Town of Halton Hills

Fairy Lake Water Quality Study

Report

Environment

Town of Halton Hills

Fairy Lake Water Quality Study

Prepared by:

AECOM
2 – 512 Woolwich Street 519 763 7783 tel
Guelph, ON, Canada N1H 3X7 519 763 1668 fax
www.aecom.com

Project Number:

107983

Date:

December, 2009

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report:

- are subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represent Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- have not been updated since the date of issuance of the Report and their accuracy is limited to the time period and circumstances in which they were collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- were prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Unless expressly stated to the contrary in the Report or the Agreement, Consultant:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared or for any inaccuracies contained in information that was provided to Consultant
- agrees that the Report represents its professional judgement as described above for the specific purpose described in the Report and the Agreement, but Consultant makes no other representations with respect to the Report or any part thereof
- in the case of subsurface, environmental or geotechnical conditions, is not responsible for variability in such conditions geographically or over time

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

AECOM
2 – 512 Woolwich Street
Guelph, ON, Canada N1H 3X7
www.aecom.com
519 763 7783 tel
519 763 1668 fax

December 22, 2009

Mr. Warren Harris
Manager of Parks and Recreation
Town of Halton Hills
1 Halton Hills Drive
Halton Hills, ON L7G 5G2

Dear Mr Harris:

Project No: 107983

Regarding: Fairy Lake Water Quality Study – Final Report

We are pleased to submit 30 copies of the final report for the Fairy Lake Water Quality Study. The objectives of the study were to identify the causes of water quality issues, identify emerging or potential concerns, and provide cost-effective recommendations for their management.

Based on our investigations, we found that Fairy Lake is a clear, shallow-water ecosite that naturally supports abundant aquatic vegetation. This interpretation implies that Fairy Lake would be more appropriately considered to be a wetland community than a lake, and should be managed accordingly. Therefore, one of the primary management recommendations is to improve public awareness and education on basic lake, wetland and wildlife ecology including information on the links between waterfowl-human interactions with water quality issues as well as the role of aquatic vegetation in healthy lake systems.

If you have any comments or questions related to this report or the work performed, please feel to contact me at 519-763-7783 extension 5141.

Sincerely,
AECOM Canada Ltd.

Deborah Sinclair

Deborah Sinclair, M.A.Sc.
Senior Aquatic Scientist

DS:lb
Encl.

Distribution List

# of Copies	Association / Company Name	PDF	Hard Copy
30	**Town of Halton Hills**	**X**	**X**
2	**AECOM Canada Inc.**	**X**	**X**

Signature Page

Report Prepared By:

Sarah Aitken, B.Sc.
Aquatic Ecologist

Report Prepared By:

Rosalind Chaundy, M.Sc.F
Senior Ecologist

Report Prepared By:

Tammy Karst-Riddoch, Ph.D.
Senior Aquatic Scientist

Report Prepared By:

James Kamstra, M.E.S.
Senior Ecologist

Report Prepared and Reviewed By:

Deborah Sinclair, M.A.Sc.
Senior Aquatic Scientist

Executive Summary

AECOM was retained by the Town of Halton Hills in June 2008 to conduct a water quality study for Fairy Lake. In addition to characterizing the lake, the study also provides recommendations to the Town staff and other park users on how to manage Fairy Lake, with specific focus on residents' concerns with proliferation of aquatic plants. This includes the appropriate public awareness and education measures related to the specific issues associated with the lake.

AECOM, in collaboration with Credit Valley Conservation (CVC) collected water quality information, sediment cores, waterfowl observations and Ecological Land Classification (ELC) information. Field investigations were completed in the summer of 2008 and 2009, and included:

- bathymetric survey;
- water quality sampling;
- sediment sampling, including sediment age, depth, composition and probable cause of 'hot spots';
- vegetation survey; and,
- waterfowl inventory.

Bathymetry
The bathymetric survey revealed that Fairy Lake has a surface area of approximately 26 ha and a perimeter of 4.6 km. The south end of the lake has a depth of less than 2 m, while deeper water is restricted to small areas in the main and Prospect Park basins of the lake. Average lake depth is 1 m and the maximum depth is 7 m.

Water Budget
Surface water inputs from precipitation represent over 90% of the total water input during the non-drought period. During the drought months (June and July) groundwater contributions are significant and account for approximately 40% of the water budget.

Water Quality
The chemical composition of Fairy Lake is characteristic of a shallow, alkaline, and productive system dominated by aquatic plants. Nutrient concentrations were elevated at all of the sampling locations in Fairy Lake, indicative of productive conditions. Bacteria levels were also elevated on one or more occasions at nearly all sampling locations. Bacteria counts were generally higher in the samples collected following rain storm events, particularly at the near shore sites. Temperature and dissolved oxygen profiles collected are common in shallow, productive lakes that do not undergo seasonal thermal stratification. Nevertheless, during periods of little mixing substantial volumes of the lake exhibit very low concentrations of dissolved oxygen and periods of anoxia are likely.

Sediments
Surface sediments from Fairy Lake were all highly organic with elevated nutrient concentrations which exceeded the Lowest Effect Level of the Provincial Sediment Quality Guidelines (PSQG, MOE 1995) for all measured nutrients with the exception of ammonia and phosphorus for selected sites. These results indicate that the sediments are highly enriched with organic matter but do not suggest that the sediments are toxic.

Vegetation Survey
The aquatic macrophyte vegetation in Fairy Lake is dominated by Eurasian Water Milfoil and Stonewort with Hornworts and several pondweed species also being abundant. Overall aquatic vegetation covers nearly all of the substrate below 2 m in depth, and a lesser amount in deeper waters. The likely causes of the proliferation of aquatic plants are high water clarity and shallow water levels in conjunction with the high nutrient concentrations in the sediments.

Waterfowl Survey
Moderate to large numbers of waterfowl were observed in and around Fairy Lake during each of the survey events, and are expected to be present from early spring through late fall. Although the waterfowl appeared to concentrate in Zone A (Figure 3) and along the boathouse area, they were also observed in other areas of the lake. On numerous occasions, people were observed feeding the geese, particularly near the boathouse.

Fairy Lake is a clear, shallow-water ecosite that naturally supports abundant aquatic vegetation. This interpretation implies that Fairy Lake would be more appropriately considered to be a wetland community than a lake, and should be managed accordingly. The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species. A moderately high diversity of native aquatic plant species is also represented.

Lake Management Recommendations
Based on the results of the field investigations, techniques to manage aquatic vegetation and waterfowl and improve water quality were considered. The goal is to provide the Town with a long-term strategy to improve water quality and aesthetics of the lake, while raising public awareness about healthy lake systems. The Town’s request to identify and provide recommendations that are cost-sensitive was considered when developing the management recommendations. The following table provides a summary of recommended management techniques for Fairy Lake, and identifies the concern addressed through the implementation of each technique.

Summary of Recommended Management Techniques

Management Technique	Water Quality	Waterfowl	Aquatic Vegetation
1. Preserve aquatic vegetation communities			•
2. Public Education	•	•	•
3. Egg oiling	•	•	
4. Improve shoreline naturalization in Prospect Park	•	•	
5. Landowner stream bank and shoreline naturalization	•		
6. Watershed – wide Poop and scoop program	•		
7. Eliminate/reduce use of fertilizers	•		•
8. Develop nutrient model	•		•
9. Reduce contaminant loads from upstream sources	•		•

Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

Fairy Lake is an impoundment of Black Creek located in the urban centre of Acton (Figure 2). The lake originated in 1830 when the Adams brothers built a dam on Black Creek to create a mill pond in order to operate a flour mill and a saw mill. Prior to the creation of the lake, the area was historically a wetland. Water from the lake was also piped to Beardmore and Co. to assist in their tannery operations. Beardmore stopped operations in 1986, and the pipeline was no longer required. The dam was left in place however and, as a consequence, higher water levels have been maintained in the 'lake'. Fairy Lake is approximately 26 hectares in area, and is at the headwater of Black Creek. As such it contributes to the water quality in that system (Sharp and Associates, 2003) and provides the main surface water source for dilution of the Acton waste water treatment plan (WWTP) downstream of the dam (CVC, 2009).

Figure 1: Fairy Lake - From bridge at Black Creek inlet

Fairy Lake, and the wetland communities surrounding it, are contained within the Eramosa River-Blue Springs Creek Provincially-Significant Wetland (PSW) complex. The southern wetland units, are also contained within the Fairy Lake Marshes Environmentally Sensitive Area (ESA). The Black Creek at Acton PSW and ESA are located downstream from Fairy Lake.

Local and area residents have been drawn to the lake for its recreational and aesthetic values for many years. Prospect Park and Rotary Park, adjacent to the lake, together provide areas for sports facilities (e.g. baseball diamonds, soccer, outdoor swimming pool), a bandshell for concerts, children's playground and a multi-use community building that provides a venue for the annual Acton Fall Fair and Canada Day celebrations. Presently, Fairy Lake provides fishing, non-motorized boating, and passive aesthetic enjoyment opportunities. There is one public beach monitored by the Region of Halton Health Department, referred to as the "Old Beach". The Town operated a boat rental facility a the lake that rented canoes and paddleboats to the public for recreation until May 2004, and the associated Boathouse Beach was closed at the time.

The lake has been termed the “Jewel of Halton Hills” as few towns or cities have similar features with such a unique heritage. Unfortunately, the natural wetland character of the lake has not always been conducive for some recreational uses (e.g., swimming and boating) and attempts to manage Fairy Lake as a ‘lake’ have been challenging.

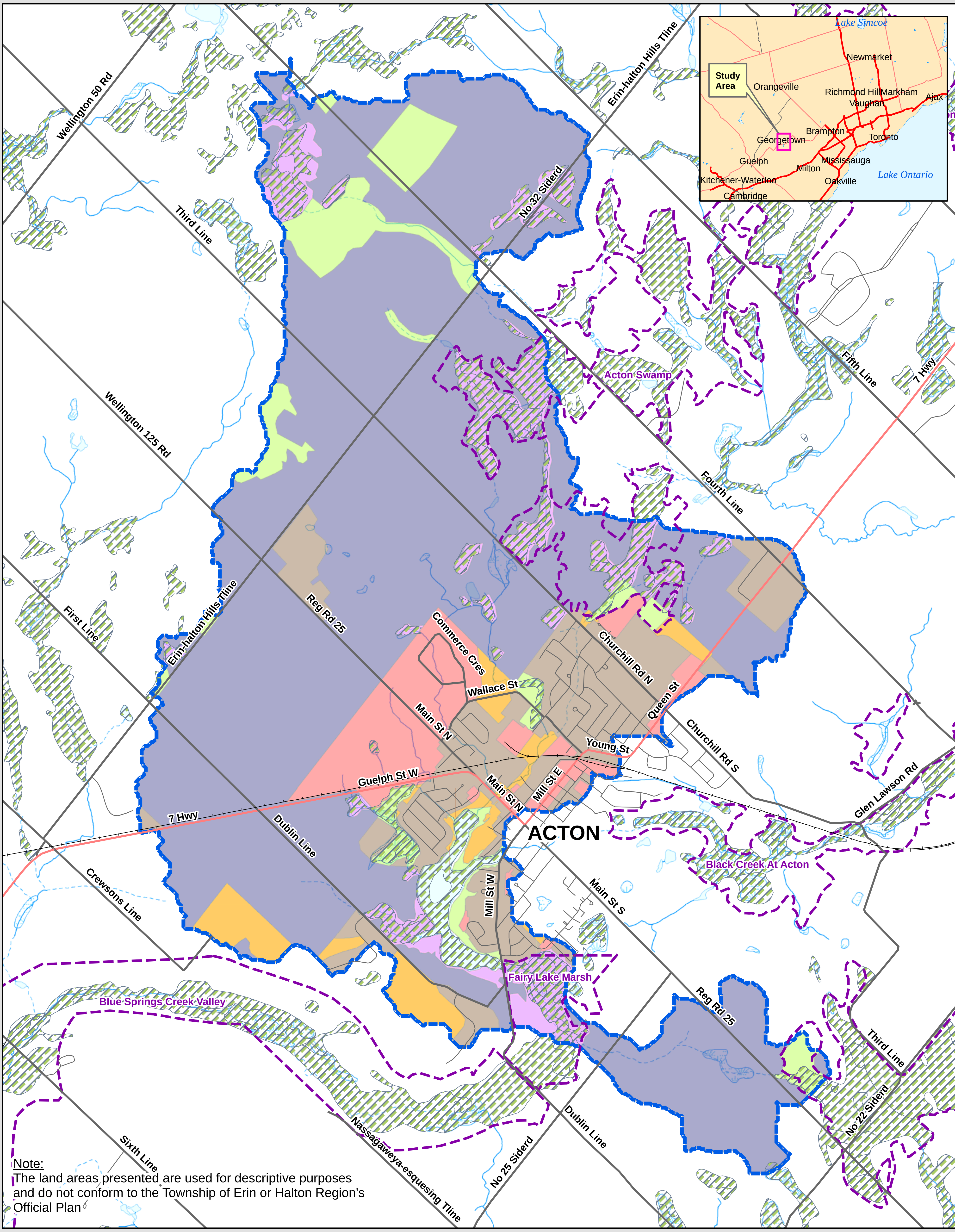
Fairy Lake’s water quality and its associated impacts have been ongoing concerns for the Town of Halton Hills (the “Town”) and its residents. Both aquatic vegetation and waterfowl have been identified as problems. As a means to control the prolific aquatic plant growth in the lake, the Town practiced plant harvesting until 1996. The activity was discontinued as a cost-saving measure. Presently, Town staff recognizes the need to understand the causes of plant growth in the lake before carrying out any management activities.

The presence of waterfowl, particularly Canada Geese, has been identified as a concern for the water quality of Fairy Lake and the recreational value of Prospect Park. High bacteria counts have resulted in periodic closures of Old Beach. The Town has undertaken some measures to mitigate the presence of waterfowl, such as implementing a “no mow” zone along selected areas on the lake’s shoreline and an annual egg oiling program, however numerous geese are still present in and around the lake.

1.1 Study Purpose

The Town recognizes management concerns for Fairy Lake that extend beyond existing water quality to include excessive plant growth and waterfowl concentrations. As such, the objectives of this water quality study are to identify the causes of water quality issues, identify emerging or potential concerns, and provide cost-effective recommendations for their management. Specifically, the Town anticipates that the study will serve as a roadmap to assist with the responsible management of Fairy Lake through:

- Developing a long-term strategy to improve water quality;
- Recommending aquatic plant management strategies;
- Identifying appropriate control measures for waterfowl;
- Developing a communications plan outline that improves public awareness, defines the role of community volunteers and promotes good stewardship; and
- Identifying areas for future study, testing and monitoring, and associated budgets.



Basemapping from Ontario Ministry of Natural Resources
Orthophotography:

N
W E
S

Kilometers
0 0.5 1
1:27,000
UTM Zone 17N, NAD 83

Legend

Fairy Lake Catchment Area

Roads
- Highway
- Major Road
- Local Road
- Railway
- ESA

Rivers
- Intermittent Stream
- Permanent Stream

Lakes and Wetlands
- Waterbody Segment
- Wetland Area, Permanent

Evaluated Wetlands
- Provincially Significant
- Locally Significant

Watershed Land Descriptions
- AGRICULTURE
- FOREST
- INDUSTRIAL AND COMMERCIAL
- PARKS and OPEN SPACE
- RESIDENTIAL
- WETLAND

Fairy Lake

Fairy Lake Catchment and Watershed Land Descriptions

December 2009
Project 107983

AECOM

Figure 2

Map Document: (D:\Projects\107983\GISSpatial\mxd\Revised MXDs July 09\107983_Fig-2_LandUse.mxd)
12/21/2009 -- 4:38:51 PM

2. Methodology

2.1 Background Information Review

AECOM conducted a review of existing background reports from local municipalities and agencies in order to examine knowledge of the key issues affecting Fairy Lake, including water quality, aquatic plants, and waterfowl. Sources of information included the following:

- Weed Control in Fairy Lake – A Presentation and Discussion of Alternatives – Mirek Sharp and Associates Inc., 2003
- Weed Inventory of Fairy Lake – Town of Halton Hills, 2004
- Background Documentation Fisheries Habitat Assessment for Fairy Lake and Black Creek – Gartner Lee Limited (GLL), 1995
- Fairy Lake Water Levels Analysis and Baseline Water Quality Study, Five Year Review, Town of Acton – GLL, 2001
- Acton Water Supply System Class Environmental Assessment – Halton Region
- A Survey of the Recreational Water Quality of Fairy Lake – Fedorowick, 1989
- Black Creek Sub-watershed Study Backgound Report – Credit Valley Conservation, 2009
- Fairy Lake Limnological Survey – University of Guelph, 1987
- Historic newspaper articles – various sources
- Eramosa – Blue Springs PSW Evaluation File – Coulson, D., J. Peluch and F. Kempf. 1984.
- Black Creek at Acton Wetland - Chuter, G. and D. Bantroch. 1987
- Egg Oiling Data – Town of Halton Hills, 2007-2009
- Old Beach Bacterial Monitoring Data – Halton Region, 1995-2009

A literature review was conducted to build upon the above-referenced material and to identify additional information relevant to waterfowl management. The following resources were reviewed:

- Habitat Modification and Canada Geese – Techniques for mitigating human/goose conflicts in urban and suburban environments (Doncaster, 2009)
- Canada Geese and Shorelines – Seasonal techniques to deter geese (Environment Canada, 2009)
- Managing Canada Geese in Urban Environments (Smith *et al.*, 1999)
- Managing problems caused by urban Canada Geese (Gosser *et al.*, 1997)
- Spraying white mineral oil on Canada goose eggs to prevent hatching (Christens *et al.*, 1995)
- Excluding non-migratory Canada Geese with overhead wire grids (Lowney, 1993)
- Management of Canada Geese at Lakeview Park and Lakefront West Park (The City of Oshawa, 2006)
- Transportation Canada: Section F – Active management using exclusion methods (Transport Canada, 2009)

- Overhead wires and monofilament lines exclude ring-billed gulls from public places (Blokpoel *et al.*, 1984)
- Canada Geese: Control and Management in Southwestern British Columbia (McFarlane-Tranquilla, 2008)

Other studies that are currently underway, and were coordinated with this study include:

- Black Creek Subwatershed Study (Credit Valley Conservation, Halton Hills, Town of Erin, and Halton Region)
- Tier 3 Pilot Water Budget (Halton Region)
- Acton Total Phosphorus Management Study (Halton Region)
- WWTP Class Environmental Assessment (Halton Region)
- Fairy Lake Water Quality and Temperature, and Dam Operation Studies (Halton Region)

2.2 Existing Conditions

Baseline field data were collected from Fairy Lake between June and September 2008. The sampling program contained the following elements:

a) Bathymetric Survey
b) Water Quality Sampling
c) Sediment Sampling (including sediment age, depth, composition and probable causes of 'hot spots')
d) Vegetation Survey
e) Waterfowl Inventory

In July 2009, an aquatic vegetation survey was conducted on the lake.

2.2.1 Lake Bathymetry and Hypsometry[1]

On July 22 and August 19, 2008, bathymetric surveys were performed to determine lake-bottom contours and used to create a bathymetric map and determine basin morphology characteristics. Bathymetry was determined by measuring water depth at regular intervals along a series of transects located across the lake. Transect locations were recorded using a Global Positioning System (GPS) and water depths were recorded using a boat-mounted depth finder. Water depths were confirmed periodically with spot measurements using a metered weighted line. Water depth values were incorporated into a Geographic Information System (GIS) framework to create a bathymetric map. In addition, a hypsographic curve of lake volume by depth was created.

[1] *Measurement of elevations of land surface with reference to mean sea level*

2.2.2 Water Quality

Water quality was sampled on four occasions during the ice free season in 2008. Sampling was conducted on June 25, July 22, August 27, and September 15, 2008. Sampling conducted in July and September followed rainfall events and June and July sampling were conducted during dry conditions. During each sampling event, surface water grab samples were collected from ten sites (Figure 3), including:

- Black Creek inlet (Site 7)
- Black Creek tributary inlets (Sites 1 and 10)
- outlet to Black Creek (Site 6)
- main basin (Site 3)
- south basin (Site 9)
- stormwater outfalls (Sites 4 and 8)
- nearshore area at the old beach (Site 5)
- adjacent to the trailer park (Site 2)

Initially, 12 sample locations were proposed. However, upon the initial site investigation, 2 of the inlets were found to be dry. As such, the total number of sample locations was reduced to 10.

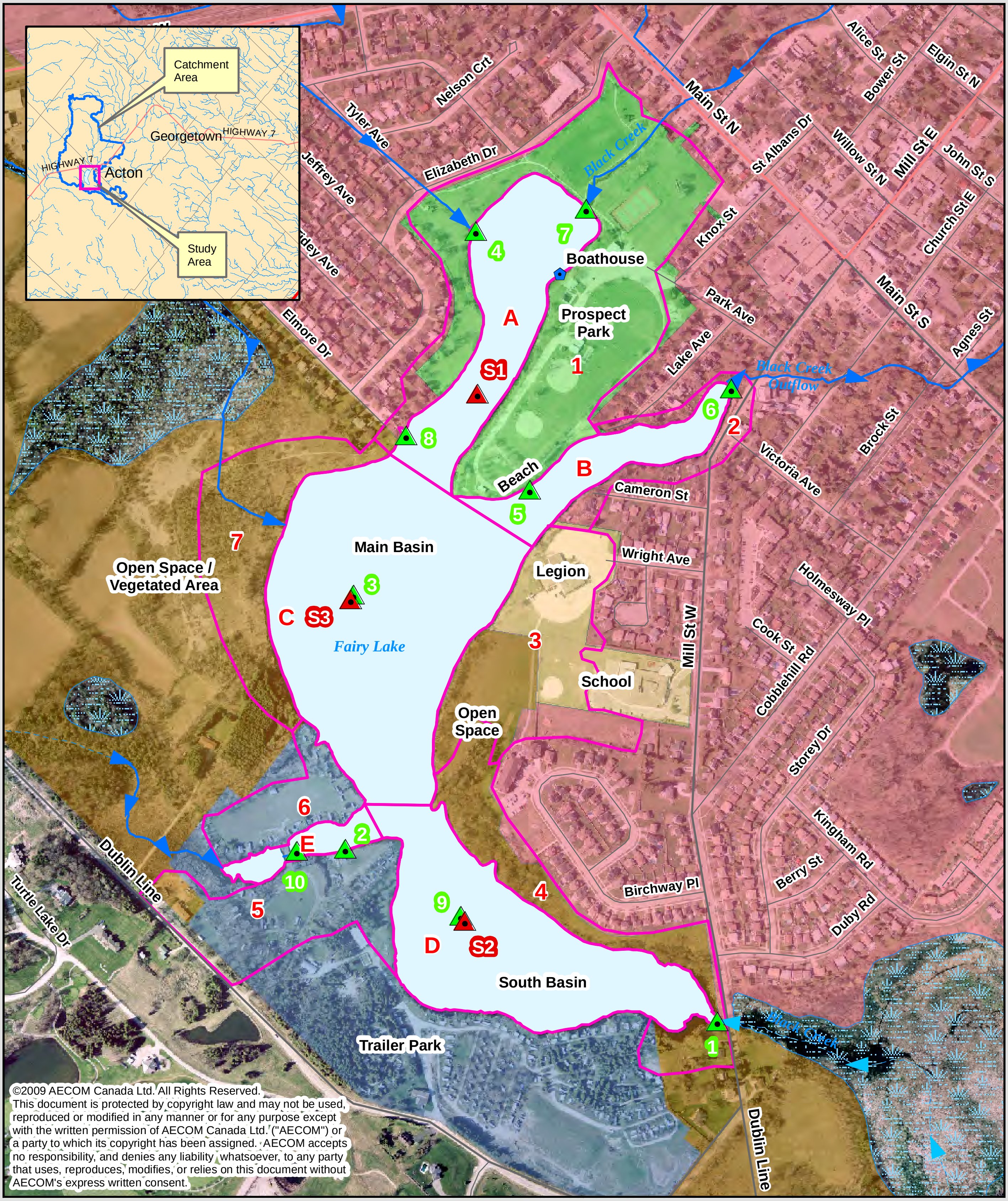
Sites 1 to 6 (Table 1) were sampled for the full parameter suite including:

- **General Water Chemistry**
  alkalinity, pH, conductivity, hardness, carbonaceous biological oxygen demand (CBOD), chloride
- **Nutrients**
  total phosphorus (TP), total Kjeldahl nitrogen (TKN), ammonia (NH_3) nitrate (NO_3), nitrite (NO_2), sulphate (SO_4), phosphate (PO_4)
- **Trace Metals and Cations**
  standard Induction-Coupled Plasma-Mass Spectrometry (ICP-MS) metals scan
- **Total suspended solids (TSS) and total dissolved solids (TDS)**
- **Bacteria**
  E. coli and fecal streptococcus

Sites 7-10 (Table 1) were sampled for a reduced parameter suite that included:

- **Nutrients**
  Dissolved organic carbon (DOC), total phosphorus (TP), total Kjeldahl nitrogen (TKN)
- **Total suspended solids (TSS)**
- **Bacteriology**
  E. coli

Water quality sampling was shared between AECOM and Credit Valley Conservation (CVC) and is described in Table 1.



Basemapping from Ontario Ministry of Natural Resources Orthophotography:

N
W E
S

Metres
0 50 100 200 300
1:7,500
UTM Zone 17N, NAD 83

Legend

- Goose Monitoring Locations
- Water Quality Sampling Sites
- Sediment Sampling Sites
- Intermittent Stream
- Permanent Stream
- Waterbody Segment
- Wetland Area, Permanent

Halton Hills Area Designation

- Open Space
- Parkland
- School / Legion
- Trailer Park
- Urban

Fairy Lake

Monitoring Locations

December 2009
Project 107983

AECOM

Figure 3

Map Document: (D:\Projects\107983\GISSpatial\mxd\Revised MXDs July 09\107983_Fig-3_MonitoringLocations.mxd)
12/21/2009 -- 4:43:37 PM

Table 1: Water quality sampling program summary

Site	Location	Parameter Suite	Sampled By		
			1 m off bottom	Dry (2 occasions)	Wet (2 occasions)
1	South basin inlet	Full		AECOM (Jun) CVC (Aug)	AECOM
2	Trailer park	Full		CVC (Aug)	AECOM
3	Main basin – central	Full	AECOM (Aug)	AECOM	AECOM
4	Tyler Avenue storm outfall	Full		AECOM (Jun) CVC (Aug)	AECOM
5	Old Beach- near shore	Full		AECOM (Jun) CVC (Aug)	AECOM
6	Near outlet to Black Creek at dam	Full		AECOM	AECOM
7	Black Creek inlet	Reduced		AECOM	AECOM
8	Elmore drive storm outlet	Reduced		AECOM	AECOM
9	South basin - central	Reduced	AECOM (Aug)	AECOM	
10	Trailer park inlet	Reduced			AECOM

Temperature and dissolved oxygen profiles were measured at 0.5 m intervals from the surface to within 0.5 m of the bottom. These measurements were taken at the two deepest (~7 m) locations in the main basin (site 3) and the south basin (site 9) during the July and August 2008 sampling events. Water samples were also collected at these sites at 1m off of the lake bottom in August and were analyzed for total phosphorus concentrations. A diurnal oxygen study was conducted in August 2008 in the main basin (site 3) using a YSI 6920 oxygen meter deployed at 1m off the lake bottom for a 24 hour period. All samples were stored in ice-packed coolers and were submitted to Maxxam Analytics, a fully accredited analytical laboratory, for analysis. Water quality results were interpreted against the Provincial Water Quality Objectives (PWQO) of the Ontario Ministry of the Environment (MOE, 2004).

2.2.2.1 Water Quality Guidelines

Ontario's Provincial Water Quality Objectives (PWQO; MOE 1994) are numerical and narrative criteria that serve as chemical and physical indicators representing a satisfactory level for surface waters (i.e., lakes and rivers) and where it discharges to the surface, the groundwater of the Province. The PWQO are set at a level of water quality, which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water. The objectives for protection of recreational water uses are based on public health and aesthetic considerations (MOE, 1994).

The PWQOs are intended to provide guidance in making water quality management decisions, as is the intention of this study. Therefore, water quality data will be compared to PWQOs to provide guidance on management recommendations for the study.

2.2.3 Sediment Sampling

Sediment cores were collected from three locations (S1-S3) in Fairy Lake (Figure 3). S1 was cored in June, 2008 and S2 and S3 were cored in August, 2008. A fourth location (S4) in the southeast basin opposite the old beach was unable to be cored because of strong currents. A modified KB gravity corer fitted with a 50 cm long plexiglass core tube was used to retrieve two short sediment cores from each of the three sites. The sediment cores were measured and physical descriptions of the sediments were made noting changes in the appearance or texture. The cores were then sectioned on site using a close-sectioning extruder. The top 10 cm of sediment from one core collected at each site was placed in sample jars and sent to Maxxam Analytics for chemical analysis. Sediments were analyzed for ammonia, total Kjeldahl nitrogen (TKN), total organic carbon (TOC) and phosphorus (by ICP). The second core from each site was sectioned at 1-cm intervals and sediments were placed in Whirlpak® bags. These samples are being kept in cold storage (at Credit Valley Conservation) for future analysis, if necessary.

2.2.3.1 Sediment Quality Guidelines

Ontario's Provincial Sediment Quality Guidelines (PSQG; MOE 1993) are a set of numerical guidelines developed for the protection of the aquatic environment by setting safe levels for metals, nutrients, and organic compounds. The PSQG establish three levels of effect based on long-term effects of exposures of sediment dwelling organisms ("benthos") to various contaminants. The lowest effect level (LEL) and the severe effect level (SEL) are based on long term effects the sediments can have on bottom dwelling organisms. The no effect level (NEL) is based on levels of contaminants that are so low, that no contaminants are passed through the food chain.

The PSQGs are intended to provide guidance in making sediment quality management decisions. As such, sediment quality will be compared to PSQGs to provide guidance on management recommendations.

2.2.4 Vegetation Survey

2.2.4.1 Shoreline inventory

Vegetation community mapping was conducted along the shoreline of Fairy Lake by an AECOM ecologist in September 2008 to determine vegetation cover, type, buffer width and dominant species. Vegetation community boundaries were reviewed through aerial photograph interpretation and were then ground-truthed for mapping and community classification. Vegetation community descriptions were based on the Ecological Land Classification after Lee *et al*., 1998.

2.2.4.2 Aquatic macrophyte vegetation inventory

Aquatic macrophyte[2] vegetation community mapping was conducted along the shoreline of Fairy Lake by an AECOM ecologist in July 2009 to determine vegetation cover, type, buffer width and dominant species. Vegetation community boundaries were ground-truthed for mapping and community classification. Vegetation community descriptions were based on the Ecological Land Classification after Lee *et al*., 1998.

2.2.5 Waterfowl Survey

A waterfowl survey form was developed for field staff and volunteers to record key information about waterfowl activity on Fairy Lake. Waterfowl surveys were conducted in June, August and September 2008 (during each of the water quality sampling events) by AECOM staff as well as community volunteers on seven occasions. Observations included the number and approximate age of waterfowl as well as notes on their behaviour. Additional comments were recorded if waterfowl were being fed by park visitors. A copy of the waterfowl survey form is included in Appendix A.

[2] *Aquatic plant in or near water (emergent, sub-emergent or floating)*

3. Results and Discussion

3.1 Background Review

The Black Creek Subwatershed Study is a land use management strategy that was initiated in 2008 to balance the economic, social and environmental needs within the Black Creek Watershed. CVC undertook the study to provide information and technical advice to address current and future land use changes, such as development, aggregate extraction and municipal servicing. Preliminary recommendations from this 'Fairy Lake Water Quality Study' will be integrated into the Black Creek Subwatershed study, which was finalized in February 2009.

Fairy Lake is a man-made lake approximately 26 ha in size located in the headwaters of the Black Creek watershed. A dam was built across Black Creek in 1830 by the Adams family in order to provide power for a flour mill. Water from the lake was also piped to Beardmore and Co. to assist in their tannery operations until 1986 when operations ceased and the pipeline was no longer required. The dam was left in place and higher water levels have been maintained in Fairy Lake. Fairy Lake is important to the community of Acton as it provides the main source of surface water for dilution of the Acton WWTP downstream of the dam.

Fairy Lake is contained within the Eramosa River-Blue Springs Creek PSW. The marsh is considered a headwaters wetland and houses a number of provincially and locally rare species. The southern wetland units, to the immediate south of Fairy Lake, are also contained within the Fairy Lake Marshes ESA. Other wetland units surrounding the lake, although also part of the PSW complex, are not included in the ESA.

The Black Creek outlet from Fairy Lake drains into the Black Creek at Acton Wetland Complex, which is also a PSW. This wetland complex is a large floodplain wetland with areas of cattail marsh and provides habitat for brook trout, and the regionally rare banded killifish[3]. The Black Creek at Acton PSW is contained within the Black Creek at Acton ESA

3.2 Catchment Area Land Use

The Fairy Lake watershed (Figure 2) is approximately 2,031 ha. It spans both the Town of Halton Hills and the Township of Erin. Major land uses in the watershed were placed into the categories of agriculture, residential, forests, parks, impermeable areas, wetlands and water surface. The area for each land use are provided in Table 2. Official Plans for the Town of Halton Hills and the Township of Erin were used to map these areas in a GIS database.

[3] visit http://www.creditvalleycons.com/recandleisure/fishing.htm#fairylake for more information

Most of the catchment (61%) is composed of agricultural areas; activities in these areas such as fertilizer application and runoff will have an influence on downstream water quality. Residential areas (low to medium density hosing) comprise 12% of the watershed. Runoff from activities in these areas (not serviced by storm sewers) includes nutrients, suspended solids, bacteria and some metals. Areas of low permeability (such as commercial areas, high density housing, and parking lots) with hardened surfaces represent 7% of the Fairy Lake watershed. Runoff from these areas includes suspended solids, metals, hydrocarbons (from fuel), and nutrients. If contaminants in runoff from residential areas and industrial areas are not captured through stormwater treatment, they will discharge to receiving watercourses. Parks and open spaces only represent approximately 3% of the watershed. A portion is, however, located adjacent to the lake. Parks are manicured or maintained areas, where fertilizers are applied, and the grass is usually mowed. Because these areas are maintained, runoff is usually high and contains elevated concentrations of nutrients.

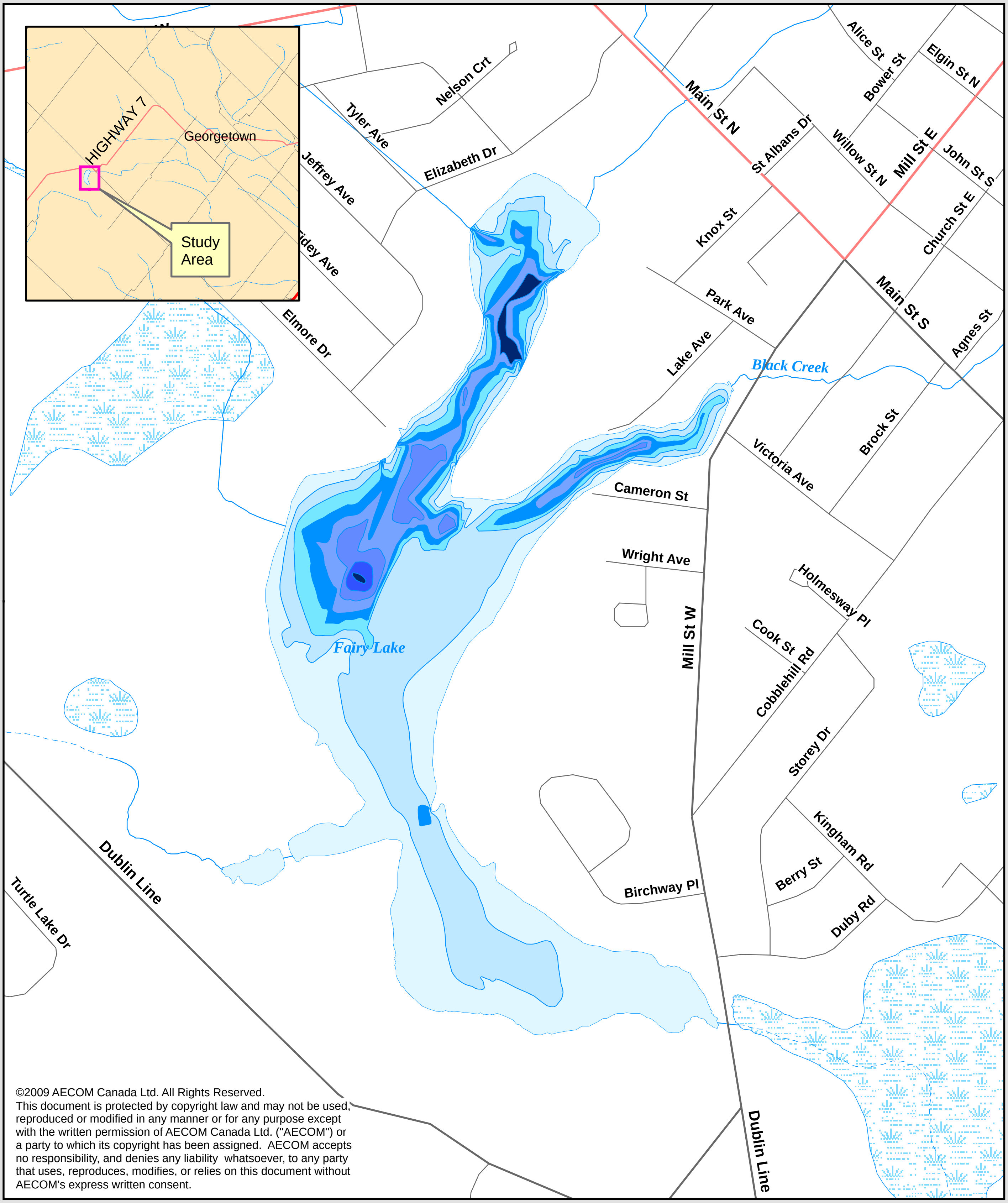
Forested areas represent 6% of the catchment. In a watershed, these areas work to slow down the transport of contaminants to a water body. Some forested areas surround Fairy Lake, which will help to reduce overland runoff. Wetland areas comprise approximately 8% of the watershed. Wetlands adjacent to Fairy Lake include the Eramosa River-Blue Springs Creek Provincially-Significant Wetland (PSW) complex and Fairy Lake Marshes Environmentally Sensitive Area (ESA). Wetland are unique, in that they act to uptake and transform nutrients (during the growing season), but also release nutrients (when plants decompose).

Table 2: Land use in the Fairy Lake watershed

Land Use	Area (ha)	%
Agricultural	1,232.3	61
Residential	252.4	12
Forests	122.5	6
Parks and Open Space	66.0	3
Industrial and Commercial	132.6	7
Wetlands	154.6	8
Water Surface	70.7	3
Total	**2,031.1**	**100**

3.3 Bathymetry

A bathymetric map with 1-m depth contours for Fairy Lake is shown in Figure 4. The lake has a surface area of 26 ha and a perimeter of 4.6 km. Most of the south portion of lake is less than 2m deep. The maximum measured depth was 7m, but this deeper water was restricted to small areas in the main basin and the north finger of the lake. The volume of the lake is 400,656 m^3. Based on the hypsographic curve for Fairy Lake, which describes the relationship between lake depth and volume, 95% of the volume of water in the lake is in the top 4m, and approximately 75% of the volume is in the top 2m (Figure 5). The mean depth of Fairy Lake is just over 1m, as approximated from the hypsographic curve (the depth above which 50% of the lake volume occurs).



Basemapping from Ontario Ministry of Natural Resources
Orthophotography:

N
W E
S

Metres
0 50 100 200 300
1:7,500
UTM Zone 17N, NAD 83

Legend

Lake Depth
- 0-1m
- 1m
- 2m
- 3m
- 4m
- 5m
- 6m
- 7m

Roads
Type
- Highway
- Major Road
- Local Road

Rivers
- Intermittent Stream
- Permanent Stream

Lakes and Wetlands
- Waterbody Segment
- Wetland Area, Permanent

Fairy Lake

Bathymetric Contours

December 2009
Project 107983

AECOM

Figure 4

Map Document: (D:\Projects\107983\GISSpatial\mxd\Revised MXDs July 09\107983_Fig-4_Bathymetric.mxd)
12/21/2009 -- 4:47:01 PM

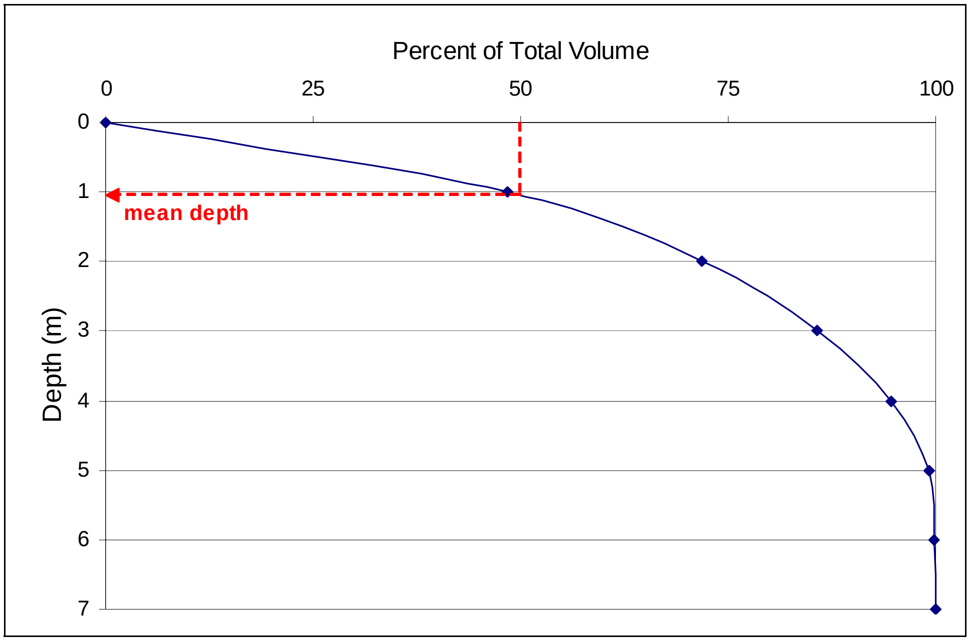


Figure 5: Fairy Lake hypsographic curve

3.4 Water Budget

In order to inform nutrient management decisions in the Fairy Lake watershed, a coarse scale water budget was calculated using available hydrological information. The water budget calculated an estimate of the relative contribution of surface water and groundwater to Fairy Lake. Estimation of the amount of surface water and groundwater that enters the lake will allow for a better understanding of management considerations.

Groundwater (GW) inflow to Fairy Lake can be estimated as:

GW inflow = change in lake storage when outflow is zero + evaporation + leakage from the dam – surface water (precipitation + runoff) inputs

In the equation above, runoff is unknown. Groundwater inputs were therefore calculated for two 1-week periods under drought conditions when surface water inputs were estimated to be 0. The mean groundwater inflow was then substituted in the above equation to estimate surface water inputs.

Outflow, precipitation and change in lake storage data are available for Fairy Lake for 2007 and 2008. The relationship between precipitation and change in storage is shown in Figure 6. Evaporation was estimated as outlined below.

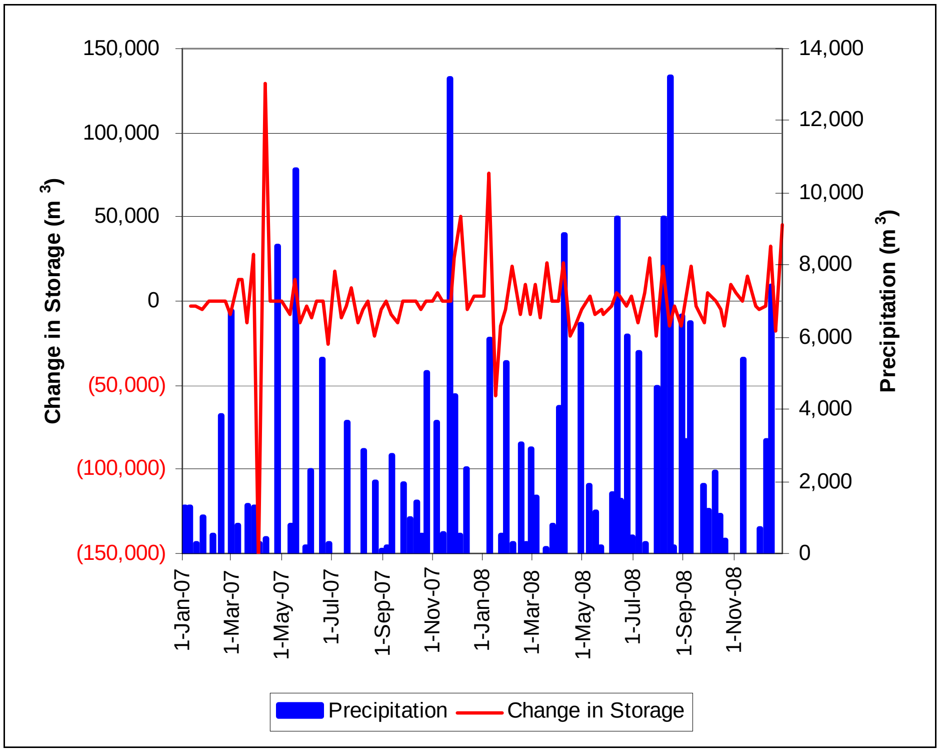


Figure 6: Fairy Lake changes in storage shown with precipitation for 2007 and 2008

The budget was calculated by obtaining the weekly flow out of Fairy Lake at the outflow during 2007 and 2008. These data were obtained from the Regional Municipality of Halton through readings taken by Town of Halton Hills staff from the staff gauge at the outflow. Flow rates were estimated using the weir equation ($Q = CLH^{1.5}$) where C = 1.5 (weir coefficient), L = weir length and H = head above the weir crest. To account for leakage through the stop logs, 0.025 m^3/sec was added to each flow estimate. It should be noted that this is a rudimentary analysis of the dam's operation and that the Region of Halton is presently assessing the dam's role in the overall water budget for the Black Creek system as well as potential impacts if dam needs to be modified, repaired or rebuilt.

Precipitation data were obtained from Environmental Canada's National Climate Data and Information Archive for the nearest climate station at Georgetown, Ontario (Station ID: 6152695).

Change in lake storage was derived from the difference between weekly staff gauge measurements.

A mean annual evaporation rate of 557 mm/yr was used in the water budget calculations. This rate is the mean of three previously reported rates in the The Halton Aquifer Management Plan (Holysh, 1997), including:

- 520 mm/yr that was provided by the report entitled "Surface and Subsurface Hydrology of the Credit River Escarpment Tributaries Headwaters Area" (Gartner Lee Ltd. 1993), which used the Thorthwaite & Mather (1959) method;
- 575 mm/yr from the same GLL study, but calculated using a water budget model; and
- 577 mm/yr that was estimated by Waterloo Geoscience Consultants in 1993 for the vicinity of the Acton Quarry.

Figure 7 shows that surface water inflow comprises the majority of water inputs to Fairy Lake (values are provided in Appendix C). During non-drought months, surface water inputs from precipitation represent over 90% of the total water inputs. The drought months (June and July) during the summer of 2007 have no surface water inflow. Groundwater contributions are only significant during these summer low flow periods when they make up approximately 40% of the water budget. During non-drought periods, groundwater contributes <5% to the water budget.

This coarse water budget was conducted in order to inform nutrient management decisions in the watershed for Fairy Lake. As most of the input to Fairy Lake has been determined to be from surface water inflows it supports careful management of the inflow in the upper watershed to maintain water quality in the lake.

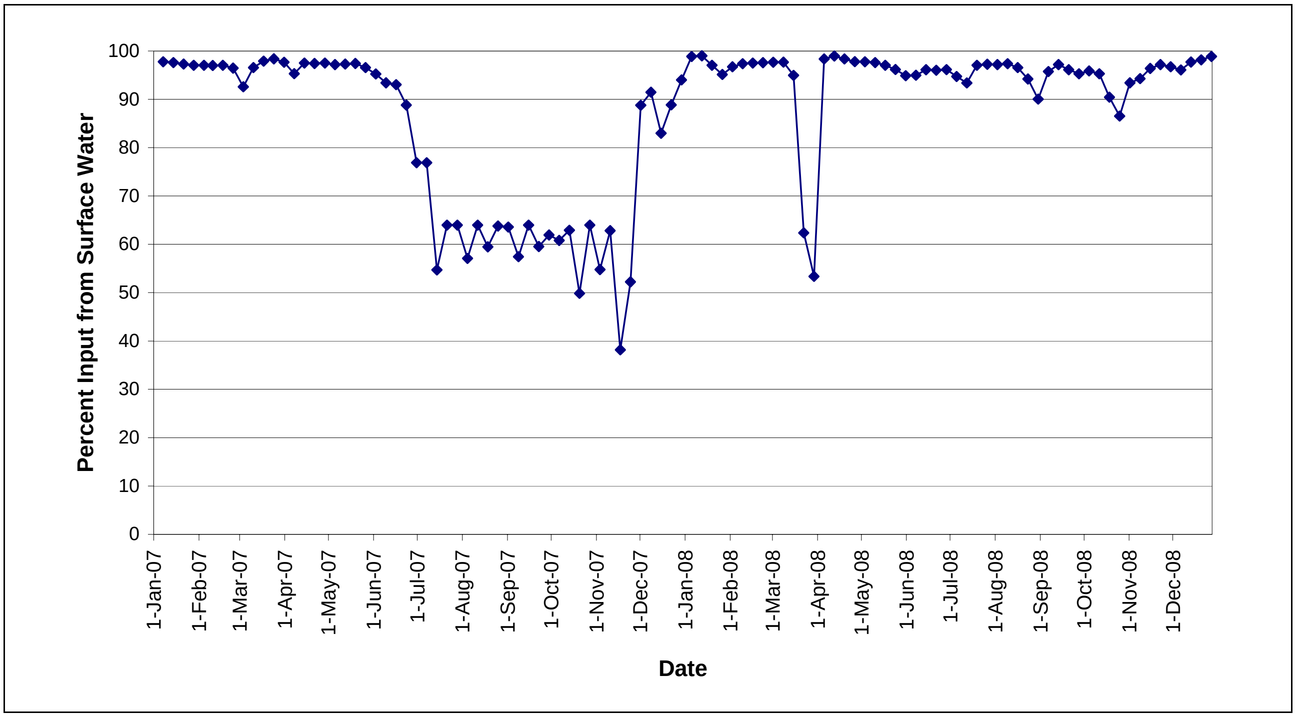


Figure 7: Percent contribution of surface water to the total water inputs to Fairy Lake.

3.5 Water Quality

Water samples were collected on 4 different occasions in Fairy Lake, two representing “dry” events, and two representing “wet” events. Preliminary review of the water quality data found no difference in the results based on event type (wet or dry). Water quality data is therefore summarized overall all four events.

Measured chemical parameters for general water chemistry from Fairy Lake are summarized as mean concentrations for each sampling location in Table 3 (full parameter suite) and Table 4 (reduced parameter suite). Overall, the chemical conditions in Fairy Lake are characteristic of a shallow, alkaline, and productive system dominated by aquatic plants.

Ontario’s Provincial Water Quality Objectives (PWQO, MOE 1994) are numerical and narrative criteria that serve as chemical and physical indicators representing a maximum satisfactory level for surface waters. The PWQO are set at a level of water quality, which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water (MOE, 1994). The PWQOs are intended to provide guidance in making water quality management decisions, as is the intention of this study. Therefore, water quality data will be compared to PWQOs to provide guidance on management recommendations for the study.

Table 3: Mean water chemistry characteristics in Fairy Lake (2008), full parameter suites.

Parameter	PWQO[1]	1 South basin inlet	2 Nearshore at trailer park	3 Main basin	4 Tyler outfall	5 Nearshore old beach	6 Outlet to Black Creek	Mean
General (mg/L)								
Alkalinity (Total as CaCO3)		229	236	202	261	167	167	210
Conductivity		549	626	627	1242	521	519	681
Dissolved Chloride (Cl)		39	52	65	223	52	53	81
Dissolved Phosphorus		0.032	0.048	0.009	0.016	0.01	0.008	0.021
Dissolved Sulphate (SO4)		2	13	27	32	23	24	20
Hardness (CaCO3)		235	237	235	278	200	198	231
Nitrate (N)	2.9[2]	ND	0.1	0.6	1.3	0.5	0.4	0.5
Nitrate + Nitrite		ND	0.1	0.6	1.3	0.5	0.4	0.5
Nitrite (N)	0.06[2]	ND	ND	0.01	0.05	0.02	0.02	0.02
Orthophosphate (P)		0.020	0.040	ND	0.045	ND	ND	0.018
pH	6.5-8.5	8.1	8.1	8.4	8.3	8.4	8.4	8.3
Total Ammonia-N		ND	ND	0.73	ND	ND	ND	0.12
Total Carbonaceous BOD		ND	6	ND	8	3	3	5
Total Dissolved Solids		356	401	408	805	339	340	442
Total Kjeldahl Nitrogen (TKN)		1.1	1.0	1.0	0.9	0.8	0.8	0.9
Total Phosphorus	0.02	**0.054**	**0.033**	**0.033**	**0.058**	**0.021**	0.019	**0.036**
Total Suspended Solids		2	13	3	10	5	2	6
Metals (µg/L)								
Total Aluminum (Al)	75	8	60	29	72	66	18	42
Total Antimony (Sb)		ND	ND	ND	ND	ND	ND	ND
Total Arsenic (As)	100	ND	2	ND	1	1	1	1
Total Barium (Ba)		38	28	9	59	33	33	33
Total Beryllium (Be)	1,100	ND	ND	ND	ND	ND	ND	ND
Total Bismuth (Bi)		ND	ND	ND	ND	ND	ND	ND
Total Boron (B)	200	14	20	18	30	18	17	20

Parameter	PWQO[1]	1 South basin inlet	2 Nearshore at trailer park	3 Main basin	4 Tyler outfall	5 Nearshore old beach	6 Outlet to Black Creek	Mean
Total Cadmium (Cd)	0.5	ND	ND	ND	ND	ND	ND	ND
Total Calcium (Ca)		66,750	72,333	14,799	82,500	49,750	47,750	55,647
Total Chromium (Cr)		ND	ND	ND	ND	ND	ND	ND
Total Cobalt (Co)	0.9	ND	ND	ND	ND	ND	ND	ND
Total Copper (Cu)	5	ND	3	2	4	2	2	3
Total Iron (Fe)	300	223	240	ND	255	160	ND	220
Total Lead (Pb)	25	ND	1	ND	1	ND	ND	1
Total Lithium (Li)		ND	ND	ND	ND	ND	ND	ND
Total Magnesium (Mg)		21,250	22,000	5,015	20,000	19,250	19,000	17,753
Total Manganese (Mn)		90	96	14	34	13	8	43
Total Molybdenum (Mo)	40	1	ND	1	1	ND	1	1
Total Nickel (Ni)	25	ND	1	1	ND	ND	ND	1
Total Potassium (K)		1,355	1,600	576	8,000	1,650	1,625	2,468
Total Selenium (Se)	100	ND	ND	ND	ND	ND	ND	ND
Total Silicon (Si)		2,873	1,980	501	3,125	1,073	945	1,750
Total Silver (Ag)		ND	ND	ND	ND	ND	ND	ND
Total Sodium (Na)		24,750	38,000	8,503	115,021	30,000	30,000	41,046
Total Strontium (Sr)		103	103	33	185	118	113	109
Total Tellurium (Te)		ND	ND	ND	ND	ND	ND	ND
Total Thallium (Tl)		ND	ND	ND	0	ND	ND	0
Total Thorium (Th)		ND	ND	ND	ND	ND	ND	ND
Total Tin (Sn)		ND	ND	ND	ND	ND	ND	ND
Total Titanium (Ti)		ND	ND	ND	ND	ND	ND	ND
Total Tungsten (W)		ND	ND	ND	ND	ND	ND	ND
Total Uranium (U)	5	0	0	1	1	1	1	1
Total Vanadium (V)	6	ND	ND	1	1	ND	ND	1
Total Zinc (Zn)	20	5	13	12	18	7	8	11
Total Zirconium (Zr)		ND	ND	ND	ND	ND	ND	ND

Notes:
1. PWQO: Provincial Water Quality Objectives, MOE 1994, updated 1999
2. CCME Canadian Water Quality Guideline for the protection of aquatic life, CCME, 1999, updated 2007
Bold values exceed the Provincial Water Quality Objective
mg/L = ppm

3.5.1 Ionic composition and metals

All of the sampling sites in Fairy Lake displayed similarly high alkalinity, pH, hardness, conductivity, and total dissolved solids reflecting the strong influence of the grey-brown luvisol soils that dominate in the catchment of the lake. An exception is water collected from the Tyler outfall (site 4), which had considerably higher conductivity, dissolved chloride and total dissolved solids than the other sites from Fairy Lake, likely due to inputs from urban runoff to this stormwater outfall.

Concentrations of metals were all within applicable PWQOs where available and were similar between most sites. The main basin (site 3) generally displayed lower concentrations of most metals than the inlet and nearshore sites. Metal concentrations from the Tyler outfall (site 4) were greatest of all of the sites, again reflecting the influence of urban runoff on the water quality from this stormwater outfall.

3.5.2 Nutrients

Overall, nutrient concentrations including phosphorus and nitrogen were elevated at all of the sampling locations in Fairy Lake, indicative of productive conditions (Tables 3 and 4, Figure 8). Total phosphorus concentrations in the offshore areas of the lake exceeded the PWQO of 0.020 mg/L for the protection against nuisance algal growth. These concentrations were similar to the concentrations of the surface source waters from the inlets and stormwater outfalls, which except for the Black Creek inlet (site 7), exceeded the PWQO of 0.030 mg/L for rivers and streams. The net phosphorus concentration in the lake, as indicated at the outlet to Black Creek, was 0.019 mg/L, indicating typical trophic status for an urban lake and some assimilation of phosphorus within the lake. Orthophosphate[4] and dissolved phosphorus concentrations were elevated in samples collected from the south inlet (site 1), the Tyler outfall (site 4) and nearshore trailer park (site 2). The accuracy of the measured concentrations of these phosphorus fractions is, however, suspect. This is particularly the case for the nearshore trailer park site where the orthophosphate and dissolved phosphorus concentrations exceeded the total phosphorus concentrations. Both orthophosphate and dissolved phosphorus are fractions of total phosphorus and so these concentrations should be less than the concentration of total phosphorus.

Table 4: Mean water chemistry characteristics in Fairy Lake (2008), reduced parameter sites

		Reduced Parameter Sites				
		7	8	9	10	
Parameter (mg/L)	PWQO	Black Creek inlet	Elmore outfall	Offshore south basin	west inlet	mean
Total Kjeldahl Nitrogen (TKN)		0.8	1.6	0.8	0.6	0.9
Dissolved Organic Carbon		8.8	2.2	9.3	8.5	7.2
Total Phosphorus	0.02	0.019	**0.034**	**0.053**	**0.049**	**0.038**
Total Suspended Solids		4	ND	3	2	3

Notes:
1. PWQO: Provincial Water Quality Objectives, MOE 1994, updated 1999
Bold values exceed the Provincial Water Quality Objective
mg/L = ppm

[4] *Orthophosphate, sometimes refereed to as "reactive phosphorus" is an inorganic form of phosphate. Orthophosphate is the most stable kind of phosphate, and is the form used by plants. Orthophosphate is produced by natural processes and is found in sewage.*

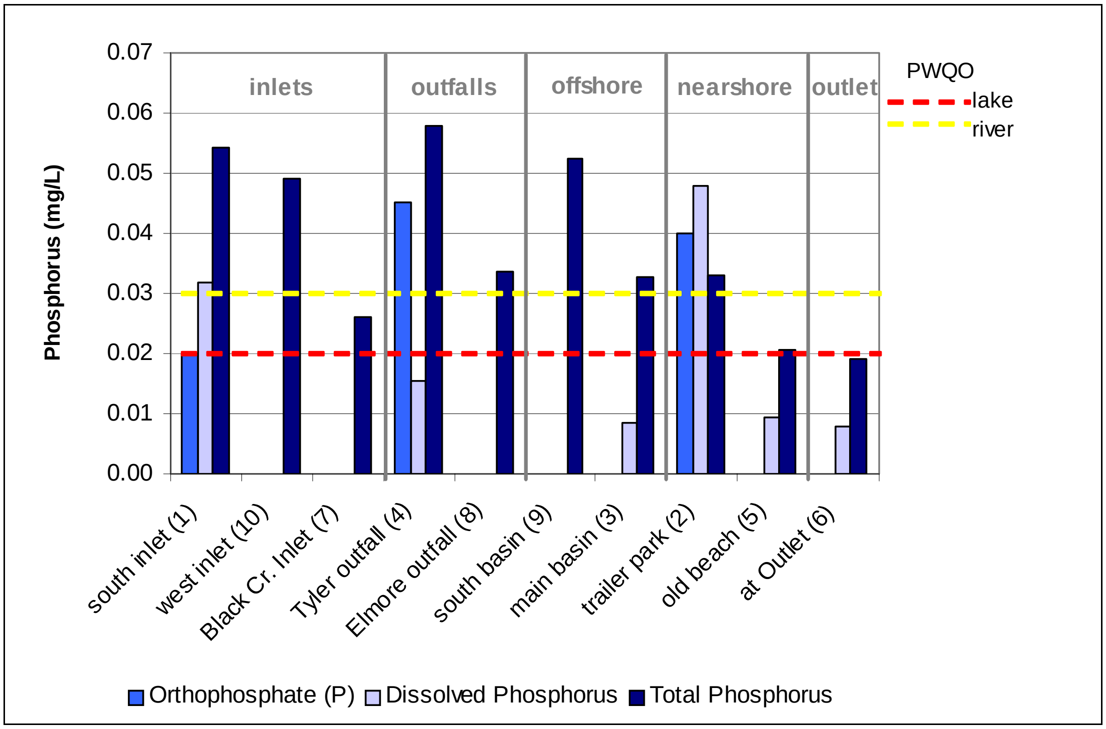


Figure 8: Mean Phosphorus Concentrations in Fairy Lake

Total Kjeldahl Nitrogen[5] (TKN) concentrations were high at all of the sampling locations ranging from 0.6 mg/L to 1.6 mg/L with a mean concentration of 0.9 mg/L, indicating productive waters. Other nitrogen parameters (ammonia-N[6], nitrate and nitrite) had low concentrations that were often not detectable (ND) at the reportable detection limits (RDLs) of the laboratory.

Dissolved organic carbon (DOC) concentrations were only measured as part of the reduced parameter suite at sites 7 to 10 on two sampling occasions each (Figure 13 and Table 4). Concentrations from the Black Creek inlet (site 7), the south inlet (site 10) and offshore in the south basin (site 9) were all exceptionally high ranging from 8.8 to 9.3 mg/L. These high DOC concentrations reflect wetland influence. Both the Black Creek and the south inlet drain large wetland areas and the south basin consists of a marsh with shallow (<2 m deep) waters dominated by dense aquatic plant communities.

[5] *The total concentration of nitrogen in a sample present as ammonia or bound in organic compounds*

[6] *A form of nitrogen found in organic materials, sewage, and many fertilizers. It is the first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is therefore an important nutrient. It converts rapidly to nitrate (NO_3) if oxygen is present. Ammonia is toxic to fish at relatively low concentrations in pH-neutral or alkaline water.*

3.5.2.1 Bacteria

Bacteria levels (*E. coli* and/or fecal streptococcus) were elevated on one or more occasions at nearly all sampling locations in Fairy Lake (Table 5). *E. coli* counts exceeded the PWQO for body contact recreation of 100 cfu/100 mL on at least one sampling date at all of the sites in Fairy Lake with the exception of the outlet to Black Creek (site 6) and the central offshore area in the south basin (site 9). Note however that the PWQO guideline is based on a geometric mean of at least 5 samples collected within a one-month period, but only one sample was analyzed per site per month in Fairy Lake. Bacteria counts were generally higher in the samples collected following rain storm events, particularly at the nearshore sites (i.e., old beach (site 5) and trailer park (site 2)) and at inlets draining wetland areas (i.e., west (site 10) and south (site 1) inlets).

Two exceptions included:

1. the Tyler outfall (site 4) where the maximum *E. coli* count (690 cfu/100 mL) occurred during low flow conditions on June 25th; and
2. the Black Creek inlet (site 7) where bacteria levels were consistently elevated on all sampling dates during low flow and storm events

Table 5: Bacteria summary for Fairy Lake

Site Number	Location	Parameter	Bacteria Counts (cfu/100mL)				
			Dry		Wet		Geometric Mean
			25-Jun	27-Aug	22-Jul	15-Sep	
1	at south inlet	Fecal streptococcus	20	80	140	1,500	135
		Escherichia coli	30	20	70	**1,000**	81
2	nearshore at trailer park	Fecal streptococcus	na	200	2,400	510	626
		Escherichia coli	na	10	**1,500**	**350**	**174**
3	main basin	Fecal streptococcus	10	30	50	330	47
		Escherichia coli	<10	40	50	**200**	74
4	Tyler outfall	Fecal streptococcus	4,000	120	400	840	634
		Escherichia coli	**690**	80	**170**	**350**	**239**
5	nearshore at old beach	Fecal streptococcus	370	20	5,100	180	287
		Escherichia coli	**380**	20	**3,500**	**110**	**233**
6	at outlet	Fecal streptococcus	90	<10	70	90	83
		Escherichia coli	40	10	90	60	38
7	at Black Cr. inlet	*Escherichia coli*	**560**	**460**	**460**	**370**	**458**
8	Elmore outfall	*Escherichia coli*	**100**	20	20	60	39
9	south basin	*Escherichia coli*	10	10	na	na	10
10	at west inlet	*Escherichia coli*	na	na	**1,000**	**150**	**387**

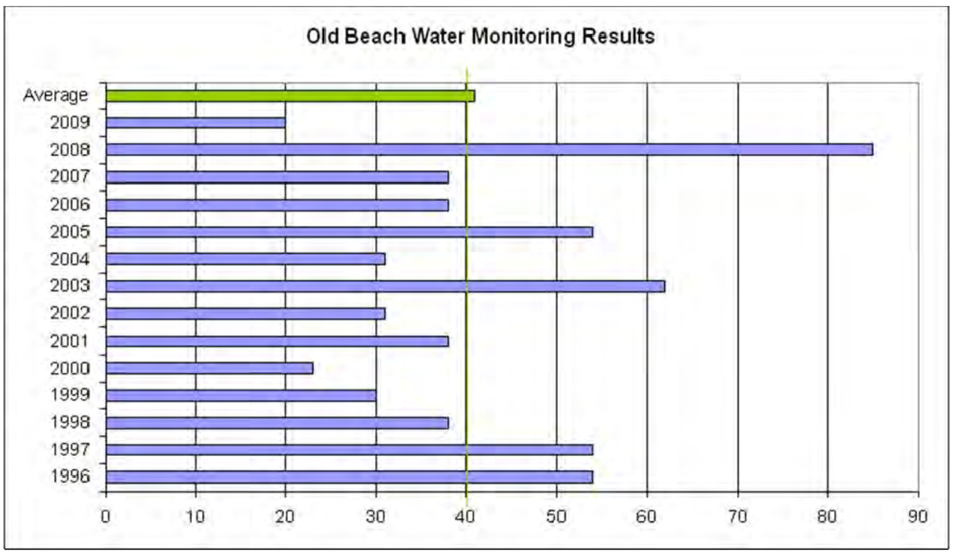
Notes: Bolded values for E. coli *exceed the PWQO of 100 cfu per 100 mL. Note that these guidelines are based on a geometric mean of at least 5 samples, which was only 4 samples for Fairy Lake. There are no guidelines for fecal streptococcus.*

Fecal streptococci counts displayed a similar pattern to the *E. coli* counts with elevated numbers in the storm event samples in nearshore and inlets draining wetland areas.

Elevated bacterial counts often occur following rain events due to the inwash of fecal matter from warm blooded animals that has accumulated on the surrounding landscape.

Beach Closures

Halton Region monitors Old Beach at Fairy Lake bacterial water quality, to ensure it is safe for body contact recreation. Based on bacterial water quality, The percentage of the season the Old Beach was closed in 2008 and 2009 was 85% and 18% respectively. The percentage of beach closures in 2008 and 2009 represent the highest and lowest respectively since 1995. The low beach closures in 2009 are likely due to the cooler weather. The average percentage of season in which the beach is closed (since 1995) due to high bacteria is 41 days, almost half of the season.



Note: Figure provided by Town of Halton Hills

Figure 9: Percentage of Season Old Beach is Closed

3.5.2.2 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen profiles taken in the summer of 2008 from the two deep basins (site 3; main basin and site 9; south basin) in Fairy Lake displayed similar patterns. At both locations, surface waters were warm (23°C to 25°C) and temperature of the water declined with depth to between 7°C and 10°C near the lake bottom (Figure 9). Surface waters were well oxygenated to a depth of 3m on July 22th and to 2m on August 19th, where a peak in oxygen concentration occurred, reaching a maximum of 17.1 mg/L on August 19th. This peak in dissolved oxygen concentration is due to oxygen production from photosynthetic activity of algae and/or aquatic plants growing at that depth in the water column. Dissolved oxygen then declined to very low mean concentrations of 0.8 mg/L and 1.4 mg/L in bottom waters below 5 m in the main and north basins, respectively.

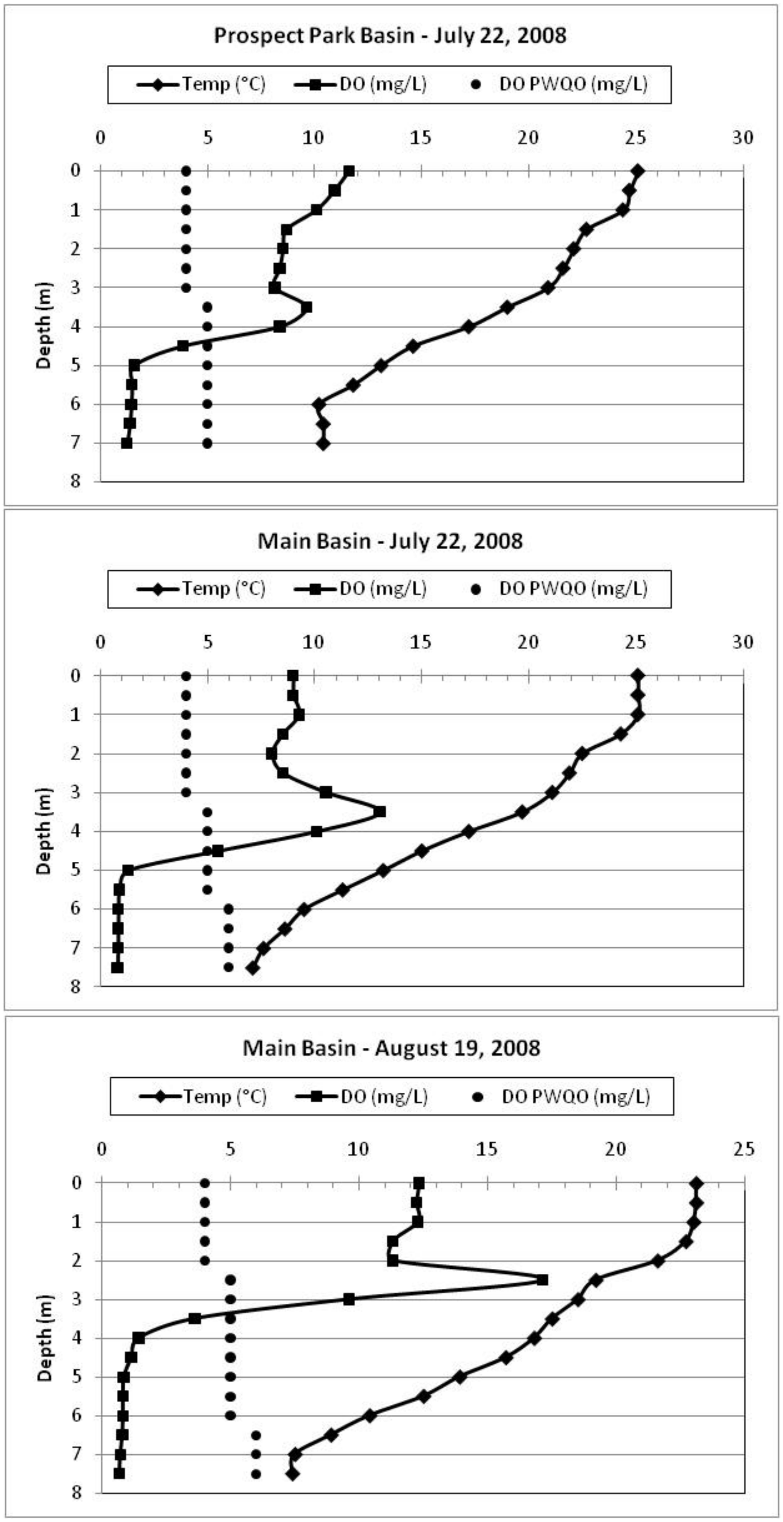


Figure 10: Temperature and dissolved oxygen profiles for Fairy Lake

Note: Dissolved oxygen PWQO is for warm water biota

The pattern of temperature and dissolved oxygen concentrations observed in Fairy Lake is common in shallow, productive lakes that do not undergo seasonal thermal stratification[7]. During prolonged periods of warm weather and calm winds, however, there may be episodes of little or no mixing of the water column such that a temperature gradient can set up in the water column as was observed in Fairy Lake. At this time, a decline in oxygen can occur in deeper waters as oxygen is consumed by decomposition of organic matter. These bottom waters can become re-oxygenated following a wind or wave event when the water column mixes. Additional temperature and oxygen profiles taken more frequently over the course of the open water season would be required to confirm this mixing regime in Fairy Lake.

The higher phosphorus concentration in water collected 1m off the lake bottom in the main basin (site 3) in August 2008 was 0.048mg/L, which was significantly higher than the concentration observed in the surface water (0.020 mg/L) on the same date. Elevated phosphorus concentration near the lake bottom could be a result of a) internal phosphorus loading due to anoxia (lack of oxygen) in Fairy Lake or b) settling and re-mineralization of organic matter from the upper waters. It should be noted that at the time of sampling in August, dissolved oxygen concentrations near the lake bottom were low in the main basin (site 3), but anoxic conditions were not present (Figure 10). During times of complete anoxia, phosphorus concentrations are likely to be substantially higher near the lake bottom.

3.6 Sediments

3.6.1 Sediment Quality

Sediment samples were collected from three locations (S1, S2 and S3) in Fairy Lake to assess the importance of sediments to aquatic plant communities, as nutrients in sediments can have an important implications for the growth of rooted aquatic plants.

The Provincial Sediment Quality Guidelines (PSQGs) are intended to provide guidance in making sediment quality management decisions (see Section 2.2.3.1). As such, sediment quality was compared to PSQGs to provide guidance on management recommendations.

Surface sediments from Fairy Lake were all highly organic with elevated nutrient concentrations (Table 6), which exceeded the Lowest Effect Level of the Provincial Sediment Quality Guidelines (PSQG; MOE 1993) for all measured nutrients with the exception of:

- ammonia (all sites were below the reportable detection limit of the laboratory of 25 μg/gm); and,
- phosphorus at site S2 in the south basin.

---

[7] Thermal stratification is the horizontal layering of the water column due to thermally-induced density differences. A thermally stratified lake is characterized by a surface layer of warm, less dense water (epilimnion) overlying a layer of colder denser water (hypolimnion). Because of the great density difference between the two layers, only the surface layer is mixed by wind. Complete mixing of the water column in stratified lakes occurs in the fall (fall turnover) once the surface waters cool sufficiently to reduce the density difference between the two layers, and in the spring (spring turnover) following ice off.

Table 6: Nutrient concentrations in Fairy Lake sediments

Parameter	Units	PSQG		S1	S2	S3
		LEL	SEL	Prospect Park basin	south basin	main basin
Total Ammonia-N	µg/g	-	-	<25	<25	<25
Total Organic Carbon	mg/kg	10,000	100,000	**53,000**	**94,000**	**43,000**
Total Kjeldahl Nitrogen	µg/g	550	4,800	**3,180**	**8,875**	**2,820**
Acid Extractable Phosphorus (P)	µg/g	600	2,000	**940**	430	**830**

Bold values exceed the Lowest Effect Level (LEL) and shaded values exceed the Severe Effect Level (SEL) of the Provincial Sediment Quality Guidelines (PSQG).

Total Organic Carbon concentrations ranged from 43,000 mg/kg at S3 to 94,000 mg/L and S2. Concentrations exceeded the Lowest Effect Level (LEL) of 10,000 mg/kg at all satiations, but did not exceed the Severe Effect Level (SEL) of 100,000 mg/kg. The south basin had the highest concentration of organic carbon. The high organic carbon concentration in the sediments is likely due to the decomposition of aquatic plants.

Total Kjeldahl nitrogen concentrations ranged from 2,820 µg/g at S3 to 8,875 µg/g at S2. Concentrations exceeded the LEL of 550 µg/g at all stations, and exceeded the SEL of 4,800 µg/g at S2. Phosphorus concentrations ranged from 430 µg/g at station S2 to 940 µg/g at station S1. Concentrations were above the LEL of 600 µg/g at S1 and S3 only. Concentrations did not exceed the LEL of 2,000 µg/g. The high concentrations of nitrogen and phosphorus reflect nutrient and organic enrichment in the sediments and do not suggest that concentrations are toxic.

3.6.2 Sediment Age and Depth

The sediment cores retrieved from Prospect Park basin (S1) and the main basin (S3) measured 21.75 cm and 29.5 cm long, respectively. Sediments in these two cores were very similar and consisted of homogeneous black to dark brown organic mud (called gyttia) from the surface to the bottom of the cores. The sediment core from a shallow (coring depth = 1.5 m) location in the south basin (S2) measured 24.5 cm-long and consisted of light brown organic sediments with an abundance of vegetative matter throughout.

Despite multiple coring attempts at each site, it was not possible to collect longer cores. Soft organic sediments of the type collected in Fairy Lake should pose no barrier to coring and so it was assumed that the length of the cores collected likely represent the depth of organic sediment accumulation at the coring locations.

In March of 2009, AECOM cored 17 locations in Fairy Lake from ice cover as part of a separate hydrological study being undertaken for the Town of Halton Hills. In this study, ~1-m long sediment cores were retrieved using a Russian peat corer. The depth of organic lacustrine sediments varied throughout the lake and ranged from 20 to 50 cm in the main and Prospect Park basins (mean depth = 35.5 cm). In the south basin, organic sediments ranged in depth from 38 to 64 cm (mean depth = 51 cm).

Organic lacustrine surface sediments in Fairy Lake likely represent the amount of sediment accumulation that has occurred since dredging of the lake in the fall of 1967 and spring of 1968 (see Appendix B for dredging articles published in the Acton Free Press). The extend of the dredging that occurred is unknown, but assuming that large portions of the lake was dredged to remove all lacustrine sediments since damming of the lake, the present depth of organic sediments represent approximately 41 years of accumulation. Based on observed organic sediment depths in Fairy Lake, the average sedimentation in the north end of Fairy Lake is ~0.9 cm per year, and 1.2 cm per year in the shallow south end of the lake. These sedimentation rates are typical for productive systems with high organic content. Note that these sedimentation rate estimates are gross estimates that do not consider compaction or consolidation of the sediments.

3.6.3 Hot Spots for Sediment Accumulation and Composition

As described in Section 3.5.2, sediment accumulation varies throughout Fairy Lake. Greater sediment accumulation typically occurs in shallow areas of the lake (e.g., the south basin, northwest shoreline area of the main basin and opposite Prospect Park) where a large amount of organic debris originating from abundant aquatic plant biomass is deposited to the lake bottom. In addition, higher rates of sediment deposition occur along the north shore of the southeast basin opposite the old beach area. This area of sediment accumulation is most likely due to natural sediment focussing processes whereby sediments are deposited with lake currents as water moves toward the outflow. Given the highly organic sediment composition observed at all of the sampling locations, the source of sediments throughout Fairy Lake is primarily biological in origin (from aquatic plant production) with no evidence of significant minerogenic sediment input from erosion, runoff or the stormwater outfalls.

3.7 Vegetation Survey

A total of 21 vegetation communities were documented within or along the shoreline of Fairy Lake. Eight of these are terrestrial, six are wetland and seven are aquatic vegetation communities. The characteristics of the communities are summarized in Table 7 and mapped on Figures 11-a and 11-b.

Table 7: Vegetation communities within and surrounding Fairy Lake

ELC Code	Community	Vegetation Characteristics
Cultural Vegetation		
CUM1-1	Dry-Moist Old Field Meadow	tree cover and shrub cover < 25%, dominated by grasses and forbs
CUP3	Conifer Plantation	planted tree cover of Scots Pine or Jack Pine or White Spruce
CUT1-5	Raspberry Cultural Thicket	Dense low shrub cover dominated by Wild Red Raspberry with old field forbs and grasses
CUT1-A	Dogwood Cultural Thicket	dense band of shoreline thicket dominated by Red-osier Dogwood
CUW1	Cultural Deciduous Woodland	Disturbed broken canopy tree cover between 35 and 60%, dominated by Manitoba Maple, Lombardy Poplar and Balsam Poplar. Variable thickets of Staghorn Sumac
Forest		
FOD7-2	Fresh - Moist Ash Lowland Deciduous Forest	Dominated by Green Ash, other trees represented including American Elm, White Willow, Blue Beech and American Basswood
FOD7-3	Fresh - Moist Willow Lowland Deciduous Forest	Dominated by White Willow and Crack Willow
FOD8-1	Fresh - Moist Poplar Deciduous Forest	Variably co-dominated by Balsam Poplar, Paper Birch, Yellow Birch and Green Ash. Dense ground cover
Thicket Swamp		
SWT2-1	Alder Mineral Thicket Swamp	Dominated by Speckled Alder with willows and dogwood
SWT2-2	Willow Mineral Thicket Swamp	Shoreline thickets dominated by Sandbar Willow, Pussy Willow and White Willow
SWT2-5	Red-osier Mineral Thicket Swamp	Shoreline thickets dominated by Red-osier Dogwood. Some willows may be present
Marsh		
MAM2-12	Common Reed Mineral Meadow Marsh	Dense stand of Common Reed
MAS2-1	Cattail Mineral Shallow Marsh	Shoreline marsh dominated by Hybrid Cattail
MAS2-2	Bulrush Mineral Shallow Marsh	Shoreline marsh dominated by Softstem Bulrush and Giant Burreed
Submerged Aquatic		
OAO	Open Aquatic	sparse cover by submerged macrophytes, usually deeper water
SAS1-3	Stonewort Submerged Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Stonewort

ELC Code	Community	Vegetation Characteristics
SAS1-4	Eurasian Water Milfoil Submerged Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Eurasian Water Milfoil. Hornwort, Stonewort, Pondweeds and Water Stargrass often also present
SAS1-4a	Northern Water Milfoil Submerged Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Northern Water Milfoil. Hornwort, Stonewort, Pondweeds and Water Stargrass often also present
SAM1-4	Pondweed Mixed Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Small Pondweed, Sago Pondweed and Hornwort. >50% cover by White Waterlily or Yellow Pondlily
SAM1-7	Water Milfoil Mixed Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Eurasian Water Milfoil. >20% cover by White Waterlily or Yellow Pondlily
SAM1-9	Stonewort Mixed Shallow Aquatic	Substrate >25% submerged macrophytes dominated by Stonewort. >20% cover by White Waterlily or Yellow Pondlily

3.7.1 Shoreline inventory

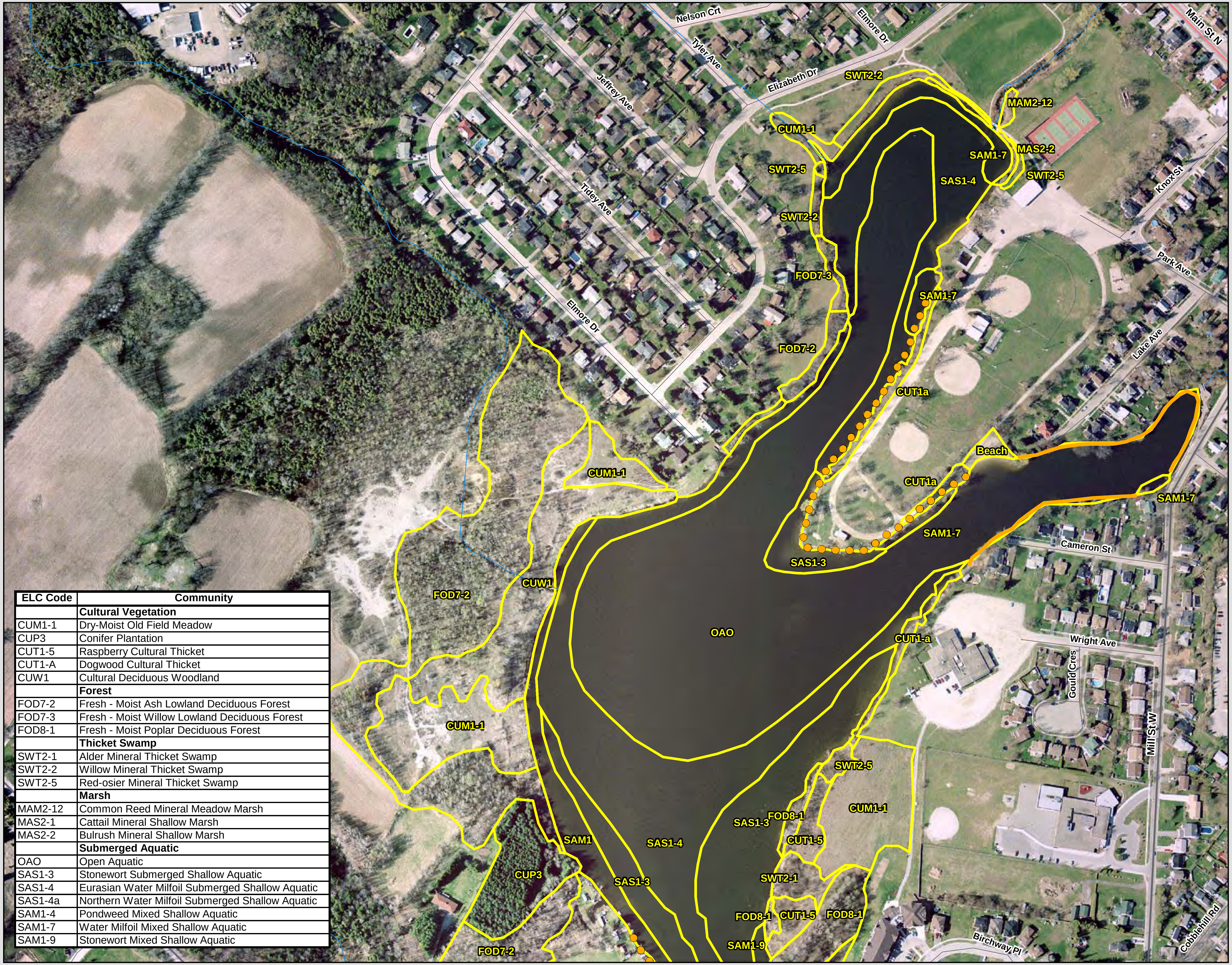
Most of the immediate shore has not been hardened or protected. The most intensive shoreline protection occurs in the northeast bay near the dam. Residents have created various hardened shorelines consisting of concrete walls, railway ties, concrete blocks or large stones. One wall on the south side of that bay had been undermined from behind and fallen over. The land owner indicated that the wall was constructed in 1919 but had fallen within the last year. The shoreline along the peninsula of Prospect Park (between the north and northeast bays) has been protected with either boulders or broken concrete. Artificial beaches have been created by dumping sand at two locations in Prospect Park.

Some concrete and tie reinforced shorelines are present within a trailer park in the small southwest bay. Boulders have been placed along much of the shoreline of the two trailer parks. Shoreline protection has not been installed in most other areas. It appears that historic filling has occurred along much of the shoreline as there is often an abrupt rise of 1 to 1.5 m immediately back from the shore. A road or railway bridge once crossed the narrow neck at the south end of the lake as there is a raised embankment of gravelly material on both sides and rows of wooden piles crossing the lake at this point.

A narrow band of thicket (i.e., less than 3 m wide) dominated by Red-osier Dogwood (*Cornus stolonifera*), Sandbar Willow (*Salix exigua*), and some other willows (*Salix* spp.) occurs along many areas of shoreline, forming a narrow riparian buffer. Deciduous forest or regenerating cultural woodland stabilize natural shorelines, particularly along the central west and southeast shores, providing an effective riparian buffer.

Mowed lawns occur along or very near the shoreline in Prospect Park, the school on the east and in the trailer parks. Lawns are a source of high nutrient runoff to Fairy Lake that stimulates growth of aquatic vegetation. Nutrients may come from fertilizer application and from Canada Geese feces.

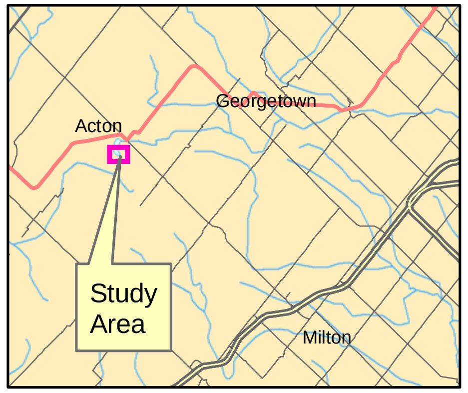
A discontinuous and very narrow (usually no more than 1 m) band of emergent marsh occurs along portions of the shoreline, but most of these were too small to map. Softstem Bulrush (*Scirpus validus*) is the most abundant species, sometimes accompanied by Giant Burreed (*Sparganium eurycarpum*), Yellow Iris (*Iris pseudacorus*) and Hybrid Cattail (*Typha X glauca*).



ELC Code	Community
	Cultural Vegetation
CUM1-1	Dry-Moist Old Field Meadow
CUP3	Conifer Plantation
CUT1-5	Raspberry Cultural Thicket
CUT1-A	Dogwood Cultural Thicket
CUW1	Cultural Deciduous Woodland
	Forest
FOD7-2	Fresh - Moist Ash Lowland Deciduous Forest
FOD7-3	Fresh - Moist Willow Lowland Deciduous Forest
FOD8-1	Fresh - Moist Poplar Deciduous Forest
	Thicket Swamp
SWT2-1	Alder Mineral Thicket Swamp
SWT2-2	Willow Mineral Thicket Swamp
SWT2-5	Red-osier Mineral Thicket Swamp
	Marsh
MAM2-12	Common Reed Mineral Meadow Marsh
MAS2-1	Cattail Mineral Shallow Marsh
MAS2-2	Bulrush Mineral Shallow Marsh
	Submerged Aquatic
OAO	Open Aquatic
SAS1-3	Stonewort Submerged Shallow Aquatic
SAS1-4	Eurasian Water Milfoil Submerged Shallow Aquatic
SAS1-4a	Northern Water Milfoil Submerged Shallow Aquatic
SAM1-4	Pondweed Mixed Shallow Aquatic
SAM1-7	Water Milfoil Mixed Shallow Aquatic
SAM1-9	Stonewort Mixed Shallow Aquatic

Legend

- Ecological Land Classification
- Boulder Reinforced Shoreline
- Hardend Shoreline
- Intermittent Stream
- Permanent Stream



Basemapping from Ontario Ministry of Natural Resources Orthophotography: 2002

N W E S

Metres

0 20 40 80 120 160

1:3,500

UTM Zone 17N, NAD 83

Fairy Lake

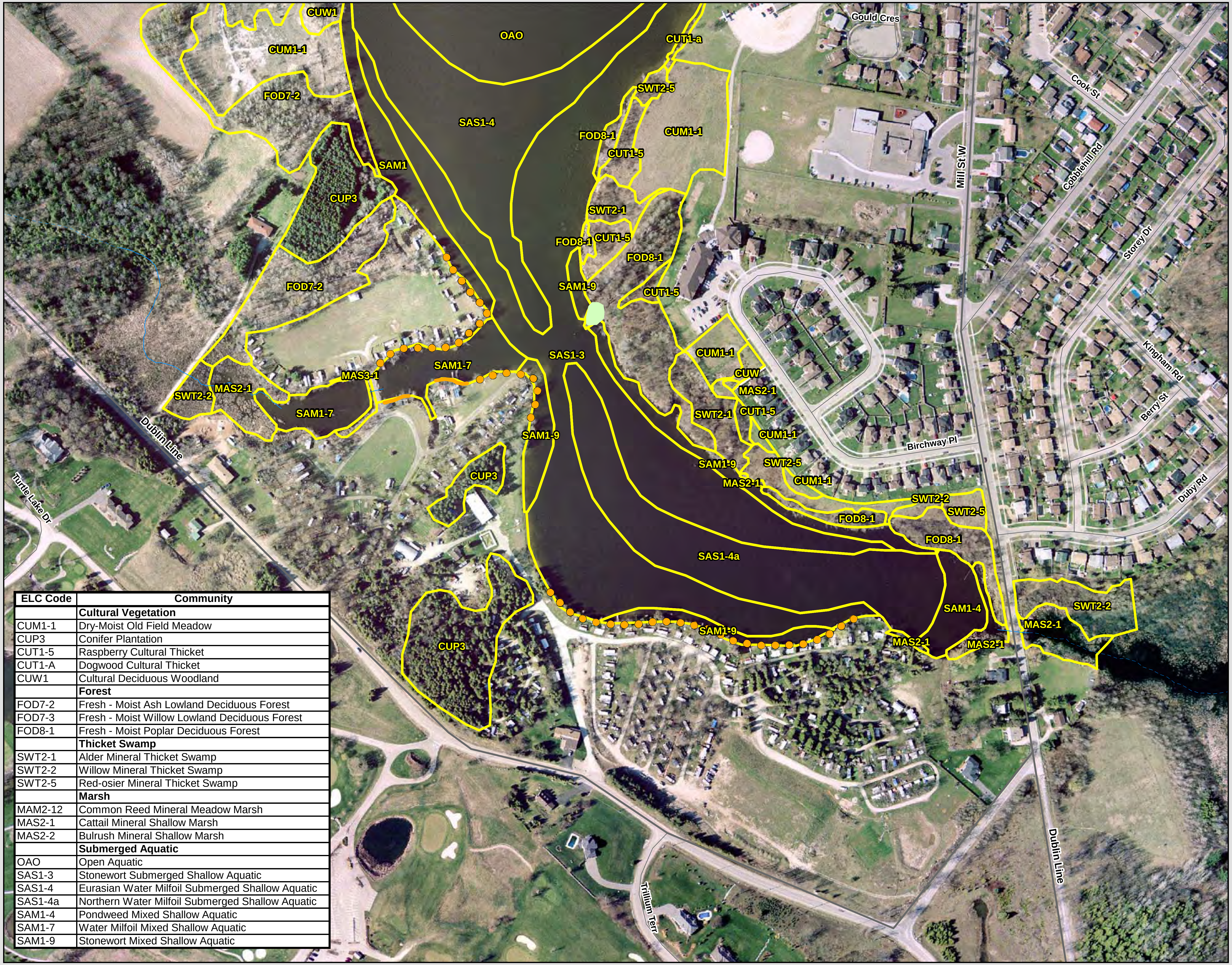
Ecological Land Classification

July 2009
Project 107983

AECOM

Figure 11a

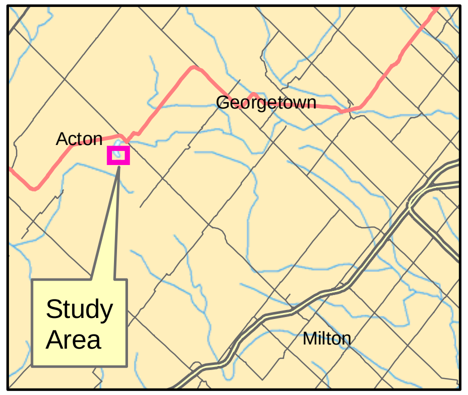
Map Document: (N:\projects\0-aecom\107983\2009\Final\GIS\Spatial\MXDs\WorkingMXDs\107983_Fig-11a_ELC.mxd)
12/23/2009 -- 2:18:44 PM



ELC Code	Community
	Cultural Vegetation
CUM1-1	Dry-Moist Old Field Meadow
CUP3	Conifer Plantation
CUT1-5	Raspberry Cultural Thicket
CUT1-A	Dogwood Cultural Thicket
CUW1	Cultural Deciduous Woodland
	Forest
FOD7-2	Fresh - Moist Ash Lowland Deciduous Forest
FOD7-3	Fresh - Moist Willow Lowland Deciduous Forest
FOD8-1	Fresh - Moist Poplar Deciduous Forest
	Thicket Swamp
SWT2-1	Alder Mineral Thicket Swamp
SWT2-2	Willow Mineral Thicket Swamp
SWT2-5	Red-osier Mineral Thicket Swamp
	Marsh
MAM2-12	Common Reed Mineral Meadow Marsh
MAS2-1	Cattail Mineral Shallow Marsh
MAS2-2	Bulrush Mineral Shallow Marsh
	Submerged Aquatic
OAO	Open Aquatic
SAS1-3	Stonewort Submerged Shallow Aquatic
SAS1-4	Eurasian Water Milfoil Submerged Shallow Aquatic
SAS1-4a	Northern Water Milfoil Submerged Shallow Aquatic
SAM1-4	Pondweed Mixed Shallow Aquatic
SAM1-7	Water Milfoil Mixed Shallow Aquatic
SAM1-9	Stonewort Mixed Shallow Aquatic

Legend

- Ecological Land Classification
- Turtle Nesting Area
- Boulder Reinforced Shoreline
- Hardend Shoreline
- Intermittent Stream
- Permanent Stream



Basemapping from Ontario Ministry of Natural Resources Orthophotography: 2002

N W E S

Metres
0 20 40 80 120 160
1:3,500
UTM Zone 17N, NAD 83

Fairy Lake

Ecological Land Classification

July 2009
Project 107983

AECOM

Figure 11b

Map Document: (N:\projects\0-aecom\107983\2009\Final\GIS\Spatial\MXDs\Working\MXDs\107983_Fig-11b_ELC.mxd)
07/17/2009 -- 11:36:43 AM

Figure 12: North end of Fairy Lake showing Water Milfoil Mixed Aquatic (SAM 1-7) in front of Bulrush Shallow Mineral Marsh (MAS2-2) and Willow Mineral Thicket Swamp (SWT2-2)

3.7.2 Aquatic vegetation

Fairy Lake is a shallow, nutrient rich, permanent waterbody. The clear waters allow good light penetration allowing luxuriant growth of submerged aquatic macrophyte vegetation. Most of the lake is less than 3 m in depth. According to the ELC protocol, more than 75% of the lake would be classified as a mixed shallow aquatic ecosite (<2 m deep) with submergent vegetation comprising >25% of the total vegetation cover. Floating-leaved plants cover is > 20% along much of the immediate shoreline.

Seven aquatic vegetation communities were documented following ELC, which are described in Table 7. These are approximately mapped in Figures 11-a and 11-b but the boundaries are not precise because of variability. Generally macrophyte cover is continuous and occupies 75 to 100% of the substrate in most of the lake that is less than 2 m deep. Macrophyte cover is sparse in the deep basins and these have been mapped as Open Water Aquatic on Figure 11. Submerged vegetation is conspicuously less abundant in the northeast arm than elsewhere, even in the shallower areas, suggesting that some residents there may be applying aquatic herbicides.

The two most dominant macrophytes are Eurasian Water Milfoil (*Myriophyllum spicatum*) and Stonewort (*Chara* sp.). Eurasian Water Milfoil can grow in waters to 5 m deep with stems often rising from the substrate to the surface. The percent cover generally decreases at depths below 2 m. It is frequently co-dominat with Hornwort (*Ceratophyllum demersum*) in the north part of the lake. Other species mixed include Crispy Pondweed (*Potamageton crispus*), Sago Pondweed (*P. pectinatus*), Small Pondweed (*P. pussillus*), Canada Waterweed (*Elodea canadensis*) and Water Stargrass (*Zosterella dubia*). In the southernmost part of the lake, Eurasian Water Milfoil is replaced by the native Northern Water Milfoil (*Myriophyllum sibiricum*).

This distinction is curious, but may be related to less contaminated inflow of waters from the creek in the southeast that is the main portion of the Eramosa River-Blue Springs Creek Provincially-Significant Wetland Complex. The southern part of the lake contained some other species such as Richardson's Pondweed (*P. richardsonii*) and Common Bladderwort (*Utricularia vulgaris*) that were not noted elsewhere.

Stonewort forms very dense mats in relatively shallow areas, particularly in the southern half of the lake. These patches often consist entirely of Stoneworts or there may be partial cover of water milfoils.

Waterlilies, particularly White Waterlily (*Nymphaea odorata*) and to a lesser extent Yellow Pondlily (*Nuphar variegata*), are conspicuous along much of the shoreline. They typically grow to depths of about 1.5 m and are usually associated with submerged macrophytes.

Several of the aquatic macrophytes are considered locally rare in the regional Municipality of Halton including Water Stargrass, Canada Waterweed and Northern Water Milfoil (Varga et al. 2000). Richardson's Pondweed was not reported to occur in Halton. This reflects the scarcity of clear water lakes that support a variety of aquatic plants. Generally these species are abundant in parts of southern Ontario where lakes are a more common part of the landscape.

3.7.3 Invasive Plant Species

Apart from the Eurasian Water Milfoil discussed above, Crispy Pondweed is also non-native that is common in Fairy Lake but it is not nearly as abundant and appears to be co-existing with native species. Cattail Marsh at Fairy Lake is dominated by Hybrid Cattail, a hybrid between the native Broad-leaved Cattail (*Typha latifolia*) and non-native Narrow-leaved Cattail (*T. angustifolia*). Hybrid Cattail has gradually replaced the native cattail, particularly in areas where water levels have been stabilized (Grace and Harrison (1986). The hybrid is ecologically similar to the native Broad-leaved Cattail. More problematic is the replacement of many emergent wetlands with the highly aggressive Common Reed (*Phragmites australis*). Currently the only Common Reed observed was near the mouth of the small stream at the northeast side of the north inlet. This species may spread around the lake in the coming years.

Credit Valley Conservation (CVC) has prepared an Invasive Species Strategy for the Credit River Watershed. The overall goals are to maintain healthy eco-systems and native biodiversity and to reduce the ecological and economic impacts of invasive species[8].

[8]*For more information visit Credit Valley Conservation's website at www.creditvalley.ca/invasives*

3.8 Waterfowl Inventory

Results of egg-oiling and waterfowl surveys in the summer and fall indicate that Canada Geese are present at least between April and October (Table 8 and Appendix A). They are also likely present in early spring and early winter or as long as Fairy Lake remains unfrozen. However, numbers of geese vary somewhat.

The Town of Halton Hills has been conducting egg-oiling in the around Fairy Lake, as a means to reduce Canada Goose populations. In 2007, 2008 and 2009; 46, 25, and 47 eggs were treated.

On August 8, 2009 and on a 2009 visit by AECOM biologist, numerous (60-70) young were observed. This is equivalent to about 10 nests. It is possible that nearby nesting geese bring their young to the lake to be reared. These nests may be in the wetland to the east of Mill St at the south-eastern extension of Fairy Lake or they also are likely to be in the golf course to the southwest – it is a fairly easy walk for geese from this golf course.

Due to the timing of the surveys, nesting activity was not directly observed, but egg-oiling results give some idea of the breeding numbers present. In the spring, April, May, and early June when geese are breeding, numbers might be at their lowest. At least several dozen geese are likely present as 10 nests were found in 2009 (Warren Harris, Town of Halton Hills). Numbers of non-breeding birds are unknown at this time. In summer, late June, July and August, when 'moult migrants' may be present, the numbers may increase. Moult migrants are geese that come from local areas and require a safe area to moult flight feathers. Numbers recorded were between about 50 and 100 or more at this time of year. In mid-September when true migrants (coming from greater distances) may be present, in addition to local breeding birds and their young, numbers appear to be consistently over 100 and reaching as high as almost 300 at times. Thus, there is a regular presence of geese at the lake throughout the year, with the exception of winter.

During the waterfowl surveys, people were often observed feeding the geese from the boathouse area in Prospect Park.

Mallards are also common on the lake for much of the year. Sometimes, over 50 were observed and it is likely that numerous Mallards are present through most of the year except winter.

Table 8: 2008 Canada Goose survey results

Date	Zone	# and Age of Geese	Behaviour	Comments	Total Geese	Survey Conducted by:
June 25, 2008	A	22		-geese being fed at boathouse	62	AECOM
	C	20				
	D	20				
August 7, 2008	1	60 adult	Grazing	All grazing on diamond #2	135	Halton Hills
	B	32 adults	Bathing	On beach		
	A	38	Swimming			
	6	5 adults	Swimming	Near trailer park		
August 8, 2008	A	6 adults 24 young	Being fed	At boathouse	90	Halton Hills
	C	5 adults 35 young	In water			
	3	4 adults 16 young	Grazing	On legion		
August 20, 2008	A	40	Eating, swimming, being fed	-geese being fed at boathouse Also 56 Mallards in A, 16 Mallards and 6 gulls in C	40	AECOM
August 21, 2008	1	54	Grazing and loafing	On ball diamonds	89	Halton Hills
				Also 6 Mallards in 5		
	8	35	Grazing and loafing	On hill area on non-active park		
August 27, 2008	A	16+	Loafing	Feeding in the lake	32+	Halton Hills
	1	12	Grazing	On ball diamond		
	5	4	Feeding in lake	Also 4 Mallards in 5		
August 31, 2008	8	12+	Grazing	Soccer field	109+	Halton Hills
	A	32	Geese	In water		
	B	10				
	C	45		Young are full grown and flying away		
	3	10	Grazing	On legion grass		
September 15, 2008	A	76	Loafing and swimming	-geese being fed at boathouse Also 64 mallards in A and 5 Mallards in E	79	AECOM
	C	1				
	E	2				
September 17, 2008	A	100+	Grazing and feeding	In water	188	Halton Hills
	B	40	Loafing	In water		
	E	20	Feeding	In water		
	5	8	Grazing and loafing	Few on land, rest in water		
	8	20	Loafing	In water		
September 30, 2008	A	37	Swimming		278	Halton Hills
	C	8	Swimming			
	1	12	Loafing	Beach behind boathouse		
	3	21	Loafing	Legion area		
	5	80	Loafing and grazing	Smallwood camp		
	6	120+	Loafing	Breezes camp		

3.9 Summary and Assessment

Water Quality

The lake is mostly sustained by surface water inflows, with groundwater only contributing to 5% of the water budget during non-drought conditions. As most of the input to Fairy Lake is surface water, and the catchment area is large, careful management of the upper watershed is necessary to maintain water quality.

Water quality of the lake is characteristic of shallow, alkaline and productive systems dominated by aquatic plants. Concentrations of metals were highest at the Tyler outfall station, reflecting the influence of urban runoff on the water quality of the lake.

Nutrients in the lake are indicative of productive conditions. Phosphorus and nitrogen concentrations were elevated at the Fairy Lake inlets, in the nearshore, and offshore areas. The average phosphorus concentration at the outlet (0.19 mg/L) indicated an acceptable trophic status[9] for an urban lake, and some assimilation of phosphorus in the lake. High DOC concentrations found in the lake reflect wetland influence on the water quality. Both Black Creek and the south inlet drain large wetland areas, and the south basin consists of a marsh dominated by aquatic plant communities. Elevated phosphorus concentrations in bottom waters can be a result of either internal phosphorus loading due to bottom anoxia or re-mineralization of organic matter from the upper waters.

Bacteria levels (*E. coli* and/or fecal streptococcus) are elevated in Fairy Lake. Bacteria counts were generally higher in the samples collected following rain storm events, particularly at the nearshore sites (i.e., old beach and trailer park) and at inlets draining wetland areas (i.e., west and south inlets). The elevated bacterial counts often occur following rain events is likely due to the runoff of fecal matter that has accumulated on the surrounding landscape.

The water quality of Fairy Lake appears to be a function of external activities and internal processes that include:

- direct discharge to the lake from upstream sources (Black Creek, the south inlet and the west inlet);
- discharge to the lake from agricultural sources upstream;
- discharge of stormsewers to the lake (e.g. Tyler and Elmore);
- internal nutrient dynamics (nutrient release from sediments during anoxia and/or re-mineralization of organic matter);
- septic systems at the trailer park (a potential, but unquantified, source)
- direct input of fecal matter from waterfowl and runoff from surrounding landscapes and the upstream catchment; and
- the local wetland setting.

---

[9] *A measure of eutrophication of a body of water using a combination of measures of water transparency, Chlorophyll-a, and total phosphorus. Degrees of eutrophication typically range from Oligotrophic (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through Mesotrophic, Eutrophic, to Hypereutrophic (minimum transparency, maximum chlorophyll-a, maximum phosphorus).*

Sediments

Surface sediments from Fairy Lakes were all highly organic with elevated nutrient concentrations. These conditions reflect nutrient and organic enrichment in the sediments. Given the highly organic sediment composition observed, the source of sediments throughout Fairy Lake is primarily biological in origin (from aquatic plant production).

Vegetation and Waterfowl

Only 5% of the public Fairy Lake shoreline is comprised of mowed grass and cultural vegetation communities. The majority of the residential properties surrounding the lake appear to be manicured, with little to no riparian vegetation. Small areas of well developed riparian buffers are found along the south arm and the west shore of the main basin. Where riparian buffers exist in Prospect Park they are very narrow (i.e., less than 3 m wide). Most of the vegetation in Prospect and Rotary Parks is mowed grass.

The aquatic macrophyte vegetation in Fairy Lake is dominated by Eurasian Water Milfoil and Stonewort with Hornworts and several pondweed species also being abundant. Overall aquatic vegetation covers nearly all of the substrate below 2 m in depth, and a lesser amount in deeper waters. The likely causes of the proliferation of aquatic plants are high water clarity and shallow water levels (the mean depth of the lake is less than 2 m) in conjunction with the high nutrient concentrations in the sediments.

Moderate to large numbers of waterfowl were observed in and around Fairy Lake during each of the survey events, and are expected to be present from early spring through late fall. Although the waterfowl appeared to concentrate in Zone A (Figure 3) and along the boathouse area, they were also observed in other areas of the lake. On numerous occasions, people were observed feeding the geese, particularly near the boathouse.

Data collected this study indicates that Fairy Lake is a clear, shallow-water ecosite[10] that naturally supports abundant aquatic vegetation. This interpretation implies that Fairy Lake would be more appropriately considered to be a wetland community than a lake, and should be managed accordingly. The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species. A moderately high diversity of native aquatic plant species is also represented.

[10] *Small ecosystem*

4. Management Alternatives and Recommendations

The Town requested a literature review of aquatic vegetation and waterfowl management techniques, in addition to Fairy Lake specific management recommendations for aquatic vegetation, waterfowl and water quality. The following two subsections (4.1 and 4.2) each contain a general review of management options (for aquatic vegetation and waterfowl respectively), and specific recommendations for Fairy Lake. The last subsection (4.3) contains only Fairly Lake specific water quality management recommendations, as a literature review of water quality management alternatives was not included in this study.

Based on the results of the field investigations, techniques to manage aquatic vegetation and waterfowl and improve water quality are considered. The goal is to provide the Town with a long-term strategy to improve water quality and aesthetics of the lake, while raising public awareness about healthy lake systems. The Town's request to identify and provide recommendations that are cost-sensitive was considered when developing the management recommendations.

4.1 Aquatic Vegetation Management Alternatives

Mirek Sharp and Associates Inc. prepared a report, entitled *"Weed Control in Fairy Lake – A Presentation and Discussion of Alternatives"* for The Town of Halton Hills in December 2003. The purpose of the study was to identify and discuss alternatives for managing nuisance weed blooms in Fairy Lake, and arose as a result of perceived liability issues associated with weeds and recreational activities being conducted there. The study included a literature review and consultation with experts and pertinent agencies (i.e., MNR, MOE and CVC), and addressed the ecological issues associated with the control of aquatic vegetation in Fairy Lake. As the report provided a comprehensive review of potential management practices, including those known to have been implemented in Ontario and most relevant to Fairy Lake, an additional literature review of best management practices was not undertaken. Rather, emphasis was placed on evaluating the alternative management approaches presented in the Mirek Sharp and Associates report, and updating it with more recent information.

Six potential alternatives were identified to control the nuisance aquatic vegetation in Fairy Lake. These include:

1) Preserve aquatic vegetation communities in their existing condition. The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species. Keeping the existing aquatic vegetation in Fairy Lake does not commit the Town to services, is the least expensive alternative, however it does not address the issue of the public's perception of weeds. .

2) Mechanical removal: raking, mechanical harvesters, underwater roto-tillers or diver-operated dredges. Advantages of mechanical removal are that results are immediately available. Disadvantages of the techniques are that they only treat the symptoms - the plants will return the following season, are disruptive to the aquatic community, are non selective in that they will

remove both native and non native species. As opposed to harvesters, cutters leave plant fragments in the water, which if not collected, can spread the plant to new areas.Of these, only mechanical harvesters are known to have been used in Ontario.

3) Chemical control: MOE generally only approves the use of, Diquat, an aquatic herbicide that goes by the trade name REWARD in Canada. Under special circumstances 2,4-D may also be approved for use by MOE. Other chemical controls, notably Fluridone, copper, Endothall and Glysophate are likely not permitted for use in Ontario.

4) Biological control: the use of biological organisms that act to reduce aquatic plant production and/or biomass (e.g., by grazing). In classical biological control, natural predators of a pest in its native range are identified, evaluated and then released in the invaded habitat. There has been some success in the US using biological controls for the management of aquatic plants such as aquatic weevils (a type of beetle; *Litodactylus leucogaster* and *Eurhychiopsis lecontei*), aquatic midges (*Cricoptopus myriophyii*), a naturalized moth (*Acentria ephemerella*) and sterile Grass carp (*Ctenopharyngodon idella*). Grass carp are not permitted in Ontario (Ontario Ministry of the Environment 2005). Two test studies are presently being conducted in Ontario with native weevils. These include one at Puslinch Lake in Cambridge and another at Lake Scugog. Preliminary results have been promising.

   a) Puslinch Lake is a small shallow completely enclosed lake located in Cambridge, Ontario. In the late 1990's Eurasian watermilfoil began to dominate the plant community. In response, the Puslinch Lake Conservation Association (PLCA) began a three year MiddFoil stocking program in 2006. Approximately 12,000 weevils were stocked in both 2006 and 2007, and 6,000 were stocked in 2008. Results from the first three years of testing have found positive response to weevil introduction. At the start of the project, average milfoil density was over 400 stems per square meter. The 2006 and 2007 follow-up surveys found that the established weevils were increasing in number. By July 2008, dense milfoil beds no longer covered large portions of the lake and very little milfoil was noted at the surface. A late-season 2009 survey revealed that the below-surface milfoil noted in 2008 was being replaced by desirable native vegetation.

   b) The Lake Scugog study was initiated in spring 2009. Test studies were initiated in the northern portion of the lake. Early 2009 studies found that the watermilfoil present in the lake was not Eurasian watermilfoil, but a new hybrid of the native northern watermilfoil. This new native northern watermilfoil is more aggressive than the Eurasian watermilfoil. Preliminary results of the study have found that sites where native weevils were added showed significant destruction of compared to the control site (Ross 2009).

5) Integrated Ecological study approach: this involves undertaking ecological studies of Fairy Lake including water chemistry, limnology, fisheries and botany to determine the root causes for the proliferation of Eurasian Water-milfoil. It would also include a comprehensive literature review of ecology of aquatic vegetation, as well as experimental trials of different management options. This approach is costly and long term with uncertain results but it has potential to get to root of the problem.

6) Shading: Shading is a potential physical management option for Fairy Lake. It consists of shading of areas of water to block photosynthesis thereby reducing cover of aquatic plants; which could be accomplished by temporary shade barriers, built canopies, water dyes or tree plantings. This would only be recommended for small recreational areas (e.g. swimming areas), where any aquatic plant growth is undesirable.

Each of these approaches were evaluated based on their applicability to Fairy Lake. Table 9 summarizes the advantages and disadvantages of each alternative.

Table 9: Alternative aquatic vegetation management approaches

Alternative	Advantage	Disadvantage	Acceptability
Preserve Aquatic Vegetation	• Least expensive. • Does not commit the Town to services or ongoing commitments.	• Does not address potential or perceived liability issues.	Yes.
Mechanical Control	• Result are immediate • No long-term pollution implications • Small or large areas can be treated	• **Only treats the symptom - weeds will eventually return.** • **Plant fragments resulting from cutting will easily spread and regrow** • **Requires annual financial commitment**. • Non-selective, removes all plants • Harvested material requires disposal. • Removal requirements vary seasonally, depending on conditions from year-to-year. • Expensive	No
Chemical Control	• Expected to be less expensive than mechanical alternatives.	• Limited effectiveness due to restricted depth of application and type of herbicides that can be used. • **Only treats the symptom - weeds will eventually return.** • **Requires annual financial commitment**. • Potential to damage native plants. • Dead weeds must be harvested to avoid oxygen depletion from decomposition. • Potential for creating algae blooms. • Not publicly-acceptable. • May be hard to discontinue if the public regards it as a service.	No
Biological Control	• More publicly-acceptable than chemical alternatives. • Selective, only removes desired species • No long-term pollution implications	• Promising species (*E. lecontei* and *A. ephemerella*) are not native to North America, although latter is naturalized. • Long-term implications relatively unknown • Expensive to treat large area	Potentially, if supported by Integrated Ecological Studies
Integrated Ecological Studies	• Ecologically-sound • Most palatable to the public. • May provide a long-term solution that does not require ongoing/annual treatment (cost effective)	• May not provide a natural solution as Fairy Lake is "man-made". • Requires extensive and potentially expensive studies. • Outcome uncertain	Yes, in the long-term.

Alternative	Advantage	Disadvantage	Acceptability
Physical Control - shading	• Inexpensive means to reduce cover in limited area or for short term. • Multi-year control	• Only useful for reducing weeds in limited areas • Non – selective, will remove all plants • Dead plants must be harvested	Yes

4.1.1 Aquatic Vegetation Management Recommendations for Fairy Lake

Mechanically or chemically removing aquatic vegetation is not the correct management option for Fairy Lake. These techniques only treat the symptoms and plant growth will eventually return. In addition plant fragments resulting from cutting can cause the spread and regrowth of plants. Integrated ecological studies is a preferred management option as it is based on additional scientific studied and is ecologically sound, however it binds the Town to extensive financial commitment. Our recommendations for aquatic vegetation management for Fairy Lake are:

1. **Preserve aquatic vegetation communities in their existing condition** – Removing aquatic vegetation is the not correct action to take for maintaining the natural equilibrium in the Fairy Lake system. The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species.

2. **Public education** – Educate the public on the role of aquatic vegetation in healthy lake ecosystems. Raise awareness on basic lake and wetland ecology. Aquatic plants do not indicate a lake problem. Plant growth is due to the high water clarity and shallow water levels in conjunction with nutrient enriched sediments. Continued management at attempts to remove vegetation are not only costly, but futile. Lake conditions, such as depth, will continuously permit the regrowth of aquatic vegetation. Section 5.3 – Education, outlines methods for communicating the "health" of the lake to residents, and changing the perception of the lake quality.

3. **Biological control –** Weevils appear to be a promising technique to as a means to control Eurasian watermilfoil populations. They are native to North America and are relatively inexpensive. Since they are still in the testing stage there are several uncertainties that exist such as the role predators (e.g. bluegill and sunfish) in regulating weevil populations and long-term environmental implications. Partnership with Universities or other research organizations may provide additional information on the applicability of weevils to small lakes with well developed mixed macrophyte community, and provide some macrophyte management for the Town of Halton Hills.

4.2 Waterfowl Management Alternatives

Nuisance waterfowl management studies have been primarily directed towards Canada Geese, which have been identified from the inventory studies to be the predominant waterfowl species utilizing Fairy Lake. The Canada Goose is a migratory bird that is protected under the *Migratory Birds Convention Act*. Without a permit it is illegal to disturb, damage or destroy the nest or eggs of the Canada goose.

Ideal breeding habitat includes manicured parks, lawns, golf courses, agricultural crops, and areas with ponds or stormwater ponds. Geese prefer grassy areas that are frequently maintained near open water, and provide unobstructed views of the pond or water. They prefer these areas for feeding and security reasons. Geese are easily adaptable and have been noted nesting in trees, roadside ditches, adjacent to swimming pools and on flat rooftops (Environment Canada, 2009). Canada Geese in constant interaction with humans will eventually lose their fear of humans. Canada Geese can become aggressive towards humans, especially when the birds are nesting and rearing their young in March, April and May.

Canada Geese usually begin breeding during their third year. Pairs will seek nesting sites (typically near the shoreline) during the first warm days in February and by mid to late March most pairs have established a breeding territory and will lay two to eight eggs. By mid-April most females will be sitting on their nests, preferably by water, along the shorelines of ponds and wetlands. Hatching occurs in May, and rearing adults will often move their brood some distance for security and for easy food accessibly. After the goslings hatch, adult geese moult their wing feathers leaving them flightless for up to six weeks. Moulting geese are reluctant to leave their feeding area and non-breeding geese will gather in large moulting flocks. By the end of July the adults and goslings are able to fly but will typically remain in the moulting area if sufficient food, water and security are present (Environment Canada, 2009).

A number of management approaches have been developed to control nuisance populations of Canada Geese, including: non-lethal passive deterrents; active scare techniques and lethal management. A discussion of these approaches is provided in below.

4.2.1 Non-Lethal Passive Deterrents

This section discusses passive deterrents that can be incorporated into a goose management plan. These suggestions are most effective when used in combination with each other in a consistent manner as well during important life stages of the Canada goose.

4.2.1.1 Discourage feeding

Regular supplemental feeding (as identified in Table 10) encourages a high concentration of geese year round which will not abandon a site as long as there is sufficient food. Education is an important tool to help discourage the feeding of geese. It is important to understand that people are not feeding the geese to cause trouble; on the contrary, they believe they are helping the birds. However, geese gain very little nutrition out of bread, crackers, and other processed grain products. Even feeding the birds corn or other grains, which are better nutritionally for the geese, is not encouraged as it may quickly make them dependent on the human food source and will increase the likelihood of not foraging for themselves.

4.2.1.2 Landscape alteration

One of the easiest ways to reduce nuisance Canada Geese populations is to change their environment. Canada Geese adapt easily to manicured and maintained grassed areas that allow unobstructed views of an adjacent water body. Such is now the case with portion of Fairy Lake. Numerous options are available to reduce the attractiveness of a site for breeding and loafing Canada Geese:

- **Increase vegetated shoreline buffer**. Allow grassed areas adjacent to the waterbody to grow longer and/or plant coarse tall grasses that are less appealing to geese. It is also important to reduce fertilization of the grassed areas. (Doncaster, 2009).

- **Obstruct views of the shoreline**. Reducing sightlines to less than nine metres makes geese feel uncomfortable (Carr, 2000). Planning the way vegetation is maintained can discourage goose access as shown Figure 13. In this landscaping configuration sinuous mowed pathways provide easy human access to the water while obstructing views for geese.

- **Obstruct access to water**. Low fences or rock walls, including natural barriers such as trees and densely planted shrubs planted along the shoreline, will reduce access to the water.

Figure credit; Doncaster, 2009

Figure 13: Using landscaping to obstruct views of shoreline

- **Use repellents**. Repellents can be applied to discourage geese from using an area. Chemicals include methyl anthranilate, dolomitic lime and anthraquinone with plant growth regulator. These chemicals act as a taste repellent and are not harmful to grass or wildlife.

- **Install temporary barriers**. Low fences marked with "Birdscare-Flash-Tape", fluttering strands of shiny Mylar tape, or highly visible material can repel geese. The barriers should be placed at goose and gosling height between the water and area to be protected. Goslings are not capable of flying over the barrier and the adults will not leave their goslings behind.

- **Install fine wire grid system**. A grid of stainless steel wires or monofilament strands (<0.5 mm in diameter or smaller) can be installed at about half a metre to 2.5 to 12 m intervals above sources of food and water. If access to the lake is needed, wires can be raised 4-6 ft above the surface and strung 10 ft apart (Berryman). Wires should be installed in parallel and on a horizontal plane. Spacing between strands depends on the target species. Wires should be installed before the arrival of the targeted waterfowl. Wires reduce the attraction of water and food, and increases uncertainty in the waterfowl, making them more susceptible to scare techniques. Disadvantages include regular monitoring of wires to release trapped birds, mono-filament deteriorates in the sun, stainless steel wire is difficult to handle during installation, and some bird injury/mortality may occur when birds fly into wires (Transport Canada, 2009).

- **Construct aquatic benches in shoreline areas**. Aquatic emergent vegetation can be installed in shallow water to create both a visual and physical barrier to geese. Benches can range in width from 3-6 m then gradually sloping towards the water. Aquatic plants along with shoreline buffer plants will act as a deterrent for Canada Geese (Doncaster, 2009). Benefits from aquatic benches include habitat for other waterfowl, nursery habitat for fish, appropriate plants can provide succession throughout growing season, reduces shoreline erosion, filters nutrient runoff from grassed areas.

- **Install hard edges**. Structures with a vertical rise from the water work well at limiting access to the geese (Doncaster, 2009). When located appropriately to avoid unnecessary hardening of a natural shoreline decks and boardwalks allow easy access for humans but will exclude the geese from access to the water.

4.2.2 Active Scare Techniques

4.2.2.1 Discourage nesting

Several scare techniques can be used to discourage geese from nesting:

- Disturb birds as soon as they arrive to deter them from settling on the property. Techniques include noisemakers, strobe lights, recorded distress calls, balloons and kites, scarecrows, motion-activated sprinklers and propane canons. A combination of techniques will prevent the geese from adapting to any one technique.
- Dogs have been used to scare geese away from sites. The dog must be fully trained and supervised during the activity. Local bylaws and park regulations must be complied with and proper permits should be obtained.

4.2.3 Lethal Management

If using this technique, it is very important to maintain a long term commitment to egg sterilization. As fewer eggs hatch the birds will eventually relocate because their breeding attempts have failed.

- **Egg oiling.** Egg oiling sterilizes the egg by coating them with non-toxic vegetable or mineral oil. This method blocks the pores in the shell and prevents further development of the embryo. It is important to return the oiled egg back to the nest so the goose will continue to incubate her eggs beyond normal hatching date and will not re-nest. Egg oiling requires a permit from the Canadian Wildlife Service. It must be demonstrated that the birds are causing, or will likely cause damage or effect health within a community. The request must include numbers of birds involved and the name of the person performing the procedure. If birds have nested, the technique should be used 10 days after the last egg is laid.

- **Egg addling**. This technique involves shaking the eggs to destroy the developing embryo. Again it is important to return the addled egg to the nest so the goose will continue to incubate her eggs beyond normal hatching date and will not re-nest. Egg addling also requires a permit from the Canadian Wildlife Service.

4.2.4 Seasonal Aspect of Deterrents

Canada Geese are migratory birds that are seasonally dependent upon specific environmental conditions for their growth and reproduction. In order to engage effective deterrents it is important to understand the biology and behaviour of the Canada goose. Canada Geese are less likely to be deterred while nesting or raising young therefore it is important to initiate deterrents before they become settled (McFarlane-Tranquilla, 2008). Table 10 summarizes seasonal considerations for deterrents generally.

Table 10: Seasonal aspects of goose deterrents

Timing	Objective	Consideration
Early Spring	• Landscape alteration • Reduce the attractiveness of feeding habitats • Prevent nesting	Landscape alteration can be done during all seasons but should be done before geese arrive and become territorial
		Begin discouraging nesting pairs before nests and territories are settled in early February.
		Nests with no eggs can be removed with no permit
Early Summer	• Manage active nests	Implement egg oiling program
Mid Summer	• Erect barriers	Geese are very reluctant to fly over barriers when they are caring for their flightless young
		Assists in keeping broods away from designated areas with temporary barriers
Mid to late summer	• Scare moulting geese away	Flocks of moulting geese are hard to remove once established. Look for geese gathering on open water and in fields with unobstructed paths to water
		In early May start checking area regularly to detect flocks of pre-moulting geese.
		Begin scaring techniques as soon as congregation of geese are noticed and before they become flightless.

4.2.5 Canada Goose Management Recommendations for Fairy Lake

No-mow zones along the edge of the lake and a relatively natural lake edge in many places have kept the goose problem from being even larger than it is. We do, however, recommend the following management options to assist Halton Hills in reducing the Canada Goose population:

1. **Continue egg oiling** – This may decrease the number of breeding adults in the future, and will continue to reduce the number of young produced in the lake. However some young geese are still seen in the lake. On August 8, 2009 and on a 2009 visit by AECOM biologist, numerous (60-70) young were observed. This is equivalent to about 10 nests. It is possible that nearby nesting geese bring their young to the lake to be reared. However, many of the geese present at Fairy Lake are not breeding birds and thus egg oiling will only ever control a minority of the goose numbers. Therefore the other measures provided are also recommended to manage Goose populations.

2. **Stop feeding geese** – This should be done through a combination of measures such as signage and education. Signs should be erected in several places including entrances to the park and near the boathouse. These signs should not only prohibit waterfowl feeding, but explain why it is necessary. Although many people will obey the signs, some will not. Town staff or other representatives should visit the boathouse and discuss the issue with anyone feeding geese. One-on-one with Town staff will help to achieve a difference in public behaviour, and should not need to be needed indefinitely.

3. **Increase shoreline naturalization in Prospect Park** – Prospect Park has a mainly naturalized shoreline, but there are a few areas where increased naturalization might further discourage geese. If consistent with other park uses, the tip of the peninsula and the small area around the boathouse beach could be planted and naturalized with native shrubs and tall emergent vegetation. Also, the no-mow zone should be planted with similar species to make the tall vegetation (versus grasses) zone wider. Woody shrub species include Red-osier Dogwood (*Cornus sericea*) and appropriate willow species such as Bebb's (*Salix bebbiana*), Pussy (*S. discolour)* and Shining Willows (*S. lucida),* as well as Nannyberry (*Viburnum lentago*) and Ninebark (*Physocarpus opulifolius*). Any other locations where the grass can be left to grow longer will also discourage geese. Naturalized shoreline width should at a minimum be 5 m and ideally between 10 to 20 m. Finally, in order to minimize sightlines for geese who prefer to be able to see a nearby lake, lines of native trees and shrubs could be planted in between the baseball diamonds and other locations.

4. **Encourage landowner shoreline naturalization** – Encourage private landowners to naturalize shorelines by planting tall emergent herbs and or dense woody vegetation (not low grasses). Some areas where this would be appropriate are single residences in the north-eastern arm of the lake (by Area B, Figure 3) around the south-western arm (by area E, Figure 3). The large grassy lawns in this latter area are probably an attractant to geese (as are the soccer field, baseball diamonds and other manicured areas of Prospect and Rotary Parks).

The measures outlined above, should reduce the goose population at Fairy Lake. Numbers, however, may not decrease significantly for a noticeable improvement in water quality. If the latter is the case, more intensive tactics such as grass repellents, wire grid systems and dog scaring are recommended. These are likely to be more expensive methods of control.

1. **Grass Repellents** – applications of substances to the grass which make turf less appealing to feeding geese might be appropriate, especially for locations such as the soccer field and baseball diamonds. These chemicals do not hurt people and have no negative aesthetic effect (methyl anthranilate (artificial grape flavouring) including trade name ReJeX-It, and Anthraquinone). The chemicals require re-application after mowing and possibly as frequently as every 4 to 5 days, but not after rain. It is less clear how effective dolomitic lime is. Note that these products will not stop birds from resting on lawns, but should lessen feeding. The amounts used need experimentation.

2. **Install a wire grid system** – installing a wire grid system over part of the lake (Area A, Figure 3), at least close to Prospect Park, will prevent the geese from landing on the water near the park. The visual impacts might not be desirable however. It would require construction such that geese could not walk or float in under the wires from the edges or the south side.

3. **Use dogs to scare geese** – using dogs to scare away geese from a site is an effective way to remove geese. It requires a professional dog handler to be on site repeatedly until the geese permanently leave. At different times of the year, the dogs would need to return to scare migrants or other geese. This hazing method also would require the dog handler to return on an annual basis, but cannot be used on moulting birds.

Installing hard edges to the lake is not recommended, except as a last resort as it reduces natural or semi-natural habitat. Noise makers are also not suggested for use at this site as this is inappropriate for a park designed for people use and that is also close to residences. The same applies to the temporary barriers of mylar or other material. Egg-addling is not needed, as it accomplishes the same purpose as egg oiling.

Formerly unwanted Canada Geese were rounded up during the flightless moult period, loaded on trucks and shipped to other jurisdictions. This was not an effective solution for it was expensive, it distributed the problem wider, and often some of the geese would return once they could fly. Consequently translocation of geese is no longer an option,

4.3 Water Quality Management Recommendations for Fairy Lake

The main water quality issues identified through the field investigations were nutrient enrichment and high bacteria concentrations. Water quality was attributed to a number of sources from both the watershed and internal processes. The relative importance of each source, however, was not quantified as part of this study. Before water quality management techniques are implemented, the contribution of each of the pollution sources to the lake should be determined to prioritize management activities (Section 6 – Future Monitoring and Study).

Regardless, a lake management plan to improve water quality must address both in lake issues and the contribution from the catchment area. A comprehensive lake management approach that includes both local and watershed-scale management recommendations are considered for Fairy Lake. Local management includes activities that can be completed in the area in and immediately surrounding Fairy Lake. These alternatives are lower in cost (compared to watershed-scale management), and can be implemented in the short term. Due to their scale, watershed-scale management activities are generally more costly than local management activities. These are, however, activities that will benefit the watershed over the long-term, and leave a positive legacy for future generations. It should be noted, that the recommendations provided are not a quick fix, rather they are linked to broader initiatives and studies in the watershed, and should be considered long-term solutions.

Local management recommendations include[11]:

1. **Public education** – Fairy Lake provides recreational and aesthetic enjoyment for its residents. Unfortunately, the aquatic vegetation is not conducive for some recreational uses (e.g., swimming and boating). Presently there is a perception that the aquatic vegetation or “weeds” is an indicator of lake problems. The Town of Halton Hills should raise the public’s awareness on basic lake, wetland and wildlife ecology, the influence of human activities on water quality, and the role of vegetation in healthy lake systems. Section 5.2 – Education, outlines methods for communicating the “health” of the lake to residents, and changing the perception of the lake quality. In spite of this, we recognize that lake use for swimming and bathing is desirable and represents a substantial benefit to some people. As such, a limited program of weed control (through shading) can be considered for the beach areas to allow the opportunity to swim and wade (subject to bacterial testing to confirm safety).
2. **Deter use by waterfowl** – Waterfowl feces can be a significant source of nutrients and bacteria to lakes and ponds. Water quality results found that bacteria counts were high in most areas of the lake, namely near the old beach, where feeding was observed on a number of occasions. In addition to active management, visitor education on the influence of waterfowl on water quality is essential to reduce waterfowl populations in and the Lake. Section 4.2.5 (Canada Goose Management) outlines recommendations to deter use by waterfowl.
3. **Implement a “Stoop and Scoop” program** – Similar to waterfowl, dog feces contain large concentrations of nutrients and are a major source of bacteria and pathogens. Trails and off-leash areas in Prospect Park are regularly used by dogs and their owners. When dog feces is left on park grass and along trails, runoff carries it into the lake itself, or storm sewers and watercourse that discharge into the lake. We recommend that the Town implement a ‘Poop and Scoop’ program, whereby biodegradable bags are provided and are disposed of at stations that contain covered garbage bins for easy disposal of the bags. The influence of dog feces on water quality should be provided at these stations, and on education signage (described above) to educate the public. We also recommend that the Town encourage a watershed wide program, encouraging owners to practices “stoop and scoop” throughout the Town and in their own backyards.

[11] *Where overlap occurs between water quality recommendations and those identified for waterfowl or aquatic vegetation, we have referenced the appropriate section*

4. **Use best practices to minimize/eliminate fertilizer use** – Fairy Lake is located in a recreational setting, and adjacent to residential areas, a trailer park, school, and open space. These traditionally represent areas of high fertilizer use. Fertilizers represent a direct source of nutrients. Although natural vegetation around the lake is capable of removing some of the nutrients, minimizing or eliminating the use of fertilizers reduces the likelihood of further nutrient enrichment. Presently, the Town of Halton Hills uses 25-10-15 non-organic fertilizer applied three times annually. The Town of Halton Hills should use best practices for fertilizer application to reduce application rates and volumes and encourage the reduction and or elimination of fertilizer use by residents. The Town should also work closely with the trailer park and other landowners to establish a nutrient management plan that focuses on the reduction of fertilizer use and naturalization of shorelines to improve runoff water quality.

5. **Improve/Increase shoreline buffers** – Buffer strips help to filter runoff from adjacent land use. As water flows through a vegetative buffer, contaminants and sediment are removed by filtration and settling in the network of plants and plant residue. Soluble contaminants, including nutrients, are taken up by the plant roots or consumed by microbes in the soil. In 2006, the Town of Halton Hills has implemented a 5 m "no mow" zone around the lake in Prospect and Rotary Parks. Much of the shoreline of Fairy Lake is vegetated. Only a small portion of the shoreline is comprised of mowed grass and cultural vegetation communities. The width of a buffer and its vegetation type, however, influence the effectiveness of a buffer. Native plants typically have denser, deeper root structures, (than conventional turf grass) which improves the infiltration of runoff. Section 5.2.5 (Canada Goose Management Recommendations) outlines recommendations to improve the shoreline buffers.

   The Town of Halton Hills should work with private landowners to improve shoreline vegetation along the lake, and throughout the watershed to reduce contaminant runoff.

Watershed-wide management recommendations include:

6. **Reduce upstream contaminant loads** - The catchment of Fairy Lake is approximately 2,000 ha, large in comparison to the size of the lake (39 ha). Land use and activities in the catchment can have an appreciable effect on the lake. Results from the 2008 field investigation found that the discharge of upstream tributaries and stormsewers are likely contributing to the water quality. Nutrients, bacteria, and metals were elevated at the inflows. The upstream catchment consists primarily of agriculture (60%), however golf courses, urban areas and industrial areas are also present. The combined runoff from these areas can contain high concentrations of nutrients, bacteria and metals. Stormwater runoff also contains high levels of nutrients, bacteria, salts and metals, as noted at the Tyler and Elmore outfalls.

   Reducing contaminant loading from the watershed is a substantial undertaking, and is a long-term management objective. Some of the methods that the Town can employ to help reduce upstream contaminant loads include:

   a. **Improve stormwater management** – settle out contaminants before they enter the catchment by directing stormwater to a management facility prior to discharge to the lake or a watercourse;
   b. **Work with landowners to reduce fertilizer application and increase vegetative buffers** – In particular, landowners with golf courses, active farming practices or livestock;

c. **Reduce runoff from impervious surfaces and increase infiltration on-site** (e.g. swales, and retention pits, use of porous materials);
d. **Encourage agricultural best management practices** – many jurisdictions offer technical and financial assistance programs for agricultural landowners. Programs offer support for the implementation of best management practices (BMPs) that protect and enhance water quality.
e. **Reduce road salt application** – implementation of a road salt reduction program, in conjunction with best management practices for salt application, can help to reduce the amount of salts applied to roads, and reduce the amount that will enter the lake.

We recommend that the Town of Halton Hills develop a nutrient model for Fairy Lake to determine the relative importance of each nutrient source (Section 6) before implementing these methods. This will help to prioritize the techniques that will have the most effect on Fairy Lake water Quality.

The Town of Halton Hills is presently working with Credit Valley Conservation (CVC), Town of Erin, and Halton Region on the Black Creek Subwatershed Study. We recommend that the details of these larger-scale management activities be determined through the land use management strategy that will be presented as part of that study. The Total Phosphorus Management Study currently underway by Halton Region, which will also help to contribute to improved water quality.

5. Communication Strategy

The main use of Fairy Lake is likely for passive recreation, simply enjoying looking at the water and the animals and plants on and around the lake, especially since the cessation of swimming activities. People watch the birds and they also go fishing or boating. Each of these uses has certain requirements and also affects the ecology of the Fairy Lake system. The recreational and aesthetic values associated with Fairy Lake can benefit all watershed residents (and non residents) by providing a healthy place to play or to enjoy a quiet sunset. In other words, a healthy Fairy Lake improves the quality of the community's life. At the same time, the communications plan may have to reflect the fact that some lake uses (such as swimming) are impaired and to establish whether or not restoration of these uses are desired, or even feasible, over the long term. The communications plan must reflect the expectations of residents and, if necessary, manage those expectations through education. An important aspect of the communication plan will be to will be support the concept that Fairy Lake is, in actuality, an adapted wetland system and that it should be managed as such.

The primary focus of a communication program should be to solicit input into the future of the lake from residents, bring awareness to residents of the resources in their own backyards (literally), inform them of what the Town is doing to improve this special feature, and to educate them on what their role in improving ecosystem services associated with Fairy Lake. This focus could then expand to showcase Fairy Lake to other parts of Southern Ontario, as an example of the quality of life in Halton Hills.

5.1 Communication Tools

Watersheds are often the best scale at which to perform public education and outreach efforts strive to achieve broad objectives. The first is to create awareness among all watershed residents that they are connected to the lake/wetland. Once residents become more "connected" to the feature, the next objective is to educate them about specific ways they can influence water quality through their daily actions.

Many communities have education programs to influence residential behaviour. Although these efforts go by a variety of terms such as watershed awareness, public outreach, and stewardship, they all have a common theme: educating residents how to live sustainably within their watershed. The review of the most influential methods in attracting residents found that messages sent through television, radio and local newspaper were consistently more influential in reaching residents than any other techniques (CWP, 2000a). Messages transmitted through meetings, brochures, local cable television and videos reached only a small segment of the residents (CWP, 2000a). The Town should therefore craft a communication/education plan that uses a mixture of techniques and is innovative in presentation.

It is noted that on the current Town of Halton Hills website there is tab entitled 'Discover Parks' in Halton Hills (http://www.town.halton-hills.on.ca/discover/parks.php) yet there is no mention of Prospect Park or Fairy Lake. Similarly, the 'Park Locator' tab provides a map of Acton which does not show Fairy Lake. In the age of the internet a cost-effective way to raise awareness of residents within the Town is to improve the effectiveness of the Town website by creating an interactive map on Fairy Lake. Information provided may include:

- location, directions to the lake, and trails, parks in the area;
- photographs/maps of the lake;
- morphometry (size, shape, depth);
- water quality;
- fish present;
- vegetation/wildlife;
- presence regionally rare species (such as Banded Killifish);
- basic lake, wetland and wildlife ecology;
- role of aquatic vegetation in healthy lake/wetland systems; and
- the influence of human activities on water quality.

The website could also include information to educate residents on the concept of a “healthy ecosystem” (e.g. what do they look like), how their actions influence the quality of Fairy Lake (over fertilization, feeding geese etc.), and what actions they can take to improve/maintain water quality. It could also provide a forum for residents to share ideas and information about “their” lake.

5.2 Education

Local and area residents have been drawn to Fairy Lake for its recreational and aesthetic values for many years. Unfortunately, the natural wetland character of the lake is not conducive for some recreational uses (e.g., swimming and boating). Presently there is a perception that aquatic vegetation or weeds is an indicator of lake problems. Plant growth in Fairy Lake is occurring because of the high water clarity and shallow water levels (the mean depth of the lake is less than 2 m) in conjunction with the high nutrient concentrations in the sediments. Continued management at attempts to remove vegetation are not only costly, but futile, as conditions of the system (such as depth) will continuously permit the regrowth of aquatic vegetation. A change in perception of the lake as more of a wetland system than a lake through education is therefore necessary.

Waterfowl have been identified by Town staff and residents as a problem. The waterfowl inventories found large numbers of Canada Geese using Fairy Lake. They were often observed being fed in and around Prospect Park. Waterfowl feces can be a significant source of nutrients and bacteria to lakes and ponds. Water quality results found that bacteria counts were high in most areas of the lake, namely near the old beach, where feeding was observed on a number of occasions. In addition to active management, visitor education on the influence of waterfowl on water quality is essential to reduce waterfowl populations in and the Lake.

Educational signage can be used to convey these messages to lake visitors and residents. Educational signage should be located in highly visible strategic areas within the park and also in an area (e.g. near the boathouse) where waterfowl feedings were observed. Illustrations should be included to clearly depict lake attributes and attract lake users to the message. It is also important to express the end result of this project and how it benefits the community with future use of the water body. Two types of signage should be considered:

- Two or three large signs located in the more heavily used areas, or known goose feeding areas, such as the boathouse and the entrance. Information included in these signs should include:
  - The unique natural heritage of Fairy Lake
  - Ecology of Fairy Lake (fish present, macrophytes growth, etc.)
  - Influence of watershed activities on the lake (e.g. runoff from surrounding land uses)
  - The influence of waterfowl on water quality
  - Impacts to waterfowl from feeding (low nutrient content)

- Smaller signs located around Fairy Lake advising users ‘Please Do Not Feed the Geese’.

Additional education on Fairy Lake ecology can be accomplished through the communication tools outlined.

5.2.1 Lake Stewardship

Through their everyday activities, residents can have a negative effect on the quality of their lake environment. Some of these activities include: lawn fertilization, car washing, fall leaf disposal, disposal of household hazardous wastes, landscaping practices, de-icing, sidewalk/driveway sweepings, watering/irrigation, and pet waste disposal. In contrast, these activities can be easily altered to improve lake health.

Lawn care has traditionally been the primary focus of many lake education efforts, which is not surprising given the potential phosphorus inputs from careless fertilization. A significant fraction of homeowners can be classified as “over-fertilizers” who apply fertilizers to their lawns two or more times a year, such that excess fertilizer ends up washed into the nearest water system in a storm. Failure to clean-up dog faeces can cause both water quality and public health problems. Dogs can be a major source of fecal coliforms and pathogens in urban watersheds if faeces are not cleaned up. This is not surprising given their population, daily defecation rate, and bacteria/pathogen production. Outdoor car washing also has the potential to results in high loads of nutrients, metals, and hydrocarbons during dry weather conditions in many watersheds, when the detergent-rich water used to wash cars flows into the streets and into storm drains.

Steps residents can take to help minimize impacts on lakes:

- reduce or eliminate the use of fertilizers, while eliminating the use of pesticides;
- minimize turf area and avoid growing lawns in areas that require supplemental irrigation;
- gradually replace lawns with native trees, shrubs and ground covers;
- cultivate lawns with the goal of absorbing runoff from roofs;
- take responsibility for disposing of pets wastes;

- encourage a “stoop and scoop” program around lakes with special garbage cans and baggies;
- use a commercial car wash;
- avoid using hoses or leaf-blowers near the street or storm drains;
- naturalization of shoreline edges and a “buffer strip” of at least 5 m along lakefront properties (with sufficient depth) to control surface runoff;
- properly disposing of yard waste (not along shoreline);
- use porous materials on driveways and walkways to allow for infiltration of stormwater runoff; and
- use roof leaders that infiltrate runoff to the ground, and not to surface water.

5.3 Potential Partnerships

A large component of a successful communication strategy is to identify the role of volunteers for specific projects. The involvement of volunteers and community groups should be encouraged through community workshops and events that could include:

- Earth Day Activities - tree plantings, garbage clean-up; and,
- Park enhancement – trail maintenance, build look out decks/points, continue waterfowl surveys, start a community water quality monitoring program.

Community groups – potential groups and organizations that could support volunteer actives that help to provide a cost-effective means to improve lake aesthetics and water quality include:

- Credit Valley Conservation
- Halton Region
- County of Wellington
- Friends of Fairy Lake
- Scouts Canada
- Rotary Clubs
- Local schools
- Local legions
- Surrounding trailer parks
- Residents of Acton
- Credit Valley Conservation – Conservation Youth Corps
- Protect our water & environmental resources (P.O.W.E.R)
- Halton/North Peel Naturalist Club
- Halton North Peel Woodlands and Wildlife Stewardship Council
- Ducks Unlimited
- TEAC (Town Environmental Advisory Committee)
- Agricultural Groups Concerned about Resources and the Environment (AgCare)
- Credit Rivers Anglers Association
- Ecological and Environmental Advisory Committee (EEAC)
- Halton Environmental Network
- Halton Region Ontario Federation of Agriculture (OFA)
- Healthy Options for People and the Environment (HOPE)
- Isaak Walton Fly-Fishing Club
- Ontario Soil and Crop Improvement Association (OSCIA)
- Ontario Federation of Agriculture (OFA)
- Protecting the Escarpment and Rural Land (PERL)
- Trout Unlimited Canada Greg Clark Chapter
- Halton Agricultural Comm. (HAC)

Potential funding sources – a variety of provincial and national funding sources provide financial assistance for stewardship programs:

- Trillium Ontario Foundation
- CFWHIP-Community Fish & Wildlife Involvement Program
- Royal Bank of Canada Blue Water Project
- TD Friends of the Environment
- Shell Environment Fund
- Evergreen Foundation- Wal-Mart- Evergreen Grants, The Home Depot – Evergreen Rebuilding Nature Grant, Unilever – Evergreen Aquatic Stewardship and Conservation Grant

In addition, CVC also implements many programs that could support the improvement of water quality and raise public awareness. Presently, the CVC only delivers these programs to a limited extent in Halton; however, with additional funding they could be expanded to include Halton Hills and the surrounding communities. Some of these programs include:

- ***Your Guide to Caring for the Credit: A Practical Handbook for Countryside Living*** – This program guides rural landowners through a self-assessment of their individual property and helps them to identify potential resources to implement beneficial stewardship practices on their properties. Improving land management practices on non-farm rural properties will help protect water quality and quantity in the watershed. These workshops are delivered through coffee or kitchen table discussions where one member of a local community invites their neighbours over and the workbook is presented to them. This is a great way for staff and residents to identify concerns to rural water quality, property management, and provide landowners an opportunity to create an action plan to protect their piece of the watershed.

- ***Stream of Dreams*** – is a community stream awareness program. The program brings together schools, businesses and their local communities in producing a public work of art. The program is an effective tool in connecting to a larger sector of the population and will be used to raise the profile of CVC's stewardship programs by engaging the population in creating community art. The program emphasizes creating a community vision for the state of the river through education and art, encouraging individuals to undertake stewardship actions to achieve that vision.

- ***Conservation Youth Corps*** – CYC is a program that engages high school youth within the watershed. The program provides an opportunity for high school students to work towards their community service requirements by working on environmental stewardship projects such as tree planting and stream restoration. CYC is currently limited in its delivery outside of the Region of Peel.

- ***Aquatic and Wetland Restoration Program*** – CVC staff provide inventory and assessments of aquatic and wetland habitats and will develop restoration opportunities in cooperation with the landowner or other community organizations and volunteers. CVC can also assist with implementation of projects including funding opportunities.

- ***Private Landowner Tree Planting*** – is a program for land owners with more than 2 acres of land. This program provides technical advice and financial assistance to landowners wishing to reforest or naturalize portions of their property. This program is fully available within Halton Hills and is delivered in partnership with the Region.

- ***Rural Water Quality Program*** **-** This program offers agricultural landowners technical and financial support for beneficial management farm practices that protect and enhance rural lands and surface and ground water quality. Financial assistance is available to qualified landowners to share the cost of implementing selected beneficial management practices that improve water quality. Currently this type of program is not available for farmers that own land in the Halton Region portion of the Black Creek subwatershed.

6. Future Monitoring and Study

6.1 Monitoring in Response to Management

Although extensive monitoring was conducted in 2008 to establish a baseline of existing conditions a routine monitoring program should be implemented to monitor the response of Fairy Lake when specific management techniques are implemented, and as a periodic “check-up” to assess if the lake is changing.

Initially, monitoring in response to management would occur more frequently, to determine if conditions are improving in response to a specific management activity, or if another management technique is necessary. As a check-up, monitoring could occur less frequently, every five years. Periodic monitoring allows the Town of Halton Hills to determine if lake conditions are stable, improving, or declining.

Due to the management problems that may arise when water quality deteriorates (i.e., oxygen depletion and fish kills), routine monitoring is recommended to identify potential problems early and allow the Town to act promptly, before conditions deteriorate.

6.1.1 Water Quality

After a management technique has been implemented monitoring should be conducted annually for the first two years or until lake conditions stabilize. Monitoring should then occur every five years. Of course, if any management initiatives are undertaken to improve water quality, or there are significant changes in the watershed, we recommend that monitoring be undertaken annually until lake conditions stabilize.

The recommended monitoring program is as follows:

The water quality monitoring program should consist of five sampling events. One should occur in January/February, representing under-ice mid-winter conditions; and four in August or September, during summer conditions. Two dry and two wet sampling events should be conducted during the summer events.

During each monitoring event, measurements should include:

a) Secchi Disk depth (m);
b) dissolved oxygen, temperature, pH and conductivity every 0.5 m;
c) surface grabs for *E. coli*;
d) surface grabs for total phosphorus, total Kjeldahl nitrogen, nitrate, total suspended solids; and
e) one meter off bottom samples of total phosphorus, iron, total Kjeldahl nitrogen, nitrate, ammonia, total suspended solids should be collected from the deep basin if the bottom water is anoxic (<0.05 mg/L DO).

Samples should be collected from each of the sampling locations used for this study. In addition, samples from outfall should be collected for chloride analysis and a ICP-MS metals scan, when flowing.

The cost to complete the water quality monitoring program described above is estimated as $10,000 for analysis and $17,000 labour (assuming outside consultants undertake the monitoring). We recommend that each monitoring program include a summary report that presents the recent data and compares it against previous data collected and discusses any trends or changes and their implications. Any long-term monitoring program should also be supported by development of a database of water quality results that allows easy access and interpretation of results by the Town of Halton Hills, the Credit Valley Conservation, and any other partners.

6.1.2 Vegetation and Waterfowl

The vegetation in and around Fairy Lake should be identified and quantified in relative terms on a five year cycle. The following items are recommended to document the vegetation and wildlife characteristics:

a) delineation of shoreline and aquatic vegetation communities including documentation of dominant species and vegetation forms; and

b) quantification of invasive vegetation species.

Once new measures and techniques have been implemented, Monitoring of Canada Goose populations should occur spring through fall to determine effectiveness of the measures.

The cost to complete the monitoring programs described above is are estimated as $7,000 for the vegetation and $8,000 for the waterfowl. Again, we have assumed that each monitoring program include a summary report that presents the recent data and compares it against previous data collected and discusses any trends or changes and their implications.

Results should be reviewed in conjunction with the other studies currently being undertaken (e.g. Black Creek Subwatershed Study and Acton Total Phosphorus Management Study)

6.2 Future Studies

Based on the 2008 field investigations, and the analysis provided herein, the Town of Halton should have a good understanding of the influence of waterfowl, the reason for the proliferation of aquatic vegetation, and the water quality issues facing Fairy Lake.

One of the water quality issues identified through the field investigations was nutrient enrichment. High concentrations were attributed to a number of sources from both the watershed and internal processes (e.g. natural watershed sources, internal phosphorus loading, and urban runoff). The relative importance of each source on lake water quality, however, was not quantified as part of this study. Before water quality management techniques are implemented, a nutrient modelling approach can be used to compare the contribution of external phosphorus loadings to internal phosphorus loadings Fairy Lake. The study should include a diurnal oxygen and phosphorus survey to calculate internal loading, and nutrient export coeffient modelling to assess loading from external sources Although results of this study would not change the management recommendations, it will prioritize lake management activities. The estimated cost to complete such a study would be $15,000 (based on outside consultants).

7. Summary

The main water quality issues identified in Fairy Lake were nutrient enrichment and high bacteria concentrations. Water quality was attributed to a number of sources from both the watershed and internal processes that include:

- direct discharge to the lake from upstream sources (Black Creek, the south inlet and the west inlet);
- discharge of stormsewers to the lake (e.g. Tyler and Elmore);
- internal nutrient dynamics (nutrient release from sediments during anoxia and/or re-mineralization of organic matter);
- direct input of fecal matter from waterfowl and runoff from surrounding landscapes; and
- local wetland setting.

The aquatic macrophyte vegetation in Fairy Lake is dominated by Eurasian Water Milfoil and Stonewort with Hornworts and several pondweed species also being abundant. Overall aquatic vegetation covers nearly all of the substrate below 2 m in depth, and a lesser amount in deeper waters. The likely causes of the proliferation of aquatic plants are high water clarity and shallow water levels (the mean depth of the lake is less than 2 m) in conjunction with the high nutrient concentrations in the sediments.

Moderate to large numbers of waterfowl were observed in and around Fairy Lake during each of the survey events, and are expected to be present from early spring through late fall. On numerous occasions, people were observed feeding the geese, particularly near the boathouse.

Data collected this study indicates that Fairy Lake is a clear, shallow-water ecosite that naturally supports abundant aquatic vegetation. This interpretation implies that Fairy Lake would be more appropriately considered to be a wetland community than a lake, and should be managed accordingly. The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species. A moderately high diversity of native aquatic plant species is also represented.

7.1 Management Recommendations for Fairy Lake

Based on the results of the field investigations, techniques to manage aquatic vegetation and waterfowl and improve water quality were considered. The goal is to provide the Town with a long-term strategy to improve water quality, appropriate recreational uses, and develop realistic management expectations for the lake, while raising public awareness about healthy lake systems. The Town’s request to identify and provide recommendations that are cost-sensitive was considered when developing the management recommendations. It should be noted, that the recommendations provided are not a quick fix, rather they are linked to broader initiatives and studies in the watershed, and should be considered long-term solutions. The following is a summary of the recommended management techniques for Fairy Lake (details are provided in sections 4, 5, and 6) and their estimated cost.

1. **Preserve aquatic vegetation communities in their existing condition.** There is no cost associated with this recommendation.

2. **Implement communication strategy** – Raise the public's awareness on basic lake, wetland, and wildlife ecology, causes of lake nutrient enrichment, the role of aquatic vegetation in healthy lake systems, the implications of waterfowl on water quality. Encourage good lake stewardship and the steps residents can take to minimize their impact on Fairy Lake. The estimated cost for the Communication Strategy (section 5) is $40,000 for signage, website update, and public engagement initiatives (assumes in-house resources).

3. **Continue egg oiling.** Estimated cost is $5,000/annum for egg oiling.

4. **Increase shoreline naturalization in Prospect Park** – Increase stream bank and shoreline naturalization in Prospect Park (and upstream catchment) by planting tall grasses and or dense woody vegetation. The estimated costs is approximately $5,000 design (botanist visit site, design and develop drawings) and $100/m for materials and labour for planting.

5. **Encourage landowner shoreline naturalization** – Encourage riparian landowners to naturalize stream banks and shorelines by planting tall grasses and or dense woody vegetation (not manicured lawns or low grasses). The estimated cost for this recommendation is included in recommendation 2.

6. **Implement a watershed-wide "Poop and Scoop" program –** The estimated cost for this task is $3,000 for installation of the disposal bags and bins. The public education costs are included in recommendation 2.

7. **Use best practices to minimize/eliminate fertilizer use –** The Town of Halton Hills should use best practices for fertilizer application to reduce application rates and volumes and encourage the reduction and or elimination of fertilizer use by residents. The Town should work closely with the trailer park and other landowners to establish a nutrient management plan that focuses on the reduction of fertilizer use and naturalization of shorelines to improve runoff water quality. The estimated cost is $5,000 for the development of a nutrient management plan.

8. **Develop a Nutrient Model** – Develop a nutrient model to determine the relative importance of each nutrient source (external and internal) to Fairy Lake Before. This should be completed prior to any of the water quality management techniques are implemented. The model will prioritize management activities, thereby prioritizing costs. The estimated cost to complete this study would be $15,000 (based on outside consultants).

9. **Reduce upstream contaminant loads** – Land use and activities in the catchment can have an appreciable effect on the lake. Reducing contaminant loading from the watershed is a substantial undertaking, and is a long-term management objective. The Town of Halton Hills should develop the nutrient model for Fairy Lake (recommendation 8) to prioritize these actions. The Town of Halton Hills should continue to coordinate and work with Halton Region and Credit Valley Conservation to reduce contaminant loads from upstream sources. The costs associated with this recommendation needs to be determined during the design phase, and in co-ordination with the Town's partners.

In order for the management activities to be effective, all agencies need to work together in a co-ordinated fashion to maximize benefit and cost effectiveness.

Table 11 provides a summary of the recommended management techniques for Fairy Lake, and identifies the concern addressed through the implementation of each technique.

Table 11: Summary of recommended management techniques

Management Technique	Water Quality	Waterfowl	Aquatic Vegetation
1. Preserve aquatic vegetation communities			•
2. Public Education	•	•	•
3. Egg oiling	•	•	
4. Improve shoreline naturalization in Prospect Park	•	•	
5. Landowner stream bank and shoreline naturalization	•		
6. Watershed – wide "Poop and Scoop" program	•		
7. Eliminate/reduce use of fertilizers	•		•
8. Develop nutrient model	•		•
9. Reduce contaminant loads from upstream sources	•		•

8. References

Blokpoel, H., and G.D. Tessier. 1984. Overhead wires and monofilament lines exclude ring-billed gulls from public places. Wildlife Society Buletin, Vol 12. No.1.

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life. Updated 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Carr, B. 2000. Canada Goose Management. City of Mississauga.

Christens, Elaine., H. Blokpoel., G. Rason. 1995. Spraying white mineral oil on Canada goose eggs to prevent hatching. Wildlife Society Bulletin, Vol. 23, No. 2.

Centre for Watershed Protection (CWP), 2000a: On Watershed Education, in *Watershed Protection Techniques*, Vol. 3 No. 3, March 2000

Credit Valley Conservation. 2009. Black Creek Subwatershed Study Background Report. February 2009. 139 pages.

Credit Valley Conservation. 2009. Watershed Planning and Regulation Policies. Draft Document.

Chuter, G. and D. Bantroch. 1987. Wetland Data Record and Evaluation- Black Creek at Acton (ESA # 60). July 16 & 20-22, 1987. Second Edition. Credit Valley Conservation Authority.

Coulson, D., J. Peluch and F. Kempf. 1984. Wetland Data Record and Evaluation- Eramosa River Valley. July 23- August 10, 1984. Second Edition. Ontario Ministry of Natural Resources. Manuscript.

Doncaster, D. and J. Keller. 2009. Habitat Modification and Canada Geese – Techniques for mitigating human/goose conflicts in urban and suburban environments.

Environment Canada. 2009. Canada Geese and Shorelines – Seasonal techniques to deter geese. http://www.on.ec.gc.ca/wildlife/brochures/pdf/geeseshorelines-e.pdf

Fedorowick, Judy. 1989. A Survey of the Recreational Water Quality of Fairy Lake, Acton Ontario. Environmental Health Department, Region of Halton.

GLL. 2005. Brampton Lakes Citywide Lake Assessment/Management Study.

GLL. 1993. Surface and Subsurface Hydrology of the Credit River Escarpment Tributaries Headwaters Area.

Gosser, A.L., M.R. Conover and T.A. Messmer. 1997. Managing problems caused by urban Canada Geese. Berryman Institute Publication 13, Utah State University, Logan, 8pp.

Holysh, S. 1997. Halton Aquifer Management Plan. Municipal Wellhead Protection Program-Technical Study

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application.

Ontario Ministry of Environment, 1993: Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Queens Printer.

Ontario Ministry of the Environment. 1994. Water Management: Policies, Guidelines, Provincial Water Quality Objectives, reprinted 1999.

Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.Lee, Harold *et al.*. 1998. Ecological Land Classification for Southern Ontario.

Varga, S., D. Leadbeater, J. Webber, J. Kaiser, B. Krins, J. Kamstra, D. Banville, E. Ashley et al. 2000: Distribution and Status of the Vascular Plants of the Greater Toronto Area. Ontario Ministry of Natural Resources, Aurora District. 103 pp.

Lowney, Martin S. 1993. Excluding non-migratory Canada Geese with overhead wire grids.

Ontario Ministry of the Environment. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Queen's Printer for Ontario, ISBN 0-7729-9248-7.

Ontario Ministry of Environment, 1994: Water Management: Policies, Guidelines, Provincial Water Quality Objectives, Queens Printer.

McFarlane-Tranquilla, L., D.W. Smith, G. Grigg and G. White. 2008. Canada Geese: Control and Management in Southwestern British Columbia. Revised edition [online]. Environment Canada, Canadian Wildlife Service, Pacific and Yukon Region. Delta, British Columbia.

Smith, Arthur E., Scott R. Craven, and Paul D. Curtis. 1999. Managing Canada Geese in Urban Environments. Jack Berryman Institute Publication 16, and Cornell University Cooperative Extension, Ithaca, N.Y.

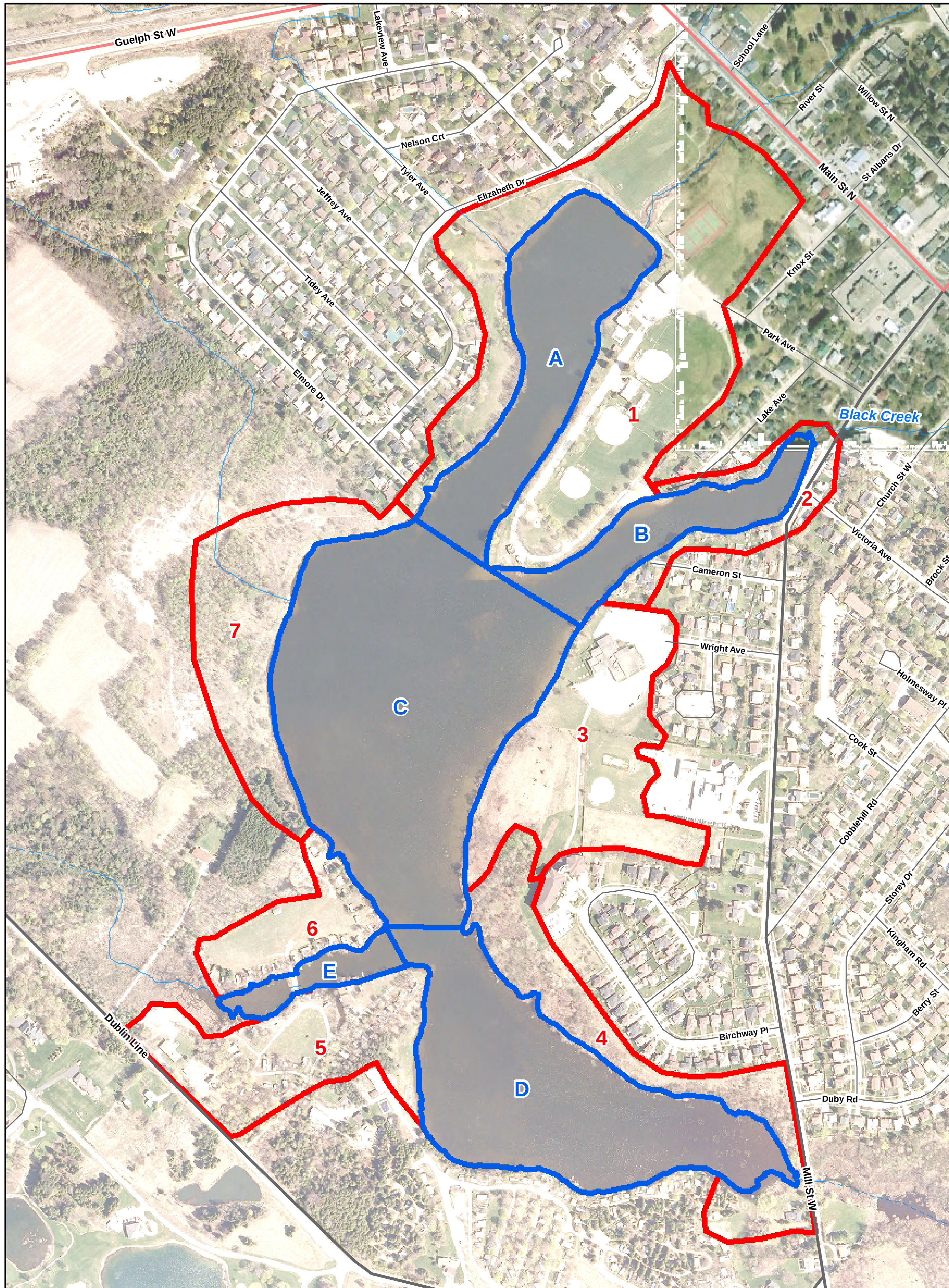
The City of Oshawa. 2006. Management of Canada Geese at Lakeview Park and Lakefront West Park. Department of Operational Services.

Transport Canada. 2002. Wildlife Control Procedures Maual (TP11500) Section F – Active management using exclusion methods.

Appendix A

Waterfowl Survey Form

Map Document: (N:\Projects\2008\80438\2008\Final\GISSpatial\MXDs\80438GooseSurvey.mxd)
15/07/2008 -- 1:09:07 PM



Fairy Lake Canada Goose Monitoring Sheet

Date: **Time:** **Weather:**

Observers:

Area	# and age of Geese	Behaviour	Comments
eg: A,B,C,D…	eg: 5 adult, 15 young	eg: Grazing, Roosting, Loafing, Flying Overhead…	Please provide any additional observations

TOWN OF ...ON HILLS
RECEIVED

This data not used in report (for some reason)

Dates not missing - no sighting or away.

??

AREA OF SURVEY

Obs = ?

Map Document: (H:\Projects\2008\60438\2008\Final\GISSpatial\MXDs\60438GooseSurvey.mxd)
15/07/2008 -- 1:09:07 PM

Fairy Lake Canada Goose Monitoring Sheet

Date: | Time: | Weather:

Observers:

Area eg: A,B,C,D...	# and age of Geese eg: 5 adult, 15 young	Behaviour eg: Grazing, Roosting, Loafing, Flying Overhead...	Comments Please provide any additional observations	
Fri. 15 Aug	23 in park	4 on water		27
17 Aug.	13 in park	53 on water	(resting in shady area)	66
21				
22	no birds			0
Sun 24.	14 in park	fly in. 50 plus 20 10 on water		94
25th	40 in park	(in shade under trees)		7
Wed 27th		20+ on water		~≥20
Fri 29	10+ in park			~≥10
Sun 31st		20+ on water		~≥20
Wed 3. Sept	20+ in park	14 on water		~≥34
Fri 5 "		20+ on water		~≥20
Sun 7 "		14 on water 2nd group 12+		~≥32
Thurs. 11 "	20+ in park			~20
Mon 15 "	30+ in park	12 on water		~42
Wed 17 "	50+ in park			~50
Thur 18 "		80+ on water	fly-in 20	~100
Sat 20 "	100+ in park			~100
Sun 21 "	100+ "	& on water		~100

real increase in [illegible]? Congregating vs. breeders or [illegible] migrants

0

AREA OF SURVEY

Map Document: (N:\Projects\2008\60438\2008\Final\GISSpatial\MXDs\60438GooseSurvey.mxd)
15/07/2008 -- 1:09:07 PM

Fairy Lake Canada Goose Monitoring Sheet

Date: | Time: | Weather:

Observers:

Area eg: A,B,C,D...	# and age of Geese eg: 5 adult, 15 young	Behaviour eg: Grazing, Roosting, Loafing, Flying Overhead...	Comments Please provide any additional observations
Wed 24 Sept	70-80 in	park / on water	~80
Sat 27	100+ in	park	~100
Sun 28		80 on water	~80
Thur 2 Oct		50+ on water	~50
Mon 6 "	Fly in 80 in park	40 on water	~120
Wed 8		10 on water	~10
Thur 9 "	12 in park		12
Sat 11 "	50+ in park		~50
Sun 12 "		100 on water	~100
Mon 13 "	Fly-in 80+ on water		~80

Jamke Kamstra - CAGoose obs

Jul 14/09

~100 centre of lake, some flew off
and in NW arm.
(~60 Mallard)

- later 60 CAGO around boathouse (assumed that
same birds as earlier
- they were being fed. at boathouse

- as told to RFC

Appendix B

Water and Sediment Chemistry and Water Budget Details

Appendix B

Water Quality Results

Table 1

Parameter Collected by: CVC	Units	DL	CVC Station 5 08/27/2008	CVC Station 11 08/27/2008	CVC Station 12 08/20/2008	CVC Station 13 08/20/2008	CVC Station 14 08/27/2008
Laboratory							
Total Carbonaceous BOD	mg/L	2	ND	6	ND	ND	ND
Conductivity	umho/cm	2	580	514	990	520	512
Total Dissolved Solids	mg/L	10	375	339	658	341	339
Total Kjeldahl Nitrogen (TKN)	mg/L	0.2	1.1	1.0	0.5	0.8	0.9
Orthophosphate (P)	mg/L	0.01	ND	0.04	ND	ND	ND
pH	pH		8.1	8.1	8.3	8.3	8.5
Dissolved Phosphorus	mg/L	0.002	0.022	0.096	0.004	0.012	0.011
Total Phosphorus	mg/L	0.002	0.042	0.039	0.019	0.018	0.019
Total Suspended Solids	mg/L	10	ND	18	ND	ND	ND
Dissolved Sulphate (SO4)	mg/L	1	1	14	27	20	20
Alkalinity (Total as CaCO3)	mg/L	1	246	187	294	179	178
Dissolved Chloride (Cl)	mg/L	1	39	45	130	47	47
Nitrite (N)	mg/L	0.01	ND	ND	ND	ND	ND
Nitrate (N)	mg/L	0.1	ND	ND	2.8	0.3	0.2
Nitrate + Nitrite	mg/L	0.1	ND	ND	2.8	0.3	0.2
Calculated Parameters							
Hardness (CaCO3)		1	260	200	330	210	200
Metals							
Total Aluminum (Al)	ug/L	5	9	18	15	17	10
Total Antimony (Sb)	ug/L	0.5	ND	ND	ND	ND	ND
Total Arsenic (As)	ug/L	1	ND	1	ND	ND	1
Total Barium (Ba)	ug/L	5	37	25	58	33	33
Total Beryllium (Be)	ug/L	0.5	ND	ND	ND	ND	ND
Total Bismuth (Bi)	ug/L	1	ND	ND	ND	ND	ND
Total Boron (B)	ug/L	10	10	20	20	20	20
Total Cadmium (Cd)	ug/L	0.1	ND	ND	ND	ND	ND
Total Calcium (Ca)	ug/L	200	70000	52000	91000	55000	53000
Total Chromium (Cr)	ug/L	5	ND	ND	ND	ND	ND
Total Cobalt (Co)	ug/L	0.5	ND	ND	ND	ND	ND
Total Copper (Cu)	ug/L	1	ND	ND	1	2	1
Total Iron (Fe)	ug/L	100	30	ND	ND	ND	ND
Total Lead (Pb)	ug/L	0.5	ND	ND	ND	ND	ND
Total Lithium (Li)	ug/L	5	ND	ND	ND	ND	ND

Table 1

Parameter / Collected by: CVC	Units	DL	CVC Station 5 08/27/2008	CVC Station 11 08/27/2008	CVC Station 12 08/20/2008	CVC Station 13 08/20/2008	CVC Station 14 08/27/2008
Total Magnesium (Mg)	ug/L	50	23000	24000	27000	21000	20000
Total Manganese (Mn)	ug/L	2	10.0	21	44	7	7
Total Molybdenum (Mo)	ug/L	1	ND	ND	ND	ND	ND
Total Nickel (Ni)	ug/L	1	ND	ND	ND	ND	ND
Total Potassium (K)	ug/L	200	70	900	1400	1800	1800
Total Selenium (Se)	ug/L	2	ND	ND	ND	ND	ND
Total Silicon (Si)	ug/L	50	220	540	4700	1300	1300
Total Silver (Ag)	ug/L	0.1	ND	ND	ND	ND	ND
Total Sodium (Na)	ug/L	100	25000	26000	82000	30000	30000
Total Strontium (Sr)	ug/L	1	96	100	140	120	110
Total Thallium (Tl)	ug/L	0.05	ND	ND	ND	ND	ND
Total Tin (Sn)	ug/L	1	ND	ND	ND	ND	ND
Total Titanium (Ti)	ug/L	5	ND	ND	ND	ND	ND
Total Tungsten (W)	ug/L	1	ND	ND	ND	ND	ND
Total Uranium (U)	ug/L	0.1	ND	0.4	0.3	0.5	0.5
Total Vanadium (V)	ug/L	1	ND	ND	ND	ND	ND
Total Zinc (Zn)	ug/L	5	5	ND	ND	ND	ND
Microbiological							
Fecal streptococcus	CFU/100mL	1	80	200	120	20	<10
Escherichia coli	CFU/100mL	10	20	10	80	20	10

ND-Non detect

DL- Detection Limit

Water Quality Data Collected By Credit Valley Conservation

Table 2: Full Parameter Water Quality Results

Station			1			2		3				4			5			6		
Parameter	Units	DL	06/25/2008*	07/22/2008**	09/15/2008**	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	08/20/2008*	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**
Laboratory																				
Total Ammonia-N	mg/L	0.05	ND	ND	ND	ND	ND	ND	0.73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Carbonaceous BOD	mg/L	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	8	ND	ND	3	ND	ND	3	ND	ND
Conductivity	umho/cm	2	578	516	523	654	711	753	630	559	564	1360	1670	949	558	490	514	556	494	513
Total Dissolved Solids	mg/L	10	382	340	325	430	435	490	420	370	350	880	1030	650	370	330	315	370	330	320
Total Kjeldahl Nitrogen (TKN)	mg/L	0.1	1.1	1.0	1.0	1.0	1.0	0.8	1.6	0.8	0.7	1.5	0.8	0.8	1.0	0.8	0.6	0.8	0.7	0.6
Orthophosphate (P)	mg/L	0.01	0.03	ND	0.01	ND	ND	ND	ND	ND	ND	0.08	ND	0.01	ND	ND	ND	ND	ND	ND
pH	pH		8.2	8.0	7.9	8.2	8.0	8.5	8.3	8.5	8.2	8.3	8.3	8.3	8.5	8.3	8.3	8.4	8.4	8.3
Dissolved Phosphorus	mg/L	0.002	0.045	0.027	0.033	0.024	0.024	0.009	0.008	0.005	0.012	0.015	0.015	0.028	0.004	0.009	0.013	0.004	0.006	0.011
Total Phosphorus	mg/L	0.002	0.063	0.035	0.077	0.034	0.026	0.023	0.059	0.020	0.029	0.11	0.024	0.079	0.023	0.022	0.020	0.026	0.013	0.018
Total Suspended Solids	mg/L	1	ND	ND	2	8	ND	7	1	1	4	19	2	9	9	4	2	4	1	1
Dissolved Sulphate (SO4)	mg/L	1	2	ND	ND	11	12 (1)	36	28	21	21	36	38	26	29	23	21	30	23	21
Alkalinity (Total as CaCO3)	mg/L	1	241	218	211	241	280	212	204	204	187	227	275	249	169	151	169	166	153	170
Dissolved Chloride (Cl)	mg/L	1	42	38	38	57	55	96	63	48	52	280	340	140	62	51	48	60	53	50
Nitrite (N)	mg/L	0.01	ND	ND	ND	ND	ND	0.01	0.01	ND	ND	0.05	ND	ND	0.02	0.01	ND	0.02	0.01	ND
Nitrate (N)	mg/L	0.1	ND	ND	ND	0.1	ND	0.9	0.8	0.4	0.4	0.5	1.3	0.7	0.7	0.5	0.3	0.7	0.5	0.3
Nitrate + Nitrite	mg/L	0.1	ND	ND	ND	0.1	ND	0.9	0.8	0.4	0.4	0.5	1.3	0.7	0.7	0.5	0.3	0.7	0.5	0.3
Calculated Parameters																				
Hardness (CaCO3)	mg/L	1	250	220	210	220	290	270	240	220	210	280	260	240	210	180	200	210	180	200
Metals																				
Total Aluminum (Al)	ug/L	5	7	ND	9	140	23	49	18	15	34	150	46	75	130	100	18	33	17	13
Total Antimony (Sb)	ug/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Arsenic (As)	ug/L	1	ND	ND	ND	2	2	ND	ND	ND	ND	1	ND	1	ND	1	1	ND	ND	ND
Total Barium (Ba)	ug/L	5	45	35	34	28	32	0.043	0.042	0.034	37	67	57	54	33	33	34	34	31	33
Total Beryllium (Be)	ug/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Bismuth (Bi)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Boron (B)	ug/L	10	ND	19	14	22	18	ND	18	18	18	26	38	34	ND	18	17	ND	17	14
Total Cadmium (Cd)	ug/L	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Calcium (Ca)	ug/L	200	74000	63000	60000	77000	88000	67	69	61	59000	81000	78000	80000	46000	48000	50000	47000	45000	46000
Total Chromium (Cr)	ug/L	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Cobalt (Co)	ug/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Copper (Cu)	ug/L	1	ND	ND	ND	3	2	1	2	2	2	6	3	4	2	2	1	2	2	1
Total Iron (Fe)	ug/L	100	ND	120	250	340	140	ND	ND	ND	ND	350	ND	160	150	170	ND	ND	ND	ND

Table 2: Full Parameter Water Quality Results

Station			1			2		3				4			5			6		
Parameter	Units	DL	06/25/2008*	07/22/2008**	09/15/2008**	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	08/20/2008*	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**
Total Lead (Pb)	ug/L	0.5	ND	ND	ND	0.6	ND	ND	ND	ND	ND	2.1	ND	0.5	ND	ND	ND	ND	ND	ND
Total Lithium (Li)	ug/L	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Magnesium (Mg)	ug/L	50	23000	20000	19000	19000	23000	19	22	20	20000	19000	18000	16000	17000	19000	20000	18000	19000	19000
Total Manganese (Mn)	ug/L	2	72	47	140	170	96	17	8	8	23	71	5	17	19	16	9	12	7	7
Total Molybdenum (Mo)	ug/L	1	1	ND	ND	ND	ND	1	ND	ND	1	1	ND	1	ND	ND	ND	ND	ND	1
Total Nickel (Ni)	ug/L	1	ND	ND	ND	ND	1	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Potassium (K)	ug/L	200	2200	920	1600	2300	1600	1.6	1.7	1.8	2300	9600	11000	10000	1200	1700	1900	1300	1600	1800
Total Selenium (Se)	ug/L	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Silicon (Si)	ug/L	50	4900	3800	590	2700	2700	0.17	1.3	2.1	2000	1600	2700	3500	290	1600	1100	180	1300	1000
Total Silver (Ag)	ug/L	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Sodium (Na)	ug/L	100	27000	23000	24000	47000	41000	4.9	3.6	3	34000	160000	160000	140000	29000	29000	32000	31000	29000	30000
Total Strontium (Sr)	ug/L	1	120	98	98	89	120	0.13	0.14	0.14	130	210	190	200	110	110	130	110	110	120
Total Tellurium (Te)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Thallium (Tl)	ug/L	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND
Total Thorium (Th)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Tin (Sn)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Titanium (Ti)	ug/L	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Tungsten (W)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Uranium (U)	ug/L	0.1	0.3	ND	ND	0.1	0.2	0.7	0.6	0.5	0.5	0.7	0.6	0.8	0.5	0.5	0.5	0.5	0.5	0.5
Total Vanadium (V)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	1	ND	1	1	ND	ND	ND	ND	ND	ND	ND
Total Zinc (Zn)	ug/L	5	5	ND	ND	13	13	8	13	ND	16	32	8	13	7	7	ND	6	11	7
Total Zirconium (Zr)	ug/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Microbiological																				
Fecal streptococcus	CFU/100mL	1	20	140	1500	2400	510	10	50	30	330	4000	400	840	370	5100	180	90	70	90
Escherichia coli	CFU/100mL	10	30	70	1000	1500	350	<10	50	40	200	690	170	350	380	3500	110	40	90	60

* indicates baseflow sampling event
** indicates storm event
ND-Not detected
DL- Detection Limit

Table 3

Parameter	Units	DL	Reduced Parameter Water Quality Results									
			7			8			9		10	
Collected by: AECOM			06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	07/22/2008**	09/15/2008**	06/25/2008*	08/20/2008*	07/22/2008**	09/15/2008**
Laboratory												
Total Kjeldahl Nitrogen (TKN)	mg/L	0.10	0.7	0.8	0.8	0.4	0.7	4.4	0.9	0.7	0.6	0.6
Dissolved Organic Carbon	mg/L	0.10	7.4	8.4	11.1	1.1	1.4	4.7	8.9	9.7	7.5	9.5
Total Phosphorus	mg/L	0.00	0.016	0.016	0.026	0.009	0.024	0.077	0.024	0.018	0.049	ND
Total Suspended Solids	mg/L	1.00	2	5	3	ND	ND	ND	5	1	2	1
Microbiological												
Escherichia coli	CFU/100mL	10.00	560	460	370	100	20	60	10	10	1000	150

* indicates baseflow sampling event
** indicates storm event
DL-detection limit
ND-Not detected

Table 4

Parameter / Collected by: AECOM	Units	DL	Total Phosphorus One Meter Off Bottom 3 08/20/2008*	9 08/20/2008*
Laboratory				
Total Phosphorus	mg/L	0.002	0.048	0.036

* indicates baseflow sampling event
DL- detection limit

Table 5

Parameter	PSQG		S1	S2	S3
Collected by: AECOM	LEL	SEL	25-Jun-08	19-Feb-09	19-Feb-09
Laboratory					
Total Ammonia-N			ND	ND	ND
Moisture			68	87	67
Total Organic Carbon	10,000	100,000	**53000**	**94000**	**43000**
Total Kjeldahl Nitrogen	550	4800	**3180**	**8560**	**2820**
Metals					
Acid Extractable Phosphorus (P)	600	2000	**940**	430	**830**

bold-exceed LEL

Table 6: Water Budget Details for Fairy Lake, 2007-2008.

Date	Lake level (m ASL)	Change in storage (m^3)	Outflow (m^3/week)	Precipitation (m^3/week)	Evaporation (m^3/week)	Total Inflow (m^3/week)	Surface Inflow (m3/week)	% Surface Water
07-Jan-07	345.39			1267.81	2716.03			
14-Jan-07	345.38	-2535.6	283,946	1267.81	2716.03	285,394	278,968	98
21-Jan-07	345.37	-2535.6	264,033	253.56	2716.03	266,495	260,070	98
28-Jan-07	345.35	-5071.2	234,163	1014.24	2716.03	235,865	229,439	97
04-Feb-07	345.35	0.0	214,250	0.00	2716.03	216,966	210,541	97
10-Feb-07	345.35	0.0	214,250	507.12	2716.03	216,459	210,034	97
17-Feb-07	345.35	0.0	214,250	3803.42	2716.03	213,163	206,737	97
24-Feb-07	345.35	0.0	214,250	0.00	2716.03	216,966	210,541	97
03-Mar-07	345.32	-7606.8	184,381	6719.37	2716.03	180,378	173,952	96
10-Mar-07	345.37	12678.1	84,816	760.68	2716.03	86,771	80,345	93
17-Mar-07	345.42	12678.1	184,381	0.00	2716.03	187,097	180,671	97
24-Mar-07	345.37	-12678.1	303,859	1318.52	2716.03	305,257	298,831	98
31-Mar-07	345.48	27891.7	392,774	1267.81	2716.03	394,222	387,796	98
07-Apr-07	344.86	-157207.8	273,296	253.56	2716.03	275,758	269,332	98
14-Apr-07	345.37	129316.1	134,598	405.70	2716.03	136,909	130,483	95
21-Apr-07	345.37	0.0	254,076	0.00	2716.03	256,793	250,367	97
28-Apr-07	345.37	0.0	254,076	8519.65	2716.03	248,273	241,847	97
05-May-07	345.37	0.0	254,076	0.00	2716.03	256,793	250,367	97
12-May-07	345.34	-7606.8	224,207	760.68	2716.03	226,162	219,736	97
19-May-07	345.39	12678.1	244,120	10649.56	2716.03	236,186	229,761	97
26-May-07	345.34	-12678.1	244,120	0.00	2716.03	246,836	240,410	97
02-Jun-07	345.33	-2535.6	184,381	202.85	2716.03	186,894	180,468	97
09-Jun-07	345.29	-10142.4	134,598	2307.41	2716.03	135,007	128,581	95
16-Jun-07	345.29	0.0	94,772	0.00	2716.03	97,488	91,062	93
23-Jun-07	345.29	0.0	94,772	5375.49	2716.03	92,113	85,687	93
30-Jun-07	345.19	-25356.1	54,946	253.56	2716.03	57,409	50,983	89
07-Jul-07	345.26	17749.3	25,077	0.00	2716.03	27,793	21,367	77
14-Jul-07	345.22	-10142.4	25,077	0.00	2716.03	27,793	21,367	77
21-Jul-07	345.21	-2535.6	15,120	3651.28	2716.03	14,185	7,759	55
28-Jul-07	345.24	7606.8	15,120	0.00	2716.03	17,836	11,410	64
04-Aug-07	345.19	-12678.1	15,120	0.00	2716.03	17,836	11,410	64
11-Aug-07	345.17	-5071.2	15,120	2865.24	2716.03	14,971	8,545	57
18-Aug-07	345.17	0.0	15,120	0.00	2716.03	17,836	11,410	64
25-Aug-07	345.09	-20284.9	15,120	1977.78	2716.03	15,858	9,432	59
01-Sep-07	345.07	-5071.2	15,120	101.42	2716.03	17,735	11,309	64
08-Sep-07	345.07	0.0	15,120	202.85	2716.03	17,633	11,207	64
15-Sep-07	345.04	-7606.8	15,120	2738.46	2716.03	15,098	8,672	57
22-Sep-07	344.99	-12678.1	15,120	0.00	2716.03	17,836	11,410	64
29-Sep-07	344.99	0.0	15,120	1952.42	2716.03	15,884	9,458	60

Table 6: Water Budget Details for Fairy Lake, 2007-2008.

Date	Lake level (m ASL)	Change in storage (m^3)	Outflow (m^3/week)	Precipitation (m^3/week)	Evaporation (m^3/week)	Total Inflow (m^3/week)	Surface Inflow (m3/week)	% Surface Water
06-Oct-07	344.99	0.0	15,120	963.53	2716.03	16,872	10,447	62
13-Oct-07	344.99	0.0	15,120	1445.30	2716.03	16,391	9,965	61
20-Oct-07	344.97	-5071.2	15,120	507.12	2716.03	17,329	10,903	63
27-Oct-07	344.97	0.0	15,120	5020.51	2716.03	12,816	6,390	50
03-Nov-07	344.97	0.0	15,120	0.00	2716.03	17,836	11,410	64
10-Nov-07	344.99	5071.2	15,120	3625.92	2716.03	14,210	7,784	55
17-Nov-07	344.99	0.0	15,120	557.83	2716.03	17,278	10,852	63
24-Nov-07	344.99	0.0	15,120	13185.17	2716.03	4,651	1775	38
01-Dec-07	345.09	25356.1	15,120	4386.61	2716.03	13,449	7,024	52
08-Dec-07	345.29	50712.2	54,946	507.12	2716.03	57,155	50,729	89
15-Dec-07	345.27	-5071.2	74,859	2332.76	2716.03	75,242	68,817	91
22-Dec-07	345.28	2535.6	35,033	0.00	2716.03	37,749	31,323	83
29-Dec-07	345.29	2535.6	54,946	0.00	2716.03	57,662	51,236	89
05-Jan-08	345.30	2535.6	104,729	0.00	2716.03	107,445	101,019	94
12-Jan-08	345.60	76068.3	559,259	5933.33	2716.03	556,041	549,615	99
19-Jan-08	345.38	-55783.4	638,911	0.00	2716.03	641,627	635,201	99
26-Jan-08	345.32	-15213.7	214,250	507.12	2716.03	216,459	210,034	97
02-Feb-08	345.30	-5071.2	134,598	5274.07	2716.03	132,040	125,614	95
09-Feb-08	345.38	20284.9	194,337	253.56	2716.03	196,800	190,374	97
16-Feb-08	345.35	-7606.8	244,120	3042.73	2716.03	243,793	237,367	97
23-Feb-08	345.39	10142.4	254,076	253.56	2716.03	256,539	250,113	97
01-Mar-08	345.36	-7606.8	264,033	2890.60	2716.03	263,858	257,433	98
08-Mar-08	345.40	10142.4	273,990	1572.08	2716.03	275,133	268,708	98
15-Mar-08	345.36	-10142.4	273,990	0.00	2716.03	276,706	270,280	98
22-Mar-08	345.45	22820.5	124,642	152.14	2716.03	127,206	120,780	95
29-Mar-08	345.45	0.0	15,120	760.68	2716.03	17,075	10,650	62
05-Apr-08	345.45	0.0	15,120	4056.98	2716.03	13,779	7,353	53
12-Apr-08	345.54	22820.5	391,386	8823.92	2716.03	385,278	378,852	98
19-Apr-08	345.46	-20284.9	610,198	0.00	2716.03	612,914	606,488	99
26-Apr-08	345.40	-15213.7	383,280	0.00	2716.03	385,996	379,570	98
03-May-08	345.38	-5071.2	293,903	6339.03	2716.03	290,280	283,854	98
10-May-08	345.39	2535.6	283,946	1876.35	2716.03	284,786	278,360	98
17-May-08	345.36	-7606.8	264,033	1166.38	2716.03	265,583	259,157	98
24-May-08	345.34	-5071.2	214,250	202.85	2716.03	216,764	210,338	97
31-May-08	345.31	-7606.8	164,468	0.00	2716.03	167,184	160,758	96
07-Jun-08	345.30	-2535.6	124,642	1673.50	2716.03	125,684	119,258	95
14-Jun-08	345.32	5071.2	134,598	9280.33	2716.03	128,034	121,608	95
21-Jun-08	345.33	2535.6	164,468	1496.01	2716.03	165,688	159,262	96
28-Jun-08	345.32	-2535.6	164,468	6034.75	2716.03	161,149	154,723	96
05-Jul-08	345.33	2535.6	164,468	456.41	2716.03	166,727	160,302	96
12-Jul-08	345.28	-12678.1	124,642	5552.99	2716.03	121,805	115,379	95

Table 6: Water Budget Details for Fairy Lake, 2007-2008.

Date	Lake level (m ASL)	Change in storage (m^3)	Outflow (m^3/week)	Precipitation (m^3/week)	Evaporation (m^3/week)	Total Inflow (m^3/week)	Surface Inflow (m3/week)	% Surface Water
19-Jul-08	345.30	5071.2	94,772	253.56	2716.03	97,235	90,809	93
26-Jul-08	345.40	25356.1	214,250	0.00	2716.03	216,966	210,541	97
02-Aug-08	345.32	-20284.9	234,163	4589.45	2716.03	232,290	225,864	97
09-Aug-08	345.40	20284.9	234,163	9280.33	2716.03	227,599	221,173	97
16-Aug-08	345.34	-15213.7	254,076	13210.53	2716.03	243,582	237,156	97
23-Aug-08	345.33	-2535.6	184,381	202.85	2716.03	186,894	180,468	97
30-Aug-08	345.27	-15213.7	114,685	6592.59	2716.03	110,809	104,383	94
06-Sep-08	345.28	2535.6	64,903	3118.80	2716.03	64,500	58,074	90
13-Sep-08	345.36	20284.9	154,511	6389.74	2716.03	150,838	144,412	96
20-Sep-08	345.35	-2535.6	224,207	0.00	2716.03	226,923	220,497	97
27-Sep-08	345.30	-12678.1	164,468	1901.71	2716.03	165,282	158,856	96
04-Oct-08	345.32	5071.2	134,598	1217.09	2716.03	136,097	129,671	95
11-Oct-08	345.32	0.0	154,511	2256.69	2716.03	154,971	148,545	96
18-Oct-08	345.30	-5071.2	134,598	1064.96	2716.03	136,249	129,824	95
25-Oct-08	345.24	-15213.7	64,903	380.34	2716.03	67,238	60,813	90
01-Nov-08	345.28	10142.4	44,990	0.00	2716.03	47,706	41,280	87
08-Nov-08	345.30	5071.2	94,772	0.00	2716.03	97,488	91,062	93
15-Nov-08	345.30	0.0	114,685	5375.49	2716.03	112,026	105,600	94
22-Nov-08	345.36	15213.7	174,424	0.00	2716.03	177,140	170,715	96
29-Nov-08	345.35	-2535.6	224,207	0.00	2716.03	226,923	220,497	97
06-Dec-08	345.33	-5071.2	194,337	709.97	2716.03	196,343	189,918	97
13-Dec-08	345.32	-2535.6	164,468	3144.16	2716.03	164,040	157,614	96
20-Dec-08	345.45	32962.9	283,946	7403.98	2716.03	279,258	272,832	98
27-Dec-08	345.38	-17749.3	343,685	0.00	2716.03	346,401	339,975	98
31-Dec-08	345.56	45641.0	560,184	0.00	2716.03	562,900	556,474	99

Appendix C

Public Open House Materials

Fairy Lake Water Quality Study

September 29, 2009

HALTON HILLS

Presentation Overview

- Project Goals and Objectives
- Process to Date
- Study Overview
- Summary and Next Steps
- Questions
- Break out session with display panels

HALTON HILLS

Study Overview

- Water Chemistry
- Bacteriology
- Sediment Quality
- Management Recommendations
  - Aquatic Vegetation
  - Waterfowl
  - Water Quality
- Summary

HALTON HILLS

Process to Date

- The Fairy Lake Water Quality Study is being done in partnership with CVC and Region of Halton in order to maximize opportunities to use similar protocols, eliminate duplication, and engage the public on watershed management issues

- The draft study findings were reviewed by the Core Team (members from Town, agencies, Council and the community)

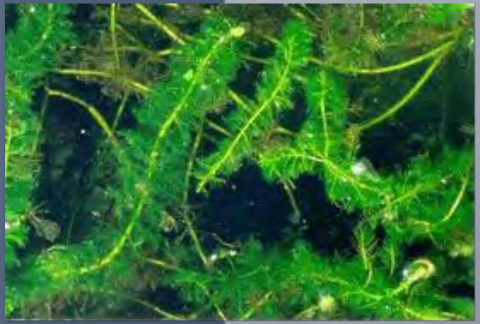
HALTON HILLS

Goals and Objectives

- Development of a **long-term strategy to improve water quality** through review of :
  - Background information relevant to weed and waterfowl management;
  - Basic bathymetry of the Lake (area and depth);
  - Limited sediment mapping in vicinity of primary outfalls;
  - Basic water budget (how water enters, flow through and exits the lake);
  - Inventory of adjacent land uses;
  - Characterization of water quality;
  - Approximate source of conditions that are precipitating the aquatic weed problem.

HALTON HILLS

Goals and Objectives



- Recommendations on **feasible weed management** strategies by assessing the site conditions and providing direction on the appropriateness of recreational uses through review of:
  - Inventory and mapping of the existing primary aquatic plants;
  - Feasibility of control for any problem plant species;
  - Identification of potential impacts on recreational uses.

HALTON HILLS

Goals and Objectives

- Identification of appropriate **control measures for waterfowl management** that are appropriate to Fairy Lake and environmentally/financially sound through review of :
  - Observations on Canada Geese;
  - Waterfowl control measures appropriate to Fairy Lake.

Photo by the Hamilton Family - Acton

HALTON HILLS

Goals and Objectives

- Development of a **communications plan outline** that improves public awareness, defines the role of community volunteers and promotes good stewardship through:
  - Identification of communication devices;
  - Identification the role of volunteers;
  - Potential communication themes.

HALTON HILLS

Goals and Objectives

Future direction required **for future study or management priorities** to address the long-term stewardship of Fairy Lake.

HALTON HILLS

Study Overview – Deborah Sinclair
Senior Aquatic Scientist

AECOM

- Water Chemistry
- Bacteriology
- Sediment Quality
- Management Recommendations
  - Aquatic Vegetation
  - Waterfowl
  - Water Quality
- Summary

HALTON HILLS

Water Chemistry - General

- Concentrations highest at Tyler outfall
- Nutrients were elevated
- High lake DOC concentrations reflect wetland influence on water quality

Parameter	Mean	Max	Min	Location of Highest Concentration
Conductivity (μmho/cm)	698.6	1242.3	520.5	Tyler outfall
Dissolved Chloride (Cl)	88.7	222.5	39.3	Tyler outfall
Total Suspended Solids	4.9	13.0	1.5	nearshore trailer park (Tyler outfall = 10 mg/L)
Total Dissolved Solids	452.6	804.5	339.0	Tyler outfall
Total Ammonia-N	0.73			Main basin only
Total Kjeldahl Nitrogen (TKN)	0.94	1.6	0.6	Elmore outfall
Nitrate (N)	0.625	1.325	0.100	Tyler outfall
Orthophosphate (P)	0.04	0.05	0.02	Tyler outfall
Dissolved Phosphorus	0.020	0.048	0.009	nearshore trailer park
Total Phosphorus	**0.040**	**0.058**	**0.021**	Tyler outfall
Total Carbonaceous BOD	5.7	8.0	3.0	Tyler outfall

HALTON HILLS

Bacteriology

- Bacteria levels were elevated
- Counts were higher in samples following rain events (esp. nearshore)
- Likely due to runoff from surrounding landscape

Location	*Escherichia coli*	
	Geometric Mean	Max
at Outlet	38	90
at west inlet	39	100
Elmore outfall	39	100
south basin	39	100
main basin	74	200
at south inlet	81	1000
nearshore at trailer park	**174**	1500
nearshore at old beach	**233**	3500
Tyler outfall	**239**	690
at Black Cr. Inlet	**458**	560

HALTON HILLS

Note: PWQO for *E. coli* of 100 cfu/100 mL is the geometric mean of 5 samples, 4 samples were collectected for Fairy Lake

Sediment Quality

- 3 sediment cores (south, main, Prospect Park basins)
- Highly organic with elevated nutrient concentrations
- Source is primarily biological - from aquatic plant production

Parameter	Unit	Prospect Park Basin	South Basin	Main Basin	PSQG LEL	PSQG SEL
Total Organic Carbon	mg/kg	**53,000**	**94,000**	**43,000**	10,000	100,000
Phosphorus	µg/g	**940**	430	**830**	600	2,000
Total Kjeldahl Nitrogen	µg/g	**3,180**	**8,875**	**2,820**	550	4,800

HALTON HILLS

Aquatic Vegetation

- Macrophyte cover occupies 75-100% of lake bottom less than 2 m deep.
- Dominant species: Eurasian Water Milfoil and Stonewort
  - Other: Crispy Pondweed, Sago Pondweed, Small Pondweed, Canada Waterweed, and Water Stargrass, Northern Water Milfoil, Richardson's Pondweed, Common Bladderwort
- Fairy Lake's clear water, shallow nature, nutrient rich sediments allows luxuriant growth of submergent aquatic vegetation

HALTON HILLS

Waterfowl

- Regular presence of Geese throughout the year
  - Exception of winter
- Numbers ranged from 32 to 278 individuals
- During the surveys, individuals were observed feeding the geese
- Waterfowl can be a significant source of nutrients and bacteria to water bodies

HALTON HILLS

Water Quality Management Recommendations

- Public education: lake vs wetland ecology
- Deter waterfowl
- Watershed wide “Stoop and Scoop”
- Reduce/eliminate fertilizer use
- Improve/increase shoreline and stream buffers
- Reduce upstream contaminant loads

HALTON HILLS

Aquatic Vegetation Management Recommendations

- Options: do nothing, mechanical, chemical, biological, ecological, shading
- Recommend no removal of aquatic vegetation
- Healthy ecosystem = variety of aquatic plants
- Education regarding lake as a wetland community

HALTON HILLS

Waterfowl Management Recommendations

- Stop feeding waterfowl
- Continue egg oiling program
- Naturalise private/public shorelines
- Monitor and implement measures such as grass repellents, wire grid over beach, scare dog tactics

HALTON HILLS

Other Recommendations

- Communication Strategy
- Education
- Stewardship
- Partnerships
- Future monitoring and studies

Photo by Credit Valley Conservation

HALTON HILLS

Summary of Key Findings

- Fairy Lake is a clear shallow-water ecosite (small ecosystem) that naturally supports abundant aquatic vegetation
- The lake surface area is approximately 26ha in size and has an average depth of 1m and a maximum depth of 7m
- Over 90% of the water entering the lake is through surface water during non-drought months
- The chemical composition of the lake is typical of urban systems
- Bacteria levels were elevated at nearly all sampling locations

HALTON HILLS

Summary of Key Findings

- Lake bottom sediments are enriched with organic matter but are not considered toxic
- Clear, shallow water with nutrient rich sediments promotes aquatic plant growth in the lake
- Canada Geese nest and graze near the lake partly because of being fed by the public
- The presence of Killifish is noteworthy it is considered rare in the watershed and is a positive finding

HALTON HILLS

Summary of Recommendations

- Preserve aquatic vegetation
- Raise awareness of wetland ecology
- Continue egg oiling program
- Increase shoreline naturalization
- Implement watershed "Stoop and Scoop" program
- Discourage fertilizer use
- Reduce upstream contaminants

HALTON HILLS

Next Steps

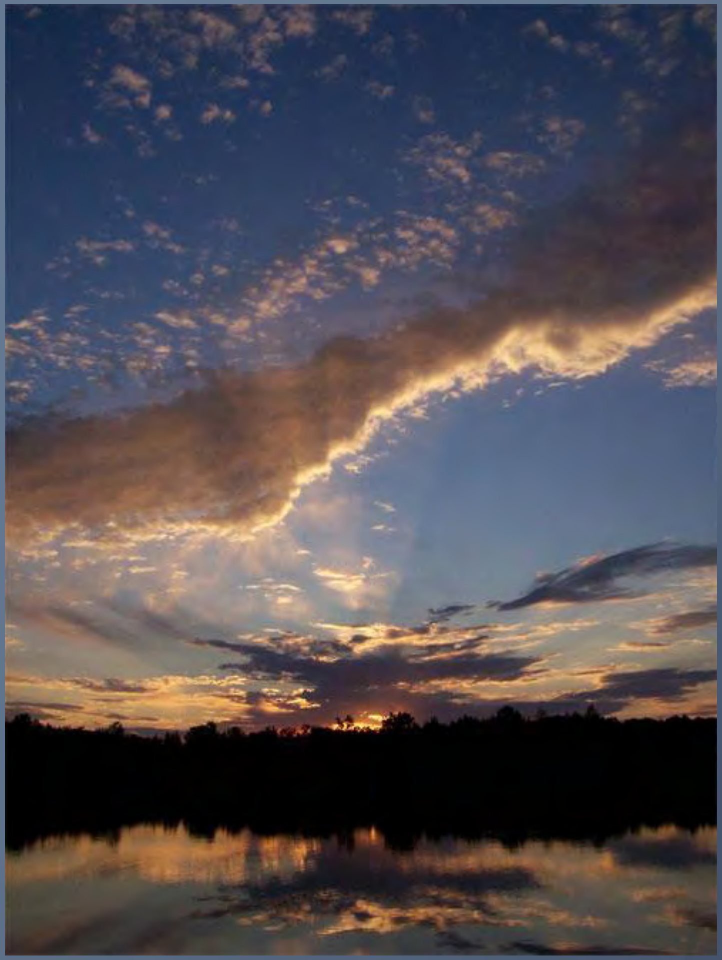


Photo by The Hamilton Family - Acton

- Sign the registry for future information
- Complete Comments Sheets
- Public Review of Draft Report

  www.haltonhills.ca
- Final Report to Council Spring 2010

HALTON HILLS

Thank You

HALTON HILLS

TOWN OF HALTON HILLS

Fairy Lake Water Quality Study
September 2009

Comment Sheet

Please complete the following information. Please list any additional comments in the space provided below.

Do you have any observations about Fairy Lake that were not addressed in the information session?

Do you have suggestions on how best to educate people on waterfowl management and/or scoop and poop programs?

How would you rank the primary recommendations of the draft Study?
(1 most important – 8 least important)

Preserve aquatic communities_____
Raise public awareness____
Continue egg oiling____
Increase shoreline naturalization___
Encourage private landowners to naturalize__
Implement "poop and scoop" program___
Avoid/reduce use of fertilizers__
Reduce contaminants from upstream sources___

Comments:

What information presented at the public meeting concerns you the most?

Additional Comments:
____
____
____
____
____
____
____

NAME (optional):____

Please leave your completed comment sheet before you leave or return by October 9, 2009 by fax 905-873-1587 or email warrenh@haltonhills.ca or at the Acton Arena and Community Centre or Civic Centre.

RECREATION AND PARKS DEPARTMENT 1 HALTON HILLS DRIVE HALTON HILLS (GEORGETOWN), ON L7G 5G2
PH.: 905-873-2601 EXT 2274 FX.: 905-873-1587

TOWN OF HALTON HILLS

Fairy Lake Water Quality Study
September 2009

PROJECT OBJECTIVES

Section 1.0 Background/Inventory of Study Area

a) Compile the necessary background information relevant to weed and waterfowl management including Ministry of Environment, Credit Valley Conservation, Department of Fisheries and Oceans, Ministry of Natural Resources, Region of Halton and Town files and regulations to supplement material collected to date in Appendix A;

b) Define the basic bathymetry of the Lake: delineate the perimeter of the lake and any islands, stream connections, transect measurements for depth of the lake at varying intervals, depth of hypolimnion (cold water at base of lake), dissolved oxygen levels;

c) Conduct limited sediment mapping in vicinity of primary outfalls (assume four locations) and obtain samples to provide a general idea of what the bottom substrate is composed of and some idea of its age, characteristics and probable causes;

d) Complete a basic water budget (how water enters, flow through and exits the lake) to understand the approximate sources of inputs;

e) Complete the inventory of adjacent land uses based on Ecological Land Classification mapping for the Fairy Lake watershed as provided by Credit Valley Conservation;

f) Provide a characterization of water quality, based on existing data and supplemented by limited sampling (assume twelve locations) over four seasons (see protocols Appendix B);

g) Identify the approximate of the source of conditions that are precipitating the aquatic weed problem;

h) Coordinate scope of work with the Black Creek Subwatershed Study to be undertaken by Credit Valley Conservation and the Town in 2008;

Section 2.0 Weed Management

a) Provide an inventory and mapping of the existing primary aquatic flora, including approximate distribution of densities of all problem, invasive aquatic weed species;

b) Conduct a review of the ecology and feasibility of control for any problem species identified based on relevant vegetation management approaches across Ontario;

c) Summarize the correlation of the problem species with the physical/chemical conditions from Section 1 Background/Inventory and provide recommendations for control and/or management and associated budget requirements;

d) Identify the potential impacts on recreational uses through assessment of weed types, habitat, level of hazard and methods of control.

Section 3.0 Waterfowl Management

a) Investigate presence of Canada Geese to determine the extent to which they contribute to water quality/weed problem;

b) Review Source Book; Habitat Modification and Canada Geese by Keller and Doncaster, Canadian Wildlife Service et al and/or identify other control measures appropriate to Fairy Lake and associated budget requirements.

Section 4.0 Communications Plan Outline

a) Outline a communications strategy to improve public awareness of the water quality strategies being implemented to address weed growth and mitigate the impacts of waterfowl. The Plan would also address the lake's potential for recreational uses and its role in the watershed;

b) Identify communication devices (e.g. interpretive signage, homeowner guides to those on the lake and within its watershed) for a communications strategy;

c) Identify the role of volunteers (e.g. weed monitoring, site clean ups, restorative planting projects) for specific projects;

d) Provide potential communication themes (e.g. litter control, restricted feeding of waterfowl, good stewardship practices) for a communications strategy.

RECREATION AND PARKS DEPARTMENT 1 HALTON HILLS DRIVE HALTON HILLS (GEORGETOWN), ON L7G 5G2
PH.: 905-873-2601 EXT 2274 FX.: 905-873-1587

Nature Walk Summary

1. How Rain Events affect Fairy Lake's Water Quality

speaker: George Zukovs

George is President and CEO of XCG Consultants Ltd and a Diplomate Water Resources Engineer of the American Society of Civil Engineers. He has over 30 years experience in environmental science and engineering and specializes watershed planning and storm water management.

George provided an overview on how rain events have changed in recent years, and how the runoffs into streams/lakes can impact drinking water sources and water quality in lakes and streams. Residents came away with a better understanding of the impacts of the substances on their property (eg. pesticides/fertilizers/car wash solution/oils & chemicals/dog & geese faeces etc) directly into lake and streams.

- What did lake first like…mostly likely much like the existing northern shore
- Urbanization of Acton, paved parking lots, flat roofs has changed how the rain moves into the watercourse
- There is more water entering the watercourse than there used to be before development (paving, driveways) and more quickly than before….results in flooding in peak storms
- Intensified land development, more cars, house pets (cats, dogs) and geese have been introduced to the area
- Fertilizing increase turf growth and promotes geese feeding
- Surface area washes into the lake after a rain event
- Bacteria from geese and dogs washes into lake resulting in beach closures
- Nutrients in fertilizer like phosphorus wash into lake
- Nutrients in Fairy Lake promote aquatic plant growth: how can we manage this better even on an individual basis? Measures like goose control and poop and scoop programs
- Provincial document on managing storm water control at MOE website (http://www.ene.gov.on.ca/en/publications/water/index.php#1)

2. Waterfowl and Fairy Lake

speaker James Kamstra

James is a Senior Terrestrial Ecologist with AECOM and has over 20 years of experience conducting environmental impact studies, biophysical inventories and ecological restoration projects. He is a recognized expert in identifying flora and fauna and is a qualified wetland evaluator.

The session with James focused on the nature of waterfowl and their impacts on water quality. While providing an overview of the natural characteristics of waterfowl, James explained the relationship between people and birds and how the impacts of feeding and over-wintering impact waterfowl and the local eco-system.

- Canada Gees is only one of waterfowl species; main concern due to impact on water quality
- Spring/Fall waterfowl include mergansers, buffalo heads, goldeneyes moving through up north- no impact on water quality
- Canada Geese and mallards stay around and in bigger numbers
- Canadian icon not same bird it used to be; 1970s geese only seen in October as migrate south stay for a few weeks, then back north again in Spring
- Didn't used to breed in south; species we se now is Giant Canada Geese
- Used to breed in mid-western states and once verge of extinction in 1800s-1900s and only 2,000 left in 1965
- Program to reduce kills and to promote movement/relocation of geese to other places has created new problems
- Since they were not hunted, feed by the public, and were able to nest everywhere, their presence in the Toronto Islands in the 1960s led them to be in then lakeshore marshes, then ponds further from the lake
- Current goose we see today is not true pure Giant but a hybrid
- 20 yrs ago geese were shipped from areas like to Mississauga from New Brunswick; now problematic in Britain, Holland
- They are beautiful birds but they eat/graze like a cow and defecate as much as a human in a day
- Now they effect water quality, beach areas, turf
- Geese like short mowed grass, near water. They don't like enclosed areas so they can be discouraged by planting buffer planting to block their sight lines, the larger the better
- People feed geese; they get used to feeding and stop feeding other places
- Waterfowl moult in late Spring after goslings born; adults lose flight patterns for about 4-6 weeks (same with ducks)
- With feeding and shelter they will congregate for moulting period; more than normally would

- About 100 geese on Fairy Lake; not a huge problem but still a concern for water quality
- High Park in Toronto large problem; eg bread companies providing geese feed
- Food is not good for geese and encourages them to locate there

- How big a problem is it? Not all water quality problems related to geese and not other issues like runoff
- Trade offs; grass repellents, wires or snow fence barriers, lines with flags/streamers but landscape options best
- Bread is not harmful; but like chocolate bar, tastes good, filling but not healthy. If they eat only bread the cease to forage and/or migrate
- Also farm fields nearby where feed on corn, winter wheat and other crops

3. Why Fairy Lake is Beneficial to You

Bob has been a Biologist/Manager at CVC for 19 yrs and is responsible for Plan Input, Research and Monitoring, and Aquatic/Wetland Restoration. He completed his M.Sc in the watershed ecosystems Program at Trent University.

Building upon his experience with the Black Creek Subwatershed, Bob discussed the relationship between Fairy Lake and the diversity of fish species. He also spoke about the benefits of wetlands as a whole while increasing the public's awareness on basic lake ecosystem/wetland/wildlife ecology

- What is a wetland; an area dominated by plants that like water…forested wetland flooded in the spring is as much a wetland as areas that contain water all year long.
- Wetlands are the most diverse and productive (amount of biomass produced)…most number of species.
- Life began in shallow seas; why do wetlands have bad image now? Last 10-15 years Province has recognized wetlands so that they can be protected.
- Fairy Lake is only part of a larger wetland complex. Wetlands regulate our water supply, just like the lake water level rises in the spring as it stores surface water. Wetlands purify our water.
- We are now using buffers and wetland protection to ensure protection of our water resources. Protecting at the source is more cost effective than repairing after contamination.
- Storm water management ponds are being built in an effort to duplicate what wetlands do naturally. The wetland evolution method scores wetlands based on hydrology, biology, social and economic values.
- Wetlands are a natural support system; air, water, land. Store carbon effectively…ecological goods and services an example of new language attempting to give value to these existing wetland systems.
- Wetlands protect against wave erosion
- Bulrushes vs. cattails…a wide range of plants. Aesthetic values but also genetic re sources are endless; medicine textiles.
- Wetlands are designed by nature; they inspire us like birds inspired the design of airplanes.
- Recreational uses for fishing, hiking, bird watching around wetlands. Land values are higher for lands adjacent to wetlands.

- People’s perception of a lake is a Canadian Shield lake; clear, rocky with no weeds. But they are low nutrient lakes.
- We will not experience the dame type of lake in Southern Ontario; this area is high nutrient lakes and best way to combat this is with aquatic plants.
- Lake would look worse if plants not absorbing nutrients….will lead to algae. We are near the tipping point with runoff and nutrients entering the lake.
- Out compete the algae with healthy macrophtyic plants; they absorb nutrients and store them all season long.
- When they die they release nutrients in the fall, but lake can handle it at that time of year when water temperature is colder.
- Algae have life span of a couple of days which is a bigger problem in the long term. Diversity of plants with verges in shallow water, trees/shrubs further up slope that like it drier, robust emergents that stay standing all winter long important for winter wildlife.
- Narrow leaf emergents, sedges and grasses and are different plant forms that animals use for different purposes. Some are edible.
- The foam on the water is either cellulose break down material of cells in the fall or the spring; it can also mean a higher concentration of phosphorus, and we know there is an elevated level of phosphorus in the lake especially if you see it all summer long. (Fall is more natural)
- There is one patch of reed canary grass (phalaris), a very strong invasive
- Invasive plants can impact water quality by disturbing natural diversity. CVC now has invasive species strategy.
- Original area was wetland; dam added to flood wetland that increase storage
- Aquatic invertebrates; bugs, feed the fish and the birds. They go through cycle in the water and end up in the air; that is why swallows are seen in the air, feeding on the emerging winged bugs.
- Turtles, snapping turtles, beaver, mink, blue heron, osprey feed on fish and are indicators of a healthy fish population. Fish are the top predators in the ecosystem.
- Northern Pike, large mouthed bass present in Fairy Lake. Rock Bass has been introduced. Black Crappy lost popular for ice fishing. Pike migrate through culvert through Mill Street culvert
- Fairy Lake water is too warm for trout population, but it is connected with the cool water fisheries located downstream and are important to the habitat. Fishing does create other economic benefits for the community.
- In 1954 Banded Killifish recorded in watershed and it was discovered in Fairy Lake.
- Killifish is indicative of the original wetland that was here. Important for research because it was one of the best fish worldwide for the control of mosquitoes world wide. Climate change makes preserving the biological diversity is all the more important. Hoop netting done in Fairy Lake and Black Creek that will come out of the Black Creek Subwatershed discussions.
- Stocking is not promoted; use fish to be indicators of a healthy environment. Most stock areas are for re-introduction of Atlantic Salmon.

- Best to fix habitat to provide for more species of fish rather than introduce species artificially

4. How You Can Help Improve Fairy Lake's Water Quality
- speaker: Heather Yates

Heather is the Supervisor, Rural Stewardship with Credit Valley Conservation. She has been working with landowners in the Credit River watershed for close to seven years, having graduated from Lakehead University in Forest Conservation.

By explaining the basic Best Management Practices for landowners, Heather illustrated how those measures can help to improve Fairy Lake's water quality. Drawing upon her experience across the watershed, Heather spoke about the importance of streamside and lakeside vegetation to improve water quality and the importance of maintaining septic systems.

http://www.creditvalleycons.com/programsandservices/caringforyourland.htm#fact

AECOM

Appendix D

Council Report and Recommendations

Council Approval of the Fairy Lake Water Quality Study

Report No. R-2010-0023 dated March 30, 2010 regarding Fairy Lake Water Quality Study Results. File No.: E05 FA

Recommendation No. GC-2010-0077

THAT Report R-2010-0023 regarding the results of the Fairy Lake Water Quality Study dated March 30, 2010 be received;

AND FURTHER THAT the Fairy Lake Water Quality Study dated December 2009 be approved as a guiding document for the management of Fairy Lake, Acton;

AND FURTHER THAT the capital budget recommendations contained within Report R-2010-0023 related to the Fairy Lake Water Quality Study be directed to staff for implementation and coordination with Credit Valley Conservation with existing resources or review by the 2011 Budget Committee as required;

AND FURTHER THAT the policies regarding the use and maintenance of Fairy Lake as contained within Report R-2010-0023 be approved per the recommendations of the Fairy Lake Water Quality Study;

AND FURTHER THAT copies of the Fairy Lake Water Quality Study dated December 2009 be made available to the public through the Town libraries and web site, and through sale by the Recreation and Parks Department.

CARRIED and Approved by Council May 11, 2010

TOWN OF HALTON HILLS
Working Together Working for You!

REPORT

REPORT TO: Mayor Bonnette and Members of Council

REPORT FROM: Warren Harris, Manager of Parks and Open Space

DATE: March 30, 2010

REPORT NO.: R-2010-0023

RE: Fairy Lake Water Quality Study Results
File: E05 FA

RECOMMENDATION:

THAT Report R-2010-0023 regarding the results of the Fairy Lake Water Quality Study dated March 30, 2010 be received;

AND FURTHER THAT the Fairy Lake Water Quality Study dated December 2009 be approved as a guiding document for the management of Fairy Lake, Acton;

AND FURTHER THAT the capital budget recommendations contained within Report R-2010-0023 related to the Fairy Lake Water Quality Study be directed to staff for implementation and coordination with Credit Valley Conservation with existing resources or review by the 2011 Budget Committee as required;

AND FURTHER THAT the policies regarding the use and maintenance of Fairy Lake as contained within Report R-2010-0023 be approved per the recommendations of the Fairy Lake Water Quality Study;

AND FURTHER THAT copies of the Fairy Lake Water Quality Study dated December 2009 be made available to the public through the Town libraries and web site, and through sale by the Recreation and Parks Department.

BACKGROUND:

The Fairy Lake Water Quality Study has been completed in order to address measures related to water quality, weed management, waterfowl control, communication strategies and long-term management options. The study has been done in partnership with Credit Valley Conservation as part of the Black Creek Subwatershed

Study in order to maximize opportunities to use similar protocols, eliminate duplication, and engage the public on watershed management issues.

Prior to a September, 2009 public meeting on the initial findings of the Fairy Lake Water Quality Study , Council adopted Recommendation GC-2009-0253 that read in part:

AND FURTHER THAT staff report back to Council on the outcomes of the Fairy Lake Water Quality public meeting and final disposition of the Study document outlined in Report R-2009-0052.

Refer to Appendix A for a copy of Report R-2009-0052 including the executive summary of draft study findings. The final Fairy Lake Water Quality Study has been made available to members of Council under separate cover.

On March 26, 2010 the Community Affairs Committee received Report R-2009-0008 and referred the Fairy Lake Water Quality Study to Council for review and approval.

COMMENTS:

The purpose of this report is to update Council on the results of a Public Meeting on the Fairy Lake Water Quality Study, submit the final report for approval as a guiding document, and to identify priority items for a future work programs.

Public Meeting Update

On September 29, 2009 a joint open house with Credit Valley Conservation and the Region of Halton was held to update the public on the initial findings of the Fairy Lake Water Quality Study and the draft Black Creek Subwatershed Study (as well as related Regional water-related issues). The meeting was preceded by a Nature Walk where consulting and agency staff informed the public on issues related to water quality, waterfowl management and fisheries/aquatics.

The meeting was promoted through a neighbourhood mail-out to 420 residents, newspaper ad, announcement at Council and web posting. The meeting was attended by approximately 30 people: comments sheets were provided and all background materials and comment sheets were posted on the Town website. This material has been consolidated in Appendix C of the final Fairy Lake Water Quality Study.

The main themes of the public feedback were focused on increased signage on waterfowl management, promotion of stewardship programs, and naturalizing of shoreline edges. With only three written submissions received, further analysis of the study's priorities is not feasible.

Executive Summary of Final Report Findings

The following are the major issues addressed in the Study:

Characterization of Fairy Lake

Fairy Lake is a clear, shallow-water ecosite that naturally supports abundant aquatic vegetation. This interpretation implies that Fairy Lake would be more appropriately considered to be a wetland community than a lake, and should be managed accordingly.

The shallow, naturally productive nature of the lake, with abundant aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and many warm water fish species. A moderately high diversity of native aquatic plant species is also represented.

The presence of Killifish and Richardsons Pondweed is noteworthy as both are considered rare in the watershed and are positive findings.

Lake depth (bathymetry)

The lake surface area is approximately 26ha in size and a perimeter of 4.6km. The south end has a depth less than 2m while deeper water is restricted to small areas in the main and Prospect Park basins of the lake: average depth is 1m and maximum depth is 7m.

Water budget (source of lake water)

Over 90% of the water entering the lake is through surface water during non-drought months; during the drought months (June and July) groundwater contributions are significant and account for approximately 40% of the total water budget.

Water quality (bacteria, temperature and oxygen levels)

The chemical composition of the lake is typical of shallow systems dominated by aquatic plants. Nutrient levels were elevated at nearly all sampling locations indicating productive conditions.

Bacteria levels were elevated on one or more occasions at nearly all locations. Temperature and dissolved oxygen levels are common for shallow, productive lakes: substantial volumes of the lake have very low concentrations of oxygen.

Sediments (results of lake-bottom sampling)

Surface sediments on the lake bottom are highly organic with elevated nutrient concentrations but are not toxic.

Clear, shallow water with a rich sediment base promotes aquatic plant growth in the lake.

Vegetation

The aquatic vegetation is dominated by Eurasian Water Milfoil and Stonewort with several other pondweed species also being abundant. The clear, shallow water levels with high nutrient levels in the sediments contribute to aquatic plant growth.

Waterfowl

Moderate to large numbers of waterfowl were observed on and around the lake. Canada Geese nest and graze near the lake partly because of being fed by the public.

Summary of Study's Main Findings

The main water quality issues identified in the Study were **nutrient enrichment** (caused by the likes of lawn fertilizers) and **high bacteria concentrations** (caused by feces or other street runoff). Water quality is impacted by a number of local and watershed issues:

- Direct discharge from upstream sources (Black Creek, south and west inlets)
- Discharge of storm sewers into the lake (eg Tyler and Elmore)
- "Internal nutrient dynamics" or nutrient release from the nature decay of aquatic vegetation causing less oxygen in the water
- Direct impact of fecal matter from waterfowl and runoff from surrounding areas (eg dog feces)
- Local wetland setting; the natural origin of the lake in a wetland area.

Fairy Lake is a clear, shallow-water ecosite (small eco-system) that naturally supports abundant aquatic vegetation and could be more appropriately considered to be a wetland community than a lake.

The rate of the accumulation of sediments in the lake bottom is typical of productive systems like Fairy Lake where aquatic plants are dominant. Based on the accumulation rate since lake dredging in the later 1960s, sediment accumulation can be attributed to plant growth and not storm or sediment runoff.

Consistently higher than provincial standard levels of water chemistry were found at the Tyler Avenue outfall indicating the need for stormwater runoff mediation at this location. Phosphorus levels were high at all but one sampling locations indicating a productive system due to the nature of the lake (clear, shallow and wetland characteristics).

A moderately high diversity of native aquatic species is represented, and the nature of the lake provides habitat for waterfowl, frogs, turtles, aquatic vertebrates and many warm water fish species. The presence of Killifish and Richardsons Pondweed is noteworthy as both are considered rare in the watershed and are positive findings. Presence of the Common Reed should be referred to the Credit Valley Conservation as part of their invasive plant species management strategy. The presence of this plant is more problematic than the Eurasian Water Milfoil or Crispy Pondweed, other non-native plants that appear to co-exist with other native plants. Six alternatives were considered for the management of the aquatic vegetation with the recommendation to preserve the existing aquatic community being the most viable due to potential eco-system impacts, cost and sustainability.

Canada Geese nest and graze near the lake partly because of being fed by the public highlighting the importance of educating the public about the drawbacks of feeding waterfowl and importance of implementing shoreline plantings.

Recreational uses such as swimming, fishing and boating will have to be addressed within the context of Fairy Lake's natural characteristics. Swimming in a designated area (Old Beach) can be managed with waterfowl management strategies outlined in the Study, and access to fishing from shore can be maintained through diagonal paths through shorelines buffers illustrated in Section 4.2 of the Study. Paddle boats and canoe rentals were discontinued at Fairy Lake as part of the business plan review of the boat rental program in 2004. The use of private small boats with electric trolling motors and canoes can be expected to continue through the provision of the boat launch ramp. Staff have confirmed with the Town's insurance carrier that the existing Parks By-law provision for non-motor propelled boats (including sail boats, canoes, kayaks, row boats, paddle boats windsurfers or ice boats) is consistent with the nature of the lake.

A better understanding of Fairy Lake's role as an ecosite is an important message to convey to the public, and the Town has a role in reducing impacts from upstream watershed uses (agricultural and residential), adjacent stormwater outfalls and turf areas, and deposits of fecal matter from waterfowl and dogs.

Summary of Recommended Management Techniques

The following is a summary of the main findings of the study and the objective that each addresses:

TABLE 1

		Study Objective Addressed		
Management Technique	**Study Reference**	**Water Quality**	**Waterfowl**	**Aquatic Vegetation**
	Section 4.1.1 pg 40			●
1. Public education	Section 4.3 pg 47	●	●	●
2. Egg oiling	Section 4.2.5 pg 45	●	●	
3. Improve shoreline naturalization in Prospect Park	Section 4.2.5 pg 45	●	●	
4. Landowner stream bank and shoreline naturalization	Section 4.2.5	●		

TABLE 1		Study Objective Addressed		
Management Technique	**Study Reference**	**Water Quality**	**Waterfowl**	**Aquatic Vegetation**
	pg 45			
5. Watershed – wide "Poop and scoop" program	Section 4.3 pg 47	●		
6. Eliminate/reduce use of fertilizers	Section 4.3 pg 48	●		●
7. Develop nutrient model	Section 4.3 pg 49	●		●
8. Reduce contaminant loads from upstream sources	Section 4.3 pg 48	●		●

Implementation Strategy

The following is an outline of the action plan items and corresponding assignment, target date and budget impact. Additional information can be found in the Study as identified by section and page number.

TABLE 2				
Study Section	**Action Plan Area and Implementation**			
4.1.1 pg 40	**Aquatic Vegetation Action Plan**	**By**	**Target Date**	**Budget Impact**
1	Do not remove aquatic vegetation	THH	2010 onward	NIL
2	Promote public education on lake ecosystems	See 5.0 Communication		
3	Biological control: research use of weevils in small lakes	CVC	2011	TBD
4.2 Pg 45	**Waterfowl Management Action Plan**	**By**	**Target Date**	**Budget Impact**
1	Continue egg oiling program	THH	2010 onward	NIL
2	Encourage public to stop feeding geese/ducks through signage and education	See 5.0 Communication		
3	Improve shoreline naturalization in	THH	2010-	$ 45,000

TABLE 2

	Prospect Park by implementing 5m wide shoreline buffer (10 m where possible)		2012	
4.2 **Pg 45**	**Waterfowl Management Action Plan**	**By**	**Target Date**	**Budget Impact**
4	Promote landowner stream bank and shoreline naturalization where manicured lawns exist	CVC	2012	TBD
5	Investigate costing of other more intensive waterfowl management tactics: grass repellents, wire grid system, scare dogs. Implement if measures 2.1 - 2.4 are not effective	THH	2013	TBD
4.3 **Pg 47**	**Water Quality Action Plan**	**By**	**Target Date**	**Budget Impact**
1	Promote public education on lake ecosytems and impacts of human activities			
	1.1 On-site signage	See 5.1.3 Communication		
	1.2 Website	THH	2011	$5,000
2	Include water quality impacts as part of messaging to discourage feeding of geese/ducks	See 5.1.4 Communication		
3	Watershed – wide “Poop and scoop” program			
	3.1 Provide bio-degradable bags and waste stations in Prospect/Rotary Parks (5 units with refills)	THH	2010	$3,000
	3.2. Install interpretive signs on impacts of dog feces on water quality	See 5.1.3 Communication		
	3.3. Promote watershed-wide impact of dog feces entering storm sewers/waterways	CVC	2011	TBD
4	Eliminate/reduce use of fertilizers			

TABLE 2				
	4.1 Reduce fertilizer use in Prospect Park	THH	2010 on	Minor savings
4.3 **Pg 47**	**Water Quality Action Plan**	**By**	**Target Date**	**Budget Impact**
	4.2 Promote reduction in fertilizer use for private landowners	CVC	2011	TBD
5	Improve shoreline naturalization in Prospect Park			
	5.1 Implement 5m wide shoreline buffer as minimum; 10m desired wherever possible to filter runoff	See 4.2.3		
	5.2 Promote landowner stream bank and shoreline naturalization where manicured lawns exist	THH and CVC	2010-2012	TBD
6	Reduce contaminant loads from upstream sources			
	6.1 Improve stormwater management (per Town's stormwater outfall quality improvement program)	THH	2011 Tyler Ave	$100K per outfall
	6.2 Work with landowners to reduce fertilizer use and increase vegetative buffers	THH and CVC	2011	TBD
	6.3 Reduce runoff and increase on-site infiltration	See 4.2 and 6.1 CVC		
	6.4 Improve agricultural best management practices	THH and CVC	2011	TBD
	6.5 Implement road salt reduction program through Region of Halton Salt management Guidelines	THH	ongoing	NIL existing Operating Budget
	6.6. Develop nutrient model for Fairy Lake	THH	2013	$15,000

TABLE 2				
	6.7. Coordinate findings of BCSS/Region of Halton studies for land use and total phosphorus management	THH, CVC and Region	2011	NIL
5.0 **Pg 50**	**Communication Strategy**	**By**	**Target Date**	**Budget Impact**
1	Communication tools			
	1.1 Use radio, TV and/or newspaper ads to educate residents and promote study findings	THH	2011	$5,000-$10,000
	1.2 Provide Study findings and promotional information on Town web-site	THH	2010	NIL
	1.3 Install 2-3 large interpretive signs regarding lake ecosystem and human impacts (e.g. fertilizers, dog feces)	THH	2011	$12,000
	1.4 Install 10-15 signs advising public of impacts of feeding waterfowl	THH	2010	$8,500
	1.5 Promote lake stewardship	THH and CVC	2010	$10,000
	1.6 Explore potential partnerships	THH	2010-2012	NIL
6.0 **Pg 56**	**Future Monitoring and Study**	**By**	**Target Date**	**Budget Impact**
1	1.1 Water quality sampling/monitoring annually for two years, then once every five years	THH and CVC	2013 2014 2019	$12,000
	1.2 Vegetation study; delineation of shoreline vegetation and invasive species	THH and CVC	2013	$5,000
	1.3 Monitor Canada Goose population annually (each Fall)	THH and CVC	2010 on	NIL

TABLE 2				
	1.4 Complete a nutrient model to identify internal/external phosphorus loading, diurnal oxygen levels	THH and CVC	2013	$15,000

Additional Implementation Strategy Issues

In addition to the strategies outlined in Table 2 above, staff note that the completion of other studies by the Region of Halton and Credit Valley Conservation may have a bearing on the timing, financing and scope of some of these initiatives. Staff advise that as part of the implementation of the Fairy Lake Water Quality Study, additional information on implementation may be presented to Budget Committee upon completion of Black Creek Subwatershed Study (Phase 3- Fall 2010) and Region of Halton studies: Tier 3, Wastewater Plant EA Update, Prospect Park Pumping Update (2011-2012).

RELATIONSHIP TO STRATEGIC PLAN:

The Fairy Lake Water Quality Study relates to the following objective under Preserve, Protect and Enhance Our Environment:

B.1 To protect and conserve the quantity and quality of our ground and surface water resources, and ensure the integrity of our watersheds and aquatic ecosystems through integrated watershed planning and management.

FINANCIAL IMPACT:

The financial impacts of the Fairy Lake Water Quality Study fall into three categories:

1. "NIL" -Items that may be addressed without cost or within existing Town programs and operating budgets;

2. "TBD" – Generally broader watershed wide issues that will be addressed as part of the outcomes of the Black Creek Subwatershed Study in 2011

3. "$3,000 - 100,000" – Capital budget items that will have to be brought forward for consideration at 2011 Budget Committee for 2011 capital budget and forecast

Staff recommend that initiatives identified in the Study that do not impact the current capital or operating budgets should proceed in 2010-2011. "To Be Determined" costs should be brought forward to Budget Committee upon completion of the Black Creek Subwatershed Study to ensure best use of Town and Agency resources.

The following table outlines the capital budget impacts that require approval from Budget Committee in 2011:

TABLE 3				
Study Section	**Capital Budget Items for Budget Committee Approval in 2011 and Forecast ***			
4.2 Pg 41	**Waterfowl Management Action Plan**	**By**	**Target Date**	**Budget Impact**
3	Improve shoreline naturalization in Prospect Park by implementing 5m wide shoreline buffer	THH	2010-2012	$ 45,000
4.3 Pg 46	**Water Quality Action Plan**	**By**	**Target Date**	**Budget Impact**
1	1.2 Website	THH	2011	$5,000
3	3.1 Provide bio-degradable bags and waste stations in Prospect/Rotary Parks (5 units with refills)	THH	2010	$3,000
6	6.1 Improve stormwater management (per Town's stormwater outfall quality improvement program)	THH	2011 Tyler Ave	$100K per outfall
5.0 Pg 50	**Communication Strategy**	**By**	**Target Date**	**Budget Impact**
1	Communication tools			
	1.1 Use radio, TV and/or newspaper ads to educate residents and promote study findings	THH	2011	$5,000-$10,000
	1.3 Install 2-3 large interpretive signs regarding lake ecosystem and human impacts (e.g. fertilizers, dog feces)	THH	2011	$12,000
	1.4 Install 10-15 signs advising public of impacts of feeding waterfowl	THH	2010	$8,500
	1.5 Promote lake stewardship	THH and CVC	2010	$10,000

TABLE 3				
Study Section	**Capital Budget Items for Budget Committee Approval in 2011 and Forecast ***			
6.0 Pg 56	**Future Monitoring and Study**	**By**	**Target Date**	**Budget Impact**
1	1.1 Water quality sampling/monitoring annually for two years, then once every five years	THH and CVC	2013 2014 2019	$12,000
6.0 Pg 56	**Future Monitoring and Study**	**By**	**Target Date**	**Budget Impact**
	1.2 Vegetation study; delineation of shoreline vegetation and invasive species	THH and CVC	2013	$5,000
	1.4 Complete a nutrient model to identify internal/external phosphorus loading, diurnal oxygen levels	THH and CVC	2013	$15,000

* 2010 initiatives will be done with existing resources wherever possible, or deferred to 2011 Capital Budget review

COMMUNICATIONS IMPACT:

Staff will provide a presentation at Council to report on the major Study findings and the contents of this report.

Upon approval, copies of the study will be available at the Town libraries and web site, as well as for sale at the Recreation and Parks Department. The communications strategy outlined in the Study will be carried out upon approval of the related budget.

ENVIRONMENTAL IMPACT:

The environmental matters associated with Fairy Lake, specifically those relating to water quality, weed management and waterfowl control, are outlined within the Fairy Lake Water Quality Study. In approving the recommendations of this Report and hence the proposed management techniques, the Town will be taking action to help protect and conserve the quantity and quality of local water resources, as well as to ensure the integrity of watershed and aquatic ecosystems. There is not a direct link to objectives of the Green Plan, but the scope of work is consistent with environmental initiatives of the Corporate Strategic Plan.

CONSULTATION:

The study findings were reviewed by the Core Team made up of representatives from Council, Infrastructure Services, Credit Valley Conservation, Town Environmental Advisory Committee (TEAC), Friends of Fairy Lake (FOFL) and Recreation and Parks. Staff at the Region of Halton were also provided with the final Study results. The Community Affairs Committee was provided with a presentation on the Study and staff from Planning, Development and Sustainability were consulted regarding environmental impacts.

CONCLUSION:

The Fairy Lake Water Quality Study addresses:

- A long-term strategy to improve water quality
- A feasible weed management strategy
- Control measures for waterfowl management
- A communication plan outline
- Future study or management priorities.

The final recommendations of the Study are to:

- Preserve existing aquatic communities in their existing condition
- Educate the public on ecology, waterfowl and aquatic vegetation
- Continue egg oiling program
- Improve shoreline naturalization on private and public lands
- Promote “poop and scoop” on a watershed basis
- Eliminate/reduce use of fertilizers on turf areas
- Reduce contaminant loads from upstream sources and stormwater outfalls.

This report outlines a management strategy and the related budget and work program impacts in order to address the study goal of defining a water quality management approach for Fairy Lake.

Respectfully submitted,

Warren Harris, O.A.L.A., PMP
Manager of Parks and Open Space

Terry Alyman
Director of Recreation and Parks

Dennis Y. Perlin
Chief Administrative Officer

REPORT

REPORT TO: Mayor Richard Bonnette and Members of Council

REPORT FROM: Warren Harris, Manager of Parks and Open Space

DATE: August 27, 2009

REPORT NO.: R-2009-0052

RE: Fairy Lake Water Quality Study Update
File: E05 FA

RECOMMENDATION:

THAT Report R-2009-0052 dated August 27, 2009 regarding the Fairy Lake Water Quality Study Update be received;

AND FURTHER THAT the material contained within Report R-2009-0052 form the basis of a joint public meeting with Credit Valley Conservation regarding Fairy Lake Water Quality and the Black Creek Subwatershed Study on September 29, 2009;

AND FURTHER THAT staff report back to Council on the outcomes of the Fairy Lake Water Quality public meeting and final disposition of the Study document outlined in Report R-2009-0052.

BACKGROUND:

In May 2008 Council approved Recommendation No. GC-2008-0181 awarding the contract for the Fairy Lake Water Quality Study to Gartner Lee Limited of Guelph (now AECOM Canada Ltd). A Core Team made up of representative(s) from Council, Infrastructure Services, Credit Valley Conservation, Town Environmental Advisory Committee (TEAC), Friends of Fairy Lake (FOFL) and Recreation and Parks reviewed a draft report dated July 30, 2009 and recommend seeking public input on the initial findings.

The Fairy Lake Water Quality Study is being done in partnership with Credit Valley Conservation as part of the Black Creek Subwatershed Study in order to maximize opportunities to use similar protocols, eliminate duplication, and engage the public on watershed management issues.

The study is also being coordinated with related initiatives being undertaken by Infrastructure Services (outfall quality) and the Region of Halton (groundwater monitoring and wastewater plant operations).

COMMENTS:

Study Goal and Objectives

The Fairy Lake Water Quality Study's goal is to determine a responsible approach to water quality management that responds to the environmental and recreational needs of the area without recommending an extensive range of work that is cost prohibitive. A two-phase approach provides for additional background research and initial findings in a first phase without requiring a larger expensive study that may recommend an unrealistic scope of rehabilitation.

The Study addresses:

1. Development of a **long-term strategy to improve water quality** by determining the on-site conditions and features of Fairy Lake through background research and inventory of the study area through review of :

    a) Background information relevant to weed and waterfowl management;
    b) Basic bathymetry of the Lake (area and depth);
    c) Limited sediment mapping in vicinity of primary outfalls;
    d) Basic water budget (how water enters, flow through and exits the lake);
    e) Inventory of adjacent land uses;
    f) Characterization of water quality;
    g) Approximate source of conditions that are precipitating the aquatic weed problem.

2. Recommendations on **feasible weed management** strategies by assessing the site conditions and providing direction on the appropriateness of recreational uses through review of:

    a) Inventory and mapping of the existing primary aquatic plants;
    b) Feasibility of control for any problem plant species;
    c) Identification of potential impacts on recreational uses.

3. Identification of appropriate **control measures for waterfowl management** that are appropriate to Fairy Lake and environmentally/financially sound through review of :

    a) Observations on Canada Geese;
    b) Waterfowl control measures appropriate to Fairy Lake.

4. Development of a **communications plan outline** that improves public awareness, defines the role of community volunteers and promotes good stewardship through:

a) Identification of communication devices;
b) Identification the role of volunteers;
c) Potential communication themes.

5. Future direction required **for future study or management priorities** to address the long-term stewardship of Fairy Lake.

The purpose of this report is to advise Council of the general findings of the Study prior to its presentation to the public as part of a joint Black Creek Subwatershed meeting on September 29, 2009.

Preliminary Study Findings

The following are the major themes resulting from the Study and form the basis of discussion points for review at the Public Meeting:

- Fairy Lake is a clear shallow-water ecosite (small ecosystem) that naturally supports abundant aquatic vegetation;
- The lake surface area is approximately 26ha in size and has an average depth of 1m and a maximum depth of 7m;
- Over 90% of the water entering the lake is through surface water during non-drought months;
- The chemical composition of the lake is typical of shallow systems with aquatic plants; bacteria levels were elevated at nearly all sampling locations;
- Lake bottom sediments are enriched with organic matter but are not toxic;
- Clear, shallow water with a rich sediment base promotes aquatic plant growth in the lake;
- Canada Geese nest and graze near the lake partly because of being fed by the public;
- The presence of Killifish and Richardsons Pondweed is noteworthy as both are considered rare in the watershed and are positive findings.

Preliminary Recommended Management Techniques

The main observation is that Fairy Lake should be more appropriately considered as a wetland community. The shallow, naturally productive nature of the lake and moderately high diversity of native aquatic vegetation provides habitat for waterfowl, frogs, turtles, aquatic invertebrates and warm water fish species. With this in mind the primary management techniques recommended by the Study include:

1. Preserve aquatic communities in their existing condition
2. Educate the public on ecology, waterfowl and aquatic vegetation
3. Continue egg oiling program
4. Improve shoreline naturalization on private and public lands
5. Promote “poop and scoop” on a watershed basis
6. Eliminate/reduce the use of fertilizers on turf areas
7. Reduce contaminant loads from upstream sources.

The public will need to be engaged on how to maintain an active recreational area like Prospect Park adjacent to the lake and shift away from common practices such as feeding geese, failing to dispose of dog feces properly, removing natural area buffers at the shoreline and/or improperly applying turfgrass fertilizers.

The implementation and costing of these strategies will be outlined in the final Study document and will take full advantage of existing partnerships with Credit Valley Conservation and the Region of Halton.

A Public Meeting on September 29, 2009 at the Acton Legion is hoped to include interpretive sessions with Credit Valley Conservation staff on lake ecology, an overview of the Black Creek Subwatershed study process and objectives, and initial findings from the Fairy Lake Water Quality Study for review and comment.

RELATIONSHIP TO STRATEGIC PLAN:

The Fairy Lake Water Quality Study relates to the following objective under Preserve, Protect and Enhance Our Environment:

B.1 To protect and conserve the quantity and quality of our ground and surface water resources, and ensure the integrity of our watersheds and aquatic ecosystems through integrated watershed planning and management.

FINANCIAL IMPACT:

There is no additional financial impact related to this report, as the study has been financed from the approved 2008 Capital Budget. Future capital budget implications will be before Council at the time the study is finalized.

COMMUNICATIONS IMPACT:

The public will be notified of the Public Meeting through newspaper advertisements, website links and area mailings. Staff will report back on the communications plan that is contained within the terms of reference for the Fairy Lake Water Quality Study.

ENVIRONMENTAL IMPACT:

There is not a direct link to objectives of the Green Plan, but the scope of work is consistent with environmental initiatives of the Corporate Strategic Plan.

CONSULTATION:

The draft study findings were reviewed by the Core Team made up of representatives from Council, Infrastructure Services, Credit Valley Conservation, Town Environmental Advisory Committee (TEAC), Friends of Fairy Lake (FOFL) and Recreation and Parks.

CONCLUSION:

The initial draft report of the Fairy Lake Water Quality Study has been completed and reviewed by the Core Team. Staff recommend that the preliminary findings and recommendations be brought to the public as part of a joint Public Meeting with Credit Valley Conservation on September 29, 2009 and reported back to Council.

Respectfully submitted,

Original signed by

Warren Harris, O.A.L.A., PMP
Manager of Parks and Open Space

Original signed by

Terry Alyman
Director of Recreation and Parks

Original signed by

Dennis Y. Perlin
Chief Administrative Officer