE
FALSE	1	HC	S	**2009-08-05**	20	0	14	92	1	22.7	9.00	95	0	FALSE
FALSE	2400	Control	mid	**2009-08-05**	20	1500	0	0	1	22.5	9.67	95	0	FALSE
FALSE	4	Control	mid	**2009-08-05**	20	1800	0	0	1	22.3	9.83	95	0	FALSE
FALSE	1	Control	mid	**2009-08-05**	20	3100	0	0	1	22.5	10.00	95	0	FALSE
FALSE	18	NB	N	**2009-08-12**	20	0	23	177	1	21.5	9.00	20	1	FALSE
TRUE	<1	NB	mid	**2009-08-12**	20	0	23	177	1	21.5	9.17	20	0	FALSE
TRUE	<1	NB	S	**2009-08-12**	20	0	23	177	1	21.5	9.33	20	0	FALSE
TRUE	<1	MP	mid	**2009-08-12**	20	0	17	116	1	22.2	10.17	50	0	FALSE
FALSE	1	HC	N	**2009-08-12**	20	0	11	85	1	22.2	9.67	40	0	FALSE
TRUE	<1	HC	mid	**2009-08-12**	20	0	11	85	1	22.2	9.83	40	0	FALSE
TRUE	<1	HC	S	**2009-08-12**	20	0	11	85	1	22.2	10.00	40	0	FALSE
FALSE	15	Control	mid	**2009-08-12**	20	1500	0	0	1	21.4	10.67	5	0	FALSE
FALSE	1	Control	mid	**2009-08-12**	20	1800	0	0	1	21.5	10.92	5	0	FALSE
TRUE	<1	Control	mid	**2009-08-12**	20	3100	0	0	1	21.2	11.00	2	0	FALSE
TRUE	<1	NB	N	**2009-08-19**	20	0	16	145	1	21.7	9.58	0	0	FALSE
TRUE	<1	NB	mid	**2009-08-19**	20	0	16	145	1	21.6	9.75	0	0	FALSE
TRUE	<1	NB	S	**2009-08-19**	20	0	16	145	1	21.6	9.92	0	0	FALSE
TRUE	<1	MP	mid	**2009-08-19**	20	0	8	198	1	20.9	8.58	0	0	FALSE
TRUE	<1	HC	N	**2009-08-19**	20	0	5	93	1	20.8	8.92	0	0	TRUE
TRUE	<1	HC	mid	**2009-08-19**	20	0	5	93	1	20.8	9.08	0	0	TRUE
TRUE	<1	HC	S	**2009-08-19**	20	0	5	93	1	20.8	9.25	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	20	1500	0	0	1	21.6	10.00	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	20	1800	0	0	1	21.9	10.08	0	0	FALSE
TRUE	<1	Control	mid	**2009-08-19**	20	3100	0	0	1	22	10.25	0	0	FALSE
FALSE	1	HC	N	**2009-08-26**	20	0	5	87	1	20.5	9.50	90	0	FALSE
TRUE	<1	HC	mid	**2009-08-26**	20	0	5	87	1	20.6	9.33	90	0	FALSE
TRUE	<1	HC	S	**2009-08-26**	20	0	5	87	1	20.6	9.17	90	1	FALSE
TRUE	<1	Control	mid	**2009-08-26**	20	1500	0	0	1	20.5	10.17	40	0	FALSE
TRUE	<1	Control	mid	**2009-08-26**	20	3100	0	0	1	20.4	10.42	15	0	FALSE
TRUE	<1	NB	N	**2009-10-14**	20	0	0	0	0	12.8	13.58	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-14**	20	0	0	0	0	12.8	13.42	100	0	FALSE
TRUE	<1	NB	S	**2009-10-14**	20	0	0	0	0	12.8	13.25	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-14**	20	0	0	0	0	13.1	14.83	100	0	FALSE
TRUE	<1	HC	N	**2009-10-14**	20	0	0	0	0	13.1	14.50	100	0	FALSE
TRUE	<1	HC	mid	**2009-10-14**	20	0	0	0	0	13.1	14.67	100	0	FALSE
TRUE	<1	HC	S	**2009-10-14**	20	0	0	0	0	13.1	14.83	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	20	1500	0	0	0	12.9	13.75	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	20	1800	0	0	0	12.9	13.58	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-14**	20	3100	0	0	0	12.8	14.08	100	0	FALSE

Table B (continuing)

E.coli cen.	E.coli (CFU/100mL)	Category	Location	Date	Depth (m)	Distance fr. Park Beach (m)	# boats present	# boats last wk	In(1)/Out(0)Boat Season	Water Temp (oC)	Time	% cloud	# Waterfowl near	# Signs for land animals
TRUE	<1	NB	N	**2009-10-20**	20	0	0	0	0	12.3	9.83	100	0	FALSE
TRUE	<1	NB	mid	**2009-10-20**	20	0	0	0	0	12.3	9.67	100	0	FALSE
TRUE	<1	NB	S	**2009-10-20**	20	0	0	0	0	12.3	9.50	100	0	FALSE
TRUE	<1	MP	mid	**2009-10-20**	20	0	0	0	0	12.5	12.75	45	0	FALSE
TRUE	<1	HC	N	**2009-10-20**	20	0	0	0	0	12.5	12.92	40	0	FALSE
TRUE	<1	HC	mid	**2009-10-20**	20	0	0	0	0	12.5	13.08	40	0	FALSE
FALSE	2	HC	S	**2009-10-20**	20	0	0	0	0	12.5	13.25	40	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	20	1500	0	0	0	12.3	10.00	100	0	TRUE
TRUE	<1	Control	mid	**2009-10-20**	20	1800	0	0	0	12.3	10.17	100	0	FALSE
TRUE	<1	Control	mid	**2009-10-20**	20	3100	0	0	0	12.3	10.33	100	0	FALSE
TRUE	<1	NB	N	**2009-10-28**	20	0	0	0	0	12.2	11.17	95	0	FALSE
TRUE	<1	NB	mid	**2009-10-28**	20	0	0	0	0	12.2	11.33	95	0	FALSE
TRUE	<1	NB	S	**2009-10-28**	20	0	0	0	0	12.2	11.50	95	0	FALSE
TRUE	<1	MP	mid	**2009-10-28**	20	0	0	0	0	12.3	11.67	95	0	FALSE
TRUE	<1	HC	N	**2009-10-28**	20	0	0	0	0	12.3	11.83	80	0	FALSE
TRUE	<1	HC	mid	**2009-10-28**	20	0	0	0	0	12.3	12.00	80	0	FALSE
TRUE	<1	HC	S	**2009-10-28**	20	0	0	0	0	12.3	12.17	80	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	20	1500	0	0	0	12.3	11.00	95	0	TRUE
TRUE	<1	Control	mid	**2009-10-28**	20	1800	0	0	0	12.3	10.83	95	0	FALSE
TRUE	<1	Control	mid	**2009-10-28**	20	3100	0	0	0	12.2	10.67	95	0	FALSE
TRUE	<1	NB	N	**2009-11-04**	20	0	0	0	0	9.8	11.17	90	0	FALSE
TRUE	<1	NB	mid	**2009-11-04**	20	0	0	0	0	9.8	11.33	90	0	FALSE
TRUE	<1	NB	S	**2009-11-04**	20	0	0	0	0	9.9	11.50	90	0	FALSE
TRUE	<1	MP	mid	**2009-11-04**	20	0	0	0	0	10.1	11.67	90	2	FALSE
TRUE	<1	HC	N	**2009-11-04**	20	0	0	0	0	10	11.83	90	0	FALSE
TRUE	<1	HC	mid	**2009-11-04**	20	0	0	0	0	10	12.00	90	0	FALSE
TRUE	<1	HC	S	**2009-11-04**	20	0	0	0	0	10	12.17	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	1500	0	0	0	9.6	11.00	90	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	1800	0	0	0	9.7	10.83	80	0	FALSE
TRUE	<1	Control	mid	**2009-11-04**	20	3100	0	0	0	9.3	10.67	80	2	FALSE
TRUE	<1	NB	N	**2009-11-09**	20	0	0	0	0	8.5	10.75	100	0	FALSE
TRUE	<1	NB	mid	**2009-11-09**	20	0	0	0	0	8.5	10.92	100	0	FALSE
TRUE	<1	NB	S	**2009-11-09**	20	0	0	0	0	8.5	11.08	100	0	FALSE
TRUE	<1	MP	mid	**2009-11-09**	20	0	0	0	0	8.2	11.25	100	0	FALSE
TRUE	<1	HC	N	**2009-11-09**	20	0	0	0	0	8.4	11.42	100	0	FALSE
TRUE	<1	HC	mid	**2009-11-09**	20	0	0	0	0	8.4	11.58	100	0	FALSE
TRUE	<1	HC	S	**2009-11-09**	20	0	0	0	0	8.4	11.75	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	1500	0	0	0	8.4	10.58	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	1800	0	0	0	8.5	10.42	100	0	FALSE
TRUE	<1	Control	mid	**2009-11-09**	20	3100	0	0	0	8.7	10.25	100	0	FALSE

APPENDIX III

2008 Pilot Study Results

The following Tables and Figures were directly copied from an internal Ministry of Environment Memorandum

by Dennis Einarson (Environmental Quality Section) to Larry Gardner (Environmental Management Section) on May 19, 2009

Table A: Bacterial Sampling Nielson Beach, August 3rd and 28th, 2008

		August 3rd		August 28th				Water Chemistry August 3rd						
Date Sampled: 08/28/2008		Fecal Coliform	E. coli	Fecal Coliform	E. coli	Streptoc	Entero	Total Kjeldahl Nitrogen (Calc)	Total Organic Nitrogen (N)	Amm (N)	Nitrate plus Nitrite (N)	Total Nitrogen (N)	Total Phos (P)	pH
		Col./100 mL	Col./100 ml	Col./100 mL	Col./100 ml	Col./100 ml	Col./100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Control 1	FF1	4	<1					0.06	0.06	<0.005	0.006	0.06	0.003	7.8
Control 2	FF2	<1	<1	4	1	< 1	1	0.06	0.04	0.019	0.003	0.06	0.004	7.9
Control 3	FF3 Deep	4	<1	3	1	3	<1							
Control 3	FF3 Shallow	4	<1					0.07	0.07	<0.005	0.002	0.07	0.007	7.9
Control 4	NB U/S Deep			5	< 1	< 1	< 1							
Control 4	NB U/S Shallow	55	3	4	< 1	< 1	< 1	0.07	0.06	0.005	0.005	0.07	0.003	7.9
Control 5	Accross Nine Mile Pt. Shallow			3	< 1	13	< 1							
Control 5	Accross From Nine Mile Pt. Deep			4	< 1	< 1	< 1							
Control 6	Ruchell Pt			2	1	< 1	< 1							
Control 6	Ruchell Pt (Agitated bottom)			2	< 1	< 1	< 1							
Control 7	Field Blank (Nielsen Beach)	<1	<1	< 1	< 1	< 1	< 1	<0.02	<0.02	<0.005	0.005	<0.02	<0.002	6.1
Beach1	NB 1 Deep	2	1	38	< 1	1	< 1							
Beach1	NB 1 Shallow	12	<1	7	2	1	< 1	0.08	0.07	0.007	0.003	0.08	0.007	7.9
Beach 2	NB 2 Deep			6	< 1	4	< 1							
Beach 2	NB 2 Shallow			750	< 1	15	1							
Beach 3	NB 3 Deep			130	50	< 1	< 1							
Beach 3	NB 3 Shallow			570	400	6	< 1							
Beach 4	NB 4 Deep	**67**	<1	6,400	1,400	6	< 1							
Beach 4	NB 4 Deep Replicate	**280**	<1											
Beach 4	NB 4 Shallow	**6700**	2	7,200	900	46	2	0.10	0.09	0.011	<0.002	0.10	0.004	7.9
Beach 5	NB 5 Deep	**5700**	1	1,800	1,000	< 1	3							
Beach 5	NB 5 Shallow	**12000**	7	14,000	7,600	< 1	< 1	0.09	0.09	<0.005	<0.002	0.09	0.003	7.9
Beach 6	NB 6 Deep			4,700	2,100	8	1							
Beach 6	NB 6 Shallow			1,300	400	17	4							
Beach 7	NB 7 Deep			110	99	4	< 1							
Beach 7	NB 7 Shallow			1,000	1,000	14	< 1							
Beach 7	NB 7 Shallow Replicate			970	800	25	< 1							
Beach 8	NB 8 Deep			71	60	2	< 1							
Beach 8	NB 8 Shallow			310	1	26	2							
Beach 9	NB 9 Deep			400	100	22	14							
Beach 9	NB 9 Shallow			76	60	4	< 1							
Beach 10	NB 10 Deep			57	26	3	2							
Beach 10	NB 10 Shallow			91	52	6	2							
Beach 11	NB 11 Deep			41	17	2	< 1							
Beach 11	NB 11 Shallow			74	15	7	< 1							
Beach 12	NB 12 Deep			54	20	2	< 1							
Beach 12	NB 12 Shallow													

25-Aug	**WWGreywater 1**	**110,000,000**	**100,000**	**< 2**	**< 2**
25-Aug	**WWGreywater 1 Replicate**	**160**	**< 1**	**4**	**< 2**
02-Sep	**TwinAnchorsGreywater2**	**22,000**	**2,200**	**< 2**	**2,700**
02-Sep	**TwinAnchorsGreywater2 Replicate**	**21,000**	**1,500**	**< 2**	**2,400**

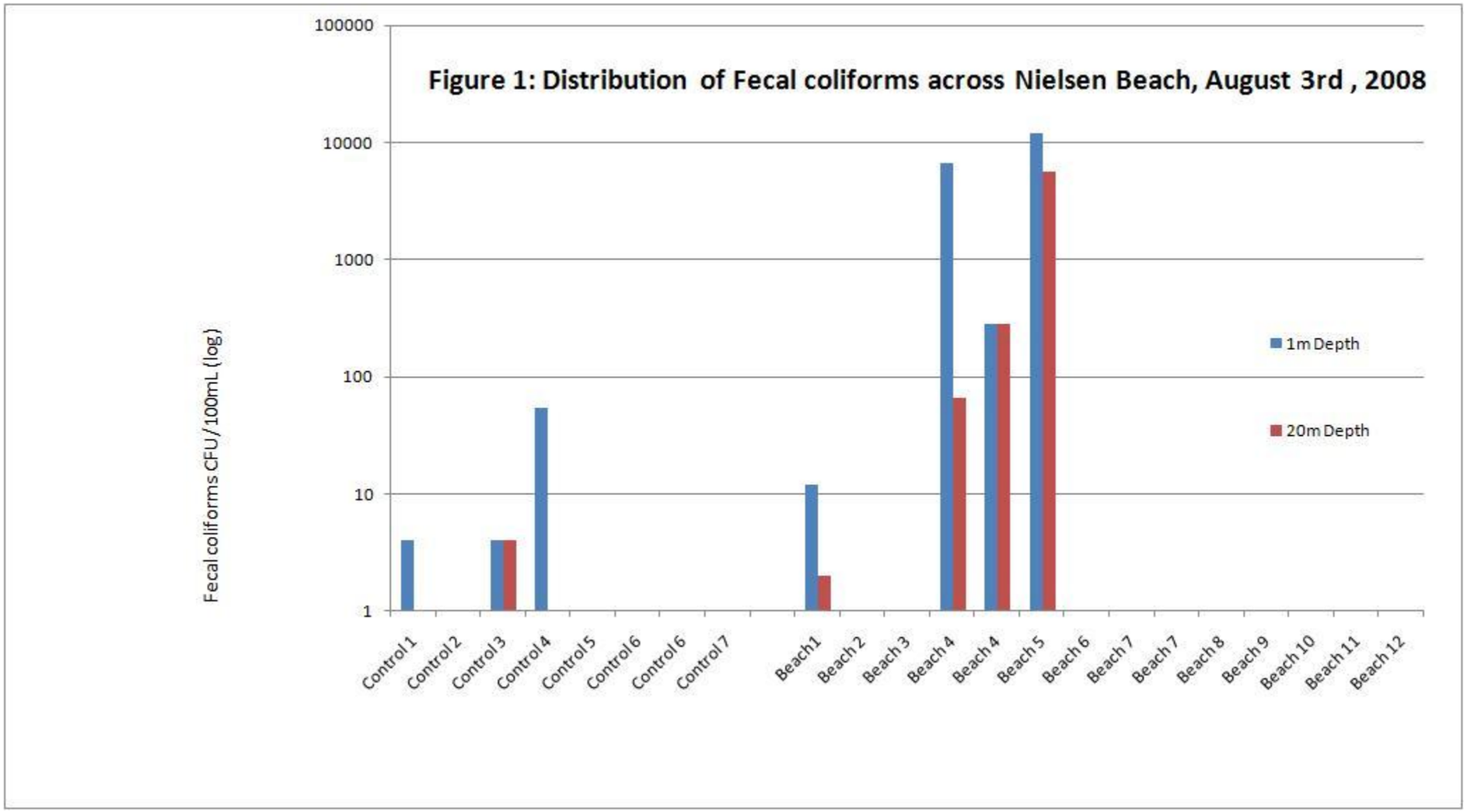
Figure 1: Distribution of Fecal coliforms across Nielsen Beach, August 3rd , 2008
Fecal coliforms CFU/100mL (log)
100000
10000
1000
100
10
1
1m Depth
20m Depth
Control 1
Control 2
Control 3
Control 4
Control 5
Control 6
Control 6
Control 7
Beach 1
Beach 2
Beach 3
Beach 4
Beach 4
Beach 5
Beach 6
Beach 7
Beach 7
Beach 8
Beach 9
Beach 10
Beach 11
Beach 12

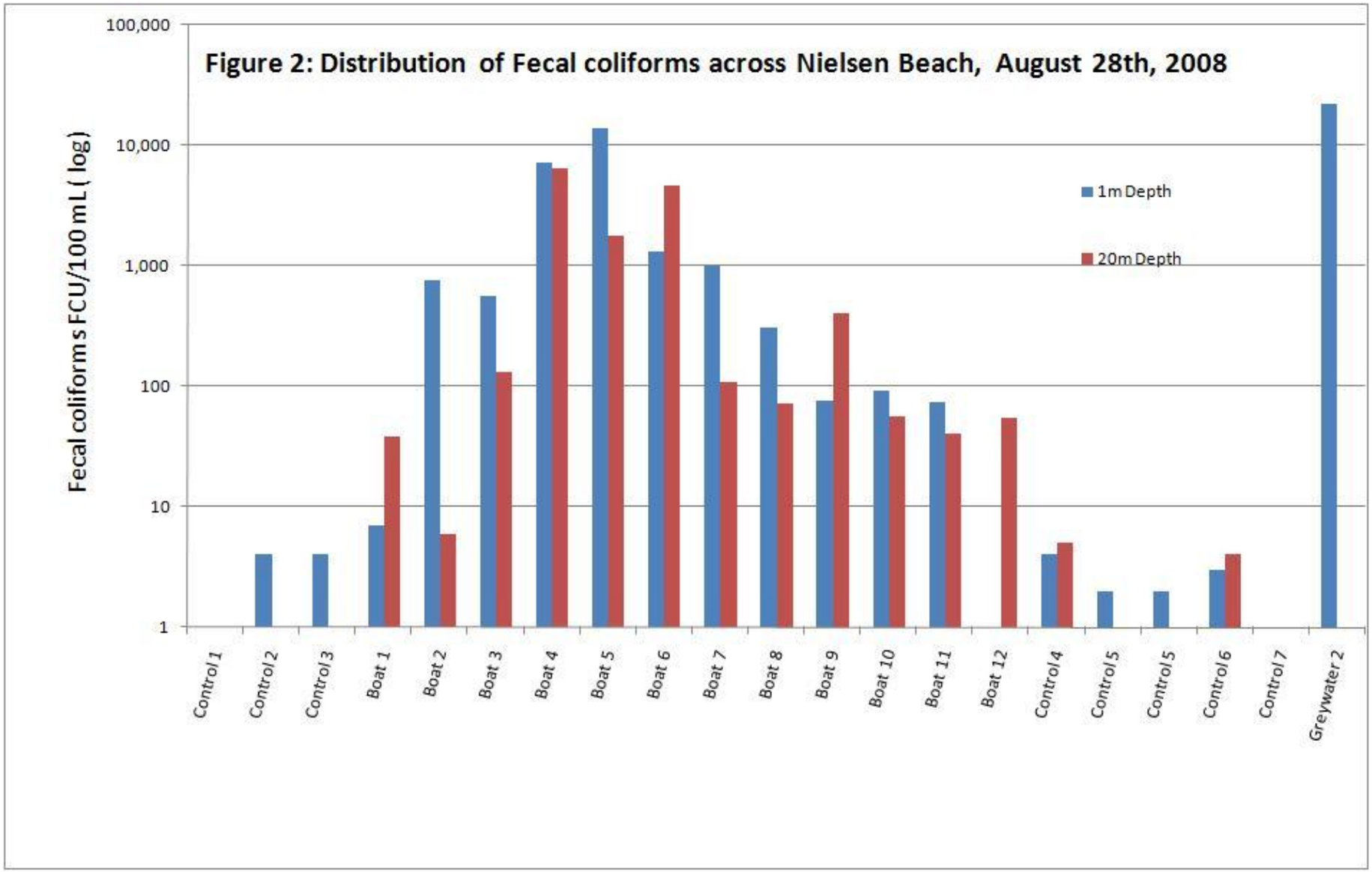
Figure 2: Distribution of Fecal coliforms across Nielsen Beach, August 28th, 2008
Fecal coliforms FCU/100 mL (log)
100,000
10,000
1,000
100
10
1
1m Depth
20m Depth
Control 1
Control 2
Control 3
Boat 1
Boat 2
Boat 3
Boat 4
Boat 5
Boat 6
Boat 7
Boat 8
Boat 9
Boat 10
Boat 11
Boat 12
Control 4
Control 5
Control 5
Control 6
Control 7
Greywater 2

Figure 3: Air Photo of 2008 Sample Sites