State of the Watershed Report

East Holland River Subwatershed

completed by
The Lake Simcoe Region Conservation Authority
2000

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STEERING COMMITTEE

Sue Seibert, Town of Aurora
Jason Unger, Town of Newmarket
Ruth Coursey, Town of East Gwillimbury
James Morning, Township of King
Andrew McNeely, Town of Whitchurch-Stouffville
M. Craig Piper, Regional Municipality of York
Peter Roberts, Ontario Ministry of Agriculture and Rural Affairs
Ian Buchanan, Ontario Ministry of Natural Resources
Steve Maude, Ontario Ministry of the Environment
Karen Jones, Ontario Ministry of the Environment
Reinie Vos, Lake Simcoe Region Conservation Authority

PUBLIC ADVISORY COMMITTEE:

Brian Clarke
James Elliott
Robert Elliott
Aimee Garcia
David Lanziner
Willard Petersen
Roger Routledge
Bob Taylor

EAST HOLLAND RIVER SUBWATERSHED STUDY TEAM

Lake Simcoe Region Conservation Authority

Michael Walters
Reinie Vos
Andrea Gynan
Geoff Peat
Tom Hogenbirk
Andrea Ferguson Jones
David Lembcke
Stefan Romberg
Graeme Davis

Hydrogeology Consultants

S. N. Singer, C. K. Cheng & I. Solovykh
Environmental Monitoring and Reporting Branch
Ontario Ministry of the Environment

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Tim Phaneuf
Aaron Wood
Joanna Parsons
Steve Rennick
Matthew Purvis
Claire Bradley

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Introduction and Goals

The Holland River watershed is located in the southwest corner of the Lake Simcoe watershed. It is composed of two major tributaries, the East Holland and the Holland\Schomberg Rivers. The East Holland River is the smaller of the two areas draining approximately 243 km² or 41% of the total Holland River Subwatershed area.

The East Holland River Subwatershed is located almost entirely with the Regional Municipality of York. It contains portions of the Municipalities of Whitchurch-Stouffville, King, East Gwillimbury, Georgina, Newmarket and Aurora. There is a small portion of the south-east section of the Subwatershed that lies in the Township of Uxbridge in the Regional Municipality of Durham.

Human activities within the Subwatershed have had a significant impact on the health of the ecosystem. In addressing the current health of the Subwatershed and developing a strategy for the future it was important that a balance be found between the environmental health of the Subwatershed and future urban growth. To this end two guiding principals were adopted, they are:

- ***To Protect What Is Healthy**, and*
- ***To Rehabilitate What Is Degraded**.*

The Health of the East Holland River Subwatershed

Natural features and functions of the Subwatershed were divided into three categories for detailed investigation being Land, Water and Community.

<u>Land</u>

A wide range of terrestrial habitats were examined and their role in offering a variety of habitats for wildlife, providing resources and recreational opportunities for humans and for maintaining the aesthetic and biological quality of the Subwatershed as a whole. Overall it was found that terrestrial habitats in the Subwatershed are highly fragmented and a mere remnant of what existed prior to settlement in the region. Species that are sensitive to habitat size and shape were found to be limited to particular areas or not found at all within the Subwatershed. Furthermore, the rapid urbanization of the Subwatershed over the past few decades continues to put pressure on these remaining terrestrial habitats.

Water
Four factors were considered that relate to water in the East Holland River Subwatershed, including Water Quality, Hydrogeology, Water Quantity and Aquatic Habitat.

Water quality in the East Holland River was found to be poor. However, when compared to historic data an improvement in water quality over time could be seen. One major source of pollution to the river was found to be from urban areas through stormwater runoff.

Three major aquifer complexes were identified in the hydrogeological analysis of the Subwatershed. These aquifers are responsible for not only providing a groundwater supply to the municipalities within the Subwatershed but also sustains the base flow of the East Holland River. Groundwater quality was also analysed and found to be good.

The East Holland River Subwatershed was modelled to determine the water quantity characteristics of the Subwatershed. The results found that the southern section of the Subwatershed has a very low runoff potential with the majority of the water evaporating or infiltrating to aquifers. The northern section has a high runoff potential due to its lower elevation and clayey soils.

Aquatic habitat in the East Holland River Subwatershed has been diminishing, especially for fish species sensitive to temperature and pollution. This is shown through the fewer sections of river inhabited by temperature sensitive species such as brook trout. Current and future development in the Subwatershed poses a threat to the remaining habitats and fisheries in the river.

Community
The factors examined under community included Recreation, Natural Hazards, Urban Growth and Infrastructure.

Numerous and diverse recreation opportunities were identified within the East Holland River Subwatershed. Some practices associated with certain recreational activities can have a detrimental effect on the health of the Subwatershed and may even impact the recreational activity itself.

The most significant natural hazard that exists in the East Holland River Subwatershed *is flooding. The majority of the flood plain has been left free of development and therefore these areas face little threat of flood damage. However, there are sections in older areas of some towns where development has occurred in the floodplain. In these areas flooding still threatens lives and property.*

Urban areas are expected to continue to grow rapidly in the East Holland River Subwatershed. The urban area of the Subwatershed is scheduled to increase by more than 50% over the next 10 to 12 years.

There are several infrastructure works scheduled to be completed in the East Holland Subwatershed including the Highway 404 extension and the Highway 400 - 404 link. These works will have an impact on the natural features of the Subwatershed. All of the scheduled works have completed an Environmental Assessment that details these impacts and the mitigating actions to be taken.

Directions For Management

The following report outlining the existing state of the East Holland Subwatershed is only one step of a strategy designed at improving the health of the Subwatershed. The next step will be the completion of a second report detailing some solutions to the problems facing the Subwatershed and their estimated costs. The report will also provide tools to assist in future planning in the Subwatershed such as an environmental screening map. Other initiatives to help monitor the health of the Subwatershed will also be recommended, such as water quality and temperature monitoring. Working together we can insure that the East Holland River Subwatershed will be a resource that future generations can enjoy as well.

PART I INTRODUCTION

Chapter 1 Background

In 1991 the Lake Simcoe Region Conservation Authority (LSRCA) initiated its first watershed plan. This plan was for Lovers and Hewitts Creek and was prepared in cooperation with the City of Barrie and the Town of Innisfil. Like many other plans, this one was initiated due to concerns over increasing development in the watershed. The majority of the work done to prepare this plan was conducted by the consulting firm of Cumming Cockburn Limited and was completed in 1995.

In 1996, the LSRCA began work on developing a watershed plan for the Uxbridge Brook. This work was requested by and done in cooperation with the Township of Uxbridge in response to growing pressures on the local sewage treatment plant and local concerns for the protection and enhancement of the natural environment. With the exception of the hydrogeology work, this plan was prepared entirely by the Conservation Authority. This plan was completed in 1997 and is currently being implemented in cooperation with the Uxbridge Brook Watershed Committee which has been appointed by the Township of Uxbridge Council.

In 1998, the LSRCA began work on a Remedial Strategy for the Maskinonge River Subwatershed in cooperation with the Town of Georgina. This plan was motivated by the poor water quality in the Maskinonge River that was causing excessive growth of duckweed in the river. Like the Uxbridge Brook Watershed Plan, this strategy was developed entirely by the LSRCA with the assistance of a consultant for the hydrogeology components. The Town is currently implementing recommendations from the Remedial Strategy and is making significant progress in improving water quality both in the river and in Lake Simcoe.

The planning process for the East Holland Subwatershed Plan was initiated in 1998 by local municipalities. It was recognised that rapid local growth being experienced in the area was placing pressure on the natural environment. This is yet another LSRCA project with hydrogeology support from the Ontario Ministry of the Environment. Field work and the development of an organisational structure were done during the summer of 1999. Data compilation and report preparation took place during the Fall/Winter/Spring of 1999/2000.

The LSRCA Watershed Planning Model has been evolving over the last nine years of work. Currently, a three stage model for developing and implementing watershed plans is being used as follows:

Stage 1 The preparation of a "State of the Watershed Report" which provides a summary of the natural and cultural resources in the watershed providing sufficient data to identify areas requiring protection or rehabilitation. Participation of a technical Steering Committee as well as a Public Advisory Committee begins during the final part of this Stage.

Stage 2 The primary work of the Steering Committee and the Public Advisory Committee begins in this Stage as the watershed management plan is developed. The work done in Stage 1 provides the background to develop a strategy to protect natural features and rehabilitate degraded areas.

Stage 3 The community guides the Lake Simcoe Region Conservation Authority in the implementation of the Watershed Plan and monitors progress towards goals set out in the Plan.

This report on the State of the East Holland River Subwatershed completes Stage 1 and provides information on the natural and cultural resources found in the Subwatershed and attempts to assess their health. The report has been developed using an ecosystem approach and indicates where linkages exist between resources. It will provide those working to develop the Subwatershed Plan with sufficient information to identify areas that require protection as well as areas that require rehabilitation.

Chapter 2 Watershed Planning Principles

The ecosystem approach to environmental management takes into consideration all components of the natural environment including land, water and air. It also considers the flow of energy throughout the system and since humans have such a significant impact on the environment, we are also included in the ecosystem. Scale is also an important aspect of ecosystems since they can range in size from a small pond to the entire planet. Therefore it is extremely important when undertaking an ecosystem based study to be sure and select the most appropriate scale for the study objectives.

To manage natural resources using an ecosystem approach it is essential to establish biophysical boundaries. Watersheds have been identified as the best "fit" for the implementation of an ecosystem study because they are virtually self contained water based ecosystems (MOE & MNR, 1993c). Watersheds are defined as an area of land drained by a watercourse and subsequently, the land draining to a tributary of a main watercourse is called a subwatershed. Watershed processes are controlled by the hydrologic cycle (Figure 2.1). This movement of water influences topography, climate and life cycles. It is due to this connectivity that any change within the watershed will impact other parts of the watershed.

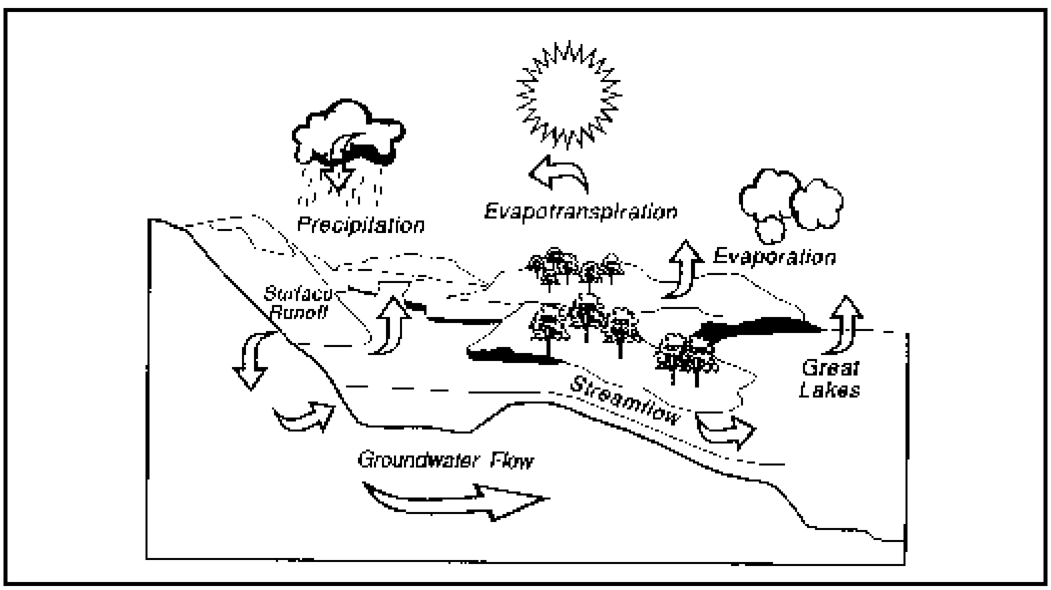


Figure 2.1 The Hydrologic Cycle (after OMOE & OMNR, 1993c.)

Watershed planning is an integrated approach that takes into consideration all socio-economic, physical and biological factors. A well-prepared subwatershed plan will contain the following components:

- The delineation of the subwatershed boundaries;
- The relationship of the subwatershed plan to other planning documents;
- The identification of form and function of natural systems;
- The resource management objectives for the subwatershed;
- Recommendations for protection, rehabilitation, and enhancement;
- An implementation plan including a strategy for future monitoring.

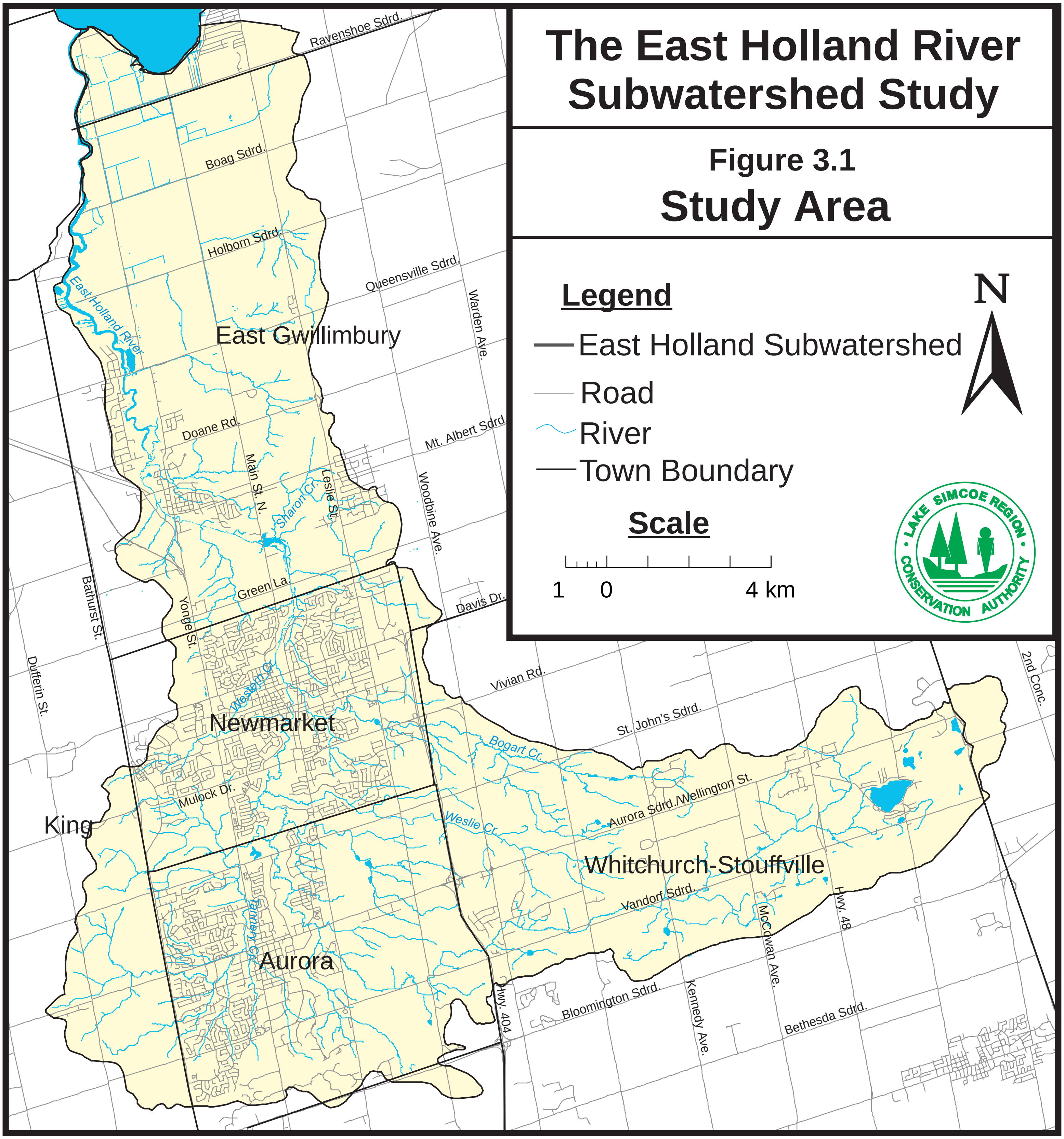
The resulting plan will protect the existing natural resources, facilitate more informed planning decisions, speed up the development planning process and ultimately, save money for all stakeholders. It is important for all to remember that it is much more beneficial, both financially and ecologically, to protect resources from degradation rather than try and undo the damage once it has been done.

Chapter 3 The East Holland River Subwatershed

The Holland River watershed is located in the southwest corner of the Lake Simcoe watershed. It is composed of two major tributaries, the East Holland and the Holland\Schomberg Rivers (Figure 3.1). The East Holland River is the smaller of the two areas draining approximately 243 km^2 or 41% of the total Holland River Subwatershed area. Like many of the rivers which drain into Lake Simcoe, the headwaters of the East Holland River originate in the Oak Ridges Moraine.

The Oak Ridges Moraine is one of the major physiographic features in Southern Ontario that was formed during the Wisconsin era of glaciation. A moraine is a linear ridge of rock debris that was pushed in front of the glacier and then left behind when the glacier retreated. The coarse, well-drained composition of the Oak Ridges Moraine makes it a very important component of the local hydrogeologic system. Infiltration of surface water allows for the recharge of both deep and shallow underground aquifers. Many of the streams in the area, including the East Holland, depend on the discharge of the shallow groundwater system to maintain baseflow. In addition, many local communities rely on the deep groundwater aquifers for their drinking water. The moraine terrain is characterised by a combination of irregular hills and many depressions. These depressions are complemented by “kettles” which are formed when partially buried remnant ice chunks are left behind by the receding glacier. As the ice chunk melts, a depression is left behind, some of which are large enough to form small lakes. Musselman Lake is an excellent example of a “kettle lake” within the East Holland Subwatershed.

The areas north of the Moraine have also felt the effect of extensive glaciation. Large quantities of glacial till, which is a conglomeration of rock, sand and clay, was deposited over the region. As a result, the bedrock below has had little influence over the physiographic development of the region. Another significant physiographic feature In the study area is the Schomberg Clay Plain which was formed when sediments were deposited by an ancient glacial lake called Lake Schomberg. This clay was deposited over the existing till plain and



The East Holland River Subwatershed Study
Figure 3.1
Study Area
Legend
East Holland Subwatershed
Road
River
Town Boundary
Scale
1 0 4 km
N
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Doane Rd.
Mt. Albert Sdrd
Green La.
Davis Dr.
Vivian Rd.
St. John's Sdrd.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Bloomington Sdrd.
Bethesda Sdrd.
Warden Ave.
Main St. N.
Leslie St.
Woodbine Ave.
Yonge St.
Bathurst St.
Dufferin St.
Hwy. 404
Kennedy Ave.
McCowan Ave.
Hwy. 48
2nd Conc.

obscures some typical till plain features such as drumlins. Figure 3.2 illustrates the topography that influences the East Holland River through the use of a Digital Elevation Model.

There are a variety of soil types in the East Holland River Subwatershed (Figure 3.3). In the urban areas of Aurora and Newmarket, clay loam which is a part of the Schomberg Clay Plain is dominant and is found in 23% of the Subwatershed. In keeping with the moraine environment, the headwater areas are a combination of sand, clay and loam. There are also organic soils in this area that occur in valley areas along the river. However, the largest portion of organic soils is found in the Holland Marsh where the entire area is organic. The east side of the Subwatershed up through East Gwillimbury is dominated by silt loam, sandy loam, fine sandy loam and loam. These soils are remnants of the edge of glacial Lake Algonquin. This combination of soil types has historically made the Subwatershed a well suited area for agriculture.

Unlike physiographic features, municipal boundaries are not readily discernable across the landscape. The East Holland River Subwatershed is located almost entirely with the Regional Municipality of York. It contains portions of the Municipalities of Whitchurch-Stouffville, King, East Gwillimbury, Georgina, Newmarket and Aurora. There is a small portion of the south-east section of the Subwatershed that lies in the Township of Uxbridge in the Regional Municipality of Durham. Human activities within the Subwatershed have had a significant impact on the health of the ecosystem. Some of these activities occurred long ago but the repercussions are still influencing the Subwatershed today. It is important therefore to understand the past history of the area to gain an understanding of existing conditions.

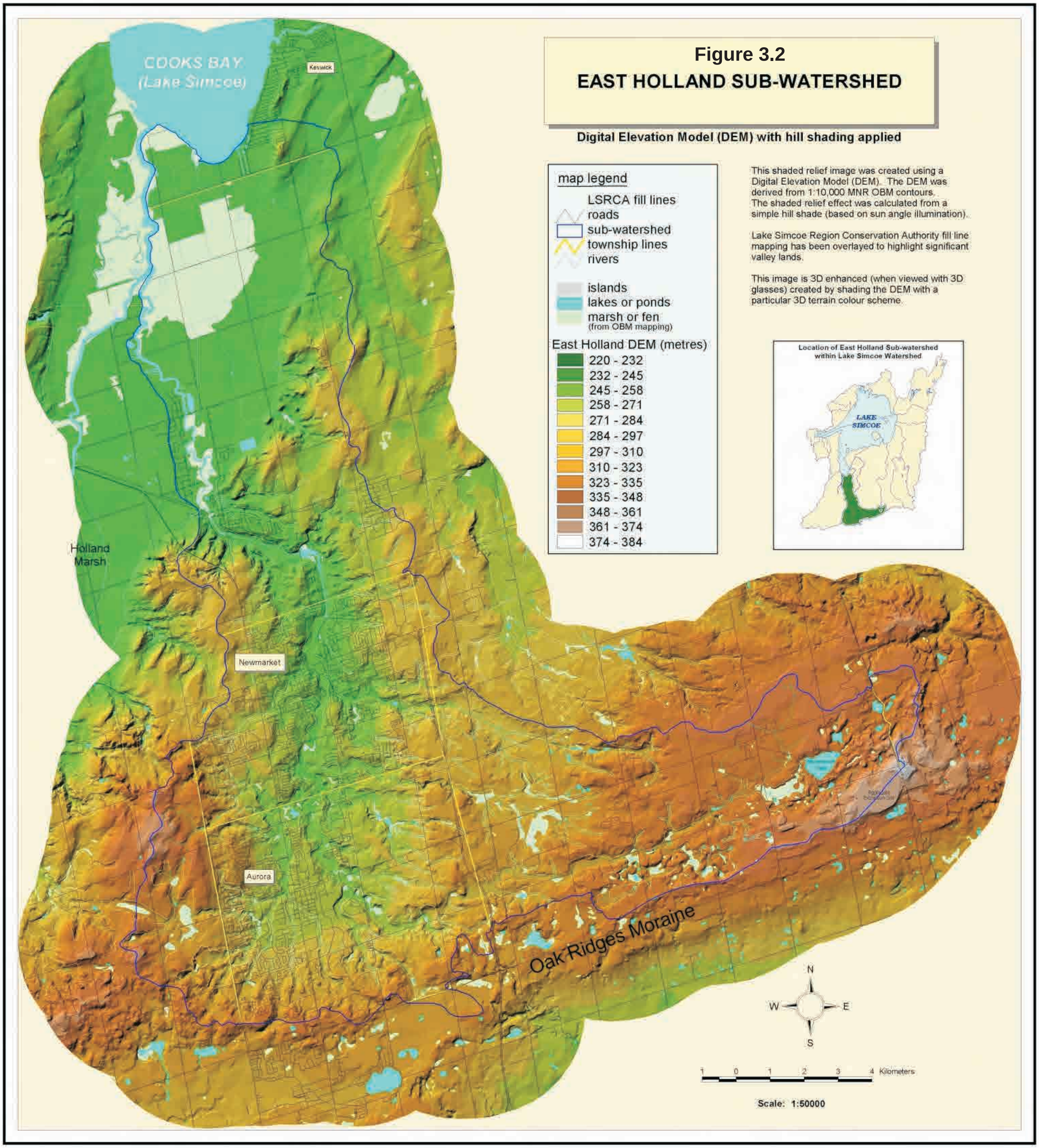
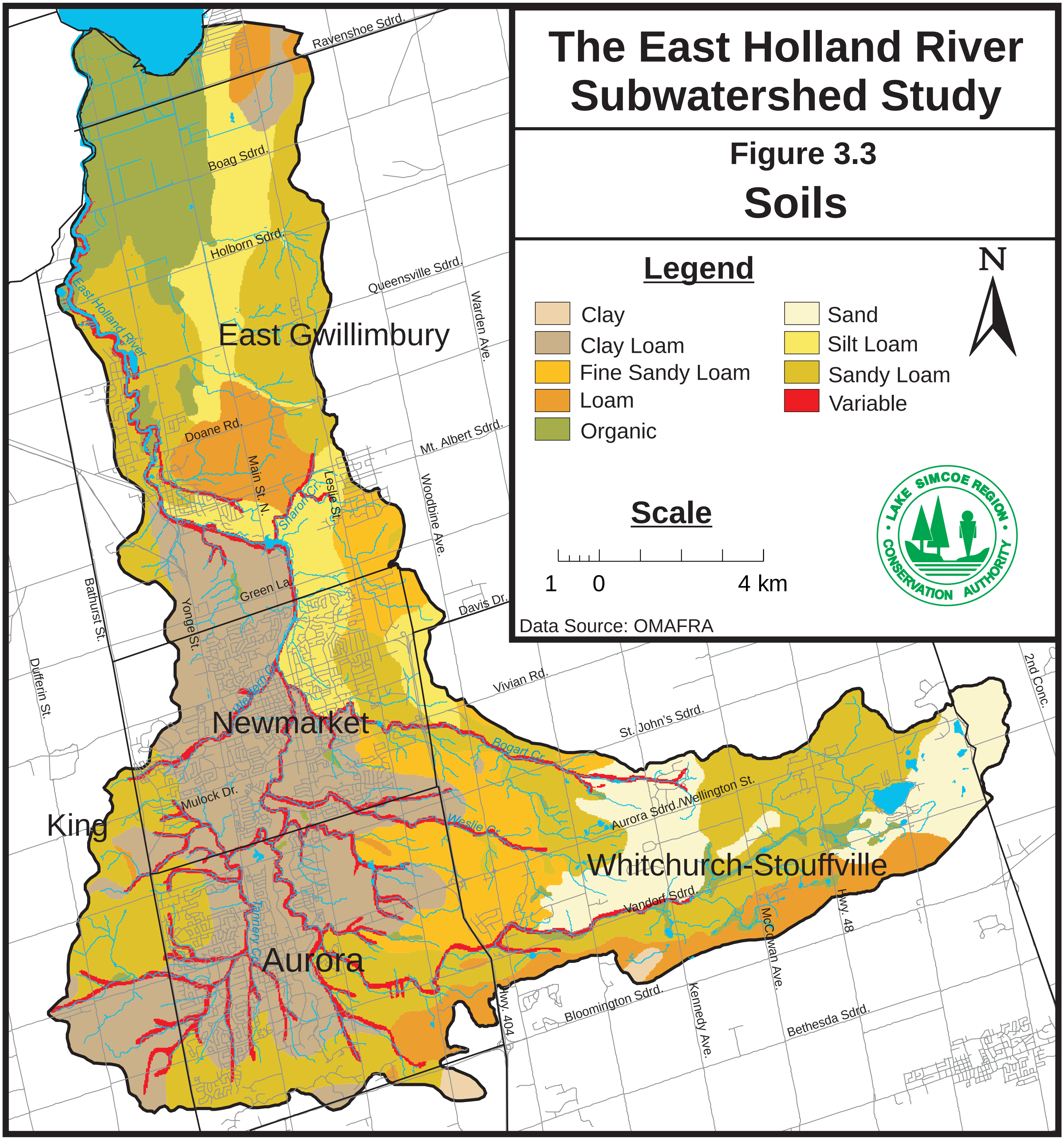


Figure 3.2
EAST HOLLAND SUB-WATERSHED
Digital Elevation Model (DEM) with hill shading applied
COOKS BAY
(Lake Simcoe)
Keswick
Holland Marsh
Newmarket
Aurora
Oak Ridges Moraine
map legend
LSRCA fill lines
roads
sub-watershed
township lines
rivers
islands
lakes or ponds
marsh or fen
(from OBM mapping)
East Holland DEM (metres)
220 - 232
232 - 245
245 - 258
258 - 271
271 - 284
284 - 297
297 - 310
310 - 323
323 - 335
335 - 348
348 - 361
361 - 374
374 - 384
This shaded relief image was created using a Digital Elevation Model (DEM). The DEM was derived from 1:10,000 MNR OBM contours. The shaded relief effect was calculated from a simple hill shade (based on sun angle illumination).
Lake Simcoe Region Conservation Authority fill line mapping has been overlayed to highlight significant valley lands.
This image is 3D enhanced (when viewed with 3D glasses) created by shading the DEM with a particular 3D terrain colour scheme.
Location of East Holland Sub-watershed within Lake Simcoe Watershed
LAKE SIMCOE
N
W
E
S
1 0 1 2 3 4 Kilometers
Scale: 1:50000



The East Holland River Subwatershed Study
Figure 3.3
Soils
Legend
Clay
Clay Loam
Fine Sandy Loam
Loam
Organic
Sand
Silt Loam
Sandy Loam
Variable
N
Scale
1 0 4 km
Data Source: OMAFRA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Doane Rd.
Mt. Albert Sdrd.
Main St. N.
Leslie St.
Woodbine Ave.
Green La.
Davis Dr.
Bathurst St.
Yonge St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
2nd Conc.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
McCowan Ave.
Hwy. 48
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.

Chapter 4 The History of the East Holland River Subwatershed

Exploration and Early Settlement

The region has been inhabited by humans since the retreat of the Wisconsin Glacier more than 3500 years ago. The native inhabitants included nomadic hunters, the Laurentian Indians and the Woodland Indians. Just prior to the arrival of the Europeans, the Iroquois occupied the region. This group had a strong presence in the area since the 12th Century. These original inhabitants were responsible for establishing the Rouge, Humber and Don Trails all of which served to connect Lake Ontario and Lake Huron via the Holland River and Lake Simcoe. These trails were of great significance to the later development and settlement of the area. These original inhabitants did not have a significant environmental impact as they generally tried to live in harmony with nature.

Early explorers.

The first European in the region was Etienne Brûlé who arrived in 1615 as part of Champlain's campaign against the Iroquois. Most European activity during this period was centred around the fur trade. In 1792, John Graves Simcoe, first Lieutenant-Governor of Upper Canada established York County. It was at this time that land grants started being issued to the settlers.

John Graves Simcoe

As a part of this early settlement, it was determined that a road connecting Lake Ontario to Lake Huron would be required to replace the current trails. This "Military Street" would eventually become Yonge Street named after Sir George Yonge, secretary of war in the British Cabinet. Augustus Jones, Deputy Provincial Surveyor began the road in 1794 which would run from York, now the City of Toronto, to the Pine Fort at

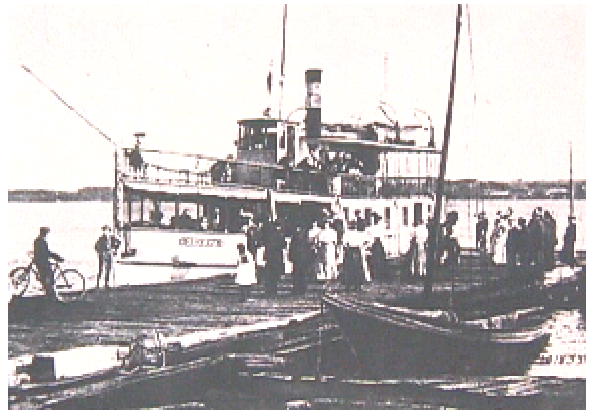
Holland Landing. The Queen's Rangers were brought in to assist with many of the major road building tasks. However, this work force was called away before the project was finished due to the returning threat of war with the United States. It was at this time that William Berczy was approached to provide assistance. Berczy had come to the area from the United States with a group of German settlers. In exchange for lands in the Markham area, Berczy and his German settlers made a significant contribution to the construction and improvement of Yonge Street.

One of the conditions of settlement for areas along Yonge Street was to clear and improve the half of the road adjacent to their property. This was only a minor contribution since there were many absentee landowners. The final completion of Yonge Street came when Augustus Jones was able to return with the Queen's Rangers. Jones was able to report back to Governor Simcoe that the road was completed to Holland Landing on February 20, 1796. While the road was still very rough, it did provide an efficient route for settlers and connected York to Lake Huron.

With the completion of Yonge Street came the development of several small communities along its length including the two largest in the East Holland Subwatershed, Aurora and Newmarket. Newmarket was the faster growing of the two due to its proximity to Holland Landing. With the construction of grain and saw mills to supply the growing number of settlers, Newmarket became the major trading centre north of York.

It was during this time period that the Holland River was given its current name. The different native peoples that inhabited the area each had their own name for the river. Prior to European settlement, the river was known both as the River Escoyondy and Miciaguean. In 1793, it was named Holland's River after Major Samuel Holland, Surveyor General of Upper Canada. The name was eventually shortened to Holland River.

In the early 1800's, settlement was also taking place around Lake Simcoe. However, problems were encountered with transporting settlers and their belongings. For years, a single schooner was the sole means of transportation within the watershed carrying out commerce around the lake. As settlement pressure increased, more schooners and later steamboats were constructed along with roadways.



One of Lake Simcoe's Steamboats.

The environmental impact of these activities was related mostly to tree clearing activities associated with road building. Also, as more people moved into the area, impacts due to the clearing of land for homesteads as well as the increases in human related wastes would have been felt. Erosion would likely have been becoming a problem as the bare ground would have been quite susceptible.

Forest to Farmland

All of the communities experienced a period of growth in 1853 when the Ontario, Simcoe and Huron Railway was completed. This rail line was later renamed the Northern Railway and eventually ran from Toronto to Collingwood on Georgian Bay. Newmarket only experienced minor growth since it was already a major centre. However, Aurora was much more significantly impacted and experienced growth both in numbers of inhabitants and in the variety of industries present. Holland Landing experienced some growth as the continuing main access point to Lake Simcoe, but never would feel the same surge in development as other areas did. The overall result was the ability of people and goods to move easily to and from York and further settlement within the East Holland Subwatershed.

The detrimental effects of development became apparent in the late 1800's when soil erosion was a significant problem in many parts of Southern Ontario. The East Holland Subwatershed was part of an area which was known as the Great Canadian Pine Belt. Lumber mills were the first source of gainful employment for a large number of settlers with several mills located throughout the Subwatershed. Extensive tree cutting for the construction of homesteads, export to Britain and the United States as well as clearing for agriculture left soils vulnerable to wind and water erosion. The ability of the land to store water was lost and severe spring flooding resulted. The summers brought intense droughts to the area. Wind erosion was so severe that some roads were blocked by the shifting sands. This collapse in forest resources resulted in the decline of the lumber industry with the majority of sawmills ceasing operations.

Detrimental effects of deforestation. (Durham Region, 1930's)

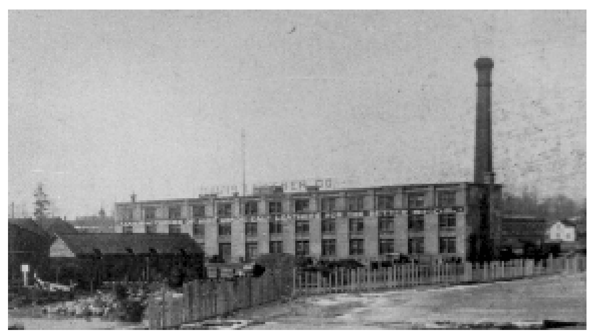
During the 1870's, farmers were encouraged to plant trees along roadways to reduce the wind erosion. These efforts were encouraged by the municipalities through a 25 cents per tree subsidy. Reforestation efforts were formalised in 1911 with the passing of the Counties Reforestation Act and subsequently by the Reforestation Act which was passed in 1921. The Reforestation Act enabled the establishment of tree nurseries and the supply of tree seedlings in addition to planting and management by the province. Counties were able to purchase barren farmland and place it under “management agreement” with the Department of Lands and Forests. This eventually led to the establishment of municipally run reforestation areas such as York Regional Forest tracts which exist today.

Industrialisation - From Rails to Roads

Most existing roads in the early 1900's were nothing more than simple reinforced earthen paths which usually turned into rivers of mud after a rainfall. The increasing demand to transport people and goods prompted the construction of better roads and alternative modes of transportation throughout the Subwatershed. One such alternative was the "radial system", an electric railway which was built in 1899 by the Metropolitan Toronto Street Railway Company. It ran up Yonge Street from North Toronto through Richmond Hill, Aurora, Newmarket and eventually all the way to Sutton. It provided an efficient mode of transportation for daily commuting, shopping trips, social events and farmers taking goods to market. The radial system so improved the access to Lake Simcoe that it is attributed with the promotion of the local tourist industry. It was not long after the radial railway was established that the number of seasonal residences, resorts and cottages around the lakeshore increased dramatically.

Concrete arch spanning the East Holland River for the Radial Railway.

The enhancements made to the transportation network benefited other aspects of the Subwatershed's economy, especially the manufacturing and agricultural industries by significantly reducing the cost and time involved with the transportation of goods. New industries like the Office Specialty Company and the Davis Leather Company established factories in Newmarket and began to flourish. It became practical to transport large quantities of locally produced eggs, butter and milk to the Toronto markets. It was during this time that the movement towards mass production, and the redistribution of the rural population towards urban centres began.



Davis Leather Company 1929.

The advent of the automobile foretold the end of the radial system. The ensuing popularity of the automobile as a cheap, independent form of travel resulted in further road reconstruction projects throughout the Subwatershed. In 1919, significant improvements were made along Yonge Street from Toronto to Barrie. As more and more people bought automobiles, the numbers using the radial railway declined and, in 1930, twenty one years after its completion, the last car arrived back at Hogg's Terminal in Toronto and the Lake Simcoe radial service was discontinued.

In the early 1900's, the idea to construct a canal connecting the Holland River to the Trent Valley Canal system was resurrected. Construction on the Newmarket Canal Project began in 1906 with the dredging of the first part of the canal from Lake Simcoe to Holland Landing. In 1908, construction began on a series of three locks, four bridges, a dock and a turning basin to be located in Newmarket. However, the project was consistently over budget and continually plagued by design problems and construction delays. This led many to question the benefit and feasibility of the project. A study was commissioned as a result and it indicated that once complete the canal operations would be extremely limited due to a lack of water. As a result, on January of 1912 the project was abandoned.

Lock #2 at Rogers Reservoir today.

Environmental impacts during this period would have been related to an increasing population and industrialisation. Water and air pollution would have been present as a result of the larger population and discharges from local factories. As the urban area grew, there would have been increases in stormwater discharges due to a decrease in vegetation and an increase in impermeable ground. The stormwater would have carried pollutants from the streets into the river and increased the flow causing erosion.

<u>A Trend Towards Urbanisation</u>

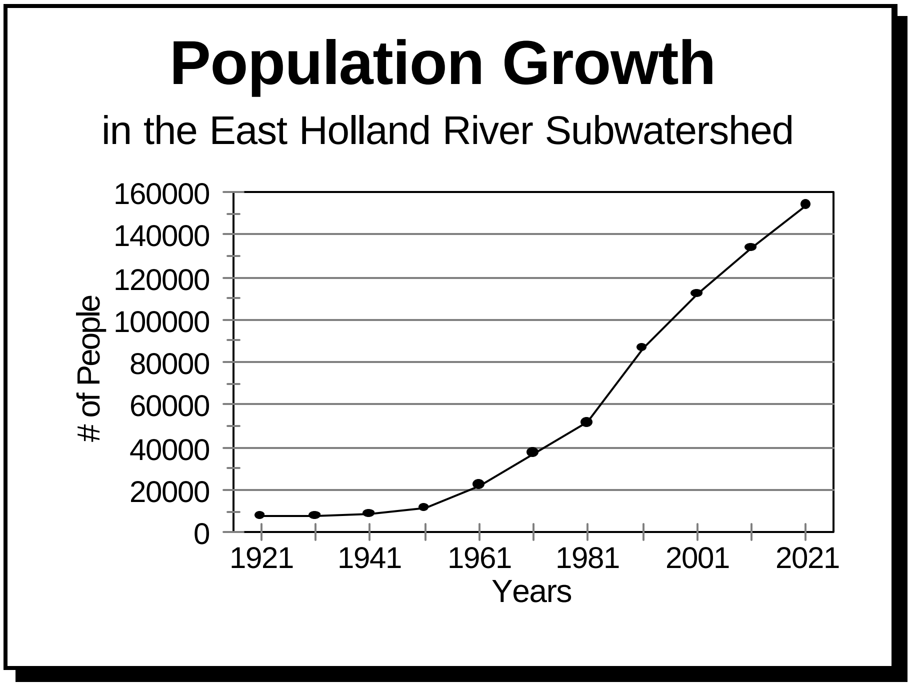
The onset of the Second World War established the need to mass produce equipment and materials to support the war effort. This resulted in further industrialisation and improvements to transportation networks. When the war finally ended, the area was witness to a massive influx of people. During this period, population growth was focussed primarily in the urban centres like Aurora and Newmarket. As these urban centres expanded so did the supporting infrastructure with the construction of new roads, storm sewer systems and sewage treatment plants. This improvement in infrastructure had environmental benefits as sewage facilities could be centralised and the effluent treated rather than hundreds of individual rudimentary household septic systems.

Agriculture also underwent a change as small mixed farms began to slowly disappear as new machinery allowed farmers to increase production. During the forty year period between 1941 an 1981 the number of farms throughout the area decreased significantly. This was due to a cycle of economic pressure to produce more for less which forced farmers to adopt new farming methods and practices. The use of chemical fertilisers to improve crop yield had become a common practice, livestock operations increased the size of their herds and fence rows were removed to create larger fields. The net effect was fewer, larger, very intensively managed farms which used up soil resources and concentrated livestock waste resulting in a detrimental effect on the environment.

This technological revolution which so influenced agriculture also changed the manufacturing industry within the area. The development of factories to meet the growing consumer demand from an increasing population required a labour force. With limited job opportunities in rural areas people started moving to the urban centres. The main concentration of manufacturing occurred in and around Toronto with areas to the north acting as distribution centres.

In the early 1980's, an increase in the popularity of the suburban communities within the Subwatershed combined with economic prosperity resulted in a further increase in the rate of population growth. This trend of high growth levels is expected to continue well into the next century (Figure 4.1).

Figure 4.1: Population Growth in the East Holland River Subwatershed



The Regional Municipality of York is one of the fastest growing municipalities in all of Canada and has been described as one of the most desirable places to live within North America. Due to this fast pace of urban growth, it was critical that a holistic and comprehensive Subwatershed Plan be initiated to protect existing natural resources and, where possible, rehabilitate or enhance ecosystem health. To this end, the Municipalities of Newmarket, Aurora, East Gwillimbury, Whitchurch-Stouffville, King and the Regional Municipality of York agreed to develop this Subwatershed Plan in partnership with the Lake Simcoe Region Conservation Authority.

Chapter 5 Study Goals and Objectives

The goal of the East Holland River Subwatershed Plan is as follows:

> *To maintain, protect and rehabilitate the health and quality of the East Holland River and its ecosystem by developing a plan that minimises impacts associated with future urban growth and addresses existing activities degrading the environment.*

This goal can be achieved by meeting the following objectives:

1. Involve all partner agencies and the public through active participation.
2. Integrate disciplines, policies, mandates and requirements of all agencies and interests.
3. Identify the location, area, extent, present status, significance, function and sensitivity of the existing natural environment within the Subwatershed.
4. Identify the location and type of development constraints within the Subwatershed.
5. Identify sources of surface water contaminants from agricultural, urban, rural and natural areas and areas where there is a potential for rehabilitation.
6. Evaluate potential impacts on water quality and on the natural environment associated with future development in the Subwatershed.
7. Identify remedial measures and control options to rehabilitate ecosystem health. Prioritise measures and options based on their cost/benefit and produce an implementation strategy, which identifies agency roles and responsibilities and a schedule for completion.
8. Identify opportunities for community involvement.
9. Assess the impact associated with future urban growth on the health of the East Holland River ecosystem and develop a strategy to minimise and/or eliminate these impacts.
10. Provide direction for the protection and rehabilitation of natural heritage features.

11. Develop the plan in conformity with the Lake Simcoe Environmental Management Strategy (LSEMS), the Oak Ridges Moraine Strategy, the York Regional Official Plan, Municipal Official Plans, Municipal By-Laws and Provincial Policy Statements.

12. Outline requirements for monitoring, and a mechanism to involve and inform the public of the results.

13. Provide information regarding potential organisational structures for implementation, identify potential sources of funding and recommendations pertaining to management options (ie. changes in policy, by-laws).

14. Encourage Municipalities by whatever appropriate means to adopt the final Subwatershed Plan and its recommendations into official policies and through the direction of funds for the undertaking of capital works.

The goals of the study have been simplified into two guiding principles which are:

1. Protect What is Healthy

Protect the ecosystem of the East Holland River by:

- **T** Protecting water resources and ecological functions,
- **T** Protecting natural linkages that still exist in the East Holland River Subwatershed.

2. Rehabilitate What is Degraded

Restore damaged resources within the Subwatershed by:

- **T** Restoring the River and its tributaries by initiating remedial projects, education programs and community involvement,
- **T** Improving water quality,
- **T** Restoring degraded habitats,
- **T** Enhancing existing wildlife and recreational areas by establishing linkages,
- **T** Involve the community and have them take responsibility for the East Holland River.

These two simple principles provide a vision for the future of the East Holland River

Subwatershed that everyone can identify with and understand. People must begin to regard the whole of the Subwatershed as home and realise that their activities, however minor they might seem, may have broader consequences to ecosystem health. This is especially true when you consider the number of people living within the Subwatershed and the cumulative impact they could have by planting a tree, reducing the amount of fertilizer they use or by disconnecting a downspout. While the large capital remedial projects may get the headlines, we cannot discount the enormous benefit from the countless smaller projects undertaken by individual residents.

It is important that in the future efforts are made to preserve ecological functions and the processes associated with a healthy natural landscape. This will be accomplished through proper planning and design of the future urban landscape to achieve a balance. This means establishing a balance between future urban growth and the needs of the East Holland River Subwatershed.

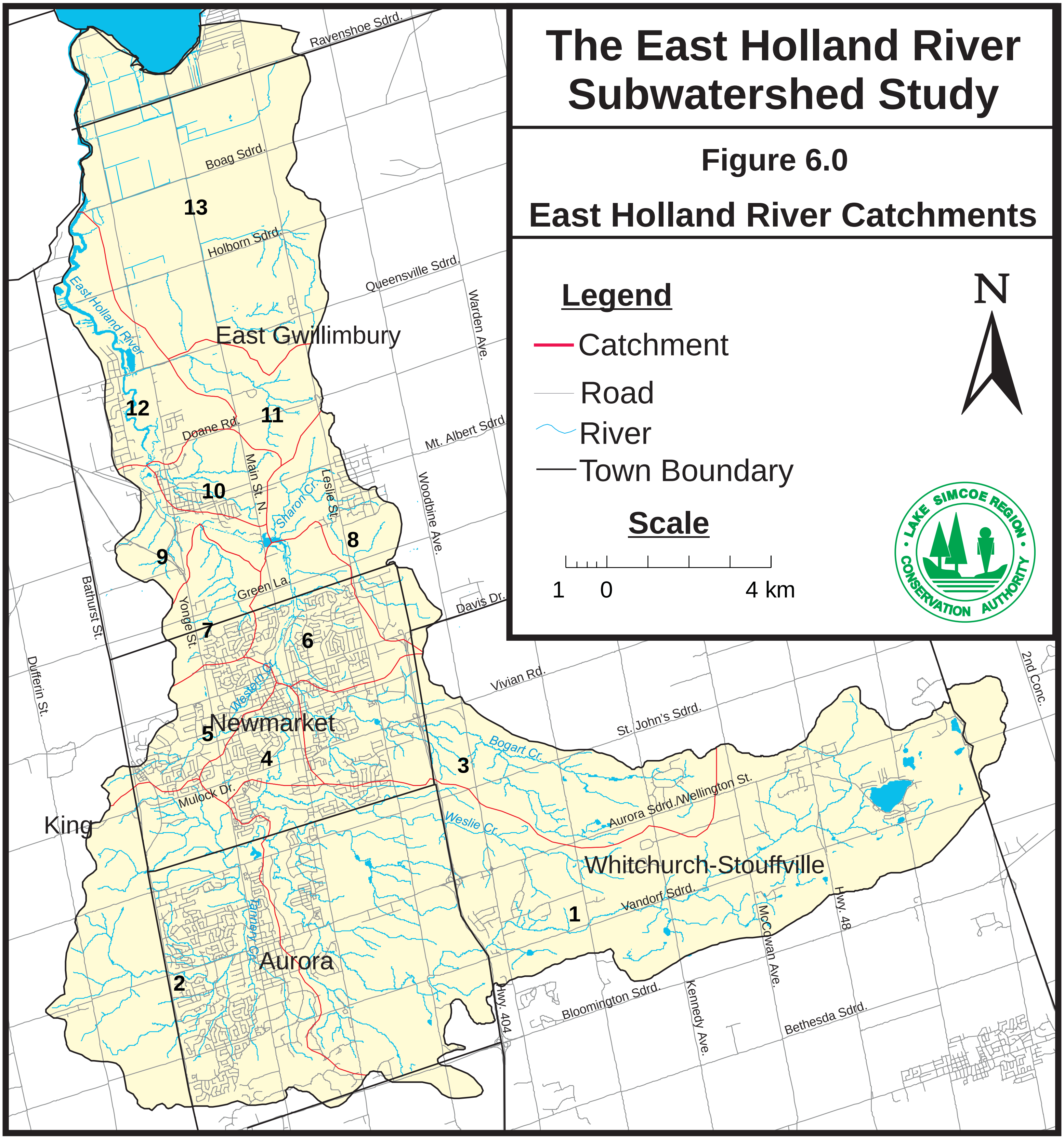
PART II THE HEALTH OF THE EAST HOLLAND RIVER SUBWATERSHED

The watershed planning approach examines the physical, biological and socio-economic characteristics of the East Holland Subwatershed to understand the interrelationships that exist between them. The natural features and functions of the watershed are therefore the controlling factors in the determination of future economic development. The following section provides a summary of these resources and functions within the East Holland River Subwatershed. It provides the necessary information to diagnose the health of the watershed and identify any ill effects associated with existing land uses and practices. Where possible, trends in Subwatershed conditions have been identified.

Natural features and functions of the East Holland River Subwatershed were divided into three categories for detailed investigation including:

- **T** Land
- **T** Water
- **T** Community

As a part of the study methodology, the East Holland River Subwatershed was divided into 13 discrete catchments as depicted in Figure 6.0. Individual catchments are considered to function as small watersheds. Using catchments allowed the data collected to be more manageable and provided more detailed analysis and site specific recommendations. Using the management issues identified, each of the catchments were assessed and individual concerns identified.


The East Holland River Subwatershed Study
Figure 6.0
East Holland River Catchments
Legend
Catchment
Road
River
Town Boundary
Scale
1 0 4 km
N
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Doane Rd.
Mt. Albert Sdrd.
Green La.
Davis Dr.
Vivian Rd.
St. John's Sdrd.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Bloomington Sdrd.
Bethesda Sdrd.
Warden Ave.
Woodbine Ave.
Main St. N.
Leslie St.
Yonge St.
Bathurst St.
Dufferin St.
Hwy. 404
Kennedy Ave.
McCowan Ave.
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There are a variety of land uses within the East Holland River Subwatershed (Figure 6.1). The prominent land use in the Subwatershed is currently agriculture comprising 52.9% of the Subwatershed. Urban land use is second prominent land use type at 23.1% and forest areas are third comprising 19.1% of the Subwatershed. However, there is a significant amount of land use variability from catchment to catchment with some being very urban and others being more rural. Figure 6.2 illustrates this variability.

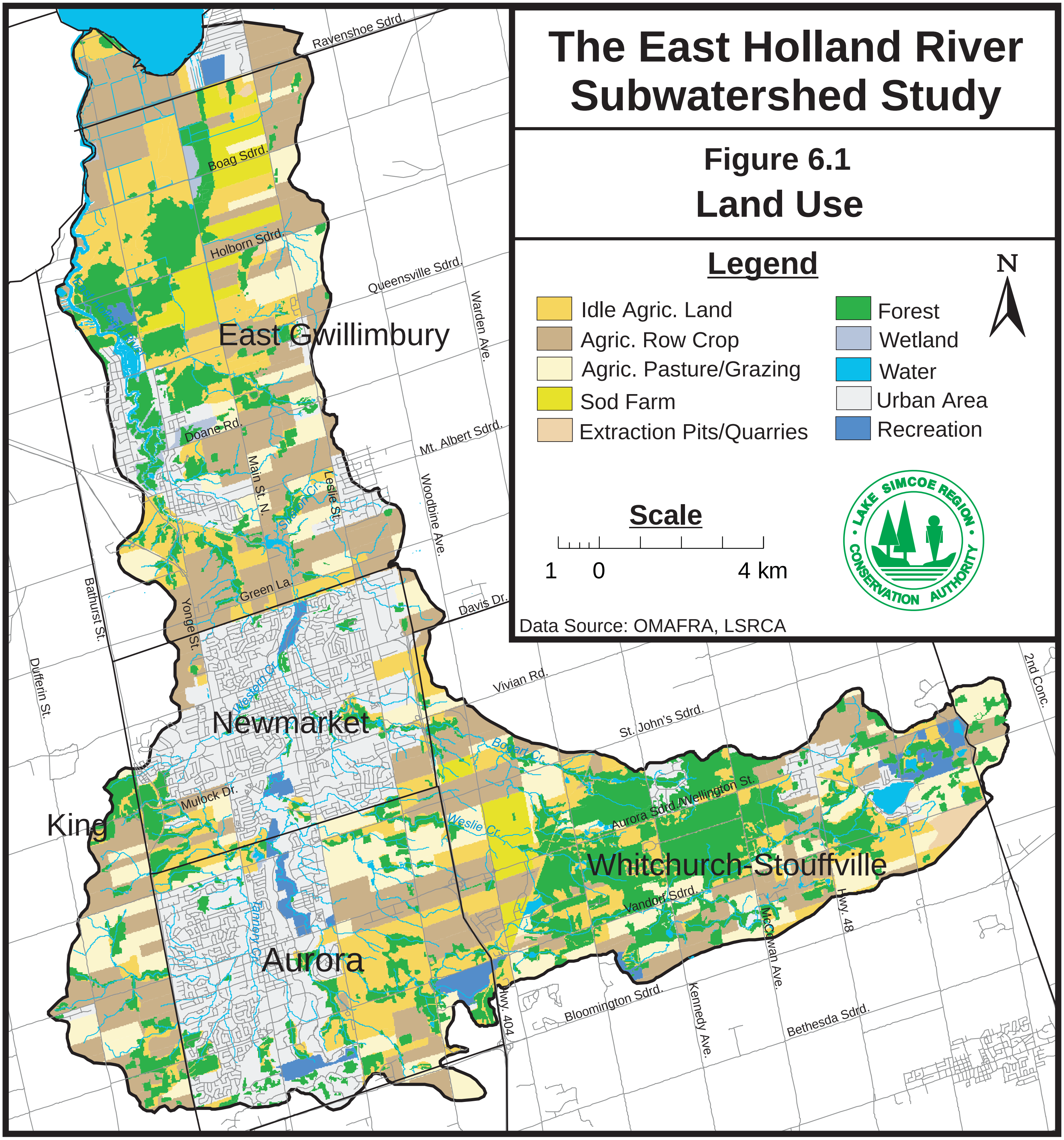
A wide range of terrestrial habitats can be found within the East Holland River Subwatershed offering a variety of habitats for wildlife, providing resources and recreational opportunities for humans and maintaining the aesthetic and biological quality of the Subwatershed as a whole. Much of the data in this section was collected from pre-existing data sets compiled previously by the Ontario Ministry of Natural Resources (OMNR), the Lake Simcoe Region Conservation Authority (LSRCA) and other agencies. This data was verified and supplemented by field reconnaissance (ground-truthing) in the summers of 1998 and 1999 by LSRCA staff. The following is a summary of these resources.

6.1 Natural Corridors

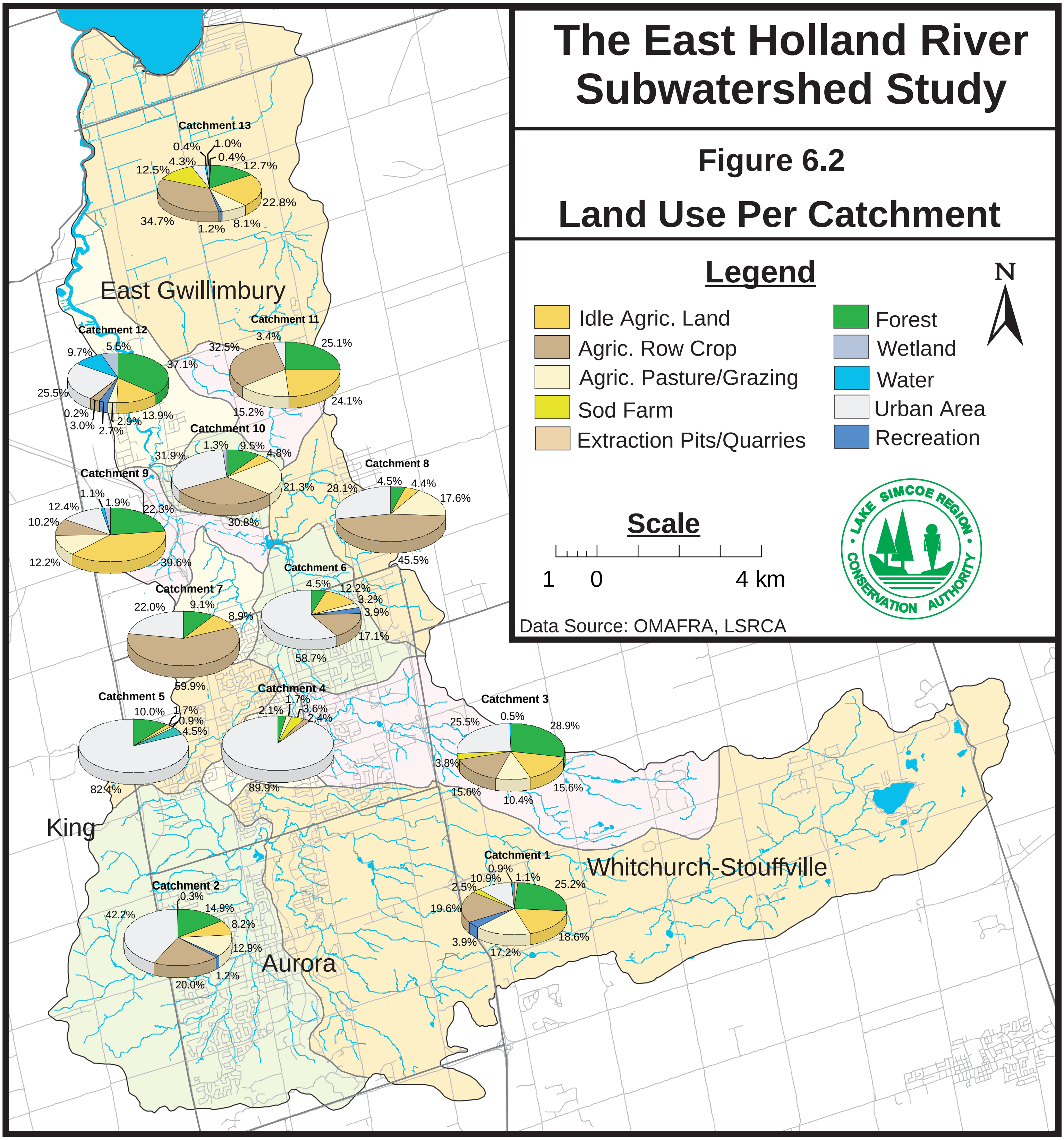
Natural corridors are areas of remnant vegetation which provide important ecological functions in addition to increasing the diversity and function of adjacent areas by providing a connecting link. Benefits of retaining and enhancing natural corridors include:

- Increased potential for wildlife species movement and reproduction
- Increased population sizes for some species of flora and fauna
- Increased local diversity of habitats and successional stages
- The maintenance of genetic variability
- Improved water quality, aquatic habitat and reduced flooding and erosion (where the corridor exists adjacent to a watercourse)
- Improved recreational opportunities and aesthetics

Throughout the East Holland River Subwatershed the most productive lands were cleared for agricultural use many years ago, while urbanisation has accelerated the loss of natural areas



The East Holland River Subwatershed Study
Figure 6.1
Land Use
Legend
Idle Agric. Land
Agric. Row Crop
Agric. Pasture/Grazing
Sod Farm
Extraction Pits/Quarries
Forest
Wetland
Water
Urban Area
Recreation
N
Scale
1 0 4 km
Data Source: OMAFRA, LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
King
Aurora
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Doane Rd.
Mt. Albert Sdrd.
Main St. N.
Leslie St.
Woodbine Ave.
Green La.
Davis Dr.
Bathurst St.
Yonge St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
2nd Conc.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Hwy. 48
McCowan Ave.
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.


The East Holland River Subwatershed Study
Figure 6.2
Land Use Per Catchment
Legend
Idle Agric. Land
Agric. Row Crop
Agric. Pasture/Grazing
Sod Farm
Extraction Pits/Quarries
Forest
Wetland
Water
Urban Area
Recreation
N
Scale
1 0 4 km
Data Source: OMAFRA, LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
King
Aurora
Whitchurch-Stouffville
Catchment 13
0.4% 1.0% 0.4% 4.3% 12.5% 12.7% 22.8% 34.7% 1.2% 8.1%
Catchment 12
5.5% 9.7% 37.1% 25.5% 0.2% 3.0% 2.7% 2.9% 13.9%
Catchment 11
3.4% 32.5% 25.1% 24.1% 15.2%
Catchment 10
1.3% 9.5% 4.8% 31.9% 21.3% 30.8%
Catchment 9
1.1% 1.9% 12.4% 10.2% 22.3% 12.2% 39.6%
Catchment 8
4.5% 4.4% 28.1% 17.6% 45.5%
Catchment 7
22.0% 9.1% 8.9% 59.9%
Catchment 6
4.5% 12.2% 3.2% 3.9% 17.1% 58.7%
Catchment 5
10.0% 1.7% 0.9% 4.5% 82.4%
Catchment 4
1.7% 2.1% 3.6% 2.4% 89.9%
Catchment 3
0.5% 25.5% 28.9% 3.8% 15.6% 10.4% 15.6%
Catchment 2
0.3% 42.2% 14.9% 8.2% 12.9% 1.2% 20.0%
Catchment 1
0.9% 10.9% 1.1% 2.5% 25.2% 19.6% 3.9% 17.2% 18.6%

in more recent times. Stream and valley systems, due largely to their inappropriateness for alternate uses, currently provide the majority of natural corridors. Many riparian areas were either not cleared of vegetation originally, or more commonly, were allowed to revert to natural conditions following abandonment. Increasing the size of remnants which currently exist along streams and valleys generally provides the best opportunity for enhancement.

The percentage of stream length which is buffered by natural corridors varies widely from catchment to catchment. Catchment 13 has the least amount of stream buffering where 5.1% of streams are buffered while catchment 9 has the most where 45.6% of streams are buffered. Overall 29.2% Subwatershed's rivers are buffered (Figure 6.3).

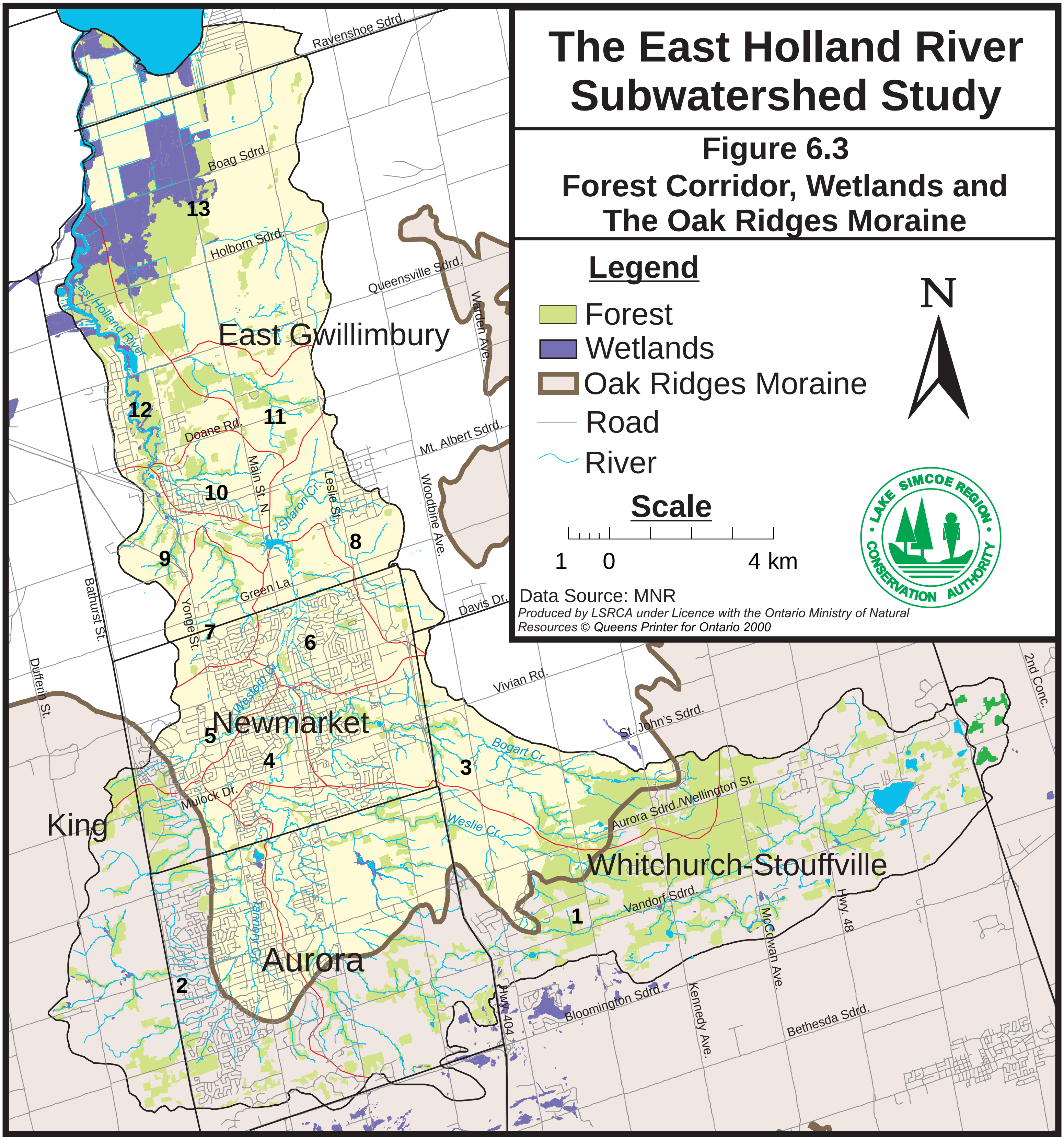
Issues include:

- A lack of natural corridors exists in many areas, particularly linking upland forests
- Retaining and enhancing corridors generally requires participation from private landowners
- Reinstating natural corridors along watercourses provides the greatest ecological benefit
- The protection of existing corridors is difficult given existing legislation and planning processes

6.2 Wildlife Habitat

Habitat is defined as the conditions required by a particular species to survive and thrive including food, water and the cover required for protection, shelter, feeding and reproduction. When the above mentioned requirements are met, environmental changes can still result in the decline of a species. This can be due to the cumulative effect of incremental losses of natural areas or the severing of a travel corridor due to land use changes (e.g. construction of a road). In either case, each species has minimum requirements and if those minimum requirements are not met, the species will not survive in that particular area.

In the fragmented landscape of much of Southern Ontario, forest interior habitat is recognised as an important feature to retain or improve where possible. Many species which are


The East Holland River Subwatershed Study
Figure 6.3
Forest Corridor, Wetlands and The Oak Ridges Moraine
Legend
Forest
Wetlands
Oak Ridges Moraine
Road
River
N
Scale
1 0 4 km
LAKE SIMCOE REGION CONSERVATION AUTHORITY
Data Source: MNR
Produced by LSRCA under Licence with the Ontario Ministry of Natural Resources © Queens Printer for Ontario 2000
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
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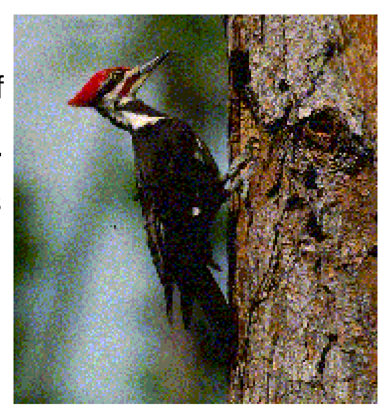
sensitive to human and other types of disturbance require interior habitat. Interior habitat is defined as forested area which is a minimum 200 metres from the nearest forest edge. Both the total area and the shape of a given woodland have an impact upon the amount of interior habitat available. Additionally, lands surrounding these key interior areas have increased levels of importance to facilitate wildlife movement. For example, woodlands within 2000 metres of each other have been found to contain increased numbers of forest interior bird species (Environment Canada *et al.*, 1998).

The East Holland River Subwatershed contains forest interior in three main areas (Figure 6.4), which should be protected where at all possible. Forest cover, while in most areas of the Subwatershed is fragmented, does provide limited habitat capacity. Outside of the main urban centres, a variety of habitat types are present including wetlands, old fields, stream corridors and various forest types. Continuity and size of natural areas are the main limiting factors for most species in the Subwatershed.

One of the more significant habitat areas of the Subwatershed is the Holland Marsh wetland and Area of Natural and Scientific Interest (ANSI). It provides habitat for five birds and 11 plant species of provincial significance and 44 species of regionally significant plants and animals. The area provides winter cover for white-tailed deer and is a waterfowl staging and production site. It is also a regionally significant spawning area for at least 11 species of fish (OMNR, 1987).

Wildlife - Birds

A list of bird species using the Subwatershed for some portion of their life cycle was constructed from a variety of sources (e.g. Gartner Lee Limited, 1999). A complete list of these species has been included in Appendix A.



Pileated woodpecker
(Dryocopus pileatus)

Waterfowl Habitat

Waterfowl species have specific habitat requirements that can be readily identified and described. A number of areas within the East Holland River Subwatershed provide valuable habitat for waterfowl for such life cycle activities as breeding, moulting and staging. Any wetland which contains areas of permanent open water will have an environment suitable for use by waterfowl. According to Ducks Unlimited Canada, waterfowl also require upland habitat on the perimeter of the wetland which is defined by a distance of approximately 100 metres from the wetland-upland boundary (Steel, personal communication).

Habitat is available and waterfowl have been observed using the Holland Marsh, Rogers Reservoir, Aurora Marsh and East Aurora Wetland. Although the exact nature of the use of these wetlands is not specified in the wetland evaluations, it is likely that they are used for feeding, breeding, staging and possibly for moulting.

Wildlife - Mammals

A list of mammal species using the Subwatershed for some portion of their life cycle was constructed from a variety of sources (e.g. Dobbyn, 1994). A complete list of these species has been included in Appendix A. Examples of common mammals within the Subwatershed are white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*) and raccoons (*Procyon lotor*). Some uncommon visitors to the area are black bears (*Ursus americanus*) and moose (*Alces alces*).

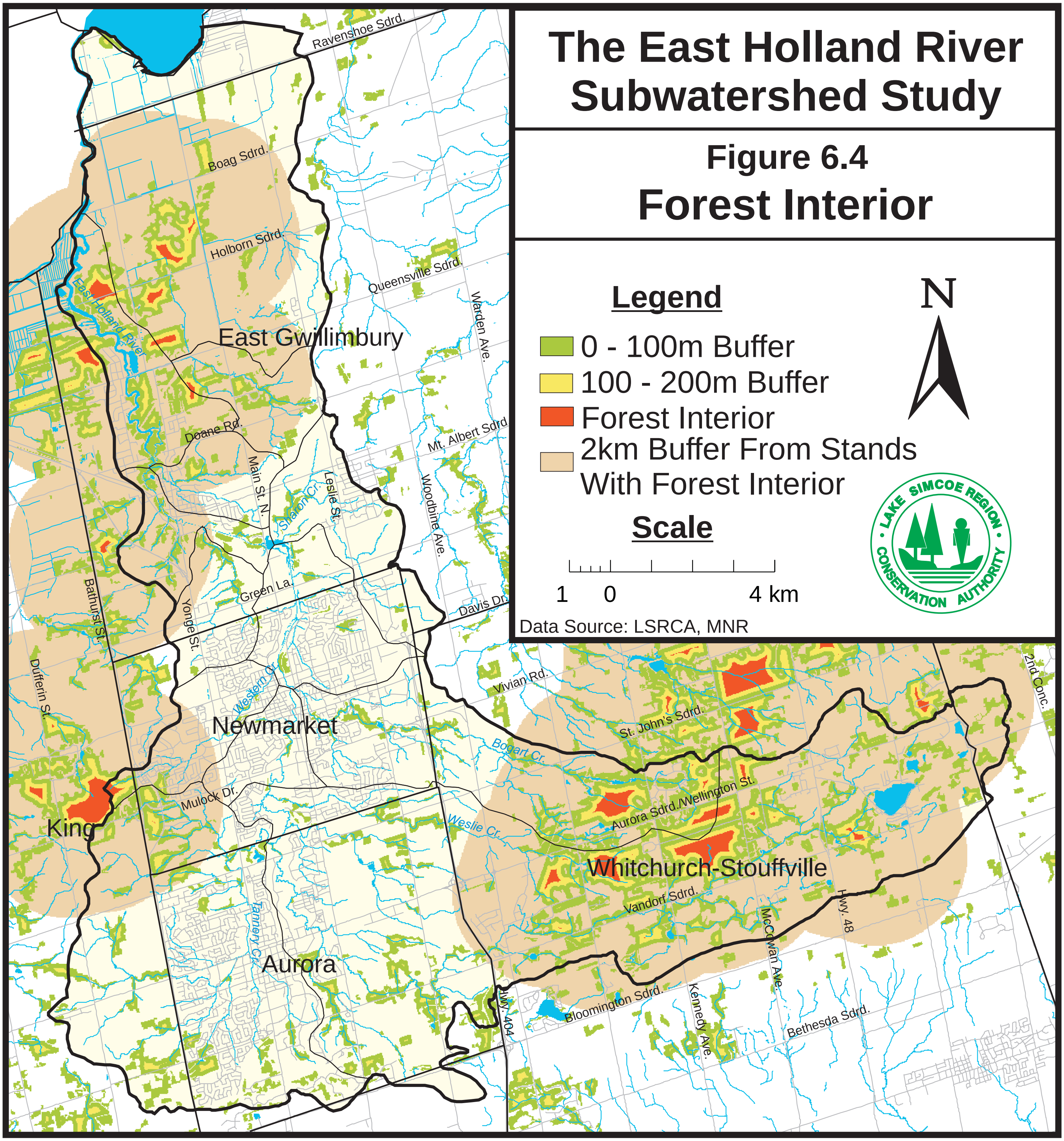
Deer Wintering Habitat

The availability of wintering habitat for white-tail deer is an important aspect of mixed forests in Ontario. Within the East Holland River Subwatershed, there is one potential deer wintering yard in the Holland Marsh that will be investigated by the OMNR.

The OMNR has defined the deer yards based on traditional use of these areas for cover and winter browse. Winter cover consists of dense stands of conifers such as hemlock and eastern white cedar (Bennet, personal communication) that have a closed canopy (ie.

The East Holland River Subwatershed Study

Figure 6.4
Forest Interior



approximately 70% canopy cover). The closed canopy prevents the loss of heat at night and the dense forest with associated shrub and brush vegetation protects the deer from cold winter winds. The minimum ideal size for winter cover habitat is 0.8 to 2 ha (depending on the size of the population using the habitat and the shape of the forested stand) with a minimum width of 90 metres (Thomas *et al.*, 1979). Areas that are suitable for winter browse are open areas or early successional forests. These conditions often result following an environmental disturbance such as a forest fire, logging or in old agricultural fields that have been allowed to naturalise. Alternatively, browse habitat may be available in open spaces created by a natural meadow or a marshy section of a wetland. In these areas, deer will feed on the twigs of young trees, shrubs such as dogwood and soft maples or the foliage of cedars. It should be noted that the use of deer yards is not as common in Southern Ontario as it is in Northern Ontario. Due to the relatively mild climate of the study area, deer only congregate in wintering yards during the most severe winter conditions (Bennet, personal communication).

<u>Wildlife - Herpetofauna</u>

A list of herpetofaunal species using the Subwatershed for some portion of their life cycle was constructed from a variety of sources. A complete list of these species has been included in Appendix A.

Green frog *(Rana clamitans)*

<u>Rare Flora and Fauna</u>

Within the East Holland River Subwatershed, 53 species that are considered to be rare or endangered (regionally or provincially) have been observed at various locations (e.g. red-headed woodpecker (*Melanerpes erythrocephalus*)). The precise location of the observed species is not described or indicated on maps contained in this report. This information is considered to be classified information and is not available to the public in order to protect these species and their habitat. A complete list of rare species has been included in Appendix A. It should be noted that these inventories should not be considered to be complete. Rare species generally occur in small populations and are often very difficult to locate. These lists may be expanded in the future as additional field work is done for other projects in the study area.

6.3 Aggregate Resources

Aggregate resources include building materials that are extracted from the earth such as sand and gravel. Information regarding the location of aggregate resources within the study area was supplied by the OMNR (Figure 6.5). The total area of licenced aggregate pits within the study area is 2.77 km^2, which represents 1.1% of the total area of the Subwatershed. Potential aggregate resource areas in the East Holland River Subwatershed include all lands that are situated on the Oak Ridges Moraine.

Gravel pit from the 1950's

6.4 Woodlands

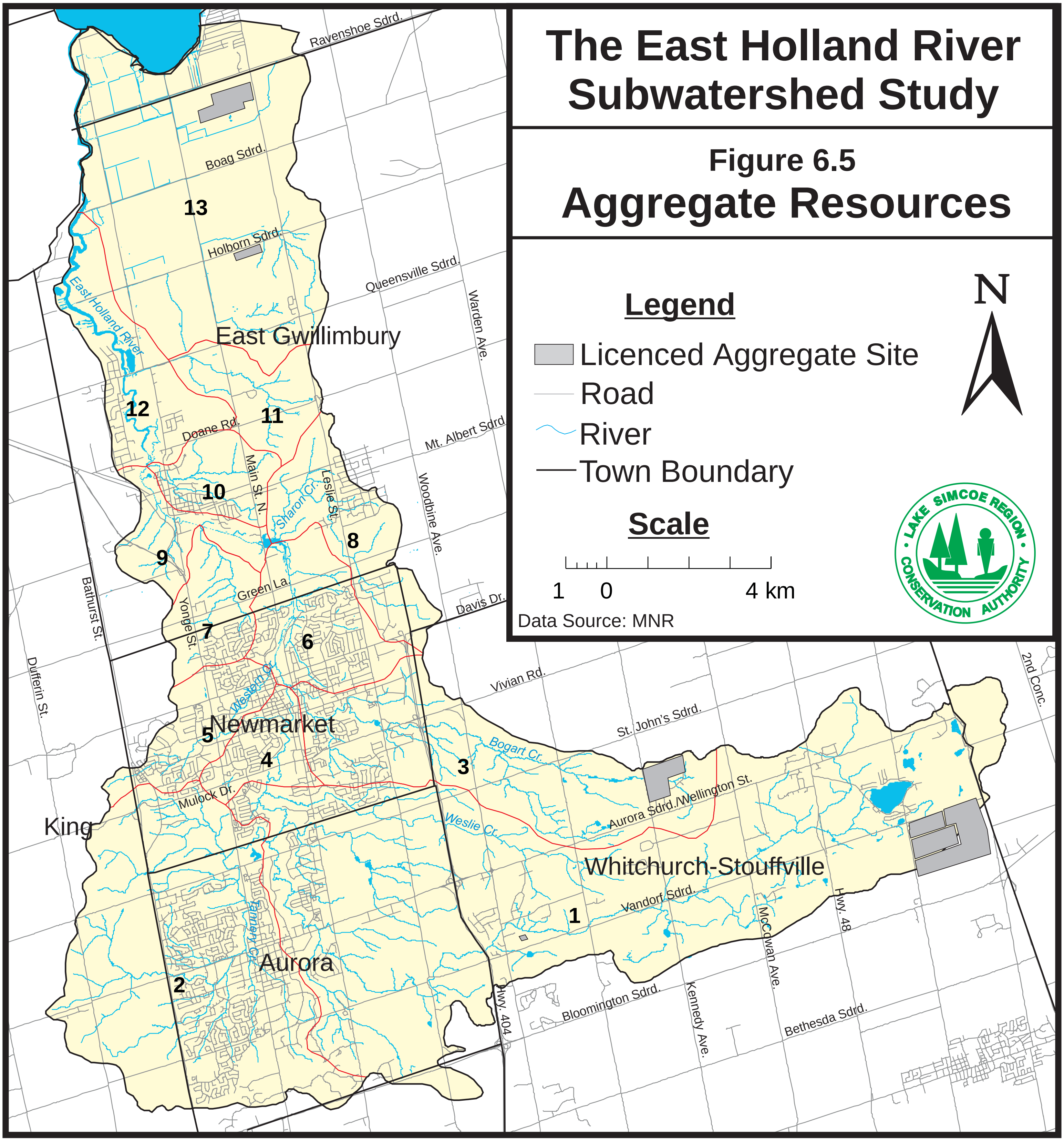
Woodlands are of critical importance in maintaining the ecological and environmental health of a subwatershed, in addition to contributing socially and economically. Benefits which directly affect subwatershed health include:

- Reduced soil erosion
- Reduced intensity and volume of stormwater
- Improved water quality in streams and lakes
- Improved soil texture, structure and fertility
- Provision of habitat for forest dependent species

Additional benefits include:

- Local climate enhancement and pollution control
- Global climate control (carbon attenuation)
- Aesthetic enhancement
- Recreational values
- Economic benefits through increased property values and forest products

A target of 25% forest cover is indicated within the Region of York Official Plan (1994) to



The East Holland River
Subwatershed Study
Figure 6.5
Aggregate Resources
Legend
Licenced Aggregate Site
Road
River
Town Boundary
Scale
1 0 4 km
Data Source: MNR
N
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
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St. John's Sdrd.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Bloomington Sdrd.
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achieve many of the benefits listed. A minimum 25% forest cover has also been listed in many watershed studies as critical to maintaining many of the values and benefits listed. The forest landscape within the East Holland River Subwatershed occupies 46.5 km^2 or 19.1% of the land base. Forest cover in individual catchments varies from a low of 2.1% in catchment 4 to a high of 37.1% in catchment 12. It generally tends to be fragmented with very few large forest tracts of 40 ha or greater (Figure 6.6).

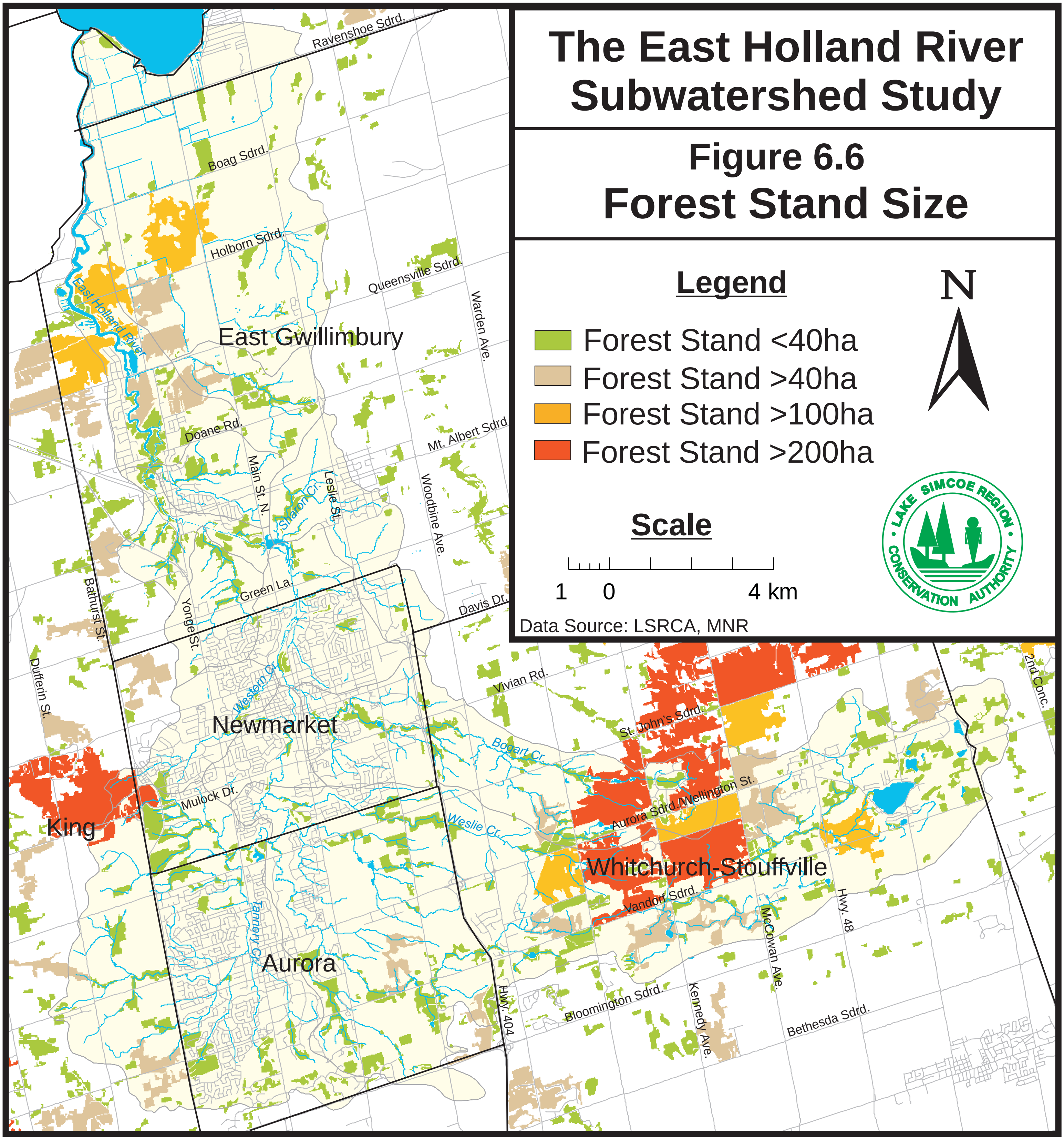
The amount of forest cover within the East Holland Subwatershed has marginally improved over the years. With present day conditions sitting at 19.1% forest cover, back in 1952 there was 18.0% forest cover (Department of Planning and Development, 1953). Even with the slight increase, this however falls short of the forest cover target the Region of York has set in its official plan of 25% (1994).

The increasing size and amalgamation of farming operations which has been occurring during the past several years has resulted in some marginal lands being taken out of production. The majority of early successional forests in the Subwatershed are the result of former agricultural areas which have reverted to forest. Additionally, most afforestation efforts in the area have been reestablishing forest cover on these former agricultural lands. Unfortunately, woodlots lost to urban development have generally negated any gains made in forest cover in agricultural areas.

Abandoned farmland reverting to forest.

Forest cover types in the Subwatershed range from low lying coniferous swamps to upland tolerant hardwood forests. Upland hardwood forests in the study area can generally be grouped into two forest

Typical mixed hardwood forest


The East Holland River
Subwatershed Study
Figure 6.6
Forest Stand Size
Legend
Forest Stand <40ha
Forest Stand >40ha
Forest Stand >100ha
Forest Stand >200ha
N
Scale
1 0 4 km
Data Source: LSRCA, MNR
LAKE SIMCOE REGION CONSERVATION AUTHORITY
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
East Holland River
East Gwillimbury
Warden Ave.
Doane Rd.
Mt. Albert Sdrd.
Main St. N.
Leslie St.
Sharon Cr.
Woodbine Ave.
Green La.
Davis Dr.
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Yonge St.
Dufferin St.
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Hwy. 404
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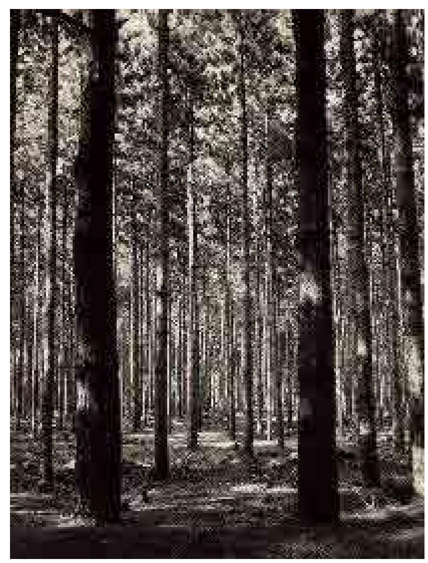
Kennedy Ave.
Bethesda Sdrd.

types: mature and early successional. Mature, shade tolerant communities are dominated by sugar maple *(Acer saccharum)*, American beech *(Fagus grandifolia)*, eastern hemlock *(Tsuga canadensis)* and associated species. Early successional forest communities are predominantly shade intolerant to mid-tolerant white ash *(Fraxinus americana)*, red ash *(Fraxinus pennsylvanica)*, poplar (*Populus spp.)*, American elm *(Ulmus americana)* and white birch *(Betula papyrifera)*.

Lowland deciduous and mixed lowlands in the Subwatershed are comprised of white cedar *(Thuja occidentalis)*, balsam poplar *(Populus balsamifera)*, trembling aspen *(Populus tremuloides)* and large tooth aspen *(Populus grandidentata*), balsam fir *(Abies balsamea)*, black ash *(Fraxinus nigra)* and silver maple *(Acer saccharinum)*. Lowland thickets are mainly comprised of willow *(Salix spp.)* and dogwood *(Cornus spp.)*.



Red pine plantation.

Softwood plantations also make up a significant portion of the forest cover in the Subwatershed due to private and public land reforestation efforts of the past several decades. Dominant species include red pine (*Pinus resinosa*), white pine (*Pinus strobus*) and white spruce (*Picea glauca*). Many plantations which are now in excess of 30 years in age are beginning to diversify through the invasion of tolerant hardwood species in the understory.

Current information is unavailable regarding the distribution and prevalence of the various forest cover types in the Subwatershed. However, the Holland Valley Conservation Report of 1961 provides some insight into changes which have occurred over the past four decades. At that time, the dominant cover types in the area were aspen, sugar maple and white elm forests. Disease, including Dutch Elm Disease, changing agricultural practices, urbanisation and changing public perceptions and land values have all impacted the forest landscape since that time.

Mature, upland woodlots are relatively rare in the Subwatershed, with the majority occurring on the Oak Ridges Moraine in the headwater areas. Many of these woodlots are degraded, however management practices are improving forest conditions in some cases. In the early 1960's, a common practice for farmers was to utilise forests for pasture, degrading over 40% of area woodlots (Holland Valley Conservation Report, 1961). While this practice has not been completely eliminated, it is now a rare occurrence in the Subwatershed. Additionally, private land stewardship initiatives through the OMNR and LSRCA have had a positive impact on managing existing woodlands and increasing forest cover through the establishment of plantations. The introduction of the Managed Forest Tax Incentive Program is also intended to educate landowners about appropriate management techniques and provide the financial incentive to follow through.

Issues include:

- Percent forest cover is inadequate throughout most of the Subwatershed
- Loss of forest area continues to occur due to land use change
- Levels of afforestation should be increased
- Private woodlands are often degraded by inappropriate management practices
- Invasive exotic species become more pervasive as urbanisation increases
- Available information is often inadequate to make appropriate land use decisions (percent of forest cover types is not known)

6.5 Wetlands, Environmentally Significant Areas (ESAs) and Areas of Natural and Scientific Interest (ANSI)

Wetlands are essential natural elements of the East Holland River Subwatershed providing environmental, economic and social benefits. Wetlands control and store surface water to assist in flood control and groundwater recharge. Wetlands also act as sediment traps to improve water quality and act as habitat for a wide variety of flora and fauna.

Overview of Aurora (McKenzie) Marsh

Within the East Holland River Subwatershed wetlands have a total area of 15 km^2 and comprise 6.15% of the total Subwatershed. There are 11 evaluated wetland complexes of which seven are provincially significant and the remaining four are locally significant. The location of these wetlands is shown in Figure 6.3. It should be noted that not all wetlands within the study area have been evaluated for various reasons (e.g. the area of the wetland is less than 2 ha in size and thus does not meet the criteria of OMNR wetland evaluation protocol). The provincially significant wetlands are:

- Holland Marsh Wetlands
- Rogers Reservoir
- Aurora (McKenzie) Marsh
- Musselman Lake Wetland Complex
- East Musselman Wetland Complex
- East Aurora Wetland Complex and
- White Rose - Preston Lake Wetland Complex

and the locally significant wetlands are:

- Snowball Wetland Complex
- Whitchurch Highland Bog
- Vandorf Bog Wetlands and
- Ballantrae Bogs

While no detailed investigations were conducted, the amount of wetlands has decreased in the East Holland River Subwatershed over the years. An example of this is the cattail marshes in the lower section of the East Holland River. Comparing aerial photography from various years (i.e. 1954, 1971, 1978 & 1995), it reveals that the cattail marshes have decreased in size, sometimes in excess of 25 metres on each side of the channel (Draper *et al.* 1985). The erosion of the streambanks and deterioration of the cattail margin along the banks is a threat to the stability of the dykes, therefore threatening the stability of the agricultural areas surrounding the East Holland River. Many factors can be considered when determining the cause of the widening and the narrowing of the streambanks measured at the sites.

Increasing width could be caused by:

- *Wave Action:* Motor boats have been identified as major contributors to the erosion of streambanks by causing more erosive wave action. Boating has become very popular over the last few decades and with a growing population in the area there has been a greater demand for recreational boating marinas resulting in more boat traffic. This increased amount of traffic is a direct cause of erosive wave action, but is not the only contributor to the problem. Erosive wave action can also be caused by natural factors such as wind. The increase of width creates a greater opportunity for larger surface waves caused by over-water wind, therefore causing the banks to erode further.

- *Water Level Fluctuation:* The annual water level fluctuation in Lake Simcoe impacts the East Holland River causing riverbank erosion and the deterioration of the cattail margin. Every year high waters flood the river and its banks causing sediment and vegetation to wash away. This flooding may also place and upward (buoyant) pressure on the roots of the cattail margin causing large areas of cattails to detach and wash away. This may also happen if ice forms at times of low water and then floats, tearing up the cattail margin as the levels rise.
- *Animal Predation:* Many species of fish and wildlife feed on the cattail margin which contributes to its deterioration. Being marsh dwellers, muskrats feed on the young cattails and also use them to construct their lodges. They also tend to burrow through dykes, causing erosion of the dyke walls. Bottom feeders such as carp stir up the sediment on the bottom making it more difficult for seed germination. Ducks feed on the young cattails and other marsh vegetation.
- *Farming:* The chemical intensive farming industry of the Holland Marsh area has resulted in high levels of nutrients and chemicals entering the Holland River. The fertilizers, herbicides and pesticides that are used, leach into the groundwater and are washed into the river during periods of precipitation. Over use of herbicides and pesticides can also stress the cattail margin resulting in a deteriorating margin.

Decreasing width could be caused by:

- As the waters of the East Holland River flow towards Lake Simcoe, sediment is picked up and carried along until it reaches the mouth of the river. When the sediment reaches the mouth and the river begins to slow down, the sediment is dropped. The dropping of the sediment causes the banks to increase.

In 1982, Ecologistics Ltd. prepared a study for the LSRCA to locate and document the Environmentally Significant Areas (ESAs) within the Lake Simcoe Watershed. This study was designed to identify and record the most important natural environments in the Subwatershed. For details on the criteria used, design, methodology and results of the study, please see the ESA report (Ecologistics, 1982) available at the LSRCA.

There are seven ESAs within the East Holland River Subwatershed and they have a total area of 53.0 km^2 and make up 21.7% of the total Subwatershed (Figure 6.7). They are:

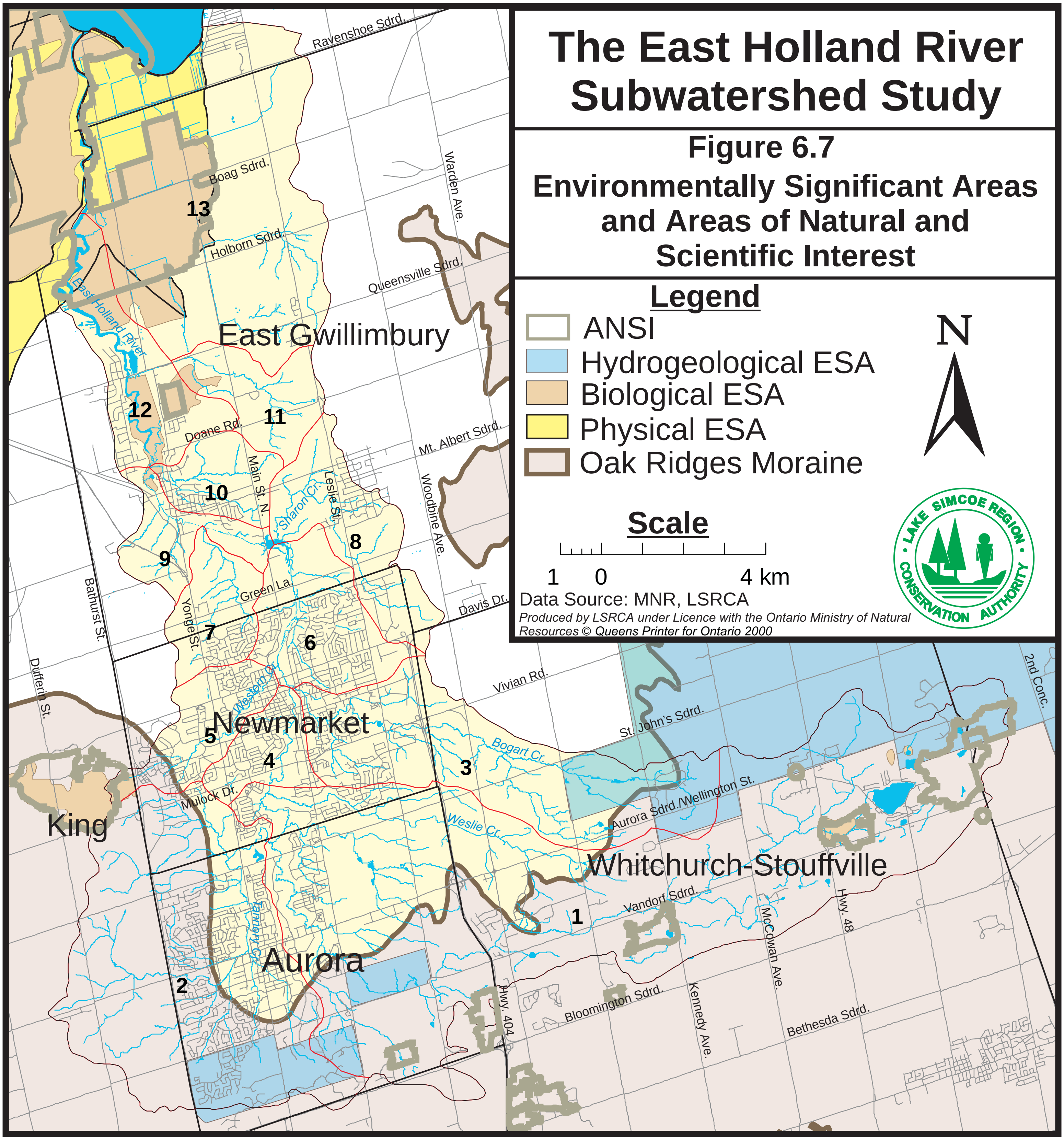
- Glenville Hills (Biological)
- Holland Marsh (Biological and Physical)
- Holland Landing (Biological)
- Musselman Lake (Biological)
- Aurora Infiltration Area (Hydrogeological)
- Vivian Infiltration Area (Hydrogeological) and
- Pefferlaw Infiltration Area (Hydrogeological)

Areas of Natural and Scientific Interest (ANSIs) are areas of land and water containing natural landscapes or features which have been identified as having values related to protection, natural heritage, scientific study or education (Lindsay, 1984).

There are eight ANSIs found within the East Holland River Subwatershed (Figure 6.7). They are:

- Holland River Marsh
- Holland Landing Prairie Relict
- Glenville Hills Kames
- White Rose West Forest
- White Rose Spillway
- Vandorf Bog
- Musselman Lake Complex and
- Musselman Lake Kettles Complex

These ANSIs have a total area of 15.7 km^2 and make up 6.4% of the total Subwatershed.



The East Holland River Subwatershed Study
Figure 6.7
Environmentally Significant Areas and Areas of Natural and Scientific Interest
Legend
ANSI
Hydrogeological ESA
Biological ESA
Physical ESA
Oak Ridges Moraine
N
Scale
1 0 4 km
Data Source: MNR, LSRCA
Produced by LSRCA under Licence with the Ontario Ministry of Natural Resources © Queens Printer for Ontario 2000
Lake Simcoe Region Conservation Authority
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Mt. Albert Sdrd.
Doane Rd.
Main St. N.
Leslie St.
Sharon Cr.
Woodbine Ave.
Green La.
Davis Dr.
Yonge St.
Bathurst St.
Dufferin St.
Western Cr.
Vivian Rd.
St. John's Sdrd.
Bogart Cr.
Mulock Dr.
Aurora Sdrd./Wellington St.
Weslie Cr.
Vandorf Sdrd.
McCowan Ave.
Hwy. 48
2nd Conc.
Tannery Cr.
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.
1
2
3
4
5
6
7
8
9
10
11
12
13

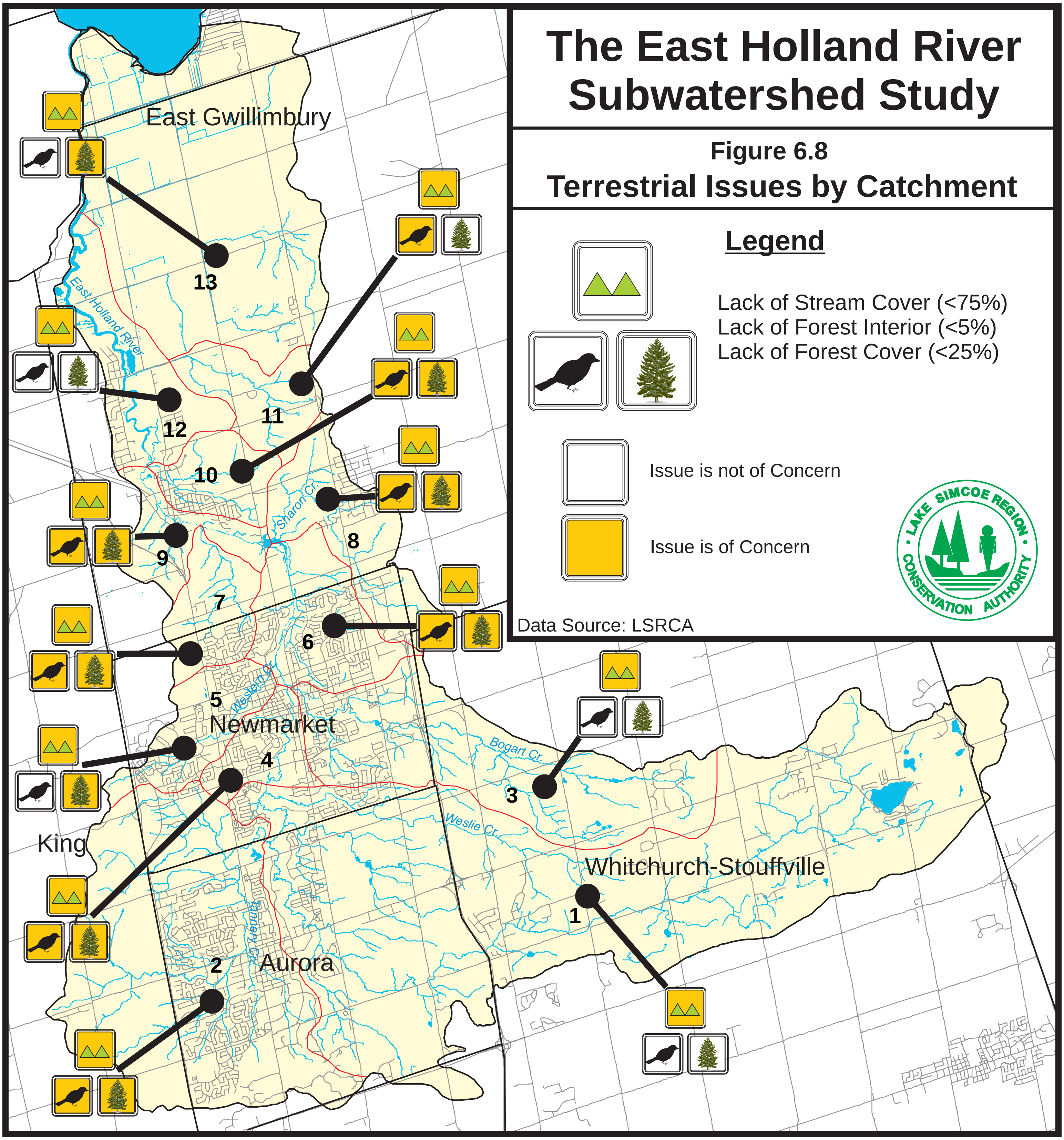
Issues for wetlands, ESAs and ANSIs include:

- **T** Destruction of wetlands
- **T** Flood storage capacities are reduced
- **T** Downstream erosion increases
- **T** Ecological functions are reduced
- **T** Recreational opportunities are reduced

Land issues that have limiting effects on flora and fauna, water quality and quantity, aquatic habitat and recreational opportunities have been grouped and displayed in Figure 6.8 for each individual catchment of the East Holland River Subwatershed.

<u>Summary</u>

While there exists a wide variety of terrestrial habitats in the East Holland River Subwatershed today, they are highly fragmented and a mere remnant of what existed prior to settlement of the region. With the highly fragmented landscape, species which are sensitive to size and shape of habitats are limited to particular areas or not found at all within the East Holland River Subwatershed. Furthermore, rapid urbanisation of the Subwatershed over the past few decades continues to put pressure on these remaining terrestrial habitats.



The East Holland River Subwatershed Study
Figure 6.8
Terrestrial Issues by Catchment
Legend
Lack of Stream Cover (<75%)
Lack of Forest Interior (<5%)
Lack of Forest Cover (<25%)
Issue is not of Concern
Issue is of Concern
Data Source: LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
East Holland River
Sharon Cr.
Western Cr.
Newmarket
King
Bogart Cr.
Weslie Cr.
Whitchurch-Stouffville
Tannery Cr.
Aurora
1
2
3
4
5
6
7
8
9
10
11
12
13

Chapter 7 Water

Water is essential for all life forms on earth; without which we could not survive. As such, it should be considered one of our most precious resources. In many parts of the world, clean fresh water has great value as it must be imported at great expense, pumped from extremely deep wells or drawn from the sea using desalination technology. In Canada, we have regarded our supply of fresh water as inexhaustible and therefore have historically placed a very low value on this resource. With the increased urbanization and more intensive land use in the 20th century, it has become apparent that the resource is actually finite and can be easily degraded if not destroyed. At the same time that our land use practices put more and more stress on our fresh water supply, we require greater and greater amounts of this resource to maintain economic growth and supply a growing population. The East Holland River system is a typical example of a subwatershed where the water resource is under stress. This chapter is intended to provide a summary of the current state of the resource as well as the changes in the resource that have occurred over the years.

7.1 Water Quality

The surface water quality of the East Holland River is significantly influenced by human land use activities occurring within the Subwatershed. The hydrologic cycle, referenced earlier, describes the process whereby water running over the surface of the ground or through the soil transports chemicals in suspension or solution into surface waters. Human activities can dramatically alter this natural process resulting in increased pollutant availability and new pathways for pollutants to enter receiving waters.

Any assessment of water quality is dependant upon the purpose for the analysis and the parameters measured. These parameters and their acceptable levels can differ greatly depending upon whether the water quality objectives are measured for human health concerns or for those related to aquatic health. The Ministry of Environment (MOE) has set objectives and guidelines for water quality related to human health and the suitability of waters for aquatic life known as the Provincial Water Quality Objectives (PWQOs) (MOEE, 1993).

The assessment of the East Holland River was undertaken primarily to obtain an understanding of conditions for aquatic health since the river is not a source of drinking water. However, the river is widely used for recreation including activities such as boating, windsurfing, water skiing and fishing therefore, human health issues associated with water/body contact were also investigated.

Water quality information for the East Holland River was obtained from the MOE for a 13 year period from 1982 to1995 for four (4) sampling stations (Figure 7.1). Each site was sampled on approximately the same day and time each month and provided enough data to undertake a fairly comprehensive analysis of the water quality conditions in the East Holland River. Specifically, the data was used to identify trends over time and determine the number of occurrences where water quality parameters exceeded the PWQOs. These results are extremely useful in providing further insight into potential pollution sources contributing to surface waters.

The following is a list of the water quality parameters that were reviewed. Parameters which showed a high percent of exceedance in this data set were investigated more thoroughly.

Aluminum	Iron
Ammonium	Lead
Arsenic	Magnesium
Barium	Manganese
Beryllium	Mercury
Cadmium	Molybdenum
Calcium	Nickel
Carbon	Nitrate, Filtered
Chloride	Nitrates, Total
Chromium	Nitrogen
Cobalt	Phenolics
Copper	Phosphate
Phosphorus	Sulphate
Potassium	Titanium
Sodium	Vanadium
Strontium	Zinc

The East Holland River Subwatershed Study

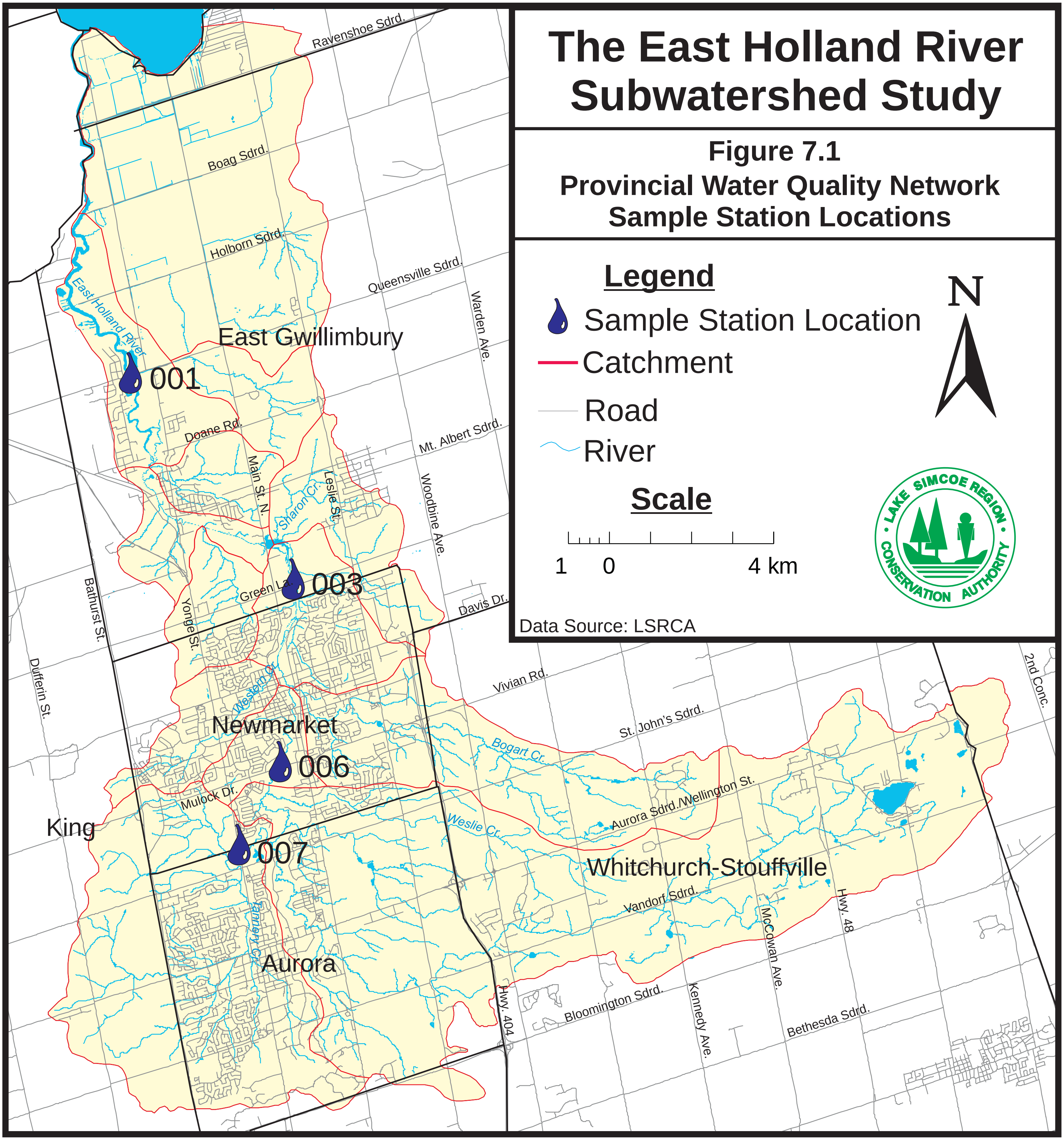


Figure 7.1
Provincial Water Quality Network
Sample Station Locations

Biological Parameters	**Physical Parameters**
BOD 5 day	Alkalinity
Coliform	Conductivity
Escherichia coli	Dissolved Oxygen
Fecal coliform	Hardness
Fecal streptococcus	pH, pH Field
Pseudomonas aeruginosa	Residue, Filtered
	Residue Particulate
	Residue Total
	Temperature
	Turbidity

Of these parameters 18 have designated PWQOs, including:

Aluminum	Lead
Beryllium	Mercury
Cadmium	Molybdenum
Chromium	Nickel
Cobalt	pH
Copper	Phenolics
Dissolved Oxygen	Phosphorus
Escherichia coli	Vanadium
Iron	Zinc

These parameters were further examined to determine the percent of the water samples that exceeded the PWQOs. The parameters that were found to exceed the PWQOs in more than 30% of the samples were investigated in greater detail, these included:

Aluminum	Iron
Copper	Phosphorus
Escherichia coli	

Data for Phenolics existed for one station only and while this station showed that 30% of the samples exceeded the PWQOs, conclusions were difficult to make from the limited information. However, as the one station showed such a high level of exceedances, future sampling should more closely examine Phenolics. Nitrogen, while not being listed in the

PWQOs was also investigated further as high concentrations of nitrogen can have detrimental effects on an aquatic ecosystem. Phosphorus, aluminum, copper and iron are also parameters that can impact the aquatic ecosystem, while *Escherichia coli* (*E. coli*) can impact human health and thereby reduce recreational opportunities.

<u>Total Phosphorus</u>

Total Phosphorus is a measure of the presence of a nutrient which is capable of promoting excessive amounts of algae and aquatic plant growth. The overabundance of algae and aquatic plants can result in the reduction of available oxygen for fish and other forms of aquatic life. The process whereby nutrients such as phosphorus stimulate excessive aquatic plant growth, resulting in the loss of available oxygen, is known as eutrophication. This process is of great concern in Lake Simcoe and is contributing to the loss of the natural cold water fishery (LSEMS, 1995). Efforts to clean up the East Holland River will also have the added benefit of improving conditions in Lake Simcoe.

In the natural environment, phosphorus moves through the ecosystem in a unique cycle. The availability of phosphorus depends on both the amount of the chemical in the system and on the rate at which it is cycled. Adding phosphorus from outside sources, such as fertilizers or industrial processes can have serious impacts on the ecosystem. Changing the storage of phosphorus in the surrounding land and soil, or the rate at which it is cycled also affects the availability of the nutrient.

Results from the monitoring indicate that land use changes and other human activities have disrupted this cycle within the East Holland River Subwatershed and have resulted in an overabundance of phosphorus. Phosphorus enters surface waters directly from rainfall, through groundwater recharge or in surface runoff. The PWQOs for Total Phosphorus for rivers are 0.03 mg/L and 0.02 mg/L in lakes. Concentrations above these levels will result in the nuisance growth of algae and other aquatic plants.

The percent of samples exceeding the PWQOs for phosphorus in the East Holland River were found to be very high. At station 001 98.87% of the samples exceeded the PWQOs, at station 003 98.86%, at station 006 94.87% and at station 007 82.8% of the samples exceeded the PWQOs. The concentrations ranged from a minimum of 0.004 mg/L at station 003, to a maximum of 2.28 mg/L at station 006 (Figure 7.2). The four stations are located in or close to urban areas suggesting that these areas are responsible for contributing large quantities of phosphorus to the river. This conclusion is also supported by literature dealing with urban runoff showing that urban areas, especially older urban areas, contribute significantly more phosphorus to a river system than a natural ecosystem (Schueler,1987). Phosphorus concentrations and sample exceedances can also be seen to increase through the urban areas as the river travels towards its mouth and is not diluted even though further inputs are added to the river.

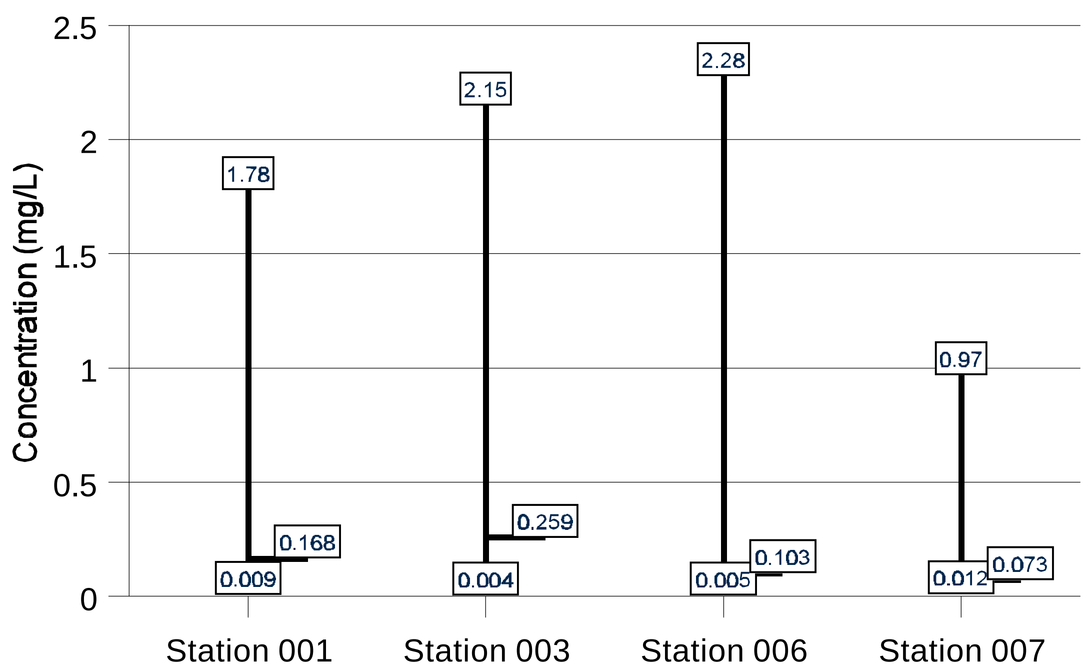


Figure 7.2: High/Low graph illustrating Total Phosphorus concentrations at four sampling sites over a 14 year period.

Two notable observations can be made from the analysis of this data. The first of which is that the phosphorus concentrations follow a seasonal trend with higher concentrations in the warmer months and lower concentrations in the cooler months. This indicates that the main method of transport of phosphorus to the river is through runoff. To address the high phosphorus concentrations, runoff sources must be identified and mitigated. The second observation that can be made is that phosphorus concentrations decrease significantly from 1983 to 1985 which corresponds to the time when the Newmarket Sewage Treatment plant was taken off line. In 1986 and 1987 another sharp increase in phosphorous levels can be observed which is likely due to the intense level of development that occurred in that period. Since 1986 and 1987 a general decline in phosphorus concentrations can be seen with slight fluctuations. However, the yearly median still shows concentrations above the PWQOs. The data ends in 1995 and therefore the effects of the last five years of rapid development are not reflected in this data set. Data examined from 1971 revealed phosphorus concentrations significantly higher than today indicating that efforts to reduce phosphorus in the river are having an effect (South Lake Simcoe Conservation Report,1973).

Nitrogen - Total Kjeldahl

Nitrogen is the main parameter that promotes the growth of aquatic plants in aquatic environments (Oron, 1990) and is therefore an important parameter when examining the water quality of the East Holland River. As was mentioned earlier, excessive aquatic plant and algae growth can contribute to eutrophication in the river which can adversely affect the health of the aquatic ecosystem.

Nitrogen moves through the ecosystem in a cycle very similar to that of phosphorus. The cycle can be altered by changing the availability of nitrogen within the system either by changing the land's ability to bind nitrogen or by adding (or removing) nitrogen. Results from the monitoring indicate that land use changes and other human activities have disrupted this cycle within the East Holland River resulting in an over abundance of nitrogen. Nitrogen enters surface waters directly from rainfall, ground water recharge, or in surface runoff.

While there are no PWQOs for nitrogen concentrations for aquatic health. Therefore, conclusions as to the severity of nitrogen concentrations in the East Holland River can really only be gained through comparisons to other rivers in the area and by comparing the different sample stations on the East Holland River.

Nitrogen concentrations measured at the four sample stations showed very high levels of nitrogen in the East Holland River. The samples ranged from a low of 0.02 mg/L at station 003 to a maximum of 15.2 mg/L at station 007. Median values at the four stations ranged from 0.52 mg/L to 1.1 mg/L (Figure 7.3).

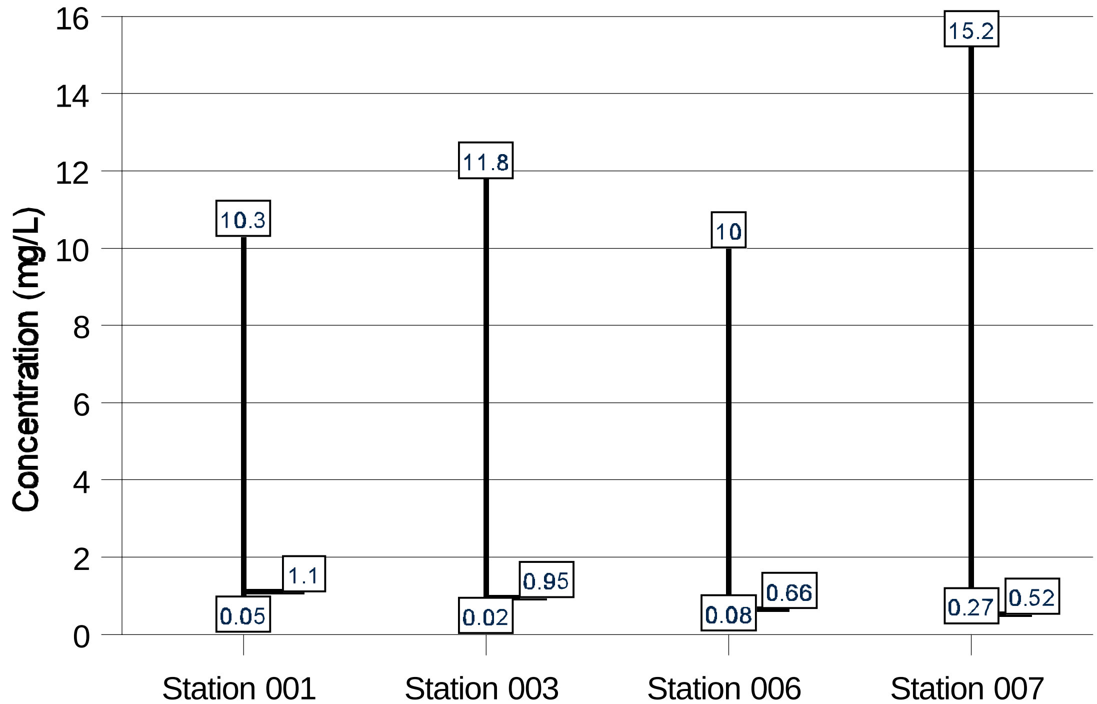


Figure 7.3: High/Low graph illustrating Nitrogen (Total Kjeldahl) at four sampling sites over a 14 year period.

When compared to other rivers in the Lake Simcoe Watershed such as the West Holland River, Black River, Maskinonge River and Pefferlaw Brook, it was found that the median value for these rivers was within the range of values found for the four East Holland River stations (0.52-1.1 mg/L). However, there is a difference in the maximum values. All four East Holland stations showed a maximum value of 10 mg/L or higher. No other stations on the other rivers were as high. Of 613 sample records which were available from the four stations on the East Holland, only 9 samples were found to be 10 mg/L or higher. However, 26 samples were found to have concentrations greater than 5 mg/L, representing 4.24% of the samples. This is significant due to the fact that these samples were not taken using rain event sampling, but were monthly samples. It could therefore be expected that there are many more instances of these very high concentrations of nitrogen entering the river.

Temporally, nitrogen shows a trend very similar to that of phosphorus. Concentrations decreased from 1983 to 1985 following the sewage treatment plant being taken off line, an increase from 1986 to 1987 during a stage of intense development, followed by a decreasing trend. Data from 1971 also shows significantly higher concentrations of nitrogen than are found today demonstrating that efforts to control nitrogen reaching the river are having an effect.

<u>Iron</u>

Iron is a naturally occurring metal found in most watercourses but generally in low concentrations. In high levels, iron is non-toxic but will act to discolour water. Levels that exceed the PWQOs of 0.3 mg/L can be detrimental to aquatic life. At all four of the sample stations the percent of samples exceeding the PWQOs was found to be quite high with 82.43% of samples exceeding at station 001, 68.75% at station 003, 60% at station 006 and 46.67% at station 007. Spatially, this shows a trend of increasing iron concentrations towards the mouth of the river. The maximum iron concentration is also found at station 001 nearest the mouth of 2.3 mg/L, with maximum concentrations decreasing towards the headwaters (Figure 7.4).

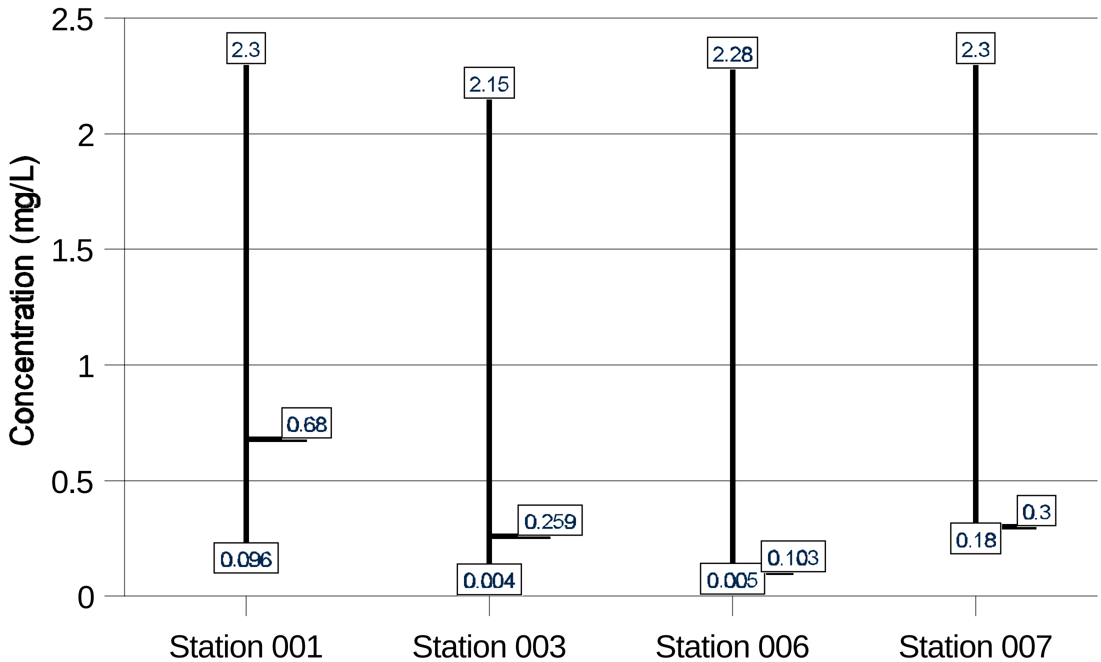


Figure 7.4: High/Low graph illustrating Iron concentrations at four sampling sites over a 14 year period.

While iron is a naturally occurring metal, the levels in the East Holland river are higher than would normally be found in a natural system, indicating a significant additional source of iron to the river. Temporally, iron concentrations can be seen to be decreasing over the sample period which is encouraging. However, the majority of yearly median concentrations still exceed the PWQOs.

Aluminum

Aluminum is naturally found in abundance in both soluble and insoluble forms. However, concentrations of aluminum may also be found in industrial wastes since aluminum is used industrially as a flocculating agent. Effects of aluminum on human health can be detrimental if ingested in large amounts. However, since the East Holland River is not used as a drinking source, this has not become an issue. Of greater concern is the aquatic ecosystem which can more readily demonstrate the ill effects of excess aluminum in the river. Toxic effects vary with pH levels and become increasingly harmful at the extremes of the pH scale. Generally, the pH of the East Holland River has remained neutral. The PWQO for aluminum is an interim objective of 0.075 mg/L for clay free samples. As the samples that were analysed were not clay free samples the following analysis should only be used as a general guide for aluminum concentrations.

At all four sample stations, a high percentage of the samples exceeded 0.075 mg/L. At station 001 81.82% of the samples exceeded 0.075 mg/L, 86.67% at station 003, 86.67% at station 006 and 60% at station 007. A maximum value of 1.2 mg/L was found at stations 006 and 007 and a minimum value of 0.03 mg/L at stations 003 and 007 (Figure 7.5). Spatially there does not seem to be a pattern to the distribution of aluminum, however as all the stations are near urban areas with industrial sectors, industry likely accounts for some of the aluminum found in the river. It is difficult to draw too many conclusions from this data set as the sampling only spans approximately one year and therefore any temporal trends are difficult to determine.

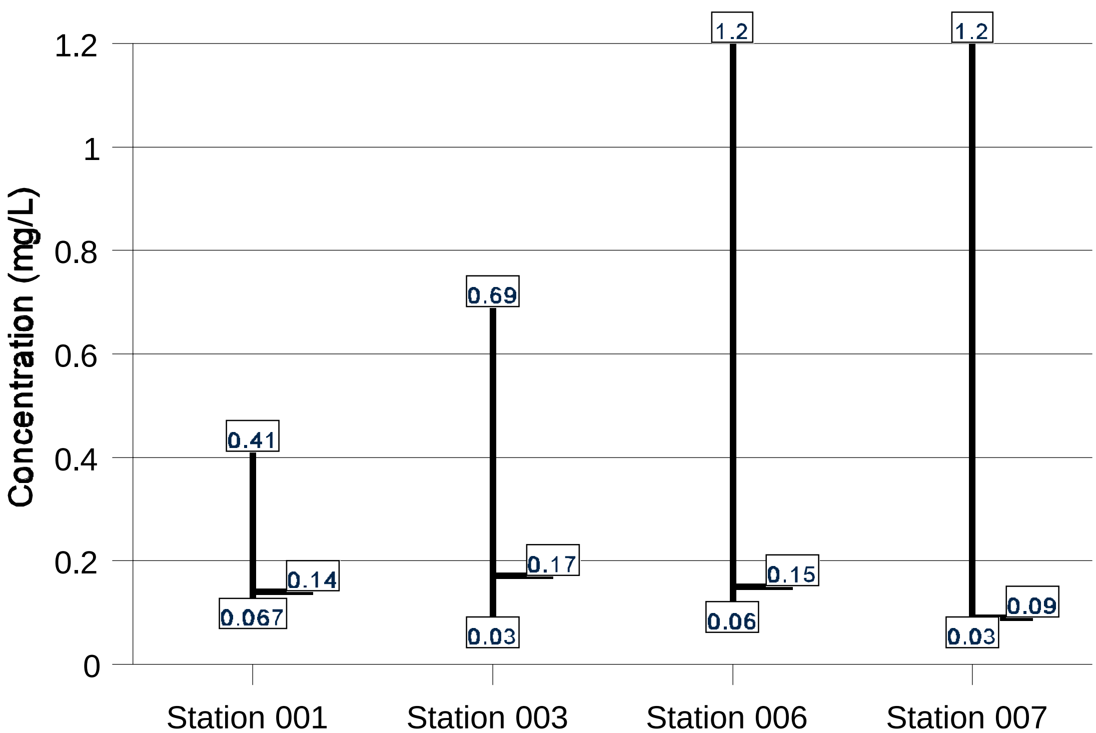


Figure 7.5: High/Low graph illustrating aluminum concentrations at four sampling sites over a 14 year period.

Aluminum concentrations in the East Holland River are considerably higher than other rivers studied in the Lake Simcoe Watershed, including the West Holland River, the Maskinonge

River and the Black River. The Black River showed both the lowest percentage of samples exceeding the 0.075 mg/L and the lowest maximum concentration. The Maskinonge showed the highest maximum concentration. The West Holland River was found to have the highest percentage of samples exceeding 0.075 mg/L of the three other rivers examined. However, none of these three rivers had exceedances as high as those found in the East Holland River. This further indicates that there is a definite source of aluminum that is entering the East Holland River. The main difference between the East Holland and the other rivers that were examined is the greater coverage of urban area in the East Holland compared to the others. This further suggests that the source of aluminum is coming from the urban areas.

Copper

While copper is a naturally occurring metal its presence in natural waters is usually an indication of industrial activity. In high concentrations copper is toxic to both humans and fish. As the East Holland River is not used as a source of drinking water the main concern is the effect of copper on the aquatic ecosystem.

The PWQO for Copper is 0.005mg/L. The percentage of samples exceeding the PWQOs ranged from 24.31% at station 001 to 34% at station 006. The maximum value was 0.41 mg/L at station 001 and a minimum value of 0.0005 mg/L at station 001. Again it is difficult to determine any spatial distribution from sample data. Compared to other rivers in the Lake Simcoe Watershed, namely the West Holland River, the Maskinonge River, the Black River and Pefferlaw Brook, the East Holland River again shows the highest percentage of samples exceeding the PWQOs. The Pefferlaw Brook had the next highest percentage of exceedances at 22%, the rest falling below this level. Looking at the copper concentrations over time the results are encouraging as a decrease in concentrations can be observed. In approximately the last 9 years of the sample set, the yearly median has fallen below the PWQOs.

Escherichia coli

The PWQOs use the relative numbers of the bacteria *Escherichia coli (E. coli)* as a health indicator to determine whether surface waters are safe for body contact recreation. The PWQOs for *E. coli* is based on a geometric mean of 100 organisms per 100 ml of water, beyond which is considered a threat to human health. The use of *E. coli* as an indicator bacteria was initiated in 1994 to replace the use of fecal coliform. Studies found that among bacteria of the coliform group, *E. coli* is considered to better represent the presence of harmful pathogen fecal bacteria.

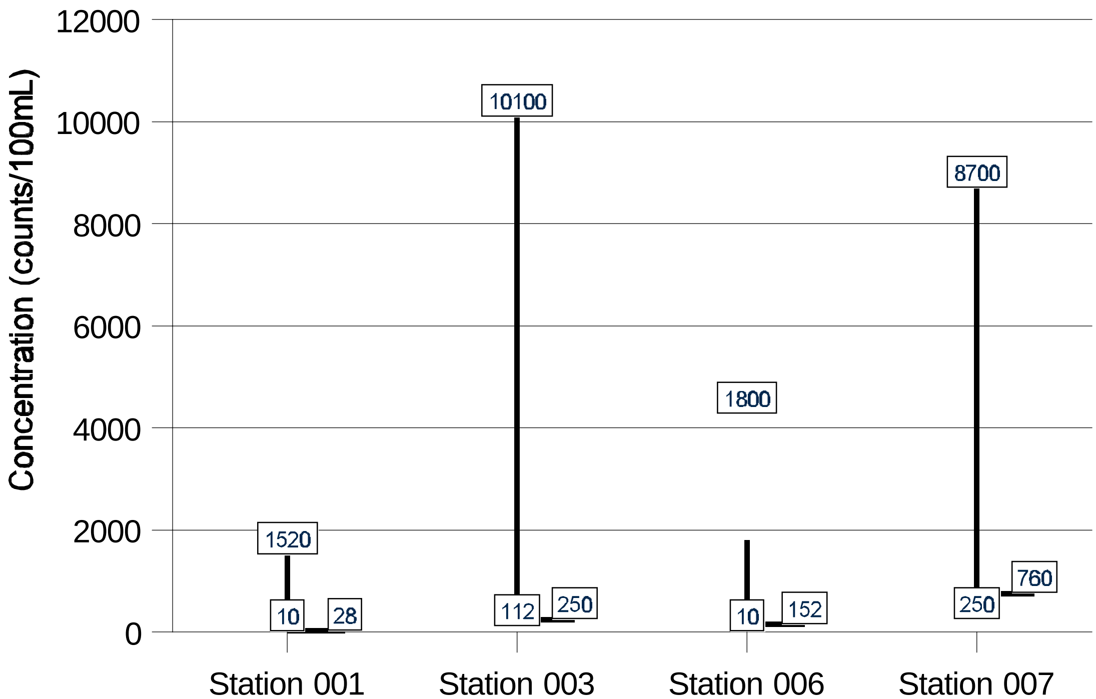


Figure 7.6: High/Low graph illustrating *E. coli* concentrations at four sampling sites.

Examination of the percent of samples exceeding the PWQOs for the four stations revealed a wide range of values. The percentage of exceedances at station 001 was 18.18%, station 006 was 53.33% and stations 003 and 007 showed 100% of samples exceeding the PWQOs. The maximum concentration was at station 003 of 10100 counts/100mL and a minimum of 10 at station 001 (Figure 7.6). Sampling for *E. coli* was only done for little over a year and therefore the data set is limited making it difficult to draw any conclusions as to the long term levels of *E. coli* in the East Holland River. However, this data does indicate that a problem exists and further investigations should be conducted.

Results

Over all, the water quality of the East Holland River is poor with 12 of the 18 parameters examined exceeding their PWQOs. The six parameters discussed above are found in concentrations high enough to seriously impact the aquatic ecosystem and reduce the recreational opportunities of the river. It is however encouraging to note that the water quality is improving. Phosphorus and nitrogen concentrations have decreased significantly from the concentrations observed in 1971 and a general decline can be observed from 1982 to 1995. The concentrations are still significantly higher than acceptable levels and efforts to reduce concentrations should be continued. Iron and copper concentrations were also found to be decreasing with the yearly median concentration for copper falling below the PWQOs. Iron concentrations are still higher than acceptable levels. Unfortunately there was not enough data to determine if aluminum and *E. coli* concentrations have been improving.

While an improvement in water quality can be observed, the concentrations are still high enough to damage the aquatic ecosystem of the river. This poor water quality not only affects the river itself but Lake Simcoe as well. High levels of phosphorus have been specifically identified by the Lake Simcoe Environmental Management Strategy (1995) as being one of key factors contributing to the declining cold water fishery in the Lake. Phosphorus concentrations in the East Holland River were found to be very high and are impacting the cold water fishery in Lake Simcoe.

Sources of Pollution

Urban Stormwater Management (SWM)

Water quality is of particular concern in the East Holland River especially phosphorus levels which are an issue in both the East Holland and Lake Simcoe itself. A major source of phosphorus can be attributed to runoff from urban or built up areas. The East Holland Subwatershed is the most heavily urbanizedd subwatershed in the Lake Simcoe Watershed and therefore managing stormwater runoff is important to the health of both the East Holland River and Lake Simcoe.

Urban stormwater runoff occurs as rain or melting snow washes streets, parking lots and rooftops of dirt and debris. This makes the type of urban land use an important consideration when attempting to quantify the environmental impacts of urban stormwater runoff. Commercial and industrial areas usually have more impervious area (e.g. paved parking lots, sidewalks, roof tops) than any other type of land use and consequently, generate more urban runoff and pollution. In sharp contrast are open areas that have little if any paved surfaces. In these areas, the natural hydrologic cycle occurs whereby water can infiltrate down into the ground to be filtered by the soil before entering local streams and watercourses or continue deeper to recharge the ground water aquifer.

The impact of stormwater runoff on stream ecosystems has been well documented and in almost every instance is detrimental to the health of local rivers and streams. Impacts to watercourses have been categorised as follows (Schueler, 1992):

- **T** Changes to stream hydrology (flow);
- **T** Changes to stream form (channel morphology);
- **T** Degraded water quality and
- **T** Degraded aquatic habitat.

These changes truly illustrate the concept of the "ecosystem" whereby all things are related or inter-connected. For example, changes to stream hydrology occur due to alterations in the natural hydrologic cycle (Figure 7.7) as a result of urbanisation. As the amount of impervious area increases, the runoff characteristics change. This change results in increases in the frequency and the magnitude

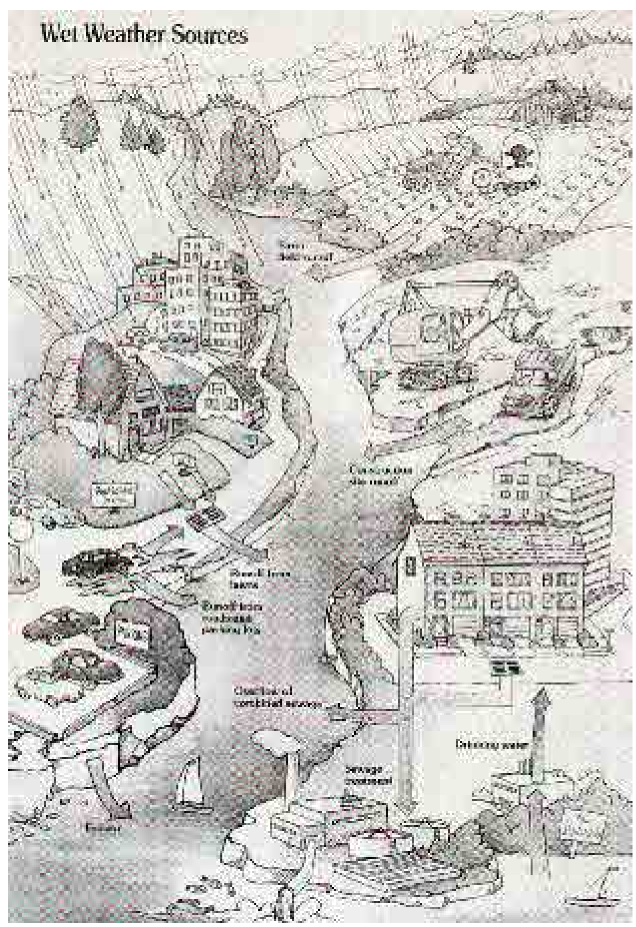


Figure 7.7: Urban Hydrologic Cycle
Source: Gosselin, H. & Johnson, B., 1995

of runoff events, a decrease in baseflow and an increase in flow velocities and energy. These changes further affect the form or morphology of the stream.

Stream channels will change shape over time as a result of changes in hydrology. Some of the problems associated with urban channels include: channel widening, down cutting, sedimentation and channel braiding. These changes occur due to the increase in the erosive force associated with the increase in stream flow. As the velocity of a stream increases, the erosive force is transferred to the streambanks that may begin to erode. If the banks are well vegetated or armoured, the erosive force may be transferred to the stream bottom and down cutting of the streambed can occur. As a result of the erosion, additional sediment and bedload are introduced into the stream system causing a further imbalance. This additional sediment when deposited along the inside bend of a river may transfer even more force along the outside bend. Further deposition can occur where the river gradient flattens out and results in the creation of a braided channel. These problems are evident all along the East Holland River and can be attributed to urbanisation within the Towns of Newmarket and Aurora.


The East Holland River at Davis Drive provides an example of a braided channel.

One of the most significant environmental impacts of stormwater runoff is to water quality. Problems with degraded water quality directly affect the aquatic ecosystem, recreational opportunities and aesthetics. Generally, concentrations of pollutants such as bacteria (e.g. *Escherichia coli*, fecal coliform, *Pseudomonas aeruginosa* and fecal streptocci), nutrients (e.g. phosphorus, nitrogen), phenolics, metals and organic compounds are higher in urban stormwater runoff than the acceptable limits established in the PWQOs (MOEE, 1994a). Other harmful impacts include increased water temperature and the collection of trash and debris.

It is a combination of all the previously mentioned changes (hydrology, channel morphology and water quality) that influences stream ecology and health. Impacts on the aquatic community range from the outright destruction of habitat to reductions in stream productivity and species diversity. The destruction of habitat can occur as spawning beds, nursery areas and structures are covered with sediment. Another way in which habitat can be destroyed is through thermal degradation. Cold water streams are defined as having a water temperature that does not exceed 20°C. Stormwater runoff can reach temperatures exceeding 30°C because it is generally draining off warm pavement. These inputs of warm water can significantly impact the temperature regime within cold water systems.

Stormwater Management Facilities (SWMF) can mitigate many of the impacts associated with stormwater runoff by intercepting and treating the runoff before it reaches the stream. A properly designed facility with both quantity and quality control acts to hold the first flush of a storm event in a wet pond allowing sediment to settle out. The same settlement process retains nutrients, like phosphorus, that are attached to the sediment. The quantity section of the pond stores the water allowing it to slowly enter the stream, reducing the damage to stream morphology associated with higher velocity and volume flows and potential flooding in some instances.

Phosphorus and sediment loading are the two main parameters examined to gauge the success of current SWM ponds. While phosphorus is a naturally occurring nutrient, excess levels can have a detrimental effect on the health of an aquatic ecosystem. In 1987, Schueler demonstrated that urban areas can be major contributors of phosphorus into a system. By comparing a hardwood forest in Virginia with a new Washington D.C. subdivision and an older urban area in Baltimore he demonstrated that the hardwood forest contributed 0.15 mg/L of phosphorus, while the subdivision contributed 0.26 mg/L and the older urban area contributed 1.08 mg/L of phosphorus. His results demonstrate that urban controls can have dramatic results in reducing the amount of phosphorus entering a river system.

More recently, monitoring work was conducted by the Ministry of the Environment concerning the effectiveness of stormwater ponds for removing phosphorus in developed residential subdivisions. Two ponds were monitored, the first pond showed a phosphorus load without treatment of 1.31 kg/ha/yr, this was reduced to 0.28 kg/ha/yr after treatment in a wet pond. The second pond had a phosphorus load of 1.27 kg/ha/yr and was reduced to 0.48 kg/ha/yr after treatment in a wet pond. The difference in effectiveness between the two ponds was attributed to differences in design. (personal communication, Weng Liang, MOE)

In the past, it was common practice to drain this polluted water directly into the East Holland River through drains and storm sewers. In many older sections of town this still occurs. On more recent developments, greater controls have been adopted that attempt to filter out some of the phosphorus and sediment. For the purpose of this study, the urban areas of Aurora, Newmarket, Holland Landing and Sharon were examined and areas with and without stormwater controls were identified and evaluated. Areas where improved controls could be implemented were also identified.

Identifying Stormwater Controls

For the purpose of this report, the term "*sewershed*" is used to describe a specific area such as city block or subdivision that drains to a common outlet by means of a subsurface system or surface topography. Sewersheds are defined by examining subdivision files, topography and through field investigation.

Subdivision files contain drawings and information on storm sewer systems that were used to determine subsurface drainage flow and direction for urban areas. By analysing the flow patterns, sewersheds could be established for areas where this information existed. However, for many urban areas this information did not exist (e.g. older sections of town), or did not contain sufficient detail to determine drainage patterns. For these areas a combination of field investigation and an examination of the topography in the area allowed for a general estimation of the sewershed boundary. Drainage from open spaces and undeveloped areas was also determined by examining existing topographic information, aerial photographs and through field investigations.

There are various methods of controlling stormwater runoff, from small-scale single lot controls to larger scale end-of-pipe stormwater management facilities. Stormwater management ponds (SWMP) are classified as end-of-pipe facilities and are generally the most effective control method in terms of cost and phosphorus reduction. There are a variety of pond types including artificial wetlands, dry ponds and wet ponds to name a few.

Wet Ponds

Wet ponds are an effective end-of-pipe SWMP and a fairly common one. A properly designed wet pond will provide both quantity and quality control. The permanent pool prevents re-suspension of sediment, minimizes blockage at the outlet, provides extended settling and allows for the biological uptake of pollutants.

Wet ponds are also designed with extended detention, which allows the pond to hold runoff after a storm and slowly release it into the receiving watercourse. By holding the increased runoff, the pond will mitigate the impact of a larger flush on the watercourse as well as reducing the risk of flooding.

Because wet ponds are so versatile, they reduce the need for multiple end-of-pipe facilities and are also less land intensive than other facilities such as wetlands. However, their uses may be limited in some areas as they do increase downstream water temperature.

Dry Ponds

Dry ponds have no permanent pool and act chiefly as a quantity control facility. As such, they are effective at erosion control and reducing the risk of flooding. Dry ponds are commonly designed with a 24-hour retention period allowing little time for contaminants to be settled out. Therefore, these facilities only make a small contribution to improving water quality. There is the potential that ponds designed with longer detention periods (such as 48 hours) may begin to improve water quality, however little monitoring data exists to confirm this. Dry ponds are mainly used in combination with other facilities or in areas where increased downstream water temperature is a major concern.

Wetlands

Artificial wetlands are an end-of-pipe facility that are very effective at improving water quality. As with wet ponds, artificial wetlands have a permanent pool that minimizes re-suspension, minimizes blockage of the outlet, provides extended settling and allows very efficient cycling of pollutants. Due to the shallow depth of wetlands, they are more land intensive than wet ponds. Their shallow depth also makes them more susceptible to problems during winter as they may freeze to the bottom negating their effectiveness at settling out contaminants. The shallow depth also reduces the quantity control capabilities of a wetland because the active volume is generally the extent of its storage capacity. These problems can be addressed by creating a hybrid wetland/wet pond facility with a deeper sediment forebay.

To date, there has been little performance monitoring of stormwater/artificial wetlands in Ontario to better understand their biological impacts and enhancements. It is assumed that water quality benefits are enhanced because of the uptake associated with the density of aquatic plants. However, it is known that like wet ponds, wetlands may increase the downstream water temperature and provide increased habitat for wildlife. The issue of providing wildlife habitat is presently being debated by many agencies and naturalist groups. SWMPs are designed for the purpose of intercepting and containing pollutants. There is valid concern that these pollutants could have an impact on wildlife using the pond. Therefore, it is recommended that features to enhance wildlife habitat not be included into the design or retrofit of SWMF.

Based on the existing SWM Practices Manual (MOEE, 1994b), there are various levels of stormwater control established to ensure the protection of receiving waters (e.g. watercourse, ditch, lake). These guidelines were produced by the Ministry of the Environment taking into consideration concerns from the Ministry of Natural Resources (Fish Habitat Protection Guidelines for Developing Areas, 1994). Four levels of protection were established focussing on the ability of SWMPs to control and remove suspended solids.
Level 1 is the most stringent level of protection designed to protect habitat which is essential to the fisheries productivity (e.g. spawning, rearing and feeding areas) and requires 80% removal of suspended solids.

Level 2 protection calls for a 70% removal of suspended solids. In this instance, the receiving water can sustain the increased loading without a decrease in fisheries productivity.

Level 3 controls are relaxed further requiring a 60% sediment removal rate again reflecting the lower quality of the receiving water for fish production.

Level 4 controls exclusively address retrofit situations where, due to site constraints the other levels of control cannot be achieved. Level 4 protection is not to be considered for any new development, only for instances where uncontrolled urban areas can implement some SWMF to improve environmental health.

It is important to realise that, while these guidelines are specific to suspended solids, other pollutants such as bacteria, metals and nutrients (e.g. phosphorus) are reduced by the same controls. Due to severe water quality problems in Lake Simcoe and the potential destruction of the cold water fishery (e.g. lake trout *Salvelinus namaycush*), the entire Watershed has been deemed a special policy area. As a result, all new development in the Watershed since 1996 has been required to construct SWMFs that meet the most stringent criteria or Level 1 protection. This special policy designation was a result of a recommendation contained in the Lake Simcoe Environmental Management Strategy (LSEMS) “Our Waters, Our Heritage, 1995” report (Activity B, Issue 9), which deals exclusively with efforts to reduce phosphorus inputs to Lake Simcoe.

Stormwater Management Facilities in the Town of Aurora

In the Town of Aurora a total of 225 individual sewersheds were identified 179 of which were classed as urban. Of these only 37 (16%) have some kind of stormwater management ponds (Figure 7.8). There are currently no stormwater ponds in Aurora that meet the Level 1 criteria. There are 4 ponds (10.8%) that are considered to meet the Level 2 criteria, another 5 ponds (13.5%) provide Level 3 protection and the remaining 28 (75.7%) are quantity control ponds, some with only a minimal degree of quality control. Ponds meeting Levels 1-3 criteria provide both quantity and quality control, however as mentioned above the amount of quality control decreases under Levels 2 and 3.

Sewersheds in Aurora were classified in five categories based on the level of stormwater management control (Figure 7.8):

- Uncontrolled (urban sewersheds that do not flow into a SWMP);
- Greenspaces (undeveloped areas where the natural drainage system still exists);
- Field (agricultural or pasture areas where the natural drainage patterns may have been altered);
- Quantity control (urban sewersheds that flow into a quantity SWMP), or
- Quantity/quality control (urban sewersheds that flow into a Level 1-3 SWMP);

Of the total land area occupied by the Town of Aurora, 42.66% is uncontrolled urban area, 21.52% is greenspaces, 23.54% is field and 12.28% is urban area draining to some type of stormwater management facility.

Phosphorus loadings for sewersheds in Aurora were determined using an adaptation of Lake

Sewersheds and Stormwater Management Ponds in Aurora

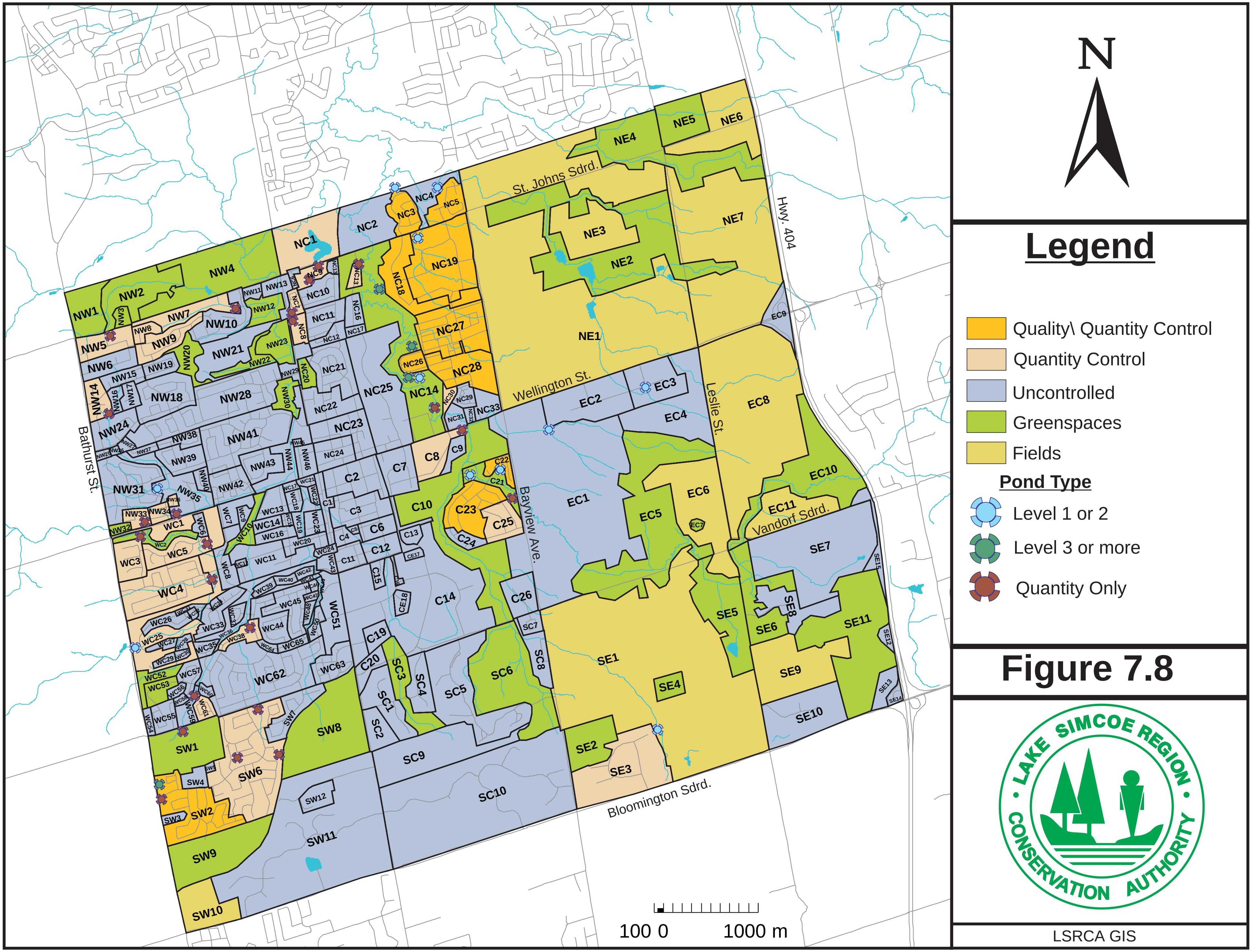


Figure 7.8

Simcoe Water Quality Model developed by BEAK Consultants in 1994 (Figure 7.8). The results of the phosphorus modelling found that the total urban load from the Town of Aurora amounted to 3401.09 kg/yr. Of this amount it was found that three urban sewersheds exceeded 200 kg/yr. A number of field classed sewersheds were also found to exceed 200 kg/yr. However, the BEAK model was not designed to predict agricultural loadings and does not provide accurate results in these areas. A seperate model, the AGNPS model (Agricultural Non-Point Source Model) was used for these areas. Of the three urban sewersheds exceeding 200 kg/yr, sewershed C14 has the highest load at 307.52 kg/yr of phosphorus followed by SC10 and SW11 at 220.59 kg/yr, 218.25 kg/yr respectively. While these sewersheds represent some of the larger urban sewersheds and partly explain the large phosphorus loads, they are also the areas that would show a large decline in overall phosphorus output if greater stormwater controls were adopted.

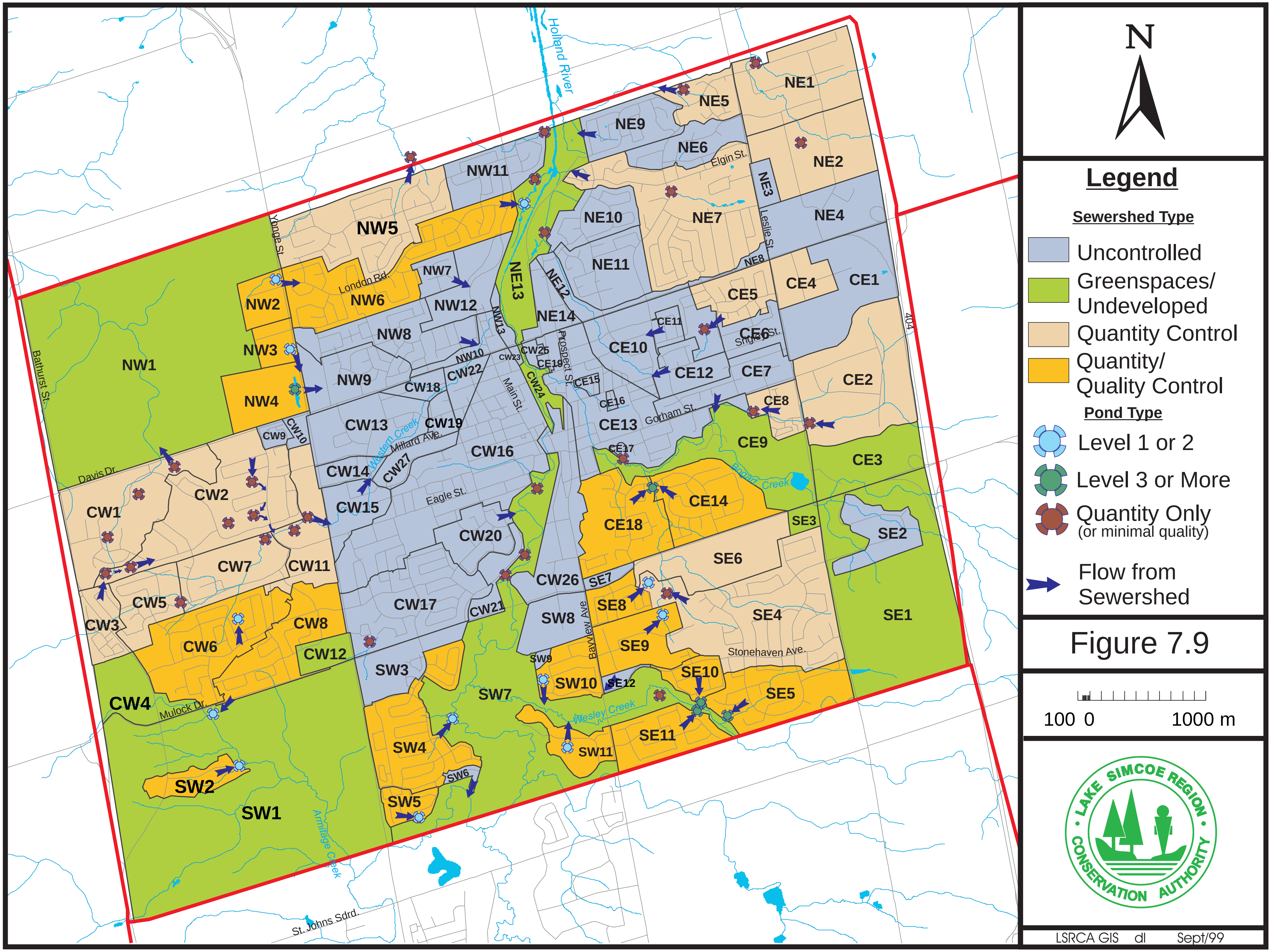
The three sewersheds that have a phosphorus loading of greater than 200 kg/yr make up 9.15% of the total Town's area and contribute 21.94% of the urban phosphorus loading. One urban sewershed has a phosphorus load between 100 and 200 kg/yr. This sewershed comprises 1.05% of the Town's area and contributes 3.88% of the urban phosphorus loading. The remaining 175 urban sewersheds have phosphorus loading levels below 100 kg/yr. These sewersheds make up 39.79% of the Town and contribute 74.18% of the urban phosphorus loading.

Stormwater Management Facilities in the Town of Newmarket

In the Town of Newmarket a total of 95 sewersheds were identified. 85 sewersheds were classed urban 46 of which have stormwater management ponds (Figure 7.9). Of these, 12 ponds (26.0%) are considered to meet the Level 1 or 2 criteria, another 5 ponds (11.0%) provide Level 3 protection and the remaining 29 (63.0%) are quantity control ponds, some with only a minimal degree of quality control.

Sewersheds in Newmarket were classified in four categories based on the level of stormwater management control (Figure 7.9):

Newmarket Sewersheds and Stormwater Management Ponds



- **T** Uncontrolled (urban sewersheds that do not flow into a SWM pond);
- **T** Open spaces/undeveloped (undeveloped areas where the natural drainage system still exists);
- **T** Quantity control (urban sewersheds that flow into a quantity SWM pond), or
- **T** Quantity/quality control (urban sewersheds that flow into a Level 1-3 SWM pond).

Of the total land area occupied by the Town of Newmarket, 29.35% is uncontrolled urban area, 30.69% is open spaces/undeveloped and 39.96% is urban area draining to some type of stormwater management facility.

Phosphorus loadings for sewersheds in Newmarket were determined using an adaptation of Lake Simcoe Water Quality Model developed by BEAK Consultants in 1994 (Figure 7.9). The results of the phosphorus modelling found that the total urban load from the Town of Newmarket amounted to 3674.85 kg/yr. Of this amount, it was found that one sewershed exceeds 200 kg/yr, CE2 at 216.72 kg/yr phosphorus load. A substantial decrease in phosphous loadings could be expected if greater stormwater controls were implemented in this area. This sewershed makes up 2.24% of the Town and contributes 5.9% of the total phosphorus loading.

Nine sewersheds have phosphorus loads between 100 and 200 kg/yr. These sewersheds make up 19.35% of the Town and contribute 33.9% of the total phosphorus loading. The remaining 75 urban sewersheds have phosphorus loadings below 100 kg/yr. These sewersheds make up 47.72% of the Town and contribute 60.21% of the total phosphorus loading.

Stormwater Management Facilities in Holland Landing

In Holland Landing 36 sewersheds were identified, based mainly on topography. The main method of drainage for the community is by curb and gutter directly to the river making it very difficult to determine common outlets and drainage areas beyond those seen by use of topography. Five quantity ponds were identified that service approximately 7.42% of Holland Landing. However, quantity ponds provide very little quality control and therefore no phosphorus reductions can be expected in stormwater runoff from Holland Landing.

Phosphorus loadings for sewersheds in Holland Landing were determined using an adaptation of Lake Simcoe Water Quality Model developed by BEAK Consultants in 1994. The results of the phosphorus modelling found that the total urban load from Holland Landing amounted to 670.73 kg/yr. There are no sewersheds that exceed 100 kg/yr however, there are four sewersheds that exceed 50 kg/yr. These four sewersheds comprise 33.76% of the urban area and contribute 34.23% of the total urban phosphorus load. The difficulty in reducing the loads from these areas is that the majority are washing directly to the river via multiple outlets, rather than from single outlets where the flow could be intercepted and treated. For these areas, as well as most of the rest of the town, alternatives to end of pipe facilities will need to be applied.

Stormwater Management Facilities in Sharon

Of the total urban area in Sharon, approximately 50.84% drains to the East Holland River via Sharon Creek, the remainder of the community drains to the Black River. It is the area that drains to the East Holland that is focussed on in this report. In this area, a total of 7 sewersheds were identified, 1 of which has level 1 quality control, 2 with quantity control only and the remaining 4 being uncontrolled.

Phosphorus loadings for sewersheds in Sharon were determined using an adaptation of Lake Simcoe Water Quality Model developed by BEAK Consultants in 1994. The results of the phosphorus modelling found that the total urban load from Sharon amounted to 112.71 kg/yr. None of the sewersheds have loadings greater than 100 kg/yr, however, the combined load flowing to the East Holland is significant at 112.71 kg/yr. Opportunities exist to reduce the amount of phosphorus entering the river.

Total Loadings

Using the BEAK model the total uncontrolled phosphorus loadings from the four urban areas can be approximated at 8448.44 kg/yr. However, the 27 stormwater facilities providing quantity control reduce the phosphorus loading by 589.06 kg/yr to 7859.38 kg/yr. This figure can still be greatly reduced by increasing the level of control on existing facilities that may not meet level 1 or 2 protection criteria (10 facilities) and by implementing quality control facilities in uncontrolled areas, including areas where the facilities provide quantity control only (64 facilities).

Presently, the urban area of these three towns is 60.28 km^2, 51.27 km^2 of which has uncontrolled stormwater discharges. In much of this uncontrolled area there is not sufficient space at common outlets for the construction of stormwater facilities. Alternatives to end of pipe facilities, such as increased street cleaning, reduced road salting and sanding (when safety permits), installation of rain barrels and soak away pits, household hazardous waste disposal, naturalisation and reduced fertilizer and pesticide use would help to improve water quality from these areas. In areas where pond retrofits or the creation of new ponds is feasible and cost effective they should be seriously considered. Areas where retrofits or new ponds could be constructed have been identified. Catchments where stormwater inputs are a concern are shown in Figure 7.10.

Agricultural Inputs

Agricultural practices are another significant source of phosphorus to the East Holland River and Lake Simcoe. The use of chemical fertilizers can result in an accumulation of phosphorus in the soil. Water draining from this soil into subsurface drainage systems will carry with it elevated levels of dissolved phosphorus. This soluble phosphorus is of particular concern because it is the fraction most easily taken up by aquatic plants and algae.

Rainwater runoff from feedlots, improperly stored manure and manure spread during winter will also contribute phosphorus into the ecosystem. Improved manure storage, diversion of runoff around feedlots and the creation of vegetative buffer strips can significantly reduce pollutant loadings from these sources. Careful timing of manure application and the incorporation of manure after spreading also lower the potential for loss of phosphorus and other pollutants.

Where livestock have direct access to a watercourse for their water supply, animal faeces with associated phosphorus and other pollutants can enter streams directly. Livestock can also cause accelerated streambank erosion by trampling vegetation, thus introducing more phosphorus and sediment to the stream. Such impacts from livestock can be controlled by installing fences and stream crossings with controlled access and by providing alternative sources of water for livestock.

In dairy operations, milkhouse wastewater may be rich in phosphorus as well. It is often discharged to a watercourse through surface drains. It can be controlled by incorporating the wastewater into a manure storage facility or by installing a treatment system.

During the summer and fall of 1999, Conservation Authority staff conducted a survey to collect information regarding individual farming operations and practices in the East Holland River Subwatershed. The intent of the survey was to assess current practices and provide direction to protect natural features and improve the environmental health of the area.

The survey was designed to assist in determining areas of concern and the farmers' willingness to help address the issues. The survey focussed on:

- The type and extent of the farming in the East Holland River Subwatershed;
- The extent to which the local farmers believe that the government and farmers should contribute (financially and technically) to agriculture pollution control measures;
- Manure storage capabilities and practices;
- The amount of tile drainage and where tiles outlet;
- Finally, if there is any interest in Landowner Environmental Assistance Programs (LEAP) or tree planting programs.

Ninety-nine (99) farms were identified in the East Holland River Subwatershed from the aerial photographs. Of these, seventy one (71) completed the survey for a return rate of seventy two percent (72%).

From the information collected, a number of general recommendations could be made which would benefit both the farming community and the environment. These are as follows:

Soil Testing

Regular soil testing is an important part of any nutrient management plan. Understanding the deficiencies of the soil ensures that the correct concentration and combination of fertilizers is used based on the crop requirement. Using just enough fertilizer will prevent any excess from running into watercourses where it can lead to excess weed growth and eventual decay decreasing the amount of oxygen in the water available for other aquatic life including fish. There may also be a benefit to the farmer since if the amount of fertilizer required is less than the amount being used, the farmer can realise a financial saving. The thirty two (32) farm owners who have never tested their soil will be encouraged to make arrangements for soil testing.

Manure Storage and Handling

Manure should be stored in an area where it is contained and any runoff is intercepted to prevent the contamination of ground and surface waters. The manure storage facility should be large enough to store a minimum of two hundred and fifty (250) days worth of manure. This size will ensure that the farmer has flexibility when scheduling manure spreading and can confine spreading to times of the year when the ground is unfrozen reducing the risk of runoff and dry enough to permit machine access without excessive compaction or running the risk of having machinery stuck in a field. The spreading of manure in the winter is not considered an acceptable practice since the material can quickly run off during a thaw. Three (3) farms have been identified as requiring the construction of suitable manure storage systems with runoff containment who have greater than 30 EAU (Equivalent Animal Units) in their operation and are less than 200m from a watercourse or drainage ditch. An additional thirty five (35) farms will require individual assessment to determine their requirements for manure storage system upgrades since their EAUs are below 30 or their storage systems are greater than 200m from the nearest watercourse or drainage ditch. Seven (7) farms spread manure in the winter and will be encouraged to spread during other times of the year.

Tile Drainage

The installation of a tile drainage system can be a very efficient method of improving the moisture conditions on very wet properties and allowing more efficient farm operations. However, extra care needs to be taken when working these fields as well as taking the time to carry out maintenance on the system to ensure it is working properly. Tile drains can provide a direct route for excess nutrients, manure or chemicals to enter watercourses. Therefore, proper use of fertilizers and careful storage of manure and chemicals is very important. It is possible to have tiles that drain into a containment lagoon from which water can be taken for irrigation to reduce pressure on groundwater resources. Using tile drained water for irrigation can also recycle any unused nutrients that were leached from the field.

Milkhouse Wastewater

Milkhouse wastewater can be a source of bacteria, phosphorus and nitrates if allowed to discharge into streams. It can be effectively contained using storage lagoons, tanks or septic systems. In many cases, it is most effective to combine it with manure storage systems in a liquid containment system. No farms were identified as discharging wastewater into streams.

Livestock Access to Watercourses

Allowing livestock to use a stream for drinking water or to cross a stream regularly can introduce bacteria and phosphorus to the stream both through direct addition of faeces or the resuspension of bed and bank materials. Trampling of the surrounding vegetation will also result in streambank erosion and the destruction of riparian habitats. To protect the streambanks, livestock should be fenced out of watercourses and provided with alternate crossing points and an alternate drinking water source. The two (2) farms that allow livestock access to a watercourse will be encouraged to fence the livestock out of the water and provide them with alternate crossings and water sources.

Watercourse Buffers

A 15 metre natural vegetation buffer (from top of bank) along watercourses is recommended. However, any size buffer will have benifits. A buffer will improve bank stability, filter excess nutrients from surface runoff, reduce soil erosion and improve water quality and aquatic habitat. The eight (8) farms which do not have a buffer on their watercourse will be encouraged to plant trees to create a buffer.

Environmental Farm Plan

Through the preparation of an Environmental Farm Plan (EFP), a farmer will be able to identify the environmental strengths and weaknesses of their operation and set goals to improve the environmental conditions on their property. Farmers who have prepared an EFP are eligible to apply for grants to assist in the implementation of environmental projects. All farmers in the study area will be encouraged to participate in the EFP program.

An additional method used to predict agricultural inputs to the East Holland River (specifically nitrogen) was the Agricultural Non-Point Source (AGNPS) model. The model simulates the runoff on a single event basis and can be used to target the significant sources contributing these nutrients to the watercourse.

<u>Summary</u>

There are various means of improving water quality. As it would appear that the main source of the chemicals that were examined are coming from the urban areas in the Subwatershed the best results would be obtained by focussing efforts in these areas. One method is improving stormwater runoff controls which would assist in addressing the high phosphorus, nitrogen and *E. coli* levels and to some extent the metals in the river. To more effectively address the inputs of metals (aluminum, copper and iron specifically) further sampling and analysis would be required to determine the sources. Once the specific sources are identified, efforts to reduce the inputs of these metals can be concentrated at these sites.

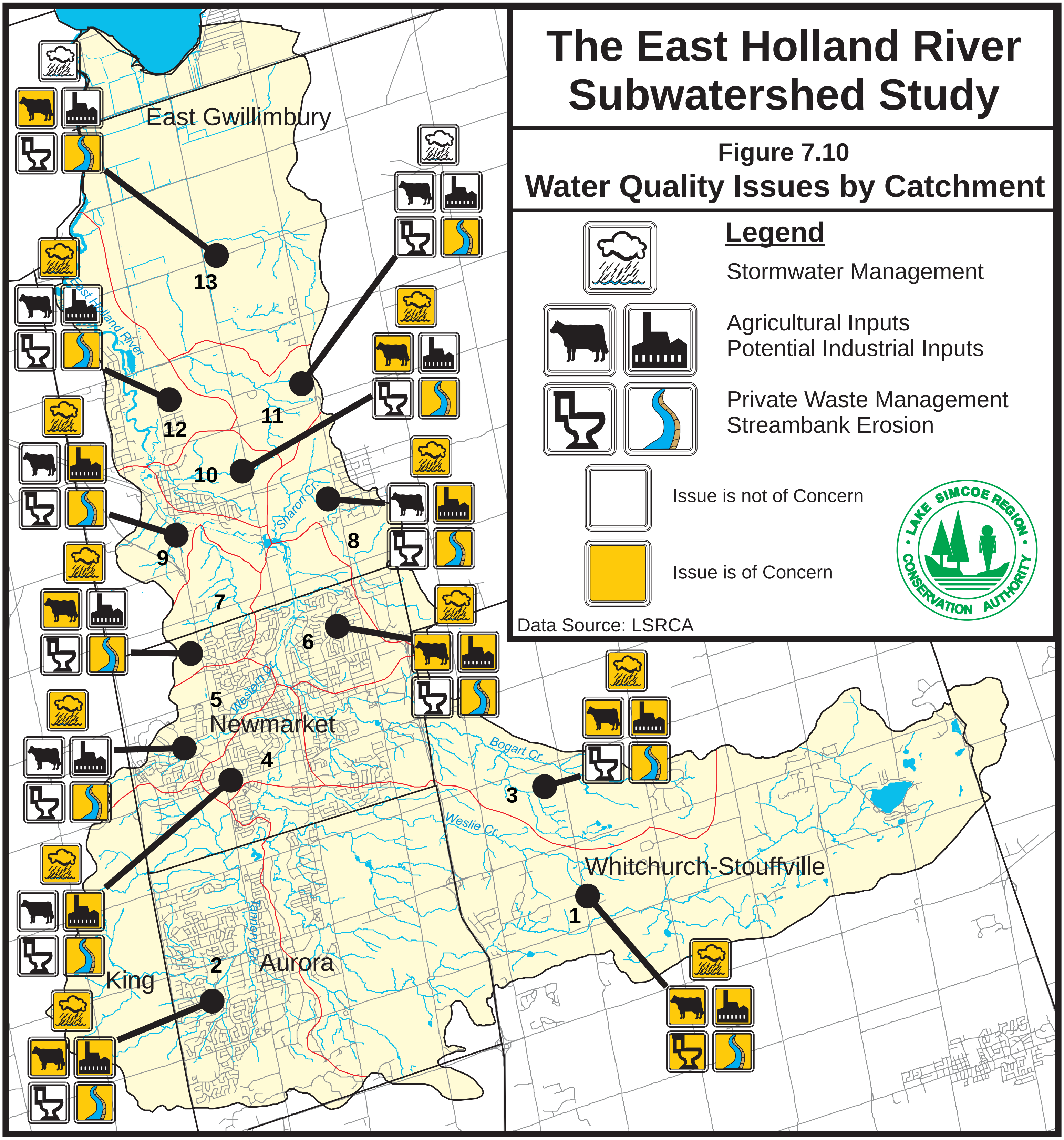

The East Holland River Subwatershed Study
Figure 7.10
Water Quality Issues by Catchment
Legend
Stormwater Management
Agricultural Inputs
Potential Industrial Inputs
Private Waste Management
Streambank Erosion
Issue is not of Concern
Issue is of Concern
Data Source: LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
1
2
3
4
5
6
7
8
9
10
11
12
13

Figure 7.10 shows catchments where water quality issues are a concern.

7.2 Hydrogeology

The report on the groundwater resources of the East Holland River Subwatershed prepared by Singer, Cheng and Solovykh in cooperation with the Ministry of the Environment describes the occurrence, quantity and quality of groundwater in the study area. An inventory of the resource was assembled for the purpose of enhancing groundwater management in a dynamic and rapidly changing landuse environment.

The report has made extensive use of data obtained from the Water Well Information System (WWIS) of the Ministry of the Environment. Approximately 4,180 well records were examined. Of these, over 2,500 records that have the highest degree of accuracy in terms of well location and elevation were selected for further analyses in conjunction with Geographic Information Systems (GIS) techniques to produce thematic hydrogeologic maps and geologic cross-sections for the Subwatershed.

Statistical techniques were used to determine the specific capacity and transmissivity distributions for bedrock and overburden wells as well as to assess the characteristics of streamflow records and fill in missing data. Further, a number of hydrologic techniques were used to estimate the potential and actual evapotranspiration and assess the long term groundwater discharge and recharge on a monthly and annual basis.

A description has been assembled to characterise the various overburden deposits in the Subwatershed, bedrock topography and groundwater occurrence in the bedrock. A limited number of water wells obtain their water supply from the bedrock and the water yield from these wells appears to be limited. This indicates that the bedrock in the Subwatershed is of minor importance as a source of water.

The various overburden deposits in the Subwatershed have been described by origin, type, thickness and areas extent. A tentative correlation with similar deposits found in neighbouring areas has been provided. Most of the groundwater supplies are obtained from overburden wells and the best aquifers consist of sand and gravel deposits of glaciofluvial or glaciolacustrine origin.

Three major aquifer complexes were identified in the overburden; the Oak Ridges Aquifer Complex within an elevation range of 260-350 metres above sea level (asl), Intermediate Aquifers within an elevation range of 180-260 metres asl and the Yonge Street Aquifer within an elevation range of 110-200 metres asl.

The reported transmissivities for wells completed in the Oak Ridges Aquifer Complex range from intermediate values of 225 and 300 m^2/day up to 400 m^2/day. The reported transmissivities for wells completed in the Intermediate Aquifers zone range from 100 to 1,771 m^2/day. The transmissivities for wells completed in the Yonge Street Aquifer range from about 1,000 m^2/day in the Newmarket area up to 4,000 m^2/day in the Holland Landing and Sharon/Queensville areas.

The Yonge Street Aquifer, which is a confined channel aquifer, provides most of the municipal groundwater supply within the Subwatershed. This water withdrawal has resulted in a decline in the piezometric level within the aquifer. Available information indicates that the hydraulic heads of the majority of production wells at Aurora and Newmarket have decreased to levels ranging from about 206 to 220 metres asl which are at or below the water level of Lake Simcoe of 219 metres asl. In addition, the hydrographs of observation wells located within the Yonge Street Aquifer but not adjacent to individual production wells also show an average water level decline of about 1.6 m/year from 1982 to 1989.

The analysis of the groundwater levels' configuration within the overburden indicates that it is a subdued reflection of the surface topography where the groundwater divides coincide closely with the Subwatershed's topographic divides. Without any stresses due to water withdrawals, the natural tendency of the groundwater regime within the Subwatershed is to discharge to Lake Simcoe. Along the way to its ultimate destination, groundwater seeps into the valleys of the East Holland River and sustains its baseflow.

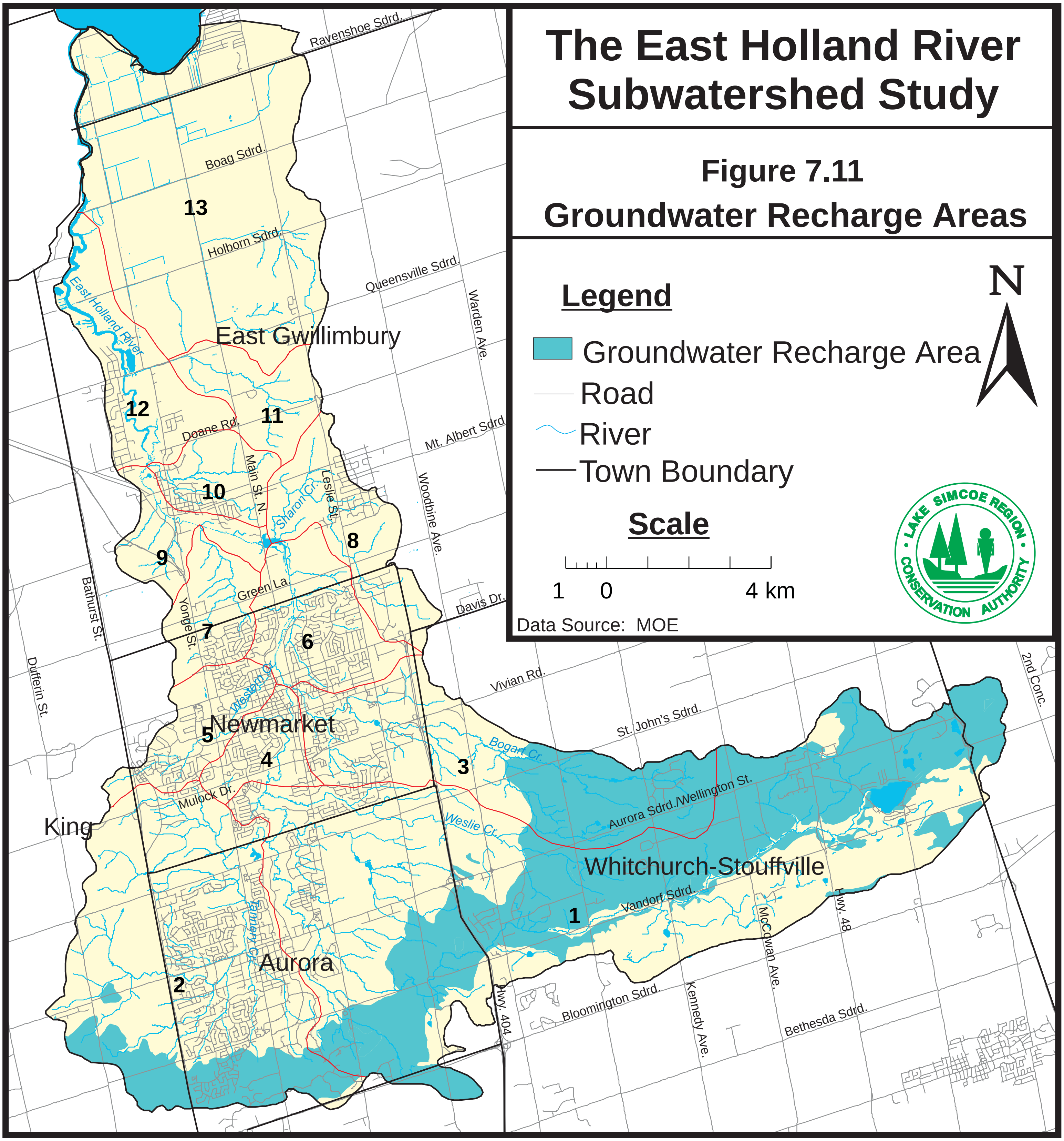
Based on available data at the Bradford Muck Research Station for the period 1975-1997, the lowest monthly temperatures are observed during the months of December, January or February and the warmest monthly temperatures are observed during the months of June, July or August. The mean annual temperature ranges between 5.1 ^{o}C and 8.1 ^{o}C, while the mean monthly temperature ranges between -13.8 ^{o}C and 25.4 ^{o}C.

Sharon Station is the only other long term meteorological station within the Subwatershed that is still in operation. The annual precipitation at this station for the period 1986-1997 ranged from 659 to 948 mm with an annual long term mean of 810 mm.

The annual potential evapotranspiration within the Subwatershed for the period 1986-1997 ranged from 552 to 616 mm with an annual long term mean of 585 mm. The annual values of actual evapotranspiration for the same period ranged from 469 to 594 mm with a long term annual mean of 531 mm.

Continuous, daily streamflow records for the period 1965-1999 are available at gauging station 02EC009 at Holland Landing. In addition, records of spot measurements of streamflow are available at five intermittent stations within the Subwatershed. The annual streamflows at stations 02EC009 for the period 1986-1997 ranged from 15 to 332 mm with an annual long term mean of 231 mm.

Groundwater discharge was estimated using a streamflow separation approach. The estimated annual groundwater discharge at station 02EC009 for the period 1986-1997 ranged from 83 to 185 mm with an annual long term mean of 125 mm. Groundwater recharge can occur anywhere within a watershed. The most important groundwater recharge area in the Subwatershed is located within the Oak Ridges Moraine (Figure 7.11) where thick sand and gravel deposits occur at the surface. The long term annual groundwater recharge within this zone is estimated to range from 250 to 275 mm.



The East Holland River Subwatershed Study
Figure 7.11
Groundwater Recharge Areas
Legend
Groundwater Recharge Area
Road
River
Town Boundary
Scale
1 0 4 km
Data Source: MOE
N
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Mt. Albert Sdrd.
Woodbine Ave.
Doane Rd.
Main St. N.
Leslie St.
Sharon Cr.
Green La.
Davis Dr.
Yonge St.
Bathurst St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
2nd Conc.
Bogart Cr.
Western Cr.
Mulock Dr.
Aurora Sdrd./Wellington St.
Wesley Cr.
Tannery Cr.
Vandorf Sdrd.
McCowan Ave.
Hwy. 48
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.
East Holland River
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The groundwater withdrawal from the Yonge Street Aquifer is not being accommodated by reduced groundwater discharge to the East Holland River. It is being balanced by increased infiltration from above and/or a shift of the groundwater divide which results in an increase in the catchment area of the aquifer.

The chemical analyses for 44 water samples collected from overburden wells were used to evaluate the natural groundwater quality and the type of groundwater found in the overburden. The quality parameters considered were sodium, total iron, chloride, sulphate, nitrate, hardness and total dissolved solids. In general, the natural (raw) groundwater quality was found to be good. Groundwater in the overburden is of calcium bicarbonate type.

Groundwater Vulnerability

Stormwater runoff and spills from urban development can carry high concentrations of pollutants which can infiltrate into the groundwater. In addition, some farming practices can also cause increases in pollution loading to the groundwater, particularly in areas with high groundwater tables. The vulnerability of groundwater to contamination depends on such elements as soil types, water table elevation, contaminant concentration and the confined/unconfined nature of the aquifer. Recharge areas are the most vulnerable to contamination due to their high capacity for infiltration. In the East Holland River Subwatershed, the primary recharge area is situated on the Oak Ridges Moraine (Figures 6.7 & 7.11). Hydrogeological Environmentally Significant Areas have also been identified (Figure 6.7) and should be considered areas of high groundwater vulnerability. Additionally, areas with sandy or sandy loam soils are vulnerable areas for groundwater contamination. In the East Holland River Subwatershed, approximately 36% of the total area consists of sandy or sandy loam soils (Figure 3.3).

7.3 Water Quantity

Water quantity can be significantly impacted by urbanization. The paving of the land, clearing of trees and alteration of river channels all have an impact on the hydrologic cycle and cause changes in water quantity. These changes can be increases relating to higher runoff rates in urban areas causing downstream flooding. Changes can also take the form of decreases due to a lack of groundwater recharge or higher levels of groundwater withdrawal which reduce the amount of base flow in local streams. This section describes the current state of water quantity in the East Holland River Subwatershed using historical modelling information and stream survey data.

Subwatershed Hydrology

Subwatershed hydrology refers to the run off characteristics of a drainage basin under various rainfall and snow melt events. Factors which influence the amount of precipitation which is converted into stream flow include soil types, soil moisture content, topography, ground cover, urban and rural land use practices, the amount of impervious area and temperature, ice and snow conditions.

The hydrology of the entire East Holland River system was analysed for the Conservation Authority in 1984 by the consulting firm Cumming Cockburn Limited (CCL) using the computer program HYMO (Williams and Hann, 1973) and rainfall data from the Toronto Bloor Street gauge. In addition, the effects of snow melt were incorporated in peak flow calculations. The HYMO model was designed to transform rainfall data into run off hydrographs and to route these hydrographs through streams and valleys. It required the user to input rainfall events as well as information describing the run off characteristics of specific areas. Current versions of this model are still being used under such names as OTTHYMO89, Visual OTTHYMO and SWMHYMO.

The primary focus of the 1984 study was the estimation of peak flows for major storm events in order to determine flood lines for most of the Holland River system as part of the Canada/Ontario Flood Damages Reduction Program. As a result, peak flows from the 1:100

year and Regional (Hurricane Hazel type) storm events were determined for numerous locations within the East Holland River system. In 1985, CCL completed the hydrologic model for the remaining event storms (1:5, 1:10, 1:25 & 1:50 year).

Various portions of the subject Subwatershed have been modeled prior to and after 1984 including Bogart Creek (1981 and 1992), Tannery Creek (1979 and 1995) and Western Creek (1990). This work was done in order to provide detailed information on flood lines in Newmarket and Aurora.

The hydrology of the Subwatershed can be characterised by two distinctly different areas. The headwater area east of Aurora/Newmarket is largely located in the Oak Ridges Moraine and as such has rolling topography with sandy soils that have very low run off potential and a high degree of infiltration. In these type of areas, approximately 90% of yearly precipitation either evaporates or infiltrates into the shallow and deep aquifers. The remaining portion of the Subwatershed (northern Aurora and Newmarket and north towards the confluence of the East Holland and the West Holland Rivers) is much lower in elevation and has, for the most part, clayey soils. These soils have a relatively high run off potential and thus low infiltration capability.

Urbanization as well as intensive agriculture uses can alter the hydrologic characteristics of a watershed. The removal of natural vegetation and the regrading of land to “improve” drainage eliminates interception and depression storage. Increases in impervious area prevent infiltration and reduce available soil storage. These changes result in an increase in run off volume and can result in increases in downstream flooding and erosion and decreases in base flow due to reduction in groundwater recharge. The East Holland River Subwatershed has experienced a high degree in urban growth in the past 25 years, especially in the areas of Aurora and Newmarket. Coupled with this growth has come an increased awareness on the part of the public, Municipalities and the Conservation Authority regarding the negative impacts of urbanization. Since the late 1970's, new development sites have been required to control peak flows to pre-development levels, generally by the use of stormwater management ponds. Similarly, developments in areas of high groundwater recharge have been required to maintain existing infiltration volumes. Beginning in the early 1990's, water quality controls became a requirement for developments due to better knowledge regarding the impacts on water quality caused by urbanization. These types of control requirements generally manage to mitigate but not necessarily eliminate increased negative impacts on the hydrology of the Subwatershed.

The current state of the resource can be described as impaired due to the intensive use of the Subwatershed by humans in the 20th century. Although a quantitative impact study has not been conducted, other studies (Schueler, 1987) have shown that there is a strong correlation between increased human activity and impairment of the hydrologic cycle. The impaired nature of the system translates to reduced base flows in streams and the main river branch, increased peak stormwater flows from urban areas and tile drained agricultural areas, decreases in run off quality, loss of cold water characteristics of many headwater streams, faster spring melt due to loss of forest cover and increases in total run off volume.

Hydraulics

Subwatershed hydraulics refers to the capacity of stream and river systems within the Subwatershed to convey stormwater during minor and major storm events. A river system consists of both the river channel, river banks and the generally much broader low area surrounding the river known as the floodplain. On the rare occasion when the capacity of the river channel and banks are exceeded, flood waters are conveyed along a broader and less distinct path. As the low areas beside the river do not flood very often, there is a tendency to overlook the danger in these areas. Historically, because of the use of water for transportation needs and mill operations, the area directly beside the river or stream has been considered prime building area. With the advent of such major flood events as Hurricane Hazel (1954), there was a move in Ontario to control flood events by the construction of dams and reservoirs. Also, there has been some recognition that floodplain areas must be identified and development kept out of these hazard areas altogether.

Between 1970 and 1995, the Conservation Authority completed floodplain mapping for all major watercourses in the study area. The floodplains in the Oak Ridges Moraine headwater areas are largely confined to the well defined valleys that is a distinct characteristic of this terrain. These floodplains tend to broaden in the clay till plains that predominate from northern Aurora north to Cook's Bay. The floodplain north of Queensville Sideroad abruptly widens to several kilometers in width.

Floodplains within Newmarket and Aurora are the main Regional (Hurricane Hazel type) storm flood damage areas in the study area. Parts of Holland Landing and the areas around Queensville Sideroad are also considered areas where significant damage is likely to occur during a Regional storm event. Areas that are subject to flooding on a more frequent basis than during a major event such as Hurricane Hazel are called flood prone areas. In general, the urban tributary watercourses within Aurora and Newmarket are prone to flooding during intense rainfall events such as summer thunderstorms. The low areas directly adjacent to the main branch of the East Holland River tend to be flood prone during the spring freshet.

Prior to the advent of floodplain management, attempts were made to control flooding problems using flood control structures such as dykes, channels and dams. Ultimately, this approach was abandoned due to failure of these protection works in a significant number of cases. In the 1970's there was a general move away from this approach in Ontario due to a better understanding of the nature of river systems. It became and is the governing view of the Province of Ontario and Conservation Authorities that rivers and streams (and their floodplains) must be allowed to maintain their conveyance and storage capacity and that new development must be located outside of the floodplain and other hazard areas.
The state of the resource can be described as improved compared to before 1970. Regulations enacted by the LSRCA under the Conservation Authorities Act have resulted in the prevention of flood damages in new development areas as well as preventing increased damages in existing flood prone areas. Extensive flood line modeling has allowed the Conservation Authority to identify floodplain limits throughout the East Holland River system. This enables Municipalities and the Conservation Authority to limit development to those areas outside the floodplain through the planning process.

Stream Inventory

The inventory consisted of the identification and description of any problem sites, digital pictures of all sites, the identification and description of any large problem-free, contiguous stream reaches and the rating of any notable erosion problems. The level of detail is intended to be adequate for the determination of the quality of aquatic habitat at any particular site. The majority of the tributaries were surveyed, however some were not surveyed due to a lack of water at the time of survey (Figure 7.12). These tributaries with low or no flow are considered intermittent.

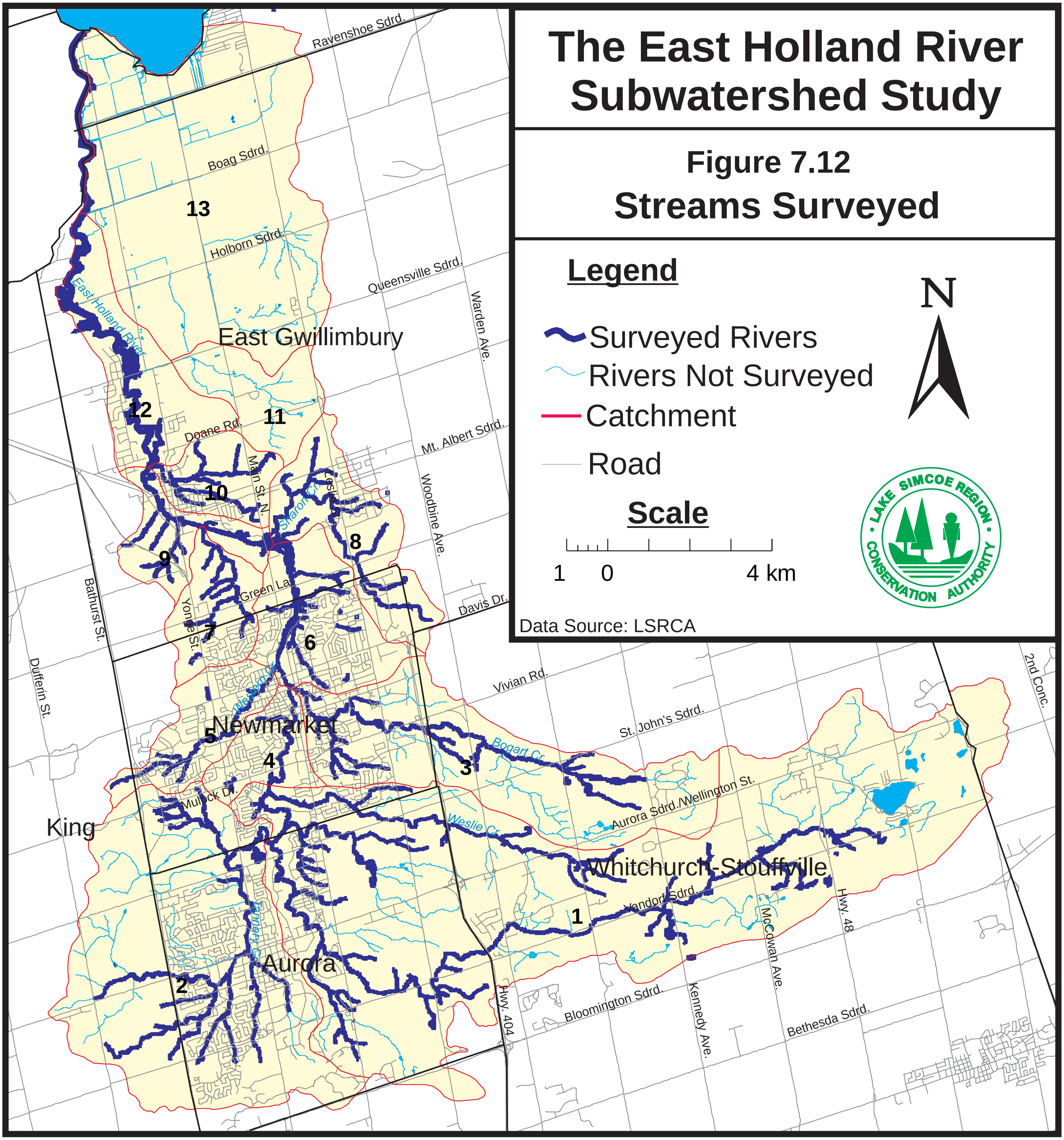
The problems identified that relate specifically to water quantity consisted of:

- Stormwater Management Facilities
- Online & Offline Ponds
- Erosion (undercut, slump or gully)
- Instream Obstructions (dam or log jam)
- Bridges
- Water Taking
- Drains & Pipes
- Storm Sewer Outfalls

In the case of erosion problems, each site has been given an erosion rating based on the size of the erosion area as well as taking into consideration comments made by field staff and photographs. The ratings are as follows:

1. Extensive erosion that should be given highest priority for remediation.
2. Moderate erosion.
3. Minor erosion.

Digital air photos with the Ontario Base Map river data overlain were used to find the river and its tributaries. Sites were labelled directly onto printed air photos in the field and transferred into the database at the office. Data sheets and digital photos were entered into a Lotus Approach database. All collected data is on file at the Conservation Authority.



The East Holland River Subwatershed Study
Figure 7.12
Streams Surveyed
Legend
Surveyed Rivers
Rivers Not Surveyed
Catchment
Road
Scale
1 0 4 km
N
Lake Simcoe Region Conservation Authority
Data Source: LSRCA
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
East Holland River
Sharon Cr.
Bogart Cr.
Western Cr.
Weslie Cr.
Tannery Cr.
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Mt. Albert Sdrd.
Doane Rd.
Green La.
Davis Dr.
Vivian Rd.
St. John's Sdrd.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Bloomington Sdrd.
Bethesda Sdrd.
Mulock Dr.
Warden Ave.
Woodbine Ave.
Main St. N.
Leslie St.
Yonge St.
Bathurst St.
Dufferin St.
Hwy. 404
Kennedy Ave.
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The East Holland River Subwatershed contains many streams and creeks that flow into the main channel. There are four major tributaries plus the main channel of the East Holland River that divide up the Subwatershed. These tributaries include: Bogart Creek, Tannery Creek, Weslie Creek and Western Creek (see Figure 3.1). Each of these creeks has their own subwatershed properties including length, catchment area, elevation drop, biophysical surroundings (terrain, vegetation) and temperature regimes. Length and catchment area are important because they show how large the drainage basin is and how much volume of water falls in the area when precipitation values are added. Elevation change calculated with length illustrates the topographic relief of the Subwatershed. The greater the relief, the more power the stream will have with a given volume of water. Biophysical surroundings of the region also help illustrate how much runoff will enter a channel. Vegetation surrounding a channel will help reduce the amount of runoff in intense downpours and promote infiltration and percolation to groundwater storage areas. A flatter slope also promotes infiltration. The temperatures recorded are important because they relate to the type of aquatic habitat in different sections of each tributary.

There were two main types of ponds observed through the course of the study, those that were "online" and those that were "offline". An online pond is directly in the line of flow of the stream course. Water from the stream flows in at one end of the pond and flows out at the other end. An offline pond is situated outside the direct line of the watercourse, however, one or more pipes or channels may join the stream and the pond. With this configuration, water flows from the stream to the pond when the water level in the pond is lower than the stream and from the pond to the stream when there is an excess amount of water in the pond. The chart on the next page identifies problem sites by Municipality.

Table 7.1 Sites by Municipality

Municipality	SWMF or Outfall	Ponds	Erosion			Obstructions		Bridges	Water Taking	Drains & Pipes
			1	2	3	Log Jam	Dam			
Aurora	6	3	10	17	41	21	3	7	3	7
East Gwillimbury	3	0	3	3	8	5	0	4	1	4
King	0	2	1	1	4	2	1	0	0	0
Newmarket	5	16	12	21	20	21	0	14	0	0
Whitchurch-Stouffville	0	13	2	6	19	12	4	7	2	14
Totals	**14**	**34**	**28**	**48**	**92**	**61**	**8**	**32**	**6**	**25**

From the information collected, a number of general recommendations can be made to remediate any of the problems identified. However, it should be noted that each site will require individual assessment to determine the works necessary as site conditions are very different throughout the Subwatershed and will dictate the methods used to correct problems. In addition, some sites have multiple problems which will require special consideration.

Stormwater Management Facilities and Outfalls

Improperly designed or malfunctioning stormwater management facilities (SWMF) can be a source of sediment and pollutants. In areas where a SWMF discharges to the river the facility needs to be checked to ensure that it is sized correctly to ensure that it is retaining sufficient water to mitigate any increases in discharge associated with storm events. The facility should be designed with multiple cells to permit the settling of sediments and contaminants and prevent them from entering the river. Vegetation should be planted arount the perimeter to cool the water. Facilities without these features should be considered for retrofit.

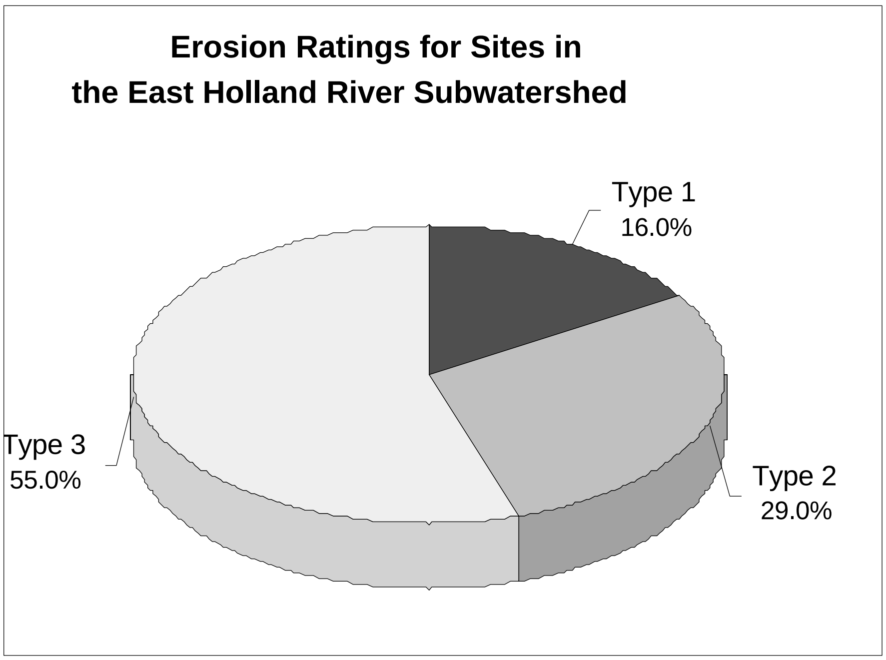
Ponds

Online ponds can be a significant source of temperature increases in a river system, and can be detrimental to sensitive species of fish which require lower temperatures (below 20EC) to survive. Water within a pond is often exposed to sunlight for extended periods of time and will discharge this warmed water into the watercourse downstream. Taking a pond offline will reduce this problem since the amount of water flushing through the pond is controlled and reduced. Another option for minimizing the warming effect is to install a "bottom draw" outlet structure that discharges only the cooler water from the bottom of a pond. Planting trees around a pond will also help to cool the water by shading the pond from the sun. It is recommended that any landowners with ponds be encouraged to shade the water with trees and other vegetation, and that any online ponds be taken offline, or fitted with a bottom draw outlet.

Erosion

Erosion is one of the most widely identified problems in this survey, with the majority of sites being found in the urban portions of the Subwatershed. Of the 168 erosion sites, 16% were identified as having a rating of 1 which indicates extensive erosion. The breakdown of erosion sites is shown in Figure 7.13 below.

Figure 7.13



There were several different types of erosion identified including undercuts, slumps and gullies. Some erosion was complicated by other factors such as bridges or log jams. For these reasons, it is difficult to suggest a general solution for all erosion problems. The use of bioengineering techniques is recommended wherever possible.

Instream Obstructions

Dams or log jams obstructing the stream can lead to many problems including erosion and the restriction of fish passage. Wherever possible, dams should be removed and the river returned to its original grade. Alternatively, fish ladders or supplementary channels can be constructed. In the case of beaver dams, the trapping and relocation of the animal may also be required. A certain amount of wood debris in a watercourse is important to provide habitat structure for aquatic species. However, larger log jams should be removed since they will tend to impede flow and, over time, will collect more debris and become an increasing problem. When removing a jog jam, the cause of the log jam should also be determined and corrected to ensure that the jam does not recur in the near future.

Bridges

Bridges and road crossings can become sites that impede fish passage due to perched culverts or cement drops. This problem can be rectified by altering the structure to bring it down to stream level. A poorly constructed bridge can also cause erosion by constricting flow and redirecting it towards the banks. In the case of a constricted waterway, the bridge would need to be resized.

Water Taking

Permits for water taking are not required if the amount taken is less than 50,000 litres per day. Therefore, a significant amount of water can be taken without regulation. This removal of water from a river can have a significant impact on the flow properties. A reduction in flow can cause sediment to settle out of the water onto the bed and, over time, decrease the depth of the river. This can have significant effects on the flow characteristics of the river and the various habitat areas. Areas where water taking has been identified should be investigated for potential detrimental effects and to ensure that the amount of water withdrawal is permitted.

Drains & Pipes

Agricultural drains can be a significant source of excess nutrients, pesticides and herbicides. Landowners need to be educated about appropriate use of fertilizers and chemicals on their properties and be encouraged to prepare a nutrient management plan to reduce the excesses entering the river.

Pipes for water, sewage and other services are often required to cross watercourses and generally do so under the bed. Over time, these pipes can become exposed and disrupt flow. In these cases, the pipes need to be relocated below the bed.

7.4 Aquatic Environment

To prepare an overview of the aquatic habitat provided throughout the reaches of the East Holland River, information was collected from a number of sources including several field inventories conducted specifically for this Subwatershed Study as well as existing literature, reports, various government records and files. Field notes on channel characteristics, stream morphology and erosion sites were collected over two summers by Lake Simcoe Region Conservation Authority staff. Fisheries and various channel characteristic information was collected through fisheries sampling records and past field inventories kept on file at the Ontario Ministry of Natural Resources (OMNR) offices in Aurora.

What is Aquatic Habitat?

Habitat can be described as a place where an animal or plant normally lives, often characterised 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 to 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 - brook trout require coarse, gravelly deposits for spawning substrates, while finer sediments in the shallow fringes of slow moving watercourses often support wetland plants that attract spawning pike and muskellunge (Scott and Crossman, 1998).

In terms of the habitat in the East Holland River and its tributaries, this section focuses on the fishery since recorded information on fish sampling and catch is available over a reasonably long period of time through the Ontario Ministry of Natural Resources offices in Aurora. It can also be assumed that if the organisms have been sampled, their habitat is supporting their population to some degree. Another benefit of examining the fishery is the inclusion of many other organisms when fish habitat is considered. The broad, federal definition of fish habitat can be seen to include many organisms (plants, insects, larvae, snails, bivalves and other animals) as part of the "food supply" referenced by the Department of Fisheries and Oceans:

> *Fish habitat means "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly for their life processes"* (from the federal Fisheries Act, DFO 1985, in Ontario Ministry of Natural Resources, 1994).

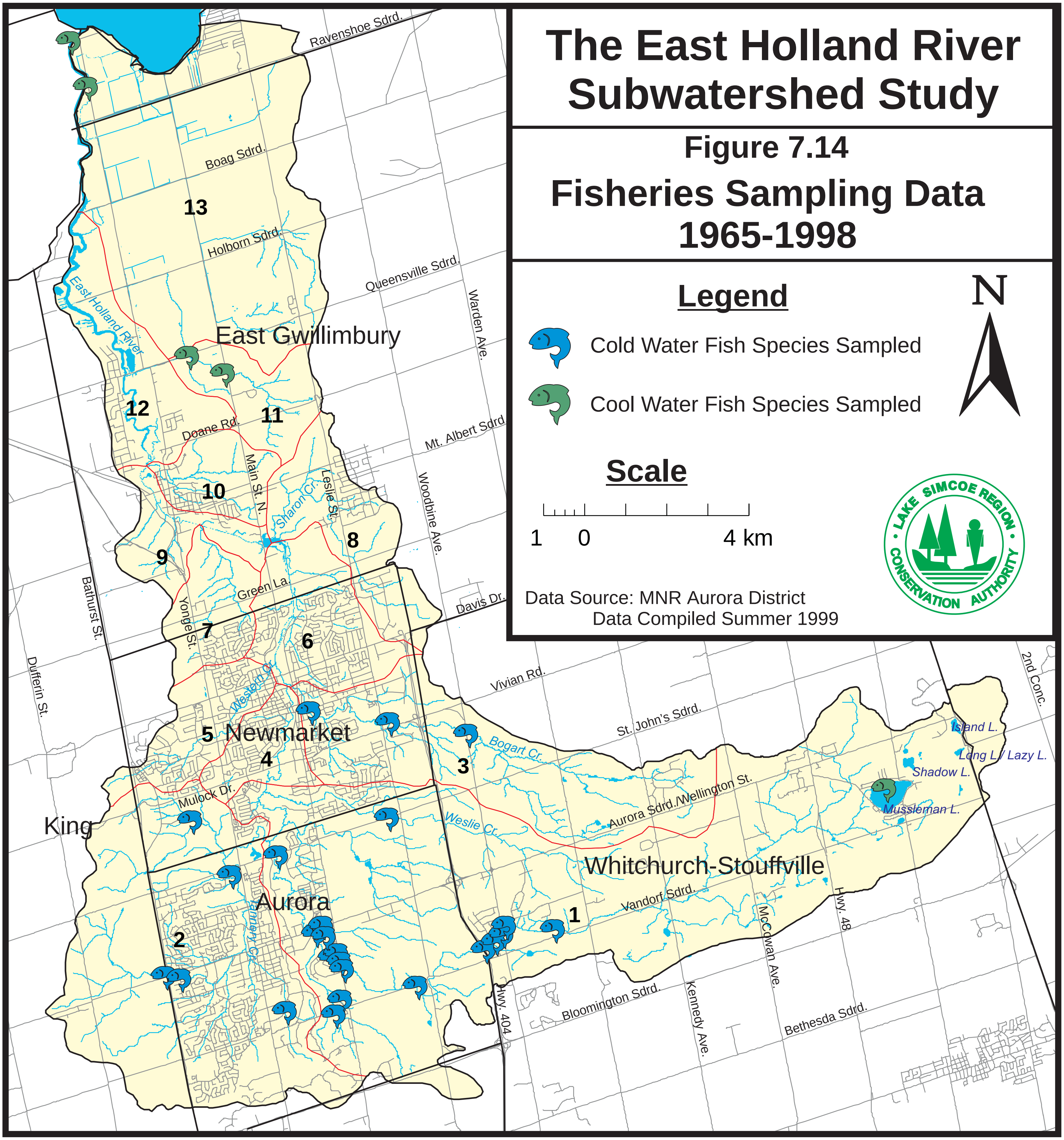
Aquatic Habitat in the East Holland River

Many of the headwater areas of the East Holland River originate on the Oak Ridges Moraine where cold groundwater discharges into the channels of the river. These typically narrow, cool tributaries flow from the slopes of the moraine, travel generally west and north towards the main branch of the river and contribute to the critical habitat conditions required by sensitive, coldwater fish species. Throughout its mid-reaches, the river and its tributaries vary in shape and other habitat characteristics, depending on the gradients, soils and adjacent land uses. In its lower reaches, the East Holland River flows through the lowlands around the south end of Lake Simcoe which were flooded during the last ice age. Large tracts of marshland flank much of the river in its lower reaches. The channels in this area tend to be wider, of flatter gradient and more meandering than in the headwaters.

The East Holland River is comprised of both coldwater and warmwater fisheries, and is home to at least one rare species of fish - the redside dace. Cold water systems generally have annual water temperatures that remain below 20EC and sustain aquatic life that is intolerant of changes in water temperature and degraded water quality. The Ontario Ministry of Natural Resources has mapped fisheries management zones (OMNR Maple District, 1994) in terms of their water temperature regimes, and their potential for supporting warm or cold water fish communities. Areas being managed by the OMNR for coldwater fisheries include the headwaters and upper reaches of Tannery Creek, Bogart Creek, the East Branch of the Holland River which flow through the Town of Whitchurch-Stouffville, most of Sharon Creek, and several other small, un-named tributaries. Specific mapping regarding management zones is available through the Aurora District Ministry of Natural Resources offices.

Two tributaries of the river have been identified for their current stream-resident cold water fisheries. These are the headwaters of the East Branch that flow through Whitchurch-Stouffville and into Aurora and portions of Bogart Creek, which flows from Whitchurch-Stouffville and through Newmarket (Appendix A). At present, the Ontario Ministry of Natural Resources actively manages reaches of Bogart Creek upstream of Mulock Drive in Newmarket as coldwater habitat for naturally reproducing populations of fish, including brook trout (personal communication, Ian Buchanan, OMNR, 1999). Rehabilitative stocking of brook trout has been undertaken in Bogart Creek several times over the last decade by the OMNR. Stocking efforts were focused in areas upstream of Mulock Drive and in the vicinity of Highway 404.

Cool and cold water fish species have also been noted on occasion in the upper reaches of tributaries throughout the Subwatershed. Fish sampling records from the OMNR have been compiled from many contributors and include data from 1965 to 1998. Brook trout and sculpins are both species of fish that prefer cold water systems. Sculpins have been recorded through the 1990's, and as recently as 1998 in the East Branch, Bogart Creek and Tannery Creek. Brook trout were sampled in the East Branch and Tannery Creek in the mid-1990's (Figure 7.14). Cool water species, such as northern pike have also been noted in several of the East Holland's tributaries, but except for sampling records from a tributary near the confluence of the East Holland and Schomberg Rivers (1996), the data for this species is almost 20 years old and may not reflect current population status (Appendix A).


The East Holland River Subwatershed Study
Figure 7.14
Fisheries Sampling Data 1965-1998
Legend
Cold Water Fish Species Sampled
Cool Water Fish Species Sampled
N
Scale
1 0 4 km
Data Source: MNR Aurora District
Data Compiled Summer 1999
LAKE SIMCOE REGION CONSERVATION AUTHORITY
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
East Gwillimbury
East Holland River
Mt. Albert Sdrd.
Doane Rd.
Main St. N.
Leslie St.
Sharon Cr.
Woodbine Ave.
Green La.
Davis Dr.
Bathurst St.
Yonge St.
Dufferin St.
Western Cr.
Newmarket
Vivian Rd.
St. John's Sdrd.
Bogart Cr.
Island L.
Long L./ Lazy L.
Shadow L.
Mussleman L.
2nd Conc.
Aurora Sdrd./Wellington St.
Mulock Dr.
King
Weslie Cr.
Whitchurch-Stouffville
Aurora
Tannery Cr.
Vandorf Sdrd.
McCowan Ave.
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Over the years, the temperature status of the East Holland River and its tributaries has been altered. An estimated 80% of the cold water designation was lost between 1952 and 1982, in reaches along the East Holland River. It is further estimated that 60% of these losses were in urban areas (Upper Holland Conservation Report, 1953; LSRCA Watershed Inventory, 1982).

The middle and lower reaches of the East Holland River and a number of its tributaries draining areas down-gradient of the moraine tend to support a fish community that is more tolerant of warmer water conditions. A popular bait fishery based on emerald shiners and golden shiners is utilised by anglers in the Holland River (Ontario Ministry of Natural Resources, 1988.). The lower reaches, the river mouth and Cook's Bay are noted for a sport fishery that includes largemouth and smallmouth bass, northern pike and yellow perch, black crappie and walleye.

Aquatic Habitat Conservation Issues

There are many factors which influence the health and quality of the aquatic habitats in the East Holland River. Some of these influences include quality and quantity of water, streambank cover, channel morphology and erosion and the connectivity of the watercourse to its upper and lower reaches and its floodplain. Effects on habitat can range from total destruction, to chronic, low-level changes in water chemistry or flows that affect community composition, diversity, abundance and vigour. For instance, incremental hardening of shorelines along the river and lakeshore can destroy highly productive shallow water areas that are commonly used as nurseries and feeding zones for fish. Severe erosion can send sediment downstream where it can settle and smother spawning beds and nursery areas. Significant warming effects can eliminate many kilometres of habitat in a coldwater stream system where fish species are known to have lower survival rates when the water temperatures frequently exceed 20°C.

Below is a discussion of several threats to the current Holland River ecosystem which were identified during field surveys during the summers of 1998 and 1999 by Lake Simcoe Region

Conservation Authority staff. A number of these issues are identified on Figure 7.15 at the end of this Section.

<u>Water Quality</u>

Water quality plays a critical role in the health of aquatic ecosystems. This has been recognised by the provincial government and as a result, guidelines have been set for acceptable levels of chemicals in water bodies for human health and the health of aquatic life. These are the Provincial Water Quality Objectives (PWQO) (MOEE, 1993). These guidelines and sampling information are described more fully in Section 7.1 of this report.

In the East Holland River, a number of parameters exceeded levels in the PWQOs in more than 30% of the samples taken over a 13 year period between 1982 and 1995. These were iron, copper, phosphorus, aluminum and the coliform bacteria *Escherichia coli*. At one station, phenolic compounds also exceeded the provincial guidelines in 30% of the samples. Nitrogen, while not having a provincial guideline concentration, was also investigated, as high levels can have detrimental ecological and human health effects. The following table outlines some of the effects and sources of these problematic parameters.

Table 7.2 Selected Water Quality Parameters and their Significance.

Selected Water Quality Parameters	Effects and Sources
Iron	**T** A naturally occurring metal, dissolved iron is found in many watercourses, but at relatively low levels. It can discolour water, giving it a reddish or "tea" colour. Iron-rich water does not generally have toxic effects on aquatic fauna. **T** The maximum acceptable concentration noted in the PWQOs for iron is 0.3 mg/L for the protection of aquatic life, human health and recreational potential of water resources. **T** Potential sources: acidic soil and water conditions can result in dissolution of naturally occurring iron; landfill leachates; industrial processes.
Copper	**T** Copper is a naturally occurring metal, but can be toxic to both humans and fish when present in high concentrations. **T** PWQOs set a maximum acceptable level of copper at 0.005mg/L to protect the health of aquatic life and humans. **T** Potential sources: naturally occurring in soils and stone - weathering and exposure to acidic conditions can dissolve copper; industrial processes; leachate from landfill or industrial waste.

Phosphorus	T	Phosphorus and many other nutrients do not have a direct effect on aquatic animals, but they encourage the growth of plants and algae. Excessive plant growth can alter aquatic environments; dense beds of plants or algae can reduce the usability of aquatic habitat. In addition, when these plants die, the decomposition process depletes the oxygen in the water, reducing its availability for aquatic life. Reduced water clarity resulting from algae suspended in the water column and excessive plant growth can also be aesthetically unpleasing and a nuisance to recreational uses.
	T	The PWQOs for total phosphorus for rivers have been set at 0.03 mg/L as the maximum acceptable concentration of this nutrient to protect aquatic life and to provide suitable conditions for recreational uses. Since plants readily take up phosphorus and usually maintain healthy concentrations in a natural system, excessive concentrations in rivers and lakes indicate abnormally high inputs.
	T	Potential sources: urban stormwater containing fertilizers, detergents, sanitary sewage, de-icing agents; rural runoff, natural sources and eroding soil particles to which phosphorus can be attached.
Aluminum	T	Aluminum can be toxic to people if it is ingested in large quantities. Toxicity to aquatic life varies with pH of the water.
	T	PWQOs set a maximum acceptable level of aluminum at 0.075mg/L to protect the health of aquatic life and humans.
	T	Potential sources: Aluminum is found in abundance in the natural world, but can also be released from industrial processes. For instance, it is often a component of flocculating agents.
Escherichia coli	T	Fecal coliforms generally do not create a negative impact on aquatic life, but high concentrations of this type of bacteria can be detrimental for human health and can reduce the suitability of a water body for recreational use. High densities of fecal bacteria such as *E. coli* in a water body indicate inputs of fecal material either from human or other animal sources.
	T	Provincial guidelines for E. coli are 100 organisms/100mL. Concentrations beyond this level pose a risk to human health.
	T	Potential sources: wildlife and domestic animals, stormwater runoff, farmland runoff, illegal cross-connections between sanitary and storm sewers.

Phenolics	**T** **T**	Phenols are produced through many industrial processes and may also be released from aquatic plants and decaying vegetation. At certain levels, phenols can be toxic to fish and may taint fish flesh, producing unpleasant tastes and odours. The PWQOs have been set at 1ug/L to protect aquatic life and recreational potential.
Nitrogen	**T** **T** **T**	Nitrogen, like phosphorus, is a key factor in plant growth, both for aquatic and terrestrial plants. It can occur in several forms in an aquatic environment, including nitrates and nitrites. In drinking water, high nitrogen levels have been linked to "blue baby" syndrome and other human health problems. In natural water bodies, excessively high levels can promote the excessive growth of aquatic plants and create problems similar to those created by phosphorus. There are no set PWQOs for nitrogen. Potential sources: lawn, garden and crop fertilizers, stormwater runoff and sanitary sewage.

Water Quantity

Natural watercourses tend to have a typical low water level range which characterises the flows over most of the year. This “base flow” is generated to a large extent by the seepage of cool groundwater into the channel. The wetted volume of the low-flow channel represents the aquatic habitat available for most of the year. During the high flows of the spring freshet, the amount of aquatic habitat can increase significantly. For instance, the flooded wetland fringes of a watercourse can provide critical spawning areas for fish species such as pike and muskellunge. Most rain events throughout the year raise the water’s surface to intermediate levels within the channel and can alter the amount of habitat accordingly. In very heavy flows, however, habitat space can actually be reduced as strong currents may force fish and other fauna to seek refuge in backwater areas or pools and turbid waters may drive animals out of their usual range.

In an urbanized Subwatershed, the natural pattern of flows in the watercourse is altered. Urban infrastructure, including roads, ditches, culverts and sewers, contain and transport runoff to the receiving streams more efficiently than undeveloped lands. This results in a faster hydrologic response to rain events in urban areas, typified by larger volumes and rapid flows (Toronto and Region Conservation Authority, 1999). Such a shift in the runoff response in urban streams has an impact on any remaining areas of natural channel, often causing erosive damage to the streambanks or bed that can reduce the ability of the channel to provide habitat for aquatic fauna.

Riparian Cover

Streambank and stream corridor vegetation serves as part of the transitional zone between land and water which is often critical for both terrestrial and aquatic life. For instance, the thick root mat that can result from stream valley vegetation helps to bind the soil and reduce erosion along a stream. A healthy vegetated corridor will also help to filter excess nutrients and some pollutants from water before it reaches the watercourse. Overhanging vegetation will provide shade to the watercourse to help maintain cool temperatures. It will also periodically drop leaves and branches into the water to create vertical structure in the stream that many fish and other organisms use for cover. Insects living among the plants may also drop into the water or reproduce in the watercourse and may serve as prey items for aquatic fauna. As development pressures grow within the Subwatershed, the reduction of cover along river banks is becoming a notable concern.

Streambank Erosion

Erosion of soil particles from streambanks and their transportation downstream is a natural and necessary part of the dynamics in a river system. Changes to the flow patterns in river systems, such as sudden, fast pulses of runoff from urban areas where stormwater is not controlled, can accelerate the erosion process, as can wave-producing disturbances such as boat wakes. Large gouges and slumps can occur in the streambanks and channel bed as a result. Higher loads of sediment moving into downstream areas can damage fish gills directly. Sediment can also be deposited on critical spawning areas or create sediment bars that divert the water and shift the channel bed. Stormwater controls and careful development planning in the vicinity of watercourses can help to reduce some of the impacts associated with development.

Streambank Alteration and Hardening

Lakeshores and stream beds and banks are constantly shifting. For many people who have waterfront properties, this can create some concerns. Streambank stabilisation efforts often include hardening by means of rock aprons, metal sheet piling, rock or wood retaining walls. Alterations, such as docks, decks, boathouses, boat ramps and vegetation cleared for recreational and visual access are also commonly seen along waterfronts. The hardening of shore areas is a cumulative process which tends to progress along with development at and near waterfront areas. Unfortunately, this common practice can be detrimental to the health of local aquatic habitats. Hardened banks may serve to repel fish directly, by increasing the depth at the water's edge and discouraging use by fish that prefer shallow waters. It may also repel fish indirectly by limiting the establishment of bank vegetation at the land-water interface.

Some structures, such as single docks may provide a more complex environment that actually attracts fish. However, high levels of development along shoreline areas can also be detrimental to aquatic health. Recent research indicates that hardened shore areas and multiple structures, such as break walls with docks and boathouses tend to either repel fish or are associated with decreases in fish abundance and/or species richness (Lange, 1999). Lange (1999) notes that such decreases may be affected by secondary factors associated with the shoreline development. For instance, shoreline areas with more structures are indicative of other human factors, such as angling pressure, heavier boat traffic, bottom disturbance and pesticide runoff from lawn care. Development may also act as a barrier or deterrent to fish movement along a shoreline.

The amount of shoreline hardening has not been quantified along the East Holland River. However, it has been noted as a problem throughout the Subwatershed wherever development occurs along watercourses or other bodies of water.

Obstructions to Fish Passage

Barriers to fish passage can be natural, such as a beaver dam or dense log jams. Many other barriers found throughout the Subwatershed are related to urban and rural developments, such as "perched" drainage culverts, dams and weirs. In either case, the aquatic fauna can be prevented from traveling along reaches of the watercourse. In some instances, barriers to migratory movement can prevent fish from reaching deep pools which serve as refuge areas in the winter or summer months. In other cases, fish are unable to access critical spawning areas or food sources.

In terms of the development-related structures, correct installation and sizing of culverts can allow adequate movement of animals past the structure. Older structures, such as historic dams, or locks can be more difficult to address. Many years of sediment is often accumulated behind the structure and should not be released in a large pulse to downstream areas if alterations need to be made.

Ponds and Thermal Impacts

Ponds, including those on private and public lands and stormwater facilities, provide a large, open surface area which, in many cases, is exposed to the sun. The result is an increase in the water temperature which can pose a threat to temperature-sensitive species in downstream areas. Ponds are often associated with water level control structures, such as weirs that may create a barrier for the passage of organisms past the obstruction.

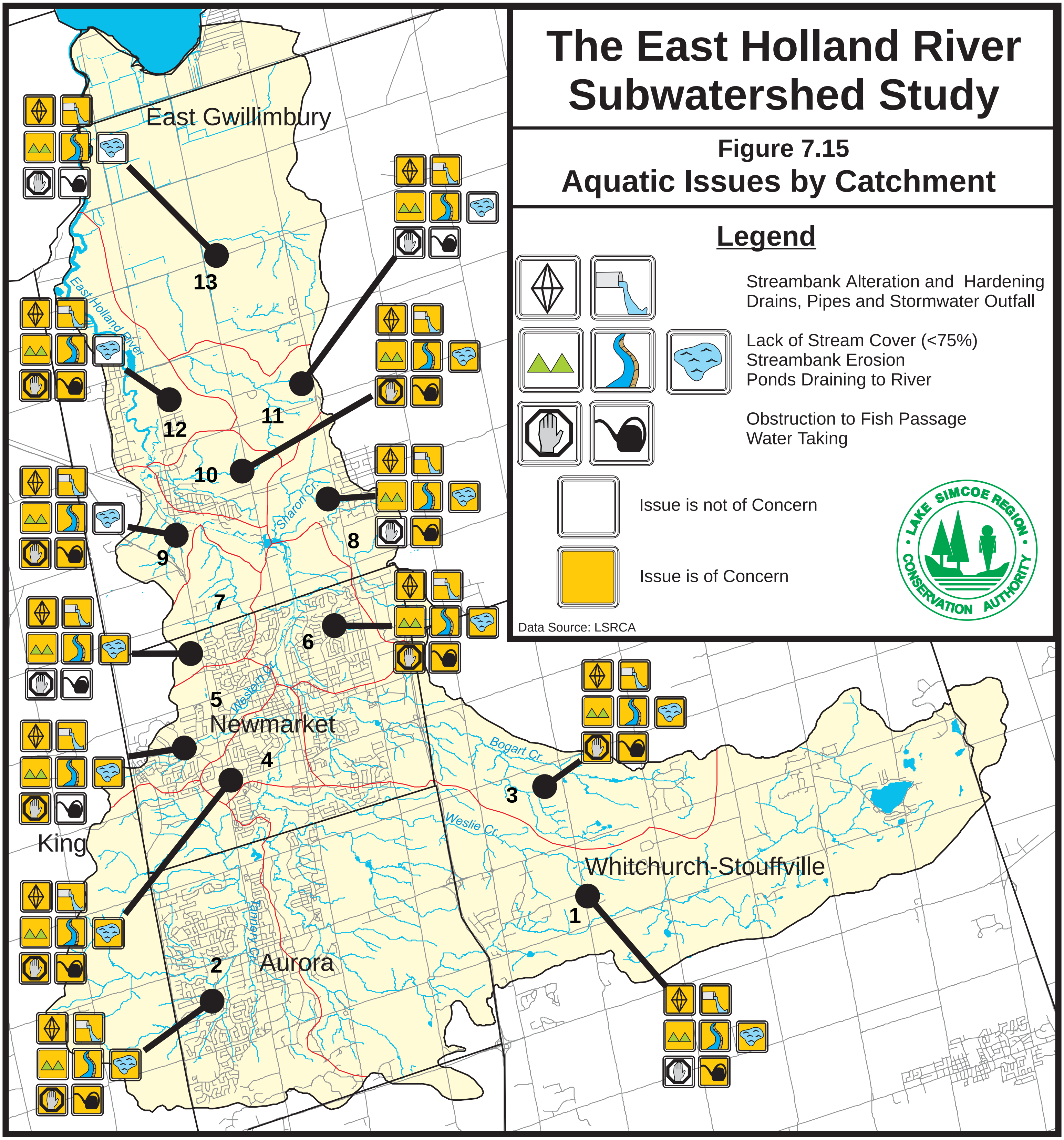
Heavy plantings of vegetation, such as trees or native shrubs around a pond will help to shade the water and reduce some of the thermal impacts. In some cases, a bypass channel will allow maintenance of the water level in a pond while allowing the cooler water to pass. Bottom draw structures, which draw off water from the bottom of a pond, rather than from the warmed surface, also provide some relief to the thermal impacts associated with ponds.

Drains, Pipes, Outfalls and Water-Taking

Drainage inputs from both urban and rural areas, as well as taking of water for irrigation or other uses can affect water quality and quantity. Stormwater and rural runoff can contain pollutants, such as oils, de-icing salt, pesticides and excess nutrients such as phosphorus. In addition, it may introduce thermal impacts. If treated properly, stormwater and farm yard runoff can have very reduced impacts. For instance, stormwater wetlands and detention facilities allow water to be temporarily held to allow removal of excess sediments and some reduction in the nutrients carried in the water. Vegetated filter strips, nutrient management systems on farms and water conservation practices will help to reduce the pollutants generated through farming practices.

Summary

Over the years, as the character of the Subwatershed has become more urban, the sections of the river inhabited by brook trout and other cold water species have diminished. This represents a reduced amount of habitat that is suitable for temperature and pollution sensitive species and may signal a decline in the habitat quality of the Subwatershed. This reduced habitat has been noted both by the Ministry of Natural Resources and many long-time Subwatershed residents. In the East Holland River Subwatershed, the high level of current development pressure poses a threat to the remaining habitats and fisheries in the river. All possible efforts should be made to protect this valued natural resource. Figure 7.15 illustrates which catchments have aquatic issues of concern.



The East Holland River Subwatershed Study
Figure 7.15
Aquatic Issues by Catchment
Legend
Streambank Alteration and Hardening
Drains, Pipes and Stormwater Outfall
Lack of Stream Cover (<75%)
Streambank Erosion
Ponds Draining to River
Obstruction to Fish Passage
Water Taking
Issue is not of Concern
Issue is of Concern
Data Source: LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
East Holland River
Sharon Cr.
Western Cr.
Newmarket
Bogart Cr.
Weslie Cr.
Tannery Cr.
King
Aurora
Whitchurch-Stouffville
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Chapter 8 Community

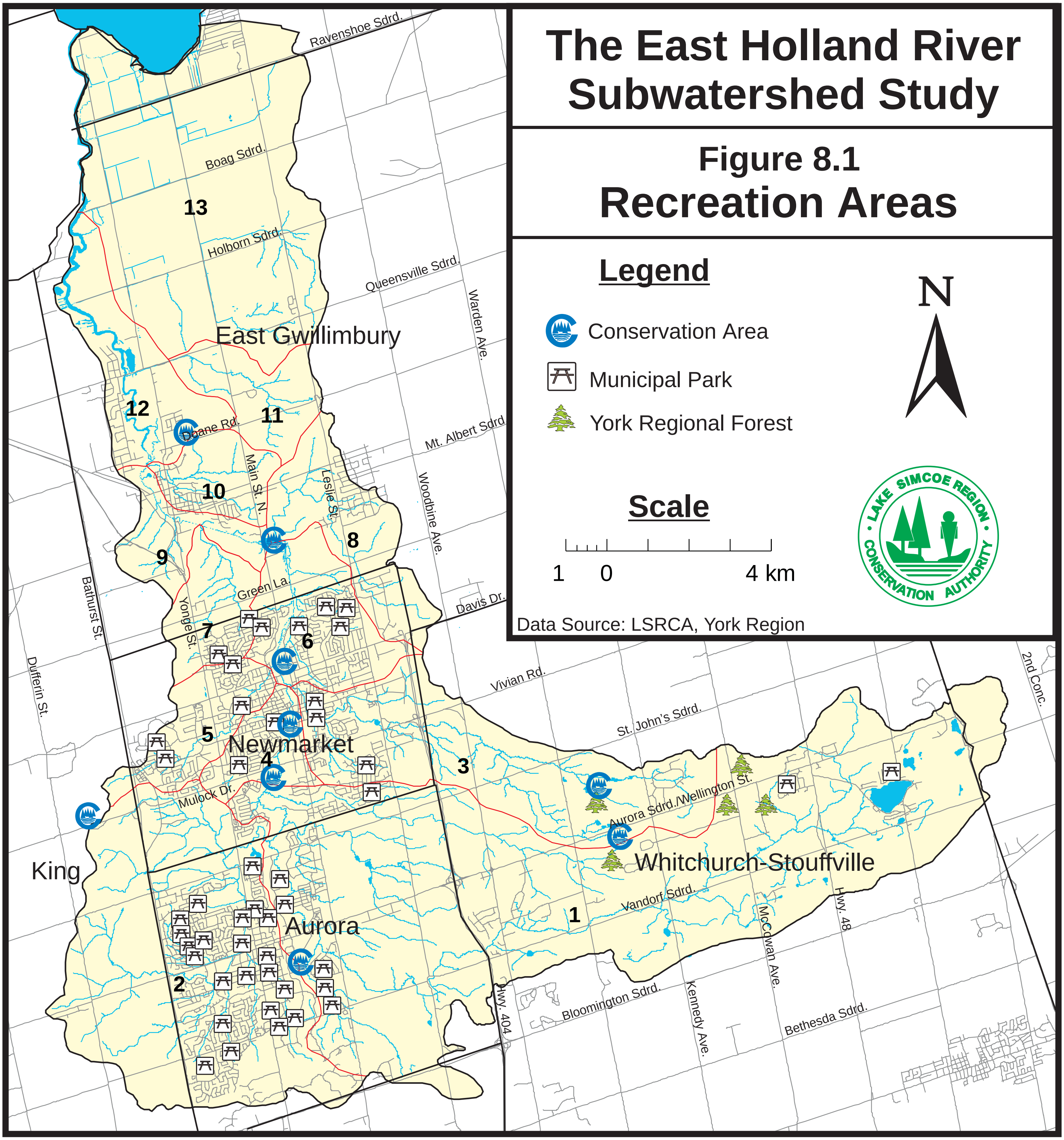
8.1 Recreation & Trails

There are numerous recreation opportunities within the East Holland River Subwatershed (Figure 8.1). Each municipality has their own system of community parks and have made commitments to retain and promote these areas. A commitment has also been made to protect natural areas within open spaces and realise that certain activities are not compatible with sensitive natural areas. Buffers around natural areas are encouraged to help protect these areas and maintain habitats. It is intended that park areas be accessible to all residents and provide a wide variety of recreation opportunities ranging from walking trails to soccer fields.

Boating is an increasingly popular activity, particularly in the lower reaches of the East Holland River where there is access to Lake Simcoe and the Trent-Severn Waterway. There are marina facilities for approximately 640 boats in the East Holland River Subwatershed. Activities associated with boating are contributing to water quality problems, streambank alteration and erosion and habitat destruction. Water quality is impacted by spills of grey water, fuel, oil and other contaminants from boats and in marina areas. In order to accommodate boats, shorelines have been altered through the construction of docks, boathouses and retaining walls. Boat wakes have a significant impact on streambank erosion and often are linked to the destruction of river side wetlands as mentioned in Section 6.5. All of these impacts are detrimental to aquatic and riparian habitat.


Observation tower at Rogers Reservoir.

The Lake Simcoe Region Conservation Authority (LSRCA) has eight conservation areas within the study area. Some of these areas, such as Wesley Brooks Conservation Area, are operated in cooperation with the local municipality while others are operated solely by the LSRCA. The Conservation Areas offer a wide variety of



The East Holland River Subwatershed Study
Figure 8.1
Recreation Areas
Legend
Conservation Area
Municipal Park
York Regional Forest
N
Scale
1 0 4 km
Data Source: LSRCA, York Region
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Doane Rd.
Mt. Albert Sdrd.
Main St. N.
Leslie St.
Woodbine Ave.
Green La.
Davis Dr.
Yonge St.
Bathurst St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
McCowan Ave.
Hwy. 48
Bethesda Sdrd.
2nd Conc.
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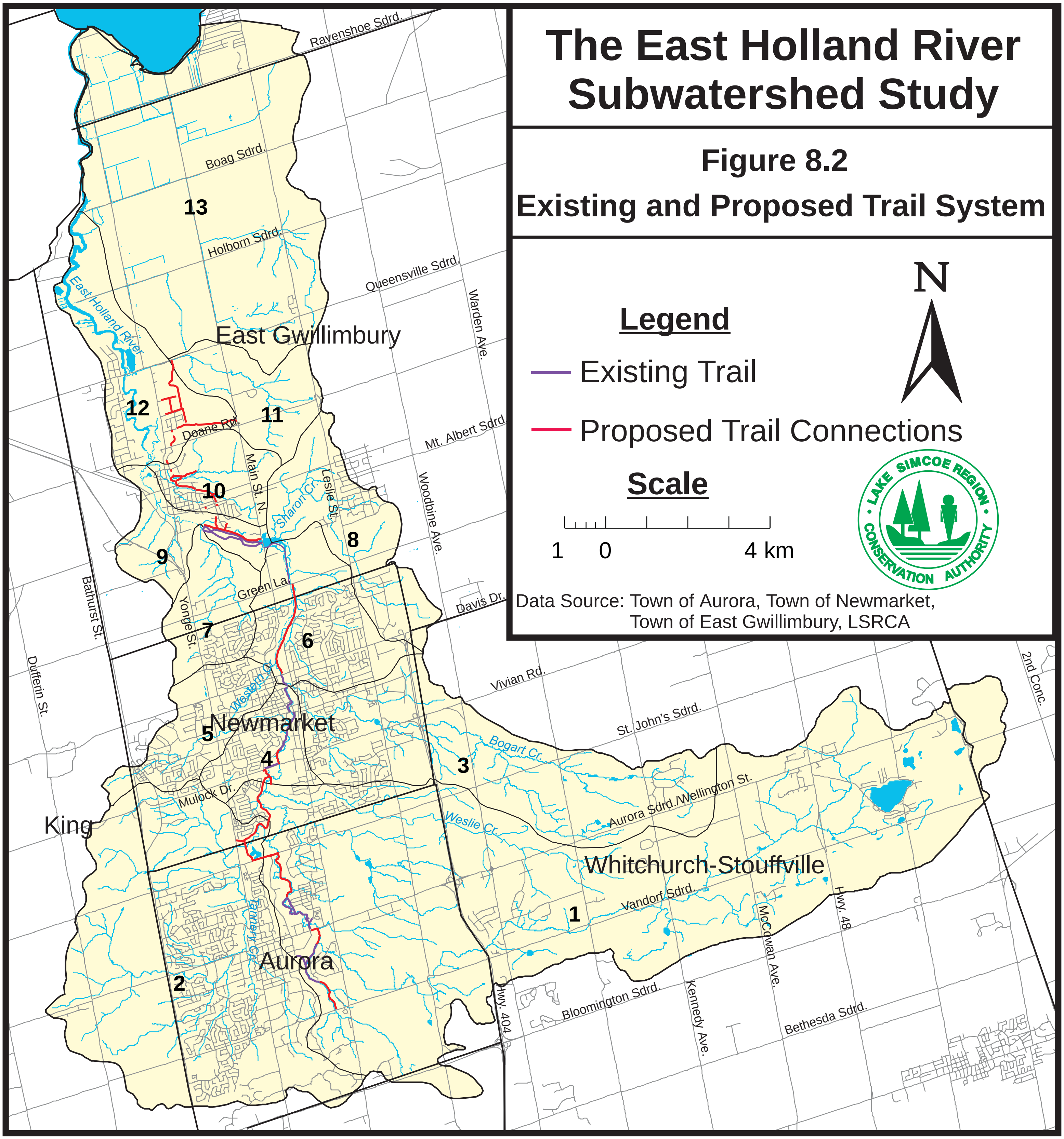
passive recreation opportunities consisting mostly of hiking trails. Sheppard's Bush Conservation Area in Aurora is the site of a Maple Syrup Festival held each spring that is a popular event for local families. Rogers Reservoir is the site of Lock #2 in the abandoned Newmarket Canal system. This nine metre high lock was constructed in 1910, but never saw any boat traffic as a result of the cancellation of the project in 1912 when it was determined that there would not be enough water in the system for it to function year round. The lock and dam structures were modified in 1968 to create the sixteen hectare reservoir. The area is managed as a recreational and wildlife habitat area with walking trails and an observation tower.

The Region of York operates five Regional Forest Tracts within the study area. These regional forests were planted as a part of reforestation efforts in the early 1900's initiated due to severe soil erosion. As the plantations have matured, they have become habitat for a wide variety of plants and animals. Each tract has a hiking trail system which ranges in length from one kilometre to two and a half kilometres providing excellent passive recreation opportunities.

Trail development in the East Holland River Subwatershed is currently very active. A major project is being undertaken by the Nokiidaa Committee which consists of representatives from the Municipalities of Aurora, Newmarket and East Gwillimbury, the Lake Simcoe Region Conservation Authority, the Region of York, service clubs and the local business community. The committee was formed to identify and initiate a trail system that would link communities and help restore environmental health in the East Holland Subwatershed.


Trail at Mabel Davis Conservation Area.

The proposed trail will extend from Vandorf Sideroad in Aurora through Newmarket to Queensville Sideroad in East Gwillimbury with a total length of 35 km. The trail will serve a local


The East Holland River Subwatershed Study
Figure 8.2
Existing and Proposed Trail System
Legend
Existing Trail
Proposed Trail Connections
Scale
1 0 4 km
N
LAKE SIMCOE REGION CONSERVATION AUTHORITY
Data Source: Town of Aurora, Town of Newmarket, Town of East Gwillimbury, LSRCA
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Mt. Albert Sdrd.
Doane Rd.
Main St. N.
Leslie St.
Woodbine Ave.
Davis Dr.
Green La.
Yonge St.
Bathurst St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
Aurora Sdrd./Wellington St.
Mulock Dr.
Vandorf Sdrd.
McCowan Ave.
Hwy. 48
2nd Conc.
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.
East Holland River
Sharon Cr.
Western Cr.
Bogart Cr.
Weslie Cr.
Tannery Cr.
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
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population of 100,000 as well as the entire Greater Toronto Area. It is expected that the trail will eventually be extended all the way to Lake Simcoe (Figure 8.2). The trail will run through some of the most urbanized areas of the Subwatershed with many areas requiring rehabilitation or enhancement. The establishment of the trail system will create an opportunity to educate the local community about environmental issues in their Subwatershed and solicit their involvement in and support for protection and rehabilitation efforts.

Further trail connections will take place at the south end of the Subwatershed in the Town of Aurora. There are plans to connect to the Trans Canada Trail as well as trails in the Town of Richmond Hill. There will also be an opportunity to connect to the Oak Ridges Moraine Trail.

With the development of any recreation facility, care must be taken to control any degradation of the natural environment as a result of recreation activities. Litter from human activities can create problems in valley lands as well as upland areas. Many items that are often carelessly discarded by humans can be dangerous to wildlife such as plastic bags and rings from beer cans. Other items may impair the natural function of the ecosystem such as old tires dumped in a stream that alter flow patterns. Other activities such as the use of recreational vehicles may not leave any litter behind, but may cause physical damage to natural areas if proper care is not taken. These activities which are hard on the natural environment should be directed to the least sensitive areas and monitored carefully.

Haskett Park Naturalization Project.

Park maintenance practices can be a significant source of environmental degradation. Landscaped parks with manicured lawns can contribute to water quality problems and affect aquatic and terrestrial organisms who depend on streams for habitat. It is accepted that areas used for playing fields require a high level of maintenance and regular mowing. However, many other areas can be naturalized reducing the amount of fertilizer applied and the level of maintenance required. In particular, naturalizing along streams creates buffers which filter any excess nutrients or chemicals as well as improve stream habitats. Naturalizing will not affect and often enhances passive recreation opportunities while providing environmental benefits. Naturalization projects are also an ideal opportunity to involve the community in the enhancement and protection of the local environment.

8.2 Natural Hazards

Natural hazards are addressed in the Provincial Policy Statement through the direction of development outside of the following areas:

T Hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes which are impacted by flooding, erosion and/or dynamic beach hazards;

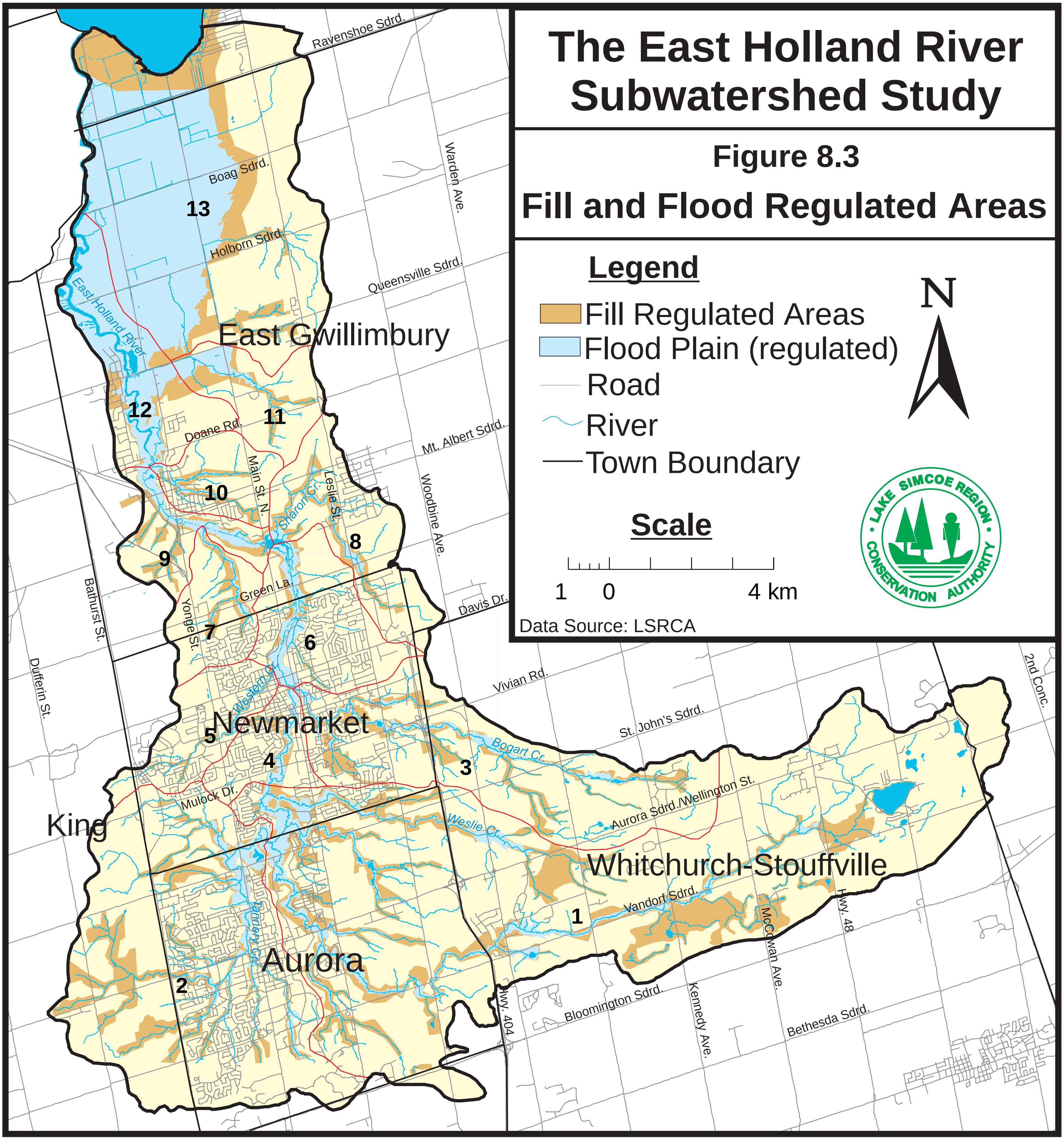
T Hazardous lands adjacent to river and stream systems which are impacted by flooding and/or erosion hazards; and

T Hazardous sites.

In the East Holland River Subwatershed the natural hazards that could apply are lands adjacent to river and stream systems which are impacted by flooding and hazardous sites. Hazardous sites may include unstable soils such as marine clays and organic soils or unstable bedrock (karst topography).

Flood line mapping has been developed for the study area (Figure 8.3). As a part of the Conservation Authority's mandate, they are responsible for regulating the floodplain and directing development away from these hazardous areas. Most of the regulated floodplain areas are confined along the river valleys. However, a significant area just south of Cooks Bay in the Keswick Marsh is within the floodplain.

Flooding in the Town of Aurora.



The East Holland River Subwatershed Study
Figure 8.3
Fill and Flood Regulated Areas
Legend
Fill Regulated Areas
Flood Plain (regulated)
Road
River
Town Boundary
N
Scale
1 0 4 km
Data Source: LSRCA
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Warden Ave.
Doane Rd.
Mt. Albert Sdrd.
Main St. N.
Leslie St.
Woodbine Ave.
Green La.
Davis Dr.
Yonge St.
Bathurst St.
Dufferin St.
Vivian Rd.
St. John's Sdrd.
2nd Conc.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
McCowan Ave.
Hwy. 48
Hwy. 404
Bloomington Sdrd.
Kennedy Ave.
Bethesda Sdrd.
East Holland River
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A study entitled "South Lake Simcoe Watershed Flood Susceptible Site Inventory and Flood Damage Estimates" was conducted in 1983 to identify areas prone to damage during a flood. The study found 21 sites prone to flood damage affecting an estimated 1,351 people and causing an estimated average annual damage of $105,498. Two things must be considered when examining the average annual damage figure, the first being that this estimate was generated in 1983 and inflation will have increased this figure. The second is that this figure is a yearly average of the damage caused by flooding up to the regional event (1 in a 100 year flood). Therefore, some years may not meet the average annual damage figure while in other years the damage costs will be considerably more. The amount of the average annual damage figure should be set aside each year to help offset damage caused by large floods. This study helps to highlight the fact that flooding in the East Holland River Subwatershed is a serious issue.

There are no sensitive marine or leda clays found in the study area. However, there are some significant areas of organic soils, particularly in the Keswick Marsh area (Figure 3.3). Development on organic soils must take into consideration that these soils have a limited capability to support structures and can give off methane gas which is highly explosive. It should be noted that most of the organic soils in the study are situated within the regulated floodplain and are therefore, already restricted from development.

There are no areas of karst topography in the study area. Karst topography occurs in areas where limestone or dolomite bedrock is eroded by water causing sinkholes, trenches and subsurface caverns. The study area has felt the effects of significant glaciation which resulted in the deposition of large amounts of moraine, till and clay over the bedrock protecting it from the erosive effects associated with the development of karst topography.

8.3 Urban Growth

The Region of York, in which the East Holland River Subwatershed is located, has been experiencing a high level of growth since the early 1980's. In particular, the Towns of Aurora and Newmarket in the study area have been steadily growing. These communities are considered a part of the Greater Toronto Area and have a large population that commutes to Toronto daily. Prior to the 1980's, population growth was steady and consistent with a slight increase in the 1950's associated with post war growth. However, after 1980, there was an increase in the popularity of suburban communities combined with improved economic prosperity resulting in the growth rate increasing dramatically with an increase of over 35,000 people between 1981 and 1991. This increased rate of population growth is expected to continue into the new millennium.

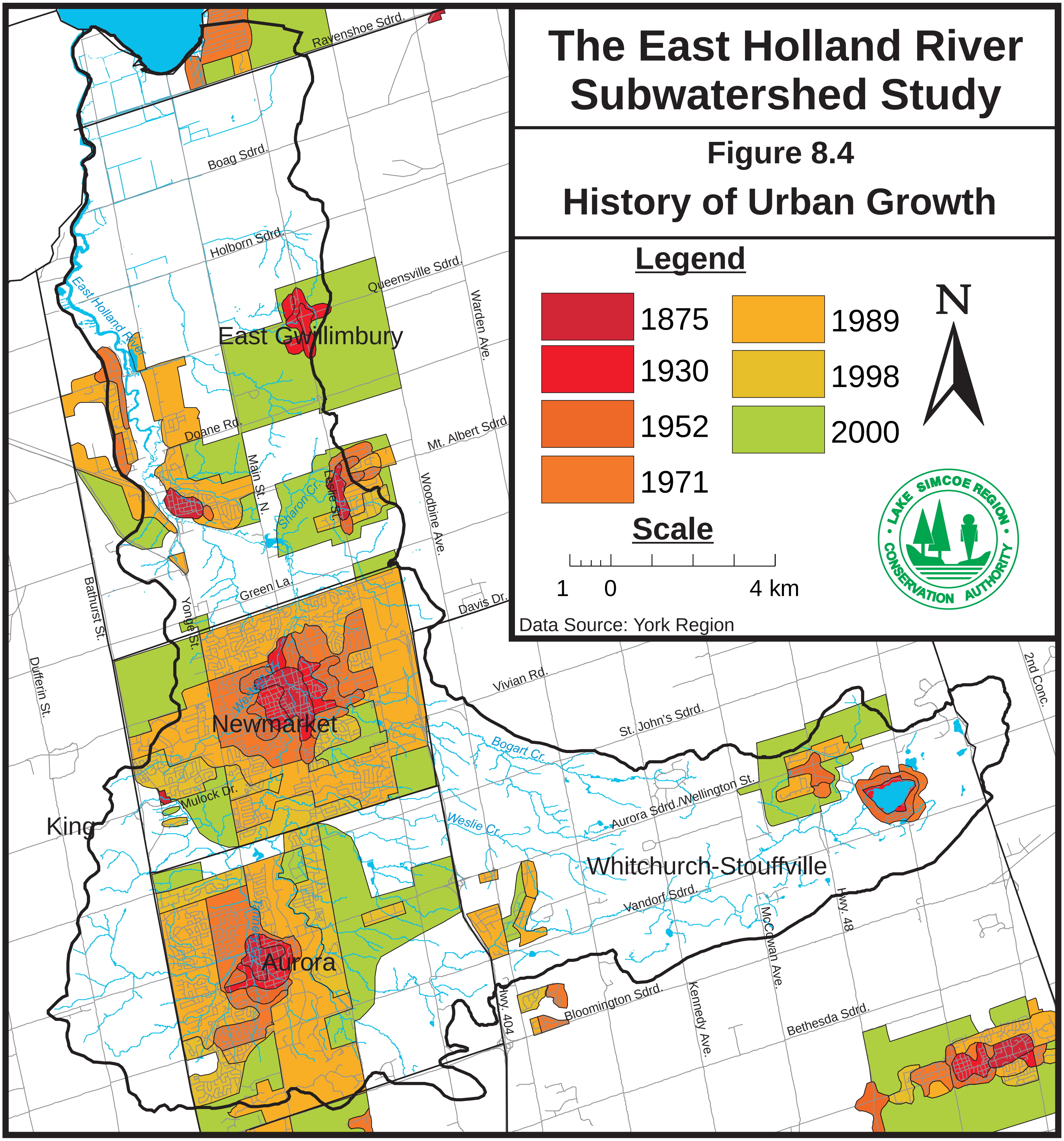
As population grows, the urban area that communities occupy also grows. The East Holland River Subwatershed has approximately 16% new urban growth proposed for the next 10 years. The table below outlines total area for each Town or Township within the East Holland River Subwatershed, as well as existing urban area. The table shows proposed new urban growth in hectares and as a percent of total township area within the Subwatershed.

Table 8.1 Projected Urban Growth

Town(ship)	Total East Holland Area (ha)	Current Urban Area in EH (ha)	Proposed New Growth (ha)	New Growth/Total Area (%)
Aurora	4711	2402	972	**21%**
East Gwillimbury	7379	1489	1171	**16%**
Georgina	542	151	141	**26%**
King	1566	0	0	**0%**
Newmarket	3529	2925	459	**13%**
Richmond Hill	145	0	0	**0%**
Uxbridge	212	0	0	**0%**
Whitchurch-Stouffville	6287	487	360	**6%**
Total	24373	7455	3976	**16%**

East Gwillimbury has the largest amount of proposed new growth because of the Queensville development. Aurora's proposed growth is likely to be spread out over 10 years but will amount to approximately 21% increase in urban area. Newmarket's urban area is proposed to grow by 13% or 459 hectares over the next 10 years. Although Georgina is planning to grow by 26%, it only amounts to 141 hectares at the south end of Keswick. Georgina comprises only 542 hectares of the East Holland River Subwatershed. Whitchurch-Stouffville estimates its future growth for the next ten years to be only 6% or 360 hectares. Overall, the urban area of the East Holland River Subwatershed is expected to increase by more than 50% over the next 10 to 12 years, with the result that nearly half of the subwatershed will be urban land use.

The actual amount and timing of growth is difficult to predict because of the plan review process and not knowing who will get final approval and when this will occur. However, areas of towns or townships that get secondary plan approval are very likely to be developed (Figure 8.4).


The East Holland River Subwatershed Study
Figure 8.4
History of Urban Growth
Legend
1875
1930
1952
1971
1989
1998
2000
N
Scale
1 0 4 km
Data Source: York Region
LAKE SIMCOE REGION CONSERVATION AUTHORITY
East Gwillimbury
Newmarket
Aurora
King
Whitchurch-Stouffville
Ravenshoe Sdrd.
Boag Sdrd.
Holborn Sdrd.
Queensville Sdrd.
Doane Rd.
Mt. Albert Sdrd.
Green La.
Davis Dr.
Vivian Rd.
St. John's Sdrd.
Mulock Dr.
Aurora Sdrd./Wellington St.
Vandorf Sdrd.
Bloomington Sdrd.
Bethesda Sdrd.
Bathurst St.
Dufferin St.
Yonge St.
Main St. N.
Leslie St.
Woodbine Ave.
Warden Ave.
Hwy. 404
Kennedy Ave.
McCowan Ave.
Hwy. 48
2nd Conc.
East Holland River
Sharon Cr.
Bogart Cr.
Weslie Cr.

8.4 Infrastructure

Highway 404 Extension

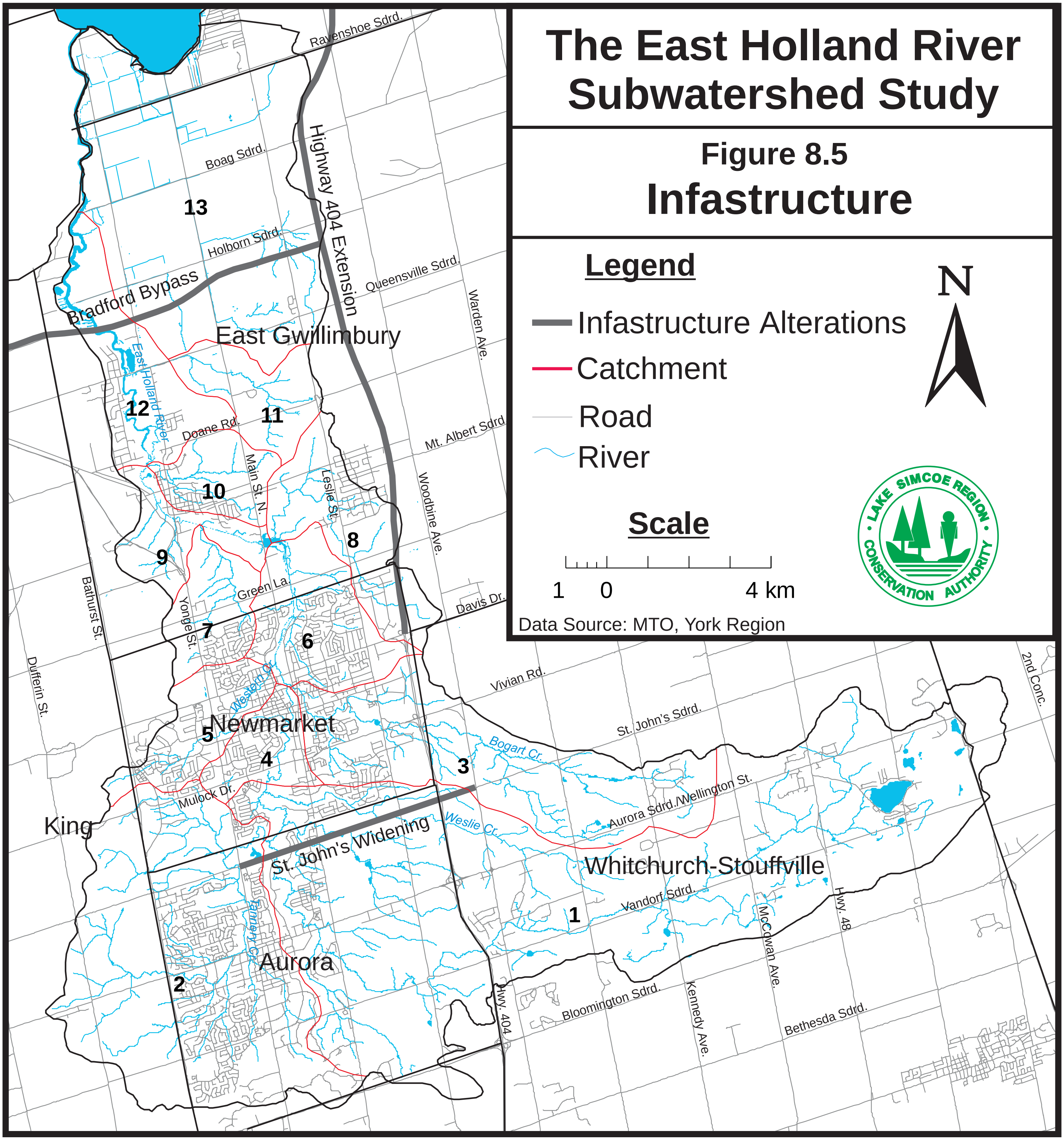
The proposed 404 extension will extend the 404 north from Davis Drive (York Regional Road 31) to Highway 12. The purpose of the extension is to improve the capacity of the transportation network in northern York and Durham Regions to meet the forecasted increase in commuter and recreational travel needs. The section of the extension that will impact the East Holland River Subwatershed is the section from Davis Drive to Sharon.

Within the East Holland River Subwatershed there are limited impacts associated with the extension. There are forest patches less than 40 hectares in size that may be affected. The extension would also likely affect the headwaters of Sharon Creek which drain to the East Holland River. The main concern associated with the creek would be stormwater runoff from the extension which would have to be dealt with carefully as some reaches of Sharon Creek are considered cold. In the Highway 404 Extension: Route Planning Study and Environmental Assessment report (Ministry of Transportation, 1997), a stormwater management plan has been identified as an aspect of the design stage giving consideration to the MOE 1994 Stormwater Management Guidelines. Figure 8.5 shows the proposed route through the Subwatershed.

Highway 400-404 Extension Link (Bradford Bypass)

The Bradford Bypass is being developed as a direct east-west link between Highway 400 and the extension of Highway 404. The intention is to alleviate an expected increase in east-west traffic on non-direct roads as well as reducing traffic congestion on existing roads and improve commuter access to highways reducing commuting time.

The proposed route will take the extension through the East Holland River Subwatershed crossing the East Holland River north of Holland Landing. The extension will impact several other natural features in the Subwatershed, including the Holland Marsh ESA, woodlands, wetlands and smaller watercourses. These issues have been identified in the Environmental Assessment Report One (Ministry of Transportation:1997) and where possible mitigation



The East Holland River Subwatershed Study

Figure 8.5
Infastructure

efforts have been proposed. Continuing impacts of the Bradford Bypass such as stormwater runoff, soil erosion and sedimentation will be addressed through Stormwater Management Practices and erosion control plans. Figure 8.5 shows the proposed route through the Subwatershed.

Widening of St. John's Sideroad

St. John's Sideroad runs east - west from the Town of Whitchurch-Stouffville, through the Town of Aurora into King Township. The section of road between Yonge Street and Woodbine Avenue can not safely and efficiently accommodate present and future levels of traffic. The proposed solution to this is to reconstruct St. John's Sideroad, widening the section between Yonge Street and Bayview Avenue to four lanes and reconstruct the section from Bayview Avenue to Woodbine Avenue to a two lane rural arterial standard.

The associated impacts of the reconstruction of St. John's Sideroad would be on the McKenzie Marsh and the East Holland where it crosses under St. John's Sideroad. In an Environmental Study Report prepared for York Region (1999) on the reconstruction of St. John's Sideroad these issues were addressed. It identified 0.22 ha of the McKenzie Marsh which would be lost (just over 2% of the total area of the wetland complex) and an impact on water quality from the increased surface area runoff of four lanes. Recommendations were made with respect to improving wildlife access to the north and south sections of the pond and to improve water quality entering the Marsh from residential areas. Of the four spots where St. John's Sideroad crosses the East Holland River or its tributaries, water quality could be affected during construction. However, this could be mitigated through the use of best management practices.

Other Works

There are three additional road widening projects proposed in the East Holland River Subwatershed, all of which are undergoing or have completed an Environmental Assessment. This will assist in minimizing and mitigating any environmental impacts that these works may have. These works include: Green Lane (completed), Vandorf Sideroad and Bathurst Street.

PART III DIRECTIONS FOR MANAGEMENT

Chapter 9 Directions for Strategy Development

9.1 Subwatershed Health: Summary of Key Issues

The following summarizes key environmental issues as discussed in this report. These issues will guide the Steering and Public Advisory Committees as they work to develop a strategy to protect healthy areas in the East Holland River Subwatershed and rehabilitate those areas which have been degraded.

LAND

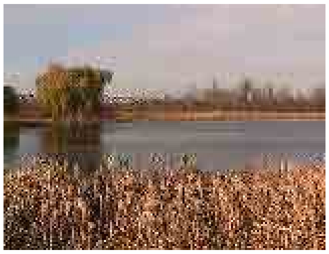
Natural Corridors:

- Natural corridors are required to maintain the ecological functions of many areas.
- A lack of natural corridors exists in many areas, particularly linking upland forests.
- Retaining and enhancing corridors generally requires participation from private landowners.
- Reinstating natural corridors along watercourses provides the greatest ecological benefit.
- The protection of existing corridors is difficult given existing legislation and planning processes.

Wildlife Habitat:

- A highly fragmented landscape of habitat areas exists.
- Wetlands are prime habitat areas and are at risk.
- Many habitat remnants are too small to support viable populations.

Aggregate Resources:	**T**	Areas designated suitable for aggregate extraction will often also be groundwater recharge areas and are extremely sensitive to development.
Woodlands: 	**T**	25% forest cover target has been established by the York Official Plan. However, forest cover currently ranges from 2.1% to 37.1% in the subcatchments with an overall of 19.1%.
	T	Reduced forest cover will result in increases in runoff and subsequent erosion and reduction in flood storage capacities.
	T	Loss of forest area continues to occur due to land use changes.
	T	Many forest areas are too small to sustain basic ecological functions.
	T	Private woodlands are often degraded by inappropriate management practices.
	T	Invasive exotic species become more widespread as urbanisation increases.
	T	Forest areas often provide excellent passive recreation opportunities which are in high demand.
	T	Available information is often inadequate to make appropriate land use decisions.

Wetlands, ESA's & ANSI's 	**T**	Increasing development is placing additional pressure on these sensitive natural areas.

WATER

Water Quality

- T Water quality is poor with 12 of the 18 parameters examined exceeding their PWQOs. Six of the exceedances were high enough to impair the aquatic ecosystem and reduce recreation opportunities.
- T Urban areas and the associated stormwater runoff appear to be the primary source of pollutants.
- T Further monitoring is required to more effectively address the sources of some of the pollutants.

Hydrogeology

- T Areas of groundwater vulnerability need to be protected to ensure clean and plentiful sources of private and Municipal drinking water as well as the maintenance of baseflow in the East Holland River.

Water Quantity

- T Increases in impervious area associated with urbanisation are causing increases in runoff volume. This increased runoff results in downstream flooding and erosion. Decreases in base flow are also being observed due to reduced groundwater infiltration.

Aquatic Environment

- T Thermal pollution and reduced riparian cover due to urbanisation has reduced the amount of coldwater fish habitat.
- T Pollution and sedimentation have reduced the populations of more sensitive aquatic species.

COMMUNITY

Recreation & Trails	**T**	Degradation of natural resources reduces recreation opportunities due to a lack of aesthetics.
	**T**	Over use of pesticides and herbicides in recreation areas is degrading water quality.
	T	An emphasis on manicured parks is reducing the naturalized portion of these green spaces and leaving streams and other natural areas unbuffered.
	T	Abuse of parks by the public is leaving them damaged and full of litter which can be a hazard to wildlife.
	T	Recreational boating is impacting on water quality, aquatic habitat and riparian habitat.
Natural Hazards	**T**	Development should continue to be directed outside of natural hazard areas.
Urban Growth 	**T**	Urban growth represents a dramatic change in land use which will significantly influence environmental health.
Infrastructure	**T**	Like urban growth, expanding infrastructure also represents a dramatic change in land use which will significantly influence environmental health.

As is implied through the use of an ecosystem approach, many of these factors are related to each other. In an effort to illustrate these interconnections, the table on the following page has been developed. In the case where two factors are related, a check has been placed in the corresponding box.

Table 9.1 Resource Factors Interconnections

Natural Corridors	Wildlife Habitat	Aggregate Resources	Woodlands	Wetlands, ESA' s & ANSI's	Water Quality	Hydrogeology	Water Quantity	Aquatic Environment	Recreation & Trails	Natural Hazards	Urban Growth	Infrastructure
Natural Corridors	U		U	U	U		U	U	U	U	U	U
	Wildlife Habitat		U	U	U		U	U			U	U
		Aggregate Resources				U	U				U	
			Woodlands	U	U	U	U	U	U	U	U	U
				Wetlands, ESA' s & ANSI's	U	U	U	U		U	U	U
					Water Quality	U		U	U		U	U
						Hydrogeology	U	U		U	U	U
							Water Quantity	U	U	U	U	U
								Aquatic Environment	U		U	U
									Recreation & Trails		U	U
										Natural Hazards	U	U
											Urban Growth	U

9.2 Developing an Environmental Screening Map

One of the primary goals of undertaking the development of a watershed management strategy for the East Holland River Subwatershed is to *"protect what is healthy"*. To accomplish this, an environmental screening map will be developed for the Subwatershed using a geographic information system. This map development process can be used to identify areas that need to be protected or areas that required special mitigation techniques if development is to occur. The different factors to be included on the map will either be considered based on existing Provincial Policy Statements or areas deemed environmentally important.

The factors to be considered were identified based on the Subwatershed Health Issues as described in the previous section. The factors include:

- Floodplains
- Aggregate Resources
- Fill Regulated Areas
- Wetlands
- ANSI
- ESA
- Forest
- Groundwater Vulnerability
- Watercourse Buffers
- Oak Ridges Moraine

The final product will consist of a map with two categories, areas covered under Provincial Policy Statements where development is strictly regulated, and areas of environmental importance where development should be carefully managed. This map will be used by Municipal and Conservation Authority planners to improve the efficiency of the development plan review process.

9.3 Monitoring

It should be acknowledged, that the water quality modelling methods used in this report were an extremely useful tool to predict the environmental impacts associated with changes in land use. However, the accuracy of any computer model is dependant upon assumptions and data which may not always reflect current environmental conditions. The most reliable method to gauge ecosystem health remains the collection of real data through field observations and measurements made within the watershed.

Several areas were identified in the report where information was lacking or was not current. Where this information is lacking it becomes very difficult to define problem areas or to determine the effectiveness of different conservation practices that may have been implemented. Monitoring is also a useful tool in ensuring that ecosystem health does not deteriorate at the expense of further urban development or any unpredicted land use changes. Monitoring efforts should encompass a wide range of activities to reflect the diversity of the ecosystem. These activities should include the regular collection of:

- Water quality data including temperature;
- Fish and other aquatic organisms (macroinvertebrates, algae,...);
- Information on changing land use practices (urban and rural);
- The number and location of capital BMP projects completed within the Subwatershed.

Monitoring efforts need not be expensive and are an excellent activity in which to involve schools, interest groups and the general public. For example, school groups could collect, and identify fish and macroinvertebrates, residents along watercourses could possibly collect water samples, and naturalists could report any observed flora and fauna. These are just a few examples of activities which could directly involve the community while providing the necessary information to evaluate the health of the East Holland River ecosystem.

GLOSSARY

Aggregate: Sand, gravel and/or broken stone which is the primary ingredient in construction materials such as concrete, roads and fill.

Aquifer: A geologic formation that transmits water, usually through saturated sands, gravels and cavernous rock.

Area of Natural and Scientific Interest (ANSI): Areas of land and water containing natural landscapes or features that have been identified by the Ministry of Natural Resources as having life science or earth science values related to protection, scientific study or education.

Base Flow: The year-round discharge of groundwater into a stream.

Best Management Practices (BMP): Practical solutions used to deal with soil and water conservation concerns including techniques used to manage agricultural and urban runoff ro modify agriculture waste management.

Bioengineering: An applied science that combines engineering, biological and ecological concepts to construct living structures for erosion and sediment control.

Buffer Zone: A planted or preserved area next to a waterway, forest or wetland intended to reduce negative impacts from adjacent land uses.

Catchment Area: An area from which rain or snowmelt drains to a lake or river.

Corridor: The naturally vegetated or revegetate areas that link or border natural areas and provide ecological functions such as habitat, passage, hydrological flow or buffering from adjacent impacts.

Development: The creation of a new lot, a change in land use or the construction of buildings and structures.

Discharge Zone: An area where groundwater comes to the surface in streams, rivers and wetlands.

Ecosystem: An interacting system of plants, animals, the land and the climate conditions that are linked by the flow of energy and the cycling of nutrients.

Endangered Species: Any native species, as listen in the Regulations under the Endangered Species Act, that is at risk of extinction throughout all or a significant portion of its Ontario range if the limiting factors are not reversed.

Environmentally Significant Area (ESA): A natural area identified by a municipality or Conservation Authority as fulfilling certain criteria for ecological significance or sensitivity.

Erosion: The wearing away or removal of soil and rock by running water, wind, ice and gravity.

Eutrophic: The state of a lake or pond rich in dissolved nutrients such as phosphates resulting in seasonal deficiencies of oxygen.

Evapotranspiration: The process where water vapour enters the atmosphere through evaporation from the land and through escaping from living plants (transpiration).

Flood Plain: The area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.

Geographic Information System (GIS): A computer tool that can be used to integrate several types or 'layers' of information about an area and perform analytical or predictive functions.

Groundwater: Water that has infiltrated below the earth's surface and moves in response to gravity, but may be restricted by impermeable rock or clay layers.

Habitat: The local environment that supplies the food, water and shelter needed by a plant or animal species to carry out its life cycle requirements.

Hazardous Lands: Property or lands that could be unsafe for development due to naturally occurring processes including flooding and erosion.

Hazardous Sites: Property or lands that could be unsafe for development or site alteration due to naturally occurring hazards such as unstable soils or bedrock.

Headwaters: Areas of a watershed where water courses originate.

Hydrogeology: The study of the presence, movement and chemistry of water beneath the surface of the earth and the factors that influence this water including interactions with surface water.

Hydrologic Cycle: The circulation of water from the atmosphere to the earth and back to the atmosphere through precipitation, runoff, infiltration, transpiration and evaporation.

Infiltration: The movement of water from the land surface into the soil and the water table.

Infrastructure: Physical structures that form the foundation for development including sewage and water works, waste management systems, electric power, communications, transit and transportation corridors and facilities and oil and gas pipelines and associated facilities.

LSRCA: Lake Simcoe Region Conservation Authority

Mitigation: The prevention, modification or alleviation of impact on the natural environment due to development.

MMAH: Ministry of Municipal Affairs and Housing

MNR: Ministry of Natural Resources

MOE: Ministry of the Environment

Non-Point Source Pollution: Pollution whose source cannot be linked to a specific location.

OMAFRA: Ontario Ministry of Agriculture, Food and Rural Affairs

Point Source Pollution: Pollution from a single source such as an industrial smoke stack.

Provincially Significant Wetland: Class 1, 2 and 3 wetlands in that part of the Great Lakes - St. Lawrence Region below the line approximating the south edge of the Canadian Shield, defined in "An Evaluation System for Wetlands of Ontario South of the Precambrian Shield. Second Edition, 1984".

PWQO: Provincial Water Quality Objectives

Recharge Zone: An area where the soil conditions allow rain and snowmelt to seep into the ground to replenish the groundwater system.

Rehabilitation: The process of restoring, recreating or repairing a damaged area to a healthy dynamic state.

Remediation: The rehabilitation of a site for valuable land uses but not necessarily restoring the site to its original natural state.

Retrofit: Works undertaken to improve a facility or bring it up to current standards.

Riparian: Relating to, living or located on the bank of a watercourse or a body of water.

Runoff: Water that moves over the land surface to run directly into rivers and streams.

Sewershed: A specific area such as city block or subdivision that drains to a common outlet by means of a subsurface system or surface topography.

Stormwater Management (SWM): The management and control of water flowing from the land to rivers or streams during storm events.

SWMF: Stormwater Management Facility

SWMP: Stormwater Management Pond

Subwatershed: The land drained by a tributary to a main watercourse.

Threatened Species: Any native species that is at risk of becoming endangered through all or a portion of its Ontario range if conditions are not changed.

Vulnerable Species: Any indigenous species that is represented in Ontario by small but relatively stable populations, and/or that occurs sporadically, or in a very restricted area or at the edge of its range as defined by MNR, the Committee on the Status of Species-At-Risk in Ontario (COSSARO) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Watershed: The area of land that drains into a river or other body of water.

Watershed Planning: A form of holistic planning that integrates watershed ecosystem resource management and land use planning.

Wetlands: Low lying wet areas supporting marsh, bog, swamp or fen plant communities where soil is saturated for most of the year.

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Appendix A

Species Lists

Fish Species in the East Holland River Subwatersheds 1965-1998

(based on records at Aurora District Ontario Ministry of Natural Resources, compiled summer 1999)

Armitage Creek

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Cottus bairdi	mottled sculpin	2	4/30/97
Culaea inconstans	brook stickleback	3	4/30/97
Pimephales notatus	bluntnose minnow	1	4/30/97
Rhinichthys atratulus	blacknose dace	2	4/30/97
Semotilus atromaculatus	creek chub	3	4/30/97

Bogart Creek

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Catostomus commersoni	white sucker	8	9/28/98
Cottus bairdi	mottled sculpin	4	9/28/98
Culaea inconstans	brook stickleback	3	9/19/86
Lepomis gibbosus	pumpkinseed	10	9/28/98
Luxilus cornutus	common shiner	3	6/25/98
Micropterus salmoides	largemouth bass	1	8/11/87
Notropis hudsonius	spottail shiner	1	8/5/94
Phoxinus eos	northern redbelly dace	1	8/5/94
Pimephales notatus	bluntnose minnow	5	8/5/94
Pimephales promelas	fathead minnow	4	9/28/98
Rhinichthys atratulus	blacknose dace	3	9/28/98
Rhinichthys cataractae	longnose dace	5	5/20/96
Semotilus atromaculatus	creek chub	8	9/28/98

East Branch

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	2	7/9/91
Catostomus commersoni	white sucker	13	9/28/98
Cottus bairdi	mottled sculpin	12	9/28/98
Cottus sp.	sculpin spp.	6	7/17/98
Culaea inconstans	brook stickleback	5	7/17/98
Cyprinidae	unidentified minnows	2	7/17/98
Etheostoma caeruleum	rainbow darter	1	9/28/98
Etheostoma exile	Iowa darter	1	7/17/98
Lepomis gibbosus	pumpkinseed	6	9/28/98
Luxilus cornutus	common shiner	8	7/17/98
Notemigonus crysoleucas	golden shiner	2	7/17/98
Notropis atherinoides	emerald shiner	1	7/17/98
Phoxinus eos	northern redbelly dace	1	1/1/65

Pimephales notatus	bluntnose minnow	2	7/9/91
Pimephales promelas	fathead minnow	8	9/28/98
Rhinichthys atratalus	blacknose dace	6	9/28/98
Rhinichthys atratulus	blacknose dace	7	7/17/98
Rhinichthys cataractae	longnose dace	9	7/17/98
Rhinichythys catacractae	longnose dace	1	8/4/87
Salvelinus fontinalis	brook trout	7	10/17/94
Semotilus atromaculatus	creek chub	18	9/28/98
Umbra limi	central mudminnow	2	6/9/76

East Holland River

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ambloplites rupestris	rock bass	1	6/27/76
Ameiurus nebulosus	brown bullhead	2	7/7/76
Carassius auratus	goldfish	1	5/31/91
Catostomus commersoni	white sucker	1	7/9/76
Cyprinus carpio	common carp	4	5/31/91
Etheostoma exile	Iowa darter	1	5/1/83
Lepomis gibbosus	pumpkinseed	3	5/31/91
Lepomis sp.	sunfish	3	7/9/76
Luxilus cornutus	common shiner	2	5/31/91
Micropterus salmoides	largemouth bass	1	7/7/76
Notemigonus crysoleucas	golden shiner	2	7/8/76
Notropis atherinoides	emerald shiner	1	5/31/91
Notropis heterodon	blackchin shiner	2	5/31/91
Notropis heterolepis	blacknose shiner	1	5/1/83
Notropis hudsonius	spottail shiner	1	7/8/76
Pimephales promelas	fathead minnow	4	5/31/91
Rhinichthys cataractae	longnose dace	1	5/31/91
Semotilus atromaculatus	creek chub	1	5/1/83

Holland-Schomberg River

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ambloplites rupestris	rock bass	1	7/17/76
Ameiurus nebulosus	brown bullhead	1	7/17/76
Amia colva	bowfin	1	7/17/76
Esox lucius	northern pike	1	7/17/76
Lepomis gibbosus	pumpkinseed	1	7/17/76
Micropterus dolomieu	smallmouth bass	1	7/17/76
Micropterus salmoides	largemouth bass	1	7/17/76
Perca flavescens	yellow perch	1	7/17/76

Island Lake

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	1	5/17/79
Carassius auratus	goldfish	1	5/17/79
Catostomus commersoni	white sucker	1	5/17/79
Lepomis gibbosus	pumpkinseed	1	5/17/79

Long (Lazy) Lake

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	1	7/6/71
Micropterus salmoides	largemouth bass	1	7/6/71

Musselman's Lake

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ambloplites rupestris	rock bass	1	7/25/80
Ameiurus nebulosus	brown bullhead	1	5/28/91
Catostomus commersoni	white sucker	1	7/25/80
Cyprinidae	minnow	1	5/28/91
Esox lucius	northern pike	1	7/25/80
Lepomis gibbosus	pumpkinseed	1	5/28/91
Micropterus salmoides	largemouth bass	1	5/28/91
Notropis stramineus	sand shiner	1	5/28/91
Perca flavescens	yellow perch	1	5/28/91
Pimephales notatus	bluntnose minnow	1	7/25/80

Shadow Lake

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	1	5/28/91
Micropterus salmoides	largemouth bass	1	5/28/91
Perca flavescens	yellow perch	1	5/28/91

Sharon Creek

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Catostomus commersoni	white sucker	3	9/17/94
Clinostomus elongatus	redside dace	1	9/17/94
Culaea inconstans	brook stickleback	3	9/17/94
Lepomis gibbosus	pumpkinseed	2	9/17/94
Notemigonus crysoleucas	golden shiner	1	7/12/93
Notropis hudsonius	spottail shiner	1	7/12/93
Pimephales notatus	bluntnose minnow	1	7/12/93
Rhinichthys atratalus	blacknose dace	2	7/21/93
Semotilus atromaculatus	creek chub	3	9/17/94

East Holland River

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Amia colva	bowfin	1	9/2/71
Cyprinus carpio	common carp	1	9/2/71
Lepomis gibbosus	pumpkinseed	1	9/2/71
Micropterus salmoides	largemouth bass	1	2/9/71
Notemigonus crysoleucas	golden shiner	1	9/2/71

Staley Lake

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	1	8/6/71

Tannery Creek

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Catostomus commersoni	white sucker	6	4/30/97
Cottus bairdi	mottled sculpin	6	4/30/97
Cottus sp.	sculpin spp.	2	8/18/94
Culaea inconstans	brook stickleback	10	4/30/97
Hybognathus hankinsoni	brassy minnow	1	5/3/90
Lepomis gibbosus	pumpkinseed	4	8/18/94
Luxilus cornutus	common shiner	1	8/18/94
Notemigonus crysoleucas	golden shiner	1	7/7/93
Phoxinus eos	northern redbelly dace	1	6/2/76
Pimephales notatus	bluntnose minnow	3	4/30/97
Pimephales promelas	fathead minnow	6	8/18/94
Rhinichthys atratulus	blacknose dace	8	4/30/97
Rhinichthys cataractae	longnose dace	3	8/18/94
Salvelinus fontinalis	brook trout	1	8/2/94
Semotilus atromaculatus	creek chub	10	4/30/97

un-named tributary

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Ameiurus nebulosus	brown bullhead	2	9/12/96
Catostomus commersoni	white sucker	1	7/20/93
Culaea inconstans	brook stickleback	4	9/12/96
Esox lucius	northern pike	2	9/12/96
Etheostoma exile	Iowa darter	1	9/12/96
Lepomis gibbosus	pumpkinseed	2	9/12/96
Pimephales promelas	fathead minnow	1	7/20/93
Semotilus atromaculatus	creek chub	7	3/20/97
Umbra limi	central mudminnow	1	10/25/89

Weslie Creek

Latin Name	Common Name	No.of Sample Dates	Most Recent Record
Cottus bairdi	mottled sculpin	1	6/8/76
Culaea inconstans	brook stickleback	2	8/5/94
Pimephales promelas	fathead minnow	1	6/8/76
Rhinichthys atratulus	blacknose dace	1	6/8/76
Semotilus atromaculatus	creek chub	3	8/5/94

Bird Species in the East Holland River Subwatershed

The following is a list of birds. Although extensive field work to inventory fauna for this report was not conducted, many of the species listed below are likely found in the East Holland River Subwatershed. However, some of the species have rather local distributions or specialised habitat requirements and thus they may not occur within the study area. As well, this list should not be considered to be complete. There are likely additional species of birds in the study area that have not been documented by the LSRCA or other agencies.

Common Name	**Species Name**
American Woodcock	*Philohela minor*
American Goldfinch	*Carduelis tristis*
American Wigeon	*Anas americana*
American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
American Black Duck	*Anas rubripes*
American Tree Sparrow	*Spizella arborea*
American Coot	*Fulica americana*
American Kestrel	*Falco sparverius*
American Redstart	*Setophaga ruticilla*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Bay-breasted Warbler	*Dendroica castanea*
Belted Kingfisher	*Megaceryle alcyon*
Black Tern	*Chlidonias niger*
Black-and-white Warbler	*Mniotilta varia*
Black-bellied Plover	*Pluvialis squatarola*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Black-capped Chickadee	*Parus atricapillus*
Black-crowned Night Heron	*Nycticorax nycticorax*
Black-throated Green Warbler	*Dendroica virens*
Black-throated Blue Warbler	*Dendroica caerulescens*
Blackburnian Warbler	*Dendroica fusca*
Blackpoll Warbler	*Dendroica striata*
Blue Jay	*Cyanocitta cristata*

Blue-winged Teal	*Anas discors*
Bobolink	*Dolichonyx oryzivorus*
Bonaparte's Gull	*Larus philadelphia*
Brant	*Branta bernicla*
Broad-winged Hawk	*Buteo platypterus*
Brown Creeper	*Certhia familiaris*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Canada Warbler	*Wilsonia canadensis*
Canada Goose	*Branta canadensis*
Cape May Warbler	*Dendroica tigrina*
Caspian Tern	*Sterna caspia*
Cedar Waxwing	*Bombycilla cedrorum*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Chimney Swift	*Chaetura pelagica*
Chipping Sparrow	*Spizella passerina*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Moorhen	*Gallinula chloropus*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Common Yellowthroat	*Geothlypis trichas*
Common Grackle	*Quiscalus quiscula*
Common Tern	*Sterna hirundo*
Common Snipe	*Capella gallinago*
Common Raven	*Corvus corax*
Common Redpoll	*Carduelis flammea*
Cooper's Hawk	*Accipiter cooperii*
Dark-eyed Junco	*Junco hyemalis*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpina*
Eastern Phoebe	*Sayornis phoebe*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Screech Owl	*Otus asio*
Eastern Meadowlark	*Sturnella magna*

Eastern Wood-Pewee	*Contopus virens*
Eastern Bluebird	*Sialia sialis*
European Starling	*Sturnus vulgaris*
Evening Grosbeak	*Hesperiphona vespertina*
Field Sparrow	*Spizella pusilla*
Fox Sparrow	*Passerella iliaca*
Gadwall	*Anas strepera*
Golden-crowned Kinglet	*Regulus satrapa*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Catbird	*Dumetella carolinensis*
Great Black-backed Gull	*Larus marinus*
Great Crested Flycatcher	*Myiarchus crinitus*
Great Blue Heron	*Ardea herodias*
Great Horned Owl	*Bubo virginianus*
Greater Yellowlegs	*Tringa melanoleuca*
Greater Scaup	*Aythya marila*
Green-backed Heron	*Butorides striatus*
Green-winged Teal	*Anas crecca*
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush	*Catharus guttatus*
Herring Gull	*Larus argentatus*
Hooded Merganser	*Lophodytes cucullatus*
Horned Grebe	*Podiceps auritus*
Horned Lark	*Eremophila alpestris*
House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Indigo Bunting	*Passerina cyanea*
Killdeer	*Charadrius vociferus*
Least Sandpiper	*Calidris minutilla*
Least Flycatcher	*Empidonax minimus*
Lesser Scaup	*Aythya affinis*
Lesser Golden Plover	*Pluvialis dominica*
Lesser Yellowlegs	*Tringa flavipes*
Lincoln's Sparrow	*Melospiza lincolnii*
Magnolia Warbler	*Dendroica magnolia*

Mallard	*Anas platyrhynchos*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mourning Dove	*Zenaida macroura*
Mourning Warbler	*Oporornis philadelphia*
Nashville Warbler	*Vermivora ruficapilla*
Northern Harrier	*Circus cyaneus*
Northern Flicker	*Colaptes auratus*
Northern Oriole	*Icterus galbula*
Northern Shrike	*Lanius excubitor*
Northern (common) Pintail	*Anas acuta*
Northern Waterthrush	*Seiurus noveboracensis*
Northern Shoveler	*Anas clypeata*
Northern Cardinal	*Cardinalis cardinalis*
Oldsquaw	*Clangula hyemalis*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapillus*
Palm Warbler	*Dendroica palmarum*
Pectoral Sandpiper	*Calidris melanotos*
Pied-billed Grebe	*Podilymbus podiceps*
Pileated Woodpecker	*Dryocopus pileatus*
Pine Siskin	*Carduelis pinus*
Pine Warbler	*Dendroica pinus*
Purple Martin	*Progne subis*
Purple Finch	*Carpodacus purpureus*
Red-breasted Merganser	*Mergus serrator*
Red-breasted Nuthatch	*Sitta canadensis*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-necked Grebe	*Podiceps grisegena*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*B. jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Redhead	*Aythya americana*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Pheasant	*Phasianus colchicus*

Ring-necked Duck	*Aythya collaris*
Rock Dove	*Columba livia*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Rough-legged Hawk	*Buteo lagopus*
Rough-winged Swallow	*Stelgidopteryx ruficollis*
Ruby-crowned Kinglet	*Regulus calendula*
Ruby-throated Hummingbird	*Archilochus colubris*
Ruddy Turnstone	*Arenaria interpres*
Ruffed Grouse	*Bonasa umbellus*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Rusty Blackbird	*Euphagus carolinus*
Sanderling	*Calidris alba*
Savannah Sparrow	*Passerculus sandwichensis*
Scarlet Tanager	*Piranga olivacea*
Semipalmated Sandpiper	*Calidris pusilla*
Semipalmated Plover	*Charadrius semipalmatus*
Sharp-shinned Hawk	*Accipiter striatus*
Short-billed Dowitcher	*Limnodromus griseus*
Snow Bunting	*Plectrophenax nivalis*
Solitary Sandpiper	*Tringa solitaria*
Solitary Vireo	*Vireo solitarius*
Song Sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Spotted Sandpiper	*Actitis macularia*
Stilt Sandpiper	*Micropalama himantopus*
Swainson's Thrush	*Catharus ustulatus*
Swamp Sparrow	*Melospiza georgiana*
Tennessee Warbler	*Vermivora peregrina*
Tree Swallow	*Iridoprocne bicolor*
Tundra Swan	*Cygnus columbianus*
Turkey Vulture	*Cathartes aura*
Upland Sandpiper	*Bartramia longicauda*
Veery	*Catharus fuscescens*
Vesper Sparrow	*Pooecetes gramineus*
Virginia Rail	*Rallus limicola*
Warbling Vireo	*Vireo gilvus*

Whimbrel	*Numenius phaeopus*
Whip-poor-will	*Caprimulgus vociferus*
White-breasted Nuthatch	*Sitta carolinensis*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-rumped Sandpiper	*Calidris fuscicollis*
White-throated Sparrow	*Zonotrichia albicollis*
White-winged Crossbill	*Loxia leucoptera*
White-winged Scoter	*Melanitta deglandi*
Wild Turkey	*Meleagris gallopavo*
Willow Flycatcher	*Empidonax traillii*
Wilson's Phalarope	*Steganopus tricolor*
Wilson's Warbler	*Wilsonia pusilla*
Winter Wren	*Troglodytes troglodytes*
Wood Thrush	*Hylocichla mustelina*
Wood Duck	*Aix sponsa*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-rumped Warbler	*Dendroica coronata*

References:

Cadman, M.D., P.F.J. Eagles and F.M. Helleiner. 1987. *Atlas of breeding birds of Ontario.*

Mammal Species in the East Holland River Subwatershed

The following is a list of mammals. Although extensive field work to inventory fauna for this report was not conducted, many of the species listed below are likely found in the East Holland River Subwatershed. However, some of the species have rather local distributions or specialized habitat requirements, and thus they may not occur within the study area. As well, this list should not be considered to be complete. There are likely additional species of mammals in the study area that have not been documented by the LSRCA or other agencies.

Common Name	Species Name
Masked Shrew	*Sorex cunereus*
Northern Water Shrew	*S. palustris*
Pigmy Shrew	*Microsorex hoyi*
Short-tailed Shrew	*Blarina brevicauda*
Smoky Shrew	*Sorex fumeus*
Hairy-tailed Mole	*Parascalops breweri*
Star-nosed Mole	*Condylura cristata*
Big Brown Bat	*Estesicus fuscus*
Eastern Pipistrelle	*Pipistrellus subflavus*
Hoary Bat	*Lasiurus cinereus*
Keen’s Bat	*Myotis keenii*
Little Brown Bat	*M. lucifugus*
Red Bat	*Lasiurus borealis*
Silver-haired Bat	*Lasionycteris*
Small-footed Bat	*Myotis leibii*
Eastern Cottontail	*Sylvilagus floridanus*
European Hare	*Lepus europaeus*
Snowshoe Hare	*L. americanus*
Beaver	*Castor canadensis*
Raccoon	*Procyon lotor*
Eastern Chipmunk	*Tamias striatus*
Eastern Grey Squirrel	*Sciurus carolinensis*
Northern Flying Squirrel	*Glaucomys sabrinus*
Red Squirrel	*Tamiasciurus hudsonicus*
Woodchuck (Groundhog)	*Marmota monax*
Deer Mouse	*Peromyscus maniculatus*

House Mouse	*Mus musculus*
Meadow Vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
Norway Rat	*Rattus norvegicus*
Redback Vole	*Clethrionomys gapperi*
Southern Bog Lemming	*Synaptomys cooperi*
White-footed Mouse	*Peromyscus leucopus*
Meadow Jumping Mouse	*Zapus hudsonius*
Woodland Jumping Mouse	*Napaeozapus insignis*
American Porcupine	*Erethizon dorsatum*
Coyote	*Canis latrans*
Red fox	*Vulpes vulpes*
American Mink	*Mustela vison*
Ermine (Short-tail Weasel)	*M. erminea*
Long-tailed Weasel	*M. frenata*
Stripped Skunk	*Mephitis mephitis*
White-tailed Deer	*Odocoileus virginianus*

References:

Dobbyn, J. A. S.. 1994. *Atlas of the Mammals of Ontario.*

Herpetofauna Species in the East Holland River Subwatershed

The following is a list of amphibians and reptiles. Although extensive field work to inventory fauna for this report was not conducted, many of the species listed below are likely found in the East Holland River Subwatershed. However, some of the species have rather local distributions or specialised habitat requirements, and thus they may not occur within the study area. As well, this list should not be considered to be complete. There are likely additional species of amphibians and reptiles in the study area that have not been documented by the LSRCA or other agencies.

AMPHIBIANS

Common Name	Species Name
Mudpuppy	*Necturus maculosus*
Blue-spotted Salamander	*Ambystoma laterale*
Jefferson's Salamander	*A. jeffersonianum*
Spotted Salamander	*A. maculatum*
Four-toed Salamander	*Hemidactyllum scutatum*
Red-backed Salamander	*Plethodon cinereus*
Red-spotted Newt	*Notophthalmus viridescens*
American Toad	*Bufo americanus*
Grey Treefrog	*Hyla versicolor*
Northern Spring Peeper	*H. crucifera*
Western Chorus Frog	*Pseudacris triseriata triseriata*
Bull Frog	*Rana catesbeiana*
Green Frog	*R. clamitans*
Leopard Frog	*R. pipens*
Mink Frog	*R. septentrionalis*
Pickerel Frog	*R. palustris*
Wood Frog	*R. sylvatica*

REPTILES

Common Name	Species Name
Snapping Turtle	*Chelydra serpentina*
Stinkpot	*Sternotherus odoratus*
Spotted Turtle	*Clemmys guttatta*

Wood Turtle	*C. insculpta*
Map Turtle	*Malaclemys geographica*
Midland Painted Turtle	*Chrysemys picta marginata*
Blanding's Turtle	*Emydoidea blandingi*
Five-lined Skink	*Eumeces fasciatus*
Eastern Hognose Snake	*Heterodon platyrhinos*
Eastern Ribbon Snake	*Thamnophis sauritus septentrionalis*
Eastern Garter Snake	*T. sirtalis sertalis*
Milk Snake	*Lampropeltis triangulum*
Northern Brown Snake	*Storeria dekayi*
Northern Water Snake	*Natrix sipedon sipedon*
Northern Ringneck Snake	*Diadophis punctata edurardsi*
Queen Snake	*Regina septenvitta*
Red-bellied Snake	*Storeria occipitomaculata*
Smooth Green Snake	*Opheodrys vernalis*

References:

South Lake Simcoe Conservation Authority. 1982. *Watershed Inventory 1982.* Newmarket, Ontario.

Vegetation Species in the East Holland River Subwatershed

The following is a list of plants. Although extensive field work to inventory fauna for this report was not conducted, many of the species listed below are likely found in the East Holland River Subwatershed. However, some of the species have rather local distributions or specialised habitat requirements, and thus they may not occur within the study area. As well, this list should not be considered to be complete. There are likely additional species of plants in the study area that have not been documented by the LSRCA or other agencies.

Common Name	Species name
Round-branched ground pine	Lycopodium dendroideum
Shining clubmoss	Lycopodium lucidulum
Horsetail	Equisetum spp.
Field horsetail	Equisetum arvense
Rough horsetail	Equisetum trachyodon
Scouring-rush	Equisetum hyemale
Smooth scouring-rush	Equisetum laevigatum
Meadow horsetail	Equisetum pratense
Dwarf scouring-rush	Equisetum scirpoides
Variegated scouring-rush	Equisetum variegatum
Rattlesnake fern	Botrychium virginianum
Cinnnamon fern	Osmunda cinnamomea
Eastern bracken fern	Pteridium aquilinum
Northern maidenhair fern	Adiantum pedatum
Northeastern lady fern	Athyrium filix-femina
Bulbet fern	Cystopteris bulbifera
Spinulose wood fern	Dryopteris carthusiana
Marginal wood fern	Dryopteris marginalis
Oak fern	Gmynocarpium dryopteris
American ostrich fern	Matteuccia struthiopteris
Sensitive fern	Onoclea sensibilis
Christmas fern	Polystichum acrostichoides
American yew	Taxus canadensis
White spruce	Picea glauca
Red pine	Pinus resinosa

White pine	Pinus strobus
Scot pine	Pinus sylvestris
Jack pine	Pinus banksiana
Eastern hemlock	Tsuga canadensis
White cedar	Thuja occidentalis
European larch	Larix decidua
Balsam fir	Abies balsamea
Narrow-leaved cattail	Typha angustifolia
Common cattail	Typha latifolia
Common arrowhead	Sagittaria latifolia
Grass	Graminae spp
Sedge	Carex spp
Black bulrush	Scirpus atrovirens
Bulrush	Scirpus spp
Bur reed	Sparganium spp
Jack-in-the-pulpit	Arisaema triphyllum
Common duckweed	Lemna minor
Wild leek	Allium schoenoprasum
Wild asparagus	Asparagus officinalis
Yellow trout-lily	Erythronium americanum
Wild lily-of-the-valley	Maianthemum canadense
Indian cucumber-root	Medola virginiana
Solomon's-seal	Polygonatum pubescens
Solomon's-seal	Polygonatum biflorum
False salomon's-seal	Smilacina racemosa
Carrion-flower	Smilax herbacea
Bristly greenbrier	Smilax hispida
Rose twisted stalk	Streptopus roseus
Purple trillium	Trillium erectum
White trillium	Trillium grandiflorum
Little blue eyed grass	Sisyrinchium montanum
Helleborine	Epipactis helleborine
Showy lady's slipper	Cypripedium reginae
Yellow lady's slipper	Cypripedium calceolus
Loesel's (Bog) twayblade	Liparis loseselii
Nodding ladies' tresses	Spiranthes cernua

Balsam poplar	Populus balsamifera
Cottonwood	Populus deltoides
Large-toothed aspen	Populus grandidentata
Trembling aspen	Populus tremuloides
Black willow	Salix nigra
Peach-leaved willow	Salix amygdaloides
Beaked willow	Salix bebbiana
Hoary willow	Salix candida
Shining willow	Salix lucida
Bitternut hickory	Carya cordiformis
Butternut	Juglans cinerea
Speckled alder	Alnus rugosa
Yellow birch	Betula alleghaniensis
White birch	Betula papyrifera
European white birch	Betula pendula
Beaked hazelnut	Corylus cornuta
Ironwood	Ostrya virginiana
American beech	Fagus grandifolia
Blue beech	Carpinus carolinia
Red oak	Quercus rubra
White oak	Quercus alba
White elm	Ulmus americana
Red elm	Ulmus rubra
Rock elm	Ulmus thomasii
Wood nettle	Laportea canadensis
Stinging nettle	Urtica dioica
Bastard toadflax	Comandra umbellata
Wild ginger	Asarum canadense
Willow weed	Polygonum lapathifolium
Lady's thumb	Polygonum persicaria
Curly dock	Rumex crispus
Bitter dock	Rumex obtusifolius
Broad-leaved spring beauty	Claytonia caroliniana
Narrow-leaved spring beauty	Claytonia virginica
Mouse-eared chickweed	Cerastium fontanum
Bladder campion	Silene vulgaris

Grass-leaved stitchwort	Stellaria graminea
White baneberry	Actaea pachypoda
Red baneberry	Actaea rubra
Actaea x ludovici	A. Pachypodia x A. rubra
Thimbleweed	Anemone virginiana
Canada anemone	Anemone canadensis
Wild columbine	Aquilegia canadensis
Marsh-marigold	Caltha palustris
Gold-thread	Coptis trifolia
Sharp-lobed hepatica	Hepatica acutiloba
Round-lobed hepatica	Hepatica americana
Small-flowered buttercup	Ranunculus abortivus
Tall buttercup	Ranunculus acris
Cursed crowfoot	Ranunculus sceleratus
Early meadow rue	Thalictrum dioicum
Tall meadow rue	Thalictrum polygamum
Blue cohosh	Caulophyllum thalictroides
May-apple	Podophyllum peltatum
Celandine	Chelidonium majus
Bloodroot	Sanguinaria canadensis
Dutchman's-breeches	Dicentra cucullaria
Garlic mustard	Alliaria petiolata
Bitter cress	Cardamine pensylvanica
Toothwort	Dentaria diphylla
Marsh yellow cress	Rorippa islandica
Penny grass	Thlaspi arvense
Bishop's cap	Mitella diphylla
Foamflower	Tiarella cordifolia
Prickly gooseberry	Ribes cynobasti
Black currant	Ribes nigrum
Agrimony	Agrimonia gryposepala
Serviceberry	Amelanchier spp.
Goat's-beard	Aruncus dioicus
Hawthorn	Crataegus chrysocarpa
Hawthorn	Crataegus spp.
Woodland strawberry	Fragaria vesca

Common strawberry	Fragaria virginiana
Yellow avens	Geum aleppicum
White avens	Geum canadense
Apple	
Domestic apple	Pyrus malus
Crabapple	Pyrus coronia
Tall cinquefoil	Pontentilla arguta
Rough cinquefoil	Potentilla norvegica
Rough-fruited cinquefoil	Potentilla recta
Pin cherry	Prunus pensylvanica
Black cherry	Prunus serotina
Chokecherry	Prunus virginiana
Black raspberry	Rubus occidentalis
Blackberry	Rubus spp
Raspberry	Rubus spp
Red raspberry	Rubus idaeus
Barren strawberry	Waldsteinia fragarioides
Crown vetch	Coronilla varia
Bird-foot trefoil	Lotus corniculatus
White sweet-clover	Melilotus alba
Hop clover	Trifolium aureum
Red clover	Trifolium pratense
White clover	Trifolium repens
Medick	Medicago spp
Bird vetch	Vicia cracca
Herb robert	Geranium robertianum
Yellow wood-sorrel	Oxalis europaea
Common wood-sorrel	Oxalis stricta
Staghorn sumac	Rhus typhina
Poison ivy	Rhus radicans
Manitoba maple	Acer negundo
Red maple	Acer rubrum
Silver maple	Acer saccharinum
Sugar maple	Acer saccharum
Mountain maple	Acer spicatum
Norway maple	Acer platanoides

Common buckthorn	Rhamnus cathartica
Spotted jewelweed	Impatiens capensis
Jewelweed	Impatiens pallida
Virginia creeper	Parthenocissus quinquefolia
Riverbank grape	Vitis riparia
Virgins bower	Clematis virginiana
Basswood	Tilia americana
Common St. John's-wort	Hypericum performatum
Canada violet	Viola canadensis
Dog violet	Viola conspersa
Marsh blue violet	Viola cucullata
Large-leaved white violet	Viola incognita
Common blue violet	Viola papilionacea
Downy yellow violet	Viola pubescens
Great-spurred violet	Viola selkirkii
Woolly blue violet	Viola sororia
Leatherwood	Dirca palustris
Purple loosestrife	Lythrum salicaria
Enchanter's nightshade	Circaea quadrisuleata
Common nightshade	Solanum nigrum
Bittersweet	Solanum dulcamara
Hairy willowherb	Epilobium hirsutum
Fireweed	Epilobium angustifolium
Sundrop	Oenothera fruticosa
Wild sarsaparilla	Aralia nudicaulis
Spikenard	Aralia racemosa
Bulbous water-hemlock	Cicuta bulbifera
Spotted water-hemlock	Cicuta maculata
Honewort	Cryptotaenia canadensis
Queen Anne's lace	Daucus carota
Sweet ciclely	Osmorhiza claytonii
Alternate-leaved dogwood	Cornus alternifolia
Red-osier dogwood	Cornus stolonifera
Round leaf dogwood	Cornus racemosa
Panicled dogwood	Cornus rugosa
Shinleaf	Pyrola elliptica

Trailing arbutus	Epigaea repens
Wintergreen	Gaultheria procumbens
Star-flower	Trientalis borealis
White ash	Fraxinus americana
Green ash	Fraxinus pennsylvanica
Black ash	Fraxinus nigra
Fringed gentian	Gentiana crinata
Closed gentian	Gentiana andrewsii
Spreading dogbane	Apocynum androsaemifolium
Indian hemp	Apocynum cannabinum
Swamp milkweed	Asclepias incarnata
Common milkweed	Asclepias syriaca
Dog strangling vine	Vincetoxicum rossicum
Field bindweed	Convolvulus arvensis
Blue phlox	Phlox divaricata
Virginia waterleaf	Hydrophyllum virginianum
Viper's-bugloss	Echium vulgare
Common gromwell	Lithosperum officinale
Forget-me-not	Myosotis scorpioides
Blue vervain	Verbena hastata
Hemp nettle	Galeopsis tetrahit
Ground ivy	Glechoma hederacea
Motherwort	Leonurus cardiaca
American water-horehound	Lycopus americanus
Peppermint	Mentha x piperta
Common mint	Mentha arvensis
Oswego-tea	Monarda didyma
Wild bergamot	Monarda fistulosa
Catnip	Nepeta cataria
Heal-all	Prunella vulgaris
Dog mint	Satureja vulgaris
Common skullcap	Scutellaria galericulata
Mad-dog skullcap	Scutellaria lateriflora
Butter-and-eggs	Linaria vulgaris
Square-stemmed monkeyflower	Mimulus ringens
Common mullein	Verbascum thapsus

American brooklime	Veronica americana
Purslane speedwell	Veronica peregrina
Lopseed	Phryma leptostachya
Rugel's plantain	Plantago rugelli
Cleavers	Galium aparine
Rough bedstraw	Galium asperllum
Sweet-scented bedstraw	Galium triflorum
Northern bedstraw	Galium boreale
Partridge-berry	Mitchella repens
Bush honeysuckle	Diervilla lonicera
Tartarian honeysuckle	Lonicera tartarica
Fly honeysuckle	Lonicera canadensis
Common elder	Sambucus canadensis
Red-berried elder	Sambucus pubens
Maple-leaved viburnum	Vibernum acerifolium
Nannyberry	Viburnum lentago
Highbush cranberry	Viburnum trilobum
American cranberry	Vaccinium macrocarpon
Creeping bellflower	Campanula rapunculoides
Bedstraw bellflower	Campanula aparinoides
Teasel	Dipsacus fullonum
Wild cucumber	Echinocystis lobata
Indian tobacco	Lobelia inflata
Yarrow	Achillea millefolium
Ragweed	Ambrosia artemisiifolia
Pearly everlasting	Anaphalis margaritacea
Pussytoes	Antennaria spp
Common burdock	Arctium minus
Tall white aster	Aster lanceolatus
White aster	Aster vimineus
One-sided aster	Aster lateriflorus
New England aster	Aster novae-angliae
Red-stemmed aster	Aster puniceus
Oxeye daisy	Chrysanthemum leucanthemum
Chickory	Cichorium intybus
Canada thistle	Cirsium arvense

Pasture thistle	Cirsium pumilum
Bull thistle	Cirsium vulgare
Annual fleabane	Erigeron annuus
Philadelphia fleabane	Erigeron philadelphicus
Spotted Joe-pye weed	Eupatorium maculatum
Bonset	Eupatorium perfoliatum
White snakeroot	Eupatorium rugosum
Orange hawkweed	Hieracium aurantiacum
King devil hawkweed	Hieracium piloselloides
Rough hawkweed	Heiracium scabrum
Elecampane	Inuba helenium
Pineapple weed	Matricaria matricarioides
Sweet colts foot	Petasites palmatus
Black-eyed susan	Rudbeckia hirta
Tall goldenrod	Solidago altissima
Canada goldenrod	Solidago canadensis
Zig-zag goldenrod	Solidago flexicaulis
Late goldenrod	Solidago gigantea
Lance-leaved goldenrod	Solidago graminifolia
Rough goldenrod	Solidago rugosa
Goldenrod	Solidago spp
Perennial sow-thistle	Sonchus arvensis
Dandelion	Taraxacum officinale
Meadow goat's-beard	Tragopogon pratensis
Colts foot	Tussilago farfara
Foxglove beard tongue	Renstemon digitalis
Common lilac	Syringa vulgaris

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Regionally Rare Plant Species in the East Holland River Subwatershed

Common Name	***Species Name***
Sweetflag	*(Acorus calamus)*
Saskatoon-berry	*(Amelanchier alnifolia var. alnifolia)*
Bog rosemary	*(Andromeda glaucophylla)*
Big bluestem	*(Andropogon gerardi)*
Little bluestem	*(Andropogon scoparius)*
Dwarf mistletoe	*(Arceuthobium pusillum)*
Bearberry	*(Arctostaphylos uva-ursi)*
Swamp-pink	*(Arethusa bulbosa)*
Butterfly-weed	*(Asclepias tuberosa)*
Swamp aster	*(Aster junciformis)*
Smooth aster	*(Aster laevis)*
Leathery grape fern	*(Botrychium multifidum)*
Least moonwort	*(Botrychium simplex)*
Water shield	*(Brasenia schreberi)*
Brome grass	*(Bromus kalmii)*
Narrow reed grass	*(Calamagrostis stricta)*
Water arum	*(Calla palustris)*
Grass pink	*(Calopogon pulchellus)*
Grass pink	*(Calopogon tuberosus)*
Harebell	*(Campanula rotundifolia)*
Awned sedge	*(Carex atherodes)*
Creeping sedge	*(Carex chordorrhiza)*
Sedge spp.	*(Carex foenea)*
Gray's sedge	*(Carex grayii)*
Houghton's sedge	*(Carex houghtonnii)*
Slender sedge	*(Carex lasiocarpa)*
Sedge spp.	*(Carex limosa)*
Livid sedge	*(Carex livida)*
Sedge spp.	*(Carex muhlenbergii)*
Few-seeded sedge	*(Carex oligosperma)*

Sedge spp.	*(Carex paupercula)*
Richardson's sedge	*(Carex richardsonii)*
Sedge spp.	*(Carex rugosperma)*
Three-fruited sedge	*(Carex trisperma)*
Tuckerman's sedge	*(Carex tuckermanii)*
New Jersey tea	*(Ceanothus americanus)*
Narrow-leaved New Jersey tea	*(Ceanothus herbaceous)*
Leatherleaf	*(Chamaedaphne calyculata)*
Twig rush	*(Cladium mariscoides)*
Low bindweed	*(Convolvulus spithamaeus)*
American hazel	*(Corylus americana)*
Nut grass	*(Cyperus filiculmis)*
Mocassin flower	*(Cypredium acaule)*
Sundew	*(Drosera rotundifolia)*
Trailing arbutus	*(Epigaea repens)*
meadow horsetail	*(Equisetum pratense)*
smooth scouring rush	*(Equisetuum laevigatum)*
Cotton grass	*(Eriophocum tenellum)*
Harestail	*(Eriophorum spissum)*
Cotton grass	*(Errophorum virginicum)*
Flowering spurge	*(Euphorbia corollata)*
Black huckleberry	*(Gaylussacia baccata)*
Closed gentian	*(Gentiana andrewsii)*
Fringed gentian	*(Gentiana crinata)*
Carolina cranesbill	*(Geranium carolinianum)*
Wild geranium	*(Geranium maculatum)*
Slender gerardia	*(Gerardia tenuifolia)*
Leafy white orchis	*(Habenaria dilatat)*
Frostweed	*(Helianthemum bicknelli)*
Frostweed	*(Helianthemum canadense)*
Sunflower	*(Helianthus laetiflorus)*
Prairie sunflower	*(Helianthus petiolaris)*
Long-leaved bluets	*(Houstonia longifolia)*
Eastern red cedar	*(Juniperus virginiana)*
Bog laurel	*(Kalmia polifolia)*
Pinweed	*(Lechea intermedia)*

Labrador tea	*(Ledum groenlandicum)*
Michigan lily	*(Lilium michiganese)*
Wood lily	*(Lilium philadelphicum)*
Kalm's lobelia	*(Lobelia kalmii)*
Hairy honeysuckle	*(Lonicera hirsuta)*
Cow wheat	*(Melampyrum lineare)*
Buckbean	*(Menyanthes trifoliata)*
Pinesap	*(Monotropa hypopithys)*
One-sided pyrola	*(Orthilia secunda)*
Sharp-leaved oryzopsis	*(Oryzopsis pungens)*
Rice-grass	*(Oryzopsis pungens)*
Interrupted fern	*(Osmunda claytoniana)*
Panic grass	*(Panicum columbianum)*
Panic grass	*(Panicum latifolium)*
Panic grass	*(Panicum linearifolium)*
Wood betony	*(Pedicularis canadensis)*
Common reed grass	*(Phragmites communis)*
Black spruce	*(Picea mariana)*
Languid poa	*(Poa languida)*
Rose pogonia	*(Pogonia ophiolossoides)*
Common polypody	*(Polypodium virginianum)*
Berchtold's pondweed	*(Potamogeton berchtoldii)*
Sand cherry	*(Prunus besseyi)*
Sand cherry	*(Prunus pumila var.besseyi)*
White water crowfoot	*(Ranunculus longirostris)*
Prairie buttercup	*(Ranunculus rhomboideus)*
Fragrant sumac	*(Rhus aromatica)*
Smooth sumac	*(Rhus glabra)*
Northern dewberry	*(Rubus flagellaris)*
Bog willow	*(Salix pedicellaris)*
Pitcher plant	*(Sarracenia purpurea)*
Three-square	*(Scirpus americanus)*
Alpine cotton grass	*(Scirpus hudsonianus)*
Red-sheathed bulrush	*(Scirpus microcarpus)*
Lined bulrush	*(Scirpus pendulns)*
Rock spikemoss	*(Selaginella rupestris)*

Tall goldenrod	*(Solidago altissima)*
Indian grass	*(Sorghastrum nutans)*
Dropseed	*(Sporobolus vaginiflorus)*
Arrow-grass	*(Triglochin maritima)*
Flat-leaved bladderwort	*(Utricularia intermedia)*
Smaller bladderwort	*(Utricularia minor)*
Highbush blueberry	*(Vaccinium corymbosum)*
Bog cranberry	*(Vaccinium oxycoccos)*
Hobblebush	*(Viburnum alnifolium)*
Witherod	*(Viburnum cassinoides)*
Stemless blue violet	*(Viola adunca)*
Northern downy violet	*(Viola Fimbriatula)*
Northern water-meal	*(Wolffia borealis)*
Columbia water-meal	*(Wolffia columbiana)*
Water-meal	*(Wolfia punctata)*
White camass	*(Zigadenus glaucus)*
Wild rice	*(Zizania palustris)*
White camas	*(Zygadenus glaucus)*

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