Chapter 2: Watershed Characterization

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2 Watershed Characterization

2.1 Introduction

This chapter provides a brief background on the characteristics of the Lake Simcoe watershed, including the natural, human and physical features and their interactions. The chapter concludes by summarizing drinking water systems in the Lake Simcoe watershed, as a prelude to the more in-depth assessment presented in Chapters 6 to 13. Watershed characteristics related to hydrologic and hydrogeologic conditions are presented in the following chapter (Chapter 3; Conceptual Water Budget). Understanding the characteristics of the Lake Simcoe watershed is essential in understanding how quality and quantity of drinking water is affected by both human and natural interactions.

The large geography covered by the Lake Simcoe watershed is quite diverse in terms of population density, economy, and land use. Human characteristics across the watershed vary from the densely populated urban centers of Barrie, Aurora and Newmarket to the west and south, to the prominent agricultural communities in most other areas. Despite over 400,000 people living in the watershed, natural heritage features are the largest single land use in the watershed, including large tracks of wetlands (e.g. in the Black River subwatershed) and woodlands.

The information presented in this chapter represents only a small fraction of information related to the Lake Simcoe watershed in numerous reports produced by the Lake Simcoe Region Conservation Authority (e.g. LSRCA 2007, 2004), and as such readers are directed to these reports for a more detailed assessment. Furthermore, Part II of the MOE[1] Assessment Report Technical Rules (MOE, 2008a) clearly states what information is required in this chapter, where the information is available. This chapter includes all of the information required by the Technical Rules.

In general, watershed characterization, and the conceptual water budget provided in the following chapter, is described as a 'drinking water focused' watershed plan, comprised of five main components as ~~outlined in the schematic~~listed below. It must be noted however, that the information provided in this watershed characterization is not used to determine Issues and Threats to specific municipal drinking water systems – see the municipal vulnerability and threats chapters (Chapters 6-13) for details on individual drinking water systems.

[1] Now, the Ministry of the Environment, Conservation and Parks (MECP)

Characterization

The five main components are:

1. **Watershed Boundaries**

   Delineates the area within the watershed, encompassing both the natural and human features

2. **Water Budget**

   Describes the movement of water through the hydrologic cycle and quantifies the amount of water flowing through the Source Protection Region

3. **Physical Geography**

   Describes the natural features in the watershed, how they have changed over time and the interactions that occur

4. **Drinking Water Systems**

   Details the location and population served by municipal and non-municipal wells, as well as the pumping rates

5. **Natural Geography and Ecology**

   Depicts the flora and fauna present within the watershed, highlighting important details, such as the current status of habitats

2.2 Watershed and Subwatershed Boundaries

The Lake Simcoe watershed is one of four watersheds with the South Georgian Bay- Lake Simcoe Source Protection Region. The three other watersheds within the Source Protection Region include the Nottawasaga Valley, the Severn Sound and the Black-Severn River watersheds (Figure 2-1; figures are located at the end of the chapter). The Lake Simcoe watershed has a total land and water surface area of 3,324 km^2, of which the lake occupies about 20 percent or 723~~2~~ km^2. The land portion of the watershed is approximately 2,600 km^2 and is drained by 35 tributary rivers, with five major tributaries accounting for more than 60 percent of the total drainage area. The Lake Simcoe watershed has been divided into 18 subwatersheds, or hydrological units (excluding Lake Simcoe Islands), each drained by one or more tributaries (Figure 2-2). The subwatersheds range in size from tens to hundreds of square kilometres and also cross political boundaries. Table 2-1 provides the drainage areas of the subwatersheds. The largest unit is the Black River subwatershed at 375 km^2. It is found within the regional municipalities of York and Durham and four local municipalities, including Georgina, Uxbridge, East Gwillimbury and Whitchurch-Stouffville.

Table 2-1: Drainage Area of subwatersheds in the Lake Simcoe Watershed (Data Source: LSRCA).

Subwatershed	Drainage Area (km^2)
Barrie Creeks	37.53
Beaver River	327.25
Black River	375.36
East Holland River	247.15
Georgina Creeks	49.33
Hawkestone Creek	47.84
Hewitt's Creek	17.52
Innisfil Creeks	107.15
Lovers Creek	59.95
Maskinonge River	63.47
Oro Creeks North	75.26
Oro Creeks South	57.39
Pefferlaw Brook	284.90
Ramara Creeks	143.51
Talbot River	70.51
Uxbridge Brook	161.34
West Holland River	351.93
Whites Creek	105.05
Lake Simcoe Islands	18.87
Lake Simcoe	722.78
Total	3,324.08

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2.3 Physical and Natural Geography

2.3.1 Natural Vegetation – wetlands, woodlands and riparian areas.

Natural vegetated areas within the Lake Simcoe watershed have been mapped using the Ecological Land Classification (ELC) approach (Lee et al., 1998). The goal of ELC is to establish a uniform and consistent method for identifying, describing, naming, mapping and organizing landscape patterns and vegetation communities. All natural heritage features have been classified to the Community Series level[2]. The Community Series level is determined by the type

[2] Community Series are the lowest (resolution) level in the ELC that can be identified without a site visit.

of vegetation or plant form that characterizes the community[3]. ~~Some of the features have been classified to the more refined level of Ecosite[4] in the ELC System.~~ These classifications involved delineating the natural heritage features into polygons, based on similar broad level vegetation communities. Data is updated on an ongoing basis as field checks are completed by natural heritage ecologists, and on a project basis.

Overall, 1,724 km^2 of the Lake Simcoe watershed is classified as natural heritage features (NHF), or approximately 44~~52~~% of the total area (Figure 2-3). Coverage of natural heritage features in the Lake Simcoe watershed is outlined below in Table 2-2. The percentage of natural vegetative cover within each subwatershed varies from as low as 17% within the Barrie subwatershed, to 57% within the Hawkestone Creek subwatershed; Georgina Island has the highest coverage at 92%. Wetlands, including swamps, bogs and marsh occupy approximately 13% of the Lake Simcoe watershed. They are scattered throughout the watershed, with the highest concentrations to the northeast and to the south of Lake Simcoe in Black, Holland, Pefferlaw, and Beaver subwatersheds. The watershed is noted for having one of the highest concentrations of large wetlands off the Canadian Shield, in southern Ontario.

Woodland cover percentage is lowest in the Beaver River subwatershed (8%) and highest on one of the Lake Simcoe Islands (Fox Island) with approximately 67%. Woodlands reduce the speed of overland water flow and erosion, increase evapotranspiration, intercept rainfall, and increase water infiltration to shallow groundwater areas.

Both wetlands and woodlands fall into the 30 metre riparian area recommended for watercourses. Vegetated riparian areas control erosion from overland flow, limit the sedimentation of surface waters, and reduce the concentrations of nutrients, pesticides and some pathogens entering the watercourse. While there are many benefits of reduced contamination to the aquatic ecosystems, the reduction is also important for ensuring quality drinking water. Just over 138 km^2 is listed as riparian area in the Lake Simcoe watershed. This means that 8% of the natural heritage features listed in Table 2-2 is within the 30 m buffer. The Hawkestone Creek subwatershed had the highest amount (80%) of NHF within riparian area and the Barrie Creek subwatershed has the lowest with 33%.

[3] The data was digitized "heads up" using 2002 colour 20 cm, 2005 colour 20 cm, 2007 colour 20 cm, and 2007 10 cm orthorectified air photo at a scale of 1:4,000. Further refinements have been accomplished through field and windshield surveys throughout the watershed.

[4] ~~An Ecosite 'level' is a finer detailed level of ELC that incorporates a consistent set of environmental factors and vegetation characteristics (Lee *et al.*, 1998)~~

Table 2-2: Natural Heritage Community Types within the Lake Simcoe Watershed (Data Source: LSRCA).

Community Type	Total Area (km²)	% of Watershed Area	% of NHF
Meadow Marsh	26.4817.54	0.9253	2.061.02
Mixed Shallow Aquatic	3.107.81	0.1123	0.2445
Floating-leaved Shallow Aquatic	0.611.91	0.026	0.0511
Mixed Swamp	151.67104.97	5.253.16	11.836.09
Open Fen	2.4992	0.09	0.197
Shallow Marsh	36.0629.90	1.250.90	2.811.73
Shrub Bog	0.4352	0.012	0.03
Shrub Fen	1.47	0.054	0.1109
Shrub Alvar	18.34	0.63	1.43
Submerged Shallow	8.136	0.285	0.6347
Thicket Swamp	84.4685.86	2.9258	6.594.98
Coniferous Swamp	64.6836.63	2.241.10	5.042.13
Deciduous Swamp	143.27128.09	4.963.85	11.177.43
Treed Bog	0.2849	0.01	0.023
Treed Fen	0.1302	0.00	0.010
Coniferous Forest	63.9243.82	2.211.32	4.982.54
Cultural Plantation	60.7152.67	2.101.58	4.733.06
Cultural Woodland	86.7539.96	3.001.20	6.762.32
Deciduous Forest	169.6844	5.8710	13.239.83
Mixed Forest	141.50132.87	4.9000	11.037.71
Cultural Meadow	116.0075.47	4.012.27	9.044.38
Cultural Savannah	5.300.24	0.1801	0.4101
Cultural Thicket	66.0561.27	2.291.84	5.153.55
Open Alvar	8.100.26	0.2801	0.6302
Open Tallgrass Prairie	0.03	0.00	0.00
Open Water	22.84721.37	0.7921.70	1.7841.85
Sand Barren	0.07	0.00	0.01
~~Natural Heritage Features within the 30m riparian area*~~	~~138.53~~	~~4.17~~	~~8.04~~
TOTALS:	1282.53**~~1,723.70~~**	44.39**~~51.85~~**	**100**

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~~*Note: the Natural Heritage Features within the 30 m Riparian area is not included in the TOTAL as it is not an additional "community type', but the area with natural heritage features that are within the 30 m riparian area of a watercourse.~~*This table does not include Lake Simcoe the waterbody as a natural heritage feature, or in the total watershed used for percentages.*

2.3.2 Surface Water Quality

The chemical, physical and microbiological characteristics of natural water make up an integrated index we define as "water quality". Water quality is a function of both natural processes and anthropogenic impacts. For example, natural processes such as weathering of minerals and various kinds of erosion are two actions that can affect the quality of surface water. There are also several types of anthropogenic influences, including point source and non-point sources of pollution. Point sources of pollution are specific, identifiable sources of contaminants to the surface water or groundwater system. Examples include municipal and industrial wastewater discharges, ruptured underground storage tanks, and landfills. Non-point sources are diffuse sources of pollution such as agricultural drainage, urban runoff, land clearing, construction activity or land application of waste that typically travel to waterways through surface runoff and infiltration. Contaminants delivered by point and non-point sources can travel in suspension and/or solution and are monitored by routine sampling of surface waters in the Lake Simcoe watershed.

Throughout the Lake Simcoe watershed there are 26~~12~~ Provincial Water Quality Monitoring Network Stations (Figure 2-4, Appendix WC-Table 1). Samples are collected 8 times a year on a monthly basis during the ice-free period. Each sample, analyzed for 32 chemical parameters in the Laboratory Services Branch of the Ministry of Environment, Conservation and Parks, is assessed using the Provincial Water Quality Objectives (PWQO) (Ministry of Environment, 1994). The goal of the PWQO is to protect and preserve aquatic life and to protect the recreational potential of surface waters within the province of Ontario. As the PWQMN is a regional scale, ambient program the information provided does not relate to any specific drinking water system - quality of surface water being used as a source for drinking water is presented in the Issues Evaluation sections of the municipal vulnerability and threats chapters (Chapters 6 to 13).

Meeting the PWQO is generally a minimum requirement, as one has to take into account the effects of multiple guideline exceedances, overall ecosystem health, and the protection of site-specific uses such as being a source of drinking water. In instances where a chemical parameter

is not included in the PWQO, the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG) is applied (Environment Canada, 2003).[5]

Analysis of data collected ~~between 2002 and 202~~2008 ~~2008~~ (Table 2-3) shows the percent of samples over a ten-year period (2011-2020) that exceeded the objectives for each parameter, as well as short- (2011-2020) and long-term trends (full period of record – varies by parameter). ~~shows the median concentration of total phosphorus is above the objective at nine of the twelve sites, with the exception of Beaver River, Lover's Creek and Hawkestone Creek. At some of the sites the median concentration of aluminum (6 sites), iron (4 sites) and total suspended solids (TSS; 1 site) also exceeded the objectives. Parameters were evaluated against their respective guideline or standard to determine the percent of exceedences that occurred.~~ Total phosphorus had the most ~~exceedences~~exceedances, with concentrations at only one ~~some~~ stations always meeting ~~being above~~ the PWQO. Despite the high ~~volume~~number of phosphorus exceedances, 11 sites are reporting declining long-term phosphorus trends. ~~Trends analysis (Seasonal Kendall test) of those sites with sufficient historical record was conducted for years 1965 through 2008 using the WQStat program. A general summary of the results is summarized in Table 2-3 below. This table shows that most parameters assessed have a decreasing trend with the exception of chloride and nitrate which have an increasing trend for 6 sites each.~~

Trend analysis over the short- and long-term show chloride~~–~~ is increasing across nearly every site with data to complete the trend analysis. Some percentage of samples exceeded the water quality objectives for chloride at 21 of 26 sites across a 10-year period. Of these 21 sites with exceedances, 10 sites exceeded the guideline in more than 50% of samples.

Nitrate water quality objectives were exceeded at least once across ten years in 15 of 26 sites, with two sites exceeding the guideline in more than 50% of samples. Across the watershed there is a mix of nitrate trends, with some sites reporting decreasing or stable nitrate~~d~~ trends, and other sites reporting increasing trends.

Only one site reported no exceedances for total suspended solids. None of the sites reported TSS exceedances more than 50% of the time. Most sites are fairly stable in their TSS samples

[5] The CWQG were developed by the Environmental Quality Branch of Environment Canada to protect aquatic species by establishing acceptable levels for substances that affect water quality and are based on toxicity data for the most sensitive species found in streams and lakes of Canada.

over the~~n~~ 10-year period between 2011 and 2020, while 6 sites show increasing long-term trends and three show decreasing long-term trends.

Table 2-3: Surface Water Quality Summary for the Lake Simcoe Watershed (Data Source: LSRCA).

Tributary	CHLORIDE	CHLORIDE	CHLORIDE	NITRATE	NITRATE	NITRATE
-	Percentage of samples > objective (210? mg/L)	Short-term trends	Long-term trends	Percentage of samples > objective (2.9 mg/L)	Short-term trends	Long-term trends
Atherley Narrows	0	Increasing	Increasing	0	No Trend	Increasing
Beaver River	1	Increasing	Increasing	2	No Trend	Increasing
Black River	6	Increasing	Increasing	0	Increasing	Increasing
Bluffs Creek	1	Increasing	Increasing	0	No Trend	No Trend
Bunkers Creek	96	n/a	n/a	52	n/a	n/a
East Holland River	89	Increasing	Increasing	0	Decreasing	Decreasing
Hawkestone Creek	0	Increasing	Increasing	0	Increasing	No Trend
Hewitts Creek	52	Increasing	Increasing	29	No Trend	No Trend
Hotchkiss Creek	92	No Trend	No Trend	1	No Trend	Decreasing
Kettleby Creek	1	Increasing	Increasing	0	No Trend	No Trend
Kidds Creek	86	n/a	n/a	59	n/a	n/a
Leonards Creek	8	Increasing	Increasing	3	Decreasing	No Trend
Lovers Creek	69	Increasing	Increasing	0	No Trend	No Trend
Maskinonge River	57	Increasing	Increasing	0	No Trend	Increasing
Mount Albert Creek	1	Increasing	Increasing	2	No Trend	Increasing
North Schomberg River	79	Increasing	Increasing	46	Decreasing	Decreasing
Pefferlaw River	0	Increasing	Increasing	0	Increasing	Increasing
Ramara Drain #1	1	No Trend	No Trend	0	No Trend	Decreasing
Sandy Cove Creek	4	n/a	n/a	8	n/a	n/a

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Tributary	CHLORIDE	CHLORIDE	CHLORIDE	NITRATE	NITRATE	NITRATE
-	Percentage of samples > objective (210? mg/L)	Short-term trends	Long-term trends	Percentage of samples > objective (2.9 mg/L)	Short-term trends	Long-term trends
Talbot River	0	No Trend	Decreasing	1	No Trend	No Trend
Tannery Creek	68	Increasing	Increasing	1	No Trend	Decreasing
Upper Schomberg River	3	No Trend	Increasing	1	Increasing	Decreasing
Uxbridge Brook	8	Increasing	Increasing	23	Increasing	Increasing
West Holland River @ Hwy 11	15	Increasing	Increasing	7	No Trend	Increasing
Western Creek	95	n/a	n/a	0	n/a	n/a
Whites Creek	0	No Trend	Increasing	4	Increasing	Increasing
Tributary	**TOTAL PHOSPHORUS**	**TOTAL PHOSPHORUS**	**TOTAL PHOSPHORUS**	**TOTAL SUSPENDED SOLIDS**	**TOTAL SUSPENDED SOLIDS**	**TOTAL SUSPENDED SOLIDS**
-	Percentage of samples > objective (0.003 mg/L)	Short-term trends	Long-term trends	Percentage of samples > objective (30 mg/L)	Short-term trends	Long-term trends
Atherley Narrows	0	No Trend	Decreasing	0	No Trend	No Trend
Beaver River	40	No Trend	Decreasing	7	No Trend	No Trend
Black River	75	No Trend	Increasing	1	Increasing	Increasing
Bluffs Creek	12	No Trend	No Trend	7	No Trend	No Trend
Bunkers Creek	62	n/a	n/a	27	n/a	n/a
East Holland River	99	No Trend	Decreasing	47	No Trend	No Trend
Hawkestone Creek	13	No Trend	No Trend	4	No Trend	No Trend
Hewitts Creek	51	No Trend	No Trend	14	No Trend	No Trend

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Tributary	CHLORIDE	CHLORIDE	CHLORIDE	NITRATE	NITRATE	NITRATE
-	Percentage of samples > objective (210? mg/L)	Short-term trends	Long-term trends	Percentage of samples > objective (2.9 mg/L)	Short-term trends	Long-term trends
Hotchkiss Creek	57	No Trend	No Trend	32	No Trend	Increasing
Kettleby Creek	44	No Trend	Decreasing	29	No Trend	No Trend
Kidds Creek	36	n/a	n/a	22	n/a	n/a
Leonards Creek	48	No Trend	Increasing	9	No Trend	No Trend
Lovers Creek	39	No Trend	Increasing	17	No Trend	Increasing
Maskinonge River	88	No Trend	Increasing	13	No Trend	Increasing
Mount Albert Creek	84	Decreasing	Decreasing	7	No Trend	No Trend
North Schomberg River	76	No Trend	Decreasing	33	No Trend	Increasing
Pefferlaw River	58	No Trend	Decreasing	5	No Trend	No Trend
Ramara Drain #1	36	No Trend	No Trend	8	No Trend	No Trend
Sandy Cove Creek	42	n/a	n/a	16	n/a	n/a
Talbot River	5	No Trend	Decreasing	1	No Trend	No Trend
Tannery Creek	77	Decreasing	Decreasing	35	Decreasing	Decreasing
Upper Schomberg River	82	No Trend	Decreasing	24	No Trend	Decreasing
Uxbridge Brook	53	Decreasing	No Trend	21	No Trend	Increasing
West Holland River @ Hwy 11	94	Decreasing	Decreasing	8	Decreasing	Decreasing
Western Creek	75	n/a	n/a	39	n/a	n/a
Whites Creek	34	No Trend	No Trend	3	No Trend	No Trend

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The Simcoe Muskoka District Health Unit monitors the *E. coli* levels in surfaces water at public beaches throughout the summer season. In the Lake Simcoe watershed this includes beaches in Barrie and Innisfil. The Provincial Water Quality Objective for *E. coli* is less than 100 *E. coli* per 100 ml sample. Figures 2-1 to 2-8 show the number of exceedances over time for 8 beaches in the area, as well as the percentage of samples that exceeded the standard each year.

Most of the beaches show increasing *E. coli* exceedances over time, especially in the last 5 years. Innisfil Beach North (54 exceedances, 83% of samples in exceedance), Centennial Park Beach, Barrie (46 exceedances, 58% of samples exceeded), Leonard's Beach, Innisfil (31 exceedances, 56% of samples exceeded), and Minet's Point Beach, Barrie (37 exceedances, 53% of samples exceeded) all reported greater than 50% of samples from the 2021 summer season as exceeding 100 *E. coli* per 100 ml. Six of the eight beaches also reported the highest percentage of exceedances in 2021 (the most recent sample year at the time of writing).

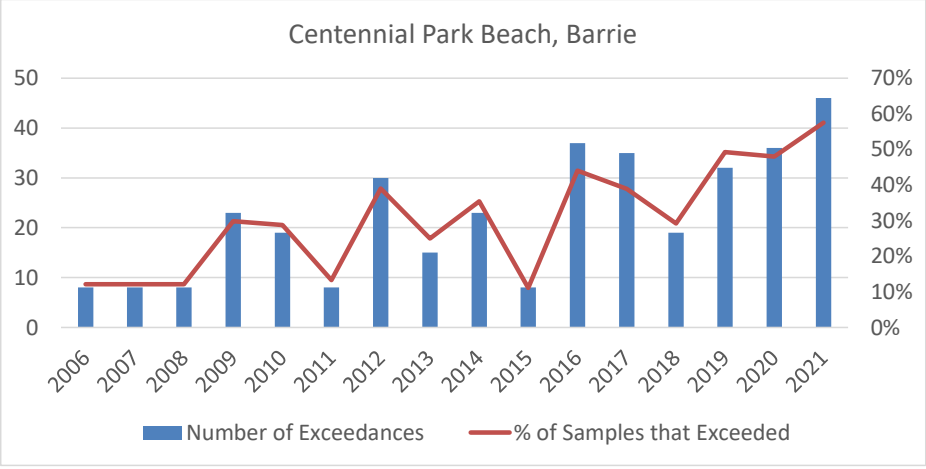

Figure 2a-1 Centennial Park Beach, Barrie: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

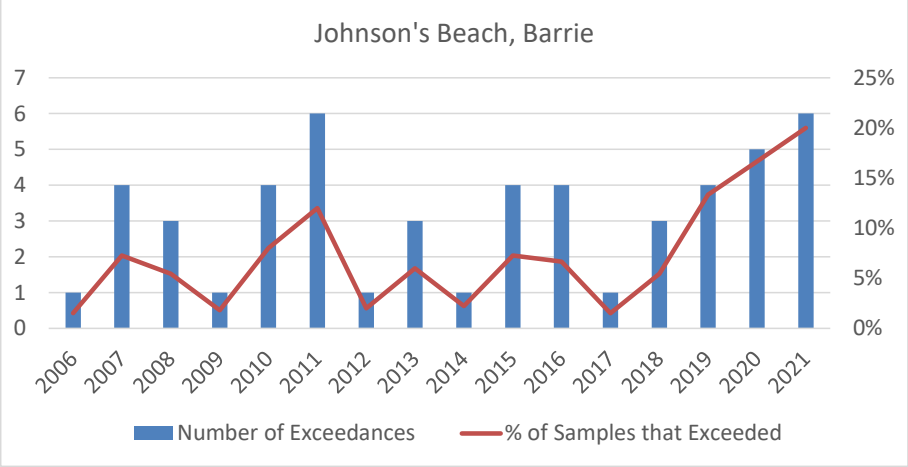

Figure 2a-2 Johnson's Beach, Barrie: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

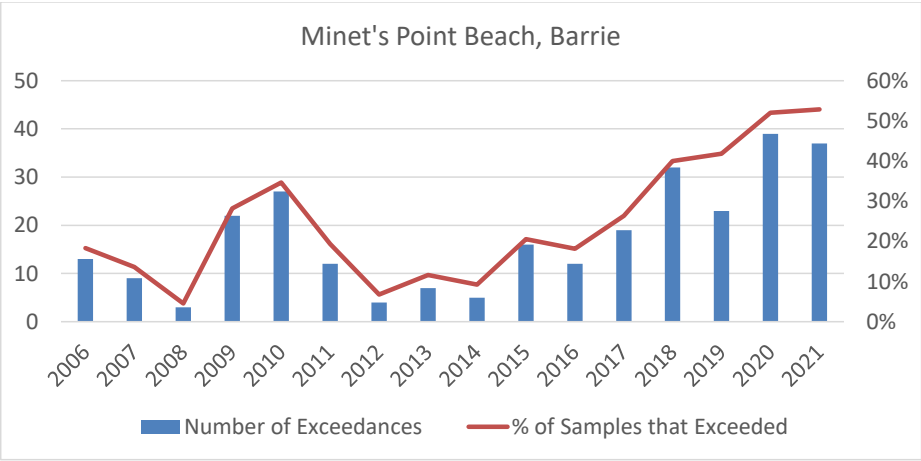

Figure 2a-3 Minet's Point Beach, Barrie: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

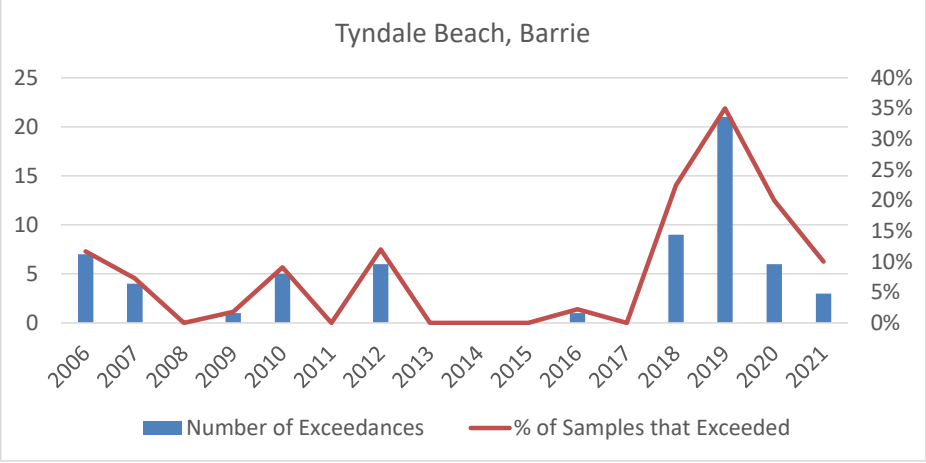

Figure 2a-4 Tyndale Beach, Barrie: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

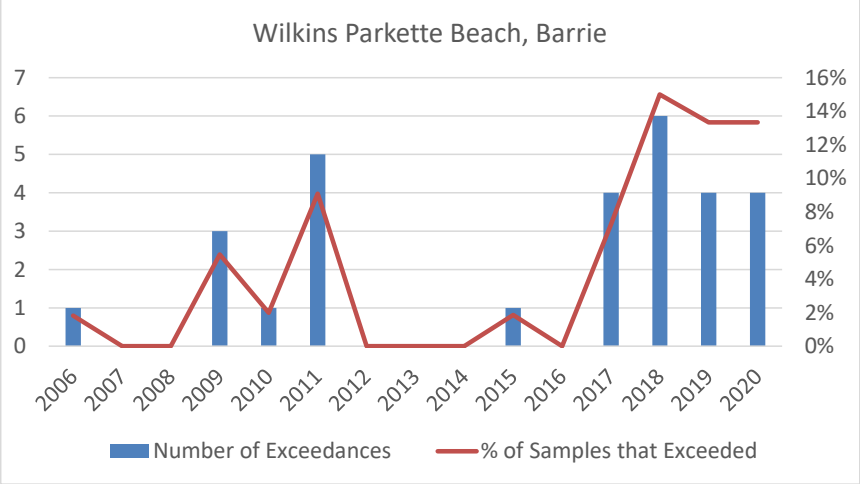

Figure 2a-5 Wilkins Parkette Beach, Barrie: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

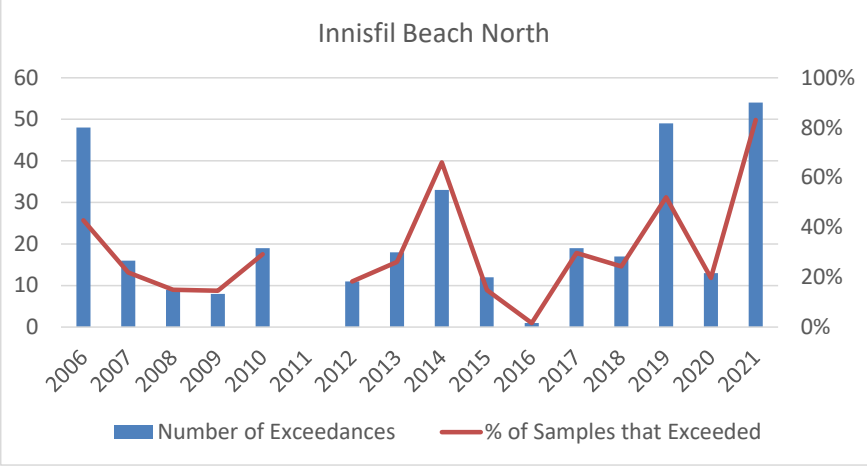

Figure 2a-6 Innisfil Beach North: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

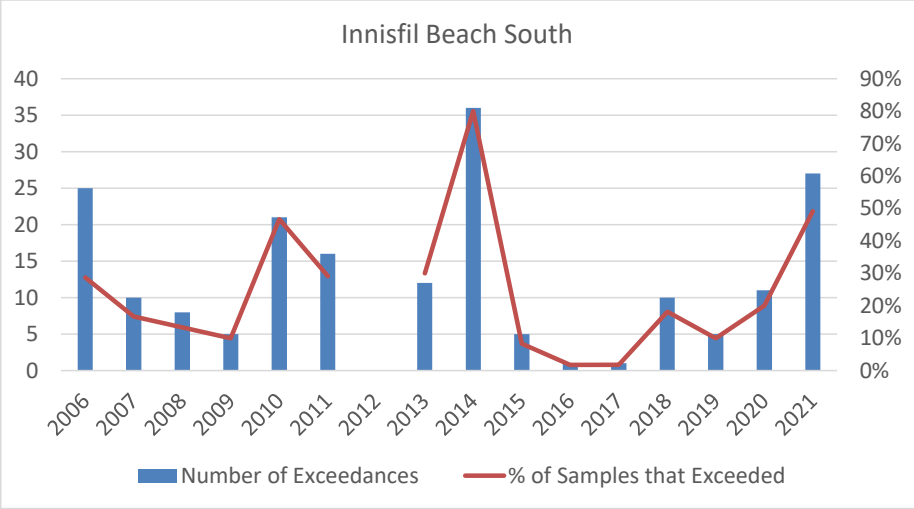

Figure 2a-7 Innisfil Beach South: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

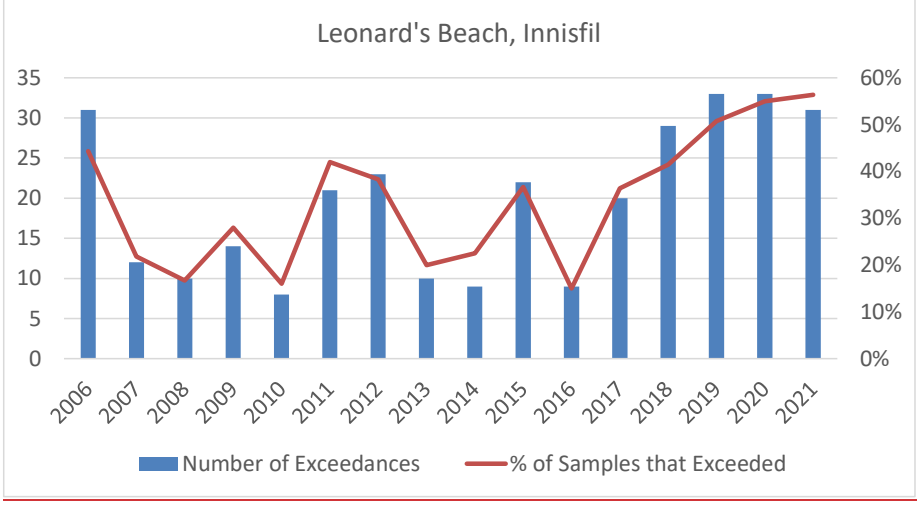

Figure 2a-8 Leonard's Beach, Innisfil: *E. Coli* Exceedances in Surface Water Samples (≥100 *E. coli* / 100 ml), 2006-2021.

2.3.3 Groundwater Quality

This assessment of groundwater quality is presented for the purpose of characterizing the Lake Simcoe watershed, and is based on the Provincial Groundwater Monitoring Network (PGMN). The PGMN was established to monitor ambient groundwater levels and quality to help set baseline conditions and assess how groundwater is affected by land use and water use. Monitoring helps identify trends and emerging issues, and provides a basis for making informed resource management decisions. It also helps measure the effectiveness of programs and policies that are designed to manage and protect the groundwater resource. As the PGMN is a regional scale, ambient program the information provided does not relate to any specific drinking water system – quality of groundwater being used as a source for drinking water is presented in the Issues Evaluation sections of the municipal vulnerability and threats chapters (Chapters 6 to 13).

Groundwater quality sampling at all of the 14 Provincial Groundwater Monitoring Network (PGMN) wells located within the watershed, was first conducted by LSRCA in 2004 (LSRCA, 2004; Figure 2-4, Appendix-WC Table 1). Each sample was analyzed for 41 chemical parameters including metals, nutrients and general chemistry. Analytical results were compared to the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQSOG).

The results shown in Table 2-4 are based on 5 samples taken over a ten-~~five~~ year period (2011~~04~~-2020~~08~~)~~, with the exception of Ramara (W0408) which only has 4 samples taken over a two year period (2007-2008).~~ To give a general overview of the groundwater quality, a selected number of parameters were chosen including: sodium, chloride, iron, aluminum, manganese, nitrite, nitrate and alkalinity. Of the 1~~3~~4 wells sampled, 5 did not exceed any of these parameters. Queensville (W0000025) exceeded the Ontario Drinking Water Standard for both sodium and chloride, while Baldwin BH1 (W0000298-2), Ramara (W0000408), and Sheppard's Bush (W0000283) exceed the sodium limit for individuals on low sodium diets (20mg/L).

Wells W0000298-2, W0000298-3~~, and~~ W0000~~58~~62, and W0000025 had high concentrations of iron and manganese, exceeding the aesthetic objectives (not health-related). W0000408 and W0000071 exceeded the aesthetic objective for iron but not manganese, while W0000065 exceeded for manganese but not iron. Aesthetic objectives, as those recommended for iron and manganese, are given for parameters that may impact the color, odour or taste of water. ~~A high concentration of aluminum (0.242 mg/l) was found in well W0283 exceeding the ODWQSOG operational guideline of 0.1 mg/L. Operational guidelines, as those recommended for aluminum, are given for parameters that could impair the efficiency of water treatment.~~

~~Well W025 yielded the highest concentrations of chloride (1000 mg/l, ODWQSOG limit 250 mg/l), sodium (400 mg/l, ODWQSOG limit 200 mg/l) and alkalinity (650mg/l, ODWQSOG limit 30-500 mg/l). As this well is a shallow well in a roadside ditch, winter salt spreading is the likely source of the exceedences. A higher than normal nitrite concentration was also detected at 0.11 mg/l. While this is lower than drinking water standard it is almost twice that of the Provincial Water Quality Objectives (PWQO) (0.06mg/L).~~

~~The only well to exceed the ODWQSOGs for nitrite was well W0283 with a concentration of 1.7mg/L, (ODWQSOG limit is 1mg/L). This particular well is located next to a parking lot and beside the Sheppard's Bush Conservation area, with subdivisions and developments nearby. There are also a number of manicured soccer fields in the area, one of which was replaced recently with Astroturf. It is likely that changes in land use or land use practices are resulting in the nitrite exceedence observed.~~

~~Guidelines~~Standards for nitrates and nitrites were not exceeded at any of the sites. Sheppard's Bush (W0000283) was the only well to exceed the Ontario Drinking Water Standard for alkalinity ($CaCO_3$).

Overall, the groundwater quality did show some ~~exceedences~~exceedances of the ODWQSOGs, mainly in iron and manganese (not health related), and only one well (W0000025) exceeding

the upper chloride limit and the sodium limit ~~and one well (W0283) exceeding nitrite levels~~. Concentrations levels are carefully monitored, ~~exceedences~~exceedances noted and appropriate actions are taken to determine the source and prevent contamination of drinking water. For information on the water quality of specific drinking water systems, see the Issues Evaluation in Chapters 6 to 13.

Table 2-4: PGMN Water Quality (20110~~04~~-200208~~)~~) (Data Source: LSRCA and PGMN/MECP).

Station	Stat.	Sodium (Na)	Chloride (Cl)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Nitrite (NO2)	Nitrate (NO3)	Alkalinity (CaCO3)
Ontario Drinking Water Standard	-	20-200 mg/L	250 mg/L	0.3 mg/L	0.1 mg/L	0.05 mg/L	1 mg/L	10 mg/L	30-500 mg/L
Baldwin BH1 (W0000298-2)	Min	47	3.5	1.89	0.004	0.083	0.002	0.014	250
Baldwin BH1 (W0000298-2)	Max	195	249	3.08	0.008	0.131	0.05	0.45	394
Baldwin BH1 (W0000298-2)	Median	79	113	2.45	0.005	0.108	0.005	0.072	280
Baldwin BH2 (W0000298-4)	Min	2.7	5	0.03	0.001	0.003	0.001	0.016	220
Baldwin BH2 (W0000298-4)	Max	18.7	9.7	0.06	0.001	0.004	0.05	0.55	240
Baldwin BH2 (W0000298-4)	Median	17.4	7.8	0.045	0.001	0.003	0.004	0.038	230
Baldwin BH3 (W0000298-3)	Min	12.8	13.9	1.92	0.001	0.073	0.003	0.015	212
Baldwin BH3 (W0000298-3)	Max	15.6	19.2	2.39	0.002	0.085	0.05	0.65	234
Baldwin BH3 (W0000298-3)	Median	14.2	16.3	2.27	0.001	0.078	0.006	0.037	230
Ballantrae (W0000071)	Min	2.5	0.8	0.23	0.001	0.01	0.002	0.01	149
Ballantrae (W0000071)	Max	3.2	9.3	0.51	0.086	0.025	0.05	0.49	178
Ballantrae (W0000071)	Median	2.6	1.1	0.34	0.002	0.011	0.009	0.038	160
Cannington (W0000062)	Min	2.8	0.8	0	0	0.003	0.002	0.013	280

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Station	Stat.	Sodium (Na)	Chloride (Cl)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Nitrite (NO2)	Nitrate (NO3)	Alkalinity (CaCO3)
Ontario Drinking Water Standard	-	20-200 mg/L	250 mg/L	0.3 mg/L	0.1 mg/L	0.05 mg/L	1 mg/L	10 mg/L	30-500 mg/L
Cannington (W0000062)	Max	3.7	137	0.45	0.001	0.071	0.057	0.543	340
Cannington (W0000062)	Median	3	2.9	0.13	0.001	0.014	0.01	0.09	311
Durham Forest BH1 (W0000039)	Min	2.2	1.8	0	0.001	0	0.001	0.177	166
Durham Forest BH1 (W0000039)	Max	3.2	2.7	0.03	0.029	0.003	0.05	0.544	215
Durham Forest BH1 (W0000039)	Median	2.6	2.1	0	0.001	0	0.002	0.229	208
Durham Forest BH4 (W0000032)	Min	2.1	2.7	0	0.001	0	0.001	0.31	141
Durham Forest BH4 (W0000032)	Max	2.6	4.6	0.13	0.002	0.041	0.05	0.568	193
Durham Forest BH4 (W0000032)	Median	2.4	3.1	0	0.001	0.005	0.004	0.467	160
Holland Landing (W0000063)	Min	2.5	44	0.02	0.001	0.249	0.01	0.008	173
Holland Landing (W0000063)	Max	14.5	132	0.05	0.001	0.44	0.05	0.45	225
Holland Landing (W0000063)	Median	3.9	92	0.04	0.001	0.354	0.012	0.09	187
Oro Pit BH1 (W0000293-2)	Min	1.9	2.2	0	0.001	0	0.002	0.09	129

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Station	Stat.	Sodium (Na)	Chloride (Cl)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Nitrite (NO2)	Nitrate (NO3)	Alkalinity (CaCO3)
Ontario Drinking Water Standard	-	20-200 mg/L	250 mg/L	0.3 mg/L	0.1 mg/L	0.05 mg/L	1 mg/L	10 mg/L	30-500 mg/L
Oro Pit BH1 (W0000293-2)	Max	4	11	0	0.002	0	0.01	3.718	237
Oro Pit BH1 (W0000293-2)	Median	2.2	7.4	0	0.002	0	0.005	0.36	160
Oro Pit BH2 (W0000293-3)	Min	3.8	5	0	0.001	0	0.001	0.45	178
Oro Pit BH2 (W0000293-3)	Max	5.6	7.9	0	0.001	0.002	0.05	0.915	280
Oro Pit BH2 (W0000293-3)	Median	4.3	6.5	0	0.001	0	0.003	0.693	221
Queensville (W0000025)	Min	224	621	0.07	0	0.043	0.004	0	170
Queensville (W0000025)	Max	362	1080	2.07	0.001	0.064	0.16	0.09	237
Queensville (W0000025)	Median	282	889	1.21	0.001	0.053	0.014	0.047	219
Ramara (W0000408)	Min	39	74	0.08	0	0.006	0.001	-0.44	265
Ramara (W0000408)	Max	49	122	0.38	0.001	0.017	0.441	0.45	319
Ramara (W0000408)	Median	44	95	0.17	0	0.01	0.004	0.037	300
Sheppards Bush (W0000283)	Min	33	1.8	0	0.01	0.003	0.01	-0.082	0.5
Sheppards Bush (W0000283)	Max	38	45	0.07	0.078	0.004	0.653	0.23	530
Sheppards Bush (W0000283)	Median	35	7.4	0.02	0.026	0.003	0.033	0.056	130

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~~Concentration exceeds limits for those on sodium-restricted diet (20 mg/L)~~
~~Concentration exceeds Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQSOGs)~~
~~^ Some samples were non-detectable (ND)~~

While not mentioned in the water quality sections above, there has been increased interest and concern of the levels of pharmaceuticals and personal care products accumulating in the environment through the movement of water (surface and ground) and what the possible impacts are on ecosystems and humans. Pharmaceuticals and Personal Care Products (PPCPs) are a group of chemicals commonly referred to as 'emerging contaminants' and 'contaminants of emerging concern'. The MECP~~OE~~ defines these terms as the presence of chemicals that were previously, or are currently, unknown, unrecognized and/or unregulated in the environment.

PPCP compounds are typically found where people use personal care products (such as their homes) or where people and animals are being treated medicinally (i.e. hospitals, veterinary clinics, etc). PPCP enter the environment through a number of channels including:

- residual pharmaceutical compounds which pass through the body into sewers;
- topical medications and personal care products that get washed off; and
- any products that are unused or expired and are improperly disposed of.

The result is these compounds are frequently found in water that is influenced by sewage (streams, rivers, ground water) and are appearing in some sources of drinking water.

~~Recently t~~The Ministry of the Environment, Conservation and Parks carried out a ~~study that~~study that involved the collection and analysis of over 250 water samples (both surface and ground) from 17 drinking water systems (full results can be found in *Survey of the Occurrence of Pharmaceuticals and Other Emerging Contaminants in Untreated Source and Finished Drinking Water in Ontario* (MOE, 2010b)). Samples were tested for 46 different pharmaceuticals, antibiotics, and hormones. Results showed that the concentration of these compounds was in the nanogram per litre (ng/L) or parts per trillium range (MOE, 2010b).

Currently there is no Canadian Drinking Water Quality Guidelines (CDWQG), Ontario Drinking Water Quality Standards (ODWQS) or Provincial Water Quality Objectives (PWQO) for pharmaceuticals, nor are there any standards in North America or Europe to go by. Since there is very little information and research on how PPCPs interact in the environment, the possible short- and long-term impacts they have on both ecosystems and humans are unknown. The Ministry of the ~~Environment has~~Environment, Conservation and Parks has conducted studies in the past that show that current drinking water treatments being used can reduce the amount of some pharmaceuticals and other contaminants of emerging concern in raw water (MOE, 2010b).

In terms of Source Water Protection, many activities that are potential sources of these compounds (e.g. sewage treatment plants, landfills) have been identified as prescribed Drinking Water Threats in the Region and may therefore be indirectly managed under the *Clean Water Act, 2006.* That being said, the current circumstances for identifying Significant Threats do not identify PCPPs as a potential hazardous chemicals and this is a shortcoming that may need to be addressed in the future as more information becomes available.

2.3.4 Aquatic Habitats – fisheries and macroinvertebrate communities

Habitat can be described as a place where an animal or plant normally lives, often characterized by a dominant plant form or physical characteristic. All living things have a number of basic requirements in their habitats including space, shelter, food, and reproduction. In an aquatic system, good water quality is an additional requirement. In a river system, water affects all of these habitat factors. Its movement and quantity affects the usability of the space in the channels, it can provide shelter and refuge by creating an area of calm in a deep pool, it carries small organisms, organic debris and sediments downstream which can provide food for many organisms and its currents incorporate air into the water column which provides oxygen for both living creatures and chemical processes in the water and sediments. Habitat features also frequently affect and are affected by other features and functions in a system. For instance, the materials comprising a channel bed can affect the amount of erosion that will take place over time; this in turn affects the channel shape and the flow dynamics of the water. The coarseness of the channel's bed load can also affect the suitability for fish habitat – some species require coarse, gravelly deposits for spawning substrates, while finer sediments in the shallow fringes of slow moving watercourses often support wetland plants that are required by other species. These ideal habitats are not always available to organisms and the aquatic communities throughout the watershed are slowly degrading due to the increased pressures of an expanding human population.

The communities impacted by anthropogenic factors tend to see a gradual and permanent change in the surrounding aquatic habitat. Normally, fish tend to be able to avoid getting diseases but, when faced with situations such as rising temperatures, murky waters and loss of habitat, they become stressed, making them susceptible to pathogens and diseases. Similarly, benthic invertebrates have a ranging tolerance to different conditions, but when these are exceeded they are unable to move to different habitats quickly, making them very vulnerable.

Degradation and loss of aquatic habitat can be attributed to numerous factors both within the watercourse and the surrounding subwatershed. Stressors to aquatic habitat include change in land use, discharge of pollutants (e.g. Wastewater treatment plants) and recreational activities. Impacts from recreational activities in these areas, for example, can include increased bank

erosion and instability, loss of riparian area resulting in an increase in input of total suspended solids (TSS) and pollution. Silt in the water can get trapped in the gills of fish and cause permanent damage. The sediment that settles on the bottom can cover the eggs of organisms, reducing the future population of a species, and can smother the benthic invertebrates living on the streambed.

Removal of riparian vegetation can also impact the communities living within watercourses. Not only does the vegetation act as a filter for debris and runoff, but shrubs and their roots provide shelter and shade to the organisms living in the water. When removed, species become vulnerable to predation and the watercourse can experience an increase in temperature. Increased water temperatures further stress the aquatic communities as this causes the levels of dissolved oxygen to decrease and forces species with specific temperature tolerance levels to leave the area, if capable of doing so. Warmer waters also provide new growth habitat for algae, further decreasing oxygen levels.

While having sites that are heavily degraded, municipalities, conservation authorities and nature groups in the Lake Simcoe watershed are continuously working towards improving and restoring streams and rivers to their historical conditions.

2.3.4.1 Fish Communities

Fish have very specific requirements for temperature regime, suspended sediment levels (turbidity), and nutrient levels. The subwatersheds of the Lake Simcoe watershed contain a variety of cold-water and warm-water species (Table 2-5, Figure 2-5), with approximately 75 fish species, and one species (redside dace) recorded on the Natural Heritage Information Centre (NHIC) species at risk database over the past 20 years.

2.3.4.1.1 Coldwater

Coldwater species are generally intolerant of increased temperatures, preferring a range between 10 and 18 degrees C. Cold temperatures are often maintained by groundwater discharge (i.e. baseflow which is the portion of stream flow supplied by groundwater discharge). If baseflow levels decline, the temperature of the watercourse will increase, encouraging warmwater species to replace the coldwater species. Coldwater species also require high levels of dissolved oxygen (which is in higher concentration in coldwater) and cannot tolerate high turbidity levels, as the suspended sediment clogs the gills and impairs the ability of the fish to breathe. Examples of coldwater species found within the Lake Simcoe watershed are brook trout (*Salvelinus fontinalis)* and rainbow smelt *(Osmerus mordax)*.

2.3.4.1.2 Warmwater

Warmwater fish species are more tolerant of higher temperatures, with most being able to tolerate temperatures up to 30 degrees C. As they are accustomed to higher temperatures, they do not require the high concentrations of dissolved oxygen that coldwater species do. Warmwater species can also survive in habitats with increased levels of suspended sediment and nutrient levels. Examples of warmwater species found within the Lake Simcoe watershed are largemouth bass (*Micropterus salmoides)* and brown bullhead *(Ameiurus nebulosus)*.

Table 2-5: Fish species caught in the Lake Simcoe watershed from 1955 to 2008 (Data Source: ~~O~~MNR, 2009).

Species	Scientific Name	Thermal Status
American Brook Lamprey	*Lethenteron appendix*	Coldwater
Lake Sturgeon*	*Acipenser fulvescens*	Coldwater
Longnose Gar	*Lepisosteus osseus*	Warmwater
Bowfin	*Amia calva*	Warmwater
Coho Salmon^	*Oncorhynchus kisutch*	Coldwater
Rainbow Trout^	*Oncorhynchus mykiss*	Coldwater
Brown Trout^	*Salmo trutta*	Coldwater
Brook Trout	*Salvelinus fontinalis*	Coldwater
Lake Trout	*Salvelinus namaycush*	Coldwater
Lake Whitefish	*Coregonus clupeaformis*	Coldwater
Lake Herring (Ciscoe)	*Coregonus artedi*	Coldwater
Rainbow Smelt^	*Osmerus mordax*	Coldwater
Northern Pike	*Esox lucius*	Coolwater
Muskellunge	*Esox masquinongy*	Warmwater
Central Mudminnow	*Umbra limi*	Warmwater
Quillback	*Carpiodes cyprinus*	Coolwater
Longnose Sucker	*Catostomus catostomus*	Coolwater
White Sucker	*Catostomus commersoni*	Coolwater
Northern Hog Sucker	*Hypentelium nigricans*	Coolwater
Greater Redhorse	*Moxostoma valenciennesi*	Coolwater
Goldfish^	*Carassius auratus*	Warmwater
Northern Redbelly Dace	*Phoxinus eos*	Warmwater
Finescale Dace	*Phoxinus neogaeus*	Warmwater
Redside Dace*	*Clinostomus elongatus*	Coolwater

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Species	Scientific Name	Thermal Status
Common Carp^	*Cyprinus carpio*	Warmwater
Brassy Minnow	*Hybognathus hankinsoni*	Warmwater
Hornyhead Chub	*Nocomis biguttatus*	Warmwater
River Chub	*Nocomis micropogon*	Warmwater
Golden Shiner	*Notemigonus crysoleucas*	Warmwater
Emerald Shiner	*Notropis atherinoides*	Coolwater
Common Shiner	*Luxilus cornutus*	Warmwater
Blackchin Shiner	*Notropis heterodon*	Warmwater
Blacknose Shiner	*Notropis heterolepis*	Warmwater
Spottail Shiner	*Notropis hudsonius*	Coolwater
Rosyface Shiner	*Notropis rubellus*	Warmwater
Spotfin Shiner	*Cyprinella spiloptera*	Warmwater
Sand Shiner	*Notropis stramineus*	Warmwater
Mimic Shiner	*Notropis volucellus*	Warmwater
Bluntnose Minnow	*Pimephales notatus*	Warmwater
Fathead Minnow	*Pimephales promelas*	Warmwater
Blacknose Dace	*Rhinichthys atratulus*	Warmwater
Longnose Dace	*Rhinichthys cataractae*	Warmwater
Creek Chub	*Semotilus atromaculatus*	Warmwater
Pearl Dace	*Margariseus margarita*	Warmwater
Central Stoneroller	*Campostoma anomalum*	Warmwater
Yellow Bullhead	*Ameiurus natalis*	Warmwater
Brown Bullhead	*Ameiurus nebulosus*	Warmwater
Channel Catfish	*Ictalurus punctatus*	Warmwater
Stonecat^	*Noturus flavus*	Warmwater
American Eel^	*Anguilla rostrata*	Warmwater
Banded Killifish	*Fundulus diaphanus*	Warmwater
Burbot	*Lota lota*	Coldwater
Brook Stickleback	*Culaea inconstans*	Warmwater
Trout-perch	*Percopsis omiscomaycus*	Warmwater
Rock Bass	*Ambloplites rupestris*	Warmwater
Green Sunfish^	*Lepomis cyanellus*	Warmwater
Pumpkinseed	*Lepomis gibbosus*	Warmwater
Bluegill^	*Lepomis macrochirus*	Warmwater

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Species	Scientific Name	Thermal Status
Smallmouth Bass	*Micropterus dolomieu*	Coolwater
Largemouth Bass	*Micropterus salmoides*	Warmwater
Black Crappie^	*Pomoxis nigromaculatus*	Warmwater
Yellow Perch	*Perca flavescens*	Warmwater
Walleye	*Sander vitreus*	Warmwater
Greenside Darter*^	*Etheostoma blennioides*	Warmwater
Rainbow Darter	*Etheostoma caeruleum*	Coolwater
Iowa Darter	*Etheostoma exile*	Warmwater
Least Darter^	*Etheostoma microperca*	Warmwater
Johnny Darter	*Etheostoma nigrum*	Warmwater
Logperch	*Percina caprodes*	Warmwater
Blackside Darter^	*Percina maculata*	Warmwater
Brook Silverside^	*Labidesthes sicculus*	Coolwater
Round Goby^	*Neogobius melanostomus*	Warmwater
Mottled Sculpin	*Cottus bairdi*	Coldwater
Slimy Sculpin	*Cottus cognatus*	Coldwater
Spoonhead Sculpin	*Cottus ricei*	Coldwater

** Species at Risk in Ontario*

^ Species is not native to the Lake Simcoe watershed

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Changes in water quality and aquatic habitat conditions can result in a shift in the aquatic community. One of the greatest stresses to aquatic habitat is urbanization. According to the Fish Habitat Mapping, an aquatic habitat is considered to be impaired if warmwater fish or no species are found at a site identified as a coldwater habitat. Fish communities were measured at 168 sites throughout the Lake Simcoe watershed from 2005 through 2007. Sampling was conducted using backpack Electro- Fishers following procedures outlined in the Stream Assessment Protocol for Southern Ontario Version 7 2005 (Stanfield 2005). As certain fish species are indicative of the thermal regime of a stream they are compared to the Fish Habitat Mapping to determine habitat impairment. The following table (Table 2-6) presents the 168 sites sampled from 2005 through to 2007. Of these sites, 63 were impaired (i.e. no fish present or warmwater species in a coldwater habitat) and the remaining 105 sites were either unimpaired or inconclusive. Location and types of aquatic habitat, based on water temperature are shown in Figure 2-5.

Table 2-6: Fish Communities in each thermal regime from 2005 through to 2007 (Source: LSRCA).

Fish Habitat	Fish Species Sampled	Warm water fish species	Coldwater fish species	None collected
Coldwater	Number of Sites	46	89	16
Warm water	Number of Sites	11	7	1

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2.3.4.2 Macroinvertebrate Communities

Aquatic insects, or benthic invertebrates, are an ideal indicator of water quality as different species have different tolerances to factors such as nutrient enrichment, dissolved solids, dissolved oxygen and temperature. Four major geographic groups of benthic communities have been identified in the Lake Simcoe watershed, these are: Oak Ridges and Oro Moraine Areas, Lowland Areas: Innisfil/Barrie Creeks and Subwatershed Outlet Areas. Benthics are defined as organisms living near or at the bottom of streams or lakes for at least part of their life cycle; including crayfish, leaches, clams, snails and the larval stages of insects. The presence or absence of certain species can be used to determine water quality at a given site. Table 2-7 summarizes the 2004-2007 results for benthic communities compared to temperature using the 2009 Ministry of Natural Resources/Conservation Authority Thermal Classification Layer. Benthic samples were collected using the Ontario Benthic Biomonitoring Network protocol (Jones, 2005). A total of 130 sites were sampled over the four year period. Their locations and condition of the aquatic invertebrates are shown in Figure 2-6. Of the 130 sites 62 were considered to be unimpaired, 50 were impaired and 18 were inconclusive.

Table 2-7: Benthic Communities in different thermal regimes from 2004 to 2007 (Data Source: LSRCA (2004-2007)).

Temperature	Unimpaired	Impaired	Inconclusive
Coldwater	59	39	15
Warm water	3	11	3

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2.4 Human Geography – population and land use

2.4.1 Population and Municipal Boundaries

Within the Lake Simcoe watershed, there are 22 municipal governments: four regions and counties, (Durham, Peel, Simcoe and York) and 18 local municipalities and separated cities (Figure 2-2). Population within the Lake Simcoe watershed during the 2001 census was estimated to be 382,887. This rose to 409,760 during the 2006 census. This represents an increase of 26,873 or 7% over a 5-year period. The most significant increases in population during the 5-year period occurred in the City of Barrie (24%) and the Towns of Newmarket (13%) and Aurora (18.6%). Population and population density of municipalities within the Lake Simcoe watershed are presented in Table 2-8 and Figure 2-7.

As many municipalities are only partially within the Source Water Protection Region, and Statistics Canada data was provided on a census consolidated subdivision (CCS) scale[6], it was necessary to estimate the actual municipal population within the SGBLS Source Protection Region using GIS[7]. This calculation used a combination of several datasets, including assessment parcel fabric, municipal population figures from Statistics Canada[8] and the Source Water Protection boundary. The approach involved allocating municipal populations through an area-weighted proportioning for the municipalities that are not entirely within the Source Protection Region. This is intended to be a preliminary estimation of population, rather than a conclusive census, and should be treated accordingly.

The Chippewas of Georgina Island is the only First Nation reserve within the watershed. This reserve had a population of 353 during the 2006 census, at a density of 22 people per km^2.

[6] Grouping of adjacent census municipalities

[7] Geographic Information System (GIS) is a computer system that can analyze and manipulate date to produce geographic representations (i.e. a map)

[8] http://www12.statcan.gc.ca/census-recensement/~~2006/dp-pd/prof/92-591/index.cfm?Lang=E~~2021/dp-pd/prof/

Table 2-8: Municipal population ~~and population density~~ (Data Source: Statistics Canada, Census 202106).

Municipality	Total municipal Population	% of CCS area within Watershed	~~Population within Watershed~~	~~Density within Watershed (persons/km²)~~
City of Kawartha Lakes	~~74,561~~79,247	4	~~5,990~~	~~50~~
City of Barrie	~~128,430~~147,829	71	~~84,504~~	~~1537~~
Town of Bradford-West Gwillimbury, County of Simcoe	~~24,039~~42,880	69	~~22,008~~	~~160~~
Town of Innisfil, County of Simcoe	~~31,175~~43,326	58	~~28,360~~	~~172~~
City of Orillia, County of Simcoe	~~30,259~~33,411	57	~~17,086~~	~~1036~~
Township of Oro-Medonte, County of Simcoe	~~20,031~~23,017	28	~~8,955~~	~~54~~
Township of Ramara, County of Simcoe	~~9,427~~10,377	40	~~5,817~~	~~33~~
Township of New Tecumseth, County of Simcoe	~~27,701~~43,948	8	~~935~~	~~42~~
Township of Springwater, County of Simcoe	~~17,456~~21,701	0.1	~~3~~	~~4~~
Township of Brock, Regional Municipality of Durham	~~11,979~~12,567	91	~~10,966~~	~~28~~
Township of Scugog, Regional municipality of Durham	21,~~439~~581	11	~~2,379~~	~~41~~
Township of Uxbridge, Regional Municipality of Durham	~~19,169~~21,556	82	~~15,621~~	~~45~~
Town of Caledon, Regional Municipality of Peel	~~57,050~~76,581	0.5	~~224~~	~~61~~

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Municipality	Total municipal Population	% of CCS area within Watershed	~~Population within Watershed~~	~~Density within Watershed (persons/km²)~~
Town of Aurora, Regional Municipality of York	~~47,629~~62,057	93	~~44,490~~	~~953~~
Town of East Gwillimbury, Regional Municipality of York	~~21,069~~42,880	100	~~21,069~~	~~85~~
Town of Georgina, Regional Municipality of York	~~42,346~~47,642	100	~~42,346~~	~~146~~
Township of King, Regional Municipality of York	~~19,487~~27,333	57	~~11,199~~	~~58~~
Town of Newmarket, Regional Municipality of York	~~74,295~~87,942	100	~~74,295~~	~~1893~~
Town of Whitchurch-Stouffville, Regional Municipality of York	~~24,390~~49,864	55	~~13,513~~	~~117~~

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2.4.2 Land use

It is important to consider land use when implementing source water protection measures because land cover, and changes to it, will affect several aspects of the water budget including surface water runoff, evaporation and infiltration. Often land being developed will have higher proportion of impervious surfaces, such as roadways, parking lots and building roofs. This, in turn increases runoff rates, resulting in erosion and reduced infiltration to recharge groundwater reserves. The potential for the introduction of contaminants to both groundwater and surface water must be a consideration when a new land use is proposed.

Land use within the Lake Simcoe watershed has been divided into 15 classes including urban, non-intensive agricultural (pasture and hay), intensive agriculture (market garden, orchard, row

crop, sod farm, tree farm), and golf course (Table 2-9). Land use classification is based on the Ecological Land Classification methods described in Section 2.3.1 (Natural Vegetation).

The largest land use within the Lake Simcoe watershed is Natural Heritage Features comprising of 4452% of the area. As described above natural heritage features include woodlands, wetlands (including Lake Simcoe) and scrubland. The second largest land use in the watershed is agriculture at 4037% (3220% intensive and 817% non-intensive). These land uses are shown in Figure 2-8.

Table 2-9: Land use in the Lake Simcoe Watershed (Data source: LSRCA).

Land use	Area (km^2)	% of total (rounded value)
Natural Heritage Feature	1283724	4452
Intensive Agriculture	931648	3220
Non-intensive Agriculture	245561	817
Urban	16242	64
Rural Development	769	32
Road	520	21
Active Aggregate	234	1
Manicured Open SpaceGolf	36.121	1
Industrial	2218	1
Estate Residential	17	1
Manicured Open Space	14	0
Institutional	2012	10
Commercial	2011	10
Rail	3	0
Inactive Aggregate	1	0
Total	**2,8893324**	**100**

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2.4.2.1 Areas of Settlement

Urban areas within the Source Water Protection area include: the Cities of Barrie, Orillia and Kawartha Lakes, the Towns of Newmarket, Aurora, Schomberg, Uxbridge, Keswick, Sutton, Bradford and Beaverton, and the Villages of Pefferlaw, Cannington, and Sunderland. Other built up areas include waterfront development along the shoreline from the Towns of Keswick to Sutton and all along the Innisfil shoreline. As previously documented, the watershed population continues to grow faster than originally anticipated, based on past population projections

(LSEMS, 1995). Urban development activities have subsequently increased to keep pace with this population growth. A comparison of the relative changes in land use distribution for existing urban Aurora, Barrie, Bradford, Newmarket, Orillia and Uxbridge shows consistent increases in the areas of both residential and commercial/industrial land uses. Construction of new dwellings was essential to meet the demands of the rising populations within the urban centers of the watershed. In the City of Barrie, 16,560 new dwellings were constructed between the years 1991 to 2001. The Town of Newmarket experienced the next largest construction boom with 6,665 new dwellings built during the same period. The total number of new dwellings constructed throughout the Lake Simcoe watershed was reported as 66,965. Areas of settlement, as defined in the *Places to Grow Act, 2005* are shown in Figure 2-9, as well as the location of First Nation reserves and Federal Lands. Data for the areas of settlement are obtained from Municipal Official Plans.

2.4.2.2 Impervious Surfaces

The hardening of the land's surface through paving and the construction of buildings significantly alters the hydrologic properties or drainage characteristics of an area. The result is reduced groundwater recharge and increased surface runoff. For the purpose of characterizing the Lake Simcoe watershed, we provide a map of impervious surfaces using the typical definition where all hardened surfaces are shown, including roads, parking lots and buildings. Figure 2-10 shows that the areas with the most impervious surface cover are the major urban areas such as Barrie, Newmarket and Orillia. Rural areas typically have very little impervious surface cover.

In the context of identifying risks to municipal drinking water systems, a slightly different definition of impervious surface area is applied to that described above. Source Water Protection defines total impervious surface area as "the surface area of all highways and other impervious land surfaces used for vehicular traffic and parking, and all pedestrian paths" (MOE, 2008a). This definition of total impervious surface is essentially used as a proxy for the application of road salt, a potential threat to municipal drinking water, as excess sodium is linked to a number of negative health issues (such as high blood pressure) and is of particular concern to those on low-sodium diets. The Technical Rules (MOE, 2008a) requires that the percentage of total impervious surface be calculated for each vulnerable area, including the Highly Vulnerable Aquifers (HVA), ~~Significant Groundwater Recharge Areas (SGRA),~~ Wellhead Protection Areas (WHPA) and Intake Protection Zones (IPZ).

Total impervious surface calculations for WHPA and IPZs were conducted as a component of the technical studies undertaken to investigate potential Threats to individual municipal drinking water supplies. The methods and results of the WHPA and IPZ impervious surface

calculations can be found in each of the municipal vulnerability and threats chapters (Chapters 6 to 13). Similarly, methods and results for total impervious surface cover for ~~the two broad scale vulnerable areas -~~ HVAs ~~and SGRAs -~~ can be found in Chapter 4.

2.4.2.3 Agriculture and the Raising of Livestock

Based on the Ontario 2001 census data, the Lake Simcoe watershed supports a conventional farm economy with 1,844 farms involved in cash crop, livestock and mixed operations. This is a decrease of 313 farms from the 2,157 that were operating in 1991. Approximately 536 km^2 of land is cultivated with alfalfa, corn, wheat, barley and vegetables being the dominant crops in the area. In addition to upland agriculture, the Holland River subwatershed supports the largest cultivated marsh or 'polder' area in Ontario. Four vegetable polders, the Keswick, Colbar, Bradford and Holland marshes, occupy roughly 37 km^2 with the Holland Marsh being the largest at 28 km^2. These polder areas originally existed as wetlands, but during the 1920s and as recently as the 1980s these area have been drained to expose the fertile organic or "muck" soils for vegetable production. Water levels within the polders are maintained through a series of pumping stations and canals surrounding the area.

The Lake Simcoe basin also is home to a small number of specialty farms, such as orchards, vineyards, wildflower and tree nurseries and turf grass operations. Generally, there has been little change in the relative distribution of these farms or land in production, with the exception of turf grass industry. The number of sod farms has risen by 22% within the watershed since 1991 and this growth can most likely be attributed to the market demand associated with urban growth in the GTA. There are a total of 19 sod farms within the basin and a total of 1,627 hectares (16.27 km^2) devoted to sod production. The Towns of Georgina and East Gwillimbury have the highest number of sod farms, each having five. However, the Town of Georgina contains the largest area in sod production with 1,100 hectares (11 km^2). Another significant fact is that the majority of sod production in that area is located within the Maskinonge River subwatershed which has been identified as having a water quantity stress in the Tier I and Tier II water budgets (see Chapter 3).

Livestock production is a significant agricultural industry within the watershed. Cattle, poultry and horses are the top three farms types within the Lake Simcoe watershed. Highest livestock densities during the 2006 census occurred in Scugog, followed by Whitchurch-Stouffville. High densities in these areas are due to the raising of hens and chickens. Of those areas with livestock farms, lowest livestock densities occurred in East Gwillimbury and Innisfil. No data was reported for the urban areas of Newmarket, Aurora, Orillia and Barrie. The location of livestock farms is presented in Figure 2-11 and the density of livestock within census consolidated subdivisions (CCS) are presented in Table 2-10.

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Table 2-10: Livestock density within Lake Simcoe Watershed census consolidated subdivisions (number/km^2). Only those CCS regions with available data are presented. (Data source: Statistics Canada, 2006 Census).

Census Consolidated Subdivision	% of CCS area within watershed	Cattle and calves	Pigs	Sheep and lambs	Horses and ponies	Hens and chickens	All others	All livestock
Whitchurch-Stouffville	55	22.4	0.0	2.8	3.6	792.5	2.4	823.7
King	57	9.6	0.0	1.9	5.7	0.0	1.9	19.2
Georgina	100	10.1	15.9	19.0	1.3	0.0	2.3	48.6
Caledon	0.5	19.6	0.0	1.3	2.4	255.8	0.6	279.7
Bradford West Gwillimbury	69	10.6	8.2	5.7	0.9	0.0	0.9	26.4
Innisfil	58	13.2	0.0	6.2	0.9	0.0	1.8	22.0
Ramara	40	19.4	0.2	4.1	0.5	4.0	1.1	29.4
East Gwillimbury	100	0.0	3.3	3.2	2.0	0.0	0.2	8.7
Brock	91	28.6	0.0	7.8	1.3	478.5	4.5	520.7
New Tecumseth	8	9.3	0.5	6.2	1.6	97.1	1.7	116.5
Uxbridge	82	20.1	7.6	1.8	2.8	312.2	2.5	347.1
Oro-Medonte	28	15.4	6.7	8.4	1.5	2.0	1.7	35.7
Scugog	11	20.8	11.4	4.1	1.8	808.8	0.9	847.8
Kawartha Lakes	4	16.6	2.6	3.4	0.9	82.2	3.3	109.0

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Estimating the number of livestock being raised in vulnerable areas is an important task in determining risks to municipal drinking water supply. Livestock and associated activities, such as the storage or application of agricultural source material (i.e. manure spreading), have the potential to be a risk to drinking water due to both the pathogens (e.g. *Escherichia coli [E. coli]*) and chemicals (e.g. nitrogen) the material contains. The Technical Rules (MOE, 2008a) require that livestock density be calculated for each vulnerable area —Wellhead Protection Area (WHPA), Intake Protection Zone (IPZ), ~~Significant Groundwater Recharge Area (SGRA)~~ and

Highly Vulnerable Aquifers (HVA). The methods used for these vulnerable areas is based on a Technical Bulletin provided by the Province (MOE, 2009b), and require interpretation of aerial photography to estimate capacity of a farm to house livestock. Methods and results of the WHPA and IPZ livestock density calculation, and whether these result in potential significant risks, can be found in each of the municipal vulnerability and threats chapters (Chapters 6 to 13). Similarly, livestock density for the ~~broad scale vulnerable areas -~~ HVAs ~~and SGRAs -~~ can be found in Chapter 4. To enable comparison of risk for different livestock types (e.g. hens versus cattle), livestock density estimates within these sections are presented as nutrient units per acre.

2.4.2.4 Managed Lands

Managed Land means land to which agricultural source material, commercial fertilizer, or non-agricultural source material (i.e. sewage or meat plant effluent) is applied (MOE 2008a). Managed lands include pasture, golf courses, residential areas, and areas where biosolids are applied. Managed Lands do not include areas such as forests, wetlands and commercial properties. The technical rules require that the percentage of managed lands within each vulnerable area (WHPA, IPZ, ~~SGRA~~ and HVA) be determined so that it can be established whether activities such as application of source material and fertilizer is a potential Significant, Moderate or Low Drinking Water Threat to the municipal water supply.

Methods and results of the WHPA and IPZ managed land calculation, and whether these result in potential Significant Threats, can be found in Chapters 6 to 13. Similarly, managed land information for the ~~broad scale vulnerable areas~~ HVAs ~~and SGRAs~~ can be found in Chapter 4.

For the purposes of characterizing the Lake Simcoe watershed, Figure 2-12, provides a broad scale overview of managed lands in the area. This figure is based on the methods prescribed by the Province in a Technical Bulletin (MOE, 2009b) and shows the Municipal Property Assessment Corporation (MPAC) land use and property codes identified as having activities that have the potential to apply nutrients. Figure 2-12 illustrates that areas of the watershed are classified as being managed lands. These include both urban (e.g. residential lawns) and rural (farms) areas.

2.5 Drinking Water Systems

Drinking water systems in Ontario are classified under O.Reg 170/03 (Drinking Water Systems) made under the *Safe Drinking Water Act, 2002*. The drinking water system classifications are:

(i) large municipal residential system;
(ii) small municipal residential system;

(iii) large municipal non-residential system;
(iv) small municipal non-residential system;
(v) non-municipal year-round residential system;
(vi) non-municipal seasonal residential system;
(vii) large non-municipal non-residential system; and
(viii) small non-municipal non-residential system.

The *Safe Drinking Water Act (SDWA), 2002*, came out of the recommendations from the Walkerton Inquiry to address the issues pertaining to the treatment and distribution of drinking water. The Act helps to protect drinking water through regulating the operation of drinking water systems and the testing of drinking water. The systems that are covered under O.Reg. 170/03 of the SDWA are listed below in Table 2-11 and include year-round municipal and private water systems that provide drinking water to residential developments and designated facilities that supply water to 'vulnerable populations' (elderly, children). These facilities consist of schools (both public and private), universities, colleges or institutions that grant degrees, health and social care facilities, children's camps, and child and youth care facilities.

The *Clean Water Act (CWA), 2006*, differs from the SDWA, in that it focuses more on protecting drinking water at the source rather than relying on the treatment system. In addition, the CWA focuses only on large and small municipal residential drinking water systems, where the SDWA focuses on municipal non-residential and non-municipal year round residential systems as well. Other drinking water systems (as previously mentioned) are regulated under the *Safe Drinking Water Act* and the *Health Protection and Promotion Act (HPPA), 1990*. For more information on the CWA and the assessment report process, please refer to Chapter 1 of this report.

Table 2-11: Drinking Water Systems and the legislation they are protected under.

Drinking Water System	Definition	Legislative Protection
Large Municipal Residential System	• Municipal • Serves major residential development & more than 100 private residences	SDWA, CWA
Small Municipal Residential System	• Municipal • Serves a major residential development & fewer than 101 private residences	SDWA, CWA
Large Municipal Non-Residential System	• Municipal • Non-residential • Capable of supplying drinking water at a rate of more than 2.9 L/s	SDWA, HPPA
Small Municipal Non-Residential System	• Municipal • Non-residential • Not capable of supplying drinking water at a rate of more than 2.9 L/s	SDWA, HPPA
Non-Municipal Year-Round Residential System	• Non-municipal • Year-round • Serves a major residential development or trailer park or campground & has more than 5 service connections	SDWA
Non-Municipal Seasonal Residential System	• Non-municipal • Seasonal • Serves a major residential development or trailer park or campground & has more than 5 service connections	HPPA
Large Non-Municipal Non-Residential System	• Non-municipal • Does not serves major residential development/trailer park or campground that has more than 5 service connections • Capable of supplying drinking water at a rate of more than 2.9 L/s	HPPA

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Drinking Water System	Definition	Legislative Protection
Small Non-Municipal Non-Residential System	• Non-municipal • Serves a designated facility or public facility • Does not serves major residential development/trailer park or campground that has more than 5 service connections • Not capable of supplying drinking water at a rate of more than 2.9 L/s	HPPA

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The Terms of Reference (ToR) for the SGBLS Assessment Reports identifies all the drinking water systems and associated wells and surface intakes required in this Assessment Report. In accordance with the ToR, only drinking water systems classified as large municipal residential, and small municipal residential have been included (Type i and ii) in this report. Within the entire SGBLS Source Protection Region there are 108 drinking water systems, serviced by 277 wells and 16 surface water intakes. Within the Lake Simcoe area there are 31 drinking water systems, serviced by 77 municipal wells and 7 surface water intakes (Figure 2-13). Locations of non-municipal and non-residential drinking water systems that are not included in this report are shown in Figure 2-14. Locations of these drinking water systems were provided by the MECP~~OE~~ and represent those systems that are registered with the ~~MOE~~ MECP under the former O.Reg 252 (now Reg 318 of the *Health Promotion and Protection Act*).

Information pertaining to each municipal drinking water system, such as the location, population served and pumping rates are presented in Table 2-12. The maximum annual and average monthly average pumping rates are available in Appendix WB-3B. A few of the drinking water systems in the South Georgian Bay-Lake Simcoe Source Protection Region are spread across more than one watershed. In the Lake Simcoe watershed, the Barrie Well Supply System is in both the Lake Simcoe and the Nottawasaga Valley watershed. Ten of the wells are in the Lake Simcoe watershed, while the other four wells are located in the Nottawasaga Valley watershed and reported rates can be found in Nottawasaga Valley Assessment Report. Where current average pumping rates were not available, maximum permitted rates were used (denoted by *).

Information presented in these tables has been sourced either directly from the municipality, or obtained through previously published reports including; North Simcoe Groundwater Study (Golder, 2005), South Simcoe Groundwater Study (Golder, 2004), Groundwater Modeling of the ORM (Earthfx and Gerber, 2008; Kassenaar and Wexler, 2006), and various other well head

protection reports from across the Source Protection Region. While specific details about each drinking water system are provided in Chapters 6-13, some notable water taking scenarios are briefly described in Chapter 3, Tier 1.

Table 2-12: Municipal Drinking Water Systems in the Lake Simcoe Watershed.

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #11	604692	4915824	1,185,885	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #12	604479	4914589	368,650	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #14	604660	4915792	596,775	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #15	604425	4915194	368,650	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #17	602045	4913788	1,155,590	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #18	602013	4913786	1,174,205	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #3A	603383	4914769	868,335	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #4A	603336	4915159	618,675	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #5	602923	4914271	1,056,310	2012
The City of Barrie	Barrie Creeks	Barrie Well Supply	1	78,500 combined (Barrie wells [10])	Well #7	602484	4914187	1,735,940	2012
The City of Barrie	*Barrie Creeks*	*Barrie Water Treatment Plant*	*1*	*61,500*	*SW*	*609391*	*4914471*	*6,081,879*	*2012*
The Town of Bradford West Gwillimbury	West Holland	Bradford\Bondhead Distribution & Supply Wells	1	11,400	Church Well 1 / Church Well 2	617149 / 617163	4885276 / 4885312	1,085,628	2012

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Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Regional Municipality Of Durham	*N/A*	*Beaverton Water Treatment Plant*	*1*	*3,891*	*SW*	-	-	*45,185*	*2012*
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW2	654832	4911906	18,789	2012
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW3	655182	4912388	41,274	2012
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW4	656815	4912382	41,828	2012
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW6	657084	4912439	8,817	2012
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW7	654825	4911912	63,763	2012
The Regional Municipality Of Durham	Beaver River	Cannington Well Supply	1	2,076 combined (Cannington wells [6])	MW8	656987	4912408	56,690	2012
The Regional Municipality Of Durham	Beaver River	Sunderland Well Supply	1	1,269 combined (Sunderland wells [2])	MW1	655078	4903042	57,464	2012
The Regional Municipality Of Durham	Beaver River	Sunderland Well Supply	1	1,269 combined (Sunderland wells [2])	MW2	655086	4903069	51,295	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
Regional Municipality of Durham	Uxbridge Brook	Uxbridge Well Supply	1	10,224 combined (Uxbridge wells [3])	MW5	651073	4885353	415,014	2012
Regional Municipality of Durham	Uxbridge Brook	Uxbridge Well Supply	1	10,224 combined (Uxbridge wells [3])	MW6	649779	4884862	609,717	2012
Regional Municipality of Durham	Uxbridge Brook	Uxbridge Well Supply	1	10,224 combined (Uxbridge wells [3])	MW7	651054	4885467	Data Gap	2012
The Town of Innisfil	*Innisfil Creeks*	*Alcona Water Treatment Plant*	*1*	*35,406****	*SW*	-	-	*3,171,915 *****	*2012*
The Town of Innisfil	Lovers Creek	Innisfil Heights Well Supply	1	700	Well #2 / Well #3	605518 / 605596	4905031 / 4904904	162,688	2012
The Town of Innisfil	Hewitts Creek	Stroud Well Supply	1	1,900 combined (Stroud wells [3])	Well #1	610368	4909451	165,980 combined (Stroud wells [3])	2012
The Town of Innisfil	Hewitts Creek	Stroud Well Supply	1	1,900 combined (Stroud wells [3])	Well #2	610358	4909422	165,980 combined (Stroud wells [3])	2012
The Town of Innisfil	Hewitts Creek	Stroud Well Supply	1	1,900 combined (Stroud wells [3])	Well #3	610388	4909478	165,980 combined (Stroud wells [3])	2012
The City of Kawartha Lakes	Beaver River	Woodville Well Supply	1	740 combined (Woodville wells [2])	Well #1	661261	4915511	215,029*	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The City of Kawartha Lakes	Beaver River	Woodville Well Supply	1	740 combined (Woodville wells [2])	Well #2	661261	4915529	215,029*	2012
The City of Kawartha Lakes	Beaver River	Woods of Manilla	1	-	Well #1	-	-	26,283	2012
The Township of Oro-Medonte	Oro Creeks South	Canterbury Subdivision Well Supply	2	43 combined (Canterbury wells [2])	Well #1	617799	4924108	1,865	2012
The Township of Oro-Medonte	Oro Creeks South	Canterbury Subdivision Well Supply	2	43 combined (Canterbury wells [2])	Well #2	617805	4924105	1,939	2012
The Township of Oro-Medonte	Hawkstone Creek	Cedar Brook Subdivision Well Supply	2	60 combined (Cedar Brook [2])	Well #1	621415	4928437	2,578	2012
The Township of Oro-Medonte	Hawkstone Creek	Cedar Brook Subdivision Well Supply	2	60 combined (Cedar Brook [2])	Well #2	621407	4928432	2,842	2012
The Township of Oro-Medonte	Oro Creeks South	Harbourwood Well Supply	1	332 combined (Harbourwood wells [2])	Well #2	617917	4922284	16,845	2012
The Township of Oro-Medonte	Oro Creeks South	Harbourwood Well Supply	1	332 combined (Harbourwood wells [2])	Well #3	617932	4922286	16,517	2012
The Township of Oro-Medonte	Oro Creeks North	Maplewood Estates Well Supply	2	127	Well #1	625393	4932099	11,784	2012
The Township of Oro-Medonte	Oro Creeks North	Maplewood Estates Well Supply	2	Data Gap	Well #2	625429	4932119	Data Gap	2022
The Township of Oro-Medonte	Oro Creeks South	Shanty Bay Well Supply	1	457 combined (Shanty Bay wells [3])	Well #1	613039	4918913	15,695	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Township of Oro-Medonte	Oro Creeks South	Shanty Bay Well Supply	1	457 combined (Shanty Bay wells [3])	Well #2	613046	4918902	17,885	2012
The Township of Oro-Medonte	Oro Creeks South	Shanty Bay Well Supply	1	457 combined (Shanty Bay wells [3])	Well #3	613027	4918912	20,075	2012
The Township of Ramara	Ramara Creeks	Bayshore Village Subdivision Well Supply	1	1,029 combined (Bayshore wells [3])	Well #3	636062	4934851	147,095* combined for DWS	2012
The Township of Ramara	Ramara Creeks	Bayshore Village Subdivision Well Supply	1	1,029 combined (Bayshore wells [3])	Well #4	636061	4934917	147,095* combined for DWS	2012
The Township of Ramara	Ramara Creeks	Bayshore Village Subdivision Well Supply	1	1,029 combined (Bayshore wells [3])	Well #5	636127	4934970	147,095* combined for DWS	2012
The Township of Ramara	*Ramara Creeks*	*Lagoon City Water Treatment Plant*	*1*	*3,000*	*SW*	-	-	*3,993,287**	*2012*
The Township of Ramara	*Ramara Creeks*	*South Ramara Water Treatment Plant*	*2*	*200*	*SW*	-	-	*542,880**	*2012*
The Township of Ramara	Ramara Creeks	Val Harbour Subdivision Well Supply	2	101	Well #1 / Well #2	635130 / 635305	4936481 / 4936512	105,85*	2012
The Regional Municipality of York	West Holland	Ansnorveldt Well Supply	1	231 combined (Ansnorveldt wells [2])	PW1	616813	4882064	6,205	2012
The Regional Municipality of York	West Holland	Ansnorveldt Well Supply	1	231 combined (Ansnorveldt wells [2])	PW2	616821	4882055	15,695	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW1	622584	4873410	709,925	2012
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW2	622577	4873385	820,885	2012
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW3	622573	4873362	1,045,360	2012
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW4	622581	4873373	1,005,940	2012
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW5	622621	4875027	978,565	2012
The Regional Municipality of York	East Holland	Aurora Well Supply	1	51,925 combined (Aurora wells [6])	PW6	624395	4875372	350,400	2012
The Regional Municipality of York	East Holland	Ballantrae/ Musselman's Well Supply	1	4,532 combined (Ballantrae/Musselman's wells PW1, PW2, PW3)	PW1	634582	4876913	227,760	2012
The Regional Municipality of York	East Holland	Ballantrae/ Musselman's Well Supply	1	4,532 combined (Ballantrae/Musselman's wells PW1, PW2, PW3)	PW2	634579	4876921	213,160	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Regional Municipality of York	East Holland	Ballantrae/ Musselman's Well Supply	1	4,532 combined (Ballantrae/Musselman's wells PW1, PW2, PW3)	PW3	636191	4877863	0	2012
The Regional Municipality of York	East Holland	Ballantrae/ Musselman's Well Supply	1	Data Gap	PW4	636202	4877876	Data Gap	2022
The Regional Municipality of York	*East Holland*	*Georgina Water Treatment Plant*	*1*	*5,283*	*SW*	-	-	*16,200,000**	*2012*
The Regional Municipality of York	East Holland	Holland Landing Well Supply	1	7,456 combined (Holland Landing wells [2])	PW1	622192	4883499	305,505	2012
The Regional Municipality of York	East Holland	Holland Landing Well Supply	1	7,456 combined (Holland Landing wells [2])	PW2	622358	4883980	296,745	2012
The Regional Municipality of York	*N/A*	*Keswick Water Treatment Plant*	*1*	*27,699*	*SW*	-	-	*50,000,000**	*2012*
The Regional Municipality of York	Black River	Mount Albert Well Supply	1	4,215 combined (Mount Albert wells [3])	PW1	635240	4887690	159870	2012
The Regional Municipality of York	Black River	Mount Albert Well Supply	1	4,215 combined (Mount Albert wells [3])	PW2	635225	4887646	136875	2012
The Regional Municipality of York	Black River	Mount Albert Well Supply	1	4,215 combined (Mount Albert wells [3])	PW3	635891	4886252	Data Gap	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW1	623862	4878651	554,435	2012
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW13	622297	4876467	1,527,525	2012
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW14	625785	4880651	141,255	2012
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW15	621693	4879513	436,175	2012
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW16	622290	4876491	1,427,880	2012
The Regional Municipality of York	East Holland	Newmarket Well Supply	1	81,798 combined (Newmarket wells [6])	PW2	621906	4878549	1,363,275	2012
The Regional Municipality of York	Maskinonge River	Queensville (York Region) Well Supply	1	3,730 combined (Queensville wells [4])	PW1	625850	4889142	778910	2012
The Regional Municipality of York	Maskinonge River	Queensville (York Region) Well Supply	1	3,730 combined (Queensville wells [4])	PW2	625850	4889115	1042440	2012
The Regional Municipality of York	East Holland	Queensville (York Region) Well Supply	1	3,730 combined (Queensville wells [4])	PW3	624272	4886639	1,034,410	2012

Municipality	Subwatershed	Drinking Water System (DWS) Name	DWS Classification	Population served by DWS	Well Name	Easting	Northing	Current Average Pumping (m^3/a)	Data current as of…
The Regional Municipality of York	East Holland	Queensville (York Region) Well Supply	1	3,730 combined (Queensville wells [4])	PW4	624249	4886634	1,222,020	2012
The Regional Municipality of York	West Holland	Schomberg Well Supply	1	1,763 combined ~~9~~Shomberg wells [3])	PW2	605452	4873047	146,365	2012
The Regional Municipality of York	West Holland	Schomberg Well Supply	1	1,763 combined ~~9~~Shomberg wells [3])	PW3	605254	4873479	118,260	2012
The Regional Municipality of York	West Holland	Schomberg Well Supply	1	1,763 combined ~~9~~Shomberg wells [3])	PW4	605263	4873483	Data Gap	2012

1 – Large Municipal System, 2 – Small Municipal System

** Maximum permitted value*

*** Current average pumping rate used in Tier 2 Water Budget*

**** Population value also includes the population served by the Alcona Treatment Plant in Bradford- West Gwillimbury in 2013*

***** Current average pumping value includes pumping needed to service the population that relies on the Alcona WTP in Bradford – West Gwillimbury (Information provided by Town of Innisfil, 2014).*

******Total Population value also includes the portion of the population served by the Alcona Water Treatment Plant in Innisfil (information provided by the Town of Innisfil).*

2.6 Interaction between Physical and Human Geography

Humans are dependent on the environment in a number of ways and the manner in which they work the land is determined by the physical geography of the surrounding environment. As technology advances more of the landscape can be modified to accommodate the needs of a community. On one hand, newer technology and methods allow for more sophisticated measures to be used to extract resources (such as drinking water) while minimizing impacts on the local environment. On the other hand, it also provides ways to supply resources to more people, encouraging population growth. By increasing the demands and stress put on an ecological system, the natural balance is altered with resulting consequences that will need to be studied and addressed.

Interactions between human and physical geography within the Lake Simcoe watershed are numerous. As previously mentioned, the population in the watershed continues to grow faster than originally anticipated. One of the cities that has seen the most dramatic increase between the 2001 and 2006 census years is the City of Barrie with a 24 % increase. This growth correlates with the Barrie Creeks subwatershed having the lowest natural vegetative cover (17%) in the Lake Simcoe watershed. As areas like the City of Barrie become more urbanized there is an associated loss of natural vegetative cover. By removing the natural vegetation, the water quality and quantity of available drinking water can be altered.

Natural Features

Natural features in the environment generally serve to maintain water quality conditions. Naturally vegetated areas including grasslands, meadows, and woodland areas tend to improve the quality of water as it flows over land. The stems and roots of the vegetation slow the flow of water, enabling soil particles and other contaminants to be deposited and increase the amount of runoff that infiltrates into the soil. Water is filtered as it flows through the soil to the groundwater. Wetlands slow the flow of water, provide storage and can absorb some contaminants, including nutrients such as phosphorus and thus have a natural filtering ability.

With the removal of natural features there is increased access for people and contaminants to waterways. As the quality of water decreases, it is not only human populations that are impacted. Through 2005 to 2007, there were 168 sites sampled for fish and of these, approximately 37% were impaired. Macroinvertibrate communities were sampled between 2004 and 2007 at 130 sites. Similar to the fish results, 38% of the sites were impaired, while 48% were unimpaired.

Agriculture

There are a number of water quality issues that are associated with agriculture. Runoff from pasture and cropland can contain high levels of nutrients, sediment, and bacteria. Wind can erode topsoil with its associated contaminants. All of these substances can end up in local watercourses if the appropriate Best Management Practices (BMPs) are not implemented. These BMPs can include conservation tillage, cover cropping, maintaining vegetated riparian buffers, cattle fencing, and the appropriate use of fertilizers and pesticides.

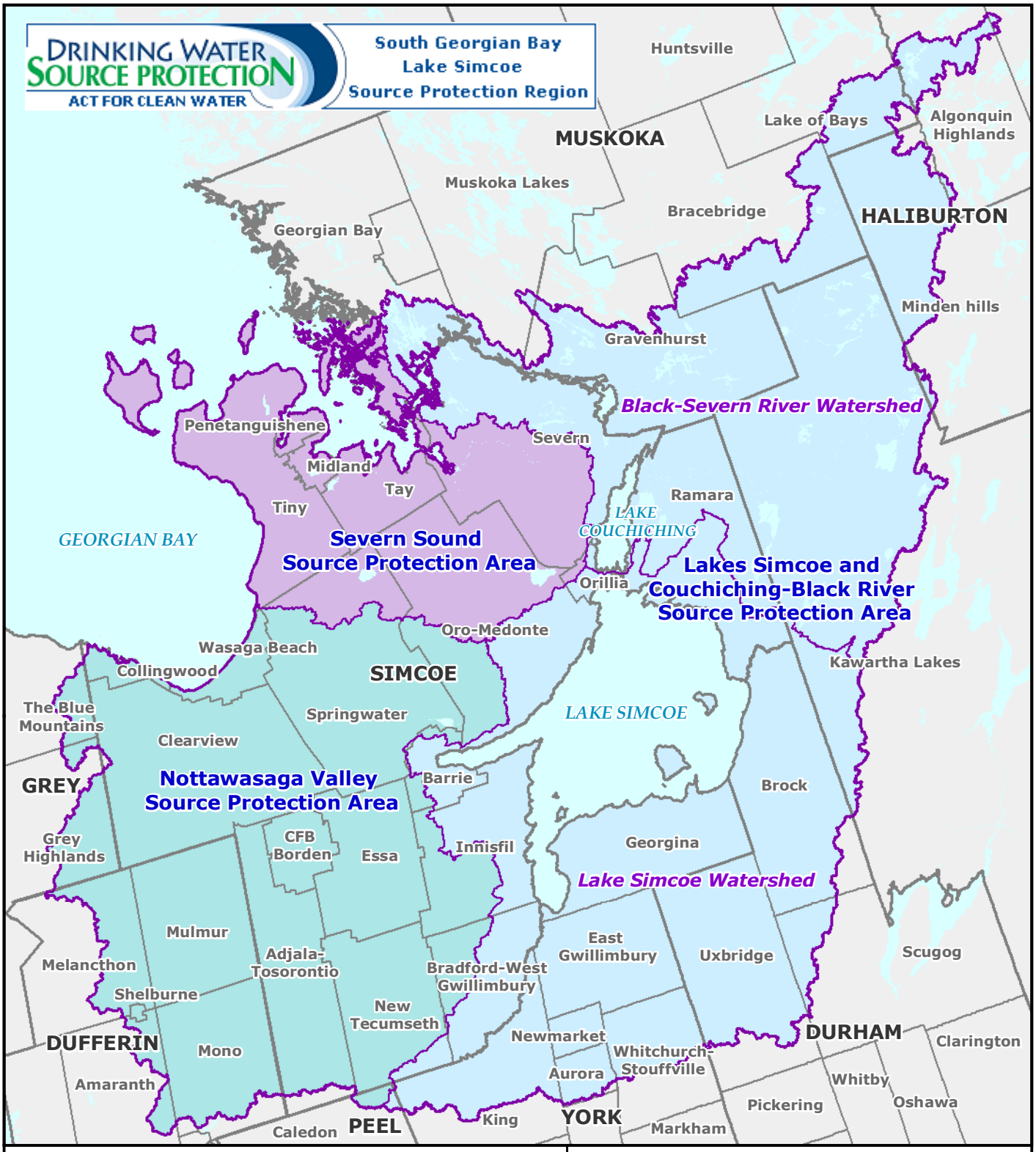
Urbanization

An increase in urbanization also leads to an increase in impervious surface areas, such as roads and rooftops. These have a significant effect on both water quality and quantity. Hardened or impervious surfaces reduce the amount of surface water infiltrating into the ground and causing an increase the volume and velocity of surface runoff, which leads to stream bank erosion, contributing more sediment to watercourses, and can even contribute to flooding. Runoff from imperious surfaces, particularly those built prior to the requirement for storm water management, can carry a host of pollutants to local watercourses. These pollutants build up on roads, driveways and parking lots and even lawns, and are washed to watercourses when it rains. Current water quality results indicate that the majority of waterways in the Lake Simcoe watershed are being impacted in some ways, especially due to elevated phosphorus. Groundwater results showed some exceedances that could be contributable to changing land uses in nearby areas. There are many pollutants that can be carried by urban storm water runoff. Some examples include nutrients and pesticides from lawns, parks and golf courses; road salts; tire residue; oil and gas; sediment; and nutrients and bacteria from pet and wild animal feces. The requirement for storm water management facilities in all new developments will help to mitigate these issues in urban areas, however, the ongoing maintenance of these facilities is crucial to ensuring that they continue to reduce sediment and nutrient loads as designed, otherwise these new developments would be contributing additional phosphorus to the system.

By characterizing the watershed, and the different elements within it, it gives a general overview of the health of the area. It puts into context the location of different features of the watershed and gives an understanding of the current pressures on drinking water supplies. By providing a broad analysis of the watershed it sets the stage for further in-depth analysis of water quantity stressors (Chapter 3) and the details for specific municipal systems (Chapters 6-13).

2.7 Data and Knowledge Gaps

This chapter contains all of the information required by the Technical Rules.



Source Water Protection Region
Source Protection Area (SPA)
Lakes Simcoe and Couchiching-Black River SPA
Nottawasaga Valley SPA
Severn Sound SPA
Watershed Boundaries
Upper Tier Municipality
Lower Tiers Municipality
Water Body

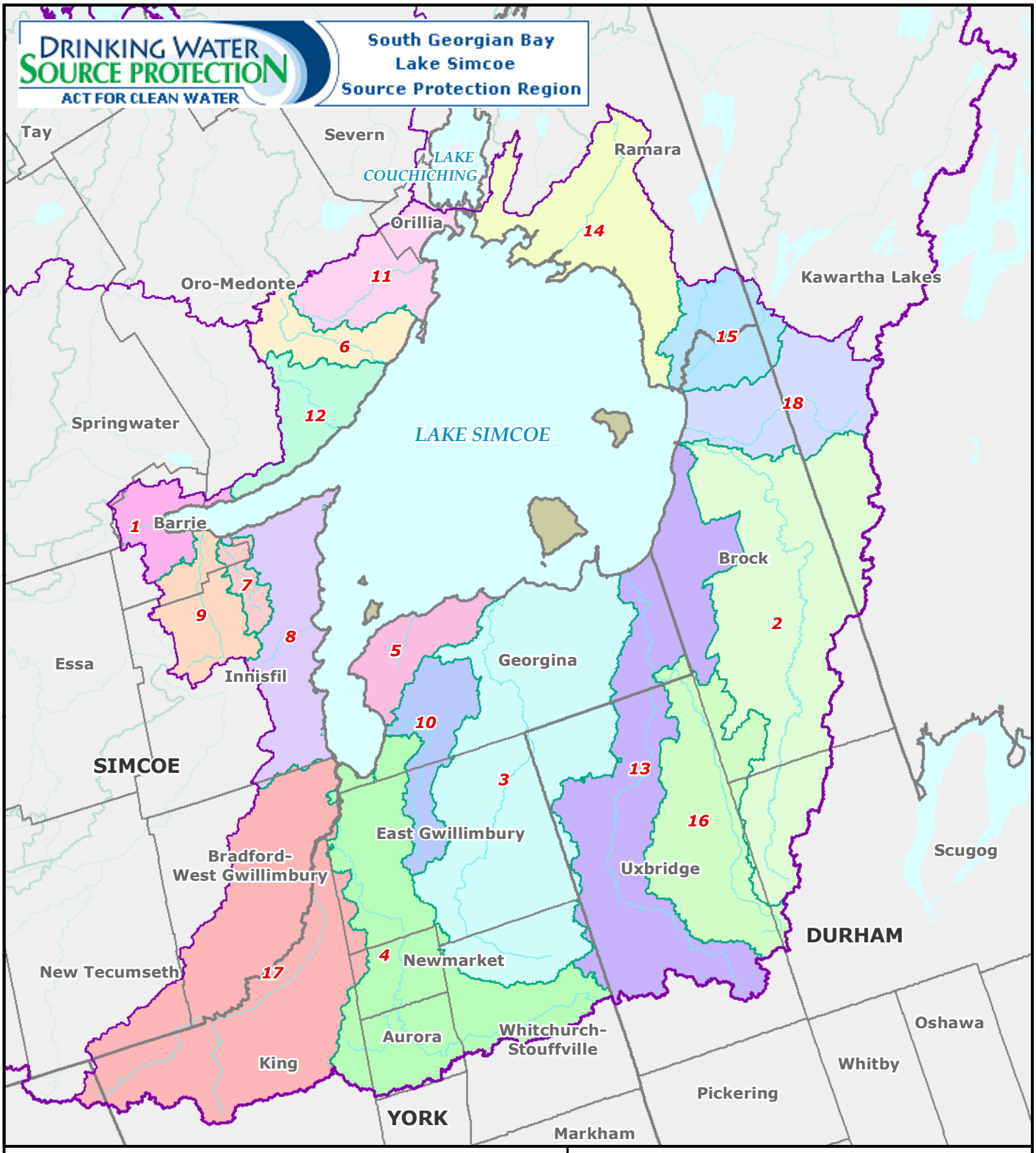
Source Water Protection Region Areas and Municipalities

Created by: LSRCA
Date: 2010-01-21

Scale: 1:750,000
0 5 10 15 20km
UTM Zone 17N, NAD83

Ontario

Figure 2-9



1, Barrie Cr.
2, Beaver R.
3, Black R.
4, East Holland
5, Georgina Cr.
6, Hawkestone Cr.
7, Hewitts Cr.
8, Innisfil Cr.
9, Lovers Cr.
10, Maskinonge R.
11, Oro Creeks N.
12, Oro Creeks S.
13, Pefferlaw Brook
14, Ramara Cr.
15, Talbot R.
16, Uxbridge Brook
17, West Holland
18, Whites Cr.
Islands
SWP Watershed Region
SWP Watershed Area
Upper Tier Municipality
Lower Tiers Municipality
Subwatershed Boundary
Water Body
Main Water Courses

Watershed and Subwatershed Boundaries and Municipality Boundaries

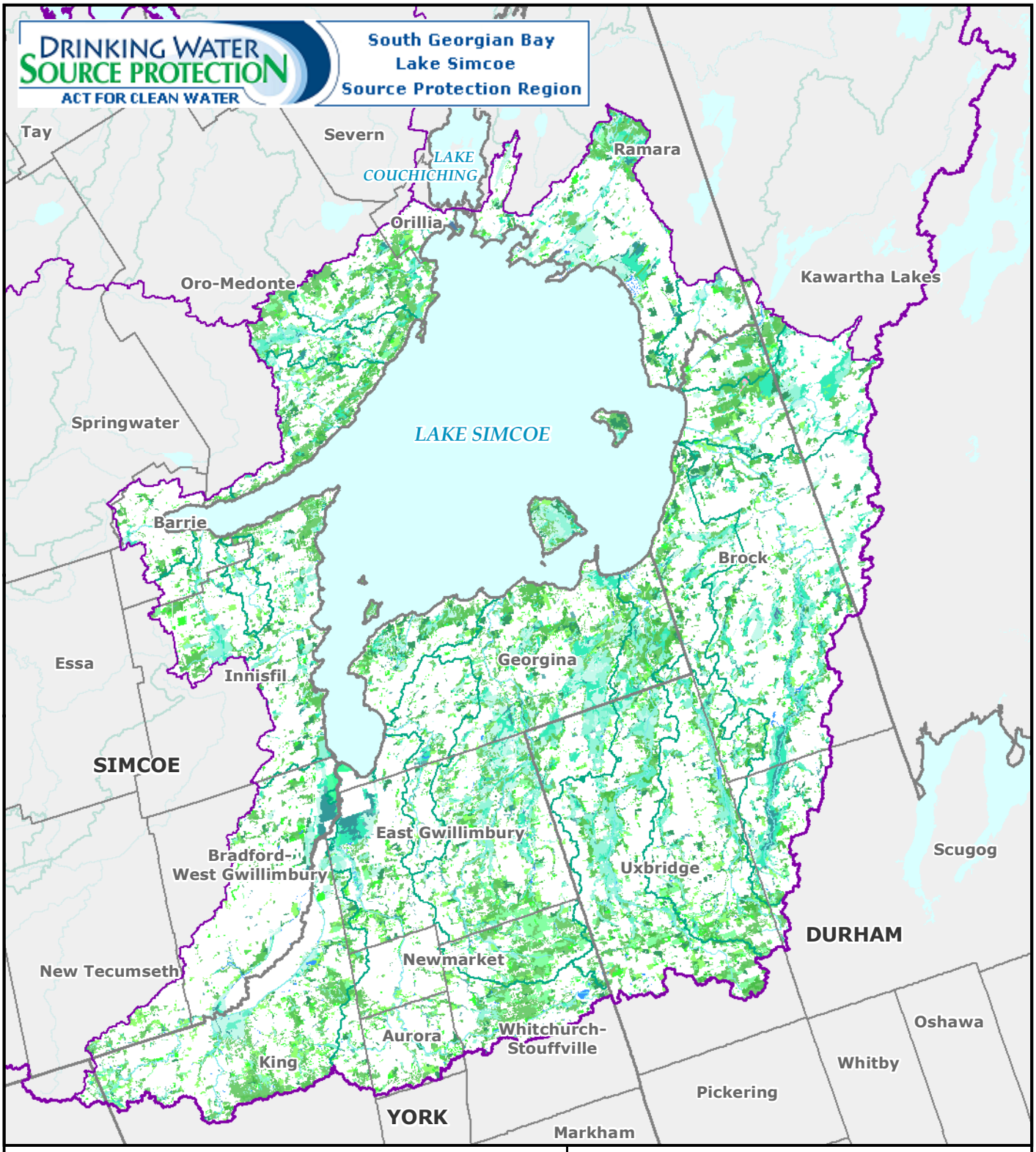
Created by: LSRCA
Date: 2010-02-16

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-10



Vegetation Area (%)

- Coniferous Forest (1.311%)
- Coniferous Swamp (1.096%)
- Cultural Meadow (2.258%)
- Cultural Plantation (1.576%)
- Cultural Savannah (0.007%)
- Cultural Thicket (1.833%)
- Cultural Woodland (1.195%)
- Deciduous Forest (5.068%)
- Deciduous Swamp (3.831%)
- Floating-leaved Shallow Aquatic (0.015%)
- Meadow Marsh (0.525%)
- Mixed Forest (3.971%)
- Mixed Shallow Aquatic (0.066%)
- Mixed Swamp (3.14%)
- Open Alvar (0.008%)
- Open Fen (0.087%)
- Open Tallgrass Prairie (0.001%)
- Open Water (0.293%)
- Shallow Marsh (0.888%)
- Shrub Bog (0.015%)
- Shrub Fen (0.044%)
- Submerged Shallow Aquatic (0.125%)
- Thicket Swamp (2.568%)
- Treed Bog (0.015%)
- Treed Fen (0.001%)

Location of Natural Vegetative Cover

Created by: LSRCA
Date: 2009-11-30

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

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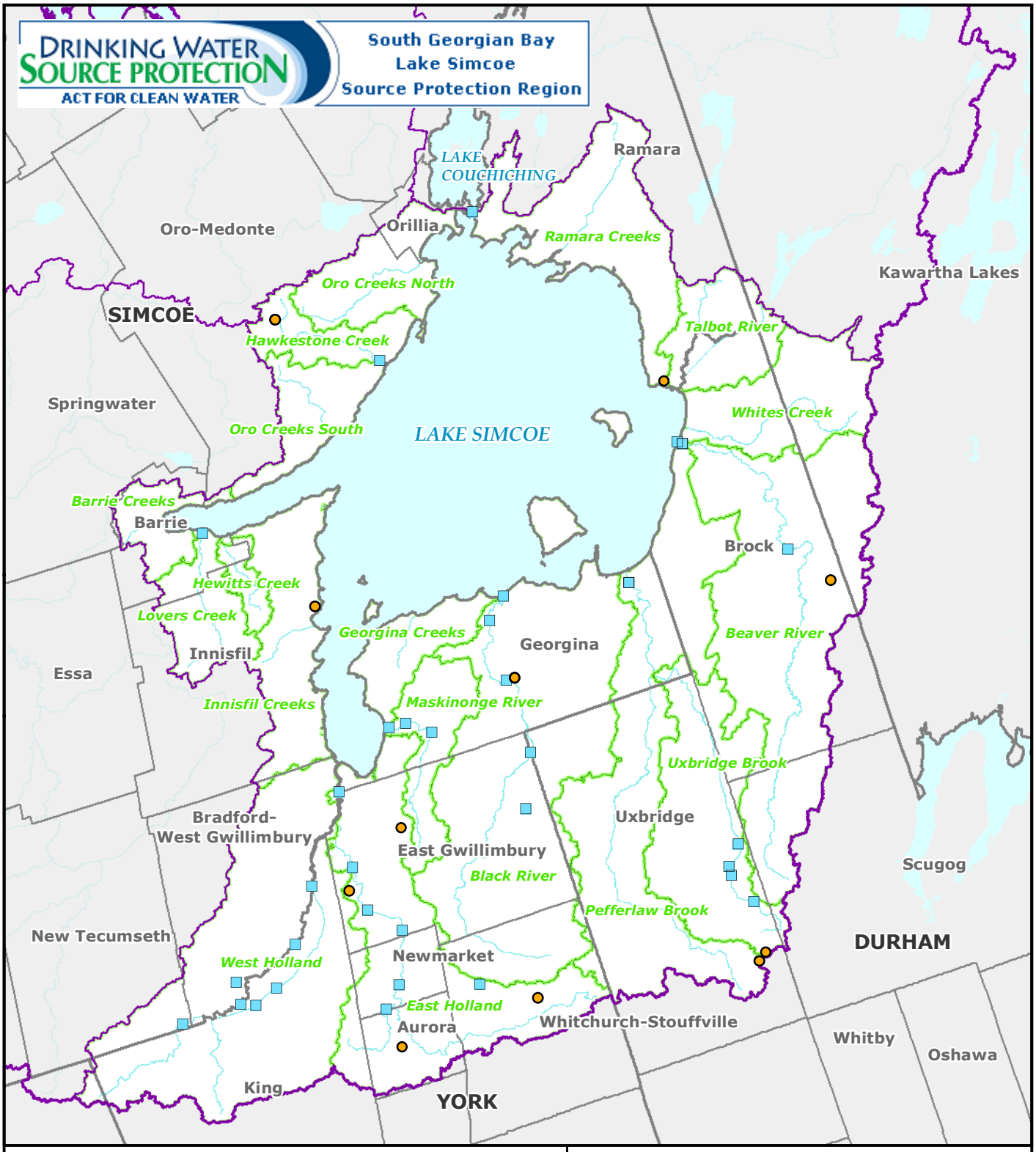
Ontario

Figure 2-11



PGMN - Groundwater
PWQMN - Water Quality
Subwatershed Boundary

Groundwater and Surface Water Monitoring Stations

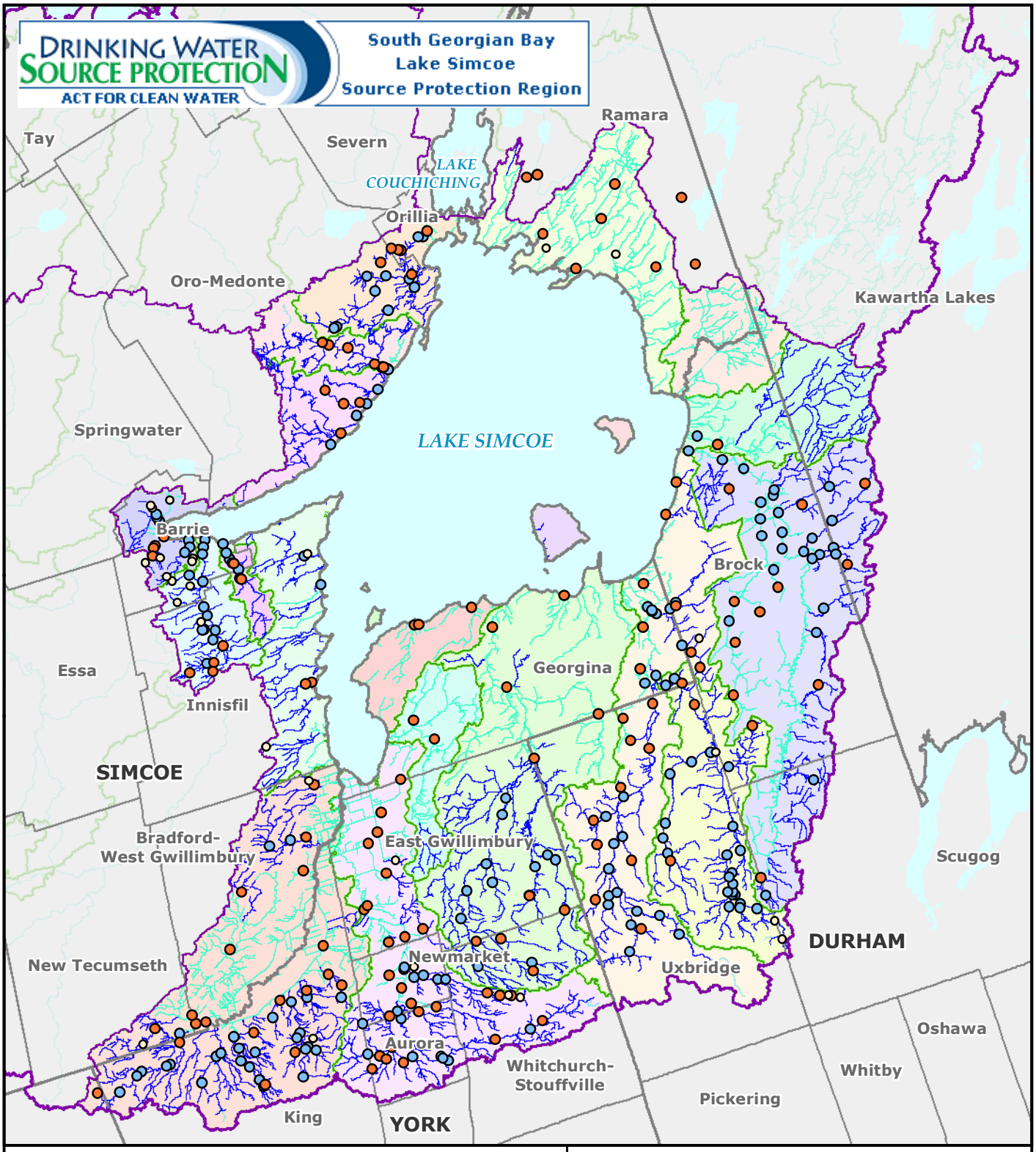
Created by: LSRCA
Date: 2010-02-02

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-12



Fish Sampling
- Warmwater Fish
- Coldwater Fish
- No Fish

Watercourse Thermal
- Cold Watercourse
- Warm Watercourse

Location and Types of Aquatic Habitat

Created by: LSRCA
Date: 2009-11-30

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

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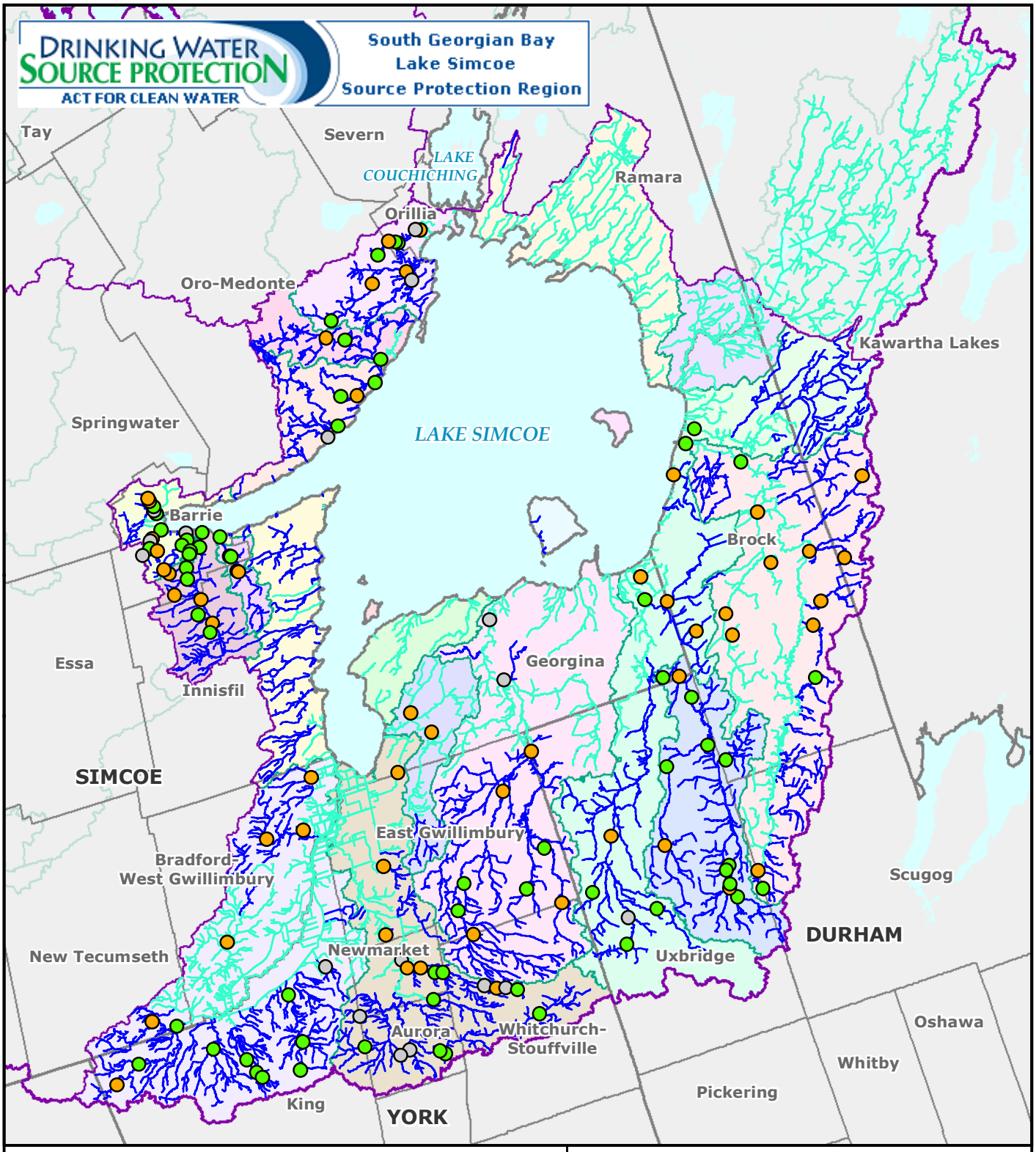
Ontario

Figure 2-13



Watercourse Thermal
- Cold Watercourse
- Warm Watercourse

Benthic Sampling (2002 - 2007)
- Unimpaired
- Impaired
- Inconclusive

Location and Condition of Aquatic Invertebrates

Created by: LSRCA
Date: 2009-11-30

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

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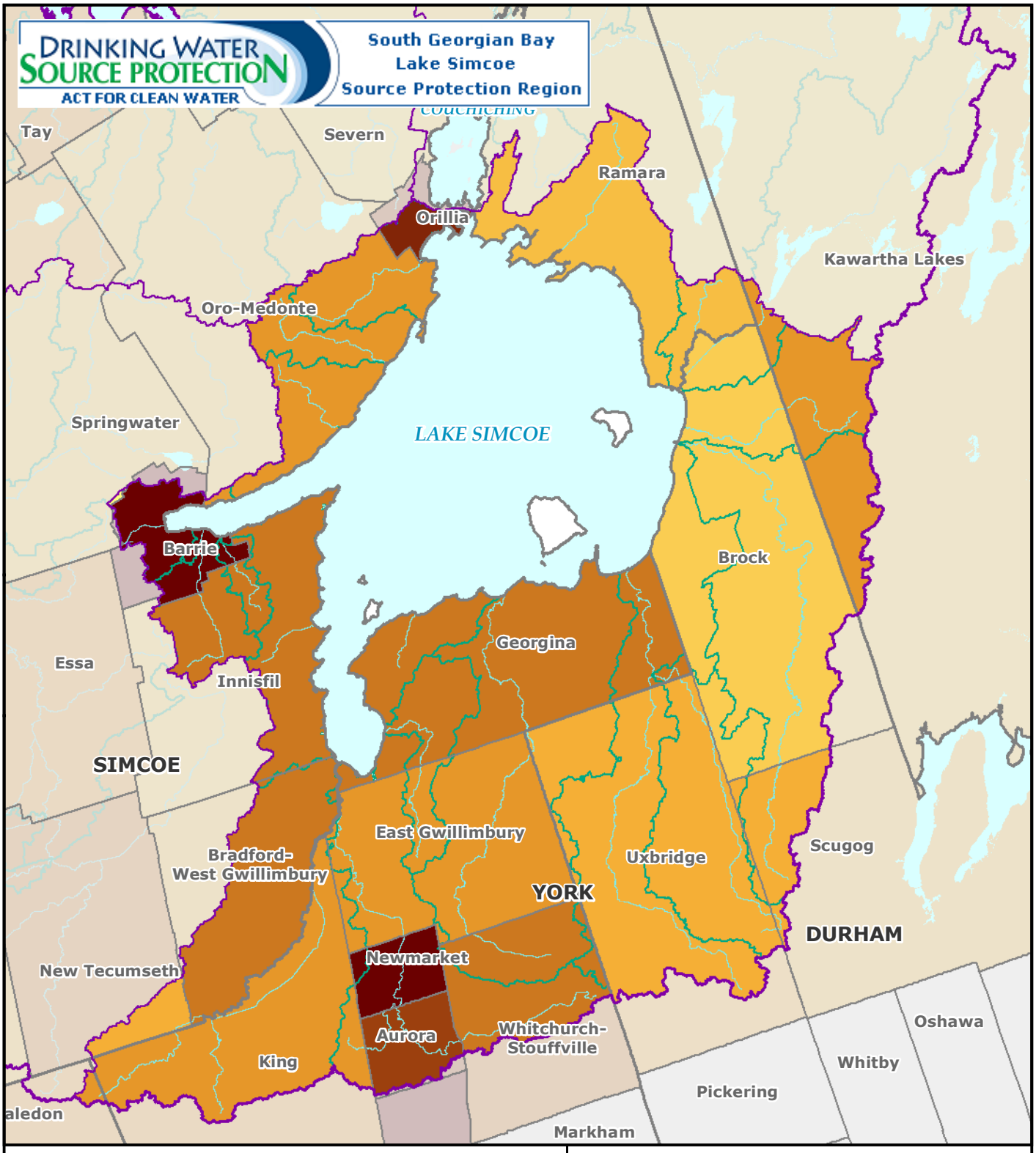
Ontario

Figure 2-14



Municipal Population Density in the Lake Simcoe Watershed

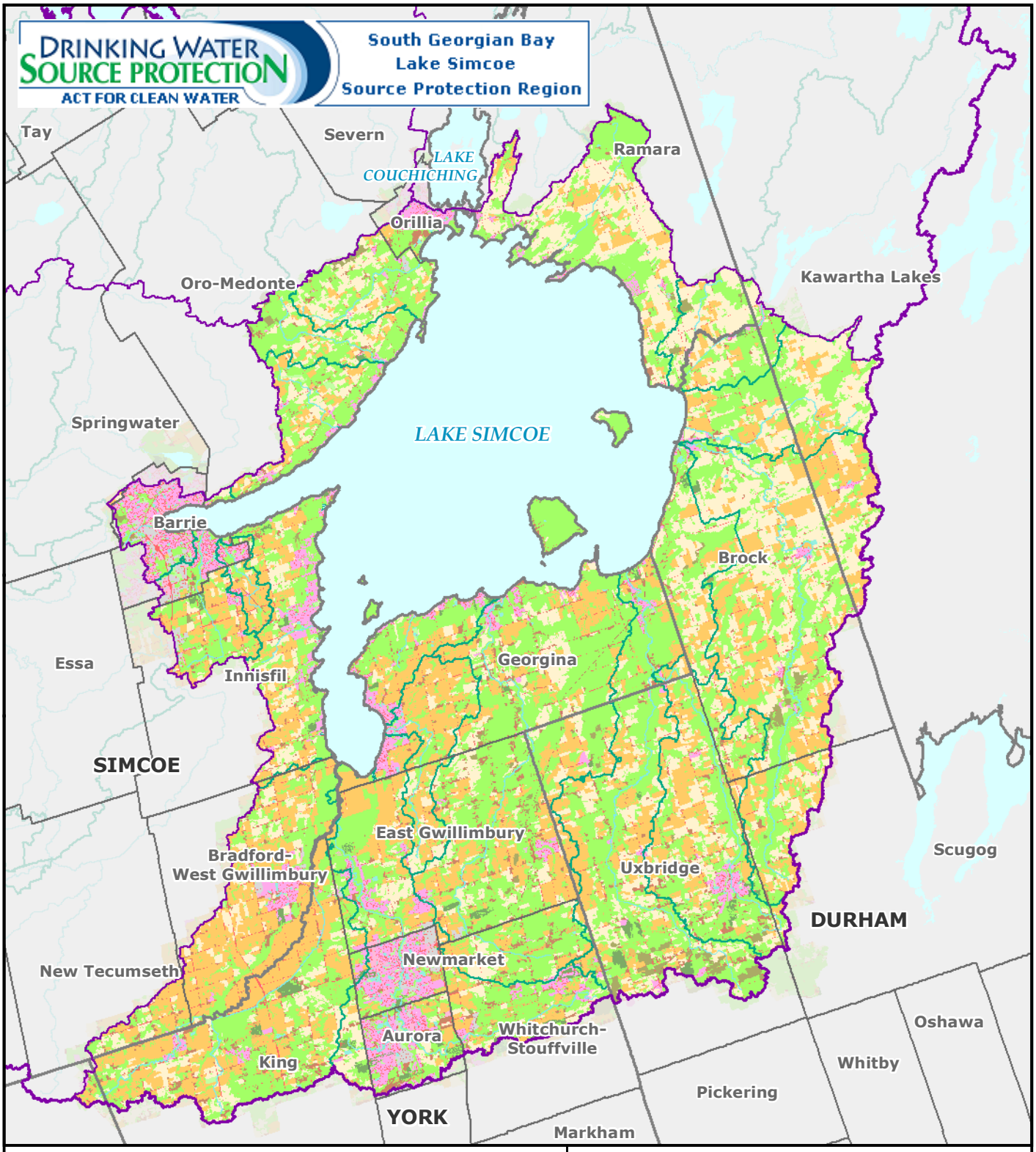
Created by: LSRCA
Date: 2010-01-26

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-15



ELC Land Use

- Active Aggregate
- Inactive Aggregate
- Intensive Agriculture
- Non-intensive Agriculture
- Commercial
- Industrial
- Institutional
- Estate Residential
- Golf Course
- Manicured Open Space
- Natural Heritage Feature
- Rail
- Road
- Rural Development
- Urban

Areas of Land Use

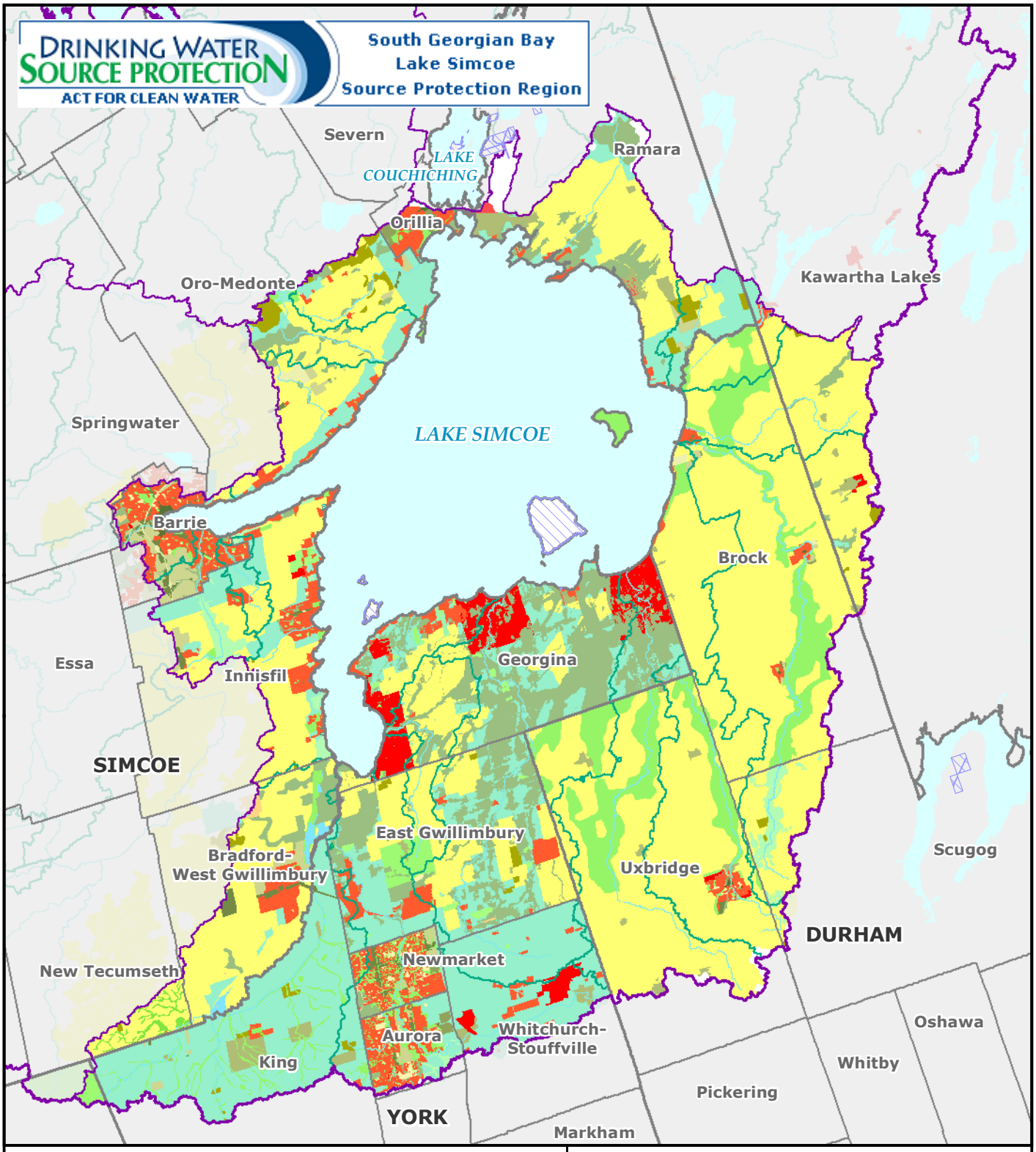
Created by: LSRCA
Date: 2010-01-13

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-16



Land Owner
- Indian Reserve
- Federal Lands

1-Designated settlement; 2-None
- 1 CBD
- 1 Commercial
- 1 Employment
- 1 Hamlet
- 1 Industrial
- 1 Infrastructure And Utility
- 1 Institutional
- 1 Landfill And Waste Disposal
- 1 Mixed Use
- 1 Residential
- 1 Urban
- 2 Aggregates And Extraction
- 2 Agricultural
- 2 Environmental Protection/Sensitive Areas
- 2 Greenlands/Natural Heritage
- 2 Hazard
- 2 Infrastructure And Utility
- 2 Open Space
- 2 Others
- 2 Park
- 2 Recreational
- 2 Referral/Deferral
- 2 Rural
- 2 Water
- 2 Wetland

Areas of Settlement and Land Owners as Defined in the *Places to Grow Act, 2005*

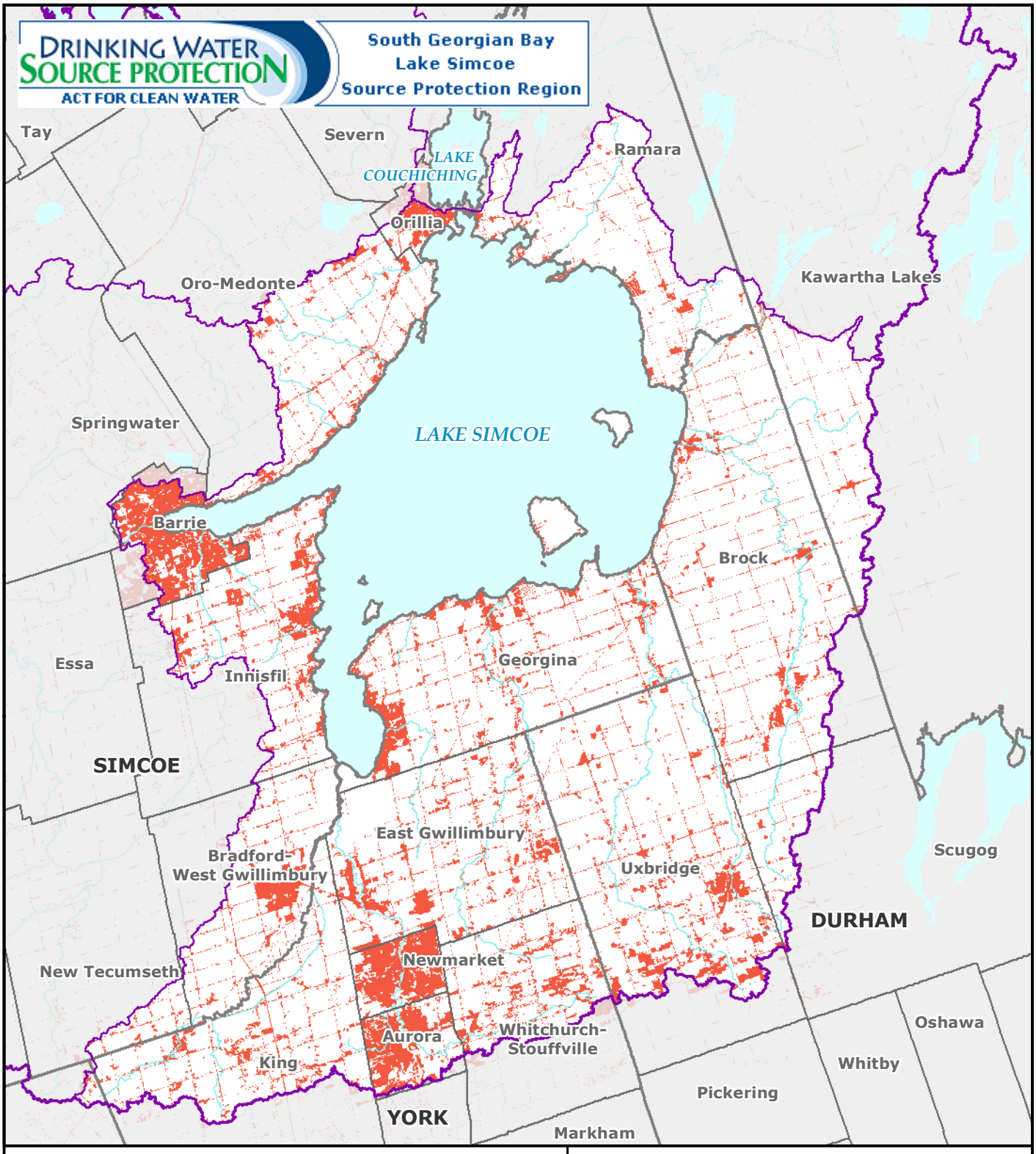
Created by: LSRCA
Date: 2010-02-26

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-17



Impervious Areas
(Hardened Surface such as roads and buildings)
SWP Watershed Region
SWP Watershed Area
Upper Tier Municipality
Lower Tiers Municipality
Water Body
Main Water Courses

Impervious Areas in Lake Simcoe Watershed

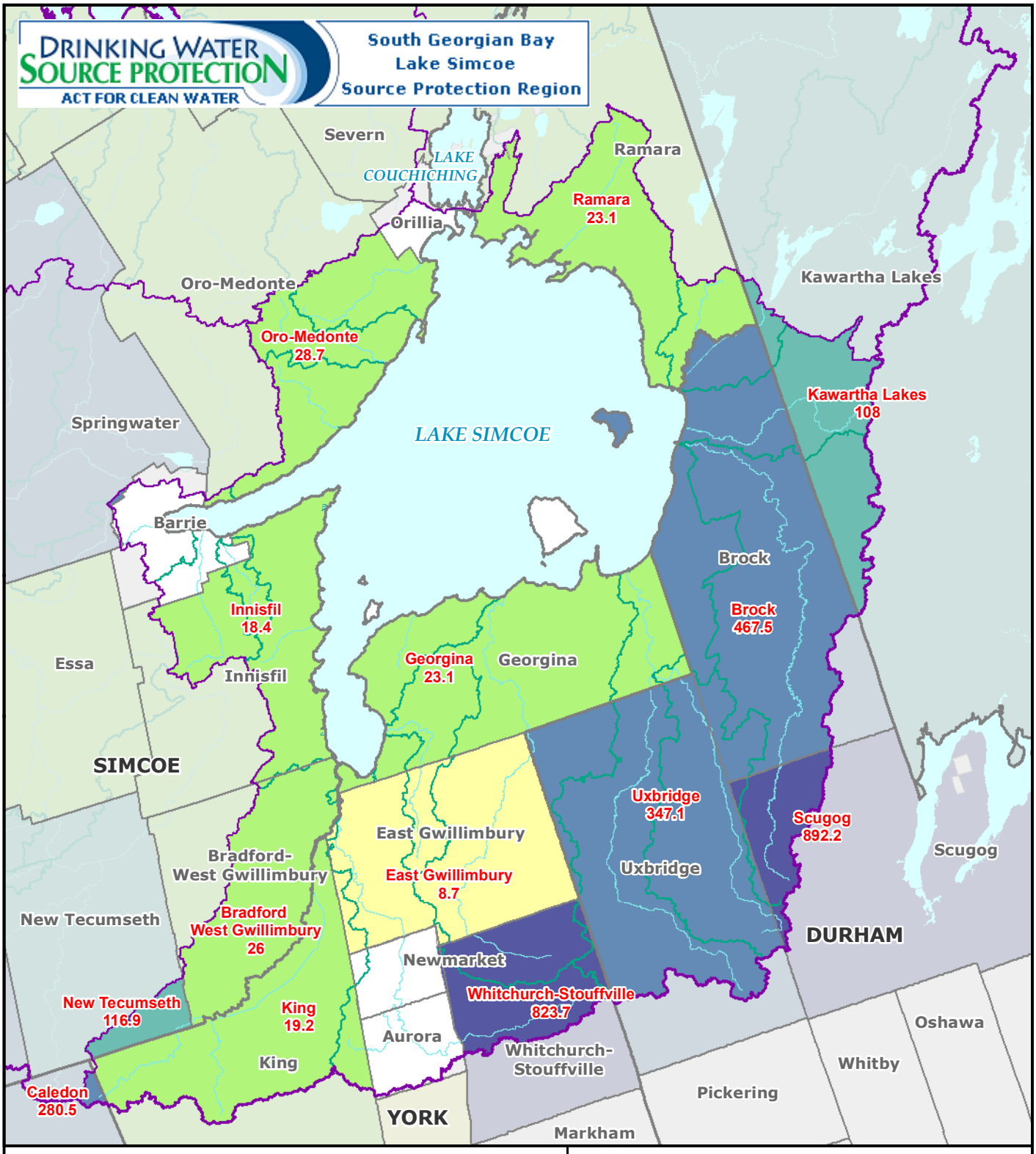
Created by: LSRCA
Date: 2010-02-16

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-18



Livestock Density (heads/km2)
- 1 - 10
- 11 - 50
- 51 - 100
- 101 - 200
- 201 - 500
- 501 - 1000

- SWP Watershed Region
- SWP Watershed Area
- Upper Tier Municipality
- Lower Tiers Municipality
- Water Body
- Main Water Courses

Location and Density of Livestock

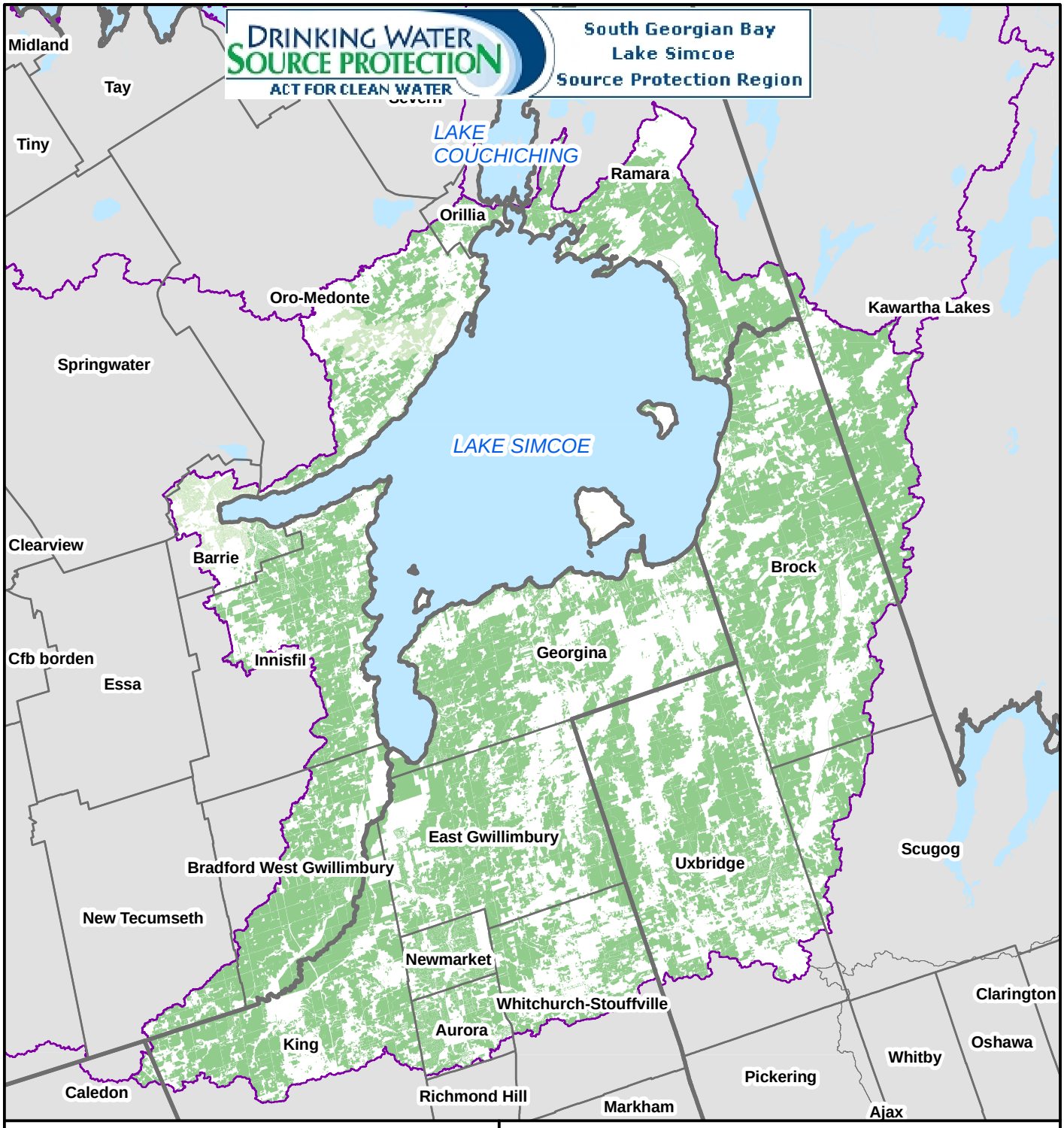
Created by: LSRCA
Date: 2010-02-17

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-19



Legend

- MANAGED LANDS (<40%)
- MANAGED LANDS (40-80%)
- MANAGED LANDS (>80%)
- UPPER TIER MUNICIPALITY
- LOWER TIER MUNICIPALITY
- SOURCE PROTECTION WATERSHED REGION

N W E S

4,600 2,300 0 4,600 Metres

Managed Lands in the Lake Simcoe Watershed

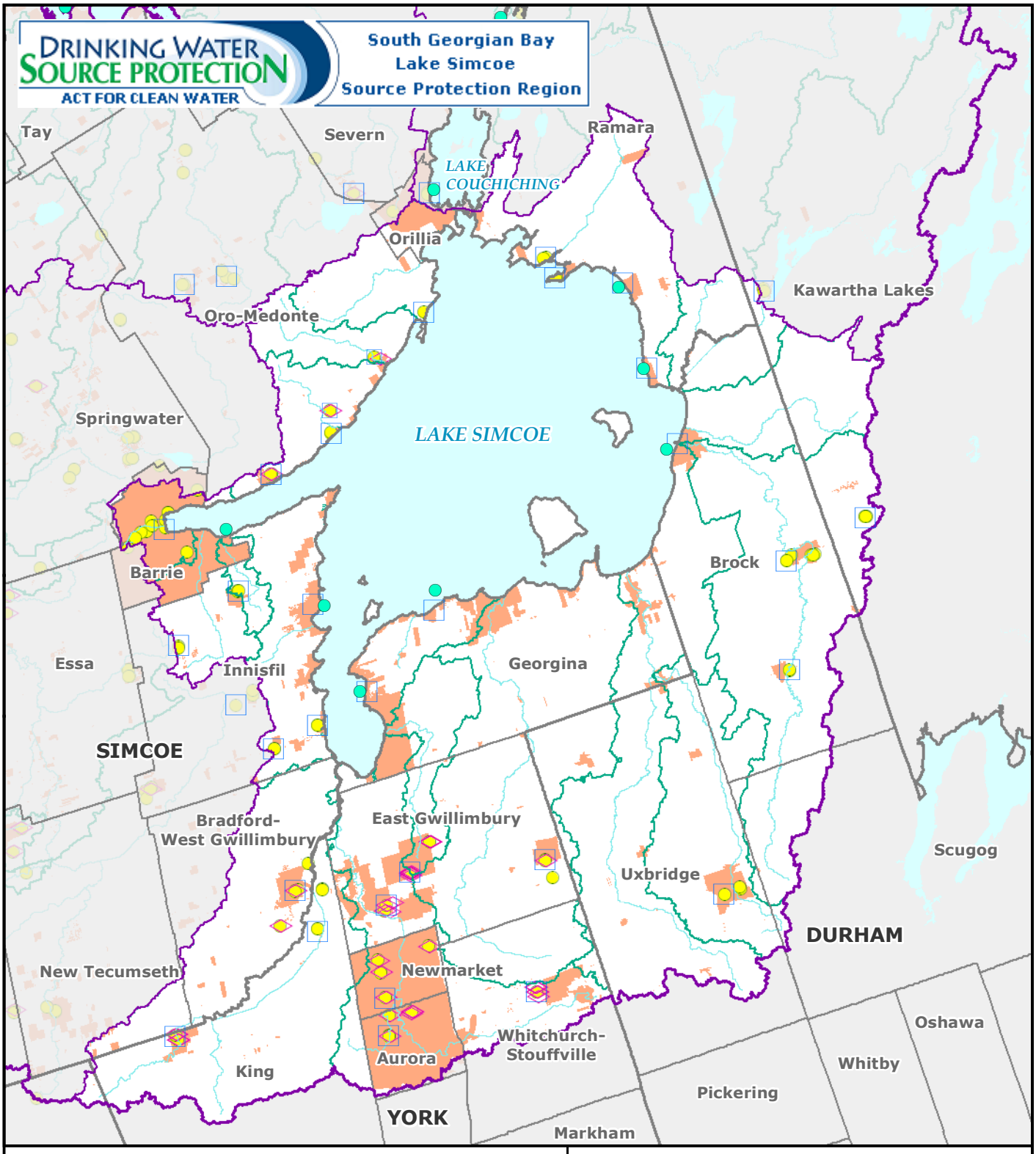
ASSESSMENT OF DRINKING WATER THREATS
SELECTED MUNICIPAL GROUNDWATER SUPPLIES
South Georgian Bay Lake Simcoe
Source Protection Region

DATE: JUNE 2010	SCALE: 1:470000
PROJECT: 0-071948.00	FILE. NO.:0-07194800F2-12

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

GENIVAR Ontario

FIGURE **2-20**



Large Municipal Residential
Small Municipal Residential
Serviced Areas (Municipal and Non-Municipal)
Municipal SW Intakes
Municipal Supply Wells
Monitoring Wells

Drinking Water System - Intakes, Supply Wells, and Monitoring Wells in Term of Reference

Created by: LSRCA
Date: 2010-02-17

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
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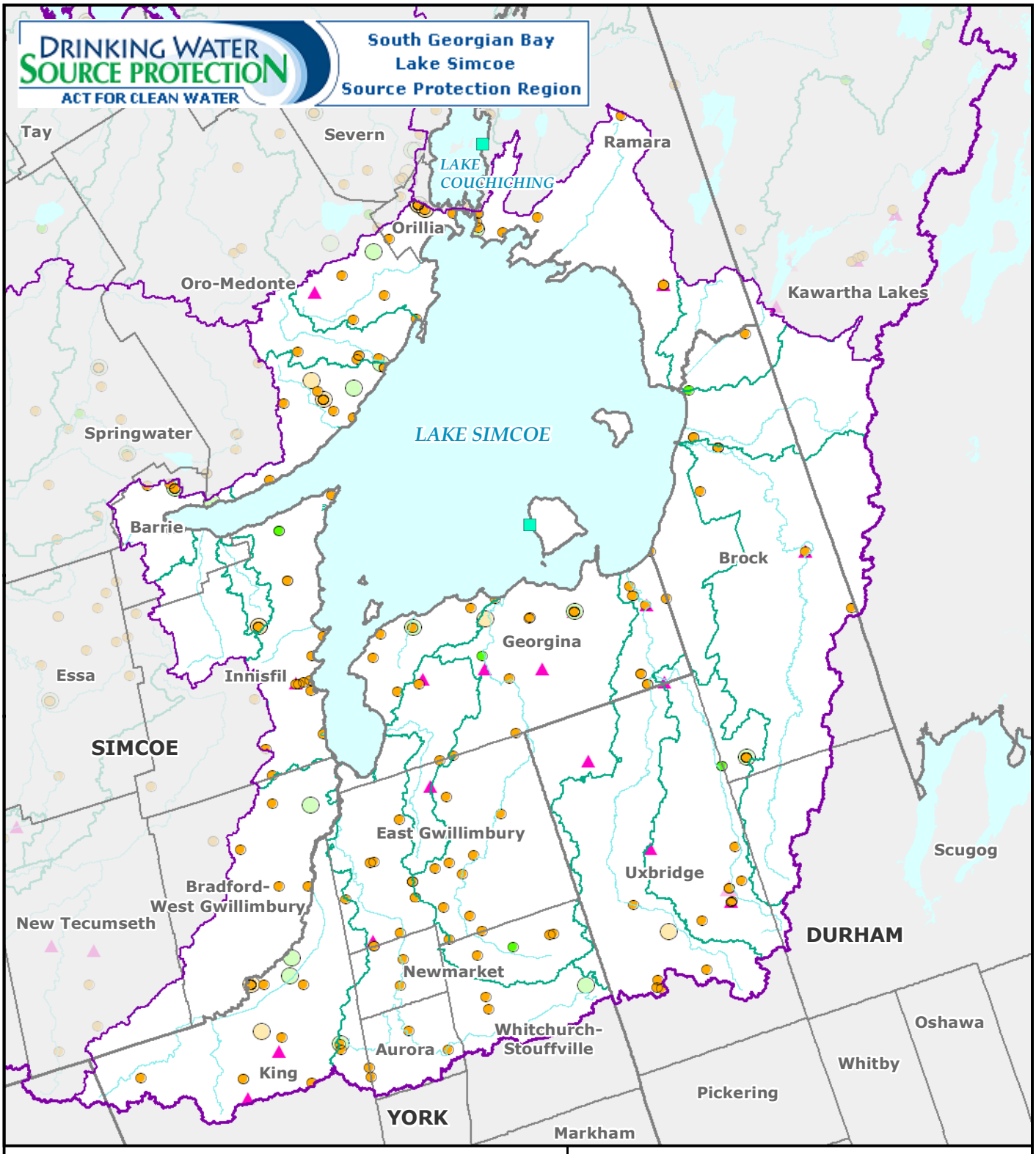
Ontario

Figure 2-21



- Surface Water Intakes -- First Nation
- Large Municipal Non-Residential
- Small Municipal Non-Residential
- Large Non-Municipal Non-Residential
- Small Non-Municipal Non-Residential
- Non-Municipal Year-Round Residential
- Non-Municipal Seasonal Residential

Drinking Water System (Non-Residential and Non-Municipal)

Created by: LSRCA
Date: 2010-02-17

Scale: 1:450,000
0 2 4 6 8 10km
UTM Zone 17N, NAD83

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 2-22