MAPLE LEAF GOLF AND COUNTRY CLUB

Recoverable Trace Metals in Sediment

Part 2

"AN AUDUBON INTERNATIONAL GREEN NEIGHBORHOOD PROJECT"

NATURAL RESOURCES COMMITTEE

April 2018

"A PROUD WINNER OF THE NATURE AWARD"

Recoverable Trace Metals in Sediment from Maple Leaf Golf and Country Club Ponds-Part 2.

Maple Leaf Golf and Country Club Natural Resources Committee, 2018.

Summary

The principal source of water to Maple Leaf Golf and Country Club (MLG&CC) ponds is from storm water runoff. The major water input to ponds is from the inflow located on the northern property line adjacent to Rampart Avenue. Ponds also receive internal inputs from the Park's storm runoff drainage systems. Sediments in the Rampart receiving pond were analyzed in 2016 for trace metals and reported. (*NRC 2017*). Sediments from five other ponds were analyzed for trace metals in 2018. The trace metal testing is part of an ongoing program to characterize storm water impact on park pond water quality and a need to establish a set of baseline data for future assessments.

Sample collection

Grab samples were collected on April 16, 2018 (see Figure 1 for locations). Originally, we intended to take core samples from the deepest part of each basin by hiring a golf ball scuba diver. However, due to numerous alligator incidents, no divers were available. Instead grab samples of sediment were collected from the nearshore zones by a snorkeler. Samples were collected on-average at 6-8-foot depths and represent a well-mixed portion of the top four inches of settled material.

The sediments were scooped directly into cleaned 500 ml wide mouth plastic jars and capped with a plastic lid. Samples were air dried, thoroughly mixed and screened through 1/8" plastic mesh to remove shells, twigs and other coarse materials.

Smaller sub samples were taken for trace metal analyses.

Analysis

Recoverable Metals in Sediment, Method EC 2404.

The method recovers metals adsorbed on sediment particles and metals in the form of insoluble salts and organic complexes. There may be some leaching of metals from the surfaces of the mineral portion of the sediment, however, metals trapped within the silicate matrix are not extracted. Recovery of metals may vary depending on the type and proportion of minerals present in the sediment. Metals extracted by this procedure are considered as "environmentally available". A half gram of homogeneous freeze-dried sediment is digested with nitric and hydrochloric acids. The sediment is analyzed by inductively coupled argon plasma- collision/reaction cell mass spectrometry (CRC-ICP-MS). Each element is measured at a specific mass to charge ratio (m/z value expressed in atomic mass units). Concentrations are reported on a dry weight basis.

Mercury in Sediment by Combustion, EPA method 7473.

Fifty milligrams of homogenized freeze-dried sediment are thermally and chemically decomposed at 750 ^{o}C in an oxygen rich environment. Released mercury vapor is measured through a set of two absorbance cells with a flameless atomic absorption spectrometer set at an absorbance of 253.7 nm.

Percent Carbon, Nitrogen and Organic Matter

Dried sediment samples (200 mesh particle size or smaller) treated with 6% sulphuric acid solution to remove inorganic carbonates were analyzed for carbon using an Exeter 440 CHNS/O Analyser. The method utilizes combustion to convert the sample elements to the following simple gases: CO2, H2O and N2. The combustion products are passed through an oxygen atmosphere to assure complete oxidation and removal of undesirable by-products, such as sulphur, phosphorous and halogen gases. Helium is the carrier gas. Measurements are made by a series of thermal conductivity detectors. Concentration of carbon, nitrogen and organic matter are reported as a percentage.

Table 1. Percent Carbon, Nitrogen and Organic Matter in Rampart Pond Sediment Samples.

Site number	% carbon	% nitrogen	% organic matter
Site 3 Rampart 2016	1.5	0.04	3.7
1	0.10	0.1	0.28
2	0.07	0.23	0.36
3	0.16	0.33	0.57
4	0.11	0.71	0.96
5	0.17	0.78	1.03

Figure 1. Trace Metal Sampling Sites- 2018 from Maple Leaf Golf and Country Club Ponds-Part 2.

Results and Observations

Elemental measurements were provided at no charge by a certified analytical laboratory in August 2018. Although the data is considered highly reliable, for these reasons their use here is for informative purposes only.

Site 1 is near the wharf on the NW corner of our largest pond. The site receives water from the Humpback bridge pond (site 2), storm water runoff from the Rampart inflow stream and reclaimed water purchased from Charlotte County. Site 2 is in the pond on the west side of the Humpback bridge. This pond primarily receives storm water runoff from the northern section of the Park's road drainage sewers. The site may receive some backflush from the pond on the eastside of the bridge. Site 3 is downstream of the Rampart inflow and is on the outflow watercourse, but also receives water from the site 1 pond. Site 4 is further downstream of site 3 near the control weir at hole 10. The sample was taken in the small eastern bay which receives some storm water from a small ditch. The bay protects the area from extreme flows which occur during heavy summer rains. Site 5 located on the west side of the pond adjacent to the 17th fairway. This pond receives water almost entirely from the SW area of the park's storm water drainage system. This pond is normally considered to be our control site since it is rarely impacted by external water sources. It is of interest that concentrations at site 2 are typically lower. One of the main differences between these sites is that site 2 is not subject to inputs that may arise from golf course operations.

Trace element concentrations as ppm (ug/g) dry weight sediment are provided in Table 2. There were no concentrations of a "hazardous" element that would cause any environmental concern. The five elements with the highest concentrations (iron, calcium, aluminum, sulphur and phosphorous) are the same elements observed with the highest concentration in the 2016 Rampart inflow study (*NRC 2017*).

In comparison the elemental concentrations measured in 2016 sediments at the Rampart inflow (shown in red text, Table 2), are in nearly all cases an order of magnitude higher than concentrations found in all other pond sediments, the only exception being manganese at site 1, which had the same concentration.

The declining trend in concentrations with distance from the Rampart source is illustrated in Figure 2 which charts the five most prominent elements. For comparison purposes the 2016 inflow concentrations for iron, aluminum and calcium had to be reduced 10 times to facilitate the charting. The only anomaly to decreasing downstream concentrations is a spike in calcium concentration at site 4.

The data indicates that the most significant source of trace metals in pond sediments is the Rampart inflow. This pattern, although not as striking was also observed for suspended solids, dissolved nitrites and fecal coliform concentrations in 2015 water samples (*MLG&CC 2015*).

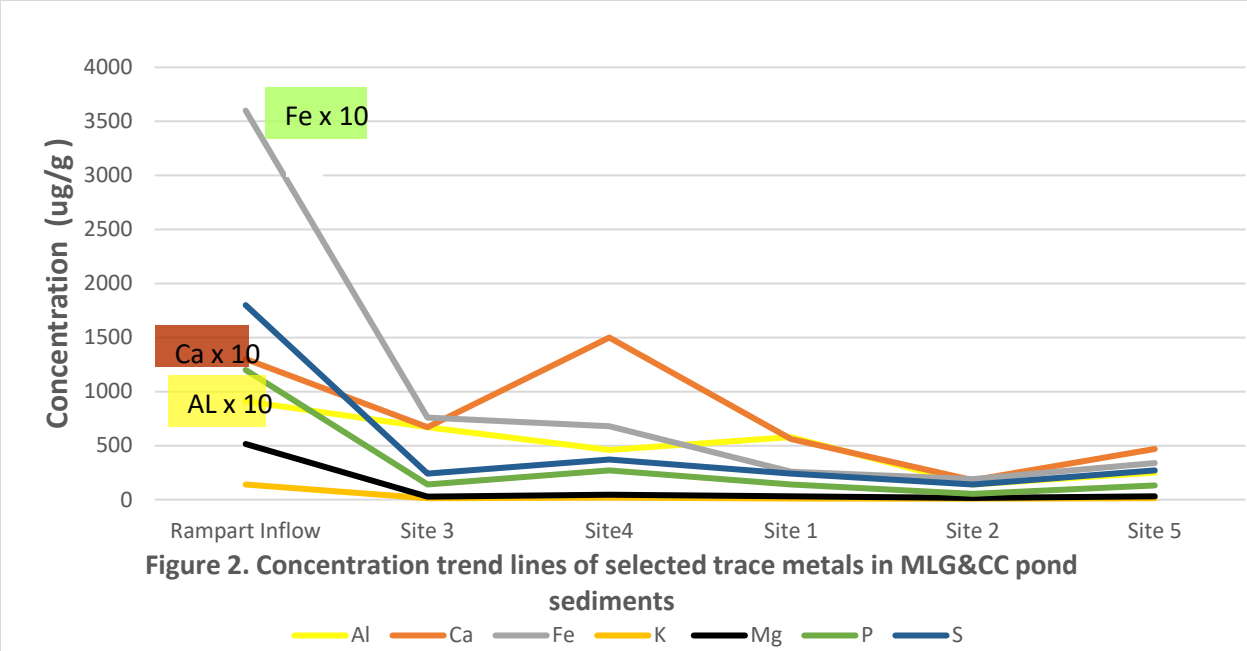

Figure 2. Concentration trend lines of selected trace metals in MLG&CC pond sediments

References

NRC, 2017. Recoverable Trace Metals in Sediment from Maple Leaf Golf and Country Club Rampart Pond, Maple Leaf Golf and Country Club Natural Resources Committee, 2017, pages 1-6.

MLG&CC 2015. Maple Leaf Golf and Country Club Inflow Water Sampling Project 2015.

Table 2. Concentration of Trace Elements in Maple Leaf Golf and Country Club Pond Bottom Sediments 2018.

Method Detection Limit	Atomic		Rampart Inflow	*Concentration* µg/g (ppm) dry weight				
MDL (ug/g)	Symbol	Chemical Name	Site 3 2016	Site 1	Site 2	Site 3	Site 4	Site 5
0.005	Ag	silver	0.042	0.002	***nd***	***bdl***	***bdl***	***bdl***
20	Al	aluminum	9100	580	140	670	460	250
0.02	As	arsenic	5.49	0.43	0.17	0.32	0.35	0.37
0.05	Au	gold	nd	***nd***	***nd***	nd	nd	nd
5	B	boron	2	***nd***	***nd***	nd	nd	nd
0.5	Ba	barium	33	2.1	0.8	1.9	1.7	1.3
0.005	Be	beryllium	0.25	0.019	0.005	0.023	0.021	0.015
0.005	Bi	bismuth	0.06	0.005	***bdl***	***bdl***	***bdl***	***bdl***
50	Ca	calcium	13000	560	180	670	1500	470
0.01	Cd	cadmium	0.08	0.01	bdl	0.01	0.02	0.01
0.02	Ce	cerium	20	1.62	0.68	1.21	1.65	0.88
0.01	Co	cobalt	0.79	0.07	0.03	0.1	0.11	0.09
0.05	Cr	chromium	22	2.19	0.48	1.44	1.38	0.79
0.005	Cs	caesium	0.15	0.014	***bdl***	0.013	0.016	0.008
0.2	Cu	copper	12	1.0	0.2	0.5	0.9	0.7
5	Fe	iron	36000	260	190	760	680	340
0.01	Ga	gallium	2.3	0.20	0.04	0.19	0.14	0.07
0.1	Gd	gadolinium	2.2	***bdl***	***bdl***	***bdl***	***bdl***	***bdl***
0.02	Ge	geranium	0.11	***bdl***	***bdl***	***bdl***	***bdl***	***bdl***
0.001	Hg	mercury	0.017	0.002	***bdl***	0.002	0.002	0.002
20	K	potassium	140	11	9	14	19	13
0.01	La	lanthanum	10	0.84	0.35	0.67	0.85	0.46
0.05	Li	lithium	4.5	0.42	0.08	0.62	0.36	0.21
10	Mg	magnesium	515	32	16	29	47	31
0.5	Mn	manganese	13	14	1.4	2.3	2.3	2.9
0.02	Mo	molybdenum	0.97	0.08	0.05	0.07	0.10	0.06

Table 2 cont'd. Concentration of Trace Elements in Maple Leaf Golf and Country Club Pond Sediments 2018.

Method Detection Limit	Atomic		Rampart	*Concentration* µg/g (ppm) dry weight				
			Inflow					
MDL (ug/g)	Symbol	Chemical Name	Site 3 2016	Site 1	Site 2	Site 3	Site 4	Site 5
5	Na	sodium	190	19	19	24	26	17
0.05	Nb	niobioum	0.09	***bdl***	***bdl***	***bdl***	***bdl***	***bdl***
0.2	Ni	nickel	3.3	0.9	***bdl***	0.4	0.4	***bdl***
20	P	phosporous	1200	140	54	140	270	130
0.02	Pb	lead	6.4	0.52	0.20	0.42	0.40	0.27
0.02	Pd	palladium	***nd***	***nd***	***nd***	***nd***	***nd***	***nd***
0.01	Pt	platinum	***nd***	***nd***	***nd***	***nd***	***nd***	***nd***
0.05	Rb	rubidium	1.1	0.08	***bdl***	0.07	0.10	0.05
0.002	Rh	rhodium	***nd***	***nd***	***nd***	***nd***	***nd***	***nd***
20	S	sulphur	1800	240	140	240	370	270
0.01	Sb	antimony	0.29	0.03	0.02	0.03	0.05	0.03
0.02	Sc	scandium	1.8	0.09	0.02	0.13	0.07	0.06
0.02	Se	selinium	0.67	0.03	0.02	0.05	0.04	0.02
0.1	Sn	tin	0.2	***nd***	***nd***	***nd***	***nd***	***nd***
0.05	Sr	strontium	140	9.9	4.4	6.9	10	6.6
0.02	Te	tellurium	***nd***	***nd***	***nd***	***nd***	***nd***	***nd***
1	Ti	titanium	13	5	2	5	6	4
0.005	Tl	thallium	0.05	0.006	***bdl***	0.006	0.1	***bdl***
0.002	U	uranium	2.6	0.33	0.10	0.30	0.50	0.26
0.1	V	vanadium	28	0.8	0.4	1.7	1.4	0.8
0.02	W	tungsten	***nd***	0.08	0.03	***bdl***	***bdl***	***bdl***
0.01	Y	yttrium	8.3	0.70	0.22	0.68	0.87	0.44
0.5	Zn	zinc	34	4.9	0.9	1.3	3.4	2.5
0.2	Zr	zirconium	1.4	***bdl***	***bdl***	***bdl***	***bdl***	***bdl***

nd = not detected

bdl= measurement below mdl.