Assimilative Capacity Studies for the Lake Simcoe Watershed and Nottawasaga River

Executive Summary

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PART 1  PROJECT OVERVIEW

1.1 Assimilative Capacity Studies Background

Assimilative capacity is defined as:

“the capability of the watercourse and/or lake to resist the effects of landscape disturbance without impairment of water quality.”

The Province of Ontario, through the Ministry of the Environment, invested in the Assimilative Capacity Studies (ACS) to be undertaken in partnership with the Lake Simcoe Region Conservation Authority (LSRCA) and Nottawasaga Valley Conservation Authority. The Assimilative Capacity Studies address technical and scientific aspects that impact 2 major watersheds within the Nottawasaga River and Lake Simcoe, 35 tributaries to Lake Simcoe and 32 sub-watersheds of the Nottawasaga River that cross the 33 municipalities (see study area map below).

The study was initiated in response to the growth pressures that are being placed on the municipalities within these two watersheds, and the already evident decline in water quality and ecosystem health. The models developed through the ACS as part of the provincial government’s Intergovernmental Action Plan (see table on following page) will provide some of the necessary tools for making responsible land use decisions in order to ensure the growth that
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occurs in the study area is undertaken in a responsible manner that would minimize environmental impacts.

1.2 Governance Structure

The provincial agencies overseeing the project are the Ministry of the Environment (MOE), Ministry of Municipal Affairs and Housing (MMAH), the Ministry of Natural Resources (MNR), LSRCA and NVCA. These ministries also provided support to the project. The LSRCA was the lead agency tasked to complete the study with the assistance of the Nottawasaga Valley Conservation Authority (NVCA). The LSRCA lead was responsible for all aspects of project management for the study including: administration, development of work plans, hiring of consultants, preparing progress reports, delivery of the final products and ensuring that an independent expert peer review of the products was completed. Senior management was committed to the project for the duration to ensure that the assigned technical staffs were available to adhere to the tight timelines.

A four-committee governance structure was developed, consisting of a shared Oversight, Steering, and Technical Committees, as well as a Communications Working Group (see governance chart on following page). The Oversight and Study Steering Committees provided the overall direction for the studies, including the approval work plans, major budget expenditure and the release of technical reports. The Technical Committee produced the work plans, requests for proposal/s, data collection and analysis, and production of the study reports.

The Chair of the Technical Committee was responsible for presenting regular project status updates to the Steering Committee throughout the course of the study. A Peer Review Committee was also established, and was comprised of members of the academic and private sector. The Communications Working Group worked with and supported the ACS team to develop and implement a communications plan aimed at building further awareness of the ACS, communicating results, and enhancing strong local municipal, regional, and provincial
government and stakeholder networks that are committed to continued action to protect water quality in the two watersheds. This report describes Phase 1, the Assimilative Capacity Study, its findings and conclusions.
1.3 **Project Components**

The estimation of the assimilative capacity of the Lake Simcoe and Nottawasaga River watersheds required the completion of several major tasks. These tasks included the completion of three (3) models: a 3-dimensional hydrodynamic model of Lake Simcoe, a hydrodynamic mixing zone model of the outflow of the Nottawasaga River at the Nottawasaga Bay, and a watershed-based water quality model. The results of the watershed-based water quality model drove the next task, the development of Total Maximum Monthly Loads for phosphorus for each of the subwatersheds in the study area. Projects that were supplementary to these tasks were the Ministry of the Environment's "Annual Water Balances, Total Phosphorus Budgets and Total Nitrogen, Chloride Loads for Lake Simcoe (1998-2004)" and the completion of a benthic invertebrate assessment on Lake Simcoe. Brief descriptions of these projects are found below.

1.3.1 **Canadian ArcView Nutrient and Water Evaluation Tool (CANWET)**

The Canadian ArcView Nutrient and Water Evaluation Tool (CANWET) is a powerful geographical information systems (GIS) tool that can demonstrate how various environmental and anthropogenic factors can interact to affect concentration and movement of chemicals in soil and water. It does this by simulating sediment and nutrient loads in conjunction with surface water processes. The model identifies sources of sediment and nutrients as well as potential areas of concern within the subwatersheds of both the Lake Simcoe and Nottawasaga River watersheds. The tool was originally developed at Cornell University in the 1980s, and was then refined by Penn State University in the 1990s for use in a GIS environment. The tool has been adapted for Canadian conditions by Greenland International Consulting, in conjunction with Penn State University.

This model assists resource managers in taking corrective action regarding sediment and nutrient pollution from sources such as urban and agricultural runoff and wastewater treatment plants. This is accomplished through predicting the impact of changes in land use on water quality, and identifying the most suitable best management. It is used by the United States Environmental Protection Agency and other agencies for the development of Total Maximum Daily Loads and watershed management. For the ACS, it is being used for the development of Total Maximum Monthly Loads, and the results from model runs are also input into both the 3-D Hydrodynamic Lake Model and Hydrodynamic Mixing Zone Model to simulate the effects of future land use changes on the Lake Simcoe and Nottawasaga River systems.

1.3.2 **3-Dimensional Hydrodynamic Lake Model**

The goal of this project was to develop a complete 3-Dimensional hydrodynamic model for Lake Simcoe with an emphasis on total phosphorus, total nitrogen and the prediction of dissolved oxygen concentrations, including the prediction of end of summer hypolimnetic dissolved oxygen concentrations based on annual phosphorus loads. Development of this model was undertaken by a partnership of two firms – Baird and Associates and Gartner Lee Ltd. Additional components of this project were to evaluate the effect of land use changes on the lake, evaluate the phosphorus load reductions that would be necessary to restore the coldwater fishery, investigate the roles and significance of the lake's two large bays, evaluate the role of internal phosphorus loading within the lake, and to make recommendations for future monitoring.
1.3.3 **Hydrodynamic Mixing Zone Model for the Nottawasaga Bay**

The goal of this project, which was undertaken by SNC Lavalin Engineers and Constructors Inc., was to enhance understanding of the complex Nottawasaga River mixing zone with specific emphasis on phosphorus and nutrient loading and subsequent biological, chemical and physical relationships. The consultants also utilized this tool to model the effects of land use changes within the Nottawasaga River watershed on the mixing zone of the Nottawasaga Bay.

1.3.4 **Total Maximum Monthly Load Development**

Total Maximum Monthly Loads (TMMLs) are targets set on a subwatershed basis that are used to ensure that subwatersheds and the basins they contribute to remain unimpaired. These targets are used extensively in the United States for watershed management. In the Lake Simcoe and Nottawasaga River watersheds, the ACS project included the development of TMMLs to assist with management of the watersheds at a smaller scale to ensure that development occurs in an environmentally responsible manner, and to target BMP efforts wisely.

The process for the development of TMMLs for each of the subwatersheds included in the study was undertaken by The Louis Berger Group. The initial portion of this process, the characterization of nutrient and sediment loads within the subwatersheds for the growth scenarios, was completed by the work of Greenland International through the CANWET model. The Louis Berger Group then used this information to determine the maximum load that could be allocated to each of the subwatersheds to ensure that concentrations remained below the framework set in accordance with the Provincial Water Quality Objectives (PWQO) set by the Ministry of the Environment – concentrations above this indicate impairment of the watercourse. The TMMLs include the load attributed to land uses from the CANWET scenarios and a margin of safety (generally about 10% of the total load). The consultants also looked at the Best Management Practices (BMPs) that would need to be implemented in order to reach or maintain the targets. While there are subwatersheds that will not be able to reach a target at which the concentration in the watercourse is within the PWQO framework, results indicate that this will be possible in the majority of subwatersheds with a combination of strict controls on loads from new developments and the implementation of BMPs.

A Public Consultation component was also included in the TMML development process. Stakeholders representing a wide range of interests were invited to workshops (one was held in each of the watersheds). The consultants outlined the process of the development of the TMMLs, and stakeholders were asked to outline their concerns. At the end of each of the two sessions, stakeholders were generally supportive with moving forward with this process and developing TMMLs to be utilized as management tools. Follow-up sessions for the workshop participants are anticipated following the completion of the ACS.

1.3.5 **Actual Estimated Annual Loadings for Lake Simcoe (1998 – 2004)**

The report “Annual Water Balances, Total Phosphorus Budgets and Total Nitrogen and Chloride Loads for Lake Simcoe (1998-2004)” (Scott et al, 2006) was completed by the Ministry of the Environment (MOE) as part of the Lake Simcoe Environmental Management Strategy (LSEMS). The MOE uses numerous sources of monitoring data to calculate the water balance of the lake and phosphorus, nitrogen and chloride inputs to the lake from a number of sources, including the lake’s tributaries, the atmosphere, waste water treatment facilities, and the agricultural
contributions. Information from this report was used for the development of both the CANWET and the 3-D Hydrodynamic model for the lake. This report has been peer reviewed and published as an LSEMS Technical Report.

1.3.6 Benthic Macro-Invertebrate Sampling and Analysis of Lake Simcoe

Stantec was selected to complete a study of the benthic macro-invertebrate community of Lake Simcoe. The field work for this study was completed in the summer of 2005. Very few benthic invertebrate studies have been completed in the lake, and this study was intended to provide baseline information for monitoring efforts to be conducted in the future. The consultants sampled invertebrates throughout the lake, at sites with varying depths and water quality conditions. The samples were analyzed using various indices in an attempt to understand how local water quality influences the benthic community, and how lake-wide management of nutrient concentrations may lead to improvements in habitat quality for benthos. This study of the benthic invertebrates of Lake Simcoe provides a benchmark for existing conditions from which to measure changes over time.
PART 2 EXECUTIVE SUMMARIES

2.1 Canadian ArcView Nutrient and Water Evaluation Tool (CANWET)

The objective of this modelling component of the ACS was to characterize loading rates from point and non-point sources using an existing conditions scenario and a committed future land use scenario based Official Plan land uses from municipalities within the study areas. This scenario was compiled by the Ministry of Municipal Affairs and Housing.

The Canadian Nutrient and Water Evaluation Tool version 2.0 (CANWET™ v2.0) was employed to model nutrient and sediment loading based on land uses in subwatersheds within the study area. Relative nutrient and sediment loading rates were compared between subwatersheds, as well as their sources within the subwatersheds. With an understanding of which areas contributed proportionally greater loads and information on the sources of those loads, future practices that can affect the greatest overall benefits to the subwatershed and receiving waters can be prioritized and directed to the locations and practices that can affect the greatest overall benefits to the sub-watershed and receiving waters. To this end, the results from the application of these tools were used to assess possible future conditions based on planning information.

The GIS layers that were needed to run the CANWET™ model were developed through a combined effort between Greenland and the GIS departments of the Lake Simcoe Region Conservation Authority (LSRCA) and the Nottawasaga Valley Conservation Authority (NVCA). These GIS layers were assembled to run the model, and historical water quality data from a number of sources were used with Environment Canada stream flow data to calibrate the models. Calibration was necessary to condition the model before running it to predict future loading rates. For both watersheds, the CANWET™ model was run for the period from 1997 to 2004 to account for variation in annual precipitation that can occur over a normal cycle of years.

Model Findings – Nottawasaga River Watershed

For the Nottawasaga River basin, the average annual loading of phosphorus at the mouth of the Nottawasaga River for this period was 47.

The net phosphorus loading rates declined between 1 and 2% for the committed future growth scenario as compared with the existing conditions scenario.

Model Findings – Lake Simcoe Watershed

For the Lake Simcoe watershed, the predicted average annual loading over the modelled period was 66 tonnes. This value compares closely to the actual estimated loading for this same period of 67.4 tonnes in the LSEMS report prepared by Scott et al (2006). Of this total, on average 43 tonnes originate from land based point and non-point sources, determined using CANWET™. Approximately 6 tonnes of this is accounted for by direct discharge to the lake from waste water treatment plants and polders. In addition, it is estimated in Scott et al (2006) that, on average, 23 tonnes of the actual estimated annual load calculated from data collected over this period are associated with atmospheric deposition.

The model predicts an increase of approximately 25% in phosphorus loading to an average of 82.5 tonnes in the committed future growth scenario for Lake Simcoe. This assumes similar precipitation patterns as occurred during the period from 1997 to 2004 and exceeds the current loading target for Lake Simcoe of 75 tonnes.
2.2 3-Dimensional Hydrodynamic Lake Model and Water Quality Model

To model Lake Simcoe, the consultant team used the DHI’s MIKE3, a 3-dimensional hydrodynamic model, and linked it with the DHI’s ECO Lab water quality/eutrophication model. The hydrodynamic model simulates thermals stratification, oxygen profiles, wind-driven currents and hydraulic forcing from inflowing tributaries. The water quality/eutrophication model utilized the output created by the hydrodynamic model to quantify the responses of the lake to loadings of phosphorus and other pollutants of interest. The water quality/eutrophication model links phosphorus loading to algal growth, the growth of aquatic plants, death and decomposition of this organic matter and subsequent oxygen consumption.

The model was set up to simulate water quality during the ice-free period, from April 1 to November 30. This period was selected based on the availability of water quality data collected by the Ministry of the Environment at the open water stations on the lake, as calibration of the model with real data is required. This modelling period coincides with the period of concern for the lake – the summer growth season. The conditions during this period contribute to the end-of-summer minimum dissolved oxygen saturation, which affects the lake’s coldwater fishery.

Following calibration, nutrient loading scenarios for land uses associated with existing conditions and for conditions under committed future growth were modelled using loading data provided by the CANWET model. The model results from the Existing and Future scenario model runs showed little change in nutrient (phosphorus and nitrogen) concentrations for the lake with the exception of Cook’s Bay. In general, the model predicted a small decrease in dissolved oxygen concentrations for the future scenarios. Although a decrease of this magnitude would not be expected to cause significant changes to the lake ecosystem and the deepwater fisheries, caution is advised. Longer term influences associated with storage and build up of phosphorus in the water column and lake bed sediments have not been considered through this study.

The visualization tools that accompany the model provide a useful method of observing the circulation patterns that develop in response to varying wind conditions and the impact on temperature, nutrient concentrations and dissolved oxygen levels. In particular, the high nutrient loading in areas such as Cook’s Bay is very clear. High phosphorus loads and warm temperatures cause algal growth in Cook’s Bay and oxygen depletion. Although temperatures in Cook’s Bay are generally too high in the summer months to support the cold water fishery, detritus such organic matter from Cook’s Bay may have impacts on other areas of the lake. These issues can be further explored with this model.

While the model was satisfactorily calibrated for this study, further data is needed to for more accurate calibration. Recommendations for the necessary monitoring for improved calibration were made by the consultants in their report. More detailed calibration will allow for a better understanding of the processes occurring in the lake.

Several recommendations were also made for improvements to the model. Of particular interest is the potential for long-term changes to phosphorus levels in the lake bed sediment and the possibility this may contribute to annual variability in phosphorus loading. The influence of wind-waves on this process should also be considered. In order for it to be used as an effective management tool, the model should be continually updated and improved upon as new information becomes available. This will be made possible through the training of LSRCA staff on the use of the model.
2.3 Hydrodynamic Mixing Zone Model for the Nottawasaga Bay

The purpose of this study was to provide a better understanding of the extent and the hydrodynamic nature of the mixing zone formed at the confluence of the Nottawasaga River with Nottawasaga Bay and Lake Huron. The modelling system employed to complete this task is called GEMMS, an acronym for Generalized Environmental Modelling System for Surfacewater. This model has been thoroughly peer reviewed and published.

Extensive data was used to develop and calibrate the model, and data from the years 2004 and 2005 were selected for the calibration process. Though the intent of the project was to model the mouth of the Nottawasaga River at Nottawasaga Bay, it was decided to extend the model domain to include the entire body of Georgian Bay. This would enable the use of measured water surface elevations and other monitoring data with the Georgian Bay watershed to enhance the model calibration. The Georgian Bay model was run and the results compared to field observations. A finer-scale model of southern Nottawasaga Bay was then prepared to assess water quality in the mixing zone in relation to total phosphorus, total nitrogen, dissolved oxygen and other parameters.

The modelling determined that the river discharge mixes quickly with the lake and that the average limit of the “near-field” hydraulic mixing zone covers an area of about 2 km$^2$. Once the initial mixing is complete, the river discharge plume becomes “passive” and winds and lake currents move and mix it in the “far-field.” Near-field and far-field mixing zones and plumes were mapped for both total phosphorus and total nitrogen for values exceeding the Provincial Water Quality Objectives for these two nutrients.

Comparisons were subsequently made between the near-field and far-field plumes resulting from land use changes. Overall, the simulations for Total Phosphorus showed that there is practically no difference in the near-field and far-field mixing zones for the land uses of the existing and committed future growth scenarios.

The simulations of Total Nitrogen showed that there is an extension in the probability of finding higher Total Nitrogen concentrations along the shore for the committed future growth scenario, but that these increases are relatively small and do not increase Total Nitrogen concentrations in Nottawasaga Bay as a whole.

The consultants make several monitoring recommendations in their report. These recommendations include systematic water quality and current monitoring at the mouth of the Nottawasaga River and the near-shore regions of Nottawasaga Bay, as well as periodic monitoring at additional sites in the river and in the Nottawasaga Bay. This increased monitoring will assist in refining the model and adding to the strength of the modelled results.

Finally, it is recommended that this additional data from field monitoring be used to progressively update and refine the GEMSS model. This information will simply enhance the model and, if the updating includes regular, daily meteorological inputs, the model could be employed as a tool for evaluating “real time” conditions. Frequent use of the model, development of new input data, and completion of a variety of regular simulations to maintain familiarity with the model would enable one or more members of the Conservation Authority to become the local expert in its use.
2.4 Total Maximum Monthly Load Development

The objective of this study was to develop a framework within which land management and land use planning decisions can be readily evaluated for their potential to impact water quality conditions, the health of resident aquatic communities, and preserve recreational use of area waterbodies. To this end, this study assessed the health of aquatic communities in the Lake Simcoe and Nottawasaga River watersheds, analyzed available water quality conditions, identified likely environmental stressors, and proposed pollutant target thresholds for use in water resource management and land planning.

The process used in this study is based on the development and implementation of the Total Maximum Daily Load (TMDL) process currently being implemented in the United States and regulated by the US Environmental Protection Agency. A TMDL is the greatest amount of a given pollutant that a water body can receive without violating water quality standards and/or designated uses. A watershed approach is used to develop the TMDL, requiring the consideration of all potential sources of pollutants, both point and non-point sources in a given drainage. Targets were set based on the approved growth scenario provided by the Ministry of Municipal Affairs and Housing. The consultants used the TMDL methodology to develop Total Maximum Monthly Load (TMML) targets for the Assimilative Capacity Studies.

Targets for the Lake Simcoe watershed were set at the subwatershed level, and took into consideration the Provincial Water Quality Objective (PWQO) for phosphorus (0.03 mg/L), as well as the overall phosphorus loading target, 75 tonnes/year. Each subwatershed was determined to be “impaired” or “unimpaired” based on a review of water quality and biological monitoring information. Impaired watersheds were assigned phosphorus load targets based on estimates presented in the CANWET Modelling Project; however, for these subwatersheds, the estimated future phosphorus loads were reduced to a level that would ensure improvement in water quality conditions. This level of reduction was determined through an analysis of the potential Best Management Practices (BMPs) that could be implemented to reduce loads. The revised phosphorus load which incorporates the implementation of BMPs became the new phosphorus load for the impaired subwatersheds. For subwatersheds considered to be “unimpaired” the target was set to equal the CANWET modelled phosphorus load.

A similar methodology was used for target setting in the Nottawasaga River watershed. “Impaired” and “Unimpaired” watersheds were treated in the same manner. However, there were watersheds that were considered impaired according to the biological indices but met the PWQO, or vice-versa. The targets for these subwatersheds were set equal to the PWQO-based loads or the lowest possible load under the implementation of a comprehensive BMP scenario if the PWQO-based load could not be met.

This study provided a starting point for implementing the use of TMMLs in these watersheds for water resource management and planning. The next step in the process is the development of a detailed implementation plan. Further monitoring may be required to refine the TMMLs and to verify that the TMMLs are not exceeded.

One of the primary objectives of Phase III of the Lake Simcoe Environmental Management Strategy was to estimate the total phosphorus loading to Lake Simcoe. The report “Annual Water Balances, Total Phosphorus Budgets and Total Nitrogen and Chloride Loads for Lake Simcoe (1998-2004)” (Scott et al, 2006) presents methods and results relating to that objective, for the period 1998 – 2004. A two-stage analysis of annual water balances was performed on the hydrological data collected throughout the study period. Total phosphorus loads (metric t • yr\(^{-1}\)) to Lake Simcoe were estimated from six source categories, including atmospheric deposition (bulk), tributary runoff, urban runoff (point and non-point), septic systems and vegetable polders (Art Janse Pumping Station). The total TP load to the lake from all sources ranged from 52.8\(^{2001-2002}\) to 76.2\(^{1999-2000}\) tons yr\(^{-1}\) and averaged 67.4 tons yr\(^{-1}\) over the six year period. The tributary and atmospheric sources constitute the greatest overall contribution. The overall contributions from sources differ depending on the parameter. Tributaries accounted for 25.8%\(^{1999-2000}\) to 45.7%\(^{2000-2001}\), total loads ranged from 18.3\(^{2001-2002}\) to 32.3\(^{2000-2001}\) tons yr\(^{-1}\) and averaged 24.7\(^{1998-2004}\) tons yr\(^{-1}\) TP.

The Art Janse Pumping Station (Holland Marsh) accounted for 0.9%\(^{1998-1999}\) to 4.7%\(^{2000-2001}\), total loads ranged from 0.55\(^{1998-1999}\) to 3.31\(^{2000-2001}\) tons yr\(^{-1}\) and averaged 1.93\(^{1999-2000}\) tons yr\(^{-1}\). The atmospheric TP contribution ranged from 24.8%\(^{2000-2001}\) to 49.3%\(^{1999-2000}\), total loads ranged from 15.8\(^{2001-2002}\) to 37.6\(^{1999-2000}\) tons yr\(^{-1}\) and averaged 23.2\(^{1998-2004}\) tons yr\(^{-1}\). The urban point source (Water Pollution Control Plants) ranged from 5.1%\(^{1999-2000}\) to 8.2%\(^{1998-1999}\), total loads ranged from 3.9\(^{1999-2000}\) to 5.4\(^{1998-1999}\) tons yr\(^{-1}\) and averaged 4.5\(^{1998-2004}\) tons yr\(^{-1}\). Urban storm water direct to Lake Simcoe ranged from 11.8%\(^{1999-2000}\) to 17.6%\(^{2001-2002}\), total loads ranged from 9.02\(^{1998-2001}\) to 9.31\(^{2001-2004}\) tons yr\(^{-1}\) and averaged 9.17\(^{1999-2000}\) tons yr\(^{-1}\). Septic systems within 100m of Lake Simcoe ranged from 5.1%\(^{1999-2000}\) to 7.3%\(^{2001-2002}\), the average annual TP contribution of septic systems to the lake was estimated to be 3.87 tons yr\(^{-1}\). The TP loss from Lake Simcoe at Atherley Narrows ranged from 7.7%\(^{1999-2000}\) to 16.5%\(^{2001-2002}\), the TP loss from Lake Simcoe at Atherley Narrows ranged from 5.9\(^{1999-2000}\) to 10.1\(^{2000-2001}\) tons yr\(^{-1}\) and averaged 8.0\(^{1998-2004}\) tons yr\(^{-1}\).

Three sources of total nitrogen (TN) to Lake Simcoe were estimated, including atmospheric deposition (bulk), tributary runoff and vegetable polders (Art Janse Pumping Station). The total TN load to the lake from all sources ranged from 1.668\(^{2001-2002}\) to 2.253\(^{2003-2004}\) tons yr\(^{-1}\) and averaged 1.950 tons yr\(^{-1}\) over the six year period. Atmospheric TN contribution ranged from 53.2\(^{2003-2004}\) to 79.4%\(^{1998-1999}\). Tributaries accounted for 19.4%\(^{1999-2000}\) to 41.1%\(^{2003-2004}\) and the Art Janse Pumping Station (Holland Marsh) ranged from 1.1%\(^{1998-1999}\) to 5.7%\(^{2003-2004}\). The overall TN loss from Lake Simcoe at Atherley Narrows ranged from 12.6%\(^{1999-2000}\) to 22.5%\(^{2001-2002}\) of total TN input to the lake. The TN loss from Lake Simcoe ranged from 253\(^{1999-2000}\) to 446\(^{2000-2001}\) tons yr\(^{-1}\) and averaged 347 tons yr\(^{-1}\).

Total chloride (Cl) loads (metric t yr\(^{-1}\)) to Lake Simcoe were estimated from four source categories, including atmospheric deposition (bulk), tributary runoff, vegetable polders (Art Janse Pumping Station) and a residual Cl load to the lake from unmonitored/ungauged sources. The residual Cl load was estimated by subtracting the sum of measured Cl inputs to the lake from export at the Atherley Narrows. Tributaries accounted for 50.8%\(^{2001-2002}\) to 81.3%\(^{2003-2004}\). The unmonitored/ungauged sources ranged from 15.1%\(^{2003-2004}\) to 46.2%\(^{2001-2002}\). The Art Janse Pumping Station (Holland Marsh) ranged from 0.9%\(^{1998-1999}\) to 3.2%\(^{1999-2000}\). Atmospheric contribution ranged from 0.9%\(^{2003-2004}\) to 1.6%\(^{1998-1999}\). The overall Cl loss from Lake Simcoe measured at Atherley Narrows ranged from 18,153\(^{1999-2000}\) to 35,987\(^{2003-2004}\) tons yr\(^{-1}\) and averaged 26,240\(^{1998-2004}\) tons yr\(^{-1}\).
2.6 Benthic Macro-Invertebrate Sampling and Analysis of Lake Simcoe

This sampling program, undertaken in October of 2005, was designed to characterize benthos throughout Lake Simcoe, with sampling stratified across water depths and areas differing in water quality. Relationships between indices of benthic community composition were explored in an attempt to understand how local water quality influences the benthic community, and how lake-wide management of nutrient concentrations may lead to improvements in habitat quality for benthos.

The benthic community of Lake Simcoe demonstrated several attributes indicative of good habitat quality. First, this 2005 survey of the benthic community produced 138 distinct taxa including representative species of relatively sensitive groups including beetles, mayflies, and caddisflies in the nearshore environment. The deeper profundal benthos was also relatively diverse with representative species of fingernail clams, snails, chironomids, amphipods, and oligochaete worms. The presence of sphaeriid clams, amphipods and, infrequently, zebra mussels in the profundal environment clearly suggested that water quality has recently been in relatively good condition in the hypolimnion.

The consultants considered several factors in their analysis – water quality, depth, and substrate. Water depth was the single largest influence on benthic community composition of the lake, as was expected. The second most important variable was sediment total organic carbon (TOC) content. Higher TOC tended to coincide with lower relative abundances of mayflies and caddisflies, implying a negative association with the benthos.

The 2005 survey of the benthos of Lake Simcoe provides a useful inventory of existing conditions, and presents a baseline against which to judge future changes in habitat quality. The sampling scheme undertaken involving shoreline, littoral and profundal sampling addresses potential impacts in three fundamental zones in the lake. The shoreline sweeps address potential on-shore impacts resulting from local activities such as septic beds, marinas and other point- and non-point discharges. The consultants have recommended that an inventory of the discharges to the lake should be overlaid with the benthic sampling locations to identify gaps in the design and opportunities for additional future monitoring. An inventory of discharges might also help to interpret some of the spatial patterns observed with the 2005 sampling.
PART 3 COMMUNICATIONS

The communications activities for the Assimilative Capacity Studies were undertaken by LM Marketing and Communications in association with DH Diane Humeniuk and Associates Incorporated. A Communications Working Group, comprised of members of both LSRCA and NVCA as well as provincial and municipal staff provided assistance and guidance to the project.

3.1 Internet Site

An internet site was developed in order to convey information to the public and ACS committee members. This website, www.assimilativecapacity.info, contained reports, presentations, background on the project, and information on events such as open houses related to the project. Since its launch in August 2005 the website has received close to 88,000 requests. The busiest months have been the first three months of 2006, which coincides with the completion of draft reports.

3.2 Intranet Site

A “partners only” intranet site was established through the project website. Through this intranet site, project partners and consultants could access and download reports, schedules, agendas and other important information as needed. Since its launch in August 2005 the intranet site has received close to 8,400 requests, which is approximately 10% of the total traffic to www.assimilativecapacity.info.

3.3 Open Houses

Two open houses were held for this project in September of 2005. One open house was held in each of the two watershed areas – in Elmvale for the Nottawasaga River watershed, and in Bradford for the Lake Simcoe watershed. The displays at these open houses outlined where the Assimilative Capacity Project fits in the context of the IGAP process, the project background, and also showcased the work of the consultants completing the project tasks. The open houses were advertised in print media and on the project website. Both open houses were well attended, with 109 participants at each. The communications consultants prepared an “Open House Summary” document summarizing the statistics of the events.

3.4 Studies Updates

The partners of the ACS completed monthly studies updates for committee members and project partners. These updates included the tasks that had been completed by each of the project consultants, as well as activities for the preparation of upcoming events.

3.5 Collateral Materials

A variety of collateral materials were produced and distributed over the course of the studies. These materials included the Ambassador and Media Kits that were provided during the Open Houses and distributed to stakeholders that were unable to attend.
PART 4 RESULTS AND RECOMMENDATIONS

4.1 Study Results

**CANWET Model**

1) The CANWET Model is a defendable tool that can be used to quantify and qualify pollutant sources (phosphorus, nitrogen, total suspended sediment) within both watersheds,

2) The model will also be used to assess and develop comprehensive management strategies for both watersheds (includes land use change along with implementation of BMPs),

3) Agriculture remains the largest source contributor of phosphorus and sediment in the Nottawasaga watershed,

4) Agriculture, urban and atmospheric sources equally contribute phosphorus loading to Lake Simcoe.

**3-Dimensional Hydrodynamic Model for Lake Simcoe**

1) The “MIKE3” Lake Simcoe model predicts the lake’s response to phosphorus loadings and other pollutants, but requires further calibration before it can be used to develop dissolved oxygen targets (previously peer reviewed empirical methods by the Ministry of the Environment have been used to confirm the lake target),

2) “MIKE3” predicts lake processes which provides a better understanding of localized impacts of nutrient and sediment loading,

3) The “MIKE3” model was set up for ice-free conditions as there were no data to support winter modeling,

4) The model can be further used to assist with Source Water Protection studies,

5) “MIKE3” predicted a small decrease in the dissolved oxygen with Lake Simcoe under committed growth,

6) “MIKE3” indicates that there are nutrient loading issues in Cook’s Bay (currently and declining in the future)

7) The hydraulic processes for Lake Simcoe are wind driven and in general the lake mixes well under these conditions,

8) Lake Couchiching flows into Lake Simcoe on occasions when strong north winds push water south.
Hydrodynamic Mixing Zone Model for Nottawasaga Bay

1) The GEMSS-HD model does not predict any widespread impact associated with the discharge from the mouth of the Nottawasaga River,

2) The hydraulic processes for the Bay are primarily wind driven, and in general the river discharge mixes well under these conditions,

3) The Bay water quality, while slightly impacted within the mixing zone, is not limiting. Therefore, targets for the development of TMMLs should be based upon limiting conditions within the Nottawasaga River.

4.2 Conclusions That Will Shape the Future

1) Both watersheds will only achieve their TMML targets under committed growth conditions provided that BMPs are fully implemented,

2) A mechanism and implementation framework needs to be developed to ensure that targets are achieved and maintained into the future,

3) The framework should include regulation and/or policy to mitigate impacts from further growth, a rehabilitation plan, and a financial framework to fund restoration projects.

4.3 Actions for Implementation

1) Further monitoring will be required to enhance the models developed for the ACS project,

2) Ongoing/improved data collection and refinement will be necessary,

3) Opportunities for funding of BMPs associated with new development must be investigated,

4) A Stewardship Tracking database to monitor BMP implementation to better manage/model stewardship activities should be developed and implemented,

5) A series of performance measures to reflect progress should be developed,

6) Annual progress reporting to stakeholders to increase transparency, should be implemented,

7) Both conservation authorities need to develop policies based on study results,

8) NVCA should develop a total loading target for the outflow of the Nottawasaga River into Nottawasaga Bay,

9) LSRCA should review the dissolved oxygen target for the lake through the Lake Simcoe Environmental Management Strategy.