VALUING NATURAL CAPITAL IN THE LAKE SIMCOE WATERSHED

Lake Simcoe Region Conservation Authority

FINAL REPORT

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Submitted by:
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Executive Summary

The importance of healthy, functioning ecosystems and the benefits they provide is increasingly being recognized within Canada and around the world. These benefits are framed around the concepts of natural capital and ecosystem services. Natural capital is the stock of natural "assets" in a region (i.e. water, forests, wetlands, grasslands, air, soil, and the assemblage of flora and fauna that make up these ecosystems). These assets provide a valuable flow of goods and services, typically referred to as ecosystem services, and broadly defined as the benefits people obtain from nature.

In 2008, the David Suzuki Foundation, Friends of the Greenbelt Foundation, and Lake Simcoe Region Conservation Authority (LSRCA) collaborated on a report to quantify the value of ecosystem services in the Lake Simcoe watershed to better understand and assess the non-market values of the watershed's natural capital. Since the report was released, there have been a number of advances in data availability, valuation approaches, and conceptual frameworks to support natural capital accounting activities. Green Analytics was commissioned by LSRCA to provide an updated assessment of the Lake Simcoe watershed making use of these advances.

Drawing on the latest data and focusing on measurable benefits that result in improvements in human well-being, this report provides an up-to-date assessment of the value of the watershed's natural capital. Value estimates for seven different ecosystem services are provided. In total, the annual value of the watershed's key ecosystem services is estimated to be $922.7 million. Ecosystem service values were translated into an average value per hectare and allocated to the appropriate Ecological Land Classification (ELC) community type. Overall, the average value of measured benefits range from lows of $440 to $629 per ha for intensive and non-intensive agriculture to a high of $8,000 per ha or more for some wetland ELC community types.

Table ES-1. Summary of Key Ecosystem Service Values for the Lake Simcoe Subwatershed

Ecosystem Service	**Measured Benefit**	**Sum of Lake Simcoe Watershed Values ($ Millions)**
Recreation	Value of recreational activity	487.4
Water supply	Value of water usage	157.0
Pollination	Value of agricultural productivity provided by pollinators	45.4
Gas regulation (clean air)	Value of avoided human health care costs from pollution	5
Disturbance regulation	Value of avoided flood damage costs	169.3
Carbon sequestration	Value of avoided social costs of climate change	35.9
Habitat and refugia	Value people place on knowing natural areas exist	22.7
Total Value		**922.7**

Six recommendations are articulated related to using the updated results to help support conservation activities within the watershed.

1. Promote findings to foster awareness
2. Encourage adoption into the Lake Simcoe Protection Plan (10-Year update)
3. Encourage Municipal governments to incorporate values into land use and policy decisions
4. Consider the impacts on natural capital values in the Conservation Authority permitting process
5. Incorporate values into subwatershed studies and other reports, plans and strategies
6. Establish ongoing natural capital accounting for the watershed

Tracking and measuring the ways in which local populations benefit from natural capital is essential to its long-term management. As with all types of assets, the natural capital of the Lake Simcoe watershed should be protected to ensure the flow of valuable ecosystem services is sustained for current and future residents of the watershed.

1 Introduction

The people, animals and plants that live in the Lake Simcoe watershed rely on the ecosystem goods and services that the natural environment provides for their existence. These services are critical to the well-being of the people, animals and plants of the watershed, yet they often go unrecognized or are undervalued. In 2008, the David Suzuki Foundation, Friends of the Greenbelt Foundation, and Lake Simcoe Region Conservation Authority (LSRCA) collaborated on a report to quantify the value of ecosystem services in the Lake Simcoe watershed to better understand and assess the non-market values of the watershed's natural capital. The outcome of this collaboration was a report titled *Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services* (June 2008), prepared by Natural Capital Research & Consulting.

Green Analytics was commissioned by LSRCA to provide an updated assessment of ecosystem service values provided by the natural capital resources within the Lake Simcoe watershed. This update relies on the most current economic and ecological conditions as well as the most up-to-date data and valuation approaches.

As per a developing trend in natural capital and ecosystem service assessments in Ontario,[1] the report focuses on linking existing ecosystem service value estimates to specific ecosystems and land cover types based on the Ecological Land Classification (ELC) found within the Lake Simcoe watershed. The benefits of using an ELC-based approach are two-fold. First, ELC is a provincially-accepted standard for mapping and classifying ecological communities that is used in the preparation of Environmental Impact Studies/Statements (required by the Provincial Policy Statement and Provincial Plans), natural environment technical reports (required by the *Aggregate Resources Act*), and other environmental assessment reports (required by the *Environmental Assessment Act*). Second, ELC recognizes site level ecological conditions and functions, and therefore results in more accurate ecosystem service valuations, which the LSRCA and its constituent municipalities can use to inform policies, projects and programs.

The results of the ecosystem service assessment of the Lake Simcoe watershed are contained in this report, which is structured as follows:

- Section 2 provides background information on the Lake Simcoe watershed, natural capital and ecosystem services, and the ELC system.
- Section 3 presents the values of ecosystem services in the Lake Simcoe watershed, with an emphasis on seven key ecosystem services.
- Section 4 provides a summary of the Lake Simcoe watershed natural capital and ecosystem service values.
- Section 5 presents recommendations and concludes the report.

[1] For example, see: Green Analytics, 2017. Ecosystem Service Values and Great Lakes Shoreline Ecosystems. Report for the Ontario Ministry of Natural Resources and Forestry. Final Report. August 2017.

2 Background

The importance of healthy, functioning ecosystems and the ecosystem services that they provide is increasingly being recognized within Canada and around the world. The result is a growing trend towards the assessment and valuation of such services. Decision-makers at various levels of government (federal, provincial, regional, municipal) are pursuing the assessment and valuation of ecosystem services to:

1. Educate the public on the importance of green spaces
2. Inform policy decisions related to natural resource consumption, management and conservation
3. Measure and track progress towards policy goals and objectives
4. Complement and incorporate ecosystem service estimates into measures of well-being, which tend to focus on traditional economic-oriented indicators (such as gross domestic product)

Commensurate with the increased interest in recognizing the value of ecosystem services, is the trend towards improved analytical approaches for assessing and valuing such services, as well as improvements and refinements to, and associations with, land classification systems.[2] The remainder of this section provides contextual information on the Lake Simcoe watershed, the definition of natural capital and ecosystem services, the applicable land classifications, and the relevance of this information to an accurate assessment of the value of natural capital and ecosystem services in the Lake Simcoe watershed.

2.1 Lake Simcoe Watershed

The Lake Simcoe watershed extends across 3,400 square kilometres and 20 municipal borders, from the Oak Ridges Moraine in the south to the Oro Moraine in the north, through York and Durham Regions, Simcoe County, the Cities of Kawartha Lakes, Barrie and Orillia, and First Nation's lands of Chippewas of Georgina Islands (Figure 1). The Lake itself covers 20 percent of the area and provides drinking water to seven municipalities. There are over 480,000 residents in the watershed; 18 major river systems; 4,225 kilometres of creek, stream and tributary channels; and a variety of natural areas and ecosystem types. The whole watershed is divided into 24 subwatersheds (Figure 2).

[2] Value of Nature to Canadians Study Taskforce. 2017. Completing and Using Ecosystem Service Assessment for Decision-Making: An Interdisciplinary Toolkit for Managers and Analysts. Ottawa, ON: Federal, Provincial, and Territorial Governments of Canada.

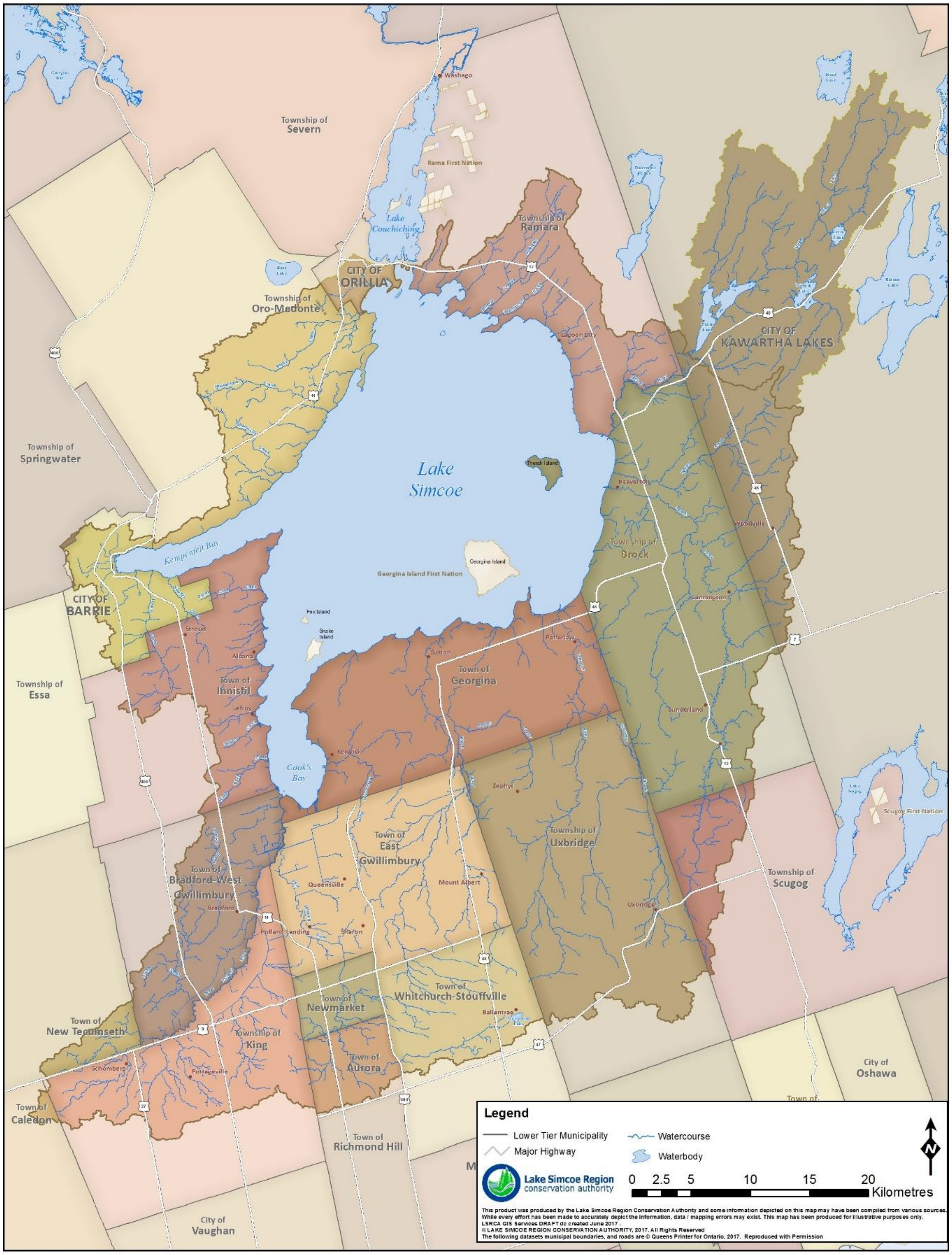

Figure 1. Municipal boundaries within the Lake Simcoe watershed

Figure 2. Subwatershed boundaries within the Lake Simcoe watershed

2.2 Natural Capital and Ecosystem Services Defined

Natural capital refers to the stock of natural "assets" in a region. Natural capital includes water, forests, wetlands, grasslands, air, and soil, as well as the assemblage of flora and fauna that make up these ecosystems. As with other forms of capital, these stocks produce a flow of valuable goods and services over time. For instance, a wetland (the stock) can absorb flood water, providing flood protection (the flow) to people and property downstream. The valuable goods and services that flow from natural capital are referred to as ecosystem services. Ecosystem services are typically defined as the benefits people obtain from nature. They are measurable and result in improvements to human well-being. In the case of flood protection, for example, the benefit that can be measured is avoided flood damages. Figure 3 illustrates the pathway from ecosystem structure to economic value.

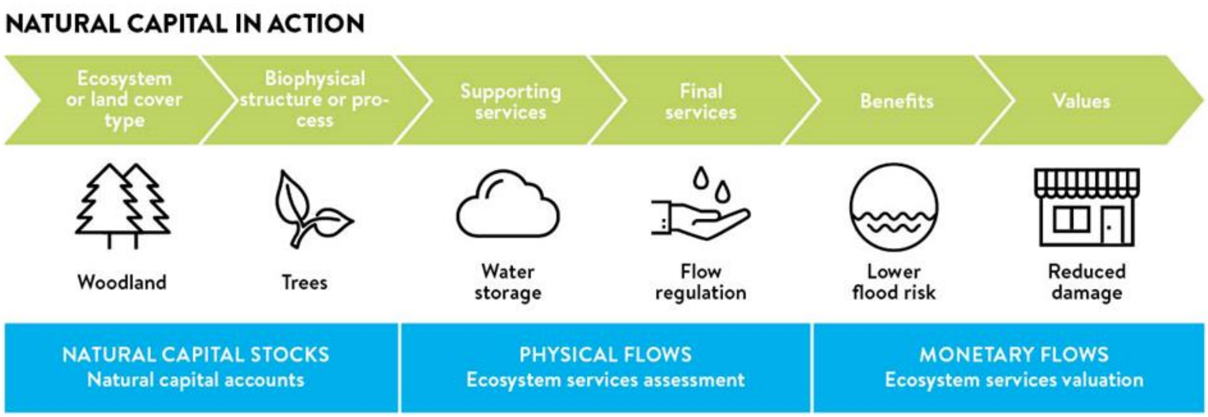

Figure 3. The pathway from ecosystem structure to economic value[3]

On the left, the stock of natural capital is defined by biophysical structure, function and processes, usually organized by land cover classifications. When ongoing biophysical structure, process and function occur in proximity to human populations, they can provide a physical flow of ecosystem services (e.g. water storage and flow regulations), which in turn produce measurable benefits (e.g. lower flood risk) that can be translated into measures of economic value (e.g. the value of avoided flood damages).

Because the concept of natural capital is focused on the benefits nature provides humans, the value we place on it is dependent on who benefits and where beneficiaries are located relative to the spatial distribution of ecosystem service flows. As a result, natural areas near large populations tend to have high associated values. For instance, a wetland or forest on an urban fringe can provide quick, easy access for recreation, and if urban development is downstream, those same features can provide flood protection benefits. An ecologically identical wetland or forest located 100 kilometers downstream of the nearest human habitation is not likely to be providing direct benefits to many people.

[3] Source of Figure: https://www.raconteur.net/sponsored/success-water-industry-much-financial-capital

Since 2008, there has been an evolution in how ecosystem services are defined and categorized. The Economics of Ecosystems and Biodiversity (TEEB) reports are frequently employed to organize the ecosystem services provided by natural capital into four types:[4]

- Provisioning services – the material outputs from ecosystems (e.g. wild foods, crops, fresh water and plant-derived medicines)
- Regulating services – services ecosystems provide by acting as regulators (e.g. filtration of pollutants by wetlands, climate regulation through carbon storage and water cycling, pollination and protection from disasters)
- Cultural services – the non-material benefits people obtain from contact with ecosystems (e.g. recreation, spiritual and aesthetic values, and education)
- Supporting services – services that underpin all other services by providing necessary biophysical functions (e.g. soil formation, photosynthesis and nutrient cycling).

There has also been significant effort to develop frameworks designed to provide more consistent measurement of the beneficial outcomes from ecosystem services. While there is still no commonly accepted standard, there are some developing standards of practice. For instance, the importance of distinguishing between intermediate (typically those defined as supporting services) and final services when accounting for natural capital. The difference between intermediate and final services is demonstrated in the value chain presented in Figure 3, which distinguishes between the value of ecosystem benefits (the final services) and the ecosystem functions that contribute to those benefits (the intermediary services). Modern convention is to focus valuation on the benefits provided by final services – the specific ways in which ecosystems are "utilized (actively or passively) to produce human well-being" – and not the intermediary ecosystem services.[5] For instance, water filtration functions provided by forests and wetlands manifest their value in the provision of clean drinking water, or safe areas for swimming. The clean drinking water or safe areas for swimming are the final services (Figure 4).

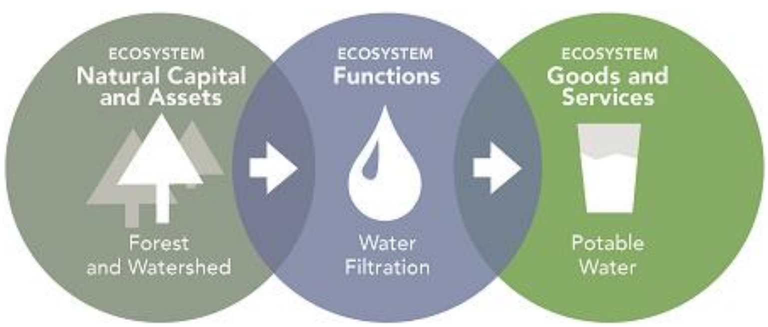

Figure 4. Example of how ecosystem functions produce final goods and services[6]

[4] TEEB (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB.
[5]Fisher, B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological economics*, *68*(3), 643-653.
[6] Source of Figure: http://www.eartheconomics.org/science-economics/

The provision of final services is dependent on intermediary services that are essential to maintaining the ecosystem service value chain. In fact, the intermediary services create the foundation from which the final services are delivered. The reason for valuing just final services, rather than intermediary and final services, is to avoid double counting.[7] The value of intermediary services should be reflected in the value of the final services and valuing both would overestimate the total value of the services provided. However, there are analytical contexts where quantifying the value of an intermediary service may make sense. For instance, the value of water filtration services may be relevant when exploring cost-benefit trade-offs associated with agricultural best management practices in riparian areas.

Despite the emphasis on measuring final ecosystem services in an accounting context, it is not always clear which services are final and which are intermediary. Carbon sequestration and pollination are two such examples,[8]both of which are identified as *key ecosystem services* in the Lake Simcoe assessment as per the following justification:

- Carbon sequestration – By using the social cost of carbon to measure the value of sequestered carbon we are, in theory, quantifying the marginal value of avoided social damages that are anticipated to result from climate change. As long as climate change costs are not included in the other ecosystem service values, it is reasonable to include these values wholly as carbon sequestration service values.
- Pollination (or support for plant cultivation) – To avoid double counting in this case, it is most important not to include both the value of agricultural production of crops and the value of pollination. This report excludes agricultural production and focuses on the specific contribution of pollination.

2.3 Why is Natural Capital Important?

Most of us know and accept that nature is essential to human well-being. The concept of natural capital recognizes that the natural environment is a fundamental asset on which our social and economic systems depend. By conceptualizing nature as an asset, we can codify, measure, and track the ways in which we depend on and impact the environment. Figure 5 depicts this relationship, highlighting that business and economic activity depends on natural capital assets to provide important inputs into production such as clean water, minerals, and timber. Natural capital is also important to human social well-being as it provides recreational and spiritual opportunities, and human health benefits due to its ability to absorb and remove pollutants. However, if we do not manage our natural assets responsibly, their value will depreciate and their ability to provide benefits will diminish. Like any asset, natural assets need to be carefully managed to ensure a sustainable supply of services.

[7] This is the same approach that is used to establish Gross Domestic Product values within the national system of economic accounts.

[8] For a detailed discussion see page 30 of Green Analytics (2016). Ontario's Good Fortune: Appreciating the Greenbelt's Natural Capital. Prepared for the Friends of the Greenbelt Foundation.

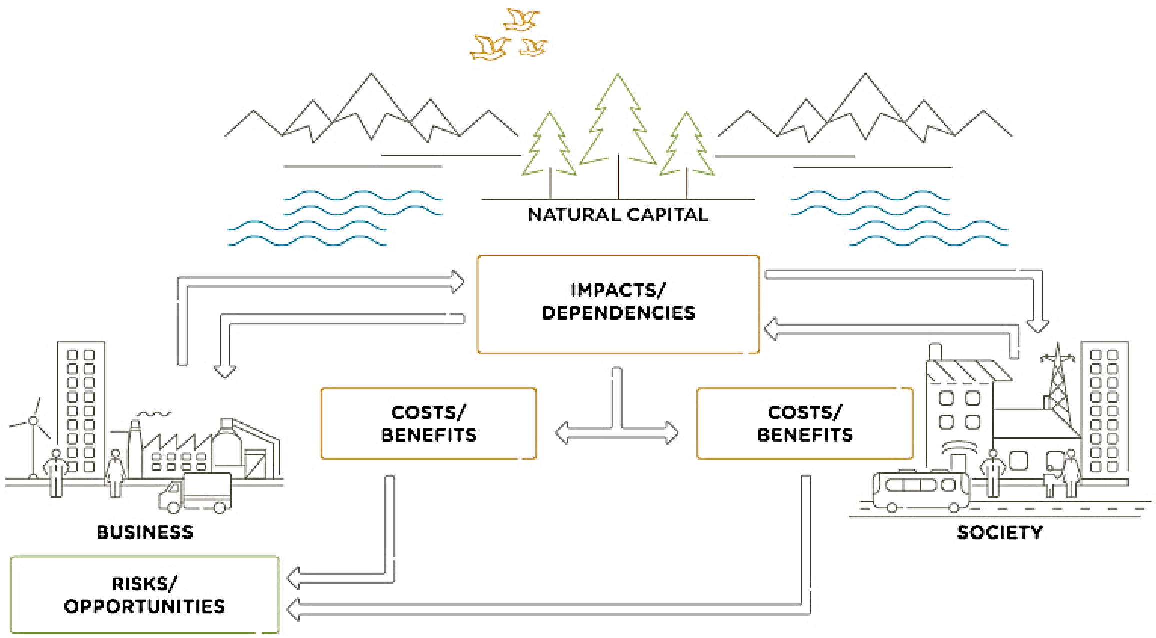

Figure 5. Conceptual diagram of social and economic dependence on natural capital[9]

When natural capital is destroyed, or its ability to provide an ecosystem service is impaired or lost, the service must be replaced for people to continue to derive the benefits that were provided by the natural system. Engineering the replacement of a service nature provides often requires expensive new infrastructure with significant operational and maintenance costs. In the long run, the preservation of natural capital and the services it provides is often the most cost-effective option (see text box below). This realization is now being incorporated into many municipal initiatives that consider natural capital assets as “green infrastructure.”

The New York City Example, as reported by Vintinner (2009)[10]

In the early 1990s, the Environmental Protection Agency introduced new requirements for public water systems. City managers determined that a new filtration system would cost $6 to $8 billion (USD) to build and another $500 million (USD) annually to operate. The alternative was a comprehensive watershed protection program including land purchase, pollution reduction and conservation easements that would allow the natural ecosystems to purify the water. The cost for this program was estimated between $1 and $1.5 billion (USD).

[9] Source of Figure: https://naturalcapitalcoalition.org/natural-capital/
[10] Vintinner, E. C. (2009). Thirsty Metropolis: A Case Study of New York City’s Drinking Water. *Lessons in Conservation*, 2: 110-132.

2.4 Ecological Land Classification

The provincial ELC program[11] (Lee et al 1998) establishes a comprehensive and consistent province-wide approach to describing, inventorying and interpreting ecosystems. According to Ontario's Ecological Land Classification Primer[12] "… the Ontario Ministry of Natural Resources and Forestry (MNRF) defines ecological units on the basis of bedrock, climate (temperature, precipitation), physiography (soils, slope, aspect) and corresponding vegetation, creating an ELC system. This classification of the landscape enables planners and ecologists to organize ecological information into logical integrated units to enable landscape planning and monitoring."

The ELC system organizes ecological units into a series of six nested hierarchal levels. Table 1 provides a summary of each level based on details provided in Lee et al. (1998).

Table 1. Summary of ELC structure

ELC Level	Description
Site Region	Highest level (or coarsest resolution). The 13 site regions in Ontario are defined as "areas of land within which the response of vegetation to the features of landform follows a consistent pattern."
System	This level reduces complex natural landscapes into three community-based units: Terrestrial, Wetland, and Aquatic.
Community Class	An organizational level that groups similar, but generalized ecological patterns and processes (e.g. forest, marsh, savannah).
Community Series	Breaks down community classes into units that are visible and recognizable on air-photos or other remote sensing techniques. They are distinguished based on vegetation cover with the community (e.g. open, shrub, treed vegetation cover, or deciduous, coniferous, mixed planted forms).
Ecosite	This level is characterized as a land scape unit integrating a consistent set of environmental factors and vegetation characteristics and represents recurring plant species patters.
Vegetation Type	This is the finest level of resolution. The purpose of this level is to distill the ecosites diversity of plant communities into a small number of relatively uniform vegetation units.

The LSRCA maintains a land cover map layer for the Lake Simcoe watershed that classifies natural heritage features on the landscape using ELC, defining features to the community series level. The mapping of natural heritage features was most recently completed using 2008-2009 aerial imagery. Some refinement of these features was completed based on 2013 aerial imagery; however, refinements were predominantly focused in areas where impervious surfaces were present. While it is recognized that the landscape has undoubtedly changed since 2008-2009, it is assumed that the natural heritage features have remained relatively unchanged; as such, the ELC community types identified in the land cover layer have been used to complete this assessment. A summary of ELC community types and the total area that they cover in the Lake Simcoe watershed is shown in Table 2.

[11] Lee et al. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Applications. SCSS Field Guide FG-02

[12] https://dr6j45jk9xcmk.cloudfront.net/documents/2710/264777.pdf

Table 2. Land cover types in the Lake Simcoe Watershed

ELC Community Types	Code	Area (ha)
Terrestrial Ecosites		
Open Alvar	ALO	169
Coniferous Forest	FOC	6,041
Deciduous Forest	FOD	17,263
Mixed Forest	FOM	12,755
Tallgrass Prairie	TPO	3
Cultural Ecosites		
Cultural Meadow	CUM	10,700
Cultural Plantation	CUP	5,792
Cultural Savannah	CUS	2
Cultural Thicket	CUT	10,169
Cultural Woodland	CUW	5,667
Wetland Ecosites		
Shrub Bog	BOS	59
Treed Bog	BOT	77
Open Fen	FEO	292
Shrub Fen	FES	149
Treed Fen	FET	3
Meadow Marsh	MAM	2,707
Shallow Marsh	MAS	3,865
Coniferous Swamp	SWC	6,638
Deciduous Swamp	SWD	14,027
Mixed Swamp	SWM	13,760
Thicket Swamp	SWT	9,918
Aquatic Ecosites		
Open Water*	OAO	73,222
Floating-leaved Shallow Aquatic	SAF	214
Mixed Shallow Aquatic	SAM	885
Submerged Shallow Aquatic	SAS	1,223
Other Non-ELC Land Cover Types		
Intensive Agriculture	IAG	94,542
Non-intensive Agriculture	NAG	27,754
Manicured Open Space	MOS	3,614

Table notes:
* Open water category largely captured the spatial area of Lake Simcoe itself. It should also be noted that many of the smaller watercourses within subwatersheds are not captured in this area estimate.

ELC is the most appropriate standard for mapping and classifying ecological communities; it is a recognized methodology in Ontario and is based on the work of the Canada Committee on Ecological Land Classification. Mapping at the community series level is typically sufficiently detailed and ecologically relevant that it can be used for site-level assessments of ecosystem services.[13] Accurate site-level assessments are a significant improvement over strategic-level ecosystem service assessments (i.e., assessments based solely on the benefit-transfer approach), as they recognize site-level ecological conditions and functions, and therefore result in more accurate ecosystem service valuations. Integrating ecosystem service valuation with ELC provides a number of advantages, including:

- Improving the mapping and inventory of ecosystem services in a way that is grounded in ecological science and standardized ecological classification protocols,
- Establishing a systematic protocol for identifying, tracking, and monitoring landscape units based on both ecological conditions and contributions to human well-being, and
- Providing a tool that can be directly applied in land use planning decisions, mapping of ecosystem services, and accounting for the ecosystem service values within a region.

Ultimately, such a framework can be used to develop an inventory of ecosystem services provided by each ecosystem functional unit. When applied spatially, such an inventory can be used to not only identify where development should be avoided, but also where development can occur, to maximize the value humans derive from our endowed natural assets.

It is for the reasons articulated above, that the ELC community types presented in Table 2 are appropriate as the basis for allocating ecosystem service values in the Lake Simcoe watershed.

Figure 6. Beaver River and surrounding wetland ecosystem, Lake Simcoe watershed

[13] Green Analytics, 2017. Ecosystem Service Values and Great Lakes Shoreline Ecosystems. Report for the Ontario Ministry of Natural Resources and Forestry. Final Report. August 2017.

3 The Value of Natural Capital in the Lake Simcoe Watershed

This section of the report contains the results of the ecosystem service assessment for the Lake Simcoe watershed. The focus is on final ecosystem services and the details are organized around broad ecosystem service benefit categories. For each service category, a description of the service is provided, along with details on how the values were estimated. Depending on the service type, the valuation approach employed varied. In all cases, values (in 2016 Canadian dollars) are converted to an annual per ha average and attributed to a specific ELC community type.

The assessment focussed on seven key ecosystem services provided by natural capital assets in the Lake Simcoe watershed. Table 3 provides a summary of each service and the measurable benefit in human well-being captured in this analysis.

Table 3. Key Ecosystem Services in the Lake Simcoe Watershed

Ecosystem Service	Measurable Benefit in Human Well-being
Recreation	Value of recreational activity
Water supply	Value of water usage
Pollination	Value of agricultural productivity provided by pollinators
Gas regulation (clean air)	Value of avoided human health care costs from pollution
Disturbance regulation	Value of avoided flood damage costs
Carbon sequestration	Value of avoided social costs of climate change
Habitat & refugia	Value people place on knowing natural areas exist

3.1 Recreation

Nature recreation is one of the most tangible ways in which people directly derive benefit from natural capital. The Lake Simcoe region is a well-known hotspot for recreation and tourism in Ontario. The lake itself is a world renowned recreational fishing destination.

Table 4 provides a summary of the estimated recreational values. These values were determined using recreation activity and expenditure data provided in the 2012 Canadian Nature Survey.[14] To generate expenditure estimates, specifically for the Lake Simcoe watershed, the adult (aged 18 and over) population determined from LSRCA's custom 2011 census data profile for the watershed boundaries was employed.[15] Participation rates for the various recreation activities were applied to the population figure to estimate the number of people within the Lake Simcoe watershed that participate in each type of recreational activity.[16] For each recreational activity, the average number of day trips (as opposed to

[14] Federal, Provincial, and Territorial Governments of Canada. 2014. *2012 Canadian Nature Survey: Awareness, participation, and expenditures in nature-based recreation, conservation, and subsistence activities.* Ottawa, ON: Canadian Councils of Resource Ministers.

[15] While this population data is not the most recent available from Statistics Canada, it is the most recent data measured directly based on LSRCA watershed boundaries providing a more accurate depiction of population within this customized geographic boundary.

[16] It should be noted this implicitly assumes the proportion of the Ontario population that engages in each recreational activity is equivalent to that of the Lake Simcoe region. If the Lake Simcoe population engages in more outdoor recreational activity than the average Ontarian, which may be the case given the level of access this population has to such activities, then these values will under estimate the recreational value.

overnight trips) was applied to the estimated relevant population, resulting in an estimate of the total number of recreational days per activity type. Daily expenditure estimates from the 2012 Canadian Nature Survey were then applied to the number of days to generate total expenditure estimates by activity (reported in the watershed value column in Table 4). These values represent the total recreation value for each activity across the Lake Simcoe watershed. To determine an average value per ha, the values were divided by the total area of assumed relevant ELC land covers. The total recreational value provided by the Lake Simcoe watershed on an annual basis is estimated to be $420 million, half of which is attributed to hiking, climbing, and horseback riding.

Table 4. Recreation and tourism annual values

Recreational Activity	Relevant ELC	Area of Relevant ELC (ha)	Watershed Value ($ thousands)	Average Value ($ per ha)
Fishing	OAO	73,222	39,555.1	540
Non-motorized water and beach	OAO	73,222	28,077.9	383
Hiking, climbing, and horseback riding	CUM; CUP; CUT; CUW; FOC; FOD; FOM; MAM; MAS; SWC; SWD; SWM; SWT	119,303	212,645.6	1,782
Hunting	CUM; CUP; CUT; CUW; FOC; FOD; FOM; MAM; MAS; SWC; SWD; SWM; SWT	119,303	10,126.9	85
Birding	ALO; CUW; CUM; CUP; CUS; CUT; FOC; FOD; FOM; MAM; MAS; SWC; SWD; SWM; SWT; TPO	125,144	72,452.4	579
Cycling and mountain biking	CUM; CUP; CUT; CUW; FOC; FOD; FOM	68,388	49,964.3	731
X-country skiing and snowshoeing	CUM; CUP; CUT; CUW; FOC; FOD; FOM	68,388	5,799.4	85
ATV and snowmobile	CUM; CUP; CUT; CUW; FOC; FOD; FOM	68,388	68,733.9	1,005
Total Recreational Value			**487,355.5**	

3.2 Water Supply

Water supply is another tangible benefit humans derive from natural capital. Access to clean drinking water is an essential human need. In addition, humans use water to support a wide array of activities, including industrial and manufacturing processes and irrigation of crops for agriculture. Ideally, the value of a clean water supply would be based on estimates of the actual volume of water taken for different end uses. Such data is not currently available.

The value of drinking water for Lake Simcoe is based on the number of households within each municipality. In this case, we assume there is sufficient supply of water to provide the necessary domestic water needs. According to a 2005 study of water values in Canada, municipal water use has been valued at $883 per household, after converting to 2016 dollars.[17] The value of clean drinking water for households is thus determined by multiplying the assumed value per household ($833) by the number of households.

The value of non-domestic water uses is based on estimates from the LSRCA 2009 water budget study.[18] Current groundwater and surface consumption estimates for Agriculture and permits to take water (other non-municipal and non-domestic water uses), measured in m^3 per year, were multiplied by the assumed marginal value for each use ($0.91 per m^3 for agriculture and $0.41 per m^3 for other uses). Assumed values are based on Dupont and Renzetti (2008) and adjusted to 2016 dollars.[19]

Table 5. Water supply annual values by municipality

Municipality	Value of Drinking Water ($ thousands)	Value of Agricultural and other Non-Domestic Water Use ($ thousands)		Total Value of Water Use ($ thousands)
		Groundwater	Surface Water	
Township of Brock	3,655	687	1,668	6,010
Township of Oro-Medonte	2,703	212	588	3,503
Town of Newmarket	24,120	14	47	24,181
Town of East Gwillimbury	6,734	726	966	8,426
Town of Aurora	15,529	144	233	15,906
Town of New Tecumseth	224	44	106	374
City of Orillia	6,578	2	5	6,586
Town of Innisfil	9,735	381	566	10,683
Town of Whitchurch-Stouffville	2,784	671	276	3,731
Town of Caledon	40	5	13	58
Township of Scugog	89	104	249	442
Township of King	2,729	328	1,785	4,841
Town of Georgina	14,216	351	1,299	15,866
Town of Bradford-West Gwillimbury	7,898	313	1,102	9,313
Township of Uxbridge	6,270	1,173	1,257	8,700
Township of Ramara	2,149	492	675	3,317
City of Barrie	31,892	69	77	32,038
City of Kawartha Lakes	1,721	366	956	3,043
Watershed Total	**139,066**	**6,083**	**11,870**	**157,018**

[17] Dupont, D. P., & Renzetti, S. (2008). Good to the last drop? An assessment of Canadian water value estimates. *Canadian Water Resources Journal*,*33*(4), 369-380.
[18] Page 53 and 56 of South Georgian Bay Lake Simcoe Source Protection Region (2009). Tier 1 Water Budget and Water Quantity Stress Assessment: Lake Simcoe Watershed.
[19] Dupont, D. P., & Renzetti, S. (2008). Good to the last drop? An assessment of Canadian water value estimates. *Canadian Water Resources Journal*,*33*(4), 369-380.

Table 5 lists the water supply values by Municipality (values by subwatershed are provided in Appendix 1). As one might suspect, the highest values occur in areas where there is the greatest number of people and, therefore, the highest water consumption. It should be noted that these values are measured and reported in the geographies where humans are benefiting from the use of water and not necessarily where the provision of clean water is generated. This is an important distinction since the health of the broader watershed system plays an important role in ensuring populations in those subwatersheds are provided with a clean water supply. This raises a difficult question in how to allocate these values to specific land cover types.

Figure 7. Open water ecosystem, Lake Simcoe watershed

For groundwater values, the allocation of value to land cover types would ideally be based on the spatial distribution of groundwater recharge rates. For surface water, a logical attribution to specific ELC community types is not straight forward. Table 6 illustrates two potential simplifying assumptions. The first takes a narrow approach and assumes specific uses are allocated to specific ELC categories. The second assumes all natural features have a role to play in the provision of clean water and so the total value is allocated and averaged across all ELC community types. Both approaches are presented for the purposes of demonstrating how a value per ha could be influenced by assumptions around which ELC community types are most relevant. Given the uncertainty in which ELC community types should be included, the broader approach capturing all features is recommended.

Table 6. Average water supply annual values per ha

Allocation Approach	Water Supply Value	Total Value ($ Millions)	ELC Assumption	Average Value ($ per ha)
To specific ELC	Drinking Water (Municipal / Domestic Use)	139	Assume value is provided by ELC that provide significant groundwater recharge (FOC; FOD; FOM; TPO; CUM; CUP; CUT; CUW; MAS; SAF; SAM; and SAS)	1,764
	Groundwater Usage (Agriculture and other Non-domestic use)	6	Assume value is provided by ELC that provide significant groundwater recharge (FOC; FOD; FOM; TPO; CUM; CUP; CUT; CUW; MAS; SAF; SAM; and SAS)	77
	Surface Water Usage (Agriculture and other Non-domestic use)	12	Assume value is provided by surface water ELC (OAO; SAF; SAM; and SAS)	157
To all ELC	Water Use	157	Assume all natural features play an import role in the provision of clean reliable water supply (All ELC codes).	783

3.3 Pollination

Pollination provided by wild pollinators and their supporting habitat is an essential service needed for plant cultivation. Without this service, many crops would simply not grow or otherwise be dependent on other forms of pollination, resulting in reduced agricultural outputs. To estimate the value of this contribution, data provided by the Ontario Ministry of Natural Resources and Forestry (OMNRF) was used.[20] The dataset was developed using a modern spatially explicit approach based on Agriculture and Agri-Food Canada (AAFC) Annual Crop Inventory[21], and the most recent pollinator relationships and crop dependencies from the scientific literature.[22] The result is a raster geospatial data file that contains the dollar contribution of identified pollinator habitat to the surrounding crops. The pollination value of each raster cell varies depending on the how close it is to a pollinator dependent crop and the specific crop types nearby. The dataset covers all of Southern Ontario. Using the Lake Simcoe watershed boundary data, these values were aggregated and estimated on a municipal basis (values by subwatershed are provided in Appendix 1). This results in an ability to estimate the average value for each municipality, as is shown in Table 7. Minimum values represent the low crop pollinator dependency ratios, whereas maximum values capture the high crop pollinator dependency ratios.

[20] Green Analytics (2016). Total Economic Value of Wild Pollinators (unpublished data). Ontario Ministry of Natural Resources and Forestry.
[21] http://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9
[22] Klein, A. M., Vaissiere, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., and Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society of London B: Biological Sciences*, 274(1608), 303-313.

Table 7. Support for plant cultivation provided by pollination, annual values by municipality

Municipality	Minimum		Maximum		Mid-Point
	($ thousands)	($ per ha)	($ thousands)	($ per ha)	($ per ha)
Township of Brock	3,185.1	208	8,102.2	529	368
Township of Oro-Medonte	2,483.2	389	5,989.2	938	664
Town of Newmarket	86.1	221	206.6	530	375
Town of East Gwillimbury	2,050.5	221	5,231.4	563	392
Town of Aurora	192.6	227	451.6	532	379
Town of New Tecumseth	492.5	348	1,227.8	868	608
City of Orillia	142.3	408	334.5	960	684
Town of Innisfil	1,917.8	336	4,880.6	855	596
Town of Whitchurch-Stouffville	780.8	224	1,843.6	530	377
Town of Caledon	73.2	400	173.4	946	673
Township of Scugog	543.6	215	1,309.5	519	367
Township of King	1,691.0	190	4,701.7	529	359
Town of Georgina	2,142.9	215	5,467.9	549	382
Town of Bradford-West Gwillimbury	1,803.4	281	4,962.8	772	526
Township of Uxbridge	2,811.4	219	6,867.8	535	377
Township of Ramara	2,839.5	357	6,942.6	874	616
City of Barrie	442.7	356	1,106.0	888	622
City of Kawartha Lakes	2,174.5	218	5,207.8	521	370
Watershed Total	**25,853.2**	**251**	**65,006.8**	**630**	**440**

Overall, the watershed provides $26 to $65 million annually in support for plant cultivation. The mid-point value of $45 million per year is used for the total watershed value calculation. On average, this translates into $440 per ha of pollinator habitat. The average value can be applied to any ELC community type that provides pollinator habitat. This includes intensive agriculture (IAG), non-intensive agriculture (NAG) and all ELC community types, with the exclusion of aquatic sites (open water (OAO), floating-leaved shallow aquatic (SAF), mixed shallow aquatic (SAM), submerged shallow aquatic (SAS)).

3.4 Gas Regulation (Clean Air)

Forested areas and trees can regulate atmospheric gases and maintain air quality by removing airborne pollutants. This results from the collection of particulate matter on the surface area of leaves and by the absorption of gaseous pollutants into leaves. Improved air quality can result in significant benefits to the surrounding population, who are likely to experience fewer visits to the hospital for respiratory and other illnesses.[23]

To estimate the value of clean air for the Lake Simcoe watershed, results of leading-edge analysis completed by David Nowak for the United States Department of Agriculture were utilized.[24] This

[23] David J. Nowak, Satoshi Hirabayashi, Allison Bodine, Eric Greenfield, 2015, "Tree and forest effects on air quality and human health in the United States," *Environmental Pollution* 193 (119-129).
[24] David J. Nowak, Satoshi Hirabayashi, Allison Bodine, Eric Greenfield, 2015, "Tree and forest effects on air quality and human health in the United States," *Environmental Pollution* 193 (119-129).

approach is similar to that applied in the recent Greenbelt study.[25] Regression equations calculated and presented in the Nowak report were applied to the specific attributes (forested area and population density) of the municipalities within the Lake Simcoe watershed. Valuation estimates were calculated using functions reported by Nowak et al. (2015). These functions estimate health-care expenses (i.e. cost of illness and willingness to pay to avoid illness), productivity losses associated with specific adverse health events, and the value of a statistical life in the case of mortality. The resulting value estimates are expressed in dollars per tonne of change in pollution and applied to the change in pollution resulting from the presence of trees in the Lake Simcoe watershed.

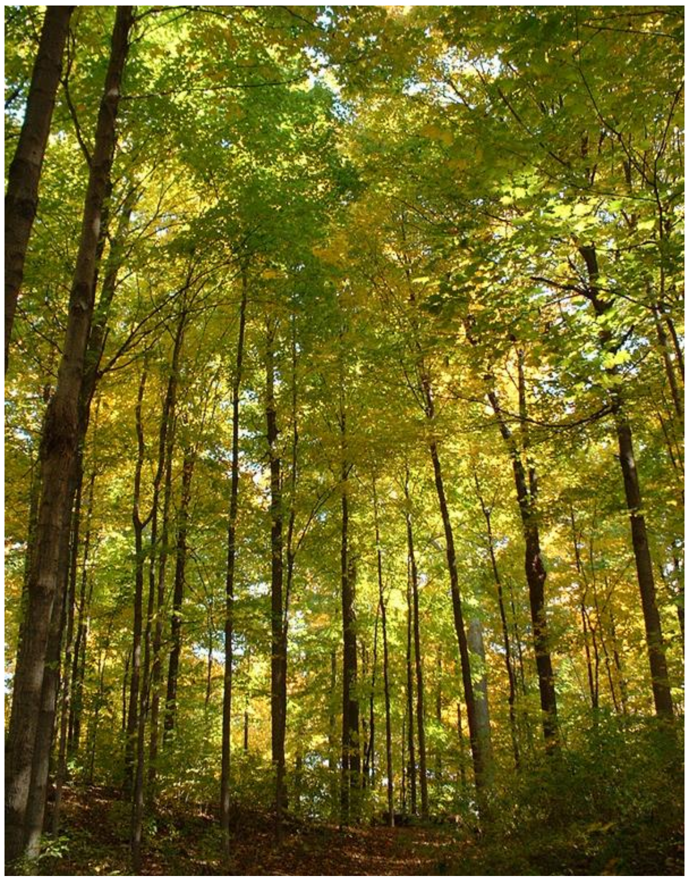

Figure 8. Forest ecosystem, Lake Simcoe watershed

Table 8 provides value estimates for each municipality by forest (including cultural woodlands and plantations) and swamp cover (see Appendix 1 for a summary of values by subwatershed). For forest and woodland ELC community types, the full calculated values were allocated. For swamp ELC community types, the values were adjusted to account for the lower density of tree cover. This was

[25] Green Analytics (2016). Ontario's Good Fortune: Appreciating the Greenbelt's Natural Capital. Prepared for the Friends of the Greenbelt Foundation.

done by assuming a 40% tree cover[26] in coniferous swamp (SWC), deciduous swamp (SWD), and mixed swamp (SWM). Other land covers were assumed to have too little forest cover to include. While other non-forest plants may contribute to the removal of air pollutions, these could not be captured within the scope of this assessment.

The highest values (on a $ per ha per year basis) exist where there are greater population densities, indicating the importance of tree cover in these areas for the purpose of supporting human health benefits. Overall, the Lake Simcoe watershed provides $5.0 million annually in human health benefits through the provision of clean air.

Table 8. Avoided human health care costs provided by gas regulation, annual values by municipality

Municipality	Forest Cover (CUP; CUW; FOC; FOD; FOM)		Swamp Cover (SWC; SWD; SWM)		Combined Total
	Total ($ thousands)	Average ($/ha)	Total ($ thousands)	Average ($/ha)	Total ($ thousands)
Township of Brock	82.2	18	37.8	8	120.1
Township of Oro-Medonte	151.4	30	23.3	13	174.7
Town of Newmarket	375.3	1242	25.0	528	400.3
Town of East Gwillimbury	212.7	57	77.3	24	290.0
Town of Aurora	519.4	683	27.0	290	546.5
Town of New Tecumseth	10.8	23	0.6	10	11.5
City of Orillia	143.1	621	22.9	264	165.9
Town of Innisfil	271.4	121	93.4	51	364.8
Town of Whitchurch-Stouffville	195.8	46	14.1	19	209.8
Town of Caledon	4.0	25	0.3	10	4.2
Township of Scugog	4.2	5	1.2	2	5.4
Township of King	120.7	29	20.9	12	141.6
Town of Georgina	440.0	93	186.8	39	626.7
Town of Bradford-West Gwillimbury	155.5	116	38.7	49	194.2
Township of Uxbridge	266.1	36	82.1	15	348.2
Township of Ramara	42.0	22	28.1	9	70.1
City of Barrie	1004.7	799	202.3	339	1207.0
City of Kawartha Lakes	67.6	9	20.3	4	87.9
Watershed Total	**4,066.9**	**80**	**902.2**	**26**	**4,969.1**

[26] The tree cover assumption for swamps was based on the ELC community type definition where swamps tree cover must be greater than 25%. Without doing a detailed assessment of tree cover for each swamp area, a conservative assumption of 40% is used. In the case of forest and wooded ELC community types it was assumed to be 100% treed area.

3.5 Disturbance Regulation

Wetlands and other natural areas can play an important role in protecting human property by regulating flood waters and erosion. Ideally, these values would be determined by carefully assessing the hydrology of each subwatershed and quantifying the level of anticipated flooding with and without flood regulating land covers. Such flood and erosion profiles can be correlated with the number of properties and other built infrastructure located within flood zones downstream of regulated land covers. For example, Moudrak et al. (2017) modelled flooding and the impact wetlands have on flooding in two southern Ontario pilot sites: one urban and one rural.[27] At the urban site, if wetlands were maintained relative to being replaced by agriculture, flood damages would be $51.1 million (or 38%) lower. This modelled scenario examined the loss of 540 ha of wetlands in Laurel Creek watershed for an average of roughly $94,600 per ha in avoided damages. At the rural site, flood damages would be $3.5 million (or 29%) lower. This modelled scenario examined the loss of 72.9 ha of wetlands in the Credit River Watershed, for an average of roughly $48,000 per ha in avoided damages. While this level of detail and hydrologic modelling was not within the scope of this study, the above example provides a powerful illustration of the impact that wetlands have in regulating flood waters in Southern Ontario and the value of avoided damages.

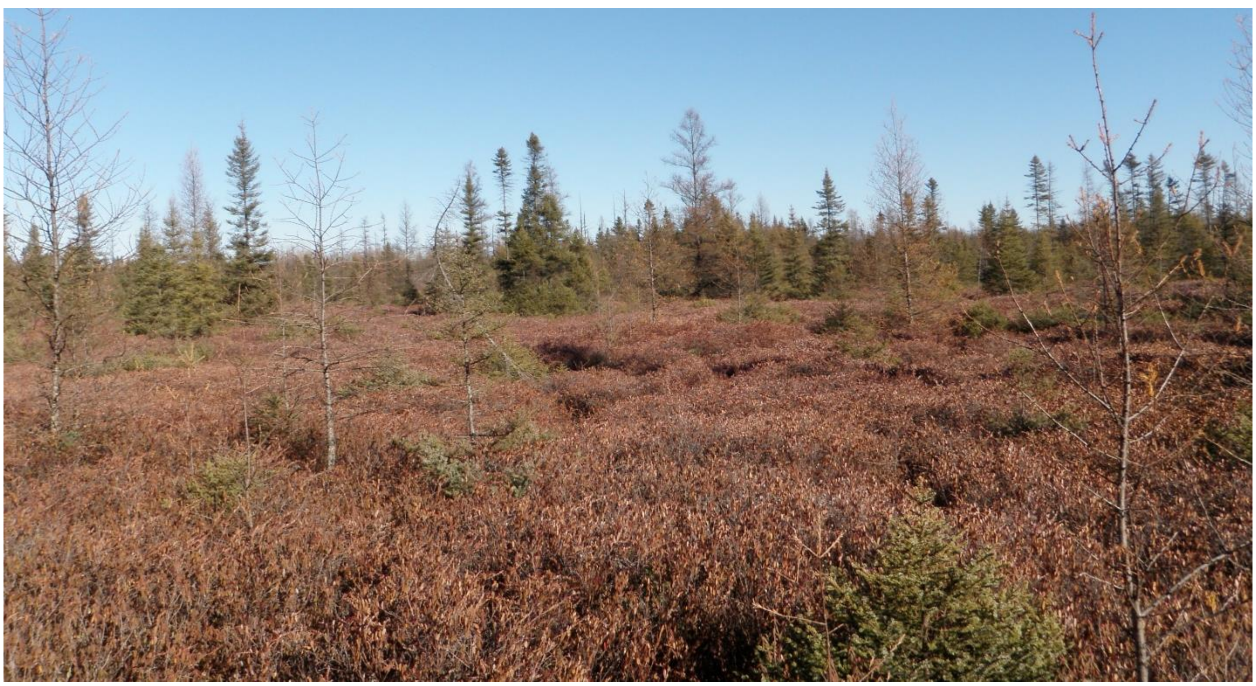

Figure 9 Wetland bog ecosystem, Lake Simcoe watershed

[27] Moudrak, N.; Hutter, A.M.; Feltmate, B. 2017. *When the Big Storms Hit: The Role of Wetlands to Limit Urban and Rural Flood Damage.* Prepared for Ontario's Ministry of Natural Resources and Forestry. Intact Centre on Climate Adaptation, University of Waterloo.

As an alternative, the approach employed in this study draws on a meta-analysis function to transfer values from several other studies focused on the regulating services provided by wetlands within agricultural landscapes.[28] The meta-regression model statistically examined 66 wetland value estimates from Europe and North America. This statistical model was employed in the Greenbelt study to determine the average value of avoided flood damages from existing wetlands.[29] Other ELC community types are likely to provide some flood regulating services as well as provide protection from other damages (e.g. erosion). However, given existing data availability and time constraints, it was only possible to estimate flood avoidance value for wetland ELC community types, resulting in conservative estimates for the value of disturbance regulation.

Drawing on processed values for wetlands in the Greenbelt, wetland complex values were allocated to specific ELC wetland community types in the Lake Simcoe watershed. Table 9 provides summary statistics for each ELC wetland community type. The maximum and minimum value represents the highest and lowest values within the data associated with each wetland type. The mean value represents the arithmetic mean of all wetland values.

Table 9. Protection of human property annual values

ELC Wetland Code	Mean Value ($ per ha)	Max Wetland Value ($ per ha)	Min Wetland Value ($ per ha)	Area Weighted Mean ($ per ha)	Area of ELC Wetland Type (ha)	Total Value ($ thousands)
BOS	11,878	20,515	4,684	4,789	59	282.5
BOT[a]	NA	NA	NA	2,015	77	155.2
FEO	5,520	9,572	2,495	3,195	292	933.0
FES	6,272	15,774	2,286	5,770	149	859.8
FET[a]	NA	NA	NA	2,015	3	6.0
MAM	6,062	20,515	2,015	4,205	2707	11,382.7
MAS	6,107	19,423	2,015	2,634	3865	10,180.2
OAO	5,820	19,423	2,015	3,152	2123	6,691.0
SAF	4,364	8,144	2,015	5,142	214	1,100.5
SAM	6,837	19,423	2,015	3,087	885	2,732.0
SAS	6,000	19,423	2,015	3,359	1223	4,107.6
SWC	5,486	15,774	2,015	3,327	6638	22,085.8
SWD	6,364	20,515	2,015	3,112	14027	43,650.3
SWM	4,874	11,593	2,015	2,862	13760	39,386.5
SWT	6,411	20,515	2,015	2,599	9918	25,780.4
					Watershed Total	**169,333.4**

Table Notes:

a) These ELC community types did not overlap with any of the valued wetlands, therefore the value was assumed to be the min value of all other wetlands valued in the Lake Simcoe watershed.

[28] Brander, L., Brouwer, R., & Wagtendonk, A. (2013). Economic valuation of regulating services provided by wetlands in agricultural landscapes: A meta-analysis. *Ecological Engineering*, *56*, 89-96.

[29] Green Analytics (2016). Ontario's Good Fortune: Appreciating the Greenbelt's Natural Capital. Prepared for the Friends of the Greenbelt Foundation.

As the statistics in the table demonstrate, flood protection from wetlands can vary significantly depending on a few factors, including the amount of economic activity and the area of wetlands in the surrounding region, as estimated by the meta-regression model. The area weighted mean can be used as a representative estimate for the value of human property protection provided by wetlands. These values are particularly conservative when viewed in the context of Moudrak et al. (2017) who estimated values that averaged $48,000 to $94,600 per ha.

3.6 Carbon Sequestration

Forests, woodlands, wetlands, grasslands, thickets, and non-intensive agriculture play an important role in mitigating climate change through the sequestration and storage of carbon dioxide and other greenhouse gases. The mitigation of climate change is likely to have a wide range of benefits to humans in the form of avoided severe weather events. Here, only sequestration is valued, as it represents the annual service flow.[30]

The first step in estimating the value of carbon sequestration is to establish the rate of sequestration. Two approaches were used in this analysis:

1. For forest land covers (including plantations and woodlands), data from the recent Greenbelt study was used, which was based on a carbon budget model that measures sequestration over time.[31] For the purpose of this report, unique sequestration rates were established for softwood (SW) and hardwood (HW). The sequestration rates fluctuated overtime, as shown in Figure 3.
2. For grasslands, non-intensive agriculture and wetlands, estimates were obtained for the rate of sequestration for each of the ecosystem types (i.e. tonnes of carbon sequestered per ha per year of ecosystem type).

Once the average rate of sequestration was determined, a price per tonne of carbon was applied to the sequestration estimates. Environment Canada's recommended social cost of carbon was used, which is currently $43.77 per tonne of CO_2e (i.e. CO_2 equivalents).[32] The social cost of carbon quantifies the marginal value of avoided social damages that are anticipated to result from climate change. In other words, it is a measure of the incremental avoided damages from a decrease in CO_2 emissions.

Since the social cost of carbon is measured in CO_2e, and sequestration is measured in tonnes, it was necessary to convert the values to comparable units. The conversion was based on the relative atomic weights. That is, 1 tonne of carbon sequestered translates into 3.667 tonnes of CO_2 removed from the atmosphere.

Figure 10 shows the trend in carbon sequestration for softwood (SW) and hardwood (HW) over time in relation to the average value per ha based on Environment Canada's social cost of carbon over the same time period. Over a 40-year period, the annual sequestration rate declines as trees mature. However,

[30] The carbon storage can also be valued. However, it represents the accumulated stock of carbon that has been sequestered in all previous years. As a result, it is not included in the annual sequestration value.
[31] Green Analytics (2016). Ontario's Good Fortune: Appreciating the Greenbelt's Natural Capital. Prepared for the Friends of the Greenbelt Foundation.
[32] http://www.ec.gc.ca/cc/default.asp?lang=En&n=BE705779-1

the social cost of carbon increases at a faster rate than the decline in sequestration, leading to a growing average value of carbon sequestration over time. The prices and rates of sequestration employed in this analysis provide the best representation of current conditions. However, LSRCA should consider revising this estimate periodically to account for changing conditions. The average values used are $102 per ha, $140 per ha, and $121 per ha for deciduous (FOD), coniferous (FOC), and mixed (FOM) forests respectively. For plantations (CUP) and woodlots (CUW) the value is assumed to be $121 per ha.

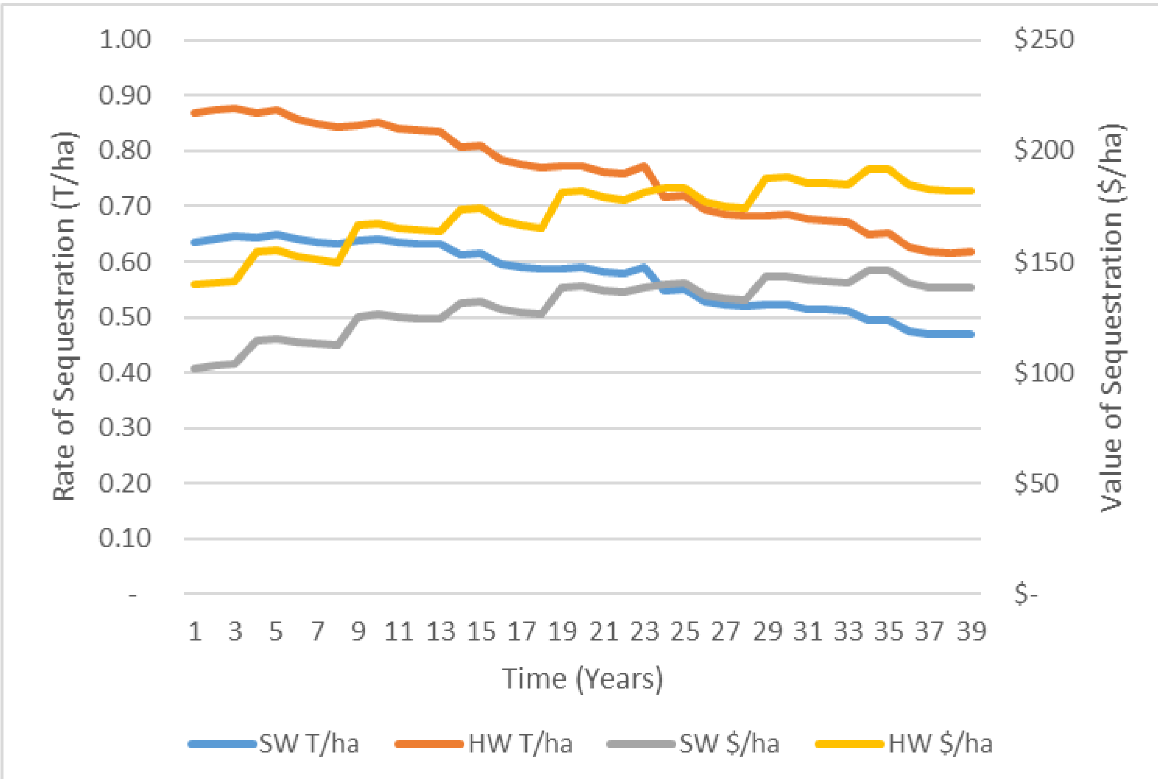

Figure 10. Comparison of carbon sequestration rates and average value per hectare

Drawing on recent literature examining the role of wetlands in sequestering carbon, a series of sequestration rates were identified for different wetland ELC community types. In this case, the ecological conditions of the studied wetlands were matched against the ELC communities in the Lake Simcoe watershed. Data on rate of carbon sequestration are drawn from Mitsch et al. (2013)[33] and Bernal and Mitsch (2012).[34] The rates of sequestration for each wetland type is then determined based on the social cost of carbon as described above. The resulting average value ranges from $169 per ha to $1289 per ha depending on the wetland community type (Table 10).

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[33] Mitsch, W. J., et al. (2013). Wetlands, carbon, and climate change. *Landscape Ecology*, *28*(4), 583-597.
[34] Bernal, B., & Mitsch, W. J. (2012). Comparing carbon sequestration in temperate freshwater wetland communities. *Global Change Biology*, *18*(5), 1636-1647.

Table 10. Wetland carbon sequestration annual values

ELC Code	Sequestration		Estimated Value ($ per ha)
	Tonnes C per ha per year	Source	
BOS	3.65	Mitsch et al. (2013)	586
BOT	3.65	Mitsch et al. (2013)	586
FEO	3.65	Mitsch et al. (2013)	586
FES	3.65	Mitsch et al. (2013)	586
FET	3.65	Mitsch et al. (2013)	586
MAM	8.03	Mitsch et al. (2013)	1289
MAS	2.1	Bernal and Mitsch (2012)	337
SWC	2.02	Bernal and Mitsch (2012)	324
SWD	4.73	Bernal and Mitsch (2012)	759
SWM	2.02	Bernal and Mitsch (2012)	324
SWT	2.02	Bernal and Mitsch (2012)	324
SAS	1.05	Bernal and Mitsch (2012)	169
SAM	1.12	Bernal and Mitsch (2012)	180
SAF	1.6	Bernal and Mitsch (2012)	257

Similarly, existing literature was used to establish sequestration rates for grasslands and non-intensive agriculture (e.g. pasture). Unfortunately, limited research was found related to grasslands, particularly in an Ontario context. The previous Lake Simcoe valuation report drew on a study that estimated an average of 0.5 tonnes of carbon per ha per year.[35] More recent research suggests that temperate grasslands can sequester anywhere from 0 to 8 tonnes of carbon per ha per year.[36] In western Canada, sequestration by grasslands averages about 0.19 tonnes of carbon per ha per year.[37] Given the uncertainty in the rate of sequestration and lack of data for Southern Ontario systems, for this report, 0.5 tonnes per ha per year is assumed. Using this rate, and the social cost of carbon noted above, the value of grassland carbon sequestration is estimated as $80 per ha. This value was applied to all grassland communities (ALO, TPO, CUS, CUM, and CUT) and non-intensive agriculture (NAG). Carbon sequestration values are summarized for all ELC community types in Table 11.

[35] Smith, W. N., Desjardins, R. L., & Grant, B. (2001). Estimated changes in soil carbon associated with agricultural practices in Canada. *Canadian Journal of Soil Science*, 81(2): 221-227.
[36] Jones, M. B., & Donnelly, A. (2004). Carbon sequestration in temperate grassland ecosystems and the influence of management, climate and elevated CO2. *New Phytologist*, *164*(3), 423-439.
[37] Wang, X., VandenBygaart, A. J., & McConkey, B. C. (2014). Land management history of Canadian grasslands and the impact on soil carbon storage. *Rangeland Ecology and Management*, *67*(4), 333-343.

Table 11. Summary of carbon sequestration annual values by ELC community type

ELC Community Types	Code	Area (ha)	Average Value ($ per ha)	Carbon Sequestration Value ($ thousands)
Terrestrial Ecosites				
Open Alvar	ALO	169	80	13.5
Coniferous Forest	FOC	6,041	102	616.1
Deciduous Forest	FOD	17,263	140	2,416.8
Mixed Forest	FOM	12,755	121	1,543.3
Tallgrass Prairie	TPO	3	80	0.2
Cultural Ecosites				
Cultural Meadow	CUM	10,700	80	856.0
Cultural Plantation	CUP	5,792	121	700.8
Cultural Savannah	CUS	2	80	0.2
Cultural Thicket	CUT	10,169	80	813.5
Cultural Woodland	CUW	5,667	121	685.7
Wetland Ecosites				
Shrub Bog	BOS	59	586	34.6
Treed Bog	BOT	77	586	45.1
Open Fen	FEO	292	586	171.1
Shrub Fen	FES	149	586	87.3
Treed Fen	FET	3	586	1.8
Meadow Marsh	MAM	2,707	1289	3,489.3
Shallow Marsh	MAS	3,865	337	1,302.5
Coniferous Swamp	SWC	6,638	324	2,150.7
Deciduous Swamp	SWD	14,027	759	10,646.5
Mixed Swamp	SWM	13,760	324	4,458.2
Thicket Swamp	SWT	9,918	324	3,213.4
Aquatic Ecosites				
Open Water	OAO	73,222		
Floating-leaved Shallow Aquatic	SAF	214	257	55.0
Mixed Shallow Aquatic	SAM	885	180	159.3
Submerged Shallow Aquatic	SAS	1,223	169	206.7
Other Non-ELC Land Cover Types				
Intensive Agriculture	IAG	94,542		
Non-intensive Agriculture	NAG	27,754	80	2,220.3
Manicured Open Space	MOS	3,614		
			Watershed Total	**35,888.2**

3.7 Habitat and Refugia

Habitat and refugia are associated with the protection and provision of natural habitat, including the knowledge that the diversity of individual species of flora and fauna – as well as the assemblage of these into connected ecosystems and habitats – is protected for current and future generations. These are referred to as existence and bequest values.

It is important to note that biodiversity itself is not a final ecosystem service. However, existence and bequest values implicitly account for it. That said, it is extremely difficult to quantify these values. As noted in the recent Greenbelt study, these values can be held for a wide range of environmental features.[38] For instance, there is a considerable body of research that examines the value of endangered species,[39] while others examine the value of vast protected areas.[40] There is considerable debate on whether valuation techniques can adequately capture the different levels of disaggregation resulting from how individuals perceive such values. A whole body of literature exists that examines the sensitivity of these values to the scope of the environmental good being studied.[41] To avoid these issues, a value is established for both aquatic and terrestrial habitat protection. The aquatic value of $42.15 per household is derived from a synthesis of the literature on water values in a Canadian context.[42] The terrestrial value of $102.10 per household is derived using a function transfer from a study conducted in Eastern Canada, quantifying the preservation of open space, wildlife habitat, and traditional country life.[43] Table 12 applies these values to the number of households in each municipality (estimates by subwatershed are provided in Appendix 1). It is important to note that, when expressed this way, the values are presented based on the location where the benefits are derived by the beneficiary and not necessarily the location of the natural features that are being valued.

Assuming the $22.7 million is generated by all the natural features in the Lake Simcoe watershed, the average value of natural cover is $116 per ha per year. Alternatively, assuming the water values are provided by aquatic ELC areas (OAO; SAF; SAM; and SAS), the average value for those areas would be $88 per ha per year, including Lake Simcoe, or $2,017 per ha per year, excluding Lake Simcoe. Likewise, assuming the land value applies to terrestrial and wetland ELC community types as well as non-intensive agriculture (NAG), the average value would be $109 per ha.

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[38] Green Analytics (2016). Ontario's Good Fortune: Appreciating the Greenbelt's Natural Capital. Prepared for the Friends of the Greenbelt Foundation.

[39] For example, Richardson, L., & Loomis, J. (2009). The total economic value of threatened, endangered and rare species: an updated meta-analysis. *Ecological Economics*, *68*(5), 1535-1548.

[40] Adamowicz, W., Boxall, P., Williams, M., & Louviere, J. (1998). Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. *American journal of agricultural economics*, *80*(1), 64-75.

[41] For example, see: Boyle, K. J., Desvousges, W. H., Johnson, F. R., Dunford, R. W., & Hudson, S. P. (1994). An investigation of part-whole biases in contingent-valuation studies. *Journal of Environmental Economics and Management*, *27*(1), 64-83; or Carson, R. T., & Mitchell, R. C. (1995). Sequencing and nesting in contingent valuation surveys. *Journal of environmental economics and Management*,*28*(2), 155-173

[42] Dupont, D. P., & Renzetti, S. (2008). Good to the last drop? An assessment of Canadian water value estimates. *Canadian Water Resources Journal*,*33*(4), 369-380.

[43] Bowker, J. M., & Didychuk, D. D. (1994). Estimation of the nonmarket benefits of agricultural land retention in eastern Canada. *Agricultural and Resource Economics Review*, *23*(2), 218-225.

Table 12. Habitat and refugia annual values by municipality

Municipality	Number of Households[a]	Water ($ thousands)	Land ($ thousands)	Total ($ thousands)
Township of Brock	4,140	174.5	422.7	597.2
Township of Oro-Medonte	3,062	129.1	312.6	441.7
Town of Newmarket	27,324	1,151.7	2,789.9	3,941.6
Town of East Gwillimbury	7,628	321.5	778.9	1,100.4
Town of Aurora	17,592	741.5	1,796.2	2,537.7
Town of New Tecumseth	254	10.7	25.9	36.6
City of Orillia	7,452	314.1	760.9	1,075.0
Town of Innisfil	11,028	464.8	1,126.0	1,590.8
Town of Whitchurch-Stouffville	3,154	132.9	322.0	455.0
Town of Caledon	45	1.9	4.6	6.5
Township of Scugog	101	4.3	10.3	14.6
Township of King	3,091	130.3	315.6	445.9
Town of Georgina	16,104	678.8	1,644.3	2,323.0
Town of Bradford-West Gwillimbury	8,947	377.1	913.5	1,290.6
Township of Uxbridge	7,103	299.4	725.2	1,024.6
Township of Ramara	2,435	102.6	248.6	351.3
City of Barrie	36,128	1,522.7	3,688.8	5,211.6
City of Kawartha Lakes	1,950	82.2	199.1	281.3
Watershed Total	157,538	6,640.0	16,085.3	22,725.3

Table notes:

a) Households are defined as Private Dwellings Occupied by Usual Residents, 2011

3.8 Services Not Accounted For

This section notes and provides a brief description of broader benefit, or final ecosystem service, categories that have not been accounted for above.

3.8.1 Aesthetic Appreciation

Aesthetic appreciation is the benefit people obtain from the natural beauty of the Lake Simcoe watershed. Many aesthetic benefits result from recreational activities and some such value would be accounted for in the recreational estimates above. Aesthetic values associated with residential properties are, however, missing from the analysis. While methods exist to quantify these values, it is difficult to do so across a broad area such as the Lake Simcoe watershed. The value of aesthetic appreciation is location specific depending not only on the aesthetic quality of an area, but also on the local real estate market. In addition, quantifying the properties across the watershed that have aesthetic amenities would require a detailed property by property assessment. Such an analysis is technically feasible, but was outside the scope of this project.

3.8.2 Waste Disposal

The natural features of the Lake Simcoe watershed can provide a natural level of assimilative capacity, which essentially allows for free or cheap waste disposal. The benefit derived from this service is difficult to quantify because it depends on the carrying capacity of the environment in which the disposal is taking place. Data and science related to cumulative effects and carrying capacity, which is highly location dependent, is limited. In addition, given the nutrient loading issues facing Lake Simcoe, it is possible we have already exceeded the natural environment's ability to provide this service, at least as it pertains to nutrient related wastes. Appendix 2 provides a landscape level assessment on the value of phosphorus removal in the Lake Simcoe watershed. However, these values are excluded from the total watershed value calculation since there is uncertainty surrounding the degree to which they have been captured in other ecosystem service categories.

3.8.3 Cultural Benefits (Information, Science, Education, and Research)

Natural areas can provide significant cultural benefits in the form of provision of information, and opportunities to conduct science, education and research. Quantifying such benefits is difficult due to data limitations. To derive an estimate for such benefits would first require an understanding of who is deriving value from the watershed for these purposes. This could be determined through a survey of primary, secondary, and post-secondary education institutions and research centres. The second step would be to establish a price for these activities. This is much more difficult. Few approaches exist to quantify these values.[44] One approach that has been used relies on the social value of research. One estimate measures this proxy value as $12,000 per article per year,[45] measured by achievement of knowledge that leads to additional economic growth.[46] To use this approach, an estimate of the annual number of scientific studies published, and the relevant ELC community types reflected, from research done within the watershed, would be needed.

[44] Phillips, S., Silverman, R., & Gore, A. (2008). Greater than zero: toward the total economic value of Alaska's National Forest Wildlands. The Wilderness Society, Washington.
[45] Note this value is reported in USD currency for the year 2000.
[46] Loomis, J. & Richardson, R. (2000). Economic Values of Protecting Roadless Areas in the United States. Washington, DC: The Wilderness Society and Heritage Forests Campaign.

4 Summary of Lake Simcoe Values

This section provides a summary of all the values described in Section 3. First a watershed total estimate is provided with a discussion of the values in relation to the previous study completed in 2008. This is followed by a summary of all ecosystem services on an average value per ha basis for the relevant ELC community types found in the Lake Simcoe watershed.

4.1 Sum of Values for the Lake Simcoe Watershed

Table 13 provides a summary of key ecosystem service values for the Lake Simcoe watershed. For each ecosystem service, the ultimate measurable benefit that was used to determine the value is also described. This is provided to clearly demonstrate what has been measured and what has not. In total, the annual value of the watershed's key ecosystem services is estimated to be $922.8 million.

Table 13. Summary of Key Ecosystem Service Values for the Lake Simcoe Subwatershed

Ecosystem Service	Measured Benefit	Sum of Lake Simcoe Watershed Values ($ Millions)
Recreation	Value of recreational activity	487.4
Water supply	Value of water usage	157.0
Pollination	Value of agricultural productivity provided by pollinators	45.4
Gas regulation (clean air)	Value of avoided human health care costs from pollution	5
Disturbance regulation	Value of avoided flood damage costs	169.3
Carbon sequestration	Value of avoided social costs of climate change	35.9
Habitat and refugia	Value people place on knowing natural areas exist	22.7
Total Value		**922.7**

When compared to the 2008 results ($975 million), this appears to be a reduction in value. However, the approach taken in this report is quite different from the previous assessment, making it difficult to compare the two estimates. Specifically, two methodological differences make direct comparisons inappropriate:

1. This study focuses the valuation on final services (i.e. the measurable benefits to human well-being), and excludes some values that were included in the previous study. For example, this study does not include seed dispersal ($537 per ha) or carbon stored ($438 to $1,302 per ha). The exclusion of such values in this study is not because these items are not valuable, but rather because of the consideration given to current accounting practices. The goal of this assessment is to measure the annual flow of ecosystem services provided by the natural capital in the Lake Simcoe watershed. Seed dispersal is not an ecosystem service but rather, it is an ecosystem function. It provides a cost free form of forest regeneration, which one may wish to consider if deciding between natural and managed forest regeneration. From a natural capital accounting perspective, the value to humans results from human use and non-use of a wooded area in its various stages of succession (e.g. aesthetic appreciation and recreation). In the case of carbon storage, a value can be placed on the stock of carbon already stored. However, this is a stock value measuring what has already been stored through previous years of sequestration.

2. This study takes a top down approach, where value is determined by measuring the total benefit provided to the people of the watershed, then the estimates are converted to an average value per hectare. In many cases throughout the previous assessment, a bottom up approach was employed where averages per ha from the literature were established first and then multiplied by the number of hectares to determine a total value for the watershed. Because the average values per hectare employed in the bottom up approach are always specific to the Lake Simcoe watershed, the resulting total values are not comparable.

When factoring in the above, making a direct comparison between the current value and the 2008 study is not reasonable. However, it is likely that the values have been increasing over time when one considers changes in population and land use over the last 10 years (from roughly 350,000 residents in 2006 to over 480,000 residents in 2016). Going forward, year over year comparisons will be facilitated by two key factors. One, the use of a standardized framework for tracking natural capital and valuing the services derived from it. Two, improved data, which will make for more comprehensive valuation, estimates linked to ELC categories with increased precision. The current assessment provides a first step in that direction.

4.2 Average Annual Ecosystem Service Values per Hectare

Table 14 provides a detailed matrix translating all ecosystem service values into an average value per hectare allocated to the appropriate ELC community type. There are two important notes to keep in mind when interpreting the values in Table 14:

1. For ecosystem services with average annual values broken down by municipalities, the value in Table 14 is an overall weighted average for the Lake Simcoe watershed.

2. Average annual per ha values should not be summed to determine a total annual per ha value for a specific ecosystem service. This could result in over representing the ecosystem service value. For instance, pollination is reported to have a value of $440 per ha across several ELC community types. The $440 per ha represents the average pollination value per ha, regardless of ELC types; summing these would result in significantly over-estimating the values.

Overall, the average annual value of measured benefits range from lows of $440 to $629 per ha for intensive and non-intensive agriculture to a high of $8,000 per ha or more for some wetland ELC community types. These values can be compared to the average cost of land securement to illustrate value generated by protected natural capital from damage or degradation. In 2010, LSRCA estimated the average cost of purchasing land for the purpose of protection, based on fair market value and confirmed by a certified land appraiser, was $3,000 per ha.[47] This suggests that a one-time investment in $3,000 per ha can yield an annual flow of benefits in many cases exceeding $3,000 per ha. In other words, this public investment is likely to pay for itself within one year in the form of public benefits measured by improvements in well-being and avoided costs.

[47] LSRCA. 2010. Natural Heritage System Land Securement Project 2011-2015. http://www.lsrca.on.ca/Shared%20Documents/reports/land-securement-2011.pdf

Table 14. Summary table of key ecosystem service values by ELC community series (2016 CAD ($) per ha/year)

ELC Community Types	Code	Recreation	Water supply*	Pollination*	Gas regulation (clean air)*	Disturbance avoidance	Carbon Sequestration	Habitat and refugia*	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	783	440			80	109	1,991
Coniferous Forest	FOC	4,267	783	440	80		102	109	5,781
Deciduous Forest	FOD	4,267	783	440	80		140	109	5,819
Mixed Forest	FOM	4,267	783	440	80		121	109	5,800
Tallgrass Prairie	TPO	579	783	440			80	109	1,991
Cultural Ecosites									
Cultural Meadow	CUM	4,267	783	440			80	109	5,679
Cultural Plantation	CUP	4,267	783	440	80		121	109	5,800
Cultural Savannah	CUS	579	783	440			80	109	1,991
Cultural Thicket	CUT	4,267	783	440			80	109	5,679
Cultural Woodland	CUW		783	440	80		121	109	1,533
Wetland Ecosites									
Shrub Bog	BOS		783	440		4,789	586	109	6,707
Treed Bog	BOT		783	440		2,015	586	109	3,933
Open Fen	FEO		783	440		3,195	586	109	5,113
Shrub Fen	FES		783	440		5,770	586	109	7,688
Treed Fen	FET		783	440		2,015	586	109	3,933
Meadow Marsh	MAM	2,446	783	440		4,205	1,289	109	9,272
Shallow Marsh	MAS	2,446	783	440		2,634	337	109	6,749
Coniferous Swamp	SWC	2,446	783	440	26	3,327	324	109	7,455

Deciduous Swamp	SWD	2,446	783	440	26	3,112	759	109	7,675
Mixed Swamp	SWM	2,446	783	440	26	2,862	324	109	6,990
Thicket Swamp	SWT	2,446	783	440		2,599	324	109	6,701
Aquatic Ecosites									
Open Water	OAO	923	783			3,152		88	4,946
Floating-leaved Shallow Aquatic	SAF		783			5,142	257	88	6,270
Mixed Shallow Aquatic	SAM		783			3,087	180	88	4,138
Submerged Shallow Aquatic	SAS		783			3,359	169	88	4,399
Other Land Covers									
Intensive Agriculture	IAG			440					440
Non-intensive Agriculture	NAG			440			80	109	629

Table Notes:
* Indicates ecosystem services where subwatershed and municipal specific values are available.

5 Recommendations and Conclusions

5.1 Recommendations

This assessment of natural capital in the Lake Simcoe watershed represents the next step in advancing towards standardized accounting and valuation of the many benefits provided by the watershed. This section provides a series of recommendations related to the findings in this report.

1. **Promote findings to foster awareness**:
    a. The LSRCA will promote and communicate the findings of this report to provincial and municipal governments, the agricultural community, the development industry, non-government organizations, other stakeholders, and the general public to foster greater awareness and recognition of natural capital and ecosystem services in the watershed community.
    b. The LSRCA should integrate the value and importance of natural capital and ecosystem goods and services into education programs and community outreach efforts to foster a greater awareness and recognition of local ecosystems in the watershed community.

2. **Encourage adoption into the Lake Simcoe Protection Plan (10-Year update):** The LSRCA should work with the provincial government to integrate the value and importance of natural capital into relevant public policy such as the Lake Simcoe Protection Plan (10-Year update) to ensure that appropriate protection is provided to natural capital assets and the ecosystem services that they provide.

3. **Encourage municipal governments to incorporate values into land use and policy decisions**: Municipal governments in the Lake Simcoe watershed should integrate the value and importance of local natural capital into public policy, such as official plans, growth strategies, land use planning policies and asset management strategies, to ensure that appropriate protection is provided to natural capital assets and the ecosystem services that they provide. At a municipal level, the values and approaches used in this study could be further refined and incorporated into asset management frameworks and accounted for alongside traditional assets. This approach is currently being advanced by the Municipal Natural Asset Initiative.[48]

4. **Consider the impacts on natural capital values in the permitting process**: The LSRCA should recognize the value and importance of natural capital through Ontario Regulation 179/06 under the *Conservation Authorities Act*, to help ensure and justify appropriate protection is provided to natural capital assets and the ecosystem services that they provide.

[48] http://institute.smartprosperity.ca/content/municipal-natural-assets-initiative

5. **Incorporate values into subwatershed studies and other reports, plans and strategies**: The LSRCA should incorporate the value and importance of natural capital and ecosystem goods and services into watershed studies, reports, plans and strategies, such as ecological offsetting plans, natural heritage system strategies, subwatershed plans, climate change strategies, restoration plans, asset management plans and land management and securement strategies. This could also apply to Environmental Impact Studies (required by the Provincial Policy Statement and Provincial Plans*)*, Natural Environment Technical Reports (required by the *Aggregate Resources Act*), and other Environmental Study Reports (required by the *Environmental Assessment Act*).

6. **Establish ongoing natural capital accounting for the watershed**:
    a. The provincial government, municipal governments and LSRCA should pursue the development of a natural capital accounting system for the Lake Simcoe watershed to better inform economic strategies so that they align more closely with the conservation of ecosystems.
    b. LSRCA, other Conservation Authorities and the MNRF should collaborate in the development of a common framework linking ecosystem service values to the ELC system. Recommendation 6(a) could be a pilot process for such a framework.
    c. In the absence of a formalized system of natural capital accounts, LSRCA will monitor the state of natural capital in the Lake Simcoe watershed and facilitate the review and update of natural capital values every five to ten years, or as needed, based on current research and industry practices, to ensure that the most relevant information is available to support the above recommendations. In support of this, LSRCA should develop and maintain a database of values for services most relevant to the watershed. This would establish a knowledge base of natural capital and ecosystem service assessment most applicable at the subwatershed level across the Lake Simcoe watershed.

Figure 11. East Holland River valley ecosystem, Lake Simcoe watershed

5.2 Conclusion

This report presents the results of an assessment of the final ecosystem service values derived from the Lake Simcoe watershed. The values can inform the potential implications of land use and resource management policy decisions in the region at the subwatershed level.

This study makes use of many advances in concepts, data, and valuation techniques to provide the most up-to-date values possible. Data gaps limit the ability to provide estimates for all final services and, as such, the values presented here should be considered conservative estimates of the values provided by the Lake Simcoe watershed.

Tracking and measuring the ways in which local populations benefit from natural capital is essential to its long-term management. As with all assets, the natural assets of the Lake Simcoe watershed should be conserved to ensure the flow of ecosystem services can be sustained for current and future residents of the watershed.

Appendix 1: Summary of Values by Subwatershed

This appendix presents ecosystem service values by subwatershed, where feasible. Note that total values presented below may differ slighted from those presented in the body of the report because of minor differences in the allocation of attributes under different geographic boundaries.

Table A1-1. Water supply annual values by subwatershed

Subwatershed	Value of Drinking Water ($ thousands)	Value of Agricultural and other Non-Domestic Water Use ($thousands)		Total Value of Water Use ($ thousands)
		Groundwater	Surface Water	
Upper Talbot River[a]	996			996
Barrie Creeks	24,001	14	14	24,028
Beaver River	3,037	188	451	3,676
Black River	6,155	1,520	3,152	10,828
East Holland	47,297	1,368	1,988	50,653
Fox Island[a]				
Georgina Creeks	4,763	267	951	5,982
Georgina Island[a]	89			89
Hawkestone Creek	263	18	28	308
Hewitts Creek	2,701	4	9	2,714
Innisfil Creeks	8,901	31	172	9,103
Lovers Creek	6,162	216	40	6,418
Maskinonge River	2,178	278	787	3,243
Oro Creeks North	7,174	16	116	7,306
Oro Creeks South	1,705	15	43	1,762
Pefferlaw Brook	3,106	922	1,048	5,076
Ramara Creeks	2,149	13	31	2,194
Snake Island[a]	11			11
Talbot River	190	315	53	557
Thorah Island[a]	22			22
Uxbridge Brook	4,947	159	285	5,390
West Holland	12,706	718	2,663	16,087
Whites Creek	509	29	70	608
Lake Simcoe (waterbody) [a,b]	19			19
Watershed Total	**139,081**	**6,090**	**11,900**	**157,071**

Table notes:

a) No data was available on how much agricultural and other non-domestic water use occurs within these subwatersheds. It is not likely that any such use is occurring in Lake Simcoe (waterbody), however, it is possible there may be some minimal use in the other subwatersheds.

b) This subwatershed captures lake boundaries. Consequently, it is mostly open water, but also includes some near shore environments such as floating-leaved shallow aquatic, mixed shallow aquatic, submerged shallow aquatic, and others. It also captures some minimal amounts of terrestrial covers located on small islands.

Table A1-2. Support for plant cultivation provided by pollination, annual values by subwatershed

Subwatershed	Minimum		Maximum		Mid-Point
	($ thousands)	($ per ha)	($ thousands)	($ per ha)	($ per ha)
Upper Talbot River	980.4	226	2,274.7	525	376
Barrie Creeks	193.4	442	440.3	1,006	724
Beaver River	2,871.1	206	7,241.5	521	364
Black River	2,868.2	221	6,984.1	538	379
East Holland	1,558.0	227	3,970.8	577	402
Fox Island					
Georgina Creeks	275.5	203	720.9	532	368
Georgina Island	7.1	242	15.9	545	393
Hawkestone Creek	669.2	394	1,610.8	947	670
Hewitts Creek	231.5	326	599.9	844	585
Innisfil Creeks	1,326.1	338	3,364.8	857	598
Lovers Creek	651.8	328	1,683.4	846	587
Maskinonge River	767.2	221	2,016.6	580	400
Oro Creeks North	1,218.1	413	2,864.6	972	693
Oro Creeks South	699.5	352	1,757.5	884	618
Pefferlaw Brook	2,239.9	217	5,485.4	530	373
Ramara Creeks	2,198.2	351	5,430.5	867	609
Snake Island					
Talbot River	925.3	319	2,215.7	763	541
Thorah Island	12.2	235	27.4	530	382
Uxbridge Brook	1,300.3	208	3,260.9	522	365
West Holland	3,952.5	241	10,800.7	658	449
Whites Creek	929.9	210	2,291.0	518	364
Lake Simcoe (Waterbody)[a]					
Watershed Total	**25,875.3**	**251**	**65,057.2**	**630**	**440**

Table Notes:

a) This subwatershed captures lake boundaries. Consequently, it is mostly open water, but also includes some near shore environments such as floating-leaved shallow aquatic, mixed shallow aquatic, submerged shallow aquatic, and others. It also captures some minimal amounts of terrestrial covers located on small islands.

Table A1-3. Avoided human health care costs provided by gas regulation, annual values by subwatershed

Subwatershed	Forest Cover (CUP; CUW; FOC; FOD; FOM)		Swamp Cover (SWC; SWD; SWM)		Combined Total ($ thousands)
	Total ($ thousands)	Average ($/ha)	Total ($ thousands)	Average ($/ha)	
Upper Talbot River	49.4	7	11.9	2	61.2
Barrie Creeks	398.2	1,065	29.6	79	427.8
Beaver River	48.6	18	25.7	10	74.4
Black River	244.2	33	96.1	13	340.3
East Holland	1,469.5	378	184.7	48	1,654.1
Fox Island	0.0	2	0.0	0	0.0
Georgina Creeks	169.1	176	44.1	46	213.2
Georgina Island	2.6	13	4.0	20	6.6
Hawkestone Creek	18.2	13	4.2	3	22.4
Hewitts Creek	45.3	328	17.1	124	62.4
Innisfil Creeks	258.7	152	67.4	40	326.1
Lovers Creek	167.7	213	64.7	82	232.4
Maskinonge River	40.9	73	8.7	15	49.6
Oro Creeks North	289.1	149	39.9	21	329.0
Oro Creeks South	88.3	54	11.3	7	99.5
Pefferlaw Brook	124.1	21	42.1	7	166.2
Ramara Creeks	35.3	27	25.4	19	60.8
Snake Island	1.2	20	0.3	5	1.5
Talbot River	6.1	6	2.7	3	8.8
Thorah Island	0.8	9	0.6	6	1.4
Uxbridge Brook	180.3	60	42.7	14	223.0
West Holland	360.8	75	80.2	17	441.0
Whites Creek	9.6	11	7.4	9	17.0
Lake Simcoe (Waterbody)[a]	0.0	2	0.0	0	0.0
Watershed Total	**4,007.9**	**84**	**810.7**	**24**	**4,818.6**

Table Notes:

a) This subwatershed captures lake boundaries. Consequently, it is mostly open water, but also includes some near shore environments such as floating-leaved shallow aquatic, mixed shallow aquatic, submerged shallow aquatic, and others. It also captures some minimal amounts of terrestrial covers located on small islands.

Table A1-4. Habitat and refugia t annual values by subwatershed

Subwatershed	Number of Households[a]	Water ($ thousands)	Land ($ thousands)	Total ($ thousands)
Upper Talbot River	1,128	47.5	115.2	162.7
Barrie Creeks	27,189	1,146.0	2,776.1	3,922.1
Beaver River	3,440	145.0	351.2	496.2
Black River	6,973	293.9	712.0	1,005.9
East Holland	53,579	2,258.3	5,470.7	7,728.9
Fox Island	0	0.0	0.0	0.0
Georgina Creeks	5,396	227.4	551.0	778.4
Georgina Island	101	4.3	10.3	14.6
Hawkestone Creek	298	12.6	30.4	43.0
Hewitts Creek	3,060	129.0	312.4	441.4
Innisfil Creeks	10,083	425.0	1,029.5	1,454.5
Lovers Creek	6,981	294.2	712.8	1,007.0
Maskinonge River	2,467	104.0	251.9	355.9
Oro Creeks North	8,127	342.5	829.8	1,172.3
Oro Creeks South	1,931	81.4	197.2	278.6
Pefferlaw Brook	3,518	148.3	359.2	507.5
Ramara Creeks	2,435	102.6	248.6	351.3
Snake Island	13	0.5	1.3	1.9
Talbot River	215	9.1	22.0	31.0
Thorah Island	25	1.1	2.6	3.6
Uxbridge Brook	5,604	236.2	572.2	808.4
West Holland	14,394	606.7	1,469.7	2,076.4
Whites Creek	577	24.3	58.9	83.2
Lake Simcoe (Waterbody)[b]	21	0.9	2.1	3.0
Watershed Total	**157,555**	**6,640.7**	**16,087.1**	**22,727.8**

Table Notes:

a) Households are defined as Private Dwellings Occupied by Usual Residents, 2011
b) This subwatershed captures lake boundaries. Consequently, it is mostly open water, but also includes some near shore environments such as floating-leaved shallow aquatic, mixed shallow aquatic, submerged shallow aquatic, and others. It also captures some minimal amounts of terrestrial covers located on small islands.

Appendix 2: Water filtration: phosphorous loading

Some ecosystems provide water filtration functions by reducing the amount of nutrients and sediment that enter waterbodies. In this way, ecosystems help improve water quality and can reduce water treatment costs. In the case of Lake Simcoe, a waterbody that has exceeded its capacity to assimilate phosphorous, these ecosystem functions are very important. However, from an accounting perspective, these values ultimately manifest themselves in changes in recreation value or drinking water value. Given the existing limitations in available data, it is not clear the degree to which these values have or have not been captured in the main analysis of this report. Therefore, we present the value of avoided phosphorus loading here.

To estimate the value of water filtration for each ELC community type, values were obtained for rates of phosphorous loading. Loading rates measure the average amount (kilograms) of nutrients that run-off lands and are transferred to waterbodies within a watershed. Such rates can be significantly influenced by human activity. The greater the loading rate, the more nutrients are transferred. The value of water filtration can be measured in terms of the avoided cost of water treatment. Since all ecosystems generally provide some natural level of nutrient loading, estimates of the ecosystem service values must be based on the difference between ecosystem types. For the purposes of the current analysis, the value of water filtration provided by grassland, wetlands, forests, cropland, and pasture ecosystems was measured in relation to loading rates for three different development types (commercial, residential, and low impact development). Development was chosen as a baseline since loadings from developed land are driven by human activities. By comparing other land cover loading rates to developed land loading rates, a proxy value for these land covers can be generated. For example, avoiding the conversion of forested land to developed land also avoids an increased amount of nutrients and sediments reaching waterbodies in the area under consideration. The loading rates employed in the current analysis were drawn from research conducted within the Lake Simcoe watershed.[49,50]

Once the difference in average loading rates were calculated, an average phosphorous removal cost was applied, resulting in an estimate of avoided costs. A 2012 study in Wisconsin estimated the removal cost to be $29 per lbs (2012 USD) [51] or $69 per kg (2016 CAD).[52] As an example, the calculation works as follows. Taking the commercial development loading rate of 1.82 kg/ha/yr, less grassland loading of 0.13 kg/ha/yr, equals 1.69 kg/ha/yr of avoided loading, multiplied by $69 per kg equals $117 per ha per year (Upper Talbot River – Grassland cell of Table A2-1).

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[49] Ministry of the Environment. (2012). Phosphorus Budget Tool in Support of Sustainable Development for Lake Simcoe Watershed.

[50] Louis Berger Group, Inc. 2010. Estimation of the Phosphorus Loadings to Lake Simcoe.

[51] Wisconsin Department of Natural Resources (2012). Phosphorous Reduction in Water Bodies: An Economic Impact Analysis. http://dnr.wi.gov/topic/SurfaceWater/documents/PhosphorusReductionEIA.pdf

[52] In 2012, USD was roughly on par CAD (using an exchange rate of 0.997 CAD per USD) and inflating to 2017 results in an estimate of $68.83 CAD.

Table A2-1. Water filtration values ($/ha/yr) based on avoided conversion to commercial development

Subwatershed	Grassland	Wetland	Forest	Cropland	Pasture/Hay
Upper Talbot River	117	125	125	91	111
Barrie Creeks	124	NA	125	68	113
Beaver River	124	125	125	112	123
Black River	123	124	124	111	121
East Holland	118	122	122	101	118
Georgina Creeks	118	125	125	92	92
Hawkestone Creek	124	125	124	114	119
Hewitts Creek	119	NA	117	113	123
Innisfil Creeks	125	NA	125	107	123
Lovers Creek	123	124	123	115	121
Maskinonge River	125	NA	NA	116	122
Oro Creeks North	119	126	125	91	105
Oro Creeks South	119	126	125	91	105
Pefferlaw Brook	124	124	125	118	122
Ramara Creeks	125	NA	125	121	124
Talbot River	117	125	125	91	111
Uxbridge Brook	124	124	125	118	122
West Holland	125	NA	125	115	124
Whites Creek	121	122	122	112	119
Watershed Average	**122**	**124**	**124**	**105**	**117**

Table A2-2. Water filtration values ($/ha/yr) based on avoided conversion to residential development

Subwatershed	Grassland	Wetland	Forest	Cropland	Pasture/Hay
Upper Talbot River	82	91	90	57	77
Barrie Creeks	89	NA	91	33	79
Beaver River	89	90	90	78	88
Black River	89	90	89	77	87
East Holland	83	87	87	67	83
Georgina Creeks	83	91	90	57	57
Hawkestone Creek	89	90	90	80	85
Hewitts Creek	84	NA	83	79	88
Innisfil Creeks	90	NA	91	72	88
Lovers Creek	89	89	89	80	87
Maskinonge River	90	NA	NA	81	88
Oro Creeks North	84	91	91	56	70
Oro Creeks South	84	91	91	56	70
Pefferlaw Brook	89	90	90	84	88
Ramara Creeks	90	NA	91	87	90

Talbot River	82	91	90	57	77
Uxbridge Brook	89	90	90	84	88
West Holland	91	NA	91	81	89
Whites Creek	87	88	88	78	85
Watershed Average	**87**	**90**	**90**	**71**	**82**

Table A2-3. Water filtration values ($/ha/yr) based on avoided conversion to low impact development

Subwatershed	Grassland	Wetland	Forest	Cropland	Pasture/Hay
Upper Talbot River	0	9	8	-26	-6
Barrie Creeks	7	NA	9	-49	-3
Beaver River	7	8	8	-4	6
Black River	7	8	7	-6	4
East Holland	1	5	5	-16	1
Georgina Creeks	1	9	8	-25	-25
Hawkestone Creek	7	8	8	-2	3
Hewitts Creek	2	NA	1	-3	6
Innisfil Creeks	8	NA	9	-10	6
Lovers Creek	7	7	7	-2	4
Maskinonge River	8	NA	NA	-1	6
Oro Creeks North	2	9	9	-26	-12
Oro Creeks South	2	9	9	-26	-12
Pefferlaw Brook	7	8	8	2	6
Ramara Creeks	8	NA	9	5	8
Talbot River	0	9	8	-26	-6
Uxbridge Brook	7	8	8	2	6
West Holland	9	NA	9	-1	7
Whites Creek	4	6	5	-4	3
Watershed Average	**5**	**8**	**7**	**-11**	**0**

Table A2-4 provides a land cover to ELC community type summary. These groupings can be employed to apply the water filtration values to ELC community types.

Table A2-4. Applicable ELC community types for each land cover

Land Cover	ELC Community Types
Grassland	ALO; TPO; CUM; CUT; CUS
Wetland	SWC; SWM; SWD; SWT; FEO; FES; FET; BOS; BOT; MAM; MAS; SAS; SAM; SAF
Forest	FOC; FOM; FOD; CUP; CUW
Cropland	IAG
Pasture/Hay	NAG

Appendix 3: Municipal Land Cover – Ecosystem Service Value Matrices

This appendix provides summary matrices for each municipality within the Lake Simcoe watershed. Note, the values presented are based solely on the conditions within the watershed boundaries. Therefore, care should be taken when using these results as they may not be broadly applicable to the whole municipality, but rather the area of the municipality that is within the watershed boundaries.

Table A3-1. Ecosystem service value matrix for the Township of Brock (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	322	368			80	109	1,458
Coniferous Forest	FOC	4,267	322	368	18		102	109	5,186
Deciduous Forest	FOD	4,267	322	368	18		140	109	5,224
Mixed Forest	FOM	4,267	322	368	18		121	109	5,205
Tallgrass Prairie	TPO	579	322	368			80	109	1,458
Cultural Ecosites									
Cultural Meadow	CUM	4,267	322	368			80	109	5,146
Cultural Plantation	CUP	4,267	322	368	18		121	109	5,205
Cultural Savannah	CUS	579	322	368			80	109	1,458
Cultural Thicket	CUT	4,267	322	368			80	109	5,146
Cultural Woodland	CUW		322	368	18		121	109	938
Wetland Ecosites									
Shrub Bog	BOS		322	368		4,789	586	109	6,174
Treed Bog	BOT		322	368		2,015	586	109	3,400
Open Fen	FEO		322	368		3,195	586	109	4,580
Shrub Fen	FES		322	368		5,770	586	109	7,155
Treed Fen	FET		322	368		2,015	586	109	3,400
Meadow Marsh	MAM	2,446	322	368		4,205	1,289	109	8,739
Shallow Marsh	MAS	2,446	322	368		2,634	337	109	6,216
Coniferous Swamp	SWC	2,446	322	368	8	3,327	324	109	6,904
Deciduous Swamp	SWD	2,446	322	368	8	3,112	759	109	7,124
Mixed Swamp	SWM	2,446	322	368	8	2,862	324	109	6,439
Thicket Swamp	SWT	2,446	322	368		2,599	324	109	6,168
Aquatic Ecosites									
Open Water	OAO	923	322			3,152		88	4,485
Floating-leaved Shallow Aquatic	SAF		322			5,142	257	88	5,809
Mixed Shallow Aquatic	SAM		322			3,087	180	88	3,677
Submerged Shallow Aquatic	SAS		322			3,359	169	88	3,938
Other Land Covers									
Intensive Agriculture	IAG			368					368
Non-intensive Agriculture	NAG			368			80	109	557

Table A3-2. Ecosystem service value matrix for the Township of Oro-Medonte (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	72	664			80	109	1,504
Coniferous Forest	FOC	4,267	72	664	30		102	109	5,244
Deciduous Forest	FOD	4,267	72	664	30		140	109	5,282
Mixed Forest	FOM	4,267	72	664	30		121	109	5,263
Tallgrass Prairie	TPO	579	72	664			80	109	1,504
Cultural Ecosites									
Cultural Meadow	CUM	4,267	72	664			80	109	5,192
Cultural Plantation	CUP	4,267	72	664	30		121	109	5,263
Cultural Savannah	CUS	579	72	664			80	109	1,504
Cultural Thicket	CUT	4,267	72	664			80	109	5,192
Cultural Woodland	CUW		72	664	30		121	109	996
Wetland Ecosites									
Shrub Bog	BOS		72	664		4,789	586	109	6,220
Treed Bog	BOT		72	664		2,015	586	109	3,446
Open Fen	FEO		72	664		3,195	586	109	4,626
Shrub Fen	FES		72	664		5,770	586	109	7,201
Treed Fen	FET		72	664		2,015	586	109	3,446
Meadow Marsh	MAM	2,446	72	664		4,205	1,289	109	8,785
Shallow Marsh	MAS	2,446	72	664		2,634	337	109	6,262
Coniferous Swamp	SWC	2,446	72	664	13	3,327	324	109	6,955
Deciduous Swamp	SWD	2,446	72	664	13	3,112	759	109	7,175
Mixed Swamp	SWM	2,446	72	664	13	2,862	324	109	6,490
Thicket Swamp	SWT	2,446	72	664		2,599	324	109	6,214
Aquatic Ecosites									
Open Water	OAO	923	72			3,152		88	4,235
Floating-leaved Shallow Aquatic	SAF		72			5,142	257	88	5,559
Mixed Shallow Aquatic	SAM		72			3,087	180	88	3,427
Submerged Shallow Aquatic	SAS		72			3,359	169	88	3,688
Other Land Covers									
Intensive Agriculture	IAG			664					664
Non-intensive Agriculture	NAG			664			80	109	853

Table A3-3. Ecosystem service value matrix for the Town of Newmarket (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	42,833	375			80	109	43,976
Coniferous Forest	FOC	4,267	42,833	375	1,242		102	109	48,928
Deciduous Forest	FOD	4,267	42,833	375	1,242		140	109	48,966
Mixed Forest	FOM	4,267	42,833	375	1,242		121	109	48,947
Tallgrass Prairie	TPO	579	42,833	375			80	109	43,976
Cultural Ecosites									
Cultural Meadow	CUM	4,267	42,833	375			80	109	47,664
Cultural Plantation	CUP	4,267	42,833	375	1,242		121	109	48,947
Cultural Savannah	CUS	579	42,833	375			80	109	43,976
Cultural Thicket	CUT	4,267	42,833	375			80	109	47,664
Cultural Woodland	CUW		42,833	375	1,242		121	109	44,680
Wetland Ecosites									
Shrub Bog	BOS		42,833	375		4,789	586	109	48,692
Treed Bog	BOT		42,833	375		2,015	586	109	45,918
Open Fen	FEO		42,833	375		3,195	586	109	47,098
Shrub Fen	FES		42,833	375		5,770	586	109	49,673
Treed Fen	FET		42,833	375		2,015	586	109	45,918
Meadow Marsh	MAM	2,446	42,833	375		4,205	1,289	109	51,257
Shallow Marsh	MAS	2,446	42,833	375		2,634	337	109	48,734
Coniferous Swamp	SWC	2,446	42,833	375	528	3,327	324	109	49,942
Deciduous Swamp	SWD	2,446	42,833	375	528	3,112	759	109	50,162
Mixed Swamp	SWM	2,446	42,833	375	528	2,862	324	109	49,477
Thicket Swamp	SWT	2,446	42,833	375		2,599	324	109	48,686
Aquatic Ecosites									
Open Water	OAO	923	42,833			3,152		88	46,996
Floating-leaved Shallow Aquatic	SAF		42,833			5,142	257	88	48,320
Mixed Shallow Aquatic	SAM		42,833			3,087	180	88	46,188
Submerged Shallow Aquatic	SAS		42,833			3,359	169	88	46,449
Other Land Covers									
Intensive Agriculture	IAG			375					375
Non-intensive Agriculture	NAG			375			80	109	564

Table A3-4. Ecosystem service value matrix for the Town of East Gwillimbury (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	823	392			80	109	1,983
Coniferous Forest	FOC	4,267	823	392	57		102	109	5,750
Deciduous Forest	FOD	4,267	823	392	57		140	109	5,788
Mixed Forest	FOM	4,267	823	392	57		121	109	5,769
Tallgrass Prairie	TPO	579	823	392			80	109	1,983
Cultural Ecosites									
Cultural Meadow	CUM	4,267	823	392			80	109	5,671
Cultural Plantation	CUP	4,267	823	392	57		121	109	5,769
Cultural Savannah	CUS	579	823	392			80	109	1,983
Cultural Thicket	CUT	4,267	823	392			80	109	5,671
Cultural Woodland	CUW		823	392	57		121	109	1,502
Wetland Ecosites									
Shrub Bog	BOS		823	392		4,789	586	109	6,699
Treed Bog	BOT		823	392		2,015	586	109	3,925
Open Fen	FEO		823	392		3,195	586	109	5,105
Shrub Fen	FES		823	392		5,770	586	109	7,680
Treed Fen	FET		823	392		2,015	586	109	3,925
Meadow Marsh	MAM	2,446	823	392		4,205	1,289	109	9,264
Shallow Marsh	MAS	2,446	823	392		2,634	337	109	6,741
Coniferous Swamp	SWC	2,446	823	392	24	3,327	324	109	7,445
Deciduous Swamp	SWD	2,446	823	392	24	3,112	759	109	7,665
Mixed Swamp	SWM	2,446	823	392	24	2,862	324	109	6,980
Thicket Swamp	SWT	2,446	823	392		2,599	324	109	6,693
Aquatic Ecosites									
Open Water	OAO	923	823			3,152		88	4,986
Floating-leaved Shallow Aquatic	SAF		823			5,142	257	88	6,310
Mixed Shallow Aquatic	SAM		823			3,087	180	88	4,178
Submerged Shallow Aquatic	SAS		823			3,359	169	88	4,439
Other Land Covers									
Intensive Agriculture	IAG			392					392
Non-intensive Agriculture	NAG			392			80	109	581

Table A3-5. Ecosystem service value matrix for the Town of Aurora (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	11,332	379			80	109	12,479
Coniferous Forest	FOC	4,267	11,332	379	683		102	109	16,872
Deciduous Forest	FOD	4,267	11,332	379	683		140	109	16,910
Mixed Forest	FOM	4,267	11,332	379	683		121	109	16,891
Tallgrass Prairie	TPO	579	11,332	379			80	109	12,479
Cultural Ecosites									
Cultural Meadow	CUM	4,267	11,332	379			80	109	16,167
Cultural Plantation	CUP	4,267	11,332	379	683		121	109	16,891
Cultural Savannah	CUS	579	11,332	379			80	109	12,479
Cultural Thicket	CUT	4,267	11,332	379			80	109	16,167
Cultural Woodland	CUW		11,332	379	683		121	109	12,624
Wetland Ecosites									
Shrub Bog	BOS		11,332	379		4,789	586	109	17,195
Treed Bog	BOT		11,332	379		2,015	586	109	14,421
Open Fen	FEO		11,332	379		3,195	586	109	15,601
Shrub Fen	FES		11,332	379		5,770	586	109	18,176
Treed Fen	FET		11,332	379		2,015	586	109	14,421
Meadow Marsh	MAM	2,446	11,332	379		4,205	1,289	109	19,760
Shallow Marsh	MAS	2,446	11,332	379		2,634	337	109	17,237
Coniferous Swamp	SWC	2,446	11,332	379	290	3,327	324	109	18,207
Deciduous Swamp	SWD	2,446	11,332	379	290	3,112	759	109	18,427
Mixed Swamp	SWM	2,446	11,332	379	290	2,862	324	109	17,742
Thicket Swamp	SWT	2,446	11,332	379		2,599	324	109	17,189
Aquatic Ecosites									
Open Water	OAO	923	11,332			3,152		88	15,495
Floating-leaved Shallow Aquatic	SAF		11,332			5,142	257	88	16,819
Mixed Shallow Aquatic	SAM		11,332			3,087	180	88	14,687
Submerged Shallow Aquatic	SAS		11,332			3,359	169	88	14,948
Other Land Covers									
Intensive Agriculture	IAG			379					379
Non-intensive Agriculture	NAG			379			80	109	568

Table A3-6. Ecosystem service value matrix for the Town of New Tecumseth (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	433	608			80	109	1,809
Coniferous Forest	FOC	4,267	433	608	23		102	109	5,542
Deciduous Forest	FOD	4,267	433	608	23		140	109	5,580
Mixed Forest	FOM	4,267	433	608	23		121	109	5,561
Tallgrass Prairie	TPO	579	433	608			80	109	1,809
Cultural Ecosites									
Cultural Meadow	CUM	4,267	433	608			80	109	5,497
Cultural Plantation	CUP	4,267	433	608	23		121	109	5,561
Cultural Savannah	CUS	579	433	608			80	109	1,809
Cultural Thicket	CUT	4,267	433	608			80	109	5,497
Cultural Woodland	CUW		433	608	23		121	109	1,294
Wetland Ecosites									
Shrub Bog	BOS		433	608		4,789	586	109	6,525
Treed Bog	BOT		433	608		2,015	586	109	3,751
Open Fen	FEO		433	608		3,195	586	109	4,931
Shrub Fen	FES		433	608		5,770	586	109	7,506
Treed Fen	FET		433	608		2,015	586	109	3,751
Meadow Marsh	MAM	2,446	433	608		4,205	1,289	109	9,090
Shallow Marsh	MAS	2,446	433	608		2,634	337	109	6,567
Coniferous Swamp	SWC	2,446	433	608	10	3,327	324	109	7,257
Deciduous Swamp	SWD	2,446	433	608	10	3,112	759	109	7,477
Mixed Swamp	SWM	2,446	433	608	10	2,862	324	109	6,792
Thicket Swamp	SWT	2,446	433	608		2,599	324	109	6,519
Aquatic Ecosites									
Open Water	OAO	923	433			3,152		88	4,596
Floating-leaved Shallow Aquatic	SAF		433			5,142	257	88	5,920
Mixed Shallow Aquatic	SAM		433			3,087	180	88	3,788
Submerged Shallow Aquatic	SAS		433			3,359	169	88	4,049
Other Land Covers									
Intensive Agriculture	IAG			608					608
Non-intensive Agriculture	NAG			608			80	109	797

Table A3-7. Ecosystem service value matrix for the City of Orillia (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	12,180	684			80	109	13,632
Coniferous Forest	FOC	4,267	12,180	684	621		102	109	17,963
Deciduous Forest	FOD	4,267	12,180	684	621		140	109	18,001
Mixed Forest	FOM	4,267	12,180	684	621		121	109	17,982
Tallgrass Prairie	TPO	579	12,180	684			80	109	13,632
Cultural Ecosites									
Cultural Meadow	CUM	4,267	12,180	684			80	109	17,320
Cultural Plantation	CUP	4,267	12,180	684	621		121	109	17,982
Cultural Savannah	CUS	579	12,180	684			80	109	13,632
Cultural Thicket	CUT	4,267	12,180	684			80	109	17,320
Cultural Woodland	CUW		12,180	684	621		121	109	13,715
Wetland Ecosites									
Shrub Bog	BOS		12,180	684		4,789	586	109	18,348
Treed Bog	BOT		12,180	684		2,015	586	109	15,574
Open Fen	FEO		12,180	684		3,195	586	109	16,754
Shrub Fen	FES		12,180	684		5,770	586	109	19,329
Treed Fen	FET		12,180	684		2,015	586	109	15,574
Meadow Marsh	MAM	2,446	12,180	684		4,205	1,289	109	20,913
Shallow Marsh	MAS	2,446	12,180	684		2,634	337	109	18,390
Coniferous Swamp	SWC	2,446	12,180	684	264	3,327	324	109	19,334
Deciduous Swamp	SWD	2,446	12,180	684	264	3,112	759	109	19,554
Mixed Swamp	SWM	2,446	12,180	684	264	2,862	324	109	18,869
Thicket Swamp	SWT	2,446	12,180	684		2,599	324	109	18,342
Aquatic Ecosites									
Open Water	OAO	923	12,180			3,152		88	16,343
Floating-leaved Shallow Aquatic	SAF		12,180			5,142	257	88	17,667
Mixed Shallow Aquatic	SAM		12,180			3,087	180	88	15,535
Submerged Shallow Aquatic	SAS		12,180			3,359	169	88	15,796
Other Land Covers									
Intensive Agriculture	IAG			684					684
Non-intensive Agriculture	NAG			684			80	109	873

Table A3-8. Ecosystem service value matrix for the Town of Innisfil (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	2,080	596			80	109	3,444
Coniferous Forest	FOC	4,267	2,080	596	121		102	109	7,275
Deciduous Forest	FOD	4,267	2,080	596	121		140	109	7,313
Mixed Forest	FOM	4,267	2,080	596	121		121	109	7,294
Tallgrass Prairie	TPO	579	2,080	596			80	109	3,444
Cultural Ecosites									
Cultural Meadow	CUM	4,267	2,080	596			80	109	7,132
Cultural Plantation	CUP	4,267	2,080	596	121		121	109	7,294
Cultural Savannah	CUS	579	2,080	596			80	109	3,444
Cultural Thicket	CUT	4,267	2,080	596			80	109	7,132
Cultural Woodland	CUW		2,080	596	121		121	109	3,027
Wetland Ecosites									
Shrub Bog	BOS		2,080	596		4,789	586	109	8,160
Treed Bog	BOT		2,080	596		2,015	586	109	5,386
Open Fen	FEO		2,080	596		3,195	586	109	6,566
Shrub Fen	FES		2,080	596		5,770	586	109	9,141
Treed Fen	FET		2,080	596		2,015	586	109	5,386
Meadow Marsh	MAM	2,446	2,080	596		4,205	1,289	109	10,725
Shallow Marsh	MAS	2,446	2,080	596		2,634	337	109	8,202
Coniferous Swamp	SWC	2,446	2,080	596	51	3,327	324	109	8,933
Deciduous Swamp	SWD	2,446	2,080	596	51	3,112	759	109	9,153
Mixed Swamp	SWM	2,446	2,080	596	51	2,862	324	109	8,468
Thicket Swamp	SWT	2,446	2,080	596		2,599	324	109	8,154
Aquatic Ecosites									
Open Water	OAO	923	2,080			3,152		88	6,243
Floating-leaved Shallow Aquatic	SAF		2,080			5,142	257	88	7,567
Mixed Shallow Aquatic	SAM		2,080			3,087	180	88	5,435
Submerged Shallow Aquatic	SAS		2,080			3,359	169	88	5,696
Other Land Covers									
Intensive Agriculture	IAG			596					596
Non-intensive Agriculture	NAG			596			80	109	785

Table A3-9. Ecosystem service value matrix for the Town of Whitchurch-Stouffville (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	596	377			80	109	1,741
Coniferous Forest	FOC	4,267	596	377	46		102	109	5,497
Deciduous Forest	FOD	4,267	596	377	46		140	109	5,535
Mixed Forest	FOM	4,267	596	377	46		121	109	5,516
Tallgrass Prairie	TPO	579	596	377			80	109	1,741
Cultural Ecosites									
Cultural Meadow	CUM	4,267	596	377			80	109	5,429
Cultural Plantation	CUP	4,267	596	377	46		121	109	5,516
Cultural Savannah	CUS	579	596	377			80	109	1,741
Cultural Thicket	CUT	4,267	596	377			80	109	5,429
Cultural Woodland	CUW		596	377	46		121	109	1,249
Wetland Ecosites									
Shrub Bog	BOS		596	377		4,789	586	109	6,457
Treed Bog	BOT		596	377		2,015	586	109	3,683
Open Fen	FEO		596	377		3,195	586	109	4,863
Shrub Fen	FES		596	377		5,770	586	109	7,438
Treed Fen	FET		596	377		2,015	586	109	3,683
Meadow Marsh	MAM	2,446	596	377		4,205	1,289	109	9,022
Shallow Marsh	MAS	2,446	596	377		2,634	337	109	6,499
Coniferous Swamp	SWC	2,446	596	377	19	3,327	324	109	7,198
Deciduous Swamp	SWD	2,446	596	377	19	3,112	759	109	7,418
Mixed Swamp	SWM	2,446	596	377	19	2,862	324	109	6,733
Thicket Swamp	SWT	2,446	596	377		2,599	324	109	6,451
Aquatic Ecosites									
Open Water	OAO	923	596			3,152		88	4,759
Floating-leaved Shallow Aquatic	SAF		596			5,142	257	88	6,083
Mixed Shallow Aquatic	SAM		596			3,087	180	88	3,951
Submerged Shallow Aquatic	SAS		596			3,359	169	88	4,212
Other Land Covers									
Intensive Agriculture	IAG			377					377
Non-intensive Agriculture	NAG			377			80	109	566

Table A3-10. Ecosystem service value matrix for the Town of Caledon (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	220	673			80	109	1,661
Coniferous Forest	FOC	4,267	220	673	25		102	109	5,396
Deciduous Forest	FOD	4,267	220	673	25		140	109	5,434
Mixed Forest	FOM	4,267	220	673	25		121	109	5,415
Tallgrass Prairie	TPO	579	220	673			80	109	1,661
Cultural Ecosites									
Cultural Meadow	CUM	4,267	220	673			80	109	5,349
Cultural Plantation	CUP	4,267	220	673	25		121	109	5,415
Cultural Savannah	CUS	579	220	673			80	109	1,661
Cultural Thicket	CUT	4,267	220	673			80	109	5,349
Cultural Woodland	CUW		220	673	25		121	109	1,148
Wetland Ecosites									
Shrub Bog	BOS		220	673		4,789	586	109	6,377
Treed Bog	BOT		220	673		2,015	586	109	3,603
Open Fen	FEO		220	673		3,195	586	109	4,783
Shrub Fen	FES		220	673		5,770	586	109	7,358
Treed Fen	FET		220	673		2,015	586	109	3,603
Meadow Marsh	MAM	2,446	220	673		4,205	1,289	109	8,942
Shallow Marsh	MAS	2,446	220	673		2,634	337	109	6,419
Coniferous Swamp	SWC	2,446	220	673	10	3,327	324	109	7,109
Deciduous Swamp	SWD	2,446	220	673	10	3,112	759	109	7,329
Mixed Swamp	SWM	2,446	220	673	10	2,862	324	109	6,644
Thicket Swamp	SWT	2,446	220	673		2,599	324	109	6,371
Aquatic Ecosites									
Open Water	OAO	923	220			3,152		88	4,383
Floating-leaved Shallow Aquatic	SAF		220			5,142	257	88	5,707
Mixed Shallow Aquatic	SAM		220			3,087	180	88	3,575
Submerged Shallow Aquatic	SAS		220			3,359	169	88	3,836
Other Land Covers									
Intensive Agriculture	IAG			673					673
Non-intensive Agriculture	NAG			673			80	109	862

Table A3-11. Ecosystem service value matrix for the Township of Scugog (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	175	367			80	109	1,310
Coniferous Forest	FOC	4,267	175	367	5		102	109	5,025
Deciduous Forest	FOD	4,267	175	367	5		140	109	5,063
Mixed Forest	FOM	4,267	175	367	5		121	109	5,044
Tallgrass Prairie	TPO	579	175	367			80	109	1,310
Cultural Ecosites									
Cultural Meadow	CUM	4,267	175	367			80	109	4,998
Cultural Plantation	CUP	4,267	175	367	5		121	109	5,044
Cultural Savannah	CUS	579	175	367			80	109	1,310
Cultural Thicket	CUT	4,267	175	367			80	109	4,998
Cultural Woodland	CUW		175	367	5		121	109	777
Wetland Ecosites									
Shrub Bog	BOS		175	367		4,789	586	109	6,026
Treed Bog	BOT		175	367		2,015	586	109	3,252
Open Fen	FEO		175	367		3,195	586	109	4,432
Shrub Fen	FES		175	367		5,770	586	109	7,007
Treed Fen	FET		175	367		2,015	586	109	3,252
Meadow Marsh	MAM	2,446	175	367		4,205	1,289	109	8,591
Shallow Marsh	MAS	2,446	175	367		2,634	337	109	6,068
Coniferous Swamp	SWC	2,446	175	367	2	3,327	324	109	6,750
Deciduous Swamp	SWD	2,446	175	367	2	3,112	759	109	6,970
Mixed Swamp	SWM	2,446	175	367	2	2,862	324	109	6,285
Thicket Swamp	SWT	2,446	175	367		2,599	324	109	6,020
Aquatic Ecosites									
Open Water	OAO	923	175			3,152		88	4,338
Floating-leaved Shallow Aquatic	SAF		175			5,142	257	88	5,662
Mixed Shallow Aquatic	SAM		175			3,087	180	88	3,530
Submerged Shallow Aquatic	SAS		175			3,359	169	88	3,791
Other Land Covers									
Intensive Agriculture	IAG			367					367
Non-intensive Agriculture	NAG			367			80	109	556

Table A3-12. Ecosystem service value matrix for the Township of King (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	626	359			80	109	1,753
Coniferous Forest	FOC	4,267	626	359	29		102	109	5,492
Deciduous Forest	FOD	4,267	626	359	29		140	109	5,530
Mixed Forest	FOM	4,267	626	359	29		121	109	5,511
Tallgrass Prairie	TPO	579	626	359			80	109	1,753
Cultural Ecosites									
Cultural Meadow	CUM	4,267	626	359			80	109	5,441
Cultural Plantation	CUP	4,267	626	359	29		121	109	5,511
Cultural Savannah	CUS	579	626	359			80	109	1,753
Cultural Thicket	CUT	4,267	626	359			80	109	5,441
Cultural Woodland	CUW		626	359	29		121	109	1,244
Wetland Ecosites									
Shrub Bog	BOS		626	359		4,789	586	109	6,469
Treed Bog	BOT		626	359		2,015	586	109	3,695
Open Fen	FEO		626	359		3,195	586	109	4,875
Shrub Fen	FES		626	359		5,770	586	109	7,450
Treed Fen	FET		626	359		2,015	586	109	3,695
Meadow Marsh	MAM	2,446	626	359		4,205	1,289	109	9,034
Shallow Marsh	MAS	2,446	626	359		2,634	337	109	6,511
Coniferous Swamp	SWC	2,446	626	359	12	3,327	324	109	7,203
Deciduous Swamp	SWD	2,446	626	359	12	3,112	759	109	7,423
Mixed Swamp	SWM	2,446	626	359	12	2,862	324	109	6,738
Thicket Swamp	SWT	2,446	626	359		2,599	324	109	6,463
Aquatic Ecosites									
Open Water	OAO	923	626			3,152		88	4,789
Floating-leaved Shallow Aquatic	SAF		626			5,142	257	88	6,113
Mixed Shallow Aquatic	SAM		626			3,087	180	88	3,981
Submerged Shallow Aquatic	SAS		626			3,359	169	88	4,242
Other Land Covers									
Intensive Agriculture	IAG			359					359
Non-intensive Agriculture	NAG			359			80	109	548

Table A3-13. Ecosystem service value matrix for the Town of Georgina (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	383	382			80	109	1,533
Coniferous Forest	FOC	4,267	383	382	93		102	109	5,336
Deciduous Forest	FOD	4,267	383	382	93		140	109	5,374
Mixed Forest	FOM	4,267	383	382	93		121	109	5,355
Tallgrass Prairie	TPO	579	383	382			80	109	1,533
Cultural Ecosites									
Cultural Meadow	CUM	4,267	383	382			80	109	5,221
Cultural Plantation	CUP	4,267	383	382	93		121	109	5,355
Cultural Savannah	CUS	579	383	382			80	109	1,533
Cultural Thicket	CUT	4,267	383	382			80	109	5,221
Cultural Woodland	CUW		383	382	93		121	109	1,088
Wetland Ecosites									
Shrub Bog	BOS		383	382		4,789	586	109	6,249
Treed Bog	BOT		383	382		2,015	586	109	3,475
Open Fen	FEO		383	382		3,195	586	109	4,655
Shrub Fen	FES		383	382		5,770	586	109	7,230
Treed Fen	FET		383	382		2,015	586	109	3,475
Meadow Marsh	MAM	2,446	383	382		4,205	1,289	109	8,814
Shallow Marsh	MAS	2,446	383	382		2,634	337	109	6,291
Coniferous Swamp	SWC	2,446	383	382	39	3,327	324	109	7,010
Deciduous Swamp	SWD	2,446	383	382	39	3,112	759	109	7,230
Mixed Swamp	SWM	2,446	383	382	39	2,862	324	109	6,545
Thicket Swamp	SWT	2,446	383	382		2,599	324	109	6,243
Aquatic Ecosites									
Open Water	OAO	923	383			3,152		88	4,546
Floating-leaved Shallow Aquatic	SAF		383			5,142	257	88	5,870
Mixed Shallow Aquatic	SAM		383			3,087	180	88	3,738
Submerged Shallow Aquatic	SAS		383			3,359	169	88	3,999
Other Land Covers									
Intensive Agriculture	IAG			382					382
Non-intensive Agriculture	NAG			382			80	109	571

Table A3-14. Ecosystem service value matrix for the Town of Bradford West Gwillimbury (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	2,461	526			80	109	3,755
Coniferous Forest	FOC	4,267	2,461	526	116		102	109	7,581
Deciduous Forest	FOD	4,267	2,461	526	116		140	109	7,619
Mixed Forest	FOM	4,267	2,461	526	116		121	109	7,600
Tallgrass Prairie	TPO	579	2,461	526			80	109	3,755
Cultural Ecosites									
Cultural Meadow	CUM	4,267	2,461	526			80	109	7,443
Cultural Plantation	CUP	4,267	2,461	526	116		121	109	7,600
Cultural Savannah	CUS	579	2,461	526			80	109	3,755
Cultural Thicket	CUT	4,267	2,461	526			80	109	7,443
Cultural Woodland	CUW		2,461	526	116		121	109	3,333
Wetland Ecosites									
Shrub Bog	BOS		2,461	526		4,789	586	109	8,471
Treed Bog	BOT		2,461	526		2,015	586	109	5,697
Open Fen	FEO		2,461	526		3,195	586	109	6,877
Shrub Fen	FES		2,461	526		5,770	586	109	9,452
Treed Fen	FET		2,461	526		2,015	586	109	5,697
Meadow Marsh	MAM	2,446	2,461	526		4,205	1,289	109	11,036
Shallow Marsh	MAS	2,446	2,461	526		2,634	337	109	8,513
Coniferous Swamp	SWC	2,446	2,461	526	49	3,327	324	109	9,242
Deciduous Swamp	SWD	2,446	2,461	526	49	3,112	759	109	9,462
Mixed Swamp	SWM	2,446	2,461	526	49	2,862	324	109	8,777
Thicket Swamp	SWT	2,446	2,461	526		2,599	324	109	8,465
Aquatic Ecosites									
Open Water	OAO	923	2,461			3,152		88	6,624
Floating-leaved Shallow Aquatic	SAF		2,461			5,142	257	88	7,948
Mixed Shallow Aquatic	SAM		2,461			3,087	180	88	5,816
Submerged Shallow Aquatic	SAS		2,461			3,359	169	88	6,077
Other Land Covers									
Intensive Agriculture	IAG			526					526
Non-intensive Agriculture	NAG			526			80	109	715

Table A3-15. Ecosystem service value matrix for the Township of Uxbridge (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	542	377			80	109	1,687
Coniferous Forest	FOC	4,267	542	377	36		102	109	5,433
Deciduous Forest	FOD	4,267	542	377	36		140	109	5,471
Mixed Forest	FOM	4,267	542	377	36		121	109	5,452
Tallgrass Prairie	TPO	579	542	377			80	109	1,687
Cultural Ecosites									
Cultural Meadow	CUM	4,267	542	377			80	109	5,375
Cultural Plantation	CUP	4,267	542	377	36		121	109	5,452
Cultural Savannah	CUS	579	542	377			80	109	1,687
Cultural Thicket	CUT	4,267	542	377			80	109	5,375
Cultural Woodland	CUW		542	377	36		121	109	1,185
Wetland Ecosites									
Shrub Bog	BOS		542	377		4,789	586	109	6,403
Treed Bog	BOT		542	377		2,015	586	109	3,629
Open Fen	FEO		542	377		3,195	586	109	4,809
Shrub Fen	FES		542	377		5,770	586	109	7,384
Treed Fen	FET		542	377		2,015	586	109	3,629
Meadow Marsh	MAM	2,446	542	377		4,205	1,289	109	8,968
Shallow Marsh	MAS	2,446	542	377		2,634	337	109	6,445
Coniferous Swamp	SWC	2,446	542	377	15	3,327	324	109	7,140
Deciduous Swamp	SWD	2,446	542	377	15	3,112	759	109	7,360
Mixed Swamp	SWM	2,446	542	377	15	2,862	324	109	6,675
Thicket Swamp	SWT	2,446	542	377		2,599	324	109	6,397
Aquatic Ecosites									
Open Water	OAO	923	542			3,152		88	4,705
Floating-leaved Shallow Aquatic	SAF		542			5,142	257	88	6,029
Mixed Shallow Aquatic	SAM		542			3,087	180	88	3,897
Submerged Shallow Aquatic	SAS		542			3,359	169	88	4,158
Other Land Covers									
Intensive Agriculture	IAG			377					377
Non-intensive Agriculture	NAG			377			80	109	566

Table A3-16. Ecosystem service value matrix for the Township of Ramara (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	446	616			80	109	1,830
Coniferous Forest	FOC	4,267	446	616	22		102	109	5,562
Deciduous Forest	FOD	4,267	446	616	22		140	109	5,600
Mixed Forest	FOM	4,267	446	616	22		121	109	5,581
Tallgrass Prairie	TPO	579	446	616			80	109	1,830
Cultural Ecosites									
Cultural Meadow	CUM	4,267	446	616			80	109	5,518
Cultural Plantation	CUP	4,267	446	616	22		121	109	5,581
Cultural Savannah	CUS	579	446	616			80	109	1,830
Cultural Thicket	CUT	4,267	446	616			80	109	5,518
Cultural Woodland	CUW		446	616	22		121	109	1,314
Wetland Ecosites									
Shrub Bog	BOS		446	616		4,789	586	109	6,546
Treed Bog	BOT		446	616		2,015	586	109	3,772
Open Fen	FEO		446	616		3,195	586	109	4,952
Shrub Fen	FES		446	616		5,770	586	109	7,527
Treed Fen	FET		446	616		2,015	586	109	3,772
Meadow Marsh	MAM	2,446	446	616		4,205	1,289	109	9,111
Shallow Marsh	MAS	2,446	446	616		2,634	337	109	6,588
Coniferous Swamp	SWC	2,446	446	616	9	3,327	324	109	7,277
Deciduous Swamp	SWD	2,446	446	616	9	3,112	759	109	7,497
Mixed Swamp	SWM	2,446	446	616	9	2,862	324	109	6,812
Thicket Swamp	SWT	2,446	446	616		2,599	324	109	6,540
Aquatic Ecosites									
Open Water	OAO	923	446			3,152		88	4,609
Floating-leaved Shallow Aquatic	SAF		446			5,142	257	88	5,933
Mixed Shallow Aquatic	SAM		446			3,087	180	88	3,801
Submerged Shallow Aquatic	SAS		446			3,359	169	88	4,062
Other Land Covers									
Intensive Agriculture	IAG			616					616
Non-intensive Agriculture	NAG			616			80	109	805

Table A3-17. Ecosystem service value matrix for the City of Barrie (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	12,445	622			80	109	13,835
Coniferous Forest	FOC	4,267	12,445	622	799		102	109	18,344
Deciduous Forest	FOD	4,267	12,445	622	799		140	109	18,382
Mixed Forest	FOM	4,267	12,445	622	799		121	109	18,363
Tallgrass Prairie	TPO	579	12,445	622			80	109	13,835
Cultural Ecosites									
Cultural Meadow	CUM	4,267	12,445	622			80	109	17,523
Cultural Plantation	CUP	4,267	12,445	622	799		121	109	18,363
Cultural Savannah	CUS	579	12,445	622			80	109	13,835
Cultural Thicket	CUT	4,267	12,445	622			80	109	17,523
Cultural Woodland	CUW		12,445	622	799		121	109	14,096
Wetland Ecosites									
Shrub Bog	BOS		12,445	622		4,789	586	109	18,551
Treed Bog	BOT		12,445	622		2,015	586	109	15,777
Open Fen	FEO		12,445	622		3,195	586	109	16,957
Shrub Fen	FES		12,445	622		5,770	586	109	19,532
Treed Fen	FET		12,445	622		2,015	586	109	15,777
Meadow Marsh	MAM	2,446	12,445	622		4,205	1,289	109	21,116
Shallow Marsh	MAS	2,446	12,445	622		2,634	337	109	18,593
Coniferous Swamp	SWC	2,446	12,445	622	339	3,327	324	109	19,612
Deciduous Swamp	SWD	2,446	12,445	622	339	3,112	759	109	19,832
Mixed Swamp	SWM	2,446	12,445	622	339	2,862	324	109	19,147
Thicket Swamp	SWT	2,446	12,445	622		2,599	324	109	18,545
Aquatic Ecosites									
Open Water	OAO	923	12,445			3,152		88	16,608
Floating-leaved Shallow Aquatic	SAF		12,445			5,142	257	88	17,932
Mixed Shallow Aquatic	SAM		12,445			3,087	180	88	15,800
Submerged Shallow Aquatic	SAS		12,445			3,359	169	88	16,061
Other Land Covers									
Intensive Agriculture	IAG			622					622
Non-intensive Agriculture	NAG			622			80	109	811

Table A3-18. Ecosystem service value matrix for the City of Kawartha Lakes (2016 CAD ($) per ha/year).

ELC Community Type	Code	Recreation	Water supply	Pollination	Gas regulation (clean air)	Disturbance avoidance	Carbon Sequestration	Habitat and refugia	Total
Terrestrial Ecosites									
Open Alvar	ALO	579	115	370			80	109	1,253
Coniferous Forest	FOC	4,267	115	370	9		102	109	4,972
Deciduous Forest	FOD	4,267	115	370	9		140	109	5,010
Mixed Forest	FOM	4,267	115	370	9		121	109	4,991
Tallgrass Prairie	TPO	579	115	370			80	109	1,253
Cultural Ecosites									
Cultural Meadow	CUM	4,267	115	370			80	109	4,941
Cultural Plantation	CUP	4,267	115	370	9		121	109	4,991
Cultural Savannah	CUS	579	115	370			80	109	1,253
Cultural Thicket	CUT	4,267	115	370			80	109	4,941
Cultural Woodland	CUW		115	370	9		121	109	724
Wetland Ecosites									
Shrub Bog	BOS		115	370		4,789	586	109	5,969
Treed Bog	BOT		115	370		2,015	586	109	3,195
Open Fen	FEO		115	370		3,195	586	109	4,375
Shrub Fen	FES		115	370		5,770	586	109	6,950
Treed Fen	FET		115	370		2,015	586	109	3,195
Meadow Marsh	MAM	2,446	115	370		4,205	1,289	109	8,534
Shallow Marsh	MAS	2,446	115	370		2,634	337	109	6,011
Coniferous Swamp	SWC	2,446	115	370	4	3,327	324	109	6,695
Deciduous Swamp	SWD	2,446	115	370	4	3,112	759	109	6,915
Mixed Swamp	SWM	2,446	115	370	4	2,862	324	109	6,230
Thicket Swamp	SWT	2,446	115	370		2,599	324	109	5,963
Aquatic Ecosites									
Open Water	OAO	923	115			3,152		88	4,278
Floating-leaved Shallow Aquatic	SAF		115			5,142	257	88	5,602
Mixed Shallow Aquatic	SAM		115			3,087	180	88	3,470
Submerged Shallow Aquatic	SAS		115			3,359	169	88	3,731
Other Land Covers									
Intensive Agriculture	IAG			370					370
Non-intensive Agriculture	NAG			370			80	109	559