Swan Lake Remediation

by Jon Van Loon

Henry Ford once stated: "Coming together is a beginning; keeping together is progress; working together is success". The following story bespeaks just such necessary cooperation. The main partners in this particular instance are Dr. Gertrud Nurnberg and colleagues of Freshwater Research, the Ministry of the Environment and the City of Markham.

Dilemma

Most small urban lakes generally have deteriorating water quality issues that, with the passage of time, result in unaesthetic and unsafe water conditions. Swan Lake is one such lake. In recent years Swan Lake residents have unhappily reported ugly, green algal blooms along the shoreline in late spring and, in late summer, slimy cyanobacterial blooms and highly turbid water quality. Occasionally widespread winter fish kills become apparent after the ice goes out. These observations are just the obvious vestiges of a complex underlying situation.

Action

Frequently these predicaments can be rectified. In this regard, the City of Markham has adopted a carefully researched remedial plan that is going into effect this spring.

History and Timeline to this Commitment

Once there was a gravel pit that became a small lake, now called Swan Lake. This happened one afternoon in the late 70's when excavators intersected an underground water flow known as an aquifer. Almost overnight the quarry filled with water resulting in a relatively pristine lake 5.5 hectares in surface area with a maximum depth of five meters and an average depth of 1.9 meters. Like many others in the GTA it gradually became encompassed in increasing urban density and received pollutant content in many ways.

The goose population has increased appreciably and their droppings and those from other waterfowl have added to the water quality problems. Another problematic issue in the Swan Lake and bordering areas was past dumping of construction-related waste. Exacerbating the pollution issues, Swan Lake, having no major natural inlet and outlet fresh water flows, is particularly susceptible to contaminant build-up. According to Dr. Nurnberg's report, while geese and other waterfowl may contribute a significant part of the external phosphorus loading, the estimated contribution is only 12% of the total value.

Two storm-water management ponds have been constructed; the most obvious to Swan Lake residents being south of the path leading from the Lakeside/Celebrity Green gate to the path bordering the lake. The storm-water management ponds retain and improve the runoff water quality from the first 25mm of runoff before discharging it back to the downstream storm sewer. Storm events larger than 25 mm will discharge directly into Swan Lake. Such ponds must be dredged of sediment every several years and residents may have observed this occurrence in 2010.

A Beginning

From an historical point of view, the first important event which indicated publically the desire of the then Town of Markham to cooperate in the betterment of Swan Lake occurred the week of July 11, 2011.

Fishing has long been a local recreation with most individuals bagging their catch and presumably consuming them. In the absence of data that the fish in the lake had been tested and found fit for human consumption and considering the potential toxic factors relating to the presence of blue green alga (cyanobacteria that can contain toxic substances) and other pollutants, particularly heavy metals, consumption of fish from Swan Lake became a concern.

To this end the first good news to be stressed in this article resides in an email from the Commissioner of Fire and Community Services Markham. It stated **"The signs will be put up this week that indicate no fishing, no swimming, no eating of these fish. We are using universal pictures to demonstrate these prohibitions so that they can be understood in any language."** This signage, that was erected as promised that week at all lake side park entrances by the city of Markham, is enforceable through By-Law 167-92, has a maximum fine of $5,000 and represents an important and laudable undertaking. Subsequently fishing has been permitted but the notice forbidding fish consumption remains.

Understanding Swan Lake Water Quality Problems

The chemical elements carbon, oxygen, nitrogen, potassium, and phosphorus and their compounds are the major nutrients essential for plant and animal growth. Of these, phosphorus and, to a much lesser extent nitrogen, are termed 'limiting nutrients'. This means that the abundance of phosphorus in aquatic eco systems like Swan Lake essentially determines the ultimate abun-

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dance of the biomass (total quantity of biological organisms) therein.

Like the other nutrient elements, phosphorus is present axiomatically in the environment but its natural abundance in water bodies is most commonly low. However, phosphorous-containing substances at elevated levels in urban area lakes can occur for example because of the presence of abutting farm animal waste run-off, excavation wastes, storm sewer discharges, fertilizers and industrial and household commercial products in a variety of forms. Phosphorus and its compounds which rise to elevated levels sufficient to cause nuisance biomass levels in water bodies like Swan Lake are due to human activity over the passage of time. The phosphorus problem time line in the case of Swan Lake began at a very low level with the lakes inception in 1979 remaining relatively flat until the late 1990's whence it accelerated upwards alarmingly to the present time.

Levels of phosphorus (P) alone that are consistently higher than about 20 ug/l (roughly the same concentration that one small drop of whisky would be diluted in a bathtub full of water) result in an undesirable increase in the primary vegetative biomass (mainly weeds and algae) of the system. But that is not the only problem that can result. "Many ecological effects can arise from stimulating primary production, but there are three particularly troubling ecological impacts: a) decreased biodiversity, b) changes in species composition and dominance, and c) toxicity effects" (Wikipedia http://creativecommons.org/licenses/by-sa/3.0/).

This is especially evident in the loss of desirable game fish at the expense of carp, perch and other coarse varieties. An example of this dilemma in Swan Lake is that a population of the popular game fish, Large Mouth Black Bass stocked in the lake in 1992, had totally died out by 2012 and has been replaced by the usual undesirable varieties such as carp, pumpkinseed and flathead minnows.

Many Swan Lake residents may have an interest in water quality venues other than just Swan Lake, for example lakes at which they have cottages or areas of water bodies where personal boats are docked and operated. In all these cases, as with Swan Lake, the primary biomass production levels, that is tracing the problem of excessive algal and aquatic weed growth, requires knowledge of classification of lakes based on phosphorus (trophic) levels.

The following terminology should be understood by all interested parties as these trophic stage terms should be in reports of any lake's water quality. Very qualitatively speaking, lakes are classified as Oligotrophic- having very low (P), Mesotrophic- having (P) levels consistently near the 20ug/l guideline, Eutrophic- having (P) levels consistently considerably above the 20ug/l guideline and Hyper-Eutrophic- having (P) levels which consistently greatly exceed the 20ug/l guideline. Lakes classified in the latter two categories are prone to the problems described in the previous Wikipedia Quotation. Obviously hyper-eutrophic lakes can become an especially serious problem. Swan Lake is a worst case scenario presently falling into the hyper-eutrophic category. It is one the three most severe cases out of 17 lakes in the GTA region that have been studied.

The Cyanobacteria Trigger to Action

Unsightly green algal slimes, coarse fish and occasional winter fish kills are one thing but the recent well established occurrence of cyanobacterial slime raises the degree of seriousness of Swan Lake's excessive phosphorus content to a much higher level. Very thin blue-green slime deposits coating segments of the surface of highly phosphorus-polluted lakes are often called blue-green algae. This term is used for what is really a deposit which, although possessing some characteristics of algae such as photosynthetic capability, is really a bacteria and is therefore more properly to be known as cyanobacteria. Worldwide there is a myriad of both terrestrial and aquatic forms of cyanobacteria. In fact it is interesting to note that many scientists place cyanobacterias in a penultimate position in the formation of the earth's atmosphere a billion or so years ago. How then has a form of cyanobacteria become the pariah of Swan Lake?

Of particular serious consequence is the propensity of

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some cyanobacteria forms to produce toxins that can be harmful if in contact with humans and other animal life. Bacterial scum of this type had been noted in Swan Lake and reported, particularly in late summer, over the past few years. In response to any potential threat from the cyanobacteria and the growing magnitude of the other problems listed above, the City of Markham commissioned a study by Freshwater Research of Bayfield Ontario with sampling done by the Toronto Regional Conservation Authority. Officially, their mandate contained the following directives: The study was to determine the possible effect of this cyanobacterial scum on humans and lake biota now and in the future with particular stress on the possible production of toxins on the samples. Finally, the study aimed to determine the feasibility and, of what nature, a remediation of this problem might entail.

Important Results

Very briefly summarized, the two main points are as follows: toxin-producing species of cyanobacteria were confirmed during the monitoring but no toxins were actually identified/measured. This undesirable bacterium was stated as likely to proliferate in the future if no remedial action was performed. Additionally, Swan Lake water, confirmed by the study to be in a highly trophic state is now clearly evident to any observer to be at a high level of damaged water quality. The very elevated level of phosphorus and its compounds were discovered in large part to originate within the lake itself, with only small amounts originating from external sources including, for example, geese droppings. This suggested that phosphorus trapped in lake sediment and decaying vegetation, through complex chemical and biochemical reactions involving periodic low oxygen conditions at the lake bottom/water interface releases the problem-causing phosphorus during the summer growing season back into the water. This phosphorus is then available to nourish the problem excessive Swan Lake biomass including the cyanobacteria.

The Excellent News - a Proposal for Remediation

Since the Swan Lake problem-causing phosphorus cycles in and out of the lake bottom sediment and water column, a treatment should involve some method of permanently trapping the bulk of the phosphorus in this detritus. This can be likened in a crude fashion to covering the bottom with a phosphorus-immobilizing blanket.

An Australia-developed product called Phoslock™ was recommended to be the best choice. This product consists of a naturally-occurring clay. Clays are finely layered in structure and this means that a substance with reactive sites capable of trapping phosphorus can be incorporated by being adsorbed onto the surface of each layer within the clay. The phosphorus is thus chemically locked into the Phoslock™ so it can no longer be released into the Swan Lake water to cause the former adverse biomass production. This will also stop the toxin-producing cyanobacteria growth.

The following describes the commitment resulting from the Freshwater Research report and recommendations that Markham has stated they will undertake: Beginning on April 29, 2013 the recommended amount of Phoslock™ will be applied to Swan Lake. The lake biomass and total phosphorus levels will continue to be monitored following the application of Phoslock™. Based on the results of monitoring, if further Phoslock™ is necessary a second application will be used to lower the phosphorus to acceptable levels.

The Future

It was also happily noted that the City of Markham is committed to long-term monitoring of Swan Lake and other water bodies as a basis on which to enact improvements throughout the area.

It is important to indicate that any remediation program such as that with Phoslock™ in Swan Lake requires careful monitoring if the best chance for success is to be realized and the good news is that such has been promised. Thus we must expect a period during which a transition will likely occur. Thus for example, if this summer some level of the previous problems might be noted this does not indicate failure of the program. As a scientist I am the first to recognize that just as Rome was not built in a day so a program for the remediation of Swan Lake must be given time to have the maximum effect. I have read and discussed much of what is available relating to Swan Lake water quality and am pleased with the proposed plan for remediation.