



# SEVERN SOUND ENVIRONMENTAL ASSOCIATION REPORT ON CHURCH BAY SEDIMENT QUALITY SURVEY 2012



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## Introduction

At the request of the Township of Georgian Bay, the Severn Sound Environmental Association conducted a sediment quality survey of Church Bay on November 23, 2012. The purpose of the survey was to characterize the quality of surficial sediment within Church Bay in comparison with a) sediment quality at a reference site outside of Church Bay within Honey Harbour, b) known sediment quality of Severn Sound and c) sediment quality guidelines.

## Background

Bajc (1994) reported on the quaternary geology of the area and indicated that embayments between Precambrian bedrock ridges within the Georgian Bay Fringe physiographic area, such as Church Bay, consist of sub-glacial conduit deposits (sands, silts and clays). These deposits lie within depressions in the Precambrian bedrock. The "native" or base material in Church Bay can consist of bedrock, sand, silts and clays which have been overlain with more recent deposits of organic muds.

## Methods

The shallow depths combined with storm events and boat traffic in the bay have made it unlikely that any long-term sediment deposition (or layering) of fine organic sediments has taken place to allow meaningful stratigraphy that could be cored. Accordingly, the survey consisted of surficial sediment sampling using a petite ponar grab. Grab samples were collected and placed in a stainless steel basin, pre-rinsed with hexane, for distribution into sample containers. Samples for petroleum hydrocarbons were collected using a separate disposable collecting device provided by the laboratory (one for each sample to avoid cross-contamination). Samples for other tests were collected from the sample using a pre-rinsed stainless steel spoon (rinsed between sites with hexane).

Fifteen sampling sites were selected to represent nearshore and offshore locations within the bay (Figure 1, Table 1). The depth of the sites within the bay ranged between 1.1 and 1.9 m (approximate deepest point in Church Bay). A location in Honey Harbour, outside Church Bay (off Royal Island) was included as a reference site (depth 8.0m). Split and replicate samples were also included for quality assurance/quality control purposes (split and replicate samples were not identified to the lab). The accredited lab used was Caduceon Environmental Laboratories. Analyses for which sediment was tested included: total phosphorus, total Kjeldahl nitrogen, total organic carbon, loss on ignition, metals (aluminum, antimony, arsenic, barium, beryllium, bismuth, cadmium,

chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, strontium, thallium, uranium, vanadium, zinc), oil and grease (total, animal, vegetable), petroleum hydrocarbons (F1-F4/BTEX) and polycyclic-aromatic hydrocarbons (PAHs). Analytical methods used by Caduceon Environmental Laboratories for PAHs, petroleum hydrocarbons and oil and grease are consistent with MOE requirements for sediment and soil testing.

Sediment data were tested for normality using a Ryan-Joiner test, and with the exception of oil and grease AN/VEG, all variables were found to be normally distributed. Statistical analyses applied to the data include the following: correlation analysis using Pearson product moment correlation coefficient was conducted for the nutrient and metals data; a Tukey-Kramer test in combination with ANOVA was used to assess differences among stations within Church Bay that were grouped by location; and descriptive statistics were applied to variables with more than 50% measured values. Variables that measured below method detection limits were not used in statistical analyses.

## **Results**

Our survey and visual observations confirmed the materials generally described by Bacj (1994) at various locations around the bay. Samples were predominantly mud with the exception of some samples taken near the bridge on Picnic Island Rd and near the shoreline nearby which were sandy. Rooted aquatic plant roots were found at 13 of 14 sampling sites within Church Bay (Table 1). The presence of hydrogen sulfide ( $H_2S$ ), a sign of anaerobic conditions, was noted in the sediment samples at two locations within Paragon Marina.

Results were compared to Ontario Ministry of Environment Sediment Quality Guidelines (lowest and severe effects levels; Persaud et al. 1993 and Fletcher 2008). Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines are also noted for information. The reference site in Honey Harbour and known sediment quality of other sites within Severn Sound are also compared with results for Church Bay (Table 2).

Table 2 shows the nutrient and metals concentrations in the sediment samples from Church Bay. The nitrogen (TKN) and phosphorus concentrations at most sites exceeded the Severe Effect Level, reflecting the highly organic nature of the sediments and enriched conditions. Note that the sediments described as sand (CB14) had low concentrations of N and P. The N and P values in Church Bay and in other parts of Honey Harbour are higher than in other areas of Severn Sound. Compared to the sediment guidelines, concentrations of metals are typical for mud sediments in Severn Sound. Most values are below or just above the Lowest Effect Level of the MOE Sediment Quality Guidelines (SQGs).

Table 3 shows the oil & grease, petroleum hydrocarbon and BTEX results from the survey. The light fractions of petroleum hydrocarbons, F1, F2 (which would have

included gasoline and fuel oil) were not present at any station in Church Bay or the Honey Harbour site. Trace amounts of the heavier fractions, F3 and F4, were found at some Church Bay stations and in the Honey Harbour station. Remarks on petroleum hydrocarbons are interpreted at the lab against standard patterns and, if a clear comparison can be made by the analyst, are described (for example as heavy oil (HO), fuel oil (FO), etc.) or given the remark “no distinct pattern” (NDP). Sample results for this survey were determined to be either heavy oil or no distinct pattern (see Table 3). Heavy oil would be the equivalent of motor oil. The total oil and grease results were compared with the guideline for oil & grease (see “Additional parameters” from the MOE Open Water Disposal Guidelines in Persaud et al. 1993; guideline = 0.15%). The sample from off the Parks Canada dock was only slightly above this guideline. Organic chemicals associated with petroleum products (called BTEX) were below detectable levels in the sediment samples (Table 3). Polycyclic aromatic hydrocarbons (PAHs) are normally associated with the burning of fossil fuels in the absence of industrial processes. In the Church Bay survey, no PAHs were detected (Table 4).

Pearson correlations showed that concentrations of all metals except for mercury were highly correlated with sediment organic content (LOI and TOC) and nutrient concentrations (TKN and TP) (Table 5). Most metals bind with organic material, thus strong correlation with TOC and LOI is expected. Due to strong correlations with sediment nutrients and organic content, all metals except for mercury were also highly correlated with one another. These findings are consistent with the relationships seen in sediments of Severn Sound (Kranzberg and Sherman, 1995).

## CHURCH BAY TRIBUTARY WATER QUALITY SURVEY 2012

As requested by the Township, SSEA conducted an investigation into the quality and potential sources of contamination from the tributary flowing into Church Bay at the Picnic Island Rd causeway to Picnic Island (Figure 1).

Several sites were documented during 2012, including the tributary drainage channels (Figure 1, Table 6). The intention of the sampling program was to collect water samples in the tributary flowing to the bay during or immediately following rain events to determine where along the route of the stream contaminant sources came in. Unfortunately, following the preliminary survey of June 18, 2012, no rain events occurred over the summer that generated flow in the stream which could be sampled by SSEA staff at a time appropriate for submitting samples.

The tributary had sufficient flow during a second survey on October 12, 2012, and the results of these samples are shown in Table 7. It is difficult to draw conclusions based on one sample taken in the fall, but it can be reported that the pH, colour, and TKN and TP concentrations were in the same ranges as those found in a 2002 survey done by MOE (Table 7). Alkalinity, conductivity and concentrations of all ions, DOC and nitrate were greater than the median reported by MOE, while the turbidity and ammonia concentration was lower than the median reported by MOE. Based on this evidence, it appears that a major change in basic water chemistry has taken place between 2002 and 2012. This should be investigated further.

Comparing data from the tributary to open water data collected in Church Bay on October 4 2011, the ionic content and nutrient concentrations of the tributary waters is much different than that of Church Bay. Nitrogen parameters were slightly elevated in the tributary compared to the open waters, and TP was more than three times greater in the tributary (Table 7). Alkalinity, conductivity and ion concentrations were all an order of magnitude greater in the tributary, indicating heavy watershed influence on basic chemistry.. From the field data collected, it can also be reported that the field conductivity upstream and downstream of the Paragon building tripled from 305 to 1071 uS/cm respectively during the October 12<sup>th</sup> sampling (Table 6). It will be necessary to pursue this investigation during 2013 in order to assess contaminant sources further.

## REFERENCES

Bajc, A.F. 1994. Quaternary geology of the Huntsville-Penetanguishene area, Central Ontario. Ontario Geological Survey, Open File Report 5882, 134p.

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**CHURCH BAY TRIBUTARY QUALITY AND SEDIMENT SURVEY 2012**  
**Cost details for project – Final cost to Township \$12,961**

<b>Church Bay Sediment Survey</b>	<b>Budget</b>	<b>In-kind</b>	<b>Invoice</b>	
Boat, motor and operator		\$0	\$622	(1)
Sampling equipment		\$3,000		
Sampling	\$2,401		\$2,401	
Sediment chemistry analyses	\$2,260		\$7,425	(2)
Sub-total:	\$4,661	\$3,000	\$10,447	
<b>Church Bay Creek Investigation</b>				
Sampling equipment		\$3,000		
Sampling	\$1,647		\$1,647	
Lab analyses	\$525		\$184	
Sub-total:	\$2,172	\$3,000	\$1,831	
Project Subtotal:	\$6,833		\$12,278	
Project Administration:	\$683		\$683	
Total Funding Request:	\$7,516		\$12,961	
Total Project Value:	\$13,516			

- (1) Note that rental boat was used instead of MOE vessel and additional in-kind equipment was provided by MOE
- (2) As per discussion with the Township, the cost of analyses was increased in order to allow for PAHs, enhanced oil and grease, petroleum hydrocarbons and BTEX