NORTH SHORE WATERSHED STUDY

North Shore Watershed

Conservation Halton

March 2006

VISION STATEMENT

Our Vision for the North Shore Watershed is a healthy watershed from the Niagara Escarpment to Hamilton Harbour. We envision a watershed where the community is harmoniously connected to streams, woodlands and other natural features in a functional system and where people are engaged in protecting and enhancing the natural environment. Through education, stewardship and careful planning, there will be a place for nature and community.

Developed by the North Shore Watershed Stakeholders

ACKNOWLEDGEMENTS

North Shore Watershed Stakeholders

The following people have given their time, expertise and experience to provide the ideas and direction for the study.

Ann Balasubramaniam	University of Guelph
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Tom Brain	Burlington Golf and Country Club
Rick Craven	Councillor, City of Burlington
Paul Cripps	City of Hamilton
Bob Curry	Hamilton Naturalists' Club
Jason Fudge	Hanson Brick
Bruce Gall	Aldershot Community Council
Teresa Giangregorio	City of Burlington
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Gavin Kellogg	Tyandaga Golf Course
Philip Kelly	City of Burlington
Joan Lougheed	Councillor, City of Burlington
Ray Martin	Hanson Brick
Tom Miller	Niagara College
Ann Milovsoroff	Citizen
Kristin O'Connor	Hamilton Harbour Remedial Action Plan Office
Paul O'Hara	Holy Sepulchre Cemetery
Rob Peachey	City of Burlington
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Preparing the watershed plan involved several steps: a stakeholder committee and writing team developing the plan; the plan underwent peer review and public review through open houses; finally, municipalities endorsed the plan. The stakeholder committee represented the mosaic of interests in the watershed. Stakeholders included representatives from municipal agencies, community groups and watershed residents. The stakeholders developed their "vision" for the watershed.

The North Shore watershed is located at the western end of Lake Ontario. It encompasses an area to the east of Grindstone Creek and is located primarily within the Aldershot area of the City of Burlington. The watershed drains a 33km^2 area originating from above the Niagara Escarpment and emptying into Hamilton Harbour. The watershed contains 4 main watercourses: Falcon, Indian, Hager and Rambo Creeks. There are also several smaller, unnamed creeks and a small portion of the Roseland Creek watershed.

The North Shore is the final portion of the overall Hamilton Harbour watershed for which a study has been undertaken. Watershed studies have previously been completed for the three major creeks that drain into the Harbour: Red Hill, Spencer and Grindstone Creeks.

Physiography has determined most of the physical characteristics of the North Shore watershed. It has dictated the vegetation and land use patterns throughout the watershed. A road and transportation network, as well as several hydro utility corridors traverse the majority of the watershed. The southern areas of the watershed are mostly urban with commercial, industrial and residential development.

The majority of remaining natural areas are associated with the south slope of the Niagara Escarpment along with gullies and ravines. Natural vegetation communities cover approximately 27% of the North Shore watershed. Several provincially and/or globally significant communities are present, including tallgrass prairie, oak savannah and talus slopes. These and other communities support a number of provincially significant plant and wildlife species.

Based on fisheries, benthic, temperature and water quality sampling, the overall aquatic health of the watershed is below its potential. Remnant populations of creek chub dominated fish communities while significant diversity is only found in the lower reaches of Indian Creek.

Watershed strategies will allow the community to care for the water resources, natural heritage, settlement areas and agriculture lands of the watershed through the Planning Process (Official Plans, Secondary Plans and

Subwatershed Studies), projects on pubic lands and stewardship initiatives on private lands. Regeneration Plans for individual tributaries and strategies for implementing the watershed initiatives are presented, specifying who will be responsible for the remedial actions. Conservation Halton will serve as the lead agency and request that the various municipalities and government agencies involved adopt the recommendations and implementation strategy outlined.

Hamilton Harbour from the north shore

1.0 INTRODUCTION

Conservation Halton, in cooperation with City of Burlington and Region of Halton, has completed a two-year study to prepare a watershed plan for the creeks along the North Shore of Burlington Bay/Hamilton Harbour. The purpose of the plan is to provide a comprehensive strategy to support environmental stewardship, guide development, and recommend restoration strategies. It was developed through a community-based approach bringing together a writing team made up of staff of Conservation Halton with a group of stakeholders representing municipalities, agencies, community groups and residents who best characterized the mosaic of interests within the watershed.

The watershed study supports Conservation Halton's corporate mission "to protect the natural environment from lake to Escarpment for present and future generations." It further supports Conservation Halton's Strategic Plan "vision" which recognizes the importance of creating a healthy watershed with clean streams, vigorous forests, abundant green space and balanced growth that results in strong livable communities.

As part of the Hamilton Harbour Remedial Action Plan (RAP), watershed studies were recommended as an important component in addressing the impact of creeks on the water quality of the bay. To this end, watershed studies have been completed for the three major creeks draining into the harbour, Red Hill, Spencer and Grindstone. The North Shore is the final portion of the Hamilton Harbour watershed which had yet to have a study completed. The North Shore Watershed Study accomplishes one of the Hamilton Harbour Remedial Action Plan (RAP) recommendations and contributes to its implementation since improved conditions in the watershed are ultimately of benefit to the health of the Bay.

Indian Creek

The watershed encompasses the area to the east of the Grindstone Creek and is located primarily within the Aldershot area of Burlington (Figure 1). The watershed extends up to the creeks' headwaters located above the Niagara Escarpment in both the City of Hamilton and City of Burlington. The study area includes Falcon, Indian, and the upper portions of Hager and Rambo Creeks. Although much of the watershed is developed, it contains many significant environmental features, such as the Niagara Escarpment, Carolinian forests, old growth forest communities, and remnant prairie and oak savannah habitats.

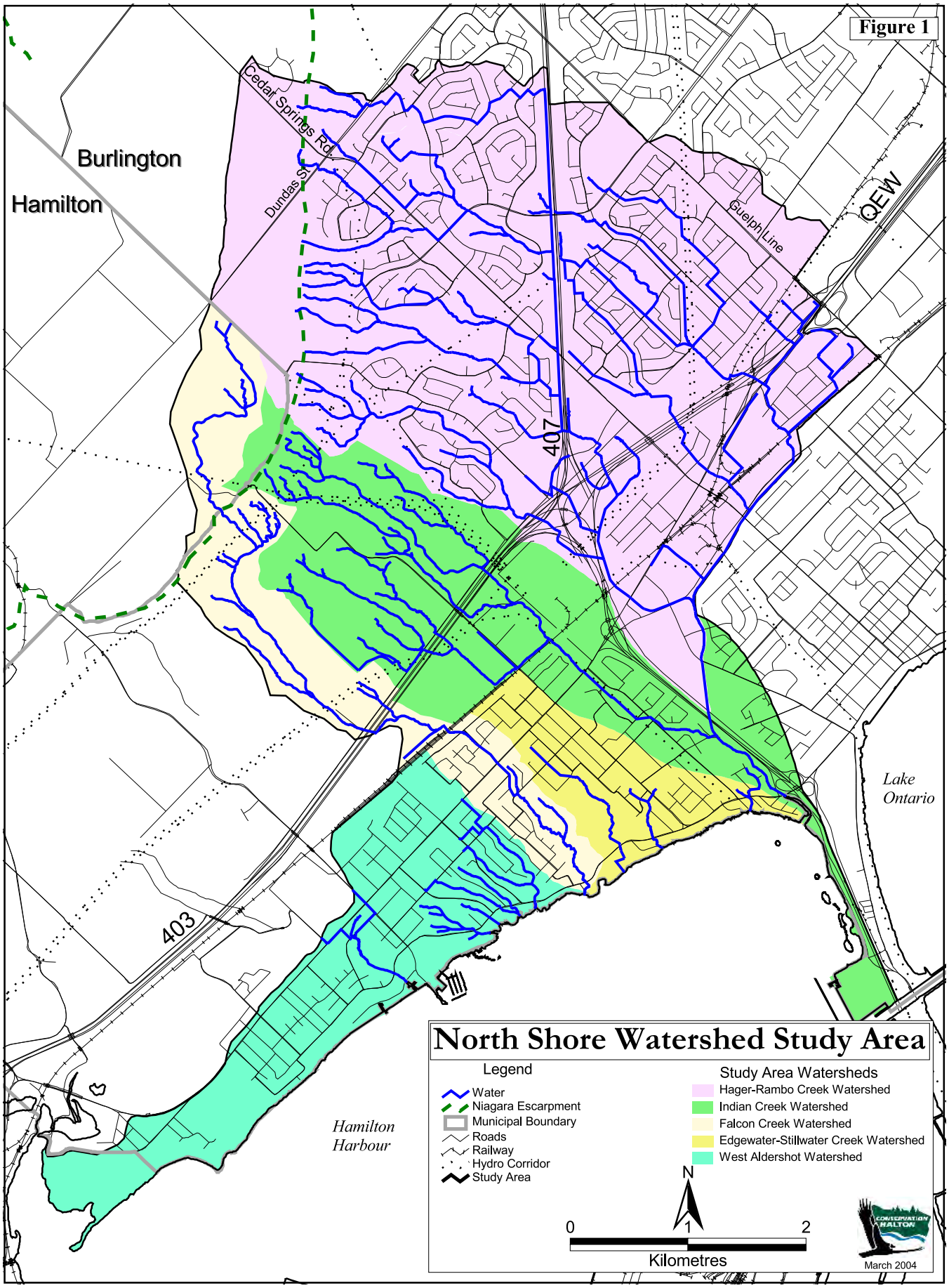


Figure 1
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
North Shore Watershed Study Area
Legend
Water
Niagara Escarpment
Municipal Boundary
Roads
Railway
Hydro Corridor
Study Area
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

Performing water sampling at Hager-Rambo diversion channel outflow

Through background data collection, field research, and public consultation, the ecological and cultural features of the watershed have been described within the watershed study. The report contains a summary of the physiography, soils, land use, cultural and natural heritage, water quality, and aquatic communities. A watershed vision was developed with input from the stakeholders group. They also participated in the development of regeneration strategies for the watershed.

Watershed strategies are proposed which allow the community to care for the watershed through the planning process (official plans, secondary plans and subwatershed studies), initiatives on public lands, and through public education and stewardship. Regeneration plans for individual tributaries and strategies for implementing the watershed initiatives are presented. They specify who will be responsible for the various remedial actions. Conservation Halton will serve as the lead agency for implementing the North Shore Watershed Study. It is requested that the municipalities and government agencies involved endorse the plan and adopt the various recommendations and implementation strategies as outlined.

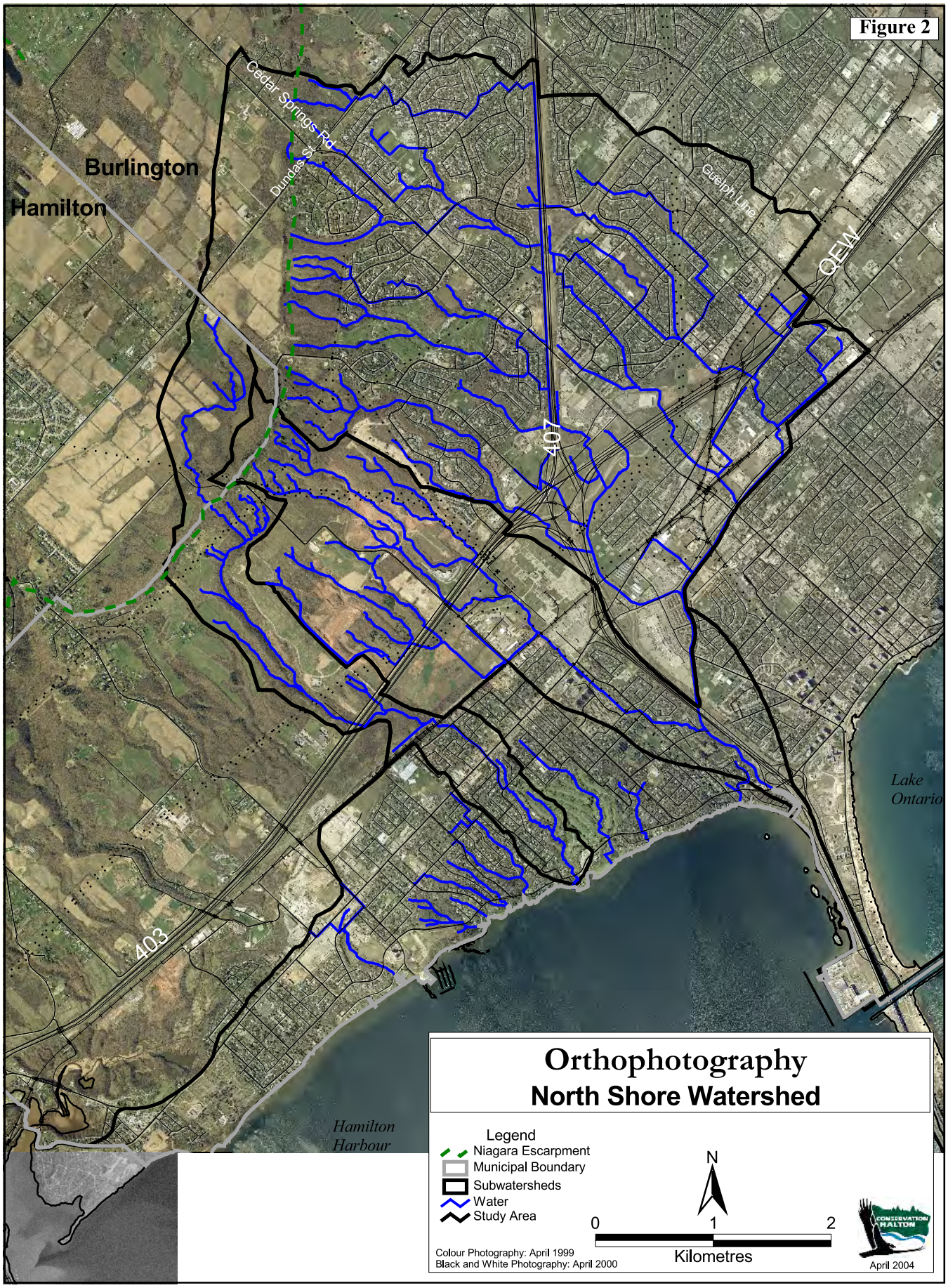


Figure 2
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
403
Lake Ontario
Hamilton Harbour
Orthophotography
North Shore Watershed
Legend
Niagara Escarpment
Municipal Boundary
Subwatersheds
Water
Study Area
N
0
1
2
Kilometres
Colour Photography: April 1999
Black and White Photography: April 2000
April 2004

2.0 WATERSHED CHARACTERIZATION

2.1 Location and Description of the North Shore Watershed

The North Shore watershed is located on the north shore of Hamilton Harbour at the western end of Lake Ontario. The creeks in the watershed originate from above the Niagara Escarpment and empty into Hamilton Harbour on its north shore. The majority of the watershed is located in the City of Burlington with a small portion of the headwaters of Falcon, Indian and Hager Creeks located in the recently amalgamated City of Hamilton (Figures 1 and 2). The total area of the North Shore watershed is about 33 km^2.

The watershed contains four larger watercourses and their associated watersheds (Figure 2). Falcon Creek originates above the Niagara Escarpment and flows down the lower slopes through gullies and ravines until it discharges into Hamilton Harbour at the Burlington Golf and Country Club. The drainage area of the Falcon Creek watershed is approximately 3.6 km^2.

East of the Falcon Creek watershed is the Indian Creek watershed. Indian Creek has two headwater tributaries that originate above the Escarpment on either side of King Road. Indian Creek empties into Hamilton Harbour at Indian Point. The drainage area of the Indian Creek watershed upstream of its confluence with the Hager-Rambo Diversion Channel is approximately 6 km^2.

Between Falcon and Indian Creeks is the Edgewater-Stillwater Creek watershed. This small, urbanized watershed also drains portions of the Burlington Golf and Country Club and is approximately 1.7 km^2.

Holy Sepulchre Cemetery in the West Aldershot Watershed

Both Hager and Rambo Creeks have two distinct headwater branches that originate on the south slope of the Escarpment near the intersection of Brant Street and Dundas Street (formerly Highway 5) and flow south toward Lake Ontario before being intercepted by Highway 407. Downstream of Highway 407, drainage is intercepted by the Hager-Rambo Diversion Channel. The Hager-Rambo Diversion Channel in turn confluences with Indian Creek at Greenwood Drive. The Hager-Rambo watershed also includes input from Highway 407 storm water management facilities. The total drainage area of the Hager/Rambo watershed that drains into Hamilton Harbour is about 17 km^2.

To the west of Falcon Creek and south of Highway 403 are several small, unnamed creeks draining to Hamilton Harbour that make up part of the West Aldershot watershed. The catchment area for these creeks is 4.4 km^2.

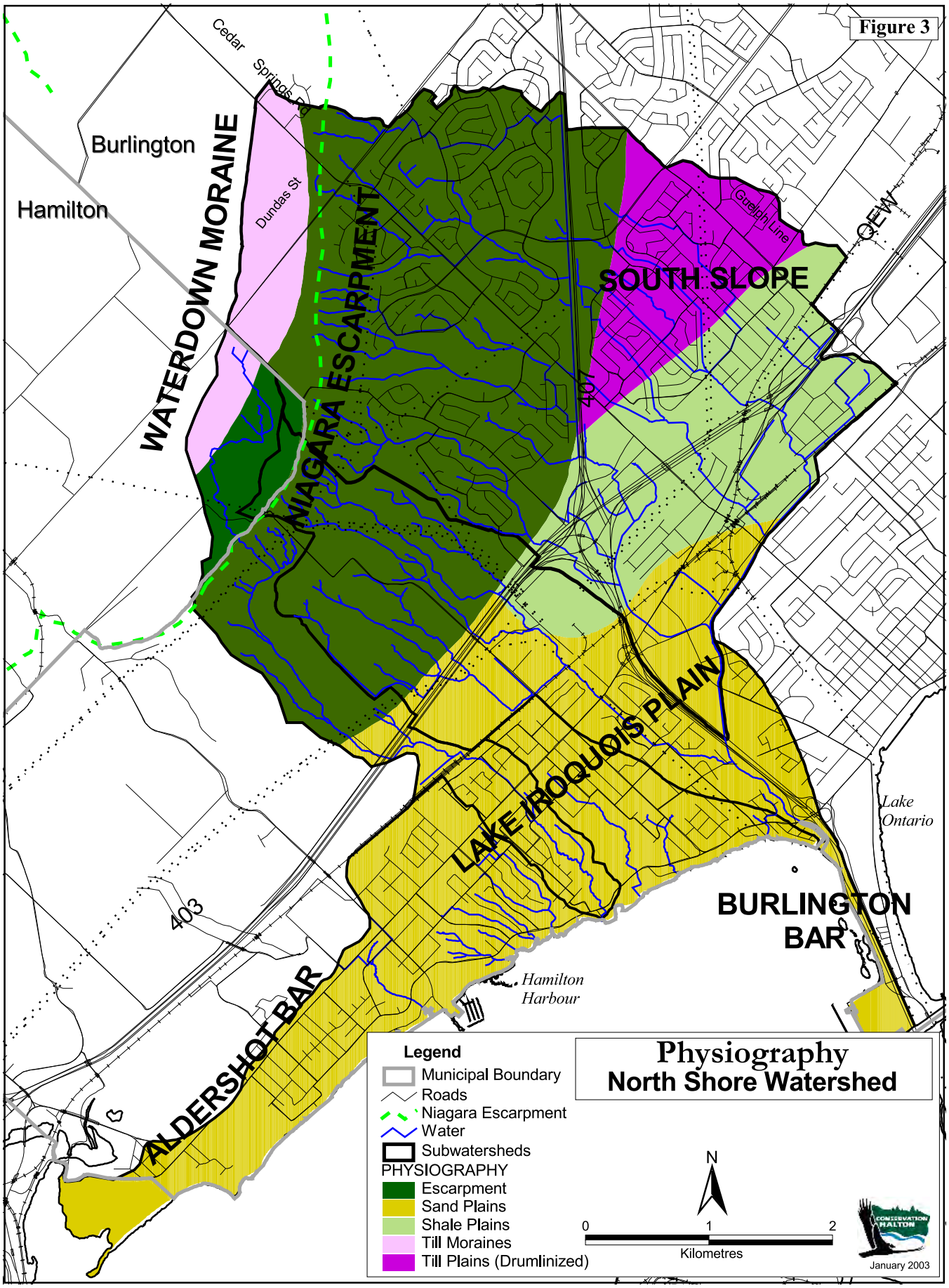


Figure 3
Cedar Springs Rd
Burlington
Hamilton
WATERDOWN MORAINE
Dundas St
NIAGARA ESCARPMENT
SOUTH SLOPE
Guelph Line
QEW
LAKE IROQUOIS PLAIN
Lake Ontario
BURLINGTON BAR
Hamilton Harbour
ALDERSHOT BAR
403
Legend
Municipal Boundary
Roads
Niagara Escarpment
Water
Subwatersheds
PHYSIOGRAPHY
Escarpment
Sand Plains
Shale Plains
Till Moraines
Till Plains (Drumlinized)
Physiography
North Shore Watershed
N
0
1
2
Kilometres
January 2003

A small portion of Roseland Creek lies within the North Shore watershed. Intermittent flows emanate from the Niagara Escarpment north of Highway 5 but are enclosed a short distance downstream of Highway 5 beneath a subdivision. At Highway 407, flows are diverted west through an enclosure beneath Highway 407 to the east branch of Hager Creek. The flows are intermittent in upper reaches of Roseland Creek. Intermittent flows and extensive channel alterations/enclosures preclude significant aquatic habitat within this portion of the Roseland Creek watershed.

2.2 Climate

Climate is a major factor that determines the character of the watershed and its biota. The climate of the North Shore watershed is primarily determined by its latitude, longitude and proximity to Lake Ontario. The centre of the watershed is about 43° 19′ meridian of north latitude and 79° 49′ meridian of west longitude. The creeks empty into Hamilton Harbour in the City of Burlington and extend approximately 7 km inland, originating above the Niagara Escarpment.

The watershed contains two climatic regions: the Lake Erie Counties region and the South Slopes region. The Lake Erie Counties region is modified by Lake Ontario and consists of a narrow band along the shoreline of Hamilton Harbour. Most of the area is urbanized. The South Slopes region is found in the upper portions of the watershed below the Niagara Escarpment. The moderating effect of Lake Ontario is the most significant climatic influence on the lower reaches of the watershed, while the Niagara Escarpment is the most significant influence in the upper reaches.

Climatic data from the watershed demonstrates the gradual decrease in mean annual temperature, length of the growing season and length of the frost-free period as one moves away from the lake. The mean annual temperature is 7.8°C in the Lake Erie Counties region and 6.7°C in the South Slopes region. Similarly the length of the growing season varies from 202 days to 205 days and length of the frost-free period from 147 days to 155 days.

Ice Fishing on Hamilton Harbour

The average annual precipitation in the watershed is approximately 760 mm, falling at the rate of about 63 mm per month, with roughly 122 mm falling as snow. Runoff is more variable than precipitation and amounts to between 20% and 50% of the precipitation, averaging about 35% or 280 mm. The incidence of runoff varies seasonally with as much as 75% of the runoff occurring from late February to late April and as little as 2% of the annual runoff occurring from July through late September.

2.3 Physiography and Surficial Geology

With the exception of the Hager-Rambo Diversion Channel, local and regional physiography has determined the physical extent of the North Shore watershed. In all parts of the watershed, physiography is intricately linked to its hydrology and hydrogeology. Physiography (Figure 3) is also the driving force that has dictated vegetation and land use patterns throughout the watershed.

Niagara Escapment at Kerncliff Park

The underlying bedrock within the watershed consists of three geological formations that overlie each other. The oldest unit is the Queenston formation, consisting of red shale, which extends from Lake Ontario to the Niagara Escarpment. Thin sequences of sandstone, dolostone and shale units, known as the Clinton and Cataract Groups, are present on the Escarpment slopes between the Queenston formation and the Amabel formation, which provides the Escarpment cap rock in the eastern portion of the watershed. A significant transition in cap rock from Amabel dolomite to Lockport dolomite occurs as one moves east to west along the Escarpment slopes within the North Shore watershed (Axon, 1989). These formations developed in an ocean environment approximately 400 to 500 million years ago.

The Wisconsinan Glaciation that receded from southern Ontario 10,000 to 12,000 years ago prominently shaped the surficial physiography of the watershed. Repeated advances and retreats of the glaciers resulted in the deposition of sediments over the bedrock. Within the North Shore watershed, sediments were plastered over the bedrock as till, deposited as moraines at glacial termini or formed coarse-grained beach deposits along the shores of glacial lakes. The physiographic regions within the North Shore watershed are described below.

2.3.1. Waterdown Moraine

The Waterdown Moraine consists of ridges of stoney till which were deposited at the edge of glacial Lake Warren by the Ontario ice lobe. Overlying the Flamborough Plain to the south of Mount Nemo and west of Medad Valley, the southernmost ridge of the moraine forms a watershed divide between Grindstone Creek and the North Shore watershed and drains to the headwaters of creek systems from Falcon Creek to Rambo Creek. Soils consist of clay loams. Land use is predominantly agricultural with some forest cover also associated with this feature.

2.3.2. Niagara Escarpment

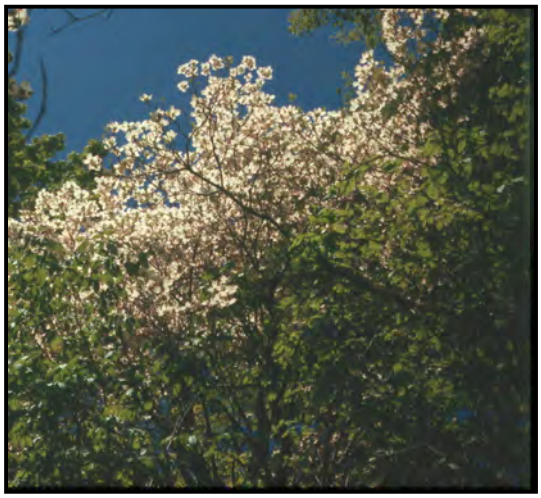
The Niagara Escarpment is the most prominent physical feature within the North Shore watershed. Formed by the differential erosion of the softer Queenston shale bedrock and the hard

Amabel/Lockport dolostone cap rock formations, the Escarpment bisects the central and eastern portions of the watershed from east to west. The Cataract and Clinton groups form the face and talus slopes of the Escarpment (Axon, 1989).

Mantled slopes associated with the Escarpment continue south of the talus slopes to approximately Highway 403. A thin veneer of fine-textured Halton Till typically covers the underlying Queenston Shale. Steep, narrow ravines associated with Falcon, Indian, Hager and Rambo Creeks dissect these slopes. The Bayview Landfill (1941 to 1972) and Burlington Landfill (1972 to 1988) sites and the licensed Hanson Brick quarries lie within the area between Sassafras Woods and urban Burlington.

This section of the Escarpment (Dundas Valley to Kerncliff Park) represents one of the few Escarpment faces with a southern aspect. This southern aspect, combined with the Escarpment's proximity to Lake Ontario, provides a relatively warm microclimate that supports nationally, provincially and regionally rare Carolinian flora and fauna.

The steep, rugged terrain of the Niagara Escarpment is generally unsuited for agriculture or other development. A thin layer of well-drained Farmington loam is present between the Escarpment brow and the clay loams of the Waterdown Moraine. As well, Falcon Creek tributaries above the Escarpment provide the necessary conditions for the formation of karst topography within this physiographic region. Cracks and fissures in the bedrock are found in close proximity to the brow of the Escarpment.



Flowering Dogwood a common shrub found in a Carolinian Forest

Large tracts of provincially and regionally significant forest cover and occasional wetlands are the dominant features within this physiographic region. Three of the four Environmentally Sensitive Areas (ESAs) found within the watershed are associated with the Niagara Escarpment.

Groundwater discharge emanating from the base of the Escarpment cliffs provides the headwater source for Indian Creek, Falcon Creek, Hager Creek and Rambo Creek. These watercourses are characterized by high gradients with elevations falling markedly from the Escarpment brow to Highway 403/ Queen Elizabeth Way (QEW) with average slopes in excess of 3% (M.M. Dillon Limited, 1979).

2.3.3. South Slope

The South Slope physiographic region lies between the Niagara Escarpment and the Iroquois Plain (described below)

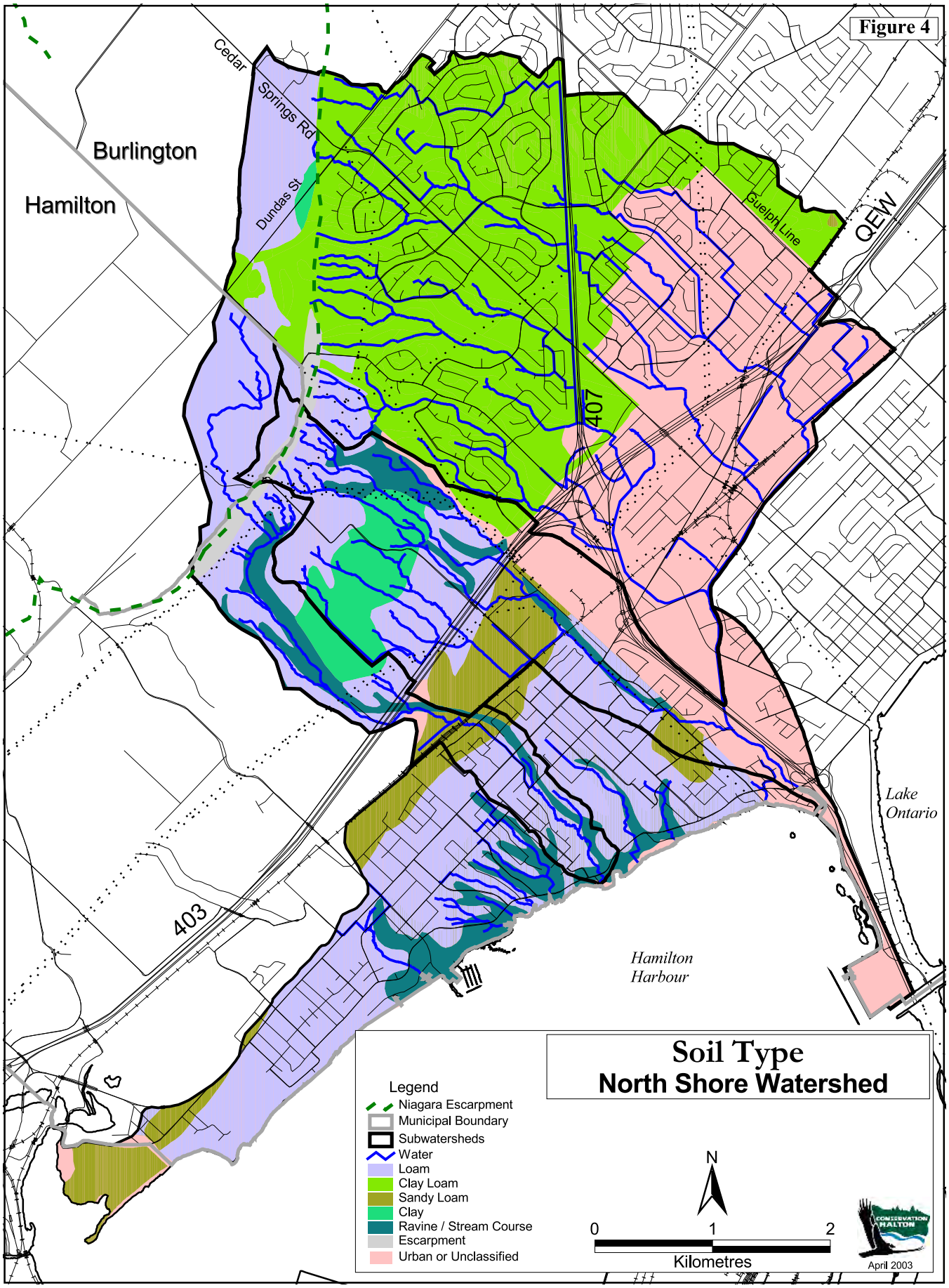


Figure 4
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Soil Type
North Shore Watershed
Legend
Niagara Escarpment
Municipal Boundary
Subwatersheds
Water
Loam
Clay Loam
Sandy Loam
Clay
Ravine / Stream Course
Escarpment
Urban or Unclassified
N
0
1
2
Kilometres
April 2003

and is underlain by the soft red shale of the Queenston Shale formation which consists of highly fractured, thinly bedded, red clay shale with occasional bands of grey limestone running parallel to the Lake Ontario shoreline. Numerous valleys have been incised into the bedrock by postglacial and fluvial erosion. Soils are dominated by clayey/silty loam till and topographic relief is generally low. The characteristic fine-textured soils and extensive clearing of vegetation over this feature limit groundwater recharge. Creeks within the Hager-Rambo watershed are located within the South Slope physiographic region.

2.3.4. Iroquois Plain

The Iroquois Plain was formed as a feature of the postglacial shoreline of Lake Iroquois when water levels were significantly higher than the present Lake Ontario. Wave action resulted in the formation of a distinct bluff cut into the underlying Queenston Shale (Holysh, 1995).

A sloping plain approximately 3 kilometres in width that extends from Hamilton Harbour to Highway 403 dominates the physiographic region located within the North Shore watershed. The Aldershot Bar, a narrow, wave-built bar consisting of cemented beach gravels, extends approximately 4.5 kilometres from Carroll's Point east-northeast along Highway 403 to Gallagher Road (Heagy, 1993). This bar forms a drainage divide between the North Shore watershed (south) and the Grindstone Creek watershed (north).

Steep bluffs approximately 25 metres in height located along the north shore of Hamilton Harbour characterize the Iroquois Plain. The plain is located in the western portion of the North Shore watershed. With the exception of these bluffs and a series of deep, narrow ravines, this feature has been largely urbanized.

The well-drained, sandy soils likely supported a mosaic of open oak woodland, oak savannah and tall grass prairie prior to settlement (Goodban *et al.*, 1999). In the late 1800's, the area was converted to orchards and market gardening; however, much of this area is now urbanized. Though not as steep as the Escarpment tributaries, Indian, Edgewater-Stillwater, Falcon and West Aldershot Creeks typically display high gradients.

2.4 Soils

The soils of the North Shore watershed are largely derived from glacial and glaciofluvial deposits that in turn have acquired their matrix from the shale bedrock (Figure 4). The action of wind and water has reworked these deposits to produce local concentrations of silt and clay. They can vary locally with the effects of drainage, the presence of vegetation, and the time available for soil development. Soils are derived from silty clay tills and local outcrops of red shale that weathers rapidly.

The predominant surface deposits within Rambo Creek and the headwaters of Indian and Falcon Creeks are clay loams overlying bedrock of the Queenston formation (Dillon Ltd., 1981). The red clay silts associated with the area are derived from weathering of the underlying Queenston shale bedrock. The Queenston shale formation consists

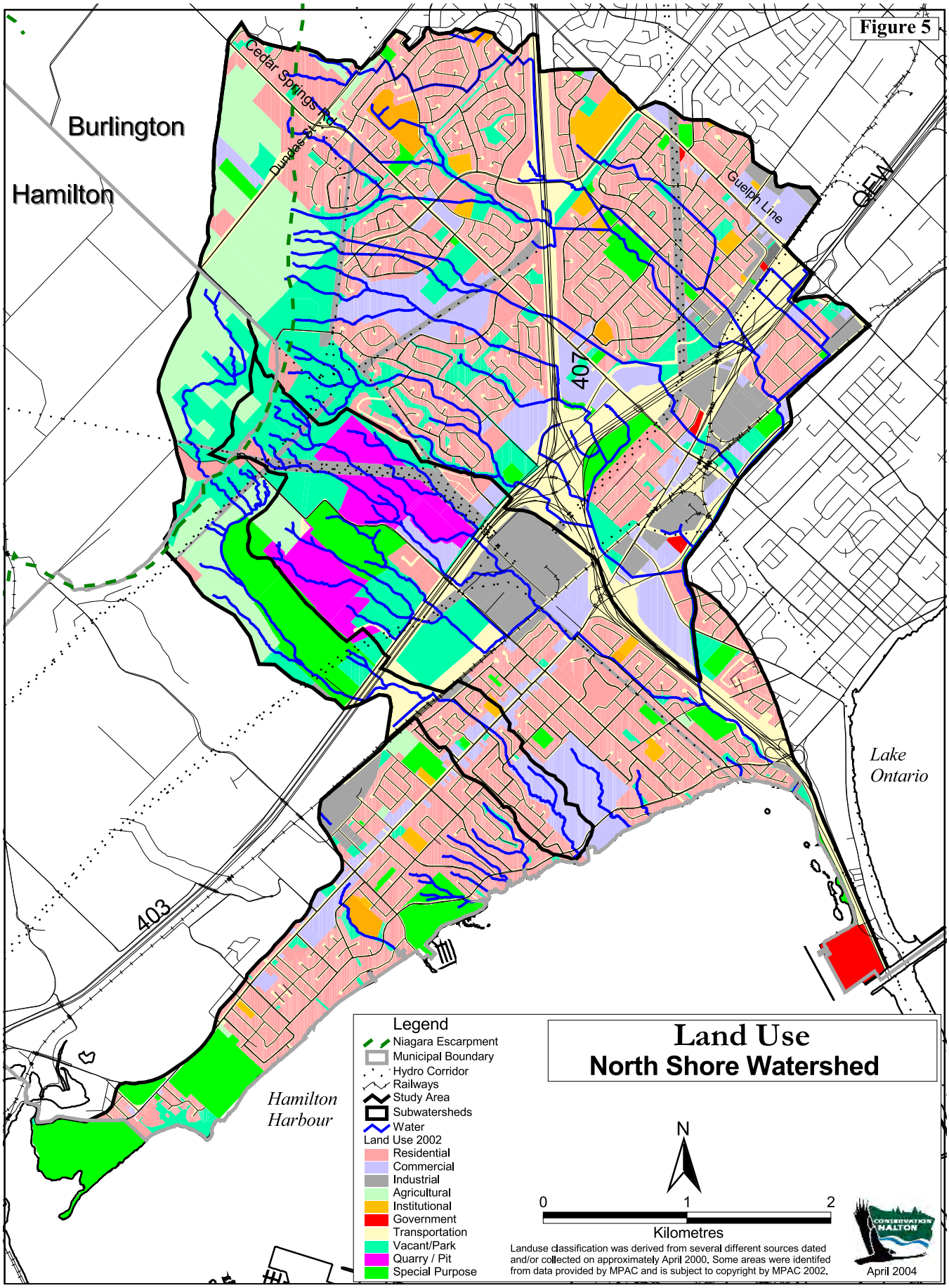


Figure 5
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Legend
Niagara Escarpment
Municipal Boundary
Hydro Corridor
Railways
Study Area
Subwatersheds
Water
Land Use 2002
Residential
Commercial
Industrial
Agricultural
Institutional
Government
Transportation
Vacant/Park
Quarry / Pit
Special Purpose
Land Use
North Shore Watershed
N
0
1
2
Kilometres
Landuse classification was derived from several different sources dated and/or collected on approximately April 2000. Some areas were identifed from data provided by MPAC and is subject to copyright by MPAC 2002.
CONSERVATION HALTON
April 2004

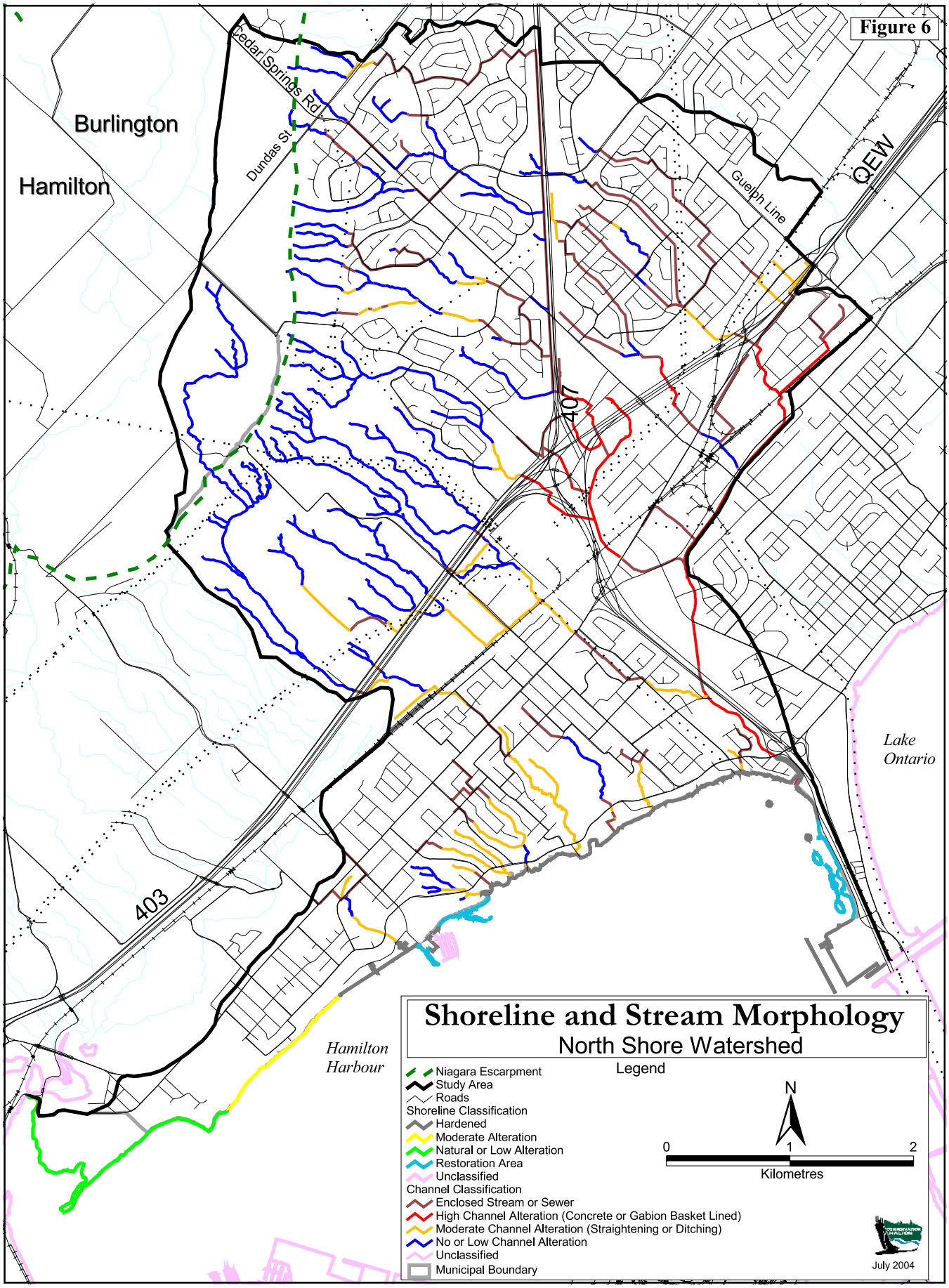


Figure 6
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Shoreline and Stream Morphology
North Shore Watershed
Legend
Niagara Escarpment
Study Area
Roads
Shoreline Classification
Hardened
Moderate Alteration
Natural or Low Alteration
Restoration Area
Unclassified
Channel Classification
Enclosed Stream or Sewer
High Channel Alteration (Concrete or Gabion Basket Lined)
Moderate Channel Alteration (Straightening or Ditching)
No or Low Channel Alteration
Unclassified
Municipal Boundary
N
0
1
2
Kilometres
July 2004

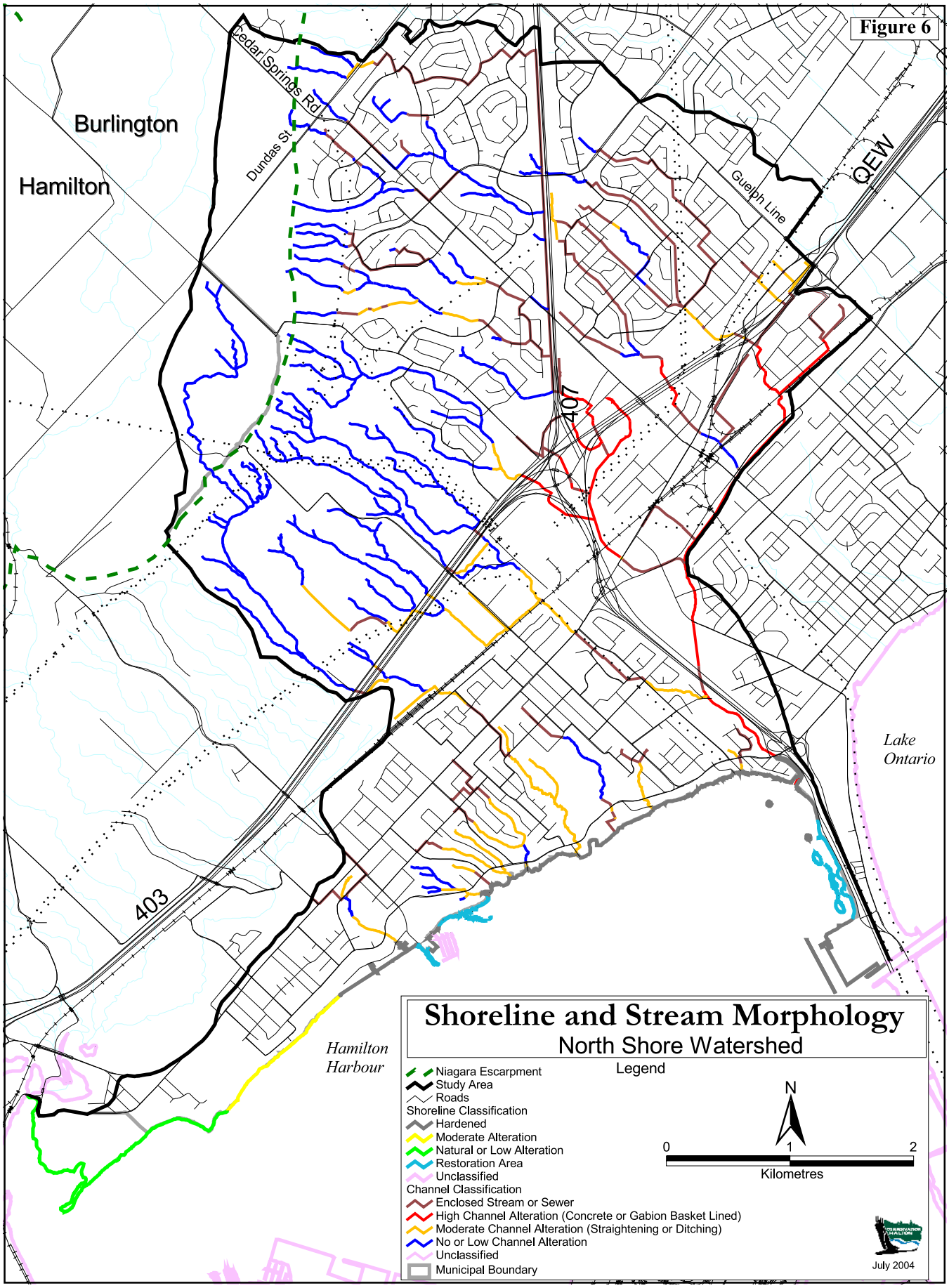


Figure 6
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Shoreline and Stream Morphology
North Shore Watershed
Legend
Niagara Escarpment
Study Area
Roads
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Natural or Low Alteration
Restoration Area
Unclassified
Channel Classification
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High Channel Alteration (Concrete or Gabion Basket Lined)
Moderate Channel Alteration (Straightening or Ditching)
No or Low Channel Alteration
Unclassified
Municipal Boundary
N
0
1
2
Kilometres
July 2004

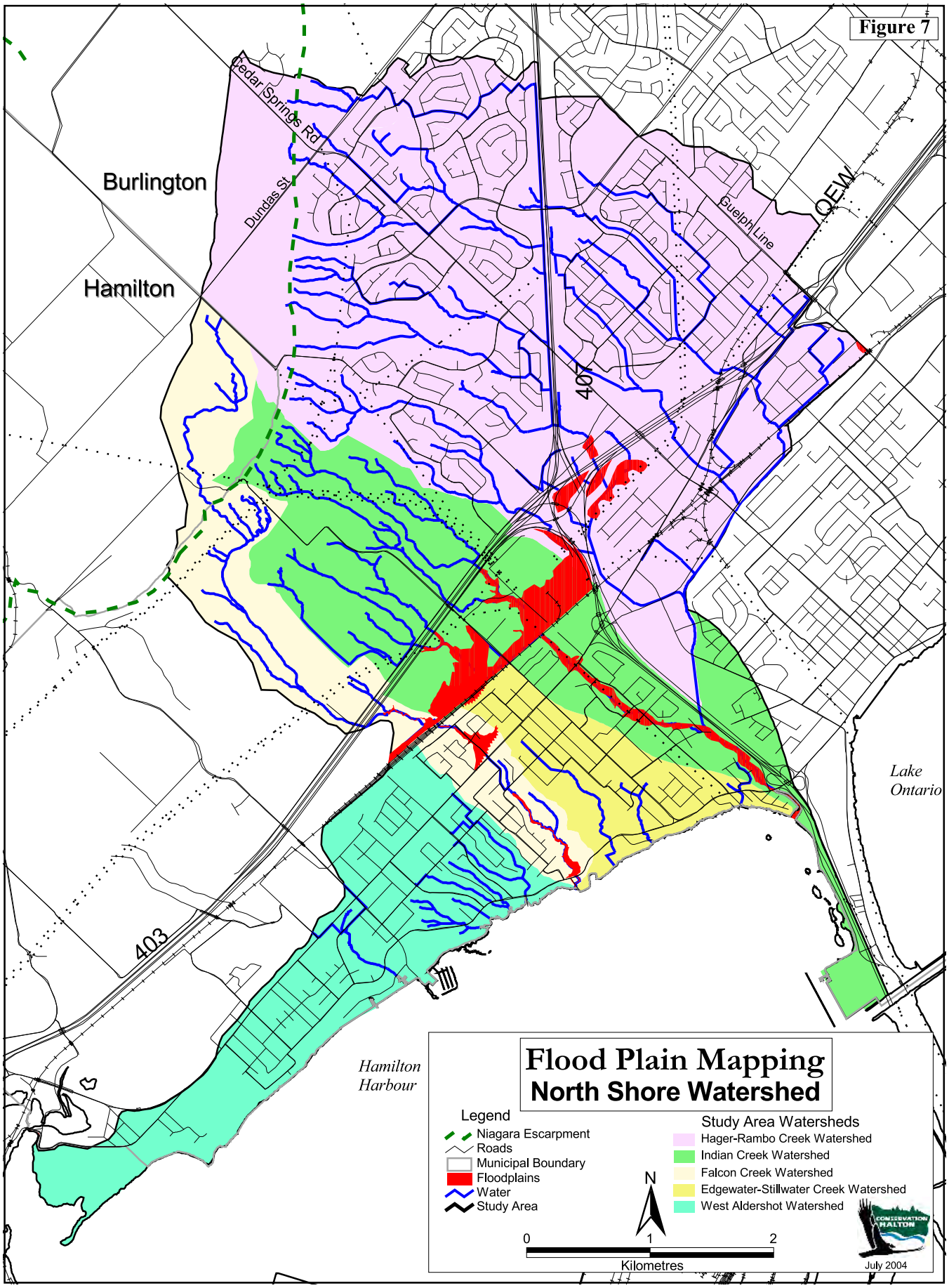


Figure 7
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Flood Plain Mapping
North Shore Watershed
Legend
Niagara Escarpment
Roads
Municipal Boundary
Floodplains
Water
Study Area
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
July 2004

of thinly bedded red clay shale with occasional bands of gray limestone. Imperfectly drained and well-drained sandy loams dominate the soils of the lower reaches of Indian and Falcon Creeks. The streambeds of the watershed are characterized by gravel and boulder beds accompanied by the accumulation of muck in local floodplains.

2.5 Land Use

The majority of the North Shore watershed is characterized as being in a mature stage of urban development (Figure 5). Several major transportation corridors including Highway 403, Highway 407, the QEW and main east-west and north-south CN/GO Transit rail lines traverse it. In addition, there is a fully developed municipal road transportation network, and a major hydro utility corridor that also traverse the watershed.

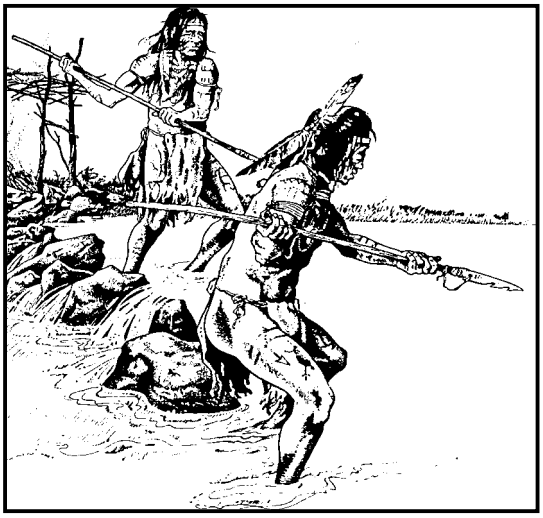
Land use includes industrial, commercial, recreational and residential components. South of Plains Road and east of Kerns Road, the watershed is mostly urban with commercial, industrial and residential development. Shale extraction and brick manufacturing are major land uses in the watershed in the vicinity of King Road. One former quarry is located on the east side of Kerns Road at the brow of the escarpment. This site is now owned by Conservation Halton and managed by the City of Burlington as Kerncliff Park. Between Plains Road and Highway 403, west of King Road some open space remains. The majority of remaining natural areas are associated with the south slope of the Niagara Escarpment and the gullies and ravines, particularly between King Road and Waterdown Road. This area also contains two closed landfill sites, the former Burlington and Bayview Landfill Sites.

Urbanization and the demand for development within the watershed have altered the natural state of the shoreline and many of the tributaries and creeks (Figure 6). Due to this urbanization, avenues of infiltration have been removed and urbanized areas have become subject to more intense and flashy runoff events. During spring runoff and large storm events the lower portions of the watercourses may be susceptible to flooding. The flood plain associated with the regional storm has been modelled for Indian Creek and is shown on Figure 7.

2.6 Ecological and Cultural Heritage

About 14,000 Before Present (BP), the Wisconsinan ice sheet began its final retreat from southern Ontario, leaving behind a legacy of till plains, moraines, drumlins, eskers, glacial spillway valleys and kettle lakes. Soil formation began on denuded landscapes through the sorting of parent materials by wind and water erosion and through biological processes (Larson *et al.*, 1999). Several unique physical features, including the Niagara Escarpment, the Iroquois Shoreline and the Iroquois sandbar, characterize the landscape. The sand deposits were formed thousands of years ago when water from the proto-Lake Erie basin flowed through the Dundas Valley into glacial Lake Iroquois. The depositional actions of this river formed a great sandbar, at Burlington Heights while a baymouth barrier gradually developed as the Hamilton-Burlington Beach (Cramin and Adams, 1995).

Vegetation developed in response to the prevailing climate and developing soils. The first postglacial vegetation communities were dominated by tundra species such as arctic willows, alders, grasses and sedges, buffalo berry, silver berry and mountain avens. The herb-dominated tundra was succeeded by shrub communities that, in turn, gave way to a boreal spruce woodland that was well established by 12,500 BP (Larson *et al.*, 1999). Mammals such as woolly mammoth, American mastodon, *Torontoceras* (a large, caribou-sized deer), giant beaver, musk-ox and caribou inhabited the landscape (Theberge, 1989).



Woodland Fishermen

With continued warming, the spruce-dominated forests declined and were replaced by jack and red pine forests. White pine forests were prevalent by 9,000 BP. Several large mammal species including woolly mammoth, American mastodon, *Torontoceras* and giant beaver became extinct during this period, possibly as a result of rapid climate change and increased human predation (Theberge, 1989).

Upland forests were gradually colonized by present-day dominant species such as oaks, sugar and red maple, hickories, white pine, ironwood and black cherry. Soft maples, ashes and poplars dominated lowland sites. Over the past 8,000 years, changes in the relative abundance of these species have occurred as a response to environmental changes and competitive interactions (Larson *et al.*, 1999).

Within the context of the North Shore watershed, a significant change in vegetation communities occurred between 6,000 years BP and 4,000 years BP. Warmer, drier climatic conditions, prevalent during this period, resulted in the extension of the Great Plains prairies into southwestern Ontario and into the North Shore watershed. A mosaic of prairie, savannah and open oak-hickory woodlands developed over well-drained sandy soils in present-day Aldershot and on thinly-mantled south-facing slopes below the Escarpment (Goodban *et al.*, 1999).

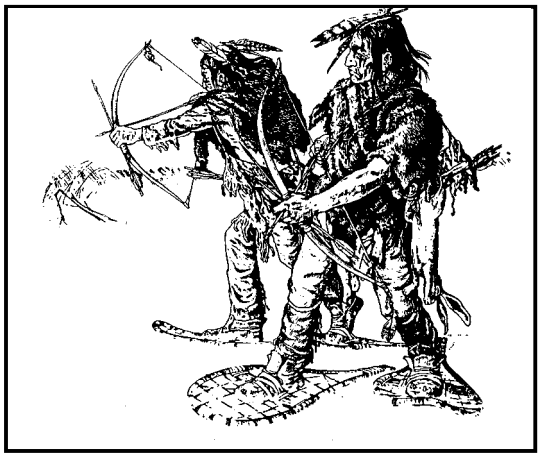
Larger mammals requiring large tracts of forest cover such as black bear, marten, fisher, wolverine, timber wolf, lynx, elk and eastern cougar colonized the area and were present within the watershed prior to European settlement. It is likely that Atlantic salmon and brook trout were plentiful within Indian Creek and possibly other North Shore tributaries.

The watershed was also inhabited by First Nations cultures. At first small bands of Archaic Indians hunted and fished in the watershed. Centuries later, the indigenous people adopted the bow and arrow and ceramic technology. These hunter-gatherers moved about the now-forested watershed according to the

seasons – from spring fishing near the beach strip (called "daonasedao" meaning "where the sand forms a bar"), to summer hunting grounds in the open oak savannah, to fall passenger-pigeon roosts, and on to the winter deer yards above the Escarpment. Trade routes linked the watershed to neighbouring territories. Unique flint points, stone pipes and clay pots were expressions of their culture. Around 1500 BP, the inhabitants of the watershed began experimenting with agriculture. Growing maize, gourds and squash, meant dependable food supplies and a more sedentary lifestyle. Permanent villages replaced temporary encampments.

The woodland cultures had a sophisticated social and political community where both men and women took prominent roles. They had entrenched religious beliefs and lived in permanent villages with long houses for up to 20 related families. Proficient farmers, they lived mostly on the crops they grew - the 'three sisters' (corn, beans and squash) as well as sunflowers for trade and tobacco for ceremonies. Hunting for elk, deer and bison, fishing for Atlantic salmon and sturgeon and foraging for nuts and berries supplemented their basic diet.

The aboriginal cultures and the watershed ecology started to change with the coming of Europeans. The first documented European visitor to the watershed was Étienne Brulé in 1616. The French explorer LaSalle and several missionaries visited the watershed on September 18, 1669. A description of the area from the late 19th century gives us an idea of what the area might have looked like to the early Europeans: "When the beach was first seen by white man it was exceedingly beautiful and picturesque. It was overgrown with immense basswood, interspersed by large oaks and willows throughout the Beach. And the wild grapes luxuriously wound its thongs among them." (Ghent Papers, 1890)



Winter Hunters

Competition around the fur trade, an increasing dependence on European trade goods and introduced diseases eventually undermined the Woodland cultures to the point where they collapsed and the populations were dispersed. During the later 17th and early 18th centuries, the Seneca Nation used the area for hunting, fishing and trapping but it probably remained largely unoccupied. By the mid 18th century, the Mississauga First Nation occupied the watershed.

The American Revolution initiated a period of momentous change. To compensate the fleeing Loyalists and forestall American incursions, the British began buying tracts of land from the Mississauga First Nation. Initially, all of the land from the Niagara River to Burlington Bay was purchased from the Mississaugas. In 1805, all of the remaining land from Burlington Bay to the Humber River was acquired. Settlers

slowly began taking up the lots, clearing the forests, building cabins and changing the face of the watershed. In 1791, there were 31 families and by 1823, there were approximately 1,000 residents.

Partly as a result of border skirmishes following the Revolutionary War, and partly because of Governor Simcoe's vision of London as the future capital of Ontario, in 1793 British troops began construction of a roadway, known as the Dundas Highway, through the watershed to link York with Niagara-on-the-Lake and southwestern Ontario. It was kept well back from the lakeshore, to prevent marauding attacks from American sailors and marines and to avoid the swamps and marshes that extended across the area. In 1794, The King's Head Inn was built on the beach to act as an inn to travelers and a depot for military provisions and troops.

Drawing Lots

In these very early days, the area around the watershed was called Head-of-the-Lake or by the township name of Barton. Hamilton Harbour was first called Lake Mecassa, then Lake Geneva and then Burlington Bay.

John Ryckman, born in Barton, described the area as he remembered it: While perhaps not entirely accurate, it provides a brief glimps of the lands as the first settlers saw them. "The [watershed] in 1803 was all forest. The shores of the bay were difficult to reach or see because they were hidden by a thick, almost impenetrable mass of trees and undergrowth. Bears ate pigs, so settlers warred on bears. Wolves gobbled sheep and geese, so they hunted and trapped wolves. They also held organized raids on rattlesnakes on the mountainside. There was plenty of game. Many a time have I seen a deer jump the fence into my back yard, and there were millions of pigeons which we clubbed as they flew low."

An important figure of the watershed in the early days was Chief Joseph Brant. By all measures he was one of the most charismatic personalities of 19th century Canada. Cultured and politically astute, Brant was leader of the powerful Six Nations peoples. His loyalty to the Crown during the upheavals of the American Revolution earned him an audience with King George in London and, in 1798, the deed to over 1,400 hectares (3,450 acres) of lakefront property in the heart of the North Shore watershed that continues to be known as Brant's Block. The area included the land on which the hospital and museum, bearing his name, are now located.

Following his death in 1807, Brant's land was sold for settlement and became Wellington Square. An early developer of Brant's land, Joseph Gage, is thought to be responsible for so honouring the Duke of Wellington. The other hero of the time, Lord Nelson, inspired names for communities in the area such as Palermo and Trafalgar, as well as for the new Township of Nelson, established in 1792 by a Royal Act.

Samuel Wilmot first surveyed the Township in June 1808. Wilmot mapped and surveyed the area north from the lake as far as two concessions north of Dundas Street (NDS). The balance of the Township had to wait until 1819 for surveyor Rueben Sherwood, who surveyed the lots in a different manner, running their lengths perpendicular to Wilmot's.

Surveying the Watershed

The Burlington area escaped any major involvement in the War of 1812. Soon after the last battles were over, settlers began to take advantage of the peace and the availability of land in Nelson Township to begin homesteading.

Although hampered by the primitive conditions and extensive forests, settlement gradually advanced. Hardy pioneers were drawn to the area by the promise of good land and unlimited opportunities. Land was cleared for farms and mills were built to take advantage of the local terrain. Accepting the land, however, brought with it duties and responsibilities. According to a Location Ticket, dated December 1825, in exchange for awarding 100 acres of land in Nelson Township to a Robert Bates, the settler was to "clear and fence five acres for every 100 acres granted; build a dwelling house of 16 feet by 20; and clear one-half of the road in front of each lot" - all within two years. Soon the scattered pioneers attracted merchants and mills that became the focal points of new communities.

One of the earliest settled areas was Aldershot, where Alex Brown, a Waterdown resident, relocated and built a wharf at LaSalle Park. The site of Brown's Wharf eventually became known as Port Flamborough and had an important effect on the agricultural and commercial development of the area.

Much of Brant's Block extending from west of Indian Point to Brant Street was cleared at this time. Some pioneers took advantage of the more open prairie habitat in Aldershot. Many of the settlers were Late Loyalists leaving the United States. Among them were the Ghents, wealthy plantation owners from North Carolina. Legend has it that many of the local apple trees were begun from seeds of Ghent trees in North Carolina.

Other early pioneers like the Kerns settled in the watershed. Many of the families who were attracted to the Aldershot area are familiar to us today in the names of streets such as Unsworth Avenue, King Road and Job's Lane. One influential family, the Filmans, arrived in the late 18th century, opening land along the shore from King Road to Indian Point. Avid bird-lovers, the Filmans are commemorated by "Birdland," the housing development

with street names such as Finch, Lark, Tanager and Oriole.

By the 1830's the area was experiencing considerable prosperity. There was an easily navigable and protected harbour, accessible through the new canal cut in 1827. Emigrants were arriving in ever-increasing numbers and many chose to stay here rather than continue on. They brought in new industry and prospering commercial interests.

19th Century Logging

Throughout Nelson Township new communities were springing up at cross-roads and near mills and port facilities. Wellington Square grew from a cluster of 16 houses in 1817 to an impressive 400 inhabitants by 1845, when it could boast of a doctor, taverns, churches, and regular boat travel to Hamilton. During the early 1830's, Port Nelson welcomed the first rector of St. Luke's Anglican Church, Dr. Thomas Greene, as a resident. Natives of Ireland, Dr. Greene and his wife, brought seedlings of their favourite plants with them - in this case, Mrs. Greene's prize roses. The Irish roses flourished, inspiring the name that the area is known by to this day: Roseland.

It was the burgeoning grain and lumber trade that boomed for the next thirty years that made Wellington Square something of a focal point. Grain and lumber handling, ship building and maintenance, and other trades attracted workers to the Lakeshore area stretching from Port Nelson to the Aldershot shoreline. Their arrival generated other services and the people to provide them - physicians, foundries, taverns, bakeries, wagon makers, tinsmiths, grocers, dry goods merchants, and on and on.

As the narrow tracks through the bush became roads, there were other significant advances included regular stagecoach services to Hamilton and Toronto. Frame houses replaced log cabins. General stores and blacksmith shops sprung up in communities like Aldershot. Families such as the Fishers, Coulsons and Eagars prospered from the sale of wheat and timber.

As the influx of settlers swelled, forest clearing and prairie/savannah conversion associated with agriculture increased, as did the need for saw and grist mills. The dams associated with these mills prevented fish species, such as Atlantic salmon, from reaching upstream spawning areas. The degradation of aquatic habitat associated with dam construction and deforestation, combined with over harvesting, resulted in the decline of fisheries within the watershed and Hamilton Harbour. The Atlantic salmon runs in the Credit River (and likely the North Shore tributaries) were largely depleted by 1855 and the species was considered extirpated from the Lake Ontario watershed in 1896 (Imhof, 2003).

By the mid-1800's, Nelson Township could boast of 17 saw mills, all water-powered and all generating hamlets around them, such as Kilbride, Lowville and Zimmerman. Most of the timber was marked for export, and when grain carts weren't lined up along Guelph Line and Brant Street waiting for the ships, lumber carts were. Lower-grade wood was cut and sold as fuel for the many steamers plying up and down the Great Lakes. Timber destined for local use required yards and dealers, and there were several large lumberyards in Port Nelson and Wellington Square at the time.

Early Saw Mill

By the time of Confederation over fifty percent of the forests had been cut down. Subsistence farming had given way to mixed farming. Wheat became the dominant cash crop and livestock were raised for sale. Parallel with the strong grain industry, lumbering continued to be an important part of Wellington Square's commercial life in the mid-1800's. Cutting down trees not only provided much-needed timber to construct homes and ships, as well as opening the land for agriculture.

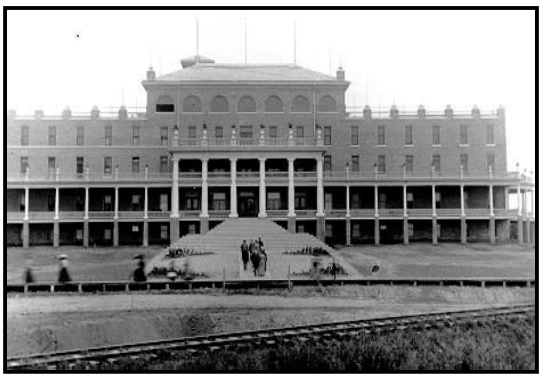
Forest clearing led to significant changes in the extent of forest cover within the watershed. As a result of clearing activities, forests that had covered much of the watershed, were gone. Loss of forest habitat combined with over harvest led to the extirpation of at least eight species of mammals (black bear, marten, fisher, wolverine, timber wolf, lynx, elk, eastern cougar) from the watershed.

The North Shore watershed lay in the heart of the nesting area for the passenger pigeon. Although numbers of passenger pigeon populations fluctuated widely, very large numbers were noted in the nearby Sixteen Mile Creek watershed in 1860 (Dept. of Commerce and Development, 1960). The last large flights in Halton County were reported in 1869 and 1870 with numbers declining rapidly thereafter as a result of habitat loss (loss of hardwood forest and associated beech nut food sources) and over-harvest (Dept. of Commerce and Development, 1960). It is unlikely that the passenger pigeon persisted past the turn of the century in the North Shore watershed. The last known sighting of the passenger pigeon in Ontario was in 1902 (Theberge, 1989).

Massasauga and timber rattlesnakes were common prior to European settlement and likely persisted until at least 1900 when loss of habitat and persecution resulted in their extirpation from the watershed. Father Galinee described encounters with rattlesnakes on the Escarpment that were “as thick as one’s arm, six or seven feet long, entirely black” (Thwaites, 1906), which appears to confirm the presence of timber rattlesnakes in the area.

With all of the established services, plus the convenience of transportation via

steamer, stage and rail (the railroad arrived in 1854) in 1873 the 800-odd residents petitioned to have Wellington Square incorporated as a village, with its name changed to Burlington.



Brant Hotel c.1915

Burlington in the late 1800's was a prosperous community typical of southern Ontario. The village extended from the lakeshore on the south to the apple orchards north of Caroline Street. At the foot of Brant Street, high-masted schooners sailed in from far away destinations such as Kingston, Montreal and Windsor. In the summer sun, boys would sit on the wharves and watch the stevedores at work, while the sound of hammers on hot steel rang from the blacksmith shops and the rattling wheels of the afternoon coach from Hamilton echoed along the road. In good weather, excursions lasting a full day might be made to visit the strawberry and melon fields of Aldershot, or the water-powered mills at Dakota, Lowville or Kilbride.

During the latter half of the 19th century, as Canada's wheat production moved westward, local farmers shifted to other crops. Thanks to the Ghents and their North Carolina seeds, apples had become a dominant local product. Vegetable farms flourished in the mild climate and the rich soils. For many years Burlington area orchards shipped vast quantities of the fruit to England and South Africa through Port Nelson. To the west of town, the sandy soil of Aldershot was especially suitable for melons, and the term "Aldershot melon" grew as familiar as "P.E.I. potato" or "B.C. apple" is today.

The original Brant home was still standing in 1875 when it was incorporated into a summer resort known as Brant House. Here, amid twenty acres of gardens, croquet lawns, ice cream parlours and dance halls, Brant House attracted tourists who relished the view out over Lake Ontario and the cool breezes that wafted off the water. Eventually the Hotel Brant was built adjacent to the Brant House and became one of the outstanding attractions of its time, with elevators, electric lights, fancy dining and expensive room rates starting at an impressive $2.50 per day and up.

The Burlington area changed considerably over the next twenty-five years. On the farms, steam and then gasoline-powered equipment replaced men and horses. With the shift in agriculture toward fresh produce, local farmers relied more on fruit production as their major income source, and larger orchards were developed.

Local farmers not only experimented with different plant varieties and new growing techniques, but also entered their produce in competitions around the world. By the turn of the century, Burlington fruits and vegetables were winning honours at exhibitions in Paris, Glasgow and Chicago, and Burlington had acquired the title of "The Garden of Canada."

Around 1900, the Burlington Canning Company, later called Canadian Canners, was constructed at the foot of Brant Street expressly to pack local produce. For decades afterwards, the

Aldershot Fruit Farm c.1920

lower Brant Street area functioned with the scent of tomato ketchup in everyone's nostrils almost every working day. Another canning firm, Tip Top Canners, operated for many years in Freeman near the Plains Road and Brant Street intersection. The Glover Basket Works was a successful company from the 1890's to the mid 1960's, with its large premises facing Brant Street near the railroad crossing.

An era of scientific invention and rapid mechanization changed the watershed in other ways. The milling industry was mostly gone and the commercial fishery was declining in Lake Ontario. But the telegraph, railways and a steadily improving regional road network all extended contact with Hamilton, Guelph and Toronto. The Radial Line - actually a form of streetcar service - provided convenient and comfortable travel between Hamilton and Burlington, extending east as far as Oakville. In the 1930's, the Queen Elizabeth Way was constructed through part of the watershed.

Between the wars, Burlington began to change from an agricultural community to a prime residential area - a hint of the explosive growth to come in the late 1950's. During this period impressive homes were established in Roseland, east of Guelph Line, and major roads were paved, encouraging the more widespread use of automobiles.

The watershed continued to prosper with many local businesses still water-based. Boat builders filled local orders and sailboats flourished during the summer. During the winter, ice boats sped across the Harbour. Residents swam in the summer and skated in the winter, and fishermen enjoyed year-round angling opportunities. In the winter the icehouses sent their teams out on the Harbour to cut ice. Big companies filled their ice sheds along the waterfront. One ice firm in the 1920's prided itself on cutting 4 tons of ice per minute for a total of 2,000 tons of ice daily.

The years following World War II brought many changes. Rapid population growth and a demand for housing brought the biggest change. Regional growth meant Aldershot became part of Burlington. The role of farming declined as whole farms were converted to suburban development. In Aldershot, the unusual soil spawned gravel, brick and clay sewer pipe operations.

In recent years growing public concern has started to address the loss of natural

areas, pollution in the creeks and Hamilton Harbour and exploitation of the Niagara Escarpment. Environmental awareness led to the designation of parts of the watershed as Environmentally Sensitive/Significant Areas (ESAs) and Areas of Natural and Scientific Interest (ANSIs). Programs like Carolinian Canada were created to help protect the vestiges of that increasingly rare forest zone. The Bay Area Restoration Council and the Bay Area Implementation Team are addressing water quality and related issues through the Hamilton Harbour Remedial Action Plan. A renewed appreciation for the value of the lakeshore has begun to transform the lands around Hamilton Harbour, including those in the North Shore watershed.

The North Shore Watershed Study presents an opportunity for the current residents of the watershed and the surrounding area to provide input in helping to determine the future of their watershed. It is intended to help guide them in translating their vision for the watershed into strategies and actions that will recognize and preserve the best of their natural and cultural heritage while allowing for continued growth, prosperity and opportunity for their future.

Aldershot fruit shipped by rail

3.0 NATURAL HERITAGE

The Natural Heritage section of the report identifies and describes the natural heritage features within the watershed through the integration of background literature review and field studies conducted in support of the North Shore Watershed Study. The elements of the existing natural heritage system are discussed, followed by an assessment of ecosystem trends and opportunities for restoration and enhancement within the watershed. This section concludes with a discussion of potential habitat protection and enhancement guidelines and recommendations for improving terrestrial, wetland and aquatic habitats and linkages within the North Shore watershed.

3.1 Previous Studies

The Natural Heritage Section builds upon a number of studies that have previously been conducted within the North Shore watershed. These studies include Area of Natural and Scientific Interest (ANSI) reports, Environmentally Sensitive/Significant Area (ESA) reports, recent studies of rare species, biological inventories of Conservation Halton properties and consultant studies.

Two keystone studies form the framework for the Natural Heritage Section: *A Bio-physical Inventory of the Niagara Escarpment and Grindstone Creek Public Open Space Areas* (Axon *et al.*, 1989) and the *Ecological Survey of the Niagara Escarpment Biosphere Reserve* (Riley *et al.*, 1996).

A Bio-physical Inventory of the Niagara Escarpment and Grindstone Creek Public Open Space Areas (Axon *et al.*, 1989) assesses the biophysical features and functions within the Public Open Space Areas identified in the Parkway Belt West Plan between Highway 403 and Dundas Street.

The *Ecological Survey of the Niagara Escarpment Biosphere Reserve* (Riley *et al.*, 1996) provides a comprehensive summary of the many biological inventories and research studies that have been conducted along the Niagara Escarpment (including the Parkway Belt West Plan area), including the provincially significant Life Science ANSI within the North Shore watershed. This report reflects the best available scientific information on natural areas within the biosphere reserve and the current principles of conservation biology as they relate to natural areas.

3.2 Natural Feature Designations

Several natural features within the North Shore watershed have been designated as significant natural areas through international, federal, provincial and regional planning policies. The Parkway Belt West Plan, a World Biosphere Reserve, one Carolinian Canada site, Areas of Natural and Scientific Interest (ANSIs) and Environmentally Sensitive/Significant Areas (ESAs) occur within the watershed. No wetlands meeting the criteria for designation as provincially significant wetlands have been identified within the watershed.

There is significant overlap of designations associated with some of these features (e.g. the Sassafras Woods

ESA is also part of an ANSI and is a Carolinian Canada site). This section provides an overview of these designations including: definition, designation criteria and figures showing the location of these natural features within the watershed. An overview of individual ANSIs and ESAs is also provided. This section provides additional detail with regard to vegetation communities, wildlife and corridors while Appendix 1 provides a listing of rare flora and fauna within the North Shore watershed.

Goldenrod

3.2.1 Parkway Belt West Plan/Niagara Escarpment Biosphere Reserve

Much of the watershed in the vicinity of the Niagara Escarpment falls within the Parkway Belt West Plan (PBWP), a provincial plan established in 1978 prior to the Niagara Escarpment Plan (NEP) to identify and implement public open space and utility corridor requirements (Axon *et al.*, 1989). Lands outside of the designated areas are subject to development restrictions and important natural features must be maintained within these areas.

Niagara Escarpment Plan Amendment 71 has transfered the Escarpment Link Area, PBWP into the Niagara Escarpment Plan. The Escarpment Link Area consists primarily of the brow and steep slopes of the Escarpment that lie within the PBWP.

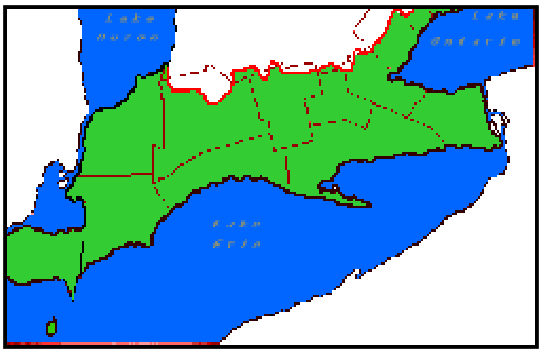
Once finalized, these lands would become part of the Niagara Escarpment World Biosphere Reserve. In 1990 portions of the Niagara Escarpment Plan Area were designated as a Niagara Escarpment Biosphere Reserve by UNESCO (United Nations Educational, Scientific and Cultural Organization). It is one of six such reserves in Canada. World Biosphere Reserves are selected to represent the world's most important ecosystems and they are intended to act as demonstration areas for both the conservation of biological diversity and the promotion of environmentally appropriate development (Riley *et al.*, 1996). The Niagara Escarpment has been designated on the basis of its ecological, cultural and scientific importance.

3.2.2 Carolinian Canada Site

In 1984 the Nature Conservancy of Canada and the World Wildlife Fund formed Carolinian Canada to identify and develop a regional protection program for the most important natural habitat areas in the Carolinian Zone (Duncan, 1989). Thirty-eight priority protection sites have been identified under this program.

Sassafras Woods ESA has also been designated as a Carolinian Canada site. This 126 hectare property consists of deciduous forest intersected by four deep ravines. Tablelands and valley rims

support significant oak and oak-hickory woodlands with savannah affinities. Mesic areas near the base of the ravines support a number of rare Carolinian flora. Much of Sassafras Woods lies within the Grindstone Creek watershed to the west; however, a significant valley system associated with Falcon Creek lies within the North Shore watershed. This valley system provides an important linkage with forested Escarpment communities to the north.



Carolinian Ecosystem In Southern Ontario

3.2.3 Areas of Natural and Scientific Interest

Areas of Natural and Scientific Interest (ANSI's) are defined as "areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study, or education" (Province of Ontario, 1997). The Ontario Ministry of Natural Resources has identified a number of Life Science and Earth Science ANSIs as part of a program "to identify areas which best illustrate unique and representative biological and physical features" within Ontario (Riley *et al.*, 1997).

Life Science ANSIs are significant representative elements of Ontario's bio-diversity and natural landscapes and include specific types of forests, valley, prairies and wetlands, their native plants and animals, and their supporting environments. They contain relatively undisturbed vegetation and landforms, and their associated species and communities (Riley *et al.*, 1997). Earth Science ANSIs consist of some of the most significant representative examples of the bedrock, fossil and landform record of Ontario and include examples of ongoing geological processes.

Provincially significant ANSIs include the most significant and best examples of the natural heritage features in Ontario. Regionally significant sites, which do not meet provincially significant criteria due to lesser importance, greater degree of disturbance and/or duplication of features, are significant at a regional level and often complement the provincially significant sites. At a local level, Sites of Biological Significance have been identified. These sites have been investigated but are deemed to be of local biological significance only (Gould, 1989).

The Provincial Policy Statement states that provincially significant ANSIs are to "be protected from incompatible development"; however, development and site alteration may be permitted in these areas if it can be "demonstrated that there will be no negative impacts on the natural features or on the ecological functions for which the area is identified". Similarly, development and site alteration may be permitted on adjacent lands if it can be demonstrated that no negative impacts will occur (Province of Ontario, 1997).

Provincially significant Life Science ANSIs have been designated as Core Natural Areas and Greenlands B within the Hamilton-Wentworth Natural Heritage System (NHS) (Regional Municipality of Hamilton-Wentworth, 1998) and Halton Region Official Plan (Regional Municipality of Halton, 1995), respectively. Regionally significant Life Science ANSIs have been designated as Linkages with the Hamilton-Wentworth NHS and as Greenlands B within the Halton Region Official Plan. Provincially and regionally significant Earth Science ANSIs have been designated as Linkages within the Hamilton-Wentworth NHS.

Tallgrass Prairie at Grove Park

Two provincially significant ANSIs (1 Life Science and 1 Earth Science) and one regionally significant Earth Science ANSI are located within the North Shore watershed (Figure 8). In addition, six Sites of Biological Significance have been identified. A description of the provincially and regionally significant ANSI sites and a listing of the Sites of Biological Significance are provided below.

Provincially Significant ANSIs

Sassafras-Waterdown Woods

Formerly separated into two ANSIs, Sassafras Woods and Waterdown Escarpment Woods have been merged into a single Life Science ANSI to reflect their close proximity and linkages. Sassafras-Waterdown Woods is considered the best remaining example of Niagara Escarpment shale slope upland forest in Site District 7-3 and is noteworthy for its assemblage of nationally, provincially and regionally significant flora, including a number of species with Carolinian and prairie-savannah affinities. The south-facing Escarpment slopes are dissected by four major stream valleys and many smaller tributaries resulting in a combination of alternating plateau and ravine systems (Varga and Jalava, 1992). Sassafras Woods has also been designated as a Carolinian Canada site and as an ESA.

Waterdown Escarpment Woods lies just north of Sassafras Woods along the Niagara Escarpment and is separated from Sassafras Woods by a narrow field and power-line corridor. Above the Escarpment, this feature supports a high diversity of vegetation including mature upland broadleaf woods, successional habitats, a broadleaf swamp and a rare white cedar (*Thuja occidentalis*)-red oak (*Quercus rubra*) community. A significant south-facing talus slope forest lies below the Escarpment cliffs and supports several rare Carolinian species.

Old Nelson Quarry

Extraction of dolostone from this abandoned quarry within Kerncliff Park has exposed the stratigraphy of the Niagara Escarpment, providing an opportunity to view the bedrock sequences. A narrow band of Rochester shale underlies the thick Amabel cap rock. This, in turn, is underlain by the Irondequoit and Reynales dolomitic formations. The Thorold sandstone formation forms the quarry floor. This Earth Science ANSI represents the most southerly exposure of the Amabel formation and represents the southern edge of the Algonquin Arch influence. The exposures of these formations, combined with abundant fossils within the dolostone, offer an excellent interpretive opportunity along the quarry face (Landplan, 1987).

Regionally Significant ANSIs

Waterdown Moraines (MNR 1983-A)

This Earth Science ANSI is located north of the brow of the Niagara Escarpment on the watershed divide between the North Shore and Grindstone Watersheds. The Waterdown Moraine is a terminal moraine feature characterized by gently rolling topography and tight clay tills.

Sites of Biological Significance

The following are sites of biological significance within the North Shore watershed (Gould, 1989):

Carroll's Point (Hamilton Harbour ESA)
West of Hendrie Valley (Woodlands Cemetery, Hamilton Harbour ESA)
Willow Point (Hamilton Harbour ESA)
Aldershot Park (LaSalle Park, Hamilton Harbour ESA)
Kerns Road Woodlot (Kerncliff Park, Waterdown Escarpment Woods ESA)
Nelson Escarpment Woods (Nelson Escarpment Woods ESA)

ESA descriptions are provided in Section 3.2.4.

3.2.4 Environmentally Sensitive / Significant Areas

The Regional Municipality of Halton and City of Hamilton (formerly Hamilton-Wentworth Region) have identified a number of areas which are deemed significant by virtue of their biophysical attributes and which are protected from adverse impacts through their respective Official Plans. These areas are referred to as Environmentally Sensitive Areas (ESAs; Halton Region) and Environmentally Significant Areas (ESAs; City of Hamilton). Four ESAs are found within the North Shore watershed (Figure 9). The rationale for ESA designation in each jurisdiction and a general description of ESAs are provided below.

Regional Municipality of Halton

A natural area/feature within Halton Region must fulfill one or more of the eleven primary criteria established by the region to evaluate candidate ESA (Geomatics International Inc., 1995). The list of primary and secondary criteria, as set out in the Regional Municipality of Halton Official Plan (1995), is provided below.

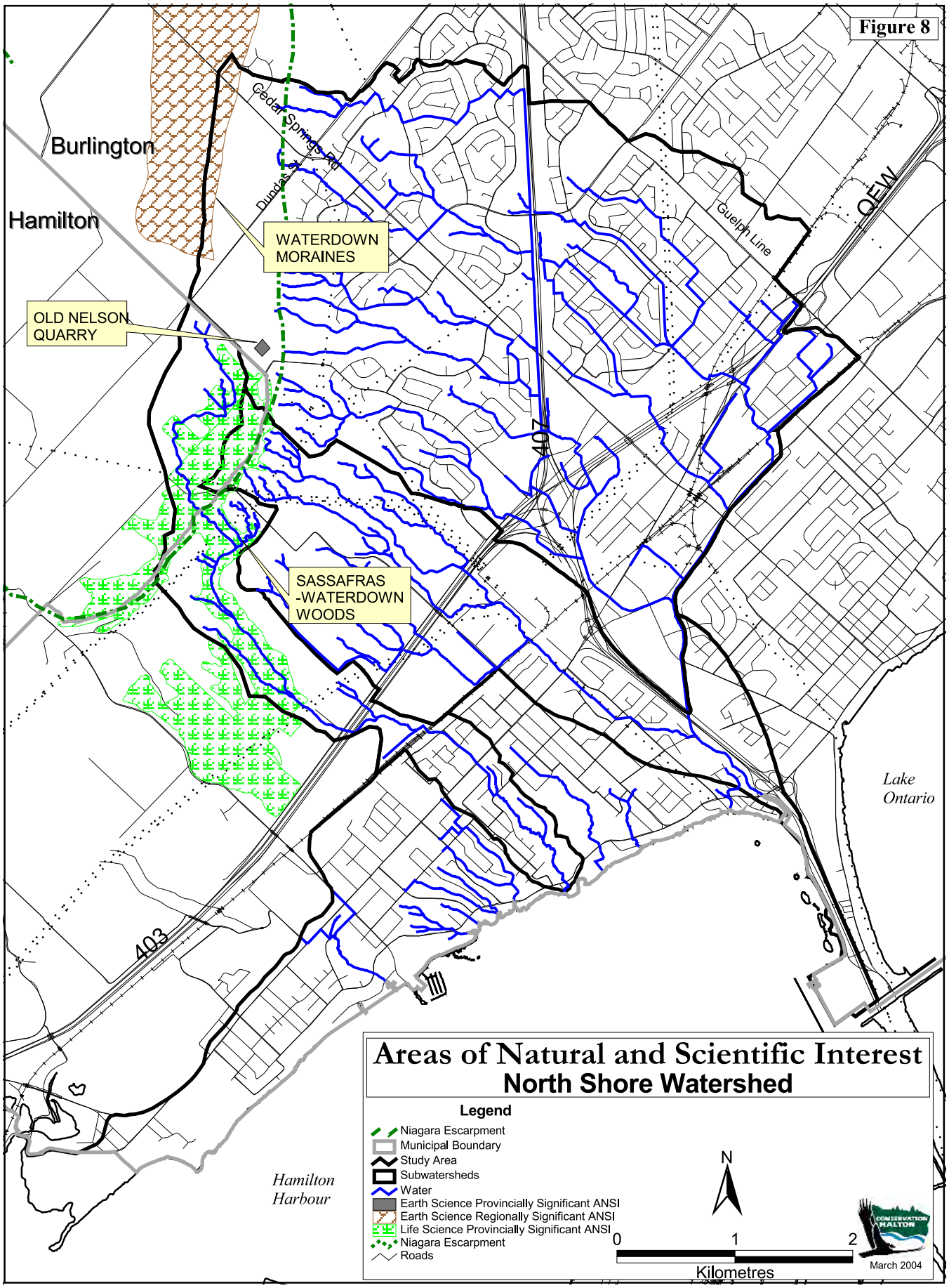


Figure 8
Burlington
Hamilton
Dundas St
Cedar Springs Rd
WATERDOWN MORAINES
OLD NELSON QUARRY
SASSAFRAS -WATERDOWN WOODS
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Areas of Natural and Scientific Interest
North Shore Watershed
Legend
Niagara Escarpment
Municipal Boundary
Study Area
Subwatersheds
Water
Earth Science Provincially Significant ANSI
Earth Science Regionally Significant ANSI
Life Science Provincially Significant ANSI
Niagara Escarpment
Roads
N
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Kilometres
March 2004

Primary Criteria

1. Areas that exhibit relatively high native plant and/or animal species richness in the context of Halton Region.
2. Areas that provide links to two or more adjacent natural systems.
3. Areas that contain a relatively high number of native plant communities in the context of Halton Region.
4. Areas that contain large (in a regional context), relatively undisturbed expanses of natural, native plant communities.
5. Areas that contain remnant native plant communities that are rare within Halton Region or that are not represented in other ESAs.
6. Areas that contain plant and/or animal species that are rare provincially or nationally.
7. Areas that contain earth science features and/or processes typical of those that were instrumental in creating Halton's landscape.
8. Areas that are determined to contribute significantly to local and/or regional groundwater recharge.
9. Areas that are determined to be significant groundwater discharge areas.
10. Areas that contribute significantly to groundwater quality.
11. Areas that contribute significantly to maintaining surface water quality.

Secondary Criteria

12. Areas that contain regionally rare plants.
13. Areas that contain high quality assemblages of native plant and/or animal species.
14. Areas that are recognized as highly aesthetic themselves or that provide designated viewpoints.
15. The location of the area, combined with its natural features, makes it particularly suitable for scientific research and conservation education purposes.

ESAs within Halton Region have been designated as Greenlands B within the Regional Official Plan (1995). Where other designations apply to an ESA, such as provincially significant wetlands, and flood plains, the more protective Greenlands A designation applies.

City of Hamilton (formerly Regional Municipality of Hamilton-Wentworth)

The former Regional Municipality of Hamilton-Wentworth has recently been incorporated within the City of Hamilton; however, the ESA policies and designations have been defined within the Regional Municipality of Hamilton-Wentworth Official Plan (1998). According to the Official Plan, ESAs within Hamilton-Wentworth consist of areas which:

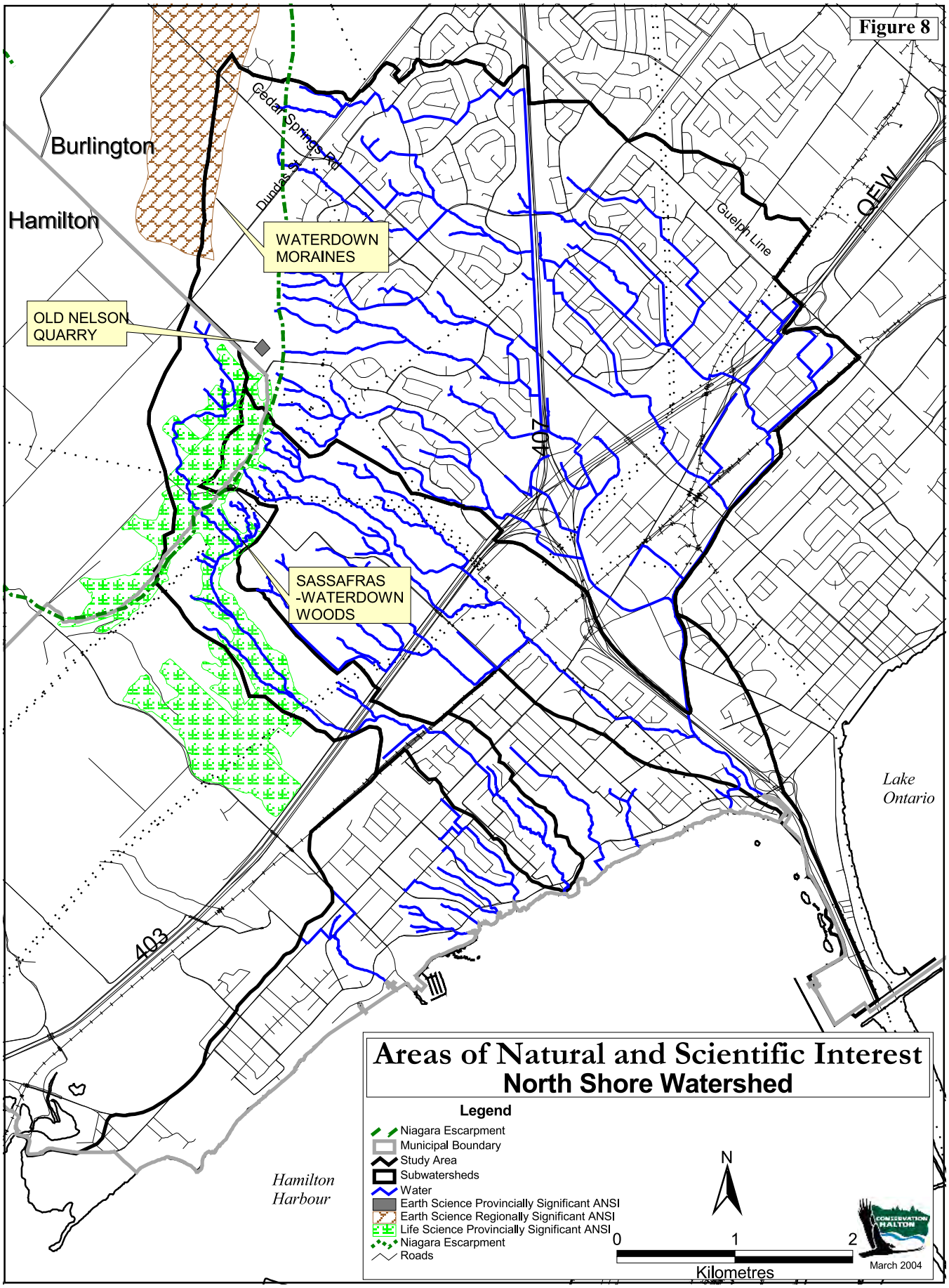
Figure 8
Burlington
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Earth Science Provincially Significant ANSI
Earth Science Regionally Significant ANSI
Life Science Provincially Significant ANSI
Niagara Escarpment
Roads
N
0
1
2
Kilometres
March 2004

1. Serve an important ecological or biological function
2. Exhibit rare or varied topography
3. Contain rare or varied plant or animal species
4. Provide habitat for rare species, including Areas of Natural and Scientific Interest (provincially designated ANSIs)
5. Have been designated as Provincially Significant Wetlands on the basis of the Provincial Policy Statement.

The ESAs identified within the Official Plan fulfill one or more of the following six standardized criteria developed through the Hamilton-Wentworth Natural Areas Inventory project (Heagy, 1993):

1. The biophysical characteristics of the area serve an important ecological function.
2. The biophysical characteristics of the area serve an important hydrological function.
3. The area exhibits a high diversity of biotic and abiotic features relative to its size, and in the context of Hamilton-Wentworth Region.
4. The area encompasses earth science features that are considered rare or poorly represented.
5. The area contains one or more natural biotic communities that are considered rare or poorly represented.
6. The area provides habitat for species considered significant in the context of Hamilton-Wentworth, the former Ontario Ministry of Natural Resources (MNR) Central Region, Ontario or Canada.

The Hamilton-Wentworth ESAs have been designated as Core Natural Areas within the Hamilton-Wentworth Natural Heritage System (NHS) and form the "backbone" of the system.

ESA Descriptions

Waterdown Escarpment Woods (FLAM-51, Halton 5)

The Waterdown Escarpment Woods is dominated by vertical bedrock exposures and lies within the Regional Municipality of Halton and the City of Hamilton. This ESA consists of tableland and talus slope forests. The south-facing talus slopes support rare Carolinian flora.

Sassafras seedling

Sassafras Woods (Halton 40)

Situated south of the talus slopes of the Escarpment, Sassafras Woods is dissected by four major ravine systems, creating a mosaic of tableland, slope and

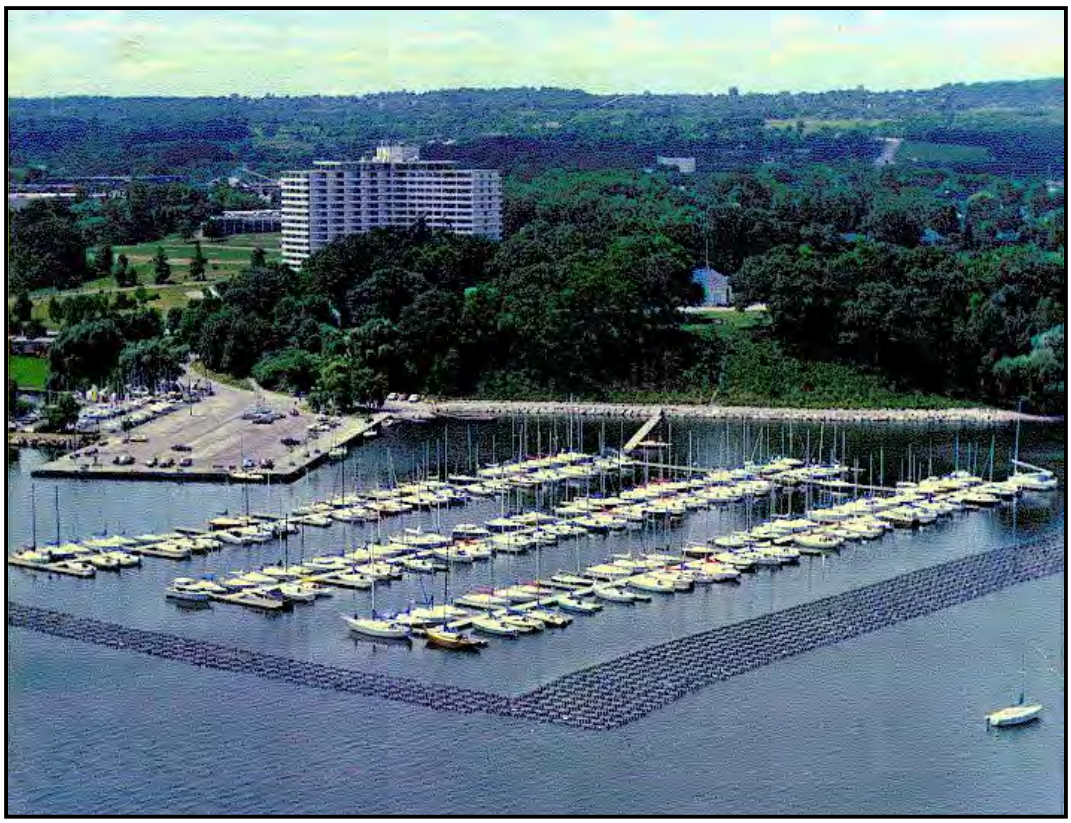
bottomland habitats. Dry tableland and valley rim habitats support open oak and oak-hickory woodlands with prairie-savannah affinities. Carolinian species are abundant within mesic ravine habitats.

Hamilton Harbour (HAMI-66)

The Hamilton Harbour ESA encompasses the open waters of Hamilton Harbour and adjoining shoreline and terrestrial habitats. Within the North Shore watershed, the ESA consists of the remnant natural land-water interfaces along the north shore of the harbour including sections of forested bluffs, Carroll's Point, Willow Point and the forests of LaSalle Park (including those north of North Shore Boulevard). The steep, south-facing bluffs support provincially rare oak woodlands and associated prairie-savannah flora. The nationally and provincially endangered hoary mountain mint (*Pycnanthemum incanum*) is present along the bluffs.

Nelson Escarpment Woods (Halton 6)

The Nelson Escarpment Woods ESA encompasses a number of valleys and ridges on the edge of the Niagara Escarpment. A portion of the Waterdown Moraine extends into the tableland forests above the Escarpment. Forest cover is dominated by sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) with scattered conifer cover (Geomatics International Inc.,1993).



LaSalle Park Located in the Hamilton Harbour

Table 1. ESA Criteria fulfillment for ESAs within Regional Municipality of Halton

ESA	Criteria														
	High native plant or animal species richness	Links two or more natural systems	High number of native plant communities	Large, undisturbed expanses of natural, native plant communities	Remnant of rare native plant communities	Provincially rare plant or animal species	Earth science feature or process	Groundwater recharge	Groundwater discharge	Groundwater quality	Surface water quality	Regionally rare species	High quality assemblage of native plant or animal species	Highly aesthetic	Suitable for scientific research and conservation education
Waterdown Escarpment Woods	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓
Sassafras Woods	✓		✓	✓	✓	✓					✓	✓	✓	✓	✓
Nelson Escarpment Woods						✓	✓					✓		✓	

Table 2. ESA Criteria fulfillment for ESAs within City of Hamilton

ESA	Criteria					
	Biophysical characteristics serve an important ecological function	Biophysical characteristics serve an important hydrological function	High diversity of biotic and abiotic features	Earth science feature considered rarely or poorly represented	One of more natural biotic community considered rare or poorly represented	Provides habitat for species considered significant
Hamilton Harbour	✓				✓	✓

3.3 Natural Habitats

Hill's site region framework provides a basis for dividing the province into thirteen ecological units (Hills, 1959). A site region is defined as an area of land that is characterized by a relatively uniform macroclimate. Within a given site region, the response of vegetation to landform features follows a consistent pattern (House and Carleton, 1988).

The North Shore watershed lies within Hill's Site Region 7E (Site District 7-3). Site District 7-3 forms part of the Eastern Deciduous Forest Region, also known as the Carolinian Life Zone. This area occupies the south shore and west-

ernmost end of Lake Ontario and is defined as "the Niagara Escarpment with lower slopes and adjacent clay plain" (Hills, 1959).

The Carolinian Life Zone of Canada (Deciduous Forest Region) is restricted to southern Ontario south of a line that runs from Grand Bend east to Toronto. The northern boundary corresponds to the northern limits of Carolinian species that are found only within this region of Canada. This zone boasts the warmest average annual temperatures, the longest frost-free season and the mildest winters in Ontario (Reid, 1985; Section 2.2).

The Deciduous Forest Region makes up less than 1% of Canada's total land area but supports a greater number of flora and fauna species than any other ecosystem in Canada. Almost one-third of Canada's rare, threatened and endangered species are found in this region (Carolinian Canada, 2003; Environment Canada, 2003). However, the moderate climate and productive soils that support biota in this life zone also attracted European settlers who prospered in this favourable environment. Clearing of hardwoods for timber and draining of wetlands for farming have eliminated much of the natural habitat within this zone. Pressures on the remaining natural habitats within this region remain high as a result of agricultural land use and urban development.

The geographical position of the North Shore watershed, combined with its physiography, create conditions suitable for the establishment of Carolinian and prairie-savannah habitats that are rare from a global, national, provincial and regional perspective. The moderating effects of Lake Ontario, combined with the south-facing slopes along the Escarpment and Hamilton Harbour provide warm, dry microclimates suitable for a variety of vascular plant and wildlife species that are at the northern limit of their range in Ontario.

Within the context of the Hamilton Harbour watershed, the North Shore watershed supports a moderate level of natural area coverage. Significant expanses of forest cover are limited to the edge of the Niagara Escarpment and adjacent areas. Below the Escarpment, the landscape has been highly fragmented by urban land uses; however, remnant natural areas support a mixture of nationally/provincially rare Carolinian and prairie/savannah communities. The Escarpment itself provides a set of specialized habitats that support rare flora and fauna. The last remaining natural sections of the Hamilton Harbour shoreline are found along the north shore (Figure 6).

This sub-section describes the natural heritage features found within the watershed. A summary and breakdown of vegetation communities within the watershed is provided using the Ecological Land Classification (ELC) protocol. This is followed by a general description of forest cover, prairie/ savannah habitat, wetlands, wildlife and corridors/linkages within the watershed.

3.3.1 Ecological Land Classification

The Ecological Land Classification (ELC) protocol (Lee *et al.*, 1998) was used to delineate and identify vegetation communities within the North Shore watershed. This protocol was developed to provide an integrated, consistent

approach to surveying and classifying ecological units on the landscape. The ELC protocol consists of six nested levels (from large scale to small scale): Site Region (Hill's Site Region 7E); System (aquatic, wetland or terrestrial); Community Class (forest, marsh, cliff); Community Series (i.e. deciduous forest); Ecosite (dry-fresh oak deciduous forest); and Vegetation Type (dry-fresh red oak deciduous forest).

System and Community Series identification can be undertaken through air photo interpretation; however, finer levels of resolution require field data collection. Data collection involves the collection of flora and fauna inventory data, use of prism sweeps, and soil auger sampling supplemented by qualitative field observations to refine feature identification to the Vegetation Type level.

For the North Shore Watershed Study, vegetation community polygons were delineated for ELC classification using aerial photo and digital ortho-photography interpretation (Figure 2). Polygon boundaries were identified using clear breaks in vegetation types and topography. Minimum polygon size (as per the ELC protocol) was 0.5 ha. Smaller features were incorporated as inclusions within larger polygons. A total of 494 polygons were identified within the watershed (Figure 10).

Fieldwork was originally planned to identify all polygons within the North Shore watershed to Vegetation Type. However, due to time constraints, a decision was made to limit fieldwork to areas that had not been documented in past ecological studies. Past studies were used to identify other polygons to Vegetation Type where sufficient level of detail was available. A list of these studies is provided below:

- Census Data and Ecological Land Classification Surveys for Red Mulberry in Hamilton and Halton Regions, Ontario (Thuring and Smith, 2001)
- Preliminary Surveys and ELC Habitat Summaries for Hoary Mountain Mint on the Burlington Bluffs in Hamilton and Burlington, Ontario (O'Hara, 2001)
- Review of NEC Amendment PH/71/90 Eastern Portion (ESG International Inc., 2001)
- CNR Land South of Highway 403 Natural Heritage Study (Ecoplans Limited, 1997)
- Biological Inventory and Evaluation of the Sassafras Woods Area of Natural and Scientific Interest (Varga and Jalava, 1992)
- A Bio-physical Inventory of the Niagara Escarpment and Grindstone Creek Public Open Space Areas (Axon *et al.*, 1989)
- Halton Regional Landfill Technical Study Biophysical Report, Site F (Bird and Hale, 1986)

Other sources, such as Forest Resource Inventory mapping, were reviewed but were determined to provide an insufficient level of detail/accuracy to permit Vegetation Type identification (Table 4); therefore a number of polygons have been identified to Community Series only. A breakdown of vegetation communities by Community Series within the North Shore watershed is provided in Table 3.

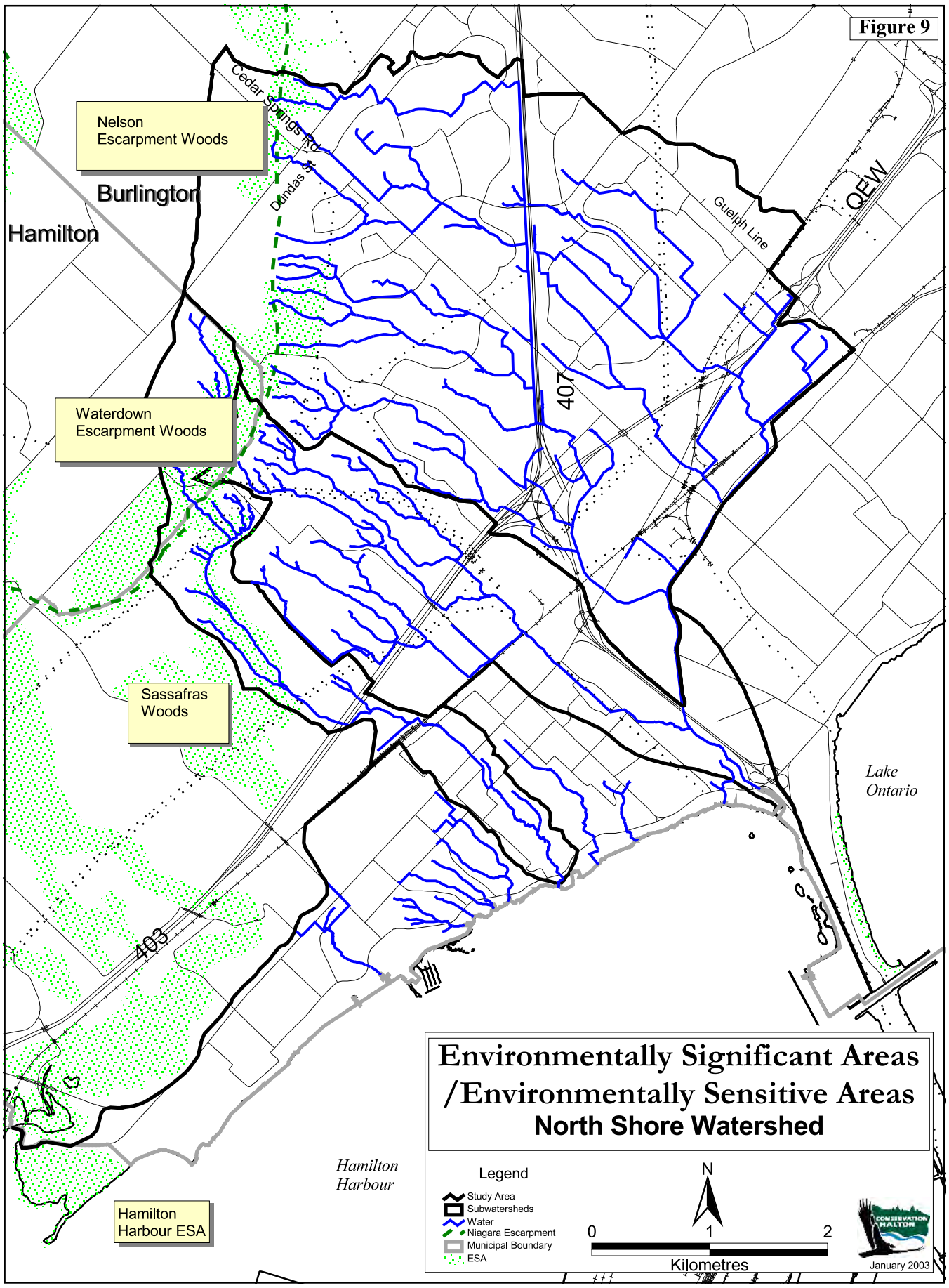


Figure 9
Nelson
Escarpment Woods
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
Waterdown
Escarpment Woods
Sassafras
Woods
Lake
Ontario
403
Hamilton
Harbour
Hamilton
Harbour ESA
Environmentally Significant Areas
/Environmentally Sensitive Areas
North Shore Watershed
Legend
Study Area
Subwatersheds
Water
Niagara Escarpment
Municipal Boundary
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January 2003

Based on ELC analysis, natural vegetation communities cover approximately 27% of the North Shore watershed. Forest cover (including plantation, woodland, forest, treed talus and swamp) is approximately 15% within the watershed and is strongly associated with the Niagara Escarpment. Cultural communities (meadow, plantation, savannah, thicket and woodland) cover approximately 11.6% of the watershed. The open alvar site is located on the floor of the Old Nelson Quarry (Kerncliff Park). It has the physical characteristics of an alvar (shallow soils over flat bedrock); however, it is cultural in origin. The alvar is not currently under active management and should be considered to function as a natural community. A significant proportion of the meadow communities are associated with highway right-of-ways along Highway 403, Highway 407 and QEW. Wetland communities constitute approximately 1% of natural vegetation cover.

A total of 158 polygons were identified to Vegetation Type within the North Shore watershed. A breakdown of these units is provided in Table 3. Several provincially significant vegetation communities are present within the North Shore watershed. Oak and oak-hickory forests and woodlands associated with dry, warm sites support provincially rare vegetation communities in the watershed. The tallgrass prairie along the CN tracks in the vicinity of Grove Park represents a globally and provincially (S1) rare community. The black oak – white oak tallgrass

Table 3. Community Series Distribution within the North Shore Watershed

Community Series	Total Area (ha)	Percentage of Watershed
Cultural Meadow	260.3	7.78
Cultural Plantation Conif	0.4	0.01
Cultural Savannah	1.4	0.04
Cultural Thicket	178.6	5.34
Cultural Woodland	1.0	0.03
Deciduous Forest	380.6	11.38
Deciduous Swamp	8.0	0.24
Meadow Marsh	0.9	0.03
Mixed Forest	25.1	0.75
Open Tallgrass Prairie	0.9	0.03
Plantation	0.7	0.02
Shallow Marsh	4.8	0.14
Tallgrass Savannah	1.4	0.04
Treed Talus	15.4	0.46
Unclassified	2441.6	73.02
Unclassified Forest Type	6.9	0.21
Unclassified Natural Area	16	0.48
TOTAL	3343.9	100.00

woodland in the same area is also considered provincially rare (S1). The fresh-moist sassafras (*Sassafras albidum*) area and the fresh-moist black walnut (*Juglans nigra*) deciduous forest (S2S3), both found in LaSalle Park, are examples of uncommon lowland Carolinian communities within the watershed. The treed talus slopes below the Niagara Escarpment cliffs represent another provincially rare vegetation community (S3). Although not confined to the Carolinian Zone, the treed talus slopes within this portion of the North Shore watershed support several rare Carolinian species.

Table 4. Vegetation type distribution within the North Shore Watershed.

ELC Code	Vegetation Type	No. of Polygons	Total Area (ha)	Provincial Significance
BLO1-1	Open Clay Bluff	1	0.6	S4
CUM1-1	Dry-Moist Old Field Meadow	34	73.7	None
CUP3-2	White Pine Coniferous Plantation	1	0.6	None
CUT1-1	Sumac Cultural Thicket	4	7.1	None
CUT1-4	Gray Dogwood Cultural Thicket	2	2.9	None
FOD1-1	Dry-Fresh Red Oak Deciduous Forest	10	20.8	S5
FOD1-2	Dry-Fresh White Oak Deciduous Forest	2	6.8	S4
FOD1-4	Dry-Fresh Mixed Oak Forest	11	19.5	S3S4
FOD2-1	Dry-Fresh Oak-Red Maple Deciduous Forest	2	3.8	S5
FOD2-2	Dry-Fresh Oak-Hickory Deciduous Forest	1	2.5	None
FOD2-3	Dry-Fresh Hickory Deciduous Forest	2	1.5	S3S4
FOD2-4	Dry-Fresh Oak-Hardwood Deciduous Forest	13	28.3	None
FOD4-2	Dry-Fresh White Ash Deciduous Forest	5	6.1	S5
FOD5-1	Dry-Fresh Sugar Maple Deciduous Forest	7	13.1	None
FOD5-3	Dry-Fresh Sugar Maple-Oak Deciduous Forest	16	25.4	S5
FOD5-4	Dry-Fresh Sugar Maple-Ironwood Deciduous Forest	2	3.3	S5
FOD5-5	Dry-Fresh Sugar Maple-Hickory Deciduous Forest	2	3.4	S4
FOD5-8	Dry-Fresh Sugar Maple-White Ash Deciduous Forest	4	5.8	S5
FOD6-1	Fresh-Moist Sugar Maple-Lowland Ash Deciduous Forest	1	0.8	S5
FOD6-5	Fresh-Moist Sugar Maple-Hardwood Deciduous Forest	1	1.5	None
FOD7-2	Fresh-Moist Ash Lowland Deciduous	7	15.7	None

ELC Code	Vegetation Type	No. of Polygons	Total Area (ha)	Provincial Significance
	Forest			
FOD7-3	Fresh-Moist Willow Lowland Deciduous Forest	2	3.0	None
FOD7-4	Fresh-Moist Black Walnut Deciduous Forest	1	0.8	S2S3
FOD8-2	Fresh-Moist Sassafras Deciduous Forest	1	0.5	None
FOM2-1	Dry-Fresh White Pine-Oak Mixed Forest	7	8.3	S5
FOM3-1	Dry-Fresh Hardwood-Hemlock Mixed Forest	2	2.6	None
FOM6-2	Fresh-Moist Hemlock-Hardwood Mixed Forest	1	0.8	None
MAM3-8	Jewelweed Organic Meadow Marsh	1	0.6	S4
MAS2-1	Cattail Mineral Shallow Marsh	2	1.9	S5
SWD2-1	Black Ash Mineral Deciduous Swamp	1	2.0	S5
SWD4-1	Willow Mineral Deciduous Forest	4	2.0	None
SWD4-3	White Birch-Poplar Deciduous Swamp	1	1.1	S5
TAT1-4	Fresh-Moist Sugar Maple Carbonate Treed Talus	2	11.5	S3
TPO1-1	Dry Tallgrass Prairie	1	0.6	S1
TPW1-1	Dry Black Oak-White Oak Tallgrass Woodland	4	7.3	S1
TOTAL		158	286.2	

Table 5. Provincial Significant (S-ranks) for Ontario.

S Rank	Definition
S1	Extremely rare in Ontario; usually 5 or fewer occurrences in the province or very few remaining individuals; often especially venerable to extirpation
S2	Very rare in Ontario; usually between 5 and 20 occurrences in the province or many individuals in fewer occurrences; often susceptible to extirpation
S3	Rare to uncommon in Ontario; usually between 20 and 100 occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances. Most species with a S3 rank are assigned to the watch list; unless they have a relatively high global rank.
S4	Common and apparently secure in Ontario; usually with more than 100 occurrences in the province.
S5	Very common and demonstrably secure in Ontario.

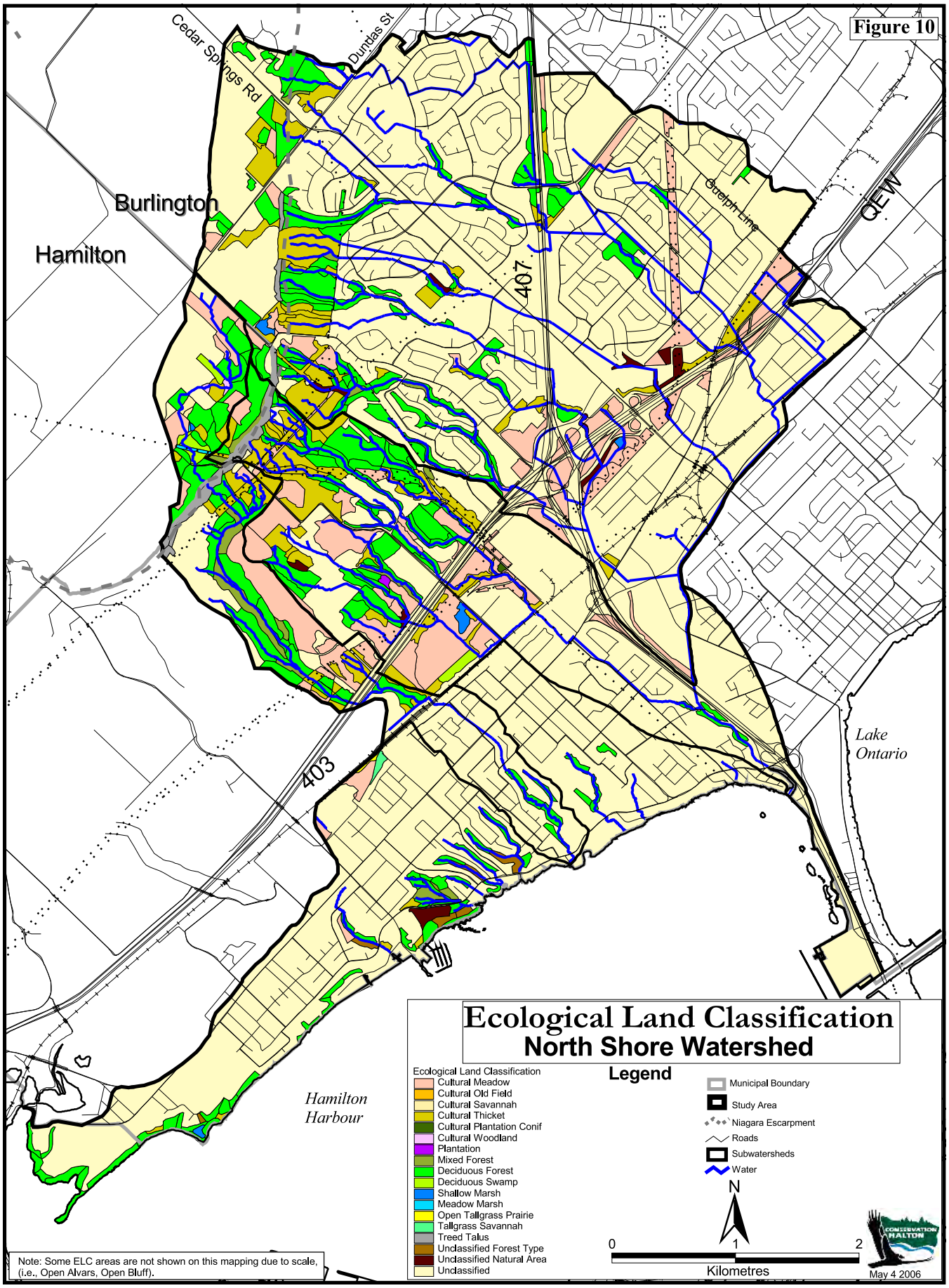
Figure 10
Cedar Springs Rd
Dundas St
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403
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Ecological Land Classification
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Deciduous Swamp
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Unclassified Natural Area
Unclassified
Municipal Boundary
Study Area
Niagara Escarpment
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Subwatersheds
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May 4 2006
Note: Some ELC areas are not shown on this mapping due to scale, (i.e., Open Alvars, Open Bluff).

3.3.2 Forest Cover

In southern Ontario, it is estimated that forest clearing between 1800 and 1920 left less than 1% of the land base in original older-growth condition and almost none in true old growth condition. More than 90% of the original upland woodlands were converted to non-forest land uses by 1920 (Larson *et al.*, 1999), a rate that exceeds wetland losses. The low point in forest cover appeared to be reached in the period around 1920 when the availability of fossil fuels and electricity began to relieve the pressure for fuel-wood consumption (Larson *et al.*, 1999). Over the past eighty years, forest cover in portions of southern Ontario has increased significantly as marginal land was found to be not viable for farming and removed from production. This increase has been particularly dramatic in counties and regions along the Niagara Escarpment where woodland cover increased by more than 36% from 1954 to 1978 (Larson *et al.*, 1999); a testament to the vast amount of clearing previously undertaken.

Forest clearing within the North Shore watershed closely followed the general pattern observed in southern Ontario. The influx of settlers in the early 1800's led to a significant reduction in the extent of forest cover within the watershed. Present forest cover, which once extended across much of the watershed, now only has coverage of 15%. Although secondary and successional forests are developing in former areas of marginal farmland along the Escarpment, loss of mature forest cover and forest fragmentation have continued within the watershed as a result of urbanization and quarry activities.

Forest cover within the North Shore watershed can be broadly grouped into several categories that reflect similar location, topography, soils and aspect (Figure 11). A brief description of these communities is provided below. Appendix 1 provides a more detailed description of these communities.

Escarpment Forest

This area consists of sugar maple-hardwood forest communities located above the Niagara Escarpment on shallow, well-drained soils as well as a small soft maple swamp. Forests along the Escarpment brow are dominated by stands of eastern white cedar and red oak. The talus slopes that extend from the western limit of the watershed to Kerncliff Park are dominated by sugar maple with white ash (*Fraxinus americana*) and basswood (*Tilia americana*) as co-dominants. The southern aspect of these slopes provides a relatively warm microclimate for several Carolinian plant species.

Escarpment South Slope Communities

Variable forest, woodland and successional vegetation communities are associated with the south slopes to the south of the Escarpment talus slope communities. The south slopes are characterized by Queenston shale bedrock thinly mantled with clay tills. The slopes are dissected by numerous ravine systems. On adjacent tablelands and near the top of south/southwest facing slopes, warmer microclimates and reduced soil moisture combined with

well-drained soils provide suitable conditions for the development of drought-adapted oak and hickory tree species and associated Carolinian and prairie-savannah species. Sugar maple forests are dominant in more mesic areas with a variety of forest, thicket and emergent marsh communities present along the base of the ravine systems. Successional forest, shrublands and old field habitats are also present in this area.

Burlington Bay Bluffs

Remnant forest/shoreline cover extends along the north shore bluffs from Woodlands Cemetery east through the Holy Sepulchre Cemetery. Other forest remnants are associated with the "Oaklands" area and the LaSalle Park bluffs. The sandy, south-facing bluffs originally consisted of open oak woodland/shrub bluffs with prairie-savannah affinities; however, slope disturbance and the proliferation of non-native trees, shrubs and ground cover have impacted these rare native communities. Remnant native communities are dominated by open oak woodlands variably dominated by red oak, black oak (*Quercus velutina*) and white oak (*Quercus alba*) with eastern white pine (*Pinus strobus*) often present. Areas of native prairie-savannah vegetation are associated with woodland glades.

Iroquois Plain Ravines

The ravines of the Iroquois Plain are narrow, deep and tend to be surrounded by residential development. Human encroachments into these forested features are common. A number of non-native species are abundant within native communities. Red oak and red oak-hardwood stands are the dominant features within relatively undisturbed ravine systems.

LaSalle Park

The LaSalle Park forest (north of North Shore Boulevard) is a remnant of the mixed red oak/eastern white pine/eastern hemlock (*Tsuga canadensis*) and red oak-hardwood forests and woodlands that once dominated the sand plains associated with the Lake Iroquois Plain. Portions of this forest appear to have old-growth characteristics with very large eastern white pine, red oak and eastern hemlock present within the stand. A rare fresh-moist sassafras forest unit is present at the north end of the forest. Adjacent landowners have encroached into the LaSalle Park forest. Dumping of garden waste and the associated spread of invasive, non-native species is evident in several portions of the stand.

LaSalle Park

City of Burlington Parks

The City of Burlington Parks located east of Kerns Road and north of Highway 403 exhibit variable levels of

disturbance, specifically Tyandaga Golf Course, Kerns Park, Mountainside Park, Cavendish Park and Duncaster Park. Agricultural grazing appears to have occurred within several of the forest units as evidenced by lack of understorey development and abundance of Eastern hophornbeam within the stands. Evidence of past cutting can be found within a number of these stands. Tableland forests consists of a mixture of red oak, white oak, sugar maple, white ash and shagbark hickory (*Carya ovata*) with oaks dominant on drier ridges with southern exposures. Eastern white pine is often present as a supercanopy species. Bottomland forests are often degraded as a result of creek erosion. White elm (*Ulmus americana*, often in decline), white ash and crack/white willow (*Salix* X *rubens*) are often dominant within these communities.

Grove Park

Grove Park

Grove Park is a remnant of the oak woodland habitat that was likely common within the Aldershot area prior to colonization. The wooded portion of the park consists of black oak woodland with scattered white oak and shagbark hickory. The understorey is manicured; however, tall grass prairie/savannah species may still be present in the seedbank. Big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*) and showy tick-trefoil (*Desmodium canadense*) are among the prairie species that continue to persist in the naturalized area between Grove Park and the CNR line to the north.

CN Lands

The CN lands are bounded by the CNR line to the south, Highway 403 to the north, Waterdown Road to the west and King Road to the east. A north-south drainage divide between the North Shore and Grindstone Creek watersheds is present in the central portion of these lands, which have been zoned for industrial development (City of Burlington, 2001 and The Corporation of the City of Burlington, 1999).

The eastern portion of these lands has been heavily disturbed and consists of a mixture of cultural meadow and thicket communities. The western portion provides a wide range of soil moisture conditions that support a mosaic of successional and mature vegetation communities. A mature dry-fresh red oak-hardwood forest lies to the west of the heavily disturbed eastern communities. Wetland communities lie to the west of the oak forest. A young black ash (*Fraxinus nigra*) swamp is contiguous with wetland communities extending west into the Grindstone Creek watershed.

3.3.3 Interior Forest Habitat

Large tracts of intact forest cover provide interior forest habitat for a number of sensitive neotropical migrant

and resident bird species. Table 6 provides a list of forest interior bird species whose breeding range covers southern Ontario (Larson *et al.*, 1999).

Interior forest is defined as cover that is found a minimum of 100 metres from a forest edge. Compact forest shapes with low edge: area ratios, such as circular and square woodlots, provide more interior habitat than forests of similar area extent but with elongate or irregular shapes that have high edge: area ratios.

Some bird species are not suited to living within a forest edge environment, because of increased incidence of predation, nest parasitism or scarcity of a particular food source within these areas. These types of birds are referred to as interior-specialist bird species. Many neotropical migrants require interior forest habitat to successfully forage and reproduce. These species are typically insectivorous and are limited in distribution to forests over 10 hectares in size (Riley and Mohr, 1994). Neotropical migrants often raise only a single, small clutch of eggs whereas generalist and resident species will raise two or even three clutches of eggs during the nesting season. These migrants tend to nest in the open on, or near, the ground. As a result of their reproductive habits, neotropical migrants are highly susceptible to predation from domestic pets, common grackles, raccoons, Virginia opossums and nest parasitism from brown-headed cowbirds.

Table 6. Forest Interior Bird Species of Southern Ontario. (Larson *et al.*, 1999)

Acadian Flycatcher	**Hooded Warbler**
Barred Owl	**Louisiana Waterthrush**
Black-and-white Warbler	Northern Goshawk
Blackburnian Warbler	**Ovenbird**
Black-throated Blue Warbler	Red-shouldered Hawk
Black-throated Green Warbler	**Scarlet Tanager**
Blue-headed Vireo	**Swainson's Thrush**
Broad-winged Hawk	**Veery**
Brown Creeper	Winter Wren
Cerulean Warbler	**Wood Thrush**
Hermit Thrush	**Yellow-throated Vireo**

Note: Species referenced in bold are considered neotropical migrants. Other species are resident or undertake relatively short migrations south of their breeding range. It should be noted that there is disagreement within the scientific community as to what species are true interior forest species. This list attempts to find a balance between exclusionary and inclusionary paradigms.

In contrast to forest interior habitat, forest edges and smaller woodlots are subject to edge effects which promote common generalist and opportunistic bird species while excluding sensitive species which require more extensive, less disturbed habitat areas. The following effects are associated with forest edges and smaller woodlots:

- greater extremes in temperature and humidity
- increased wind and desiccation

- increased solar radiation
- increased predation and parasitism
- increased numbers of aggressive, non-native species and pathogens
- increased disturbance from noise, water and air pollution
- improved access for motor vehicles, vegetation clearing and development

Although forest interior species may occasionally breed in smaller woodlots and forest edges, these habitats may be population "sinks" as successful nesting and rearing is uncommon. In contrast, extensive areas of interior forest habitat act as population "sources" where annual production equals or exceeds annual mortality rates. Forest interior habitat supports other taxa that require large tracts of forests for reproduction, foraging and shelter. Weak-flying butterflies such as the West Virginia White are dependent on sheltered interior woodland habitats with specific plant hosts. Herptiles such as Jefferson salamander, wood frog and yellow spotted salamander are strongly associated with large, undisturbed forest habitat with vernal pools for breeding. Similarly, mammals such as flying squirrels and porcupines require large forest tracts to carry out their life cycles.

Within the North Shore watershed, few forest stands provide interior forest habitat (Figure 11). The elongated shape of many of the natural areas within the watershed and their fragmentation by hydro corridors and roads has resulted in relatively few areas with interior forest. This is true not only in the urbanized portion of the watershed but in the relatively large forest tracts along the Escarpment as well. Interior forest habitat is generally restricted to the Waterdown Escarpment Woods, Nelson Escarpment Woods and Sassafras Woods ESAs. Deep interior forest habitat (forest core areas greater than 200 metres from the forest edge) is negligible within the North Shore watershed.

3.3.4 Prairie/Savannah Habitat

Prairie and savannah vegetation formerly occurred discontinuously across much of southern Ontario. This habitat expanded into southern Ontario during a warm, dry climatic phase that peaked approximately 5,000 years ago (Goodban *et al.*, 1999). Climatic conditions and associated increases in the natural frequency of fires led to the extension of these vegetation communities from the central portion of the continent, particularly in sandy, well-drained areas. As relatively cooler, wetter conditions returned to southern Ontario, many of these prairie/savannah communities were maintained through periodic burning by native peoples, thereby repressing shrub and sapling development and maintaining grassland and open oak woodland habitats to support rich populations of game animals including elk and deer. Later, agricultural settlements were based on these open, well-drained areas where supplementary game was readily available.

Lack of tree cover and excellent drainage resulted in extensive clearing of prairie, savannah and woodland habitat to accommodate agriculture and urbanization. Less than one percent of the pre-settlement prairie and savannah remains in southern Ontario (Goodban *et al.*, 1999). Prairie, savannah and

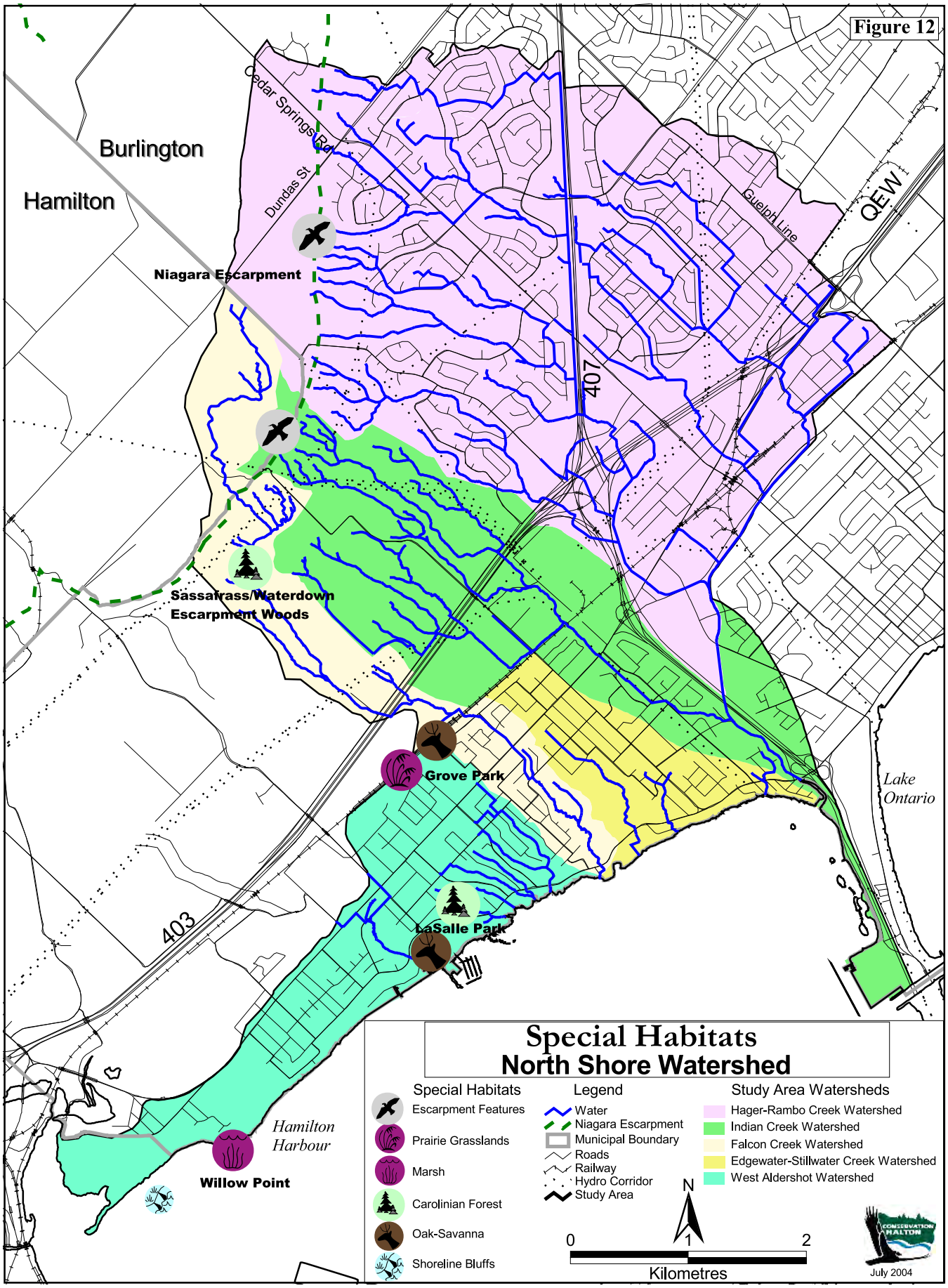


Figure 12
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Niagara Escarpment
Sassafrass/Waterdown
Escarpment Woods
Grove Park
LaSalle Park
Willow Point
Hamilton
Harbour
Lake
Ontario
Special Habitats
North Shore Watershed
Special Habitats
Escarpment Features
Prairie Grasslands
Marsh
Carolinian Forest
Oak-Savanna
Shoreline Bluffs
Legend
Water
Niagara Escarpment
Municipal Boundary
Roads
Railway
Hydro Corridor
Study Area
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
July 2004

oak woodland communities in Ontario are considered extremely rare and are ranked S1 (extremely rare in Ontario) by the Natural Heritage Information Centre (Bakowsky, 1996). They are also considered to be globally rare. The remnant prairie/savannah and oak woodland features represent the most rare and most threatened community types within the North Shore watershed.

Historical records indicate that prairie and oak savannah vegetation, referred to in original land surveys as "plains", was fairly widespread around the perimeter of the westernmost end of Lake Ontario (minimum area of 3800 ha; Goodban *et al.*, 1999). Within the North Shore watershed, these communities were likely associated with the well-drained soils of the Iroquois Plain and the Aldershot Bar (i.e. Burlington Bay Bluffs, Grove Park and CN lands; Section 3.4.2). The formerly open character of this area is reflected in the name of the major east-west road that crosses this feature: Plains Road. Areas with prairie-savannah affinities are also associated with woodland and succesional habitats from Sassafras Woods east through the Hanson Brick properties. Though well-drained soils are not present, the clay tills are very shallow and are prone to desiccation allowing drought-tolerant oak woodlands and associated prairie-savannah flora to thrive. It is estimated that less than 0.1% of the original extent of prairie and savannah remains in the Hamilton area, including the North Shore watershed (Goodban *et al.*, 1999).

A brief description of prairie/savannah features within the North Shore watershed is provided below. Parairie/savannah significant species are found in Appendix 1.

Escarpment South Slope

Tablelands and the upper portion of south/southwest facing slopes provide suitable dry to dry-mesic conditions that support open oak, oak-hickory and shrubland communities. A number of vascular plant species with prairie-savannah affinities are found within these communities. Associated shrub species include fragrant sumac (*Rhus aromatica*), black huckleberry (*Gaylussacia baccata*), dryland blueberry (*Vaccinium pallidum*), lowbush blueberry (*Vaccinium angustifolium*) and New Jersey tea (*Ceanothus americanus*). Ground cover species with prairie-savannah affinities include smooth aster (*Aster laevis*), American colombo (*Swertia carolinensis*), stout goldenrod (*Solidago squarrosa*), woodland sunflower (*Helianthus divaricatus*), bastard toadflax (*Comandra umbellate*) and yellow pimpernel (*Taenidia integerrima*).

Burlington Bay Bluffs

Remnant native communities are dominated by open oak woodlands variably dominated by red oak, black oak and white oak with eastern white pine often present. Areas of native prairie vegetation are present in woodland glades including species such as big bluestem, little bluestem (*Schizachyrium scoparium*), switch grass (*Panicum virgatum*), Canada wild-rye (*Elymus canadensis*), butterfly-weed (*Asclepias tuberosa*), northern dewberry (*Rubus flagellaris*), woodland sunflower,

smooth aster, sky-blue aster (*Symphyotrichum oolentangiense*), sharp-leaved goldenrod (*Solidago arguta*) and hoary mountain mint (O'Hara, pers. comm.).

Grove Park

Grove Park is a remnant of the oak woodland habitat that was likely common within the Aldershot area prior to colonization. The wooded portion of the park consists of black oak woodland with scattered white oak and shagbark hickory. The understorey is manicured; however, tall grass prairie/savannah species may still be present in the seedbank.

A pocket of tallgrass prairie is located just north of the black oak woodland along the CNR tracks. This site supports a number of regionally rare prairie species including big bluestem, little bluestem, Indian grass, northern dewberry, upland willow (*Salix humilis*) and sky-blue aster (O'Hara, pers. comm.).

CN Lands

The western portion of the CN lands provides a wide range of soil moisture conditions that support an assortment of successional and mature vegetation communities. Cultural meadows along the CN tracks likely support patches of prairie-savannah flora such as big bluestem (O'Hara, pers.comm.; ELC study) and should be investigated further.

3.3.5 Wetlands

Wetlands are an integral part of the natural landscape. These features include lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to, or at, the surface. Saturated conditions in these areas result in the formation of hydric soils that favour hydrophytic and/or water tolerant plants.

Historically viewed as unattractive and potentially dangerous by early settlers, it is now recognized that wetlands support a number of vital ecological, hydrologic and economic and cultural functions.

Following European settlement in the 1800's, timber operations and wetland drainage, to facilitate agriculture and urbanization, significantly reduced wetland coverage in southern Ontario. A historical loss of more than 70% of the wetlands south and east of the Canadian Shield has been documented (Riley and Mohr, 1994). The extensive wetlands associated with the south shore of Hamilton Harbour were filled in to facilitate industrial development in Hamilton.

Performing a Transect on CN land

Historical coverage of wetlands within the North Shore watershed appears to have been low. The significant slopes associated with the Niagara Escarpment

and the presence of well-drained soils on flatter areas above and below the Escarpment were not conducive to wetland formation. Wetlands likely included small swamps above the Escarpment, linear wetlands/bottomland communities along the base of ravines and estuarine marshes at the confluence of the watershed creeks with Hamilton Harbour and along the shallow near shore of the harbour within the watershed. Swamps (tree and shrub cover) and marshes (emergent, floating and submerged vegetation cover) are present within the watershed while fens and bogs, the two other wetland types found in southern Ontario, are absent. Wetlands currently cover approximately 1% of the North Shore watershed.

Historical loss of wetland cover within the watershed is perhaps most pronounced where the watershed creeks meet the harbour. These estuarine areas have been infilled or degraded through shoreline development. Only the Indian Creek estuary remains though it, too, has been degraded by adjacent development and biotic disturbances (carp). Indian Creek originally flowed into Brant's Pond, a large coastal wetland, prior to discharging to Hamilton Harbour. The northeastern shoreline of the harbour was described as a complex system of lagoons backing onto a sand beach (Trotter *et al.*, 1998). Recently, work undertaken through the Fish and Wildlife Habitat Restoration Project of the Hamilton Harbour RAP has attempted to restore wetland, aquatic and terrestrial habitat along the northeastern shoreline through the construction of habitat islands and shoals which protect backshore lagoons and mudflats (Trotter *et al.*, 1998).

Loss of ravine wetlands has occurred through urban development and quarry activities. Recently, a relatively large ravine wetland was removed to facilitate extraction from the Hanson Brick quarry west of King Road.

Existing wetlands within the North Shore watershed have not been evaluated using the Ministry of Natural Resources Wetland Evaluation System (MNR, 1993), which evaluates wetlands based on their biological, hydrologic, social, and special features attributes. Typically, wetlands must be at least 2 hectares in size to be evaluated although smaller wetland units may be evaluated as part of a larger wetland complex (MNR, 1993). Only three wetland units within the watershed appear to meet the 2 hectare size criteria. A brief description of existing wetland communities within the North Shore watershed is provided below.

Waterdown Escarpment Woods

A seasonally flooded soft maple swamp lies above the Escarpment within Waterdown Escarpment Woods. A hydro corridor has been constructed through this community and a wet meadow has developed underneath the hydro lines (Axon *et al.*, 1989). Since this wetland is greater than 2 hectares in size, further evaluation of this wetland is recommended.

Escarpment Ravine Bottomlands

A number of ravine bottomland features are associated with watercourses descending south from the Escarpment to Highway 403/QEW. Tree cover, where present, consists of a mixture of

mesic-wet tree species such as sugar maple, white ash, white elm, basswood and willows (Salix spp.). Forest cover is interspersed with pockets of thicket swamp and emergent marsh. Thicket swamps consist of red osier dogwood (*Cornus stolonifera*)/shrub willow thickets with a variety of graminoids and forbs. Emergent marshes consist of cattail (*Typha* spp.) marshes and wet graminoid/forb meadows. These wetlands do not meet the 2 hectare size criterion for evaluation.

Iroquois Plain Ravine Bottomlands

These narrow, linear features are often in private ownership and vary in their level of disturbance. The ravines associated with LaSalle Park (north of North Shore Boulevard) appear to represent the least-disturbed example of these systems. Tree cover is dominated by willows (*Salix* X *rubens*, *S. nigra*), Manitoba maple (*Acer negundo*) and Norway maple (*Acer platanoides*). Like some other wetlands in the North Shore watershed, these wetlands do not meet the 2 hectare size criterion for evaluation.

Kerncliff Park/Old Nelson Quarry

The wetland along the base of the quarry wall is located in the west corner of the quarry. This wetland consists of a permanent pool of open water surrounded by robust emergents. A wet meadow community, dominated by variegated horsetail (*Equisetum variegatum*), sedges (*Carex* spp., *Scirpus pendulus*) and rushes (*Juncus* spp.), has developed along the south shore of the wetland. This wetland does not meet the 2 hectare size criterion for evaluation.

Willow Point/North Shore

Willow Point is the last remaining natural wetland along the Hamilton Harbour shoreline. A cattail (*Typha* spp.) marsh and balsam poplar (*Populus balsamifera*) swamp form the core of the wetland. A small duckweed marsh is also present. The shoreline is lined with a crack/white willow (*Salix* X *rubens*) community that contributes to nearshore fish habitat within the Harbour. This wetland is greater than 2 hectares in size. Although small, this wetland may be a provincially significant wetland by virtue of its special features (landscape rarity, rare species, significant waterfowl habitat in association with harbour). Further evaluation of this wetland is recommended.

Shallow, nearshore habitats along the north shore of Hamilton Harbour support variable open marsh communities dominated by submerged aquatic vegetation (Minns, 1992). Aquatic vegetation density, coverage and diversity along the shoreline are positively correlated with natural shoreline conditions. Along the wooded bluffs from Carroll's Point through Holy Sepulchre Cemetery, tape grass (*Vallisneria americana*) is abundant with water milfoil (*Myriophyllum* spp.) and pondweeds (*Potamogeton* spp.) also present. Along the hardened shorelines to the east, aquatic vegetation is patchy with occasional monocultures of tape grass. The construction of habitat islands along the northeastern shoreline (undertaken as part of the Fish and Wildlife Habitat Restoration Project) has created quiescent backwater areas that now support significant aquatic vegetation cover.

CNR Lands Wetland

A black ash swamp is located within the CNR lands along the west boundary of the watershed. A mosaic of contiguous thicket swamp, marsh and open pond communities lies to the west of the swamp (outside of the watershed). Since this wetland is greater than 2 hectares in size, further evaluation of this wetland complex is recommended.

3.4 Wildlife

The natural areas within the North Shore watershed provide habitat for a diverse array of wildlife. This subsection provides an overview of wildlife and habitat associations within the watershed.

3.4.1 Herpetofauna

A diverse assemblage of herpetofauna continues to persist within the North Shore watershed despite intensive urbanization.

Amphibians that require the close proximity of wetland breeding habitats to forest habitats are generally restricted to the larger forest units associated with the Escarpment and Sassafras Woods. Red-spotted newt, Jefferson salamander, yellow spotted salamander, spring peeper, wood frog and gray treefrog are found in these areas.

Eastern red-backed salamander, which does not require vernal pools for breeding, has a wider distribution and is found in most of the larger forest remnants. Western chorus frogs are rare but have been observed on the Hanson Brick lands west of King Road (Proctor and Redfern Limited, 1982).

The eastern spiny softshell turtle (nationally and provincially threatened), common map turtle (nationally special concern), and musk turtle (nationally special concern) have been recorded along the north shore of Hamilton Harbour between the Hamilton Bar and Willow Point. Common map turtle has been known to nest along the harbour shoreline north of Carroll's Point (McCormick, 1989). A recent study conducted by RBG reconfirmed the presence of eastern spiny softshell turtle and reported numerous common map turtles basking along the western shore of Carroll's Bay (Clavering and Pomfret, 2003).

Eastern Red-backed Salamander

Lack of wetland habitats and intensive urbanization within the eastern and southern portions of the watershed provide limited opportunities for aquatic-based herpetofauna although tolerant species such as American toad, northern leopard frog, green frog, snapping turtle and Midland painted turtle (LaSalle Park, CN Lands, Willow Point) have persisted. Efforts should be made to restore and maintain wetland habitats to support the natural range of species expected to occur.

Terrestrial reptiles have fared somewhat better with a relatively diverse assemblage of snakes associated with the larger forest blocks of the Niagara Escarpment and Sassafras Woods. Eastern garter snake, brown snake, eastern milk snake (nationally special concern) and the sensitive/rare northern ringneck snake are found in these areas. The northern ringneck snake appears to have an affinity toward the talus slopes of the Escarpment.

Eastern Garter Snake

Escarpment crevices and remnant rock piles at the abandoned quarry in Kerncliff Park provide important snake hibernacula. Large numbers of eastern garter snakes, eastern milk snake and brown snake have been observed in early spring at the eastern and western ends of the quarry (Axon *et al.*, 1989; Featherstone, 1998). The sensitive/rare northern ringneck snake has also been observed in Kerncliffe Park (McIlveen, pers. comm.). The south-facing escarpment slopes within the watershed provide a warmer microclimate that is likely favourable for overwintering snakes.

3.4.2 Avifauna

Lack of forest interior habitat within the North Shore watershed restricts the diversity of forest interior species that breed within the watershed, however some species, such as scarlet tanager, brown creeper, ovenbird and wood thrush, occur in larger blocks of forest associated with Sassafras Woods-Waterdown Escarpment Woods.

Avian species with Carolinian affinities such as tufted titmouse, orchard oriole and Carolina wren have been recorded as breeders within the North Shore watershed. One species with a more northern affinity, golden-crowned kinglet, has also been recorded as an active nester within the watershed.

Wetlands within the watershed provide breeding and foraging habitat for species such as red-winged blackbird and common yellowthroat. At Kerncliff Park, cliff swallows actively forage over the open water portion of the wetland and nest on the adjacent cliffs. The relatively secretive Virginia rail and sora have also been recorded from this site. Black-crowned night heron utilize the Willow Point wetland for foraging.

Hamilton Harbour has been identified as a provincially significant waterfowl staging and wintering area (Heagy, 1993). Mudflats and shorelines along the harbour provide important staging habitat for a number of shorebirds. The northern shoreline of the harbour contributes to these staging and overwintering functions. The RAP Fish and Wildlife Habitat Restoration Project has constructed a series of islands and emergent shoals

along the northeastern shoreline which support a number of colonial nesting birds such as Caspian tern, common tern, black-crowned night heron, ring-billed gull, herring gull and double-crested cormorant. Mudflats to the east of the islands provide foraging habitat for a number of shorebird species.

Black-capped Chickadee

Agricultural and urban landscapes provide habitat for a number of generalist/ opportunistic bird species such as blue jay, robin, crow, starling, grackle, song sparrow, chipping sparrow, house sparrow and cardinal. The parasitic brown-headed cowbird is also associated with these urban, agricultural and edge habitats.

Two Important Bird Areas (IBAs) are located in the North Shore watershed; West End of Lake Ontario and Hamilton Harbour Waterbird Colonies (Bird Studies Canada, 2004). There are four categories into which an area can fall. These categories are:

1. Threatened species
2. Restricted range species
3. Biome restricted/representative species
4. Congregatory species

For each category the area is ranked as being globally, continentally or nationally significant. In instances where an area satifies more than one category, the highest significance determined the overall rank for the area.

IBA Descriptions

Hamilton Harbour Waterbird Colonies, Hamilton Ontario (ON020)

This globally significant IBA is located at the extreme western end of Lake Ontario separated from the lake by a large sandbar. Waterbird colonies are concentrated in the Eastport area and the harbour's northeast corner on two small artificial islands, Neare and Farre.

Four species have been observed at this site in significant numbers; ring-billed gulls (*Larus delawarensis*), Caspian terns (*Sterna caspia*), common terns (*Sterna hirundo*), and black-crowned night-herons (*Nycticorax nycticorax*). Other nesting waterbirds in the area include double-crested cormorants (*Phalacrocorax auritus*) and herring gulls (*Larus argentatus*).

West End of Lake Ontario, Hamilton Ontario (ON022)

The globally significant West End of Lake Ontario stretches from Port Credit to Burlington Bay and east to the mouth of the Niagara River.

Thousands and sometimes tens of thousand of diving ducks can be found in this IBA. The most abundant species occurrances are greater scaup (*Aythya marila*), white-winged scoter (Melanitta fusca) and long-tailed duck (Clangula hyemalis) with more than 1% of their

estimated North American population. Other species of diving ducks that occur in impressive numbers include common goldeneye (Bucephala clangula), king eider (Somateria spectabilis) and surf scoter (Melanitta persicillata).

Porcupine

3.4.3 Mammals

The forested, successional and urban environments found within the North Shore watershed support a moderately diverse assemblage of mammals. Some species, such as coyote and white-tailed deer are ubiquitous through a wide range of habitats and may even encroach into urban areas. Large deer herds have been reported along the south slopes below the Niagara Escarpment. Striped skunk, Virginia opossum, red fox, eastern cottontail, raccoon, groundhog and grey squirrel are abundant in old fields, successional shrubland and forest edge habitats. Raccoon and grey squirrel, in particular, have adapted well to urban environments.

The mammal community of the Sassafras Woods-Waterdown Escarpment Woods area reflects the high quality, relatively undisturbed habitats that lie in close proximity to the urban area. More sensitive species such as porcupine, long-tailed weasel, masked shrew, smoky shrew, short-tailed shrew, white-footed mouse and meadow jumping mouse are present within these communities (Armour *et al.*, 1979). However, mammals requiring large tracts of contiguous forest cover (i.e. bobcat, river otter) are not present within the watershed.

Urbanization of streams and the paucity of wetlands within the North Shore watershed have resulted in limited opportunities for aquatic-oriented mammals. Tolerant species such as muskrat may persist in remnant wetlands and unaltered stream reaches. Beaver occur at LaSalle Park and along the restored northeastern shoreline of the harbour. Efforts should be made to restore and maintain the watershed to support the natural range of species expected to occur.

3.5 Rare Species

Rare species of flora and fauna in the North Shore watershed are largely associated with ESAs; however, unlike other watersheds within the jurisdiction of Conservation Halton, undesignated areas also may support significant species, particularly vascular plants. These species are generally at the limits

of their natural range or are associated with rare prairie-savannah habitats. Local extirpation of these species may occur through adverse natural or human-induced changes to their environment. Rare species can also recolonize historical and former ranges if positive habitat changes occur (i.e. management of succession in prairie/savannah communities, increases in interior forest habitat, corridor enhancement).

Appendix 1 contains a listing of the nationally, provincially and regionally rare species within the watershed ESAs and undesignated natural areas. Where ESAs extend outside of the watershed boundaries, an attempt has been made, using source documents, to include only those species found within the watershed.

3.6 Invasive Species

Invasive vascular plant species are significantly impacting native habitats throughout the North Shore watershed. North of QEW/Highway 403, garlic mustard (*Alliaria petiolata*) is often a dominant feature of the ground flora while common buckthorn (*Rhamnus cathartica*) and Tartarian honeysuckle (*Lonicera tatarica*) are present in the shrub layer.

South of the highway system, impacts associated with invasive species are often severe. Norway maple is often a dominant understory species and is occasionally dominant within the overstorey throughout this portion of the watershed. Within the southern portion of the watershed, Norway maples have demonstrated an uncanny ability to outcompete native vegetation under a variety of conditions ranging from dry tablelands to dry-mesic slopes to fresh-moist bottomlands. Mature Norway maple stands develop extremely thick canopies that restrict understorey development and ground cover growth. Lack of ground cover within stands of Norway Maple has been implicated in significant soil and slope erosion within the City of Toronto. The continued development of Norway maple stands on steep slopes such as the Burlington Bluffs may exacerbate existing slope instability.

Vetch at CN lands

Along Burlington Bluffs, black locust (*Robinia pseudo-acacia*), sycamore maple (*Acer pseudoplatanus*) and tree-of-heaven (*Ailanthus altissima*) are also abundant. Common buckthorn, non-native honeysuckles (*Lonicera* spp.), white mulberry (*Morus alba*), barberries (*Berberis* spp.) and common privet (*Ligustrum vulgare*) are often dominant within the understorey and shrub layers. White mulberry has been implicated as a major stressor on endangered red mulberry (*Morus rubra*) populations due to its propensity to interbreed with red mulberry and produce hybrids. Garlic mustard, periwinkle (*Vinca minor*) and non-native ivy form dense mats along the forest floor.

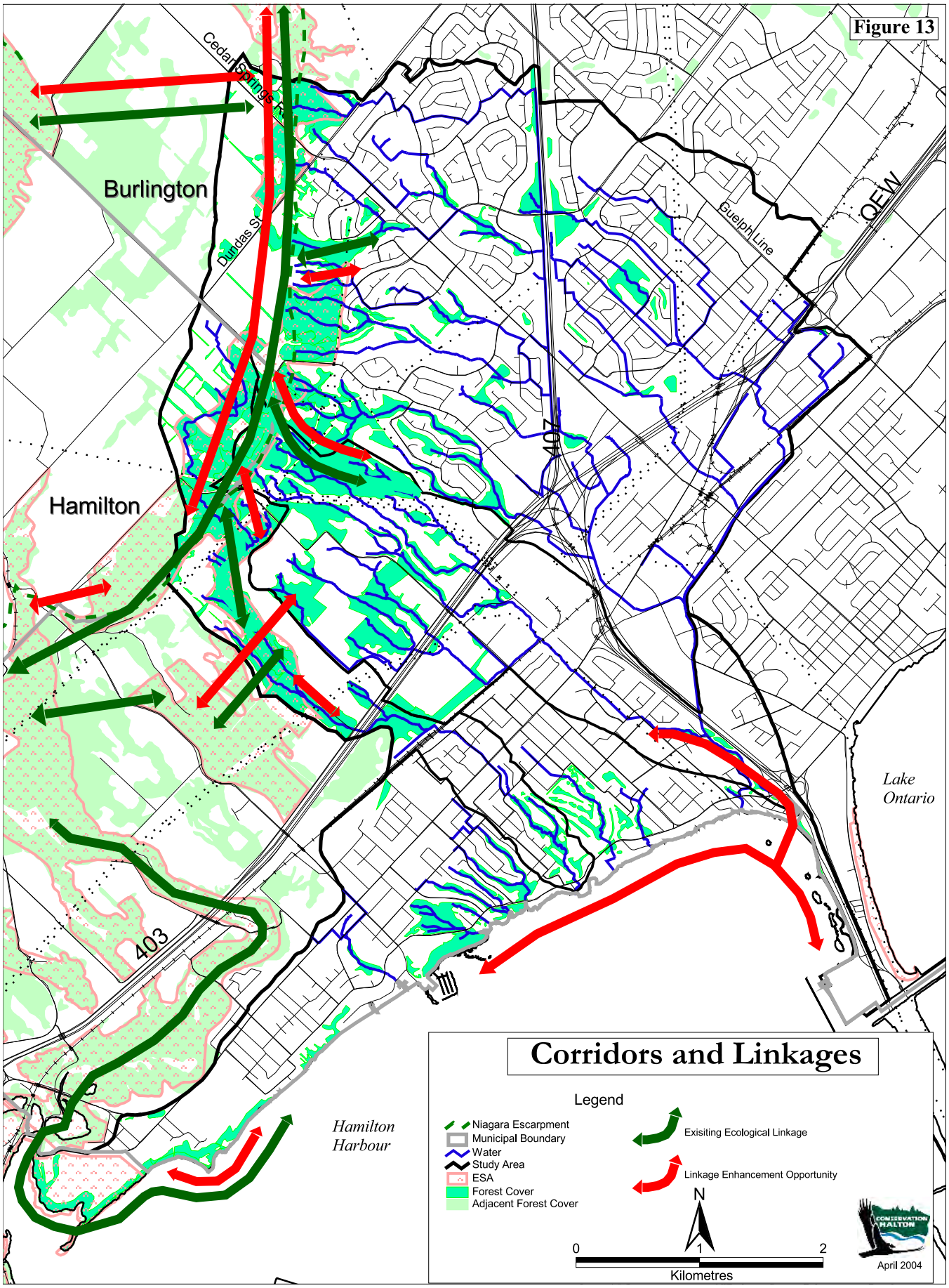


Figure 13
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Corridors and Linkages
Legend
Niagara Escarpment
Municipal Boundary
Water
Study Area
ESA
Forest Cover
Adjacent Forest Cover
Exisiting Ecological Linkage
Linkage Enhancement Opportunity
N
0
1
2
Kilometres
April 2004

The oak-dominated forest stands in Aldershot are under extreme stress as a result of encroachment by non-native species. Without significant control measures, most native forest and woodland communities within Aldershot will likely be displaced or significantly degraded within a generation.

3.7 Corridors and Linkages

Ecosystems cannot be considered in isolation because wildlife moves and changes across landscapes. The connections between habitat patches and the distances between patches are important because biodiversity can only be maintained if effective dispersal between patches is occurring (Larson *et al.*, 1999). In southern Ontario, the density of forest fragments on the landscape and the overall proportion of habitat may be more critical to long-term sustainability of populations than immediate woodland habitat (Riley and Mohr, 1994). Effective dispersal between patches occurs through natural corridors and linkages. Such corridors and linkages are collectively referred to as a natural heritage system, a concept which is integral to ecologically sound planning (MNR, 1999).

Corridors are generally elongate, naturally vegetated areas that link or border natural areas within and between watersheds (Riley and Mohr, 1994). Within the North Shore watershed, they tend to follow biophysical breaks in the landscape such as watercourses and associated valleys, the Niagara Escarpment and the Hamilton Harbour bluffs (Figure 13). Anthropogenic features such as hydro and pipeline right-of-ways and railways also function as corridors, particularly in urban portions of the watershed where natural corridors are rare or absent.

Corridors exist at different scales. Finer scale features include fencerows and hedgerows that may be important at a local level while larger scale features may provide significant ecological functions internally and act as substantive passageways for plant and animal species and communities.

Corridors provide passage for animals that require a variety of habitats to survive. They allow the movement and reproductive interchange for populations of plant and animal species, and buffer natural areas and processes from adjacent land-use activities (Riley and Mohr, 1994). Properly designed corridors may counter the effects of habitat fragmentation since the viability of habitat islands (i.e. woodlots) as suitable wildlife habitat often depends on outside recruitment of animals (Noss, 1987a,b). In southern Ontario, the re-establishment of corridors over time may lead to the re-colonization and range expansion of taxa that were extirpated or suffered significant range contractions since European settlement.

Although a number of benefits may be derived from natural corridors, adverse impacts may also be associated with some corridors. Narrow corridors may provide habitat for edge species such as European starling, common grackle, brown-headed cowbird and red-winged blackbird. These corridors may act as funnels, attracting predators, competitors and brood parasites to a forest (Ambuel and Temple, 1983). However, the majority of studies have shown corridors to be an effective conservation tool (Beier and Noss, 1998).

The North Shore Watershed

Overall, natural corridors provide important habitat connections within watersheds and provide linkages to adjacent watersheds. In most cases, the ecological benefits of corridors far outweigh any disadvantages, particularly in agricultural and urban settings (Noss, 1987a,b;) such as those found within the North Shore watershed. A description of corridors/linkages found within the North Shore watershed, including linkages to adjacent natural areas outside of the watershed, is provided above (Figure 13). Given the size of the watershed and the significant extent of natural features therein, discussion is limited to larger scale corridors on the landscape. It is noted that smaller scale features (i.e. hedgerows) may be important, particularly from a cumulative and/or local context, however a description of these features is beyond the scope of this report. The significance of these smaller scale features should be determined through additional study such as subwatershed and secondary plans or Environmental Impact Studies if changes are proposed through development.

Carolinian Canada embarked upon the Big Picture Project in 1999, with the objective of developing a network of core natural areas linked together and to the surrounding landscape (Carolinian Canada, undated). This vision called for a near doubling of natural cover within the Carolinian Zone over the course of the next few generations (Carolinian Canada, 2001). More recently, the project was expanded to include all of southern Ontario (NHIC 2003). These

data will be useful in providing a basis for more detailed, local level natural heritage system planning.

3.7.1 Riparian Corridors

Unlike other watersheds within the jurisdiction of Conservation Halton, the North Shore watercourses are highly fragmented by urban development and major transportation corridors and generally do not provide the significant linkages between core natural areas within the watershed. An exception to this would be the Falcon Creek ravine system which links Sassafras Woods with Waterdown Escarpment Woods. Similarly, the riparian corridor associated with the LaSalle Park tributaries (north of North Shore Boulevard) provides a linkage between the northern LaSalle forest, the LaSalle bluffs and ultimately Hamilton Harbour.

Migratory fish species from Lake Ontario and Hamilton Harbour utilize Indian Creek and, possibly, the downstream reaches of other North Shore watercourses to access spawning habitat. All watercourses within the North Shore watershed act as corridors which convey flows, sediment loads, nutrients and pollutants to Hamilton Harbour.

3.7.2 Escarpment/Interwatershed Corridors

This section of the Niagara Escarpment is part of an almost unbroken forested corridor which extends for 26 km from Dundas Valley to Mount Nemo (Varga and Jalava, 1992). This corridor provides an interwatershed connection between the Spencer Creek, Grindstone Creek, Falcon Creek, Indian Creek, Hager Creek, Rambo Creek, Roseland Creek, Tuck Creek, Shoreacres Creek, Appleby Creek, Sheldon Creek and Bronte Creek watersheds.

The Escarpment forest ESAs along the slopes and adjacent tablelands of the Niagara Escarpment form part of a large mega-corridor which extends from Niagara Falls to Tobermory (Riley *et al.*, 1996) and the Canadian Shield. The Niagara Escarpment itself is linked to the Oak Ridges Moraine near Caledon and through other habitat corridors to the Long Point Biosphere Reserve along the shore of Lake Erie (Hounsell, 1999), forming part of a provincial network of corridors. It is also part of an international corridor extending from the Niagara Escarpment east through the Oak Ridges Moraine to the Frontenac axis of the Canadian Shield which, in turn, provides links north to Algonquin Park and south to the Adirondack mountains. Collectively, this corridor is referred to as the Niagara Escarpment-Oak Ridges Moraine-Algonquin to Adirondak Heritage (NOAH) initiative.

3.7.3 Hamilton Harbour Linkages

The harbour/shoreline interface represents an important linkage within the North Shore watershed. Natural cover along portions of this shoreline represent the last natural feature remnants along the Hamilton Harbour shoreline. Forest cover along the harbour bluffs stabilizes these features, reducing sediment loading to the harbour. Overhanging trees provide shade and cover for aquatic biota and may provide basking sites for turtles in sunny locations. Natural shoreline areas provide access for nesting turtles (i.e. common map turtles) which nest on

sand/gravel shorelines. Black-crowned night herons nest on the northeastern shoreline islands and forage in the Willow Point wetland. Natural shorelines and forested slopes are an important component of the provincially significant staging and over wintering waterfowl habitats associated with Hamilton Harbour and also support staging shorebirds and songbirds during spring and fall migration. Within the area colonial nesting birds such as Caspian tern, common tern, black-crowned night heron, ring-billed gull, herring gull and double-crested cormorants can be found. Mudflats to the east of the islands provide foraging habitat for a number of shorebird species as well.

The remedial action plan (RAP) for this area includes a detailed fish and wildlife habitat restoration project. Specifically "Water quality and fish habitat should be improved to permit an edible, naturally reproducing fishery for warm water species. Water and habitat conditions in Hamilton Harbour should not limit natural reproduction or the edibility of cold water species" and "Healthy and self sustaining resident and non-resident wildlife populations should be enhanced on a Harbour-wide basis through water quality improvements, habitat rehabilitation and protection" (Cairns *et al.*, 1998). The project proposes to create 372 hectares of fish habitat and 16 km of littoral edge along the Hamilton Harbour. The remedial action plan for this area also has shoreline softening as a target. The shoreline of LaSalle Park has had vigorous growth of trees and shrubs, which were planted as part of the restoration project. A "Natural Areas Nurturing" program is being used to provide ongoing vegetation maintenance for the area. The improved habitat has attracted large number of juvenile largemouth bass, black crappie, smallmouth bass, yellow perch and walleye to the area. Diversity has increased from 6-8 to 16-18 different species. The aquatic plant community on the Northeastern shoreline has grown up over the past few years and provided additional habitat to fish in the area. As a result the fish community using the area has expanded from 6 species to 16.

3.8 Natural Areas Management Issues and Guidelines

Natural areas within the North Shore watershed should be protected and enhanced to maintain and increase the extent of remnant natural areas and to enhance intra- and inter-watershed habitat links. Enhancement and restoration of natural areas will ultimately improve the overall health of the watershed as well as Hamilton Harbour.

3.8.1 Forest Cover and Riparian Habitat

A number of watershed habitat targets have been established for the Great Lakes Areas of Concern (AOCs; Environment Canada *et al.*, 1998) such as Hamilton Harbour. Table 7 outlines habitat targets which, when achieved, will result in the creation of a natural heritage system that exhibits a high degree of biodiversity and robustness.

Watershed and subwatershed analyses have been conducted to assess how the North Shore watershed and its subwatersheds meet these habitat targets. The results of these analyses are provided in Table 8.

Forest Cover

Fifteen percent of the watershed is forested. Some areas of marginal farmland along the Escarpment have been removed from agricultural production and, if left alone or managed properly, will eventually revert to forest cover. However, other forested areas have recently been lost as a result of urbanization and quarry operation. Forest cover does not meet the AOC target of 30% coverage and it is unlikely that the 30% target can be attained in this urbanized watershed; however, opportunities to maintain and increase forest cover should be strongly encouraged since any increase in forest cover would assist the Hamilton Harbour RAP in moving toward the 30% forest cover objective for the entire Hamilton Harbour watershed. Further, since the entire North Shore watershed lies within the Carolinian zone, increases in forest cover would assist Carolinian Canada in reducing landscape fragmentation and protecting, enhancing and restoring natural core areas and corridors.

Table 7. Habitat Targets for Great Lakes Areas of Concern (adapted from Environment Canada *et al.*, 1998).

Parameter	Target	Rationale
Percent Forest Cover in Watershed	> 30%	Will support most bird species expected within range
Size of Largest Forest Patch (minimum 500 m wide)	200 ha	Will support most bird species expected within range
Percent of Watershed that is Forest Cover 100 m or farther from edge	> 10%	Will support most forest-interior and edge bird species
Percent of Watershed that is Forest Cover 200 m or farther from edge	> 5%	Will support most forest-interior bird species expected within range
Percent of First to Third Order Streams * with at least 30 m wide buffers	> 75%	Should maintain high water quality and stream integrity
Percent of Watershed that is impervious	< 15%	Potential to maintain coldwater streams

* Stream order is a method of ranking stream segments in a drainage basin in which larger segments are given higher order numbers. Headwater tributaries are assigned order 1, where two order 1 streams combine, the next (downstream) segment becomes order 2, where two order 2 segments combine, the next (downstream) segment becomes and order 3, etc. (Newbury and Gaboury, 1993).

Table 8. Comparison of North Shore Watershed to AOC Habitat Targets.

Great Lakes AOC Targets					
	Forest Cover >30%	Largest Forest Patch >200 ha	>10% of Watershed as Interior Forest Habitat	>5% of Watershed as Deep Interior Habitat	>75% of Riparian Habitat with 30 m Buffers
Watershed	15%	1*	1.3%	0.00004%	22%
Hager-Rambo	17%	0	1.3%	0.009%	17%
Indian	47%	0	3.4%	0.001%	27%
Falcon	69%	0	4%	0%	52%
Edgewater-Stillwater	9%	0	0%	0%	1.5%
West Aldershot	9%	0	0.08%	0%	12%

*forest patch is contiguous with >200 ha patch which extends outside of the watershed

Interior forest cover within the North Shore watershed (1.3%) does not meet the AOC target of 10%. The Falcon and Indian Creek subwatersheds support the most forest interior habitat at 4% and 3.4% of subwatershed cover, respectively. Negligible deep interior forest habitat is present within any portion of the North Shore watershed. Similar to the previous arguments to increase overall forest cover, all opportunities should be explored to fill in forest gaps, particularly along the Escarpment and Escarpment South Slope areas, to maximize interior forest habitat within the North Shore watershed and to insulate these relatively intact units from the spread of invasive vascular plant species.

The North Shore watershed has one large forest patch (> 200 ha) which extends along the Niagara Escarpment to areas outside of the watershed; however, this linear forest feature does not meet the width criterion for large forest patches (>500 metres width). As noted above, reforestation of forest gaps along the Escarpment would assist in moving the Escarpment forests toward this width objective.

Reforestation to promote the establishment of compact forest blocks with significant interior forest habitat should be a significant focus of stewardship and reforestation initiatives. Abandoned agricultural lands, quarry lands and landfills along the brow and slopes of the Niagara Escarpment provide excellent opportunities for reforestation. Emphasis should be on the creation of compact forest shapes to maximize the size and extent of interior habitat within watershed forests.

Although reforestation of significant forest blocks is important, protection and enhancement of remnant forest features within the south portion of the North Shore watershed is also vital. Rare habitats within Aldershot are under siege by invasive, non-native species. Concerted action by landowners and the community is required to attempt to control these species to prevent the

displacement of native habitats. Enhancement/naturalization of degraded oak woodlands such as those at Grove Park and LaSalle Park (south) could assist in bringing back small vignettes of provincially rare oak savannah which was likely common along the Iroquois Plain prior to settlement.

Municipalities and landowners should be encouraged to use indigenous plant species for all plantings, particularly regeneration projects, to enhance indigenous plant communities and to minimize the spread of invasive, non-native species into natural habitats within the watershed. If ornamental plantings are deemed necessary, proponents should be encouraged to use aesthetically pleasing native species or non-invasive non-native species as substitutes for invasive species such as Norway maple, sycamore maple, tree-of-heaven, black locust, white mulberry and common privet.

Encroachment into natural areas is a significant issue within the watershed. Activities such as the dumping of garden refuse have resulted in impacts to forest ground cover and the spread of invasive, non-native species through natural areas. Public agencies and community groups should use education as a tool to address the encroachment issue. Examples could include: articles in local newspapers, mail-outs to landowners abutting natural areas and information that could be provided at community events. Where problems persist, consideration should be given to fencing public lands from private lands to minimize future encroachment.

Riparian/Shoreline Habitat

The North Shore watershed and its subwatersheds do not meet the AOC targets for riparian habitat on first to third order streams. Overall, the 30 metres riparian cover target is met on only 25% of the watercourses within the watershed. Riparian cover is greatest on Falcon Creek (52%) with all other watersheds falling below 30% coverage. Lack of riparian cover is associated with nutrient enrichment, increased instream temperatures, localized bank erosion and impedance of wildlife movement (Environment Canada *et al.*, 1996). Although the AOC target may not be achievable within most of the North Shore watershed, movement toward this target would likely improve water quality within the North Shore watercourses and, ultimately, Hamilton Harbour. Increased riparian cover within the North Shore watershed would assist the Hamilton Harbour RAP in moving toward AOC objectives within the larger Hamilton Harbour watershed.

Restoration/enhancement of riparian habitat along watercourses within the North Shore watershed provides an opportunity to enhance aquatic habitat and downstream water quality while providing some limited opportunities to enhance wildlife habitat and linkages. All watercourses within the North Shore watershed could benefit from riparian habitat enhancement as implemented through a variety of programs. Water quality within the watershed and, in an incremental fashion, Hamilton Harbour will benefit from restoration of riparian corridors.

With the exception of Indian and Falcon Creek, the small watercourses within Aldershot are not protected through Conservation Halton regulations under the Conservation Authorities Act (Ontario Regulation 150/90). Consideration should be given to designating these watercourses and their valley systems as regulated areas during future review of Conservation Halton's regulated areas.

Similar consideration should be given to regulating the Burlington Bluffs and adjacent shoreline to ensure that activities which may destabilize the bluffs or further harden the shoreline do not occur. Initiatives to naturally stabilize unstable bluff sections and to soften hardened sections of the shoreline should be encouraged, where feasible. Currently, the shoreline falls under the jurisdiction of two Conservation Authorities. Hamilton Conservation Authority has jurisdiction over lands below the high water mark whereas Conservation Halton has responsibility for lands above the high water mark. Consideration should be given to transferring jurisdiction to one Conservation Authority to streamline shoreline planning.

Although on-line ponds are present within the watershed, the impacts of these ponds are far less than the impacts associated with extensive urbanization. Unlike rural watersheds, where on-line pond removal in headwater areas is often a high priority to facilitate fish passage, reduce loss of baseflow and reduce thermal impacts, the removal of headwater ponds within the North Shore watershed is not likely to have significant benefits since urbanization in downstream areas would quickly override any positive impacts associated with pond removal/retrofitting. An emphasis on the removal of barriers to fish passage, channel naturalization and riparian plantings would maximize aquatic habitat potential within the North Shore watershed.

3.8.2 Prairie-Savannah

Prairie-savannah habitats, likely common within the North Shore watershed prior to colonization, have been nearly extirpated from the watershed. Existing habitats, consisting of open oak woodlands and prairie patches, are under pressure from non-native species, quarry operations and urban development. Concerted efforts are required to control invasive non-native species, particularly in the Aldershot area, if rare oak woodlands are to be protected and enhanced. A number of rare species are present on the Hanson Brick lands below the Escarpment. Hanson Brick should be encouraged to work with public agencies and community groups to salvage rare flora prior to excavation and to rehabilitate quarry areas with appropriate native species following excavation.

It is likely that small prairie-savannah remnants remain to be discovered within the North Shore watershed, particularly in remnant natural areas along the Iroquois Plain in Aldershot and along rail lines. Additional research should be conducted to identify, protect and enhance these remnant communities.

3.8.3 Wetlands

Three unevaluated wetlands are present within the North Shore watershed (Waterdown Escarpment Woods swamp,

Willow Point marsh/swamp and CN lands complex. These wetlands should be evaluated and afforded appropriate protection under provincial policy, official plans and Conservation Halton regulations.

3.8.4 Linkages and Corridors

Natural corridors and linkages have been highly fragmented by development within the watershed. These adverse impacts can be partially addressed through implementation of the strategies outlined for aquatic habitat, wetlands and forest within the watershed.

Restored riparian corridors within the North Shore watershed will buffer watercourses from the adverse impacts of adjacent land-use activities and will enhance aquatic habitat within the watershed. Water quality within the watershed and, in an incremental fashion, Hamilton Harbour will benefit from restoration of riparian corridors. In some situations, the restoration of riparian corridors may re-connect natural core areas, facilitating the movement and reproductive interchange between populations of plant and animal species.

Reforestation is encouraged to link natural heritage features and to increase the areal extent of interior forest habitat along the Niagara Escarpment. Through reforestation efforts, stronger linkages can be restored along the Niagara Escarpment and to adjacent watersheds. On a larger scale, restoration of linkages and corridors at a local watershed level will enhance the function of the Escarpment mega-corridor system.

It should be noted that references to corridors and linkages apply to *ecological connectivity only*. These references *do not* imply any access to private or public lands through trail system extension or creation of new access trails.

3.8.5 Monitoring

Long-term monitoring of the natural areas within the North Shore watershed is important to identify and assess ecosystem changes associated with changing land uses and ongoing restoration projects. Information from these monitoring efforts is required to ensure that restoration projects are achieving their objectives and to assist in the development and prioritization of

Stream Monitoring

future projects within the watershed. Conservation Halton is currently developing a long-term monitoring program that will meet these objectives. Consideration should be given to providing community groups with training and suitable protocols to assist in monitoring efforts.

RECOMMENDATIONS TO CARE FOR NATURAL HERITAGE

1. Protect wetlands
2. Improve quality of wetlands
3. Protect forest habitats
4. Protect/expand interior forest habitat
5. Protect/restore critical/sensitive habitat
6. Protect/enhance natural corridors and linkages
7. Protect/restore fish habitat
8. Protect/enhance valley lands
9. Reduce/eliminate proliferation of non-native/invasive species
10. Protect/enhance viewscapes into and from the watershed
11. Reduce use/misuse of pesticides
12. Protect/enhance non-forest habitat
13. Protect/enhance wildlife populations

Hamilton Harbour

4.0 SURFACE WATER QUALITY AND AQUATIC HABITAT

4.1 Watercourse Descriptions

The physical characteristics of the various watersheds within the North Shore study area (Figure 1, 2, 3, 4 and 6) and general descriptions of these watercourses, focusing on location, underlying physiography, adjacent natural features and land uses are provided below. Many creek reaches have been highly altered to facilitate stormwater management and urbanization.

4.1.1 Hager-Rambo Diversion Channel

Hagar-Rambo Diversion Channel

The Hager-Rambo Diversion Channel was constructed in 1976 to mitigate downstream flood damage through the diversion of flows from the upper reaches of Hager and Rambo Creek watersheds. Flows from the upper watersheds are intercepted by a concrete prismatic channel that flows parallel to Fairview Street, discharging to Indian Creek at Greenwood Drive. The diversion channel does not provide significant aquatic habitat since it is characterized by flashy flows (eg. water levels rise rapidly in the channel during rainfall events) and lack of natural substrates.

4.1.2 Roseland Creek

A small portion of Roseland Creek lies within the North Shore watershed. Intermittent flows emanate from the Niagara Escarpment north of Highway 5 but are enclosed a short distance downstream of Highway 5 beneath a subdivision. At Highway 407, flows are diverted west through an enclosure beneath Highway 407 to the east branch of Hager Creek. The flows are intermittent in upper reaches of Roseland Creek. Intermittent flows and extensive channel alterations/enclosures preclude significant aquatic habitat within this portion of the Roseland Creek watershed.

4.1.3 Rambo Creek

Urbanization has highly altered natural drainage patterns within Rambo Creek watershed. Rambo Creek originally flowed to Lake Ontario through downtown Burlington. However, following the construction of the Hager-Rambo Diversion Channel in 1976, the upper portions of the watershed were diverted to Indian Creek (Hamilton Harbour). The portions of Rambo Creek that are within the North Shore watershed are divided into the East Rambo Creek and West Rambo Creek.

The headwaters of Rambo Creek emanate from the slopes of the Niagara Escarpment within the Waterdown Escarpment Woods ESA. These tributaries then flow through suburban Burlington and the Tyandaga Golf Course. At Highway 407, all of the flow

from the West Rambo and the major flows from East Rambo are diverted and enclosed beneath the highway to the east branch of Hager Creek.

Downstream of Highway 407, the remnant branches of Rambo Creek are fed by storm sewer drainage and are largely enclosed except for small portions of open altered channel sections upstream of the QEW. Downstream of the QEW, East Rambo Creek flows through an open concrete channel to the Hager-Rambo Diversion Channel. West Rambo Creek flows through an altered, but more natural, channel to the diversion channel. The approximate change in grade from the headwaters of Rambo Creek to the Hager-Rambo Diversion Channel are 90 m and 170 m for West Rambo Creek and East Rambo Creek, respectively (Dillon Ltd., 1981) with an average gradient of about 3%.

4.1.4 Hager Creek

Similar to Rambo Creek, urbanization has highly altered natural drainage patterns within the Hager Creek watershed. Hager Creek originally drained to Lake Ontario through downtown Burlington; however, following the construction of the Hager-Rambo Diversion Channel, the upper portions of the watershed were diverted westward to Indian Creek (Hamilton Harbour). The portions of Hager Creek that are within the North Shore watershed are divided into East and West Branches.

The headwater tributaries of Hager Creek arise along the Niagara Escarpment within the Waterdown Escarpment Woods ESA. Upstream of Highway 407 the headwater tributaries flow through well-vegetated valley systems which bisect subdivision development. Portions of the creek are enclosed beneath suburban portions of Burlington. Downstream of Highway 407, East Hager Creek intercepts diverted flow from portions of the Rambo Creek watershed which then flows through a natural channel for several hundred metres before

Hager Creek

discharging into the stormwater ponds between North Service Road and the QEW, and the Freeman Pond stormwater facility downstream of the QEW. Downstream of Freeman Pond, the flows are diverted through the Hager-Rambo Diversion Channel to Indian Creek.

The approximate change in grade from the headwaters of Hager Creek to the Hager-Rambo Diversion Channel are 107 m and 100 m for West Hager Creek and East Hager Creek, respectively (Dillon Ltd., 1981) with an average gradient of about 3%.

4.1.5 Indian Creek

The headwaters of Indian Creek emanate above the Escarpment slopes within the Waterdown Escarpment Woods ESA and flow through urban areas of

Burlington to Hamilton Harbour. The intermittent eastern tributaries originate in well-forested valleys associated with the Niagara Escarpment and drain to the eastern portion of the Hanson Brick Quarry (east of King Road). Severe erosion and significant sediment loads are generated from this site Flows from the quarry enter forested ravines which extend downstream to Highway 403. Downstream of Highway 403, the eastern tributaries coalesce and join the western branch at the CN tracks.

Black-crowned Night Heron at Indian Creek

The western branch of Indian Creek receives intermittent surface drainage from the former Bayview Landfill site and the active Hanson Brick quarry (west of King Road). Downstream of the landfill and quarry, the western branch flows through forested ravines downstream to Highway 403, except for a portion of a tributary that is enclosed. Flows from the eastern tributaries are intercepted by an on-line stormwater management facility on the North side of the North Service Road. Flows are then directed through a straightened, altered channel south of Highway 403 and then eastward along the CN tracks before discharging to the eastern branch.

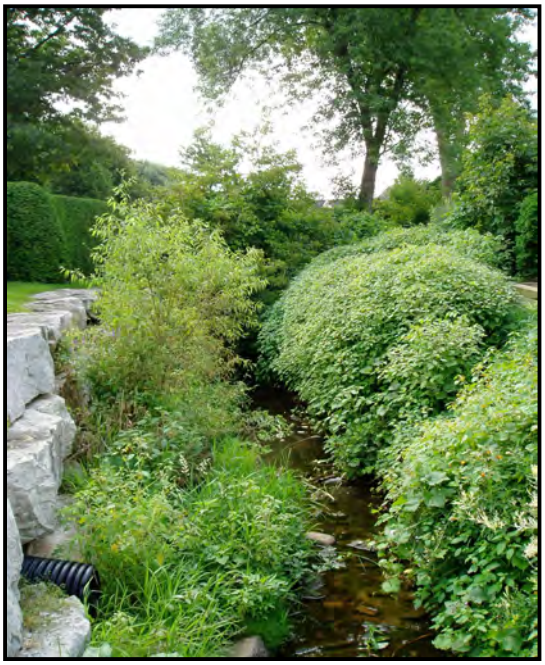
Indian Creek is enclosed downstream of Plains Road to Cedar Avenue through City of Burlington parkland. At Greenwood Drive, Indian Creek intercepts flow from the Hager-Rambo Diversion Channel and flows parallel to the QEW downstream to Hamilton Harbour. Significant increases in discharge associated with a near-tripling of drainage area associated with the Hager-Rambo Diversion Channel exposes this downstream reach of Indian Creek to intense periods of high flows and erosion during storm events.

The predominant surface deposits within the headwater areas of Indian Creek are clay loams overlying bedrock of the Queenston formation (Dillon Ltd., 1981). The red clay silts associated with the area are derived from weathering of the underlying Queenston shale bedrock. The Queenston Shale formation consists of thinly bedded red clay shale with occasional bands of grey limestone. Closer to the Hamilton Harbour, the soils are dominated by imperfectly drained and well-drained sandy loams downstream of Highway 403.

4.1.6 Falcon Creek

The headwaters of Falcon Creek originate above the Niagara Escarpment and descend the Escarpment slope through well-vegetated valleys of the Waterdown Escarpment Woods and Sassafras Woods ESAs. The decommissioned Burlington Landfill site lies adjacent to the creek valley upstream of Highway 403. Downstream of the highway, the creek flows through a vegetated valley to the CN tracks and flows through a subdivision becoming enclosed at Dorset Avenue and re-emerging within a subdivision

downstream of Plains Road. South of Townsend Avenue, Falcon Creek flows through the well-vegetated valley associated with the Burlington Golf and Country Club prior to discharging to Hamilton Harbour.



Falcon Creek at Northshore Blvd.

4.1.7 West Aldershot Watershed Creeks

The creeks within the West Aldershot watershed (Forest Glen, Teal, LaSalle and West Aldershot) are generally small (< 1 km in length) and emanate from forested ravines north of North Shore Boulevard. Though small, these creeks support permanent (albeit low) baseflow. Groundwater discharge appears to be associated with the sandy loam soils within this portion of the watershed. Storm sewer discharge also assists in maintaining permanent flow in at least some of these creek systems. Generally, culverts beneath North Shore Boulevard are barriers to fish passage on these systems.

4.2 Surface Water Quality

A survey and analysis of surface water quality in the North Shore watershed has been undertaken as a component of the watershed study. The survey is made up of two segments. One segment is the review of existing surface water quality data from all sources. The other segment was the North Shore Water Quality Monitoring Program (NSWQMP), a targeted surface water monitoring program of moderate intensity, undertaken by staff of Conservation Halton during 2001 and 2002.

4.2.1 Literature Review

The review of existing surface water quality information related to the North Shore watershed included several reports.

In 1992 and 1993, *Boyter and Struger* of Environment Canada conducted a study of metals concentrations in suspended solids and surficial sediments at several

RECOMMENDATIONS TO CARE FOR SURFACE WATER QUALITY

1. Protect and enhance surface water quality
2. Reduce sources of thermal pollution
3. Reduce and/or mitigate the impacts of erosion
4. Protect areas of recharge and discharge

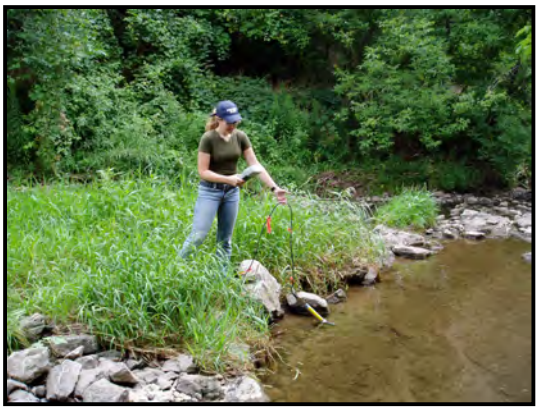
Hamilton Harbour tributaries, including Indian Creek. The metals sampled included: aluminum, cadmium, cobalt, chromium, copper iron, manganese nickel, lead, vanadium, zinc and mercury. One sample was taken of suspended sediments while two samples were taken of surficial sediments in Indian Creek. No sample location was provided. Results of the study indicate that concentrations of manganese, lead and zinc in suspended solids and surficial sediments sometimes exceed "Lowest Effect Levels." Concentrations of cadmium in suspended solids exceed both "Lowest Effect Levels" and "Severe Effect Levels." (Note: These terms relate to water quality guidelines; however, no definition is provided.)

In 1993, *Draper & Assoc*. prepared a study of storm event monitoring of Hamilton Harbour tributaries for the Hamilton Region C.A. The report provides data on total phosphorus, suspended solids and zinc concentrations from several sources in Hamilton Harbour, including Indian Creek. The study attempts to estimate loads delivered to the Harbour. However, the author of the report indicates that considerable caution must be exercised in interpreting the data (due to a lack of some flow information). The author recommends further study to determine the sources of total phosphorus, suspended solids and zinc in the watershed.

In 1992, *Boyd* of the Ontario Ministry of Environment summarized existing MOE data on concentrations of metals and polycyclic aromatic hydrocarbons (PAHs) in suspended sediments from ten sources in Hamilton Harbour, including Indian Creek. According to the author, the report "provides a direct indication of the quality of the sediment [at] each source but only provides an indirect indication of water quality and total loading at each site." The report was prepared to compare various sediment sources to the Harbour, ranging from effluent from Stelco and Dofasco to effluent from Waste Water Treatment Plants to inflow from watershed tributaries. In general, the paper reports that median concentrations of metals in suspended sediments from the streams were significantly lower than concentrations from the other sources. Median concentrations of metals in suspended sediments from Indian Creek were very similar to concentrations from Cootes Paradise, Grindstone Creek and Redhill Creek. The paper also reports that median concentrations of Total PAH in suspended sediments from the streams were somewhat lower than concentrations from the other sources.

In 1997, staff of Conservation Halton conducted a preliminary survey of some of the creeks in the North Shore watershed in order to establish potential sites for a water quality monitoring study. The data collected examines several parameters, including: certain bacteria (fecal coliform, *Fecal streptococcus* and *E. coli*), temperature, pH, conductivity, dissolved oxygen, alkalinity, chlorides, residue (total and particulate), turbidity, total phosphorus, (ortho)phosphate, total Kjeldahl nitrogen, ammonium, nitrates, nitrites, phenolics, biochemical oxygen demand (5 Day), and certain metals, primarily copper, iron, lead and zinc. The results of this single sampling are included with the results of the NSWQMP.

Dove, Painter and Kraft (2003) of Environment Canada prepared a report detailing results from a screening-level survey of recently deposited sediment quality undertaken in the summer of 2002 near the mouths of tributaries draining to the Niagara River and Lake Ontario as far east as the Bay of Quinte. A total of 147 samples were obtained, representing 131 tributaries and 16 field duplicate samples.



Water Quality Sampling

Two of the creeks in the North Shore watershed were sampled as part of the study. The sediments of both Indian Creek and Falcon Creek were found to contain elevated levels of certain pesticides and metals.

The Environment Canada sampling program was based on the Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants, developed by the United States Geological Survey (USGS) for the U.S. National Water-Quality Assessment Program (NAWQA; Shelton and Capel, 1994). A number of sub-samples are combined at each site so that one sample is obtained that is representative of the overall conditions in that tributary.

The samples were analyzed for 26 organochlorine compounds plus nine (9) PCB Aroclors and Total PCBs. Sixteen (16) PAH compounds and 36 metals were analyzed, and the inorganic and organic carbon content as well as grain size distribution of each sample was determined. For many of the tributaries, this study represents the first information related to organic compounds in sediments.

A total of eleven (11) organochlorine parameters were not detected in any sample. The DDT metabolite DDE was the most commonly detected organochlorine, with widespread occurrence. Concentrations were, in general, also higher than were observed in the 2001 survey of Lake Erie tributaries. Half of the sites had total DDE concentrations exceeding the federal Probable Effect Level (PEL). The parent product DDT was also detected at 30% of sites. Endosulfan, an organochlorine pesticide, was also commonly found (endosulfan and/or its metabolites was detected at 20% of sites), but there is no sediment quality guideline for this compound. The banned insecticide chlordane was detected at 14% of sites. Lindane and mirex were only detected at one site each, and the industrial organochlorines HCB and OCS were not detected at any site in this survey. One or more PCB Aroclors was detected in 65 tributaries (50% of all sites). Total PCB concentrations exceeded federal Threshold Effect Level (TEL) guidelines at 33 sites and the federal PEL was exceeded at a further two (2) sites.

Polycyclic aromatic hydrocarbons (PAHs) were found to be widespread, and each of the PAH compounds

analyzed was detected in at least one sample. Exceedence of one or more federal TEL guidelines for PAHs occurred at 68% of the sites and PEL exceedences occurred at 18% of sites. In general, PAH concentrations appeared to be higher in or near urbanized areas, but some PAH contamination was observed even at sites with little urbanization nearby.

At many sites, the detection of metals is likely related to the natural occurrence of trace elements in stream sediments. For some metals, however, concentrations appeared to be elevated relative to federal PEL sediment quality guidelines as well as background levels. These metals included chromium, copper, mercury, lead, and zinc. Other metals, including manganese and iron, appeared to be elevated at certain sites above natural, background concentrations.

4.2.1.1 Indian Creek

Boyter and Struger (1992) found that "storm flow concentrations of metals in suspended solids and surficial sediments from Indian Creek exceeded the guidelines in 75% of the samples. For baseflow concentrations, 20% of the samples from Indian Creek exceeded the guidelines." The report notes that no mercury concentrations exceeded the Provincial Water Quality Objectives. The results from Indian Creek were very similar to Grindstone, Redhill and Spencer Creeks.

According to *Draper & Assoc*., Indian Creek could be a significant source of suspended sediments, total phosphorus and zinc being delivered to Hamilton Harbour. In particular, the Unit Area Load (Total Load/Watershed Area) for each parameter is often higher for Indian Creek than for the other creeks. The author reports that highway realignment and urban development in the watershed could be responsible for increased erosion and baseflow.

Boyd's report states that median concentrations of Total PAH in suspended sediments from Indian Creek were somewhat higher than concentrations from Cootes Paradise, Grindstone Creek and Redhill Creek.

Benthic Sampling

According to *Dove, Painter and Kraft* of Environment Canada, Indian Creek showed elevated concentrations of dieldrin. Dieldrin is the major breakdown product of aldrin, a pesticide that was used primarily for termite control and on selected crops. Aldrin and dieldrin are banned in the U.S. and have been discontinued in Canada since 1990.

Aldrin was not detected at any site, but its breakdown product dieldrin was detected at 8 sites, including Indian Creek. Dieldrin was found in Indian Creek at concentrations exceeding both the PEL of 6.67 ng/g and the Threshold Effect Level (TEL) of 2.85 ng/g. The concentration of dieldrin in Indian Creek

was 14 ng/g, and was the highest concentration measured in the 130 tributaries sampled in this study.

Dove, Painter and Kraft also note Indian Creek showed elevated concentrations of arsenic (As). Arsenic is a metalloid and a nonessential trace element. Its release from anthropogenic sources is mainly from gold and base metal production facilities, with smaller releases from the use of arsenical pesticides, wood preservatives, coal-fired power generation and disposal of domestic and industrial wastes (Environment Canada, 1993). Arsenic was found to exceed sediment quality TEL of 5.9 ng/g relatively frequently. Exceedences of the PEL (17 ug/g) were less common. The concentration of arsenic in Indian Creek was 23 ng/g and is likely related to anthropogenic activities.

Indian Creek

4.2.1.2 Falcon Creek

Dove, Painter and Kraft report that Falcon Creek showed elevated concentrations of chlordane relative to other sampling sites. Chlordane is a banned organochlorine insecticide that was used on crops and for flea and ticks on pets. Canada discontinued its use in

1990 due to its persistence and toxicity. Total chlordane was detected in Falcon Creek and found above its federal guideline of 8.87 ng/g. The concentration of total chlordane in Falcon Creek was 10 ng/g.

Endosulfan is an insecticide that is the most heavily applied organochlorine in Ontario (Harris et al., 1998). It is used as an alternative for more persistent organochlorines on a multitude of crops. Falcon Creek contained the highest concentrations of total endosulfan (calculated as the total concentration of the three endosulfan parameters), and the parent compounds (endosulfan I and endosulfan II) observed in the 130 tributaries sampled.

The presence of these contaminants in the sediments of the North Shore watershed may be related to current or past practices in the watershed. It is not clear, but possible, that the pesticides or metals could account for the reduced benthic and fish populations. Further study is required to confirm these findings, and look for potential sources.

4.2.2 North Shore Watershed Water Quality Monitoring Program

The data collected as part of the North Shore Watershed Water Quality Monitoring Program (NSWQMP) are designed to complement and augment the existing data. In 2001 and 2002, seven sampling stations were established throughout the watershed. The locations of the stations were designed to help pinpoint any potential sources of contamination in addition to providing the most complete overall picture of water quality throughout the watershed. Data were collected five times. Figure 14 shows the location of the sampling stations in the North Shore watershed.

The parameters monitored as part of NSWQMP are essentially the same as those of the PWQMN. In addition, samples were taken to detect polycyclic aromatic hydrocarbons (PAH), pesticides and bacteria (*E. coli*). Laboratory analysis of the samples is provided by the PSC Analytical Services Inc., Burlington, ON.

Ministry of Environment (MOE) objectives for the protection of the fresh water aquatic environment are used for most water quality parameters monitored by Conservation Halton as part of the NSWQMP. In the case of bacteria, the MOE objective for recreational use is applied. By meeting these, all other objectives, except the most stringent relating to drinking water, are met. Where applicable, federal guidelines are also considered. The parameters sampled are broad-based indicators of surface water quality and when used in conjunction with fisheries and benthic data, can provide a general picture of the overall health of an aquatic ecosystem.

Results of the NSWQMP indicate that while most water quality parameters measured meet MOE water quality objectives, two are sources of concern. Based on all available data, total phosphorus and bacteria concentrations are often elevated in the watershed.

While not toxic by itself, elevated phosphorus levels can lead to degradation of the aquatic environment. Based on the NSWQMP data, 100% of total phosphorus concentrations sampled exceed the desired level of less than 0.03 mg/l.

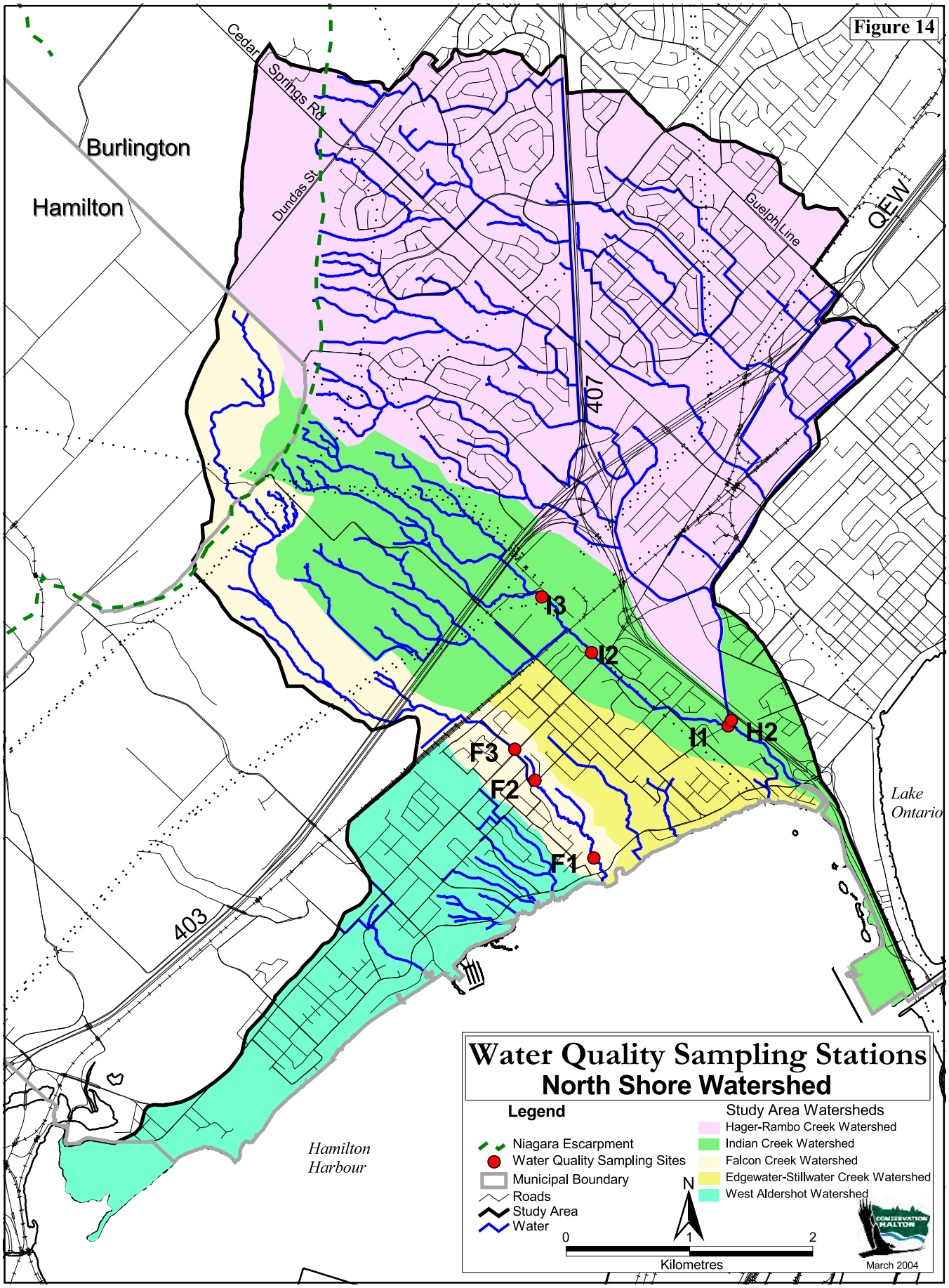


Figure 14
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
I3
I2
I1
H2
F3
F2
F1
Lake Ontario
Hamilton Harbour
Water Quality Sampling Stations
North Shore Watershed
Legend
Niagara Escarpment
Water Quality Sampling Sites
Municipal Boundary
Roads
Study Area
Water
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

High concentrations of phosphorus can result in excessive plant/algae growth and ultimately, in eutrophication and oxygen depletion. Because phosphorus tends to bind to soil particles, there is a close relationship between phosphorus and erosion. Areas with high levels of erosion usually have increased suspended sediments and phosphorus concentrations. Elevated levels of sediments can adversely affect fish habitat.

High bacteria concentrations can pose a health hazard for recreational use or human contact (Table 10). It is believed that runoff from land, the major source of sediments, phosphorus and bacteria, has increased in the watershed due primarily to urban development and various land use practices. A lack of riparian buffer strips along some reaches of the creeks compounds the problem. High concentrations of *E. coli* were found throughout the watershed. Concentrations monitored consistently exceeded provincial objectives (100 *Ec*./100ml) and federal guidelines (200 *Ec*./100ml) for recreational use. Only a limited number of bacteria samples were taken as part of the NSWQMP. Due to the limited sample size no specific sources of contamination could be identified. Surface runoff from urban centres, hardened surfaces and a lack of riparian buffers are thought to contribute to the elevated bacteria concentrations.

Concentrations of metals sampled were found to meet provincial objectives and many samples were below detection limits (BD).

A scan of PAHs and pesticides was also taken on one occasion. The unpublished results indicate the presences of these compounds in the water column, although not in concentrations that are cause for concern. None of these parameters sampled exceeded provincial guidelines.

The followings is a brief overview of total phosphorus and *E. coli* concentrations in the three main subwatersheds.

4.2.2.1 Hager-Rambo Diversion Channel

The median concentration of total phosphorus in the Hager-Rambo diversion channel was approximately 0.09 mg/l. The maximum individual reading for Total Phosphorus was 0.18 mg/l.

Maximum concentrations of 4,400 *Ec*/100ml have been recorded in the Hager-Rambo diversion channel. The geometric mean of *E. coli* concentration was more than 2,600 *Ec*./100ml.

4.2.2.2 Indian Creek

The median concentration of total phosphorus in Indian Creek was approximately 0.16 mg/l. The maximum individual reading for Total Phosphorus in Indian Creek was 0.55 mg/l.

Maximum concentrations of 8,000 *Ec*/100ml have been recorded in Indian Creek. The geometric mean of *E. coli* concentration was more than 2,400 *Ec*./100ml in Indian Creek.

4.2.2.3 Falcon Creek

The median concentration of total phosphorus in Falcon Creek was approximately 0.47 mg/l. The maximum

reading for total phosphorus was as high as 0.72 mg/l in Falcon Creek.

Maximum concentrations of 8,000 *Ec*/100ml have been recorded in Falcon Creek. The geometric mean of *E. coli* concentration was more than 4,000 *Ec*./100ml.

4.2.2.4 Water Quality Summary

The results of the NSWQMP and other studies provide a general picture of water quality that is consistent with the benthic invertebrate and the instream temperature sampling, which was also conducted as part of the North Shore Watershed Study. The results indicate moderately impaired water quality and are representative of a small, urban watershed with some anthropogenic inputs. Caution should be used in interpreting/using the data since it is based on a very limited sample size.

Buffer strips, modified land use practices, stormwater Best Management Practices and public education can all be used to reduce the impact of, pollutants in the watershed.

Table 9 summarizes Total Phosphorus concentrations at the three key stations in the North Shore watershed. Table 10 summarizes *E. coli* concentration at the same stations.

Hager-Rambo Diversion Channel Under Construction

Table 9. Total Phosphorus at three stations within the North Shore Watershed.

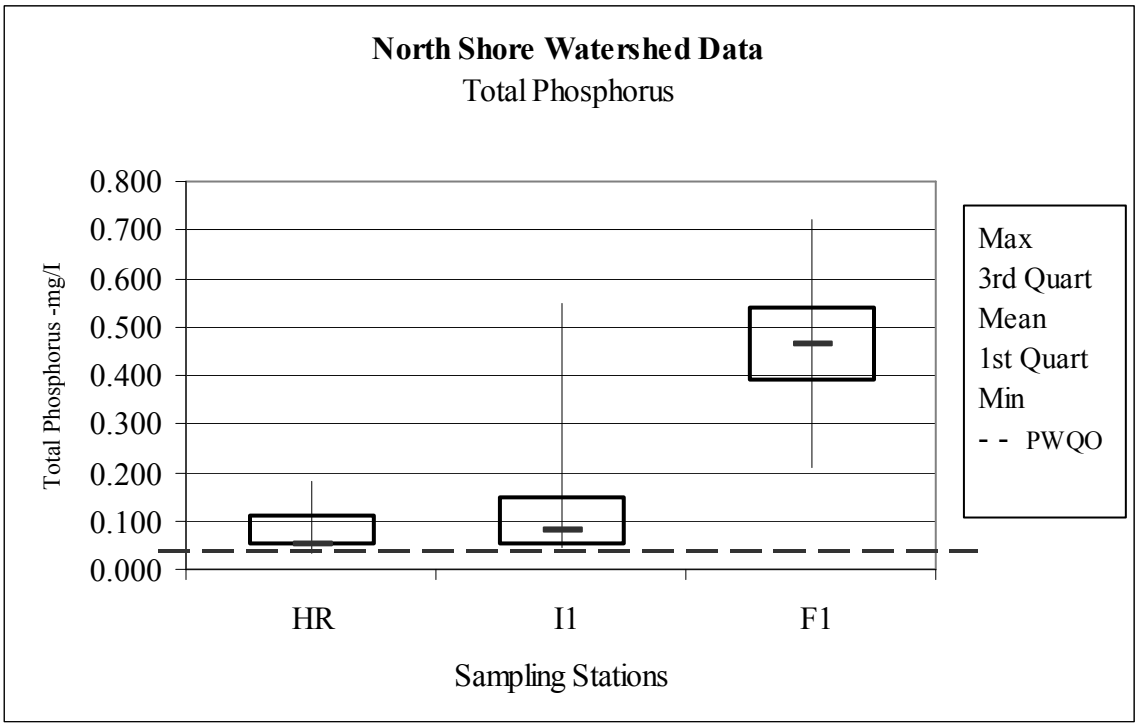
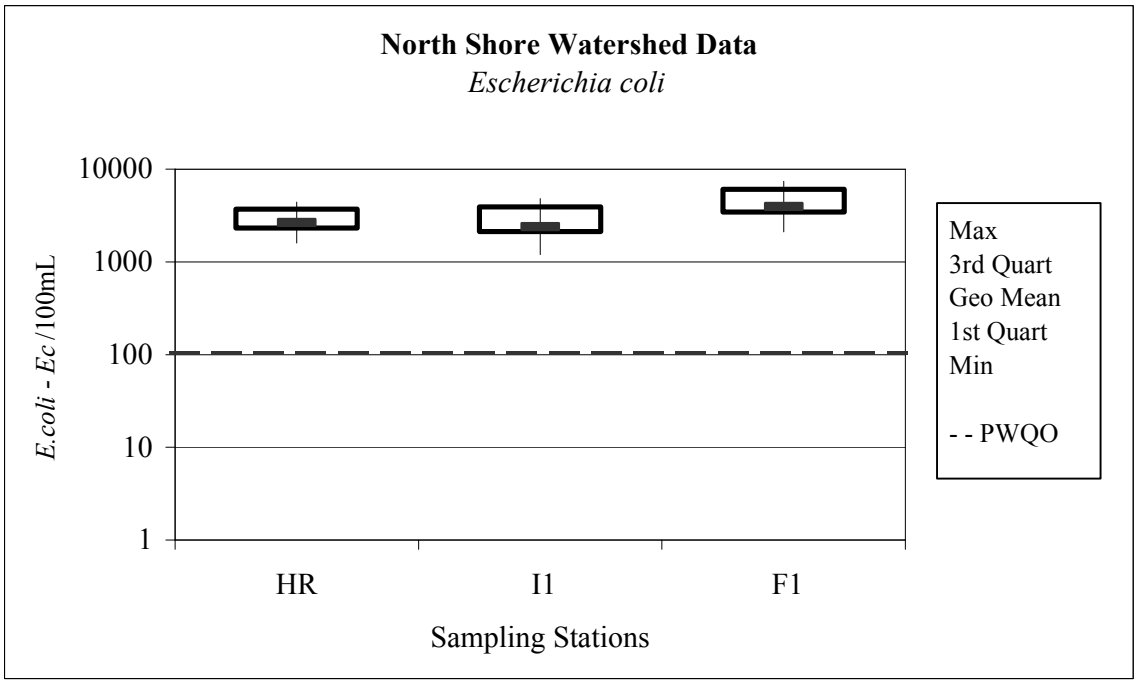


Table 10. *E coli* at three stations within the North Shore Watershed.



4.3 Instream Temperature Survey

A formal instream temperature survey of the North Shore watershed was conducted during the summers of 2001 and 2002 using the thermal stability methodology developed by Stoneman and Jones (1996). This methodology was developed to determine the presence and location of coldwater, coolwater and warmwater habitats in southern Ontario.

Following two to three days of relatively stable, warm weather (no precipitation, maximum air temperatures greater than 24.5^{o}C), water temperatures were taken at easily accessible stations (typically roadsides and bridges) between 4:00 and 4:30 p.m. This measurement represented the maximum daily water temperature and was compared with the maximum daily air temperature (obtained from Environment Canada) using the nomogram designed for southern Ontario streams (Stoneman and Jones, 1996). Based on the protocol, coldwater sites ideal for brook trout and brown trout have an average daily maximum temperature of approximately 14°C. Coolwater sites average approximately 18°C and are ideal for rainbow trout while warmwater sites have average maximum daily water temperatures of approximately 23°C.

The thermal stability protocol provides a general depiction of instream thermal conditions within the watershed. However, it is limited in that it may not identify local areas of thermal refugia (groundwater upwellings, spring sources) which may support salmonids during periods of thermal stress in otherwise marginal coolwater and warmwater habitats. Its utility is also limited in highly urbanized systems since creek enclosures and storm sewer flows can artificially reduce summer instream temperatures.

Sixteen stations were sampled using this methodology on August 7, 2001 and July 9, 2002 (Figure 15). The distribution of instream temperature stations by tributary and subreach is provided in Table 11. Results of station sampling are provided in Appendix 5.

Instream Temperature Sampling

The intent of instream temperature monitoring was to assist in identifying aquatic habitat potential and to prioritize aquatic habitat restoration opportunities within the North Shore watershed. As noted above, the protocol's utility is constrained in highly urbanized systems and aside from assisting in our assessments of baseflow, did not provide highly useful information for this study. Although coolwater reaches are present within the watershed, most of these reaches appear to be associated with upstream enclosures and storm sewer discharge. Where coolwater reaches are associated with groundwater discharge (i.e. West Aldershot Subwatershed), barriers immediately upstream of North Shore Boulevard preclude salmonid migration and baseflows appear to be too

low to support significant resident salmonid populations. The thermal regimes predicted by the protocol within the North Shore Watershed Study creeks are illustrated in Figure 16 and are described in the following subsections.

4.3.1 Rambo Creek

One instream temperature station (R1) was sampled in the lower reaches of West Rambo Creek. Coolwater (Table 11) habitat was identified by the protocol; however, the majority of the creek downstream of Highway 407 is fed by storm sewer discharge or is enclosed which would artificially lower downstream temperatures. No stations were sampled in the upper reaches of Rambo Creek since flows are intermittent.

4.3.2 Hager Creek

Two stations were sampled in the west and east branches of Hager Creek upstream of the QEW/Highway 403.

Upstream of the sampling site, West Hager is sheltered by riparian cover, but quickly warms in the more exposed successional field habitat upstream of North Service Road. This reach of west Hager (Station H1) upstream of the highway provides warmwater habitat (Table 11).

Conducting a Stream Survey on Indian Creek

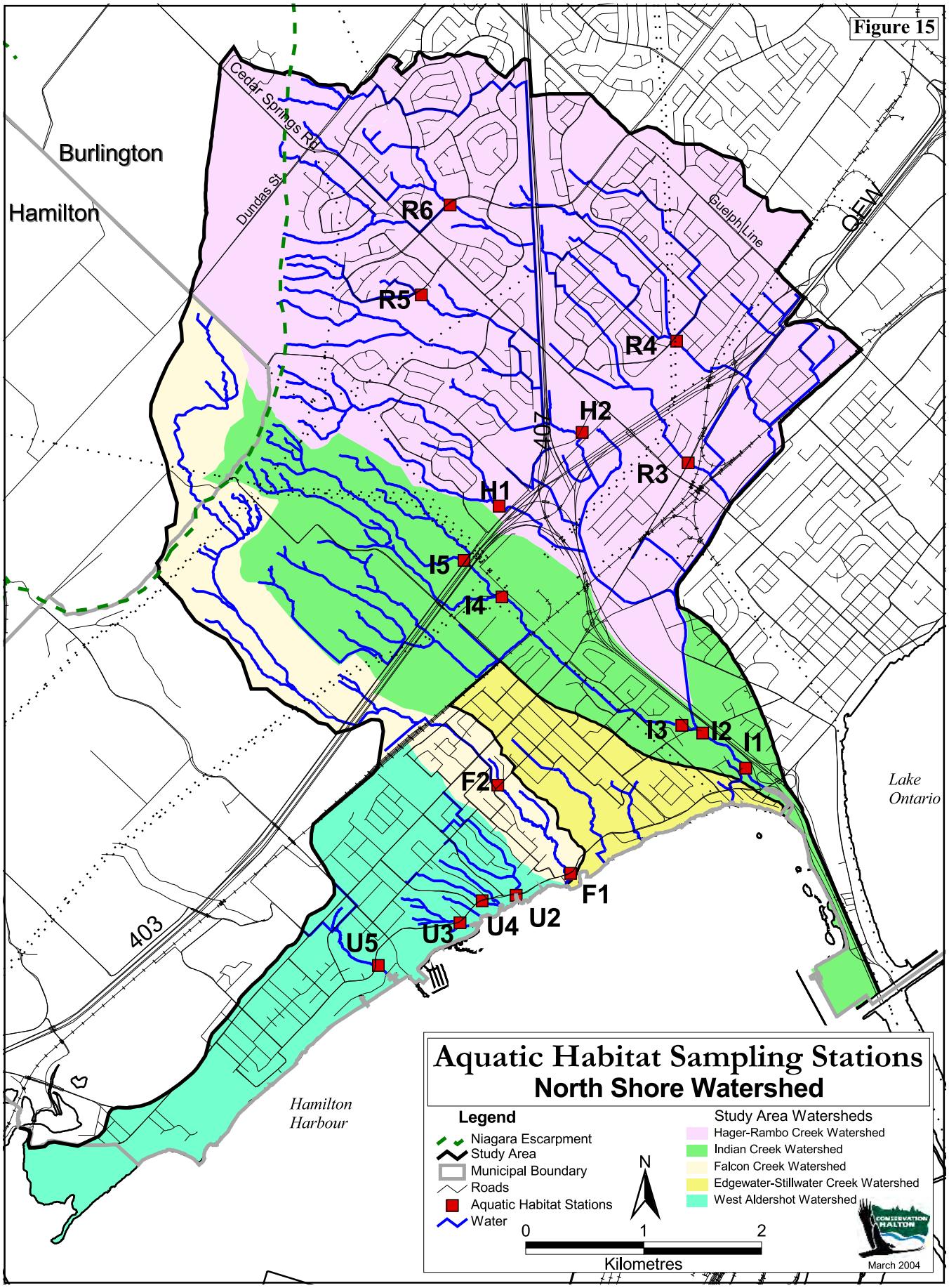


Figure 15
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
403
Lake Ontario
Hamilton Harbour
R6
R5
R4
R3
H2
H1
I5
I4
I3
I2
I1
F2
F1
U2
U3
U4
U5
Aquatic Habitat Sampling Stations
North Shore Watershed
Legend
Niagara Escarpment
Study Area
Municipal Boundary
Roads
Aquatic Habitat Stations
Water
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

Table 11. Distribution of Instream Temperature Stations by Tributary. (* indicates areas affected by upstream stream enclosures)

Creek/Watershed	Stations	Temperature Class
Rambo	R1(west branch)	Cool*
Hager	H1(west branch)	Warm
	H2 (east branch)	Cool
Indian	I1	Warm
	I2	Warm
	I3	Warm
	I4	Warm
	I5	Cool
	I6	Cool
		Marginal
	I7	Cool
		Marginal
Falcon	F1	Cool
		Marginal
	F2	Cool
West Aldershot	T1	Cool
	FG1	Cool
	L1	Cool
	WA1	Cool

The east branch of Hager Creek (Station H2) is largely intermittent upstream of Highway 407. Many changes have recently occurred to the east branch of Hager Creek including the diversion of flows and sewer discharge from upper Rambo Creek and other areas beneath Highway 407 and the upgrading of the Freeman stormwater management ponds between the North Service Road and the QEW. Downstream of Highway 407, the diverted flows from upper Rambo Creek and storm sewers contribute to coolwater conditions and permanent flows. The stretch of stream between Highway 407 and the Freeman ponds does not support a viable fish community, though the stream temperatures indicate coolwater conditions (Table 11). There is an opportunity to reintroduce a viable fish community into this reach of the creek. Although no sampling was conducted downstream of the Freeman ponds or within the concrete prismatic channels, it is assumed that these areas are considered warmwater.

4.3.3 Indian Creek

Seven stations were sampled within the Indian Creek watershed. Flows are generally intermittent upstream of Highway 403, and begin to gain flow downstream of the highway. The most likely source of this flow is from enclosed/diverted flow beneath the highway and possible groundwater discharge from the well-drained Grimsby sandy loam. The channel becomes enclosed downstream of Plains Road and emerges along Francis Road.

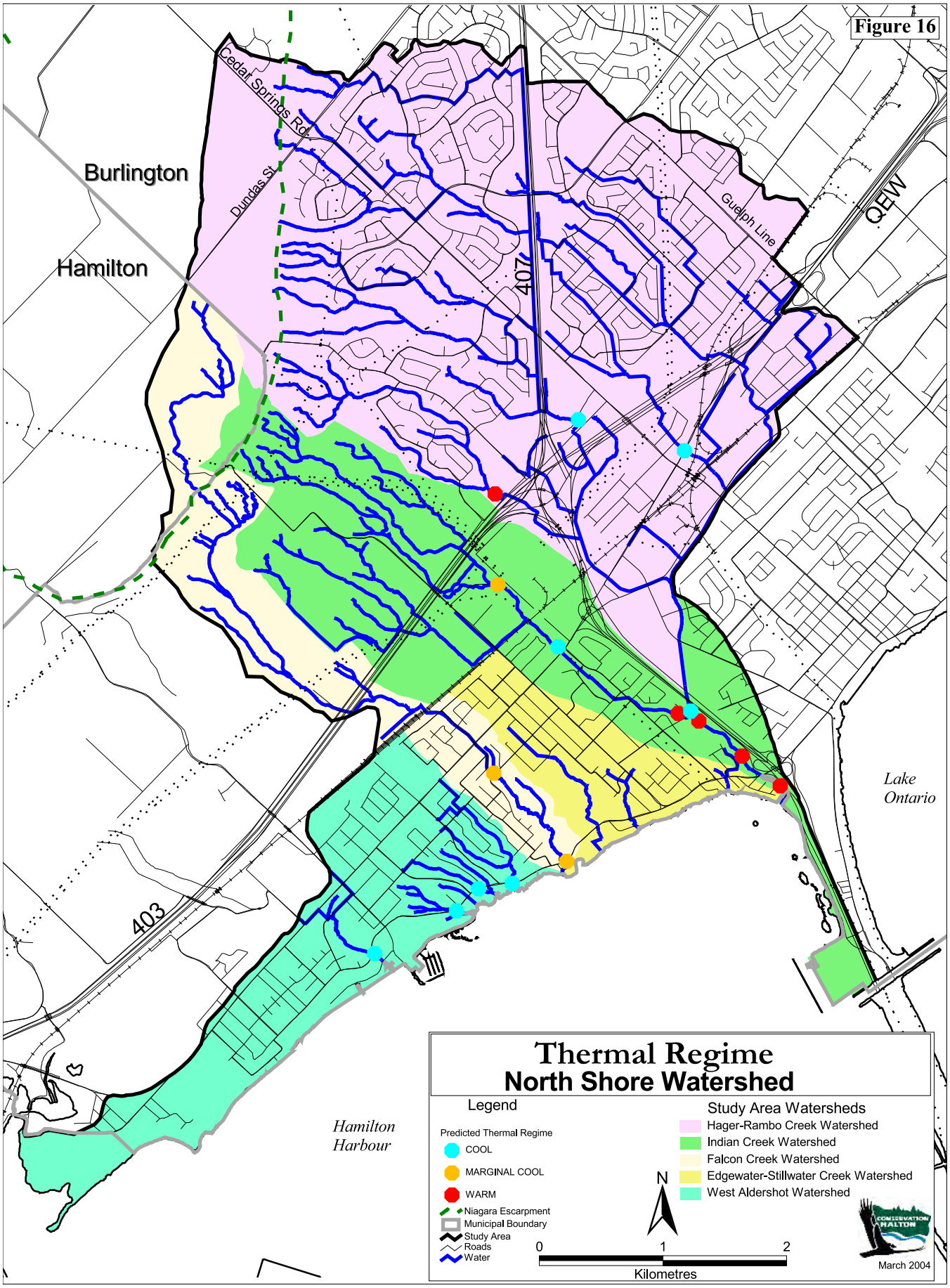


Figure 16
Burlington
Hamilton
Cedar Springs Rd
Dundas St
407
Guelph Line
QEW
403
Lake Ontario
Hamilton Harbour
Thermal Regime
North Shore Watershed
Legend
Predicted Thermal Regime
COOL
MARGINAL COOL
WARM
Niagara Escarpment
Municipal Boundary
Study Area
Roads
Water
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

The stream quickly warms due to lack of riparian vegetation cover and joins the Hager-Rambo Diversion Channel. Temperature sampling also indicates that warmer water within the Hager-Rambo Diversion Channel experiences cooling in the enclosure beneath the QEW as shown by coolwater conditions at Station I3 (Table 11). Warmwater conditions (Table 11) dominate downstream of the Hager-Rambo Diversion Channel and Indian Creek confluence to Lake Ontario. The creek channel is largely exposed with little cover.

4.3.4 Edgewater-Stillwater Creeks

No stations were sampled within the Edgewater-Stillwater watershed. The thermal conditions of these creeks are unknown.

4.3.5 Falcon Creek

Two stations were sampled on this system. Falcon Creek is intermittent upstream of Highway 403. The channel is enclosed downstream of the highway until it reaches Townsend Avenue. Permanent flow is supplied from sewer and stormwater diversion beneath the highway and possibly groundwater discharge from the well-drained sandy loams downstream of Townsend Avenue. Downstream of Townsend Avenue, the stream flows through a well-vegetated valley where coolwater conditions dominate to Lake Ontario (Table 11).

4.3.6 West Aldershot Watershed

Four stations were sampled within the Teal, Forest Glen, LaSalle and West Aldershot Creeks. Coolwater conditions were found within the four stations of these creeks (Table 11). The creeks are fed by storm sewer flow and groundwater discharge associated with the well-drained Grimbsy sandy loam soils.

4.4 Benthic Macroinvertebrate Study

Benthic macroinvertebrates are “bottom dwelling” organisms without backbones that are associated with the substrata of a watercourse, for at least part of their life cycle. These bottom substrates include sediments, debris, logs, macrophyte and filamentous algae. Macroinvertebrates are generally visible to the naked eye. Representative groups include aquatic insects such as stonefly larvae, mayfly larvae, caddisfly larvae, beetles, true bugs, true flies and other invertebrates including isopods, amphipods, crayfishes, clams, snails and worms.

Benthic macroinvertebrates are widely used as bioindicators in the assessment of water quality because they are sedentary, very abundant, easily sampled, continuously subject to local environmental stressors and show a wide range of tolerances to various degrees and types of pollution. Benthic macroinvertebrates are extremely beneficial in water quality assessments since they cannot avoid stressor-related events in the stream, which may be missed by traditional chemical analyses if not sampled during the event. Furthermore, the benthic community composition can provide a means to monitor changes in local ecosystems and water quality. Thus if pollution is moderate or severe, the whole community structure in a stream may simplify in favour of tolerant species. By assessing indicator species, diversity

and functional groups, it is possible to determine water quality.

It is important to note that "water quality" as discussed in this section of the watershed study, may differ from those described in other sections. The definition of water quality in this section deals entirely with ecological water quality as it relates to physicochemical parameters and not water quality as it pertains to human health, although it is recognized that both are intertwined.

Indian Creek

Adjacent and upstream land use affects water quality in streams and rivers. Aquatic benthic communities downstream of urban environments are affected by urban stormwater runoff which may contain road salts, chlorine from improper swimming pool discharge, tars, oils, gasoline, metals, rubber tire derivatives and elevated temperatures (Mackie, 1998). Urban land development can have a twofold effect on aquatic systems and benthic organisms due to increases in sediment loads during construction and increases in storm discharge due to development (increase in impervious area leading to reduced infiltration and increased surface runoff). Artificial channelization of streams is also associated with urbanization and can cause a decrease in habitat, and increased erosion. Poor agricultural and animal husbandry practices can also adversely impact water quality and can result in increased sediment loads, habitat destruction and organic enrichment. Runoff from fields and lawns can result in organic enrichment (fertilizers), increased sediment loading and the direct input of pesticides and herbicides into the stream (Mackie, 1998) if there is not an adequate buffer surrounding the stream or if the storm sewer system discharges directly into a creek. Direct and indirect habitat loss, including the destruction of upstream wetlands, can also degrade water quality. Artificial impoundments such as dams, reservoirs and on-line ponds have detrimental effects on streams and rivers by imposing a lentic habitat within a lotic system (Mackie, 1998), disrupting stream dynamics and increasing stream temperatures.

To assess water quality within the North Shore watershed on an ecological basis, nine benthic macroinvertebrate stations were sampled from August to September 2001 (Figure 15, Table 12). Although benthic samples are ideally obtained during the early spring or late fall to ensure the collection of more mature insects, this was not feasible given the limited staff resources available during these time periods. The stations were selected to provide an overview of the benthic resources and water quality throughout the watershed. Samples were not obtained from the upper headwaters due to the intermittent nature of these systems. Samples were also not obtained from the concrete prismatic channels or the smaller tributaries within the Edgewater-Stillwater or West

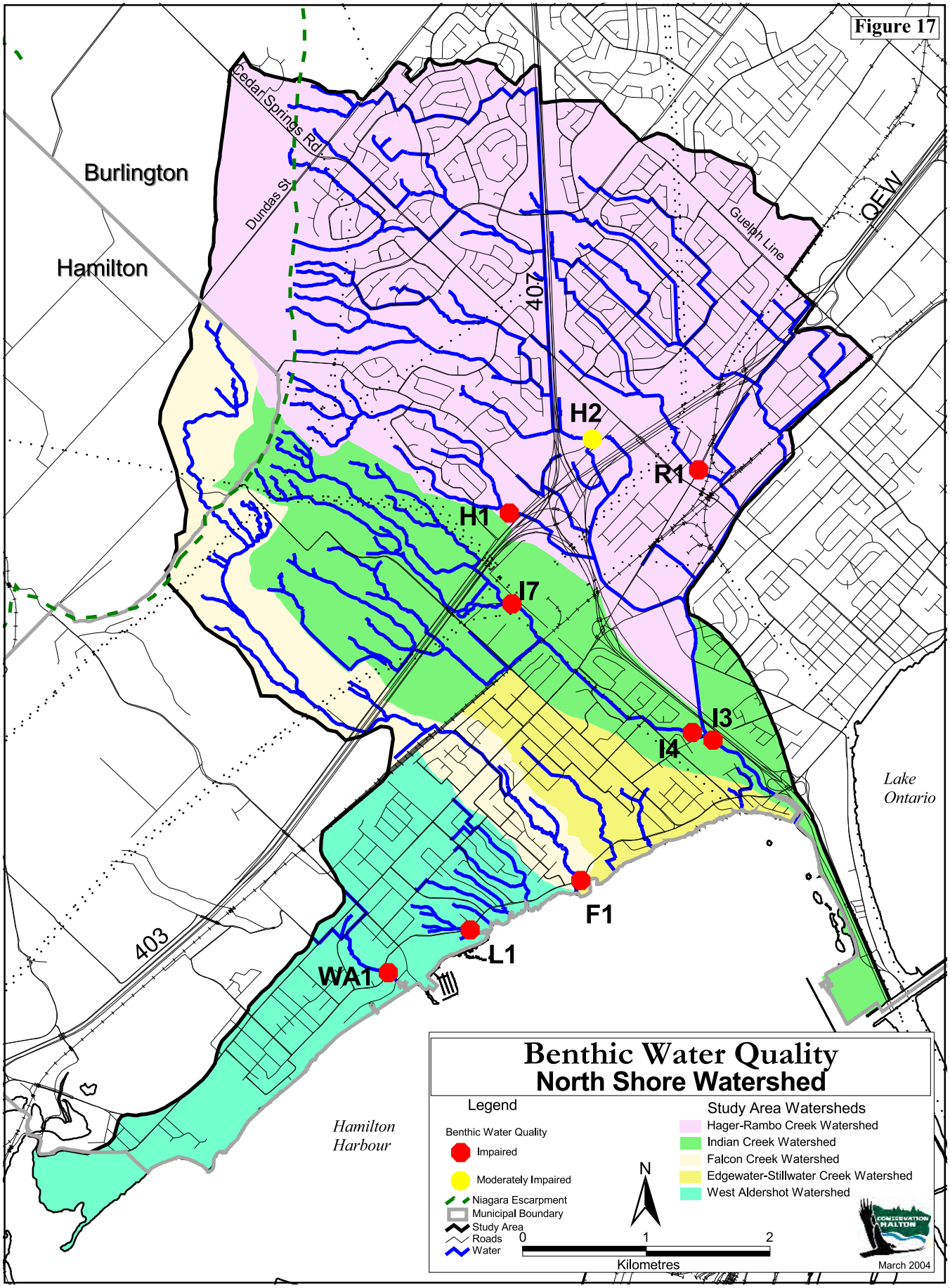


Figure 17
Burlington
Hamilton
Cedar Springs Rd
Dundas St
407
Guelph Line
QEW
H2
R1
H1
I7
I3
I4
F1
L1
WA1
403
Lake Ontario
Hamilton Harbour
Benthic Water Quality
North Shore Watershed
Legend
Benthic Water Quality
Impaired
Moderately Impaired
Niagara Escarpment
Municipal Boundary
Study Area
Roads
Water
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

Table 12. Distribution of Benthic Stations by Creek/Watershed

Creek/Watershed	Stations
Rambo	R1
Hager	H1,H2
Indian	I3,I4,I7
Falcon	F1
West Aldershot	WA1,L1

Aldershot watersheds due to lack of suitable substrate or flow for invertebrate colonization. The benthic sampling procedure followed the BioMAP protocol (Griffiths, 1998). Two quantitative Surber samples (0.093 m^2 sampling area, 600 um mesh) were collected from riffle habitats and one qualitative D-Frame sweep sample was collected from representative habitats at each station. Each sample was live-sorted and preserved in 90% ethanol. Sample identification was performed in the lab using a standard dissecting microscope (up to 40x magnification). Specimens were identified to the "lowest practical taxonomic level" whenever possible. Some species or genera could not be identified to the lowest practical level due to lab and magnification constraints.

A number of biological indices were utilized to assess each site including: percentage aquatic worms (Oligochaeta), percentage midges (Chironomidae), percentage aquatic sowbugs (Isopoda), percentage snails (Gastropoda), percentage true flies (Diptera), percentage insects, percentage dominant taxon, percentage feeding guild, number of taxa (taxa richness), percentage total of Mayfly (Ephemeroptera), Stonefly (Plecoptera) and Caddisfly (Trichoptera) species (EPT), Hilsenhoff Biotic Index (HBI) and BioMAP Water Quality Index (WQI). The results of each index is provided in Appendix 4. Since the natural unimpaired populations can experience a great deal of variation, the use of multiple indices can help tease out subtle trends of impairment or unimpairment. Each index has its own set of inherent benefits and capabilities in detecting stream impairment and is associated with a range of values that correspond to three possible stream conditions: Unimpaired, Moderately Impaired or Impaired (Appendix 4) (CEW, 2002). To provide a more robust measurement of stream condition at a site, an overall aggregate assessment of all the indices was then used. The result of the indices was then tallied for each site and the site was classified in one of three categories: Unimpaired, Moderately Impaired or Impaired.

If four or more of the indices were shown to be within the unimpaired limits the site was declared as "Unimpaired". If five to eight indices were calculated outside of the expected (Unimpaired) limits, the site condition was reported as "Moderately Impaired", and if greater than 8 indices were outside of the unimpaired limits the site was rated as "Impaired" (adapted from CEW, 2002). The degree and potential causes of impairment were then determined by examining the individual indices and site conditions (Figure 17).

An overall summary of water quality designation criteria, as determined through the analysis of multiple benthic

indices, is presented in Appendix 4. The following subsections provide a description of assessed conditions for watercourses and watercourse reaches of the West Aldershot, Falcon, Indian, Hager and Rambo watersheds. Water quality designations at each station are presented in Table 13. No stations were sampled within Roseland Creek due to lack of appropriate habitat.

urbanization and associated erosion. Much of the upstream portion of this reach has been enclosed and food production from periphyton and riparian vegetation within the stream may be inadequate to support a healthy benthic community. The site is also associated with upstream storm sewer drainage from residential and industrial areas in addition to runoff from the QEW and

Table 13. Summary of Water Quality Designations Associated with Benthic Stations

Creek/Watershed	Stations	Benthic Water Quality	Dominant Taxonomic Group	Inferred Nutrient Conditions	Dominant Feeding Guild	Inferred Thermal Conditions	Inferred Oxygen Conditions
Rambo	R1	Impaired	Isopods	Mesotrophic	Scavengers	Warm	Moderate
Hager	H1	Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Warm	Moderate
	H2	Moderately Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Warm	Moderate
Indian	I3	Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Cool to Warm	Moderate
	I4	Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Cool to Warm	Moderate
	I7	Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Cool to Warm	Moderate
Falcon	F1	Impaired	Midges	Mesotrophic	Scavengers /Collectors	Cool to Warm	Moderate
West Aldershot	WA1	Impaired	Isopods	Mesotrophic	Scavengers /Collectors	Cool	Low
	L1	Impaired	Amphipods	Mesotrophic	Scavengers /Collectors	Cool	Low

4.4.1 Rambo Creek

One station (R1) was sampled within this reach. The benthic water quality at the station was impaired (Table 13). The major contributors to the impaired benthic water quality at the site are lack of adequate food supply, runoff from

Highway 407. This runoff contains potentially toxic substances as previously discussed. Lack of storm water management in some of these areas likely contributes to erosion and large sediment loads, and poorer water quality downstream.

4.4.2 Hager Creek

Two stations were sampled within the west (H1) and east (H2) branches of Hager Creek upstream of Highway 403. The benthic water quality in the west tributary was impaired and moderately impaired in the east tributary (Table 13). The major contributor to the impaired benthic water quality at the site is urbanization and increased erosion. Some of the upstream portion of the east tributary has been channelized but both it and the west tributary appear to have sufficient riparian wooded areas that would help provide a suitable food source to support a healthy benthic community. The east tributary is also associated with upstream storm sewer drainage from residential areas as well as Highway 407, while the west tributary is associated with residential areas. This runoff contains potentially toxic substances such as road salts, chlorine from improper swimming pool discharge, tars, oils, gasoline, metals, rubber tire derivatives, pesticides and detergents (Mackie, 1998). Lack of storm water management in some of these areas likely contribute to large sediment loads, and poorer water quality downstream.

4.4.3 Indian Creek

Two stations were sampled within the lower reaches of Indian Creek, upstream (I4) and downstream (I3) of the Hager-Rambo Diversion Channel confluence. The benthic water quality was impaired at both sites, though the downstream site is less impaired (Table 13). Upstream of the diversion channel the major contributors to the impaired benthic water quality at the site are lack of adequate food supply, runoff from urbanization and increased erosion. A long stretch of the stream is buried from Fairview Street to Cedar Avenue, and thus does not provide a suitable food source to support a healthy benthic population. Downstream of Cedar Avenue, the stream is surrounded by some wooded riparian vegetation. The stream also drains urbanized residential and industrial areas that contain potentially toxic substances. This tributary is associated with drainage from the upstream quarry that contributes a great deal of sediment load. Lack of storm water management and channelization in some of these areas also likely contribute to large sediment loads, and poorer water quality downstream.

Adult Damselflies

Downstream of the Hager-Rambo Diversion Channel and Indian Creek confluence (I3), the major contributors to the impaired benthic water quality are lack of adequate food supply, runoff from urbanization and increased erosion. The Hager-Rambo Diversion Channel contains water draining from the upper portions of Hager Creek and Rambo Creek and thus lacks a sufficient food source for the benthic organisms. The water quality is slightly less impaired downstream of the confluence than

upstream. This seems contrary to what would be expected since one would expect higher water temperatures from water in the diversion channel. However, water temperatures from the diversion channel are actually cooler than expected. It is hypothesized that the water temperature is lowered when the water flows underground for approximately 200m upstream of the site. The confluence of the two channels likely contributes some aeration effects that would improve water quality. The decreased water temperature and aeration from the tributary confluences positively contributes to water quality. The stream also drains a portion of Highway 403, urbanized residential and industrial areas and is affected by the associated pollutants.

One station was sampled within the middle reaches of Indian Creek (I7). The benthic water quality was impaired (Table 13). The major contributors to the impaired benthic water quality at the site are runoff from urbanization and quarrying activities and erosion due to lack of stormwater management. This tributary is associated with drainage from the upstream quarry that contributes a great deal of sediment load. Lack of storm water management and stream channelization in some of these areas also likely contributes to large sediment loads, and poor water quality downstream.

Furthermore, surface water quality and sediment (Dove et al., 2003) analyses indicated a number of alarming trends associated with urban runoff, pesticides, and other toxicants that would effect the benthic community within Indian Creek including elevated levels of dieldren, aldrin, and several metals.

4.4.4 Falcon Creek

One station was sampled within the lower reaches of Falcon Creek (F1). The benthic water quality was severely impaired (Table 13). The site lacks many of the organisms that one would expect in a permanent flowing creek. It is hypothesized that a toxic event or series of events caused by an unidentified source may be playing a role in the severe impairment at the site. Properties with swimming pools directly adjacent to the creek were observed discharging pool water into the creek during the 2003 field season. This could be the cause of the impaired benthic community if the pool water was recently shocked with chlorine and allowed to discharge to the creek. The creek may also receive regular doses of pesticide runoff associated with the upstream golf course operations and residential subdivision. Furthermore, surface water quality and sediment (Dove et al. 2003) analyses indicated a number of alarming trends associated with urban runoff, pesticides, and other toxicants that would effect the benthic community within Falcon Creek including elevated levels of endosulfan, and chlordane.

4.4.5 LaSalle Creek

One station was sampled within LaSalle Creek (L1). The benthic water quality at the site was impaired (Table 13). The major contributors to the impaired benthic water quality at the site are largely unknown though some effects could be attributable to runoff from upstream urbanization. The lack of suitable riffle substrate (sands), and flow through a small, low gradient wetland area may further explain the impairment,

as exhibited by the presence of many low oxygen tolerant organisms.

4.4.6 West Aldershot Creek

One station was sampled within the West Aldershot Creek (WA1). The benthic water quality at the site was impaired (Table 13). The major contributors to the impaired benthic water quality at the site are runoff from upstream urbanization and erosion. This tributary is associated with drainage from the upstream residential area.

4.5 Fish Community Study

4.5.1 Historical Sampling

The historical fish community studies have been very limited in the North Shore Watershed Study area. These studies are summarized in Appendix 3, and were associated with specific development or research projects.

The fisheries community of the near shore area of Hamilton Harbour associated with the North Shore watershed is well documented and also discussed below.

4.5.2 Fish Community Sampling Protocol

Although Conservation Halton and other groups have performed individual site-specific fish community assessments in the past, a watershed-scale assessment within the creeks has not been previously undertaken within the North Shore watershed. To address this deficiency, fish community sampling was carried out in support of the North Shore Watershed Study in 2001.

The sampling effort was generally directed toward the lower portions of the watersheds where flows are not intermittent. Many stations were paired with benthic, temperature and water

Electrofishing

quality stations to allow for community comparisons.

The sampling program carried out was moderate in intensity. The program was not intended to provide quantitative fish community analyses or to define the ultimate extent of fish habitat within the watershed. The purpose of the monitoring program was to qualitatively assess the existing fisheries community composition and compare it to historic records wherever possible. It should be noted that comparison of data from different surveys may be limited by differences in survey effort, methodology and timing of sampling. Sampling was conducted in mid to late summer. Although some reaches were deemed intermittent, they may provide seasonal habitat at different times of year.

Fish community sampling was conducted at 17 stations within the main branch and tributaries of the North Shore watershed as part of the watershed study (Figure 15). Sampling results and historical records are provided in Appendix 3. Table 14 shows the distribution of sampling sites by subreach and tributary.

Fish community sampling consisted of electrofishing using a backpack electrofisher and one or two netters. At each station, sampling progressed upstream in a systematic manner with an objective of sampling the full range of habitats available within a particular stream reach. Depending on stream size and habitat heterogeneity, the sampled reach varied from 50 m to over 300 m in length.

A Ministry of Natural Resources Field Collection Record form was completed for each station. Relevant data recorded on these forms include site location, station diagram, sample time, sample date, species captured (numbers and approximate sizes), substrate, cover and water and air temperatures.

The following subsections describe the fish community and functions associated with the various reaches of the North Shore watershed. Within each reach, the existing fish community is described and compared to past records (where available).

No stations were sampled within Roseland Creek due to lack of appropriate habitat.

Table 14. Distribution of Fish Community Sampling Stations by Subreach and Tributary.

Creek/Watershed	Stations
Rambo	R1,R2,R3,R4
Hager	H1,H2
Indian	I2,I3,I4,I7,I8
Falcon	F1,F2
West Aldershot	T1,FG1,L1,WA1

4.5.3 Fish Community Sampling Results

4.5.3.1 Rambo Creek

Rambo Creek is highly altered and consists of a series of naturalized, enclosed, concrete or altered channels (Figure 18). The fish community in Rambo Creek is limited to remnant populations of creek chub (*Semotilus atromaculatus*) found in the lower reaches of the east and west tributaries of Rambo Creek, between Highway 403 and the Hager-Rambo Diversion Channel. Recent sampling efforts prior to the construction of Highway 407 (SNC-Lavalin Engineers and Constructors Inc., 1999) and sampling efforts from this study did not find any fish communities in the upper reaches of Rambo Creek. Although some reaches were deemed intermittent, they may provide seasonal habitat at different times of year. It is not known if ponds and stormwater ponds associated with the creek contain any fisheries. Several barriers to fish passage exist within Rambo Creek. The largest barrier to fish passage within East Rambo Creek is associated with the enclosed channel at Mountain Side Drive and the largest barrier within West Rambo Creek is associated with the enclosed channel at Leighland Road. The Hager-Rambo Diversion Channel also represents a barrier to fish passage since it is very difficult for fish to migrate through the concrete channel (Figure 19).

4.5.3.2 Hager Creek

Similar to Rambo Creek, Hager Creek is highly altered and consists of a series of naturalized, enclosed, concrete or altered channels (Figure 18). Sampling in support of this study and 1998 sampling in support of a Highway 403 (EcoTec, 1999) study indicate the fish community in Hager Creek is limited to remnant populations of creek chub, common shiner, and white sucker found in the lower reaches of West Hager. Previous sampling efforts in the east branch of Hager Creek, upstream of North Service Road did not yield any results. In 2001, a single carp (*Cypriinus carpio*) was captured during the course of this study.

Creek Chub

Recent changes in flow diversion beneath Highway 407 into the East Hager and stormwater management ponds associated with Highway 403 may have sufficiently improved flow conditions within this reach to potentially support a more diverse fish community. Recent sampling efforts prior to the construction of Highway 407 (SNC-Lavalin Engineers and Constructors Inc., 1999) did not find any fish communities in the upper reaches of Hager Creek. Although some reaches were deemed intermittent, they may pro-

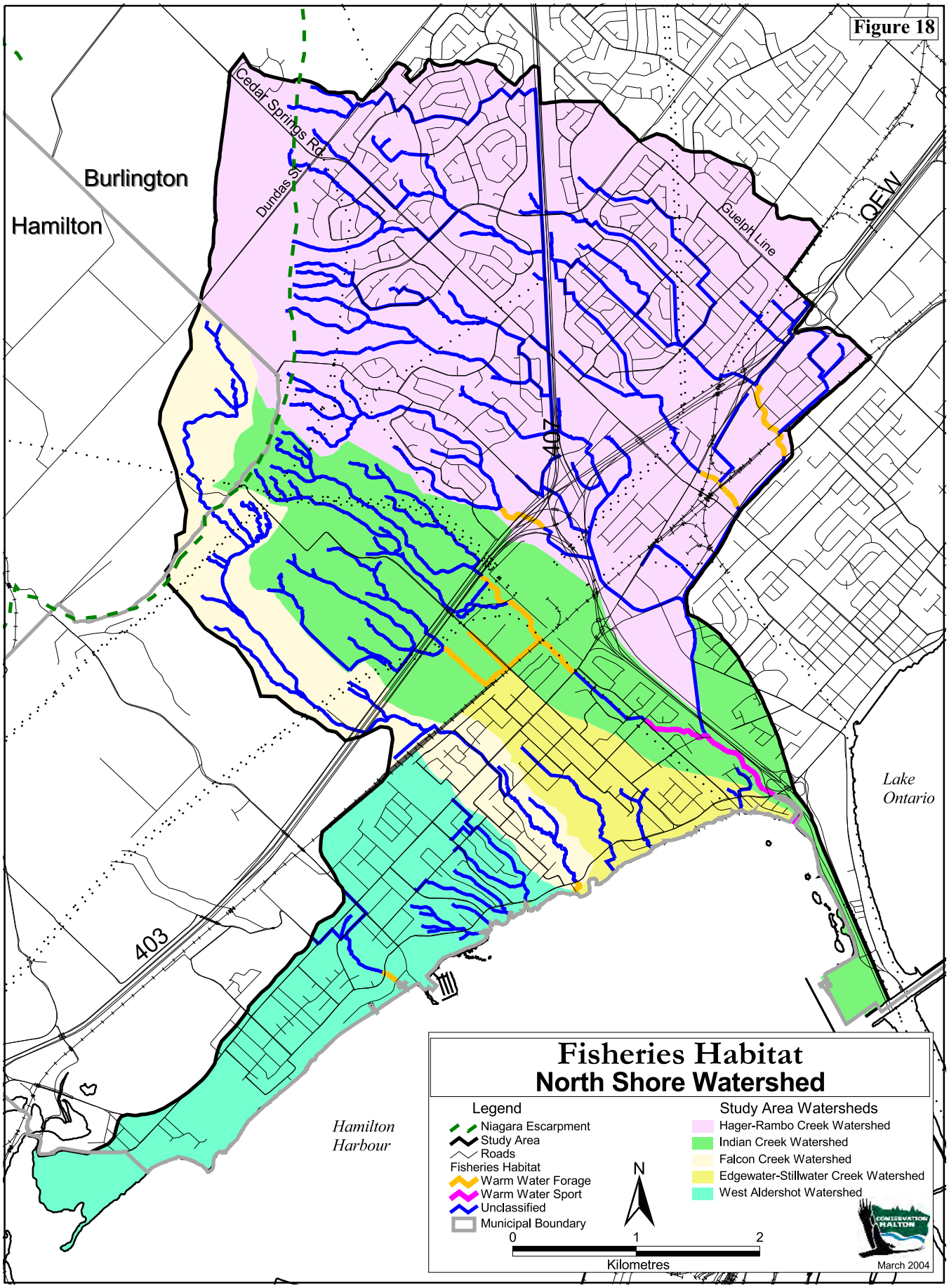


Figure 18
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Fisheries Habitat
North Shore Watershed
Legend
Niagara Escarpment
Study Area
Roads
Fisheries Habitat
Warm Water Forage
Warm Water Sport
Unclassified
Municipal Boundary
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

vide seasonal habitat at different times of year. It is not known if ponds and stormwater ponds associated with the creek contain any fisheries. Several barriers to fish passage exist within Hager Creek that are primarily associated with the Highway 403 and QEW interchange stormwater facility (Figure 19).

Blacknose Dace

4.5.3.3 Indian Creek

Indian Creek is highly altered and consists of a series of naturalized, enclosed, or altered channels (Figure 18). The fish community in the upper reaches of East Indian Creek is limited to remnant populations of creek chub found in the vicinity of Highway 403. West Indian Creek is intermittent and supports a remnant fish community of creek chub (EcoTec, 1999). Downstream of Francis Road, Indian Creek contains the most diverse fish community within the entire North Shore watershed, particularly downstream of the Hager-Rambo Diversion Channel. This reach is known to support several species including blacknose dace (*Rhinichthys atratulus*), bluntnose minnow (*Pimephales notatus)*, carp, creek chub, fathead minnow (*Pimephales promelas)*, goldfish (*Carassius auratus*), lake chub (*Couesius plumbeus*), longnose dace (*Rhinichthys cataractae*), northern red bellied dace (*Phoxinus eos*), round goby (*Neogobius melanostomus*), white sucker (*Catostomus commersoni*) and possibly brassy minnow (*Hybognathus hankinsoni*), common shiner (*Luxilus cornutus*) and pumpkinseed (*Lepomis gibbosus*). Chinook salmon (*Oncorhynchus tshawytscha*) have also been observed migrating into Indian Creek, though the creek does not likely support active reproduction. The estuary habitat at the mouth of Indian Creek may also serve as an important refuge area for Hamilton Harbour fishes. It is very likely that the estuary contains several other fish species not captured in this study. Since the conditions are not conducive to electrofishing, no sampling was conducted in the Indian Creek estuary. The enclosure of Indian Creek along Francis Road, and the culvert at North Shore Boulevard represent the largest barriers to fish passage in Indian Creek (Figure 19).

Furthermore, surface water quality and sediment (Dove et al., 2003) analyses indicated a number of alarming trends associated with urban runoff, pesticides, and other toxicants that would effect the fish community within Indian Creek including elevated levels of dieldren, aldrin, and several metals.

4.5.3.4 Edgewater-Stillwater Watershed

These small creeks have been altered and enclosed during the development of the Burlington Golf and Country Club and surrounding suburban area (Figure 18). A small population of minnows was observed in Edgewater Creek in 2000. It is not known if the ponds associated with the Burlington Golf and

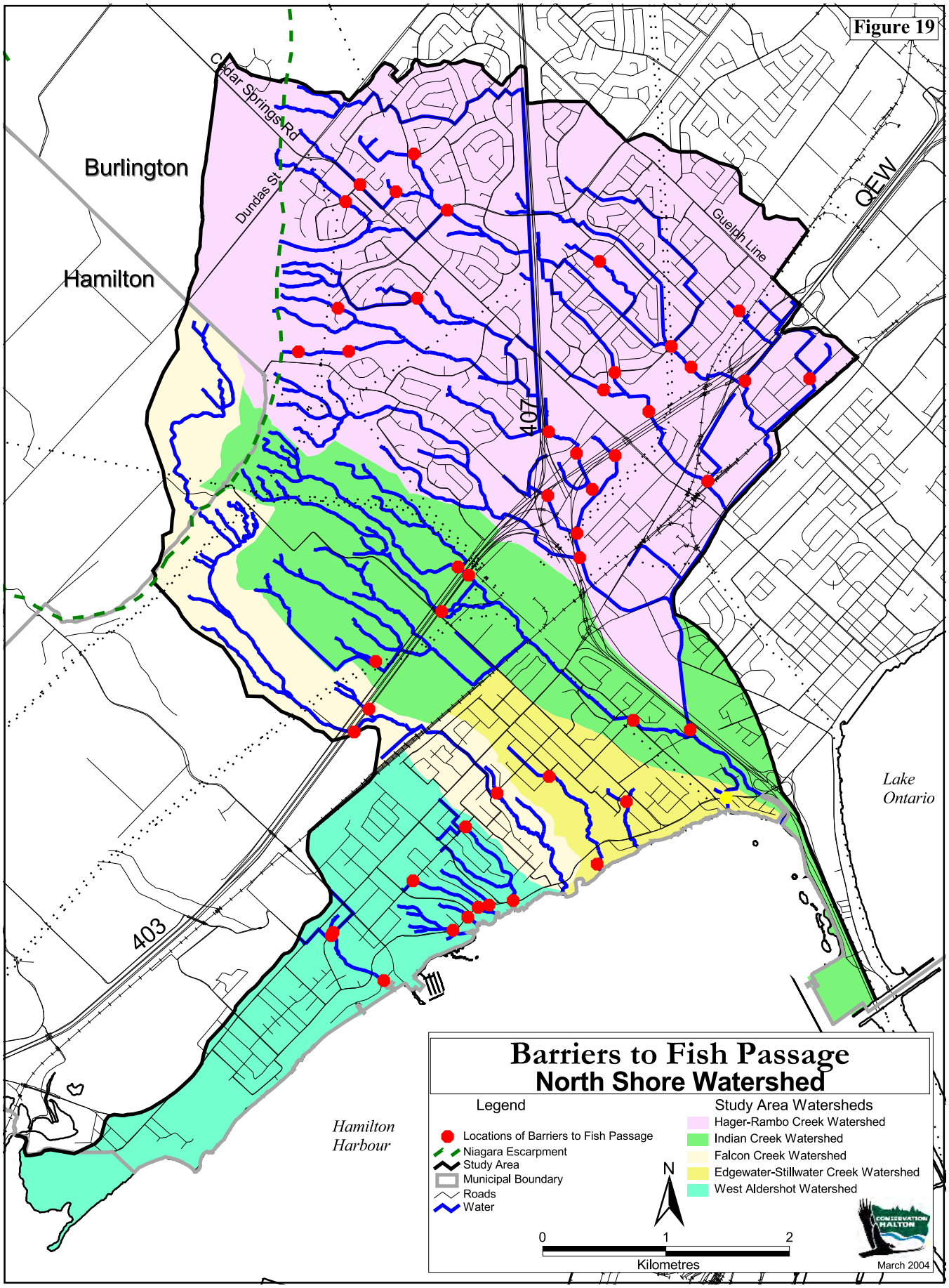


Figure 19
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Barriers to Fish Passage
North Shore Watershed
Legend
Locations of Barriers to Fish Passage
Niagara Escarpment
Study Area
Municipal Boundary
Roads
Water
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
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2
Kilometres
March 2004

Country Club support a natural fish community.

4.5.3.5 Falcon Creek

The upper reaches of Falcon Creek are generally well forested and naturalized while the mid reaches are highly altered and consist of a series of naturalized, enclosed, or altered channels (Figure 18). Upstream of the CN tracks flows are intermittent and baitfish were observed in 1997 (Ecoplans, 1997). Naturalized channels with permanent flow are found below Townsend Avenue. Sampling undertaken in this reach in support of the National Sewer Pipe Limited study in 1982 found several species of warmwater forage fish including bluntnose minnow, fathead minnow, mimic shiner (*Notropis volucellus*) and spottail shiner (*Notropis hudsonius*). There are conflicts between this report and the ROM database listing for this report which also includes emerald shiner (*Notropis atherinoides)* and spotfin shiner (*Cyprinella spiloptera*). Sampling efforts in 2001 and 2002 failed to capture a similar diversity of fishes within this same reach except for a single creek chub caught during benthic sampling and a single carp. Several private swimming pools are known to discharge water directly to the creek, which may be responsible for the lack of a fish community in this reach. Furthermore, surface water quality and sediment (Dove et al. 2003) analyses indicated a number of alarming trends associated with urban runoff, pesticides, and other toxicants that would effect the benthic community within Falcon Creek including elevated levels of endosulfan, and chlordane. A barrier to fish passage is associated with the culvert and enclosure at Townsend Avenue (Figure 19).

4.5.3.6 West Aldershot Watershed

Teal Creek supports a limited fish community of warmwater forage fish including creek chub and fathead minnow downstream of North Shore Boulevard. Similarly West Aldershot Creek supports a remnant population of creek chub downstream of North Shore Boulevard. Both creeks have direct access to the Hamilton Harbour. LaSalle Creek, Forest Glen Creek, and the portions of Teal and West Aldershot Creeks upstream of North Shore Boulevard do not contain viable fish communities. Ponds associated with LaSalle Park/Creek were not sampled during the course of this study. Barriers to fish passage in these creeks are associated with the culverts at North Shore Boulevard (Figure 19).

4.5.3.7 Summary

The fish community within the North Shore watershed has undergone significant changes since European settlement. Fish habitat has been highly altered and disturbed (Figure 18, 19). The majority of fish communities within the watershed consist of remnant populations of tolerant warmwater forage fishes.

4.6 Hamilton Harbour Near Shore Aquatic Habitat

Hamilton Harbour is the receiving body for the North Shore watershed. The harbour contains a large deep water and littoral aquatic system. Numerous different types of fish habitat are found

within the harbour including clear open waters, rocky shoals and turbid marshes (Dwyer, 2003). A severe loss of fish habitat has been documented along the shoreline since European settlement. The shoreline associated with the North Shore watershed has largely been altered from its original configuration. Breakwalls and other forms of shoreline hardening are prevalent along the majority of the shoreline. A large area of unprotected shoreline is found between Willow Point and the Desjardins Canal. Recent efforts by the Hamilton Harbour Fish and Wildlife Habitat Restoration Project have helped to re-establish fish habitat within the harbour through the creation of islands and emergent shoals at LaSalle Park and the north eastern shoreline to the north of the Canada Centre for Inland Waters.

In total, 93 fish species have been collected in Hamilton Harbour since the early 1900's, with only 52 species being recorded since 1990 (Dwyer, 2003). Many of these species have been locally extirpated including muskellunge (*Esox masquinongy*), Atlantic salmon (*Salmo salar*) and cisco (*Coregonus artedi*). Other species that were once abundant, such as northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*) have been severely reduced in population size. Common species within the harbour include common carp

RECOMMENDATIONS TO CARE FOR THE BAY

1. Net discharge of phosphorus meet loading targets for creeks
2. Protect riparian buffers
3. Remediate source of sediment
4. Control urban runoff
5. Shoreline remediation/naturalization
6. Water conservation strategies
7. Complete and implement watershed studies
8. Implement stormwater management practices
9. Undertake groundwater studies and monitoring throughout the Hamilton Harbour watershed
10. Goal of zero discharge of trace metals and organics
11. Reduction of pesticide use
12. Restore ecosystems of the lower reaches of the Hamilton Harbour tributaries
13. Habitat protection from overuse by the public
14. Provide more physical access to the shores of Hamilton Harbour
15. Promotion of natural ecosystems appreciation throughout the entire watershed area
16. Protection of the views and vistas of the Harbour
17. Develop, maintain and evaluate public education programs
18. Distribution of information on Harbour and watershed conditions
19. Initiate an adoption program for stream sections
20. Continue to implement the Hamilton-Halton Watershed Stewardship Program
21. Continue to monitor creek water quality
22. Continued surveillance and monitoring

(*Cyprinus carpio*), white perch (*Morone americana*), gizzard shad (*Dorosoma cepedianum*), blue gill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*) and brown bullhead (*Ameiurus nebulosus*). The round goby has recently been captured within Hamilton Harbour (Faulkenham and Theysmeyer, 2001). This exotic species has been implicated in the predation of native sunfish species as well as the displacement of the native slimy sculpin (*Cottus cognatus*) (Faulkenham and Theysmeyer, 2001).

4.7 Aquatic Ecosystem Health Summary

An assessment of aquatic ecosystem health requires an evaluation of the parameters that contribute to healthy aquatic ecosystems. These parameters are often studied in isolation; however, since they are closely intertwined in nature, an integration of these individual studies is required to form a holistic perspective on aquatic ecosystem health. This section integrates the results of the water quality, instream temperature, benthic invertebrate, fisheries, physiography and natural heritage chapters of this report.

Aquatic ecosystem health was defined as high, moderate or poor on a reach-by-reach basis through an assessment of the following parameters: water quality, benthic community, fish community, instream temperature regime, instream habitat and riparian cover. Table 15 provides a description of these parameters and their relationships to aquatic ecosystem health.

Stream reaches characterized by good aquatic ecosystem health would have most, if not all, parameters within the good health category. Conversely, reaches characterized by poor aquatic ecosystem health would have most parameters falling within the poor health category. Aquatic ecosystem health within the North Shore watershed is illustrated in Figure 20. The following subsections provide a summary of aquatic health for each subreach/tributary within the North Shore watershed.

Creek Chub

Table 15. Aquatic Ecosystem Health Parameters.

Parameter	Good Aquatic Ecosystem Health	Fair Aquatic Ecosystem Health	Poor Aquatic Ecosystem Health
Water Quality	Most parameters regularly meet PWQO	Some parameters occasionally do not meet PWQO	Several parameters regularly do not meet PWQO
Benthic Community	Unimpaired	Moderate impairment	Impaired
Fish Community	Expected community based on stream order* and physiography	Moderate diversity, absence of expected species, presence of some non-indigenous species	Expected community not present (i.e. poor diversity, expected species absent, non-indigenous species abundant)
Instream Temperature Regime	Appropriate based on stream order and physiography	Marginal based on stream order and physiography	Inappropriate based on stream order and physiography
Instream Habitat	Natural channel	Some alteration of aquatic habitat	Altered channel (on-line ponds, dredging, barrier to fish passage, concrete channel, urbanization)
Riparian Cover	Well buffered	Patchy/sporadic buffering	Absent/sparse buffering

PWQO = Provincial Water Quality Objectives

*Stream order is a method of ranking stream segments in a drainage basin in which larger (downstream) segments are given higher order numbers. Headwater tributaries are assigned order 1; where two order 1 streams combine, the next (downstream) segment becomes order 2; where two order 2 segments combine, the next (downstream) segment becomes order 3, etc. (Newbury and Gaboury, 1993).

4.7.1 Rambo Creek

Rambo Creek is highly altered and consists of a series of naturalized, enclosed, concrete or altered channels. The predominant surface deposits consist of clay and silt loams overlying bedrock of Queenston Shale. Landuse is generally characterized as urbanized with commercial, industrial and residential development, with the majority of forest cover and riparian cover associated with the escarpment. Greater than 15% of the watershed is

impervious, which fails to meet the Area of Concern target. Riparian cover with 30m buffers is 17%, which is well below the AOC habitat targets of 75%. Water quality is moderately impaired with high nutrient loads. Although coolwater conditions prevail in the lower reaches of the west branch, the benthic community indicates impaired conditions. The fish community in Rambo Creek is limited to remnant populations of creek chub found in the lower reaches of the east and west tributaries, between Highway 403 and Hager-Rambo Diversion Channel. Riparian cover is generally sparse in most areas where there is a natural channel. Rambo Creek is characterized as having poor aquatic ecosystem health.

4.7.2 Hager Creek

Hager Creek is highly altered and consists of a series of naturalized, enclosed, concrete or altered channels. The predominant surface deposits consist of clay and silt loams overlying bedrock of Queenston Shale. Landuse is generally characterized as urbanized with commercial, industrial and residential development, with the majority of forest cover and riparian cover associated with the escarpment. Greater than 15% of the watershed is impervious, which fails to meet the AOC target. Riparian cover with 30m buffers is 17%, which is well below the AOC habitat targets of 75%. Water quality is moderately impaired with high nutrient loads. Coolwater conditions prevail in East Hager and the benthic community is moderately impaired. The fish community in East Hager is largely non-existent. Warmwater conditions prevail in West Hager and the benthic community is impaired. The fish community in west Hager is limited to remnant populations of creek chub. Hager Creek is characterized as having poor aquatic ecosystem health.

4.7.3 Indian Creek

Indian Creek is highly altered and consists of a series of naturalized, enclosed, or altered channels. The headwaters emanate above the escarpment, flowing through well-forested valleys and draining to urban Burlington. The predominant surface deposits consist of clay and silt loams overlying bedrock of Queenston Shale. Landuse is generally characterized as urbanized with quarry, landfill, commercial, industrial and residential development. Greater than 15% of the watershed is impervious, which fails to meet the AOC target. Riparian cover with 30m buffers is 27%, which is well below the AOC habitat targets of 75%. Water quality is moderately impaired with high nutrient loads and bacteria levels. Sediment quality within the creek revealed elevated concentrations of several toxicants including dieldrin, aldrin, and metals (Dove et al., 2003. The headwaters of the stream are generally intermittent. Downstream of Highway 403, coolwater conditions prevail though the benthic invertebrate communities are indicative of impaired conditions. The fish community in this reach consists of a remnant population of creek chub. Warmwater conditions prevail in the lower reaches of Indian creek and the benthic community indicates impaired conditions. The fisheries community consists of a relatively diverse warmwater forage fish community. Indian Creek is characterized as having poor aquatic ecosystem health.

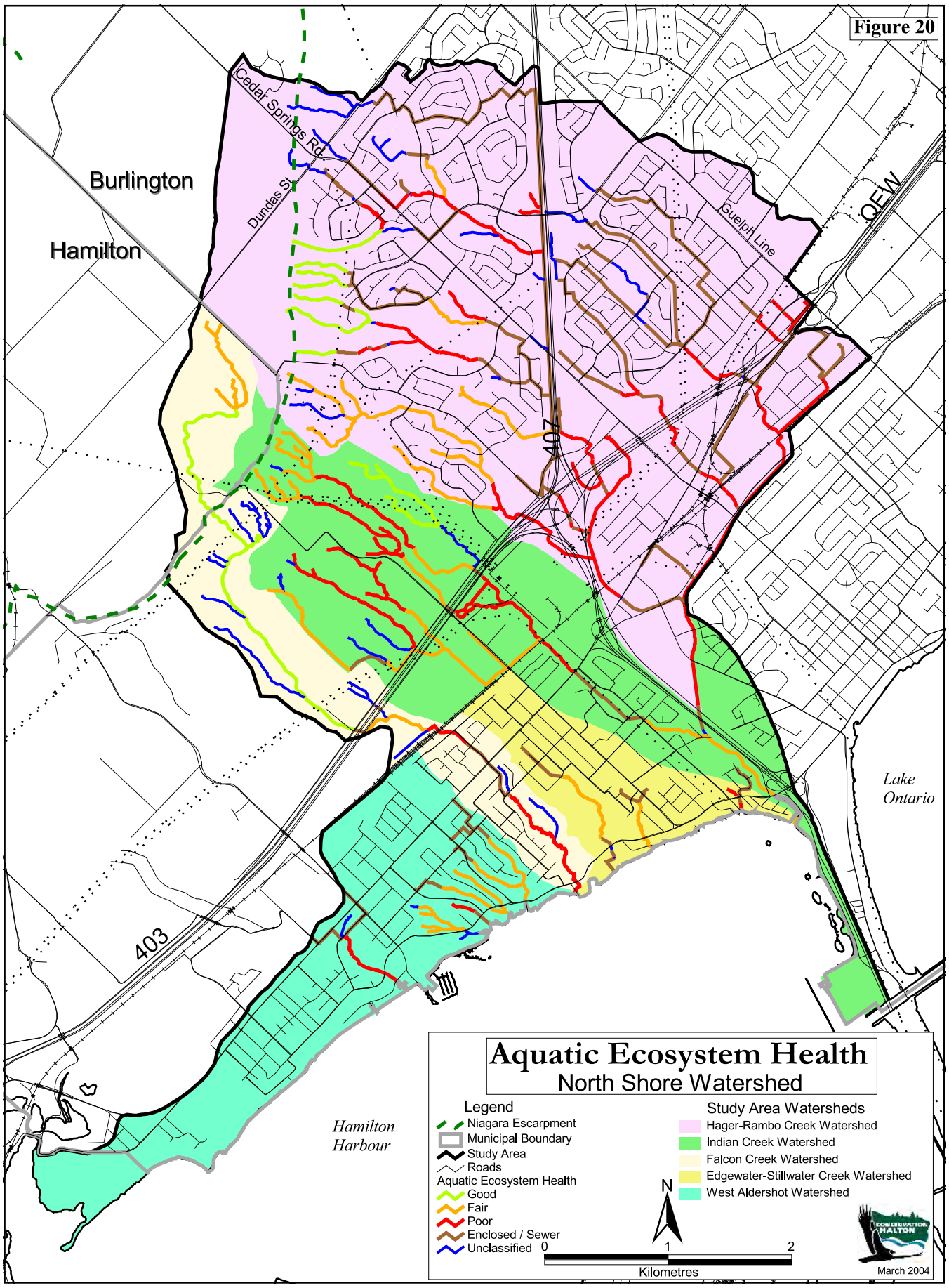


Figure 20
Burlington
Hamilton
Cedar Springs Rd
Dundas St
Guelph Line
QEW
407
403
Lake Ontario
Hamilton Harbour
Aquatic Ecosystem Health
North Shore Watershed
Legend
Niagara Escarpment
Municipal Boundary
Study Area
Roads
Aquatic Ecosystem Health
Good
Fair
Poor
Enclosed / Sewer
Unclassified
Study Area Watersheds
Hager-Rambo Creek Watershed
Indian Creek Watershed
Falcon Creek Watershed
Edgewater-Stillwater Creek Watershed
West Aldershot Watershed
N
0
1
2
Kilometres
March 2004

4.7.4 Edgewater-Stillwater Watershed

These small creeks have been altered and enclosed during the development of the Burlington Golf and Country Club and surrounding suburban area. The predominant surface deposits consist of sandy soils associated with the Iroquois Plain. Less than 15% of the watershed is impervious, which meets the AOC target. Riparian cover with 30m buffers is 1.5%, which is well below the AOC habitat targets of 75% and the lowest in the North Shore Watershed Study area. A small population of minnows was observed in Edgewater Creek in 2000. No water quality, benthic or temperature sampling occurred in the watershed. The aquatic ecosystem throughout the watershed was not characterized.

4.7.5 Falcon Creek

The upper reaches of Falcon Creek are generally well forested and naturalized while the mid reaches are highly altered and consist of a series of naturalized, enclosed, or altered channels. Naturalized channels with permanent flow and good riparian cover are only found below Townsend Avenue. The predominant surface deposits consist of clay loams in the upper watershed and sandy loams in the lower watershed. Landuse is generally characterized as urbanized with commercial, industrial and residential development, with the majority of forest cover and riparian cover associated with the escarpment. Riparian cover with 30m buffers is 52%, which approaches the AOC habitat targets of 75%, and is the highest in the North Shore Watershed Study area. Water quality sampling indicates moderately impaired conditions with elevated nutrients and bacterial levels. Sediments contained elevated levels of endosulfan and chlordane (Dove et al., 2003). Coolwater conditions prevail, though benthic invertebrate sampling indicated impaired conditions. The fish community is severely impaired. Falcon Creek is characterized as having poor aquatic ecosystem health.

4.7.6 West Aldershot Watershed

Thermal conditions in Teal Creek are characterized as coolwater, supporting a limited community of warmwater forage fishes including creek chub and fathead minnow downstream of North Shore Boulevard. Forest Glen Creek is characterized as coolwater, but it is not large enough to support a viable benthic and fish community. LaSalle Creek is characterized as coolwater, with the benthic community indicating impaired conditions and no fish community. West Aldershot Creek is characterized as a coolwater creek with the benthic community indicating impaired conditions, which support a remnant population of creek chub downstream of North Shore Boulevard. The predominant surface deposits consist of sandy soils associated with the Iroquois Plain. Less than 15% of the watershed is impervious, which meets the AOC target. Riparian cover with 30m buffers is 12%, which is well below the AOC habitat targets of 75%. The creeks within the West Aldershot watershed are characterized as having poor aquatic ecosystem health.

5.0 COMMUNITY ISSUES

The North Shore Watershed study has been developed by Conservation Halton using a community-based approach bringing together a writing team made up of staff of Conservation Halton with a group of stakeholders representing municipalities, agencies, community groups and residents who best characterized the mosaic of interests within the watershed. The purpose of the plan is to address community issues through comprehensive strategies to support environmental stewardship, guide development, and recommend restoration strategies.

The majority of the North Shore watershed is characterized as being in a mature stage of urban development. The lands below the escarpment and generally to the east of Kerns Road are fully developed with new development being primarily through infilling. Lands to the south of the CNR tracks through Aldershot are also fully built out. Continued urban residential growth is planned for the Waterdown area on lands above the Niagara Escarpment in the Falcon and Grindstone Creek watersheds. Approval of the Waterdown urban expansion was conditional upon the completion of a subwatershed study and a transportation master plan. The transportation master plan was required to address the need for additional east-west and north-south capacity associated

Stakeholder tour of the watershed at Kerncliff Park

with the urban growth. As part of the Environmental Assessment, roadway improvement options were considered including assessment of the capacity of Brant Street and Kearns Road, and the evaluation of alternative corridors. Three north-south alternatives were evaluated, two of which involved upgrades to King Road in combination with Waterdown Road improvements and a third alternative which involved widening Waterdown Road to four lanes. The King Road alternatives have the potential to seriously impact the Niagara Escarpment and the natural areas in proximity to it.

A portion of the North Aldershot Planning Area of the City of Burlington, known as the East Sector, lies within the North Shore watershed. It is located between Highway 403 and the former Town of Flamborough boundary, extending westward to Old Waterdown Road and the Sassafras Woods ESA, and east to the limit of existing development west of Kerns Road. Future development in the East Sector is limited by municipal policies for the North Aldershot Planning Area. These policies recognize that the area is outside of the City of Burlington's urban area and that new development must be compatible with North Aldershot's existing character, landscape and environment. In addition, the area functions as an urban separator between Aldershot/ Burlington and Waterdown. Existing land uses within the East Sector include two closed landfill sites, shale extraction and brick manufacturing as well as remnant agricultural parcels.

Stakeholders Meeting

Future industrial development is proposed within the CN lands located south of Highway 403 and west of King Road. Consideration of flood plain, stormwater management, stream morphology and protection of existing natural heritage features will need to be examined as part of any future development scenario for the area.

Stakeholders inspecting Freeman Pond

A number of major transportation and utility corridors cross through the North Shore watershed. These include Highway 403, Highway 407, QEW, the main east-west and north-south CN/GO Transit rail lines, and major hydro utility corridors.

At a series of stakeholder meetings and public open houses, a variety of issues and concerns were raised by watershed residents. In general these included: urbanization and the increased demand for development within the watershed; impacts from ever-expanding transportation and utility corridors; water quality and stream morphology; the destruction of aquatic habitat; potential loss of life and property damage as a result of flooding; possible expansion of quarry operations; the potential loss of urban separator; safeguarding forests, valley lands, wetlands and shoreline bluffs; the protection of sensitive natural areas from over exploitation; and protection of viewscapes into and from the watershed.

The North Shore watershed stakeholders examined the watershed and developed recommendations as to how the individual watersheds within the study area could be sustained or enhanced. The specific strategies and recommendations are detailed in Chapters 6 and 7.

RECOMMENDATIONS TO CARE FOR COMMUNITY

1. Reduce/mitigate the impacts of urban development
2. Reduce/mitigate the impacts associated with transportation
3. Reduce the threat of flooding
4. Reduce potential loss of life/property damage from natural hazards
5. Maintain an urban separator of natural habitat and non-urban areas between Burlington and Waterdown
6. Protect valley lands, wetlands and harbour shoreline bluffs
7. Promote sensitive public use of natural areas
8. Protect existing agricultural usage within the watershed
9. Reduce/mitigate impacts of aggregate extraction
10. Reduce/mitigate impacts of golf course development
11. Reduce/mitigate impacts of cemeteries

Kerncliff Park

6.0 VISION FOR TOMORROW

6.1 Vision Statement

The following vision was developed by the North Shore watershed stakeholders and residents. It is based on an understanding of the watershed resources and community needs of today and provides direction for their protection in the future. The vision formed the basis for the regeneration actions and implementation strategies presented in the Watershed Study.

Our Vision for the North Shore Watershed is a healthy watershed from the Niagara Escarpment to Hamilton Harbour. We envision a watershed where the community is harmoniously connected to streams, woodlands and other natural features in a functional system and where people are engaged in protecting and enhancing the natural environment. Through education, stewardship and careful planning, there will be a place for nature and community.

6.2 Guiding Principles

· *Create A Community-based Plan*

"Community-based planning" seeks to have those who have the most at stake, "stakeholders", working together towards a common vision. All aspects of the watershed, water, nature, community and agriculture, are dependent on the health of the North Shore watershed. The interrelationships between each must be taken into consideration to ensure that they are not in conflict and ideally able to successfully co-exist. The flowing water network affects and is affected by land uses that represent the visions of both individuals and the community. Planning for the watershed is, therefore, a shared responsibility.

· *Know and Value Our Heritage*

The North Shore watershed is a dynamic feature. It has been a resource to various communities of people for almost 10,000 years. By knowing the past cultural and ecological heritage, it provides an important perspective for the future; a future held in trust for the future generations.

· *Have a Vision for the Future*

The community of people within the watershed share a common vision for the future. The vision includes a commitment to sustain water resources, natural features, and community interests.

· *Take Responsibility*

The watershed study defines targets and makes recommendations to implement the vision for the watershed. It also identifies strategies and those responsible for implementing these actions.

· *Regenerate What is Degraded*

Opportunities to enhance and regenerate the watershed and its natural heritage have been identified. Issues that need solutions for agriculture and community development to prosper are essential, as

well as creating opportunities for the public to enjoy and sustain a linked system of open space.

6.3 Regeneration Plans

6.3.1 Introduction

The North Shore watershed stakeholders examined the watershed and have produced recommendations on how the individual watersheds within the study area could be sustained or enhanced. In order to make the recommendations more manageable and easier to implement, the study area was divided into four groupings of watersheds of similar size, topography, land use, environmental issues and stresses, including:

- Hager-Rambo Creek Watersheds
- Indian Creek Watershed
- Falcon and Edgewater-Stillwater Creek Watersheds
- West Aldershot Watersheds

The stakeholder committee identified specific opportunities to preserve, sustain, regenerate and enhance portions of the watershed within each area. Based on these opportunities, regeneration plans containing general recommendations were formulated. The opportunities were divided into three types: stewardship opportunities to be implemented on private properties; project opportunities to be implemented on public lands; and areas requiring additional special studies before specific strategies can be formulated. The general recommendations were applied to all four areas. The opportunities identified in these regeneration plans are not the only occasions where preservation and regeneration activities can occur. The committee focused on the most obvious and manageable situations as a starting point. It is intended that as the plan is reviewed and revisited, other opportunities will be identified and implemented over time.

The regeneration plan for each area is presented in three parts; a general description, together with the challenges and opportunities for that area; a chart detailing the regeneration actions needed for each opportunity; and a map identifying and illustrating the challenges and opportunities.

Each map focuses on the specific areas detailing the major landscape components and road network. Each regeneration approach is located and identified:

the circles highlight stewardship opportunities on private property;

the rectangles highlight project opportunities on public lands; and

the triangles highlight sites in need of further special studies.

The regeneration actions are identified and illustrated by a unique symbol within the regeneration approach. The relative priority of each regeneration action is indicated by a colour code:

- **red** indicating a high priority requiring considerable modification to regenerate the site;

- **yellow** indicating a moderate priority requiring some modification to enhance the site;

- **green** indicating a low priority requiring protection to sustain the features and functions of the site, and

- **clear** indicating not applicable to that site.

ways. The majority of shade in a creek or river is supplied by riparian vegetation. Shade acts to maintain low water temperatures, allowing many native plants and animals to survive. Buffers decrease the amount of available light preventing excessive and nuisance

Stakeholder tour of North Shore Watershed

6.3.2 Regeneration Actions Applicable to the Entire North Shore Watershed

Riparian Habitat, Wetlands, Forest Cover, Linkages and Corridors

Riparian vegetation is essential to the health of watercourses and watersheds. The lack of vegetated riparian buffers is a major issue affecting the North Shore watershed. Riparian buffer vegetation influences river systems in numerous

algae growth. If natural vegetation is cleared for development, agricultural or aesthetic reasons, water temperatures and light will increase and greatly disturb the natural ecosystem.

Buffer strips prevent streambank erosion and stream siltation, which in turn benefit stream health and property maintenance costs. Buffers reduce nutrient transport, provide sediment filtration, and vital food sources for aquatic animals.

Stewardship opportunities to increase riparian cover along watercourses should be identified and developed with all landowners. Residents mowing riparian habitats or extending their maintenance activities on to adjacent public lands should be discouraged. In developing areas the width of riparian buffers should be established through subwatershed or other planning studies. Generally the intermittent headwaters support significant riparian cover; however, stream reaches outside of these features that are effected by landuse activities exhibit sparse or patchy riparian cover.

Riparian habitat targets have been established for the Great Lakes Areas of Concern (AOC; Environment Canada *et al*., 1996) which includes Hamilton Harbour. Based on these targets, at least 75% of stream length along first to third order streams within a watershed should support riparian habitat to maintain high stream integrity. Further, at least 75% of stream length along first to third order streams should support 30 m vegetated buffers on both sides of the creek to maintain high water quality. Since the watershed is highly altered and urbanized, it may be impossible or impractical to reach these targets in urbanized areas of the watershed, although the targets may still attainable in undeveloped areas.

To increase riparian habitats within the North Shore watershed, stewardship opportunities on private and public lands should be identified and developed. The Hamilton Halton Watershed Stewardship Program, the Field and Stream Rescue Team and private landowners are examples of groups/individuals who have shown an active interest in riparian regeneration. It is hoped that successful partnerships will continue to be forged to increase riparian cover and enhance aquatic habitat within the watershed where possible.

Although riparian enhancement is an important component of aquatic habitat restoration within the North Shore watershed, opportunities must be assessed in concert with other natural area objectives. For example, interspersion of habitats may be essential to wetland function.

Forest cover within the watershed is well below the Great Lakes Areas of Concern (AOC) target of 30%. The overall amount of large forest patches, interior forest cover and deep interior forest cover within the watershed do not meet the AOC targets. Reforestation to promote the establishment of forest blocks with significant forest habitat should be a primary focus of stewardship and reforestation initiatives.

Natural corridors and linkages have been severed by land use activities and development within the watershed. A significant opportunity exists to create wildlife links and ecological corridors within the watershed. Restoration of wetlands, riparian corridors, and reforestation will reconnect natural core areas, facilitating the movement and reproductive interchange between populations of plant and animal species.

Monitoring

Long-term monitoring is an important component of watershed planning and management. Conservation Halton is preparing a long-term monitoring strategy which will involve regular monitoring of a number of watercourse

stations strategically placed within the North Shore watershed. Monitoring will include fluvial geomorphic, aquatic and terrestrial communities, and water quality assessment. The frequency of monitoring will be determined by proposed land use. Where land use is anticipated to remain static, monitoring will be carried out at five to ten year intervals. Where significant land use change is anticipated (i.e. developing areas), stations will be monitored at two year intervals. Results of monitoring and recommendations for future management will be presented in regular reports which will be timed to coincide with other agency planning initiatives (i.e. Official Plan review) to provide a mechanism to incorporate monitoring recommendations into other planning initiatives. Surface water and groundwater quality and quantity should be protected and enhanced where possible. The identification of pollution sources, mitigation of erosion, and protection of recharge and discharge areas should be implemented.

Development and Protection of Natural Areas

Development is proposed within portions of the watershed. All future development should take into consideration the protection, maintenance and enhancement of natural features. The following guidelines should be implemented related to development:

- undertake subwatershed studies prior to secondary plans;
- continue to mitigate the impacts of stormwater management through stormwater management plans using best management practices;
- continue to enforce the Conservation Authority Fill, Construction and Alteration to Watercourse regulations;
- enact and enforce municipal topsoil preservation, site alteration and tree cutting bylaws;
- update municipal ESA studies;
- continue to require the preparation of Environmental Impact Assessments for proposed developments within and adjacent to ESAs and significant natural areas through the Provincial Policy Statement and regional/ municipal Official Plans.

Protection of natural areas can also be accomplished through:

- dedication or acquisition for Public Open Space;
- voluntary stewardship protection agreements;
- tax incentives through conservation land tax programs;
- promotion of stewardship projects within the watershed;
- demonstration projects on public lands;
- implementation of long-term monitoring to assess changes in watershed health.

Maintaining a Balance Between Public Access and Protecting Sensitive Natural Areas

Although the North Shore watershed is highly urbanized, the natural features found within it are significant and highly valued by its residents. The population of the urban areas (Waterdown and Aldershot) associated with the North Shore watershed is expected to increase

over the next twenty-five years. Accompanying this population growth will be an increased demand for the use of natural areas. Future park master planning should consider the protection of these natural areas while maintaining the balance between public access and protecting the sensitive natural areas. Impacts have resulted from unauthorized trails and improper trail use from mountain biking, ATV and hiking activities in some natural areas. Unauthorized trails can disturb or destroy essential habitat, while other animal activities such as mating, foraging or hunting maybe disrupted.

Norway Maple, Dog Strangling Vine and Garlic Mustard are highly invasive species that have devastated native vegetation communities.

Encroachment

Many of the North Shore watershed natural areas (i.e. creek valleys) are associated with urbanized areas. Encroachment occurs when natural areas are utilized through inappropriate personal use by landowners.

Residents may encroach on natural areas in an attempt to increase their usage of

Freeman Pond

Trees are also often cut or damaged when unauthorized trails are established and tree root mass damage is especially evident in certain areas. The introduction of highly invasive species is also a large concern, particularly in these ecologically sensitive areas. For example, Tree of Heaven, Black Locust,

the natural area. Often residents are unaware that "cleaning up" natural areas such as removing fallen or dead branches from the ground has detrimental effects to a natural area since dead leaves and woody debris provide essential habitat for wildlife and vital nutrients to the soil. The dumping of

yard waste, grass clippings and composting of naturally degrading materials within natural areas can also be detrimental. Yard waste materials such as leaves and clippings can smother existing vegetation and help contribute to the spread of invasive plant species in natural areas. Planting invasive plants such as Periwinkle or Norway Maple adjacent to natural areas can also affect natural communities by their spread into these areas where they can outcompete the natural vegetation.

Stakeholders at Grove Park

The clearing of vegetation and mowing of areas adjacent to creeks and watercourses can increase and aggravate erosion problems. Buffer strips and stream side vegetation prevent streambank erosion and stream siltation, which in turn benefit stream health, land loss and property maintenance costs. Structures (sheds, patios, stairs, playgrounds), landscaping (flower beds, gardens), dumping (garbage, compost and yard waste), paths, mowing, or alterations to creek can contribute to the deterioration of natural areas. Improper discharge from swimming pools can also have detrimental effects to native vegetation, wildlife and water quality.

Public Education, Stewardship and Interpretation

A unique opportunity exists to provide public education regarding environmental awareness and issues, encroachment and natural heritage to local residents and visitors. Through different public groups such as the Bay Area Restoration Council and the Aldershot Community Council, public education could be utilized to help inform and educate the public about their local natural areas. Stewardship efforts through groups such as Stream and Field Rescue and the Hamilton-Halton Watershed Stewardship Program should continue to work with landowners and other interested parties in their restoration and education efforts in promoting environmental stewardship.

Harbour Shoreline

Shorelines play an important role as part of the complex and dynamic natural coastal ecosystem. They provide important and vital habitat for flora and fauna while functioning as a buffer and absorbing lake wave energy. An ecosystem approach should be incorporated into any shoreline treatment designs. Landowners should be encouraged to consider natural coastal processes and shoreline naturalization when considering any shoreline treatment. Efforts should focus on long-term erosion solutions, preserving cobble/shingle beaches, the protection and regeneration of aquatic and terrestrial habitats and not negatively impacting adjacent shoreline neighbours.

6.4 Watershed Regeneration Plans

Hager-Rambo Regeneration Plan (Figure 21)

Hager-Rambo Creek Watersheds	
Municipalities	
• City of Hamilton • City of Burlington (Region of Halton)	
Settlement Areas	
• Burlington, Hamilton	
Subwatershed Area & Gradient	
• **Total Area**	**17.3 km^2**
• **Gradient**	**3.1%**
Physiological Features	
• South Slope - clay silt, low recharge/discharge capability • Waterdown Moraine – loam till, low recharge/discharge • Iroquois Plain - shale plain and sand plain low recharge/discharge capability • Niagara Escarpment and Spillway - sand and gravel deposits, high recharge/discharge capability	
Significant Natural Features	
• Waterdown Escarpment Woods (ESA) (Provincially Significant Life Science ANSI) • Nelson Escarpment Woods (ESA) • Old Nelson Quarry (Kerncliff Park) (Provincially Significant Earth Science ANSI)	
Significant Forest Cover	
• Waterdown Escarpment Woods (ESA) • Nelson Escarpment Woods (ESA) • Kerncliff Park	

The Hager-Rambo Creek Watersheds Regeneration Plan identifies:

- three sites with specific stewardship recommendations;
- eight site regeneration opportunities on public lands; and
- one area in need of special study.

Stewardship Opportunities

Escarpment Linkages
These sites offer an opportunity to improve and enhance forest cover, interior forest habitat and linkages through reforestation and naturalization in key areas along the Escarpment and talus slopes. It also offers opportunities to provide public education that could

include natural heritage and ecological awareness.

Kerns Road & Four Seasons Drive
Stewardship activities to enhance riparian buffers and habitat would improve the thermal regime in the creek. The site also represents a stewardship opportunity to provide public education and interpretation while enhancing natural features by decreasing landowner encroachment and dumping into valleys.

Rambo Creek
The reaches of Rambo Creek immediately upstream of the Hager-Rambo Diversion Channel are highly altered and channelized. They offer stewardship opportunities to enhance the riparian habitat surrounding the creek and potential to enhance fisheries habitat. Regeneration efforts should concentrate on riparian enhancement and other erosion controls to decrease sedimentation and erosion, while enhancing habitat.

Project Opportunities

Tyandaga Golf Course
The golf course offers an opportunity for naturalization and public education efforts to coincide with public recreation. Stewardship efforts should focus on encouraging Audubon (or equivalent) certification for the golf course and minimizing the impacts of the golf course on the natural environment by optimizing pesticide and fertilizer use, retrofitting or removal of the on-line ponds and managing water taking in a sustainable manner.

East Rambo Pond
The stormwater management pond located on East Rambo Creek offers opportunities to reestablish riparian habitat to shade and buffer the pond which will help mitigate thermal impacts of the pond. Riparian plantings and naturalization should be encouraged at the site. The site should continue to be maintained to sustain water quantity control.

East Rambo Pond

Burlington Recreational Park
The City of Burlington has recently acquired this site for the development of a public park. The site will be developed with recreational sports fields and natural areas. The site offers an excellent opportunity for reforestation along the Escarpment brow to enhance forest habitat and wildlife corridors. The site also offers an excellent forum for public education to promote environmental awareness, stewardship and the restoration efforts. Stormwater management should also be implemented with the development of

Table 16. Hager-Rambo Creek Watersheds Regeneration Actions

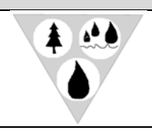
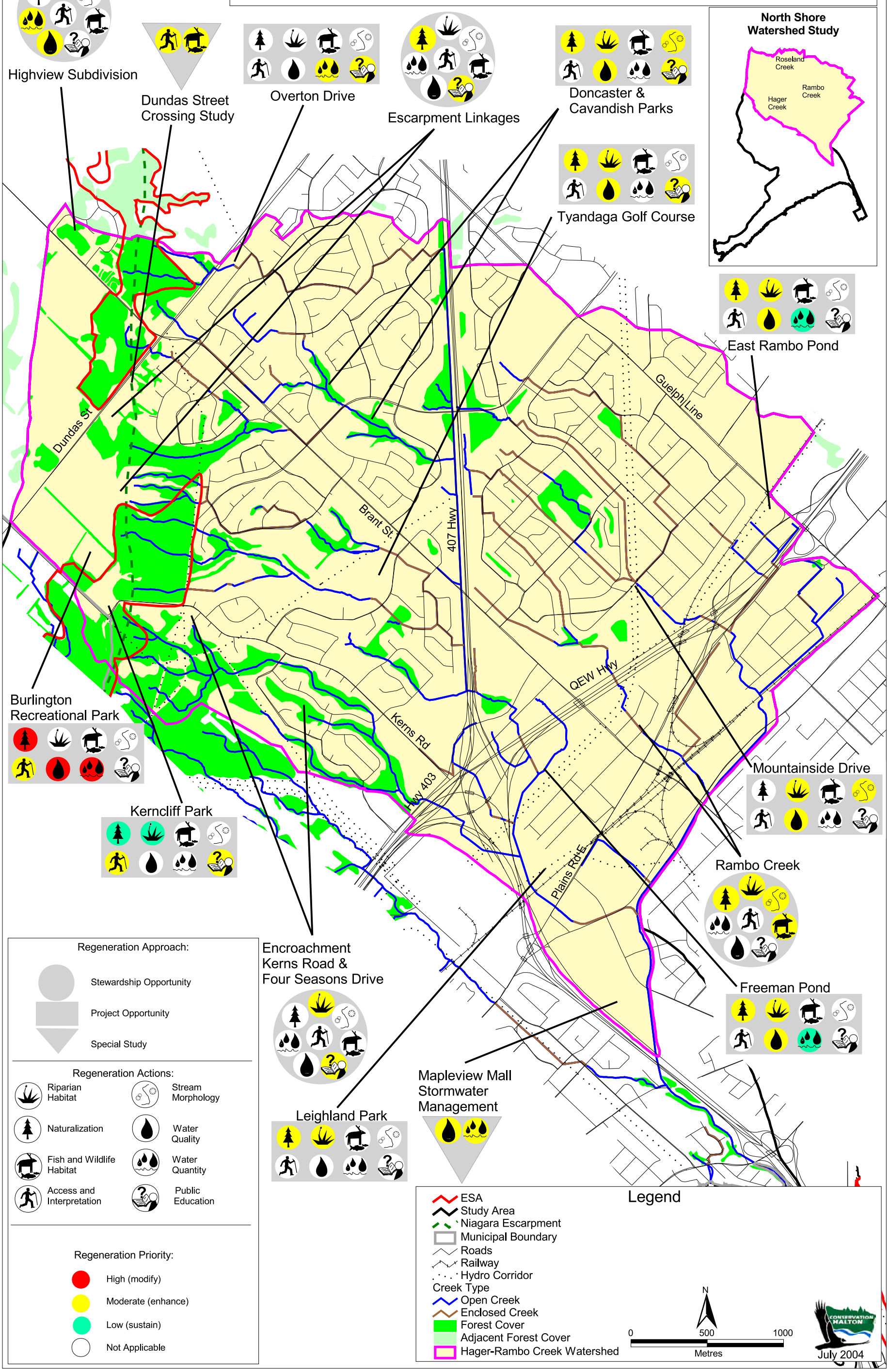
STEWARDSHIP OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Highview Subdivision			• Enhance water quantity and in privately owned communal well supply	
	Escarpment Linkages	• Enhance forest cover and linkages along escarpment and talus slope			• Opportunities to provide public education through interpretive signage to describe restoration efforts and natural heritage
	Kerns Road & Four Seasons Drive	• Reestablish riparian habitat to shade and buffer creek			• Encourage landowners to decrease encroachment and dumping into valleys through stewardship and public education
	Rambo Creek	• Reestablish riparian habitat to shade and buffer creek	• Enhance existing fisheries habitat where feasible	• Potential for improvement to water quality through erosion protection and stormwater management	
PROJECT OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Overton Drive			• Maintenance and removal of debris from grates to prevent flooding	• Educate landowners regarding flood risks and protection of swales and drainage features on private lands
	Tyandaga Golf Course	• Encourage reestablishment of riparian habitat • Rehabilitation or allow naturalization of habitat outside of the area of play		• Examine opportunities to retrofit /remove on-line ponds	• Encourage Audubon certification or equivalent
	East Rambo Pond	• Reestablish riparian habitat to shade and buffer pond • Allow naturalization to occur		• Potential for improvement to water quality through vegetation • Sustain quantity control through stormwater management pond	
	Burlington Recreational Park	• Encourage reforestation to enhance forest habitat and corridor along escarpment and brow		• Implement stormwater management to address quantity and quality issues	• Promote environmental awareness and stewardship through public education and interpretive signage
	Kerncliffe Park	• Maintain existing natural features • Encourage reforestation & naturalization to enhance habitat			• Promote environmental awareness, protection and stewardship through public education and interpretive signage • Encourage eco-friendly trail usage i.e. limit mountain biking to designated trails
	Leighland Park	• Reestablish riparian habitat to shade and buffer creek • Encourage reforestation & naturalization to reduce extent of manicured lawns			
	Freeman Pond	• Reestablish riparian habitat to shade and buffer creek and naturalized slopes		• Sustain flood and erosion protection through quantity controls • Examine further opportunities to retrofit and continue to provide quality controls	
	Mountain Side Drive	• Reestablish riparian habitat to shade and buffer creek		• Opportunities to enhance water quality through erosion control, riparian plantings and maintenance of exposed pipeline	
	Duncaster and Cavendish Parks	• Reestablish riparian habitat to shade and buffer creek • Encourage reforestation & naturalization to reduce extent of manicured lawns and invasive species	• Enhance stream morphology	• Opportunities to enhance water quality through erosion control, riparian plantings	• Promote environmental awareness, protection and stewardship through public education and interpretive signage
SPECIAL STUDY					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Dundas Street Crossing		• Examine opportunities to enhance wildlife corridors across Dundas St.		• Examine opportunities to enhance public access /Bruce Trail across Dundas St.
	Maple View Mall Stormwater Management			• Examine opportunities to enhance stormwater management	

Figure 21

North Shore Watershed Regeneration Plan

Hager-Rambo Creek Watershed



the park to address water quantity and quality issues.

Kerncliff Park
Kerncliff Park offers many rehabilitation and education opportunities. Opportunities exist to continue to naturalize, enhance forest habitat within the park. The natural features in Kerncliff Park should continue to be protected. The park should continue to promote environmental awareness and protection through public education. Park users should also be encouraged to practice environmentally friendly trail usage such as limiting the creation of new trails.

Leighland Park
Leighland Park, located downstream of the Freeman Pond Stormwater management facility offers opportunities for reestablishing riparian habitat through plantings and buffer strips to buffer and shade the creek. The site also offers prospects for naturalization and reforestation.

Freeman Pond
The Freeman Pond was designed for flood storage in the event of a regional storm to help mitigate flood damage. The site can be further naturalized to reestablish riparian habitat to mitigate thermal impacts. Opportunities should be examined to retrofit the facility to continue to improve quality controls.

Mountain Side Drive
The small park located south of Mountain Side Drive offers several opportunities for naturalization and reestablishing riparian habitat to enhance water quality. The banks of the channel within the park are rapidly eroding and erosion controls should be implemented to help improve water quality. A gas pipeline has also become exposed in the stream that should be reburied.

Duncaster and Cavendish Parks
These parks offer opportunities for naturalization, reforestation and for reestablishing riparian habitat associated with the creek. Restoration efforts could focus on invasive species removal and native species naturalization. Erosion controls and riparian plantings should also be implemented to decrease erosion problems at the site. The site offers an opportunity for public education, particularly because of its location next to St. Mark's and Paul A. Fisher schools.

Special Studies

Wildlife/Public Crossing Feasibility Study
The potential for a wildlife and public crossing where the Bruce Trail crosses Dundas Street should be examined to enhance wildlife passage and public accessibility.

Stormwater Management Maple View Mall
Opportunities should be examined to enhance stormwater management associated with the Maple View Mall and the large impervious parking area to help mitigate flashy stormwater flows from the property that could impact downstream residents.

Indian Creek Regeneration Plan (Figure 22)

Indian Creek Watershed	
Municipalities	
• City of Hamilton • City of Burlington (Region of Halton)	
Settlement Areas	
• Burlington (Aldershot), Hamilton (Waterdown)	
Subwatershed Area & Gradient	
• **Total Area**	**6.1 km^2**
• **Gradient**	**2.9 %**
Physiological Features	
• South Slope - clay silt, low recharge/discharge capability • Iroquois Plain - shale plain and sand plain low recharge/discharge capability • Niagara Escarpment and Spillway - sand and gravel deposits, high recharge/discharge capability	
Significant Natural Features	
• Waterdown Escarpment Woods (ESA) (Provincially Significant Life Science ANSI) • Sassafras Woods (ESA) (Provincially Significant Life Science ANSI)	
Significant Forest Cover	
• Waterdown Escarpment Woods (ESA) • Sassafras Woods (ESA)	

The Indian Creek Watershed Regeneration Plan identifies:

- five sites with specific stewardship recommendations;
- five site regeneration opportunities on public lands; and
- three areas in need of special study.

Stewardship Opportunities

Waterdown Urban Expansion
There are many opportunities associated with the proposed urban expansion of Waterdown. Development plans should incorporate stormwater management and ensure that existing drainage patterns into cracks and fissures at the Escarpment brow continue to be maintained and protected. There are also opportunities for reforestation and naturalization to enhance interior forest habitat within the site.

Hanson Brick East Extraction Area
The Hanson Brick east extraction area is prone to erosion and is a large source of sediment to Hamilton Harbour. Through the reestablishment of forest and riparian habitat, soils can be stabilized, erosion reduced and water quality increased. There is an opportunity for a progressive rehabilitation plan to be implemented on the site to help renaturalize areas post

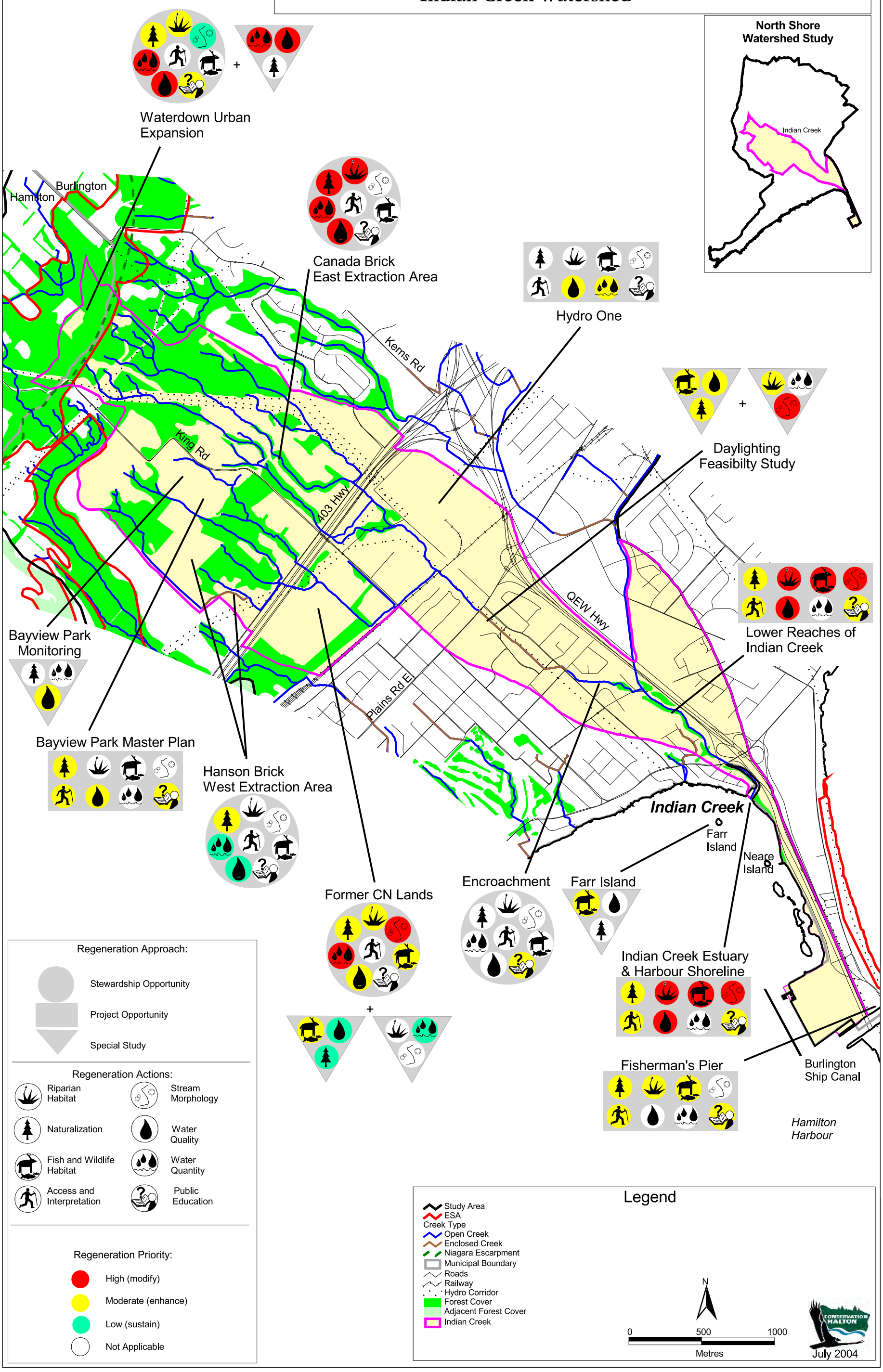
Table 17. Indian Creek Watershed Regeneration Actions

STEWARDSHIP OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Waterdown Urban Expansion	• Encourage reforestation and naturalization to enhance interior forest habitat	• Maintain existing drainage patterns as part of development plan	• Require water quality and quantity control through stormwater management • Ensure protection of existing drainage patterns into cracks & fissures at escarpment brow	• Promote significance of natural features, environmental awareness, protection and stewardship through public education and interpretive signage for future residence and public
	Hanson Brick East Extraction Area	• Reestablish of forest and riparian habitat to stabilize exposed soils and reduce erosion • Implement progressive rehabilitation to renaturalize site following extraction • Potential for salvaging and transplanting native plant materials to for on-site rehabilitate		• Address water quality and erosion issues through riparian buffers and stormwater management	
	Hanson Brick West Extraction Area	• Implement progressive rehabilitation to renaturalize site following extraction		• Maintain stormwater management to enhance quality and quantity of stormwater	
	Former CN Lands	• Reestablish riparian habitat to shade and buffer creek • Encourage naturalization to enhance buffer, existing forest and remnant prairie habitat	• Opportunities to improve stream morphology • Protect potentially significant natural features as part of development plan • Opportunities to enhance fish and wildlife habitat	• Require water quality and quantity control through stormwater management • Address flooding issue associated with railway	
	Encroachment				• Opportunities to enhance natural areas, decrease encroachment and erosion through public education
PROJECT OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Hydro One			• Opportunities to enhance water quality, quantity and erosion issues through retrofit of stormwater management	
	Bayview Park Master Plan	• Continue reforestation to aid naturalization		• Enhance water quality where necessary as per results of monitoring	• Promote environmental awareness, protection and stewardship through public education and interpretive signage
	Lower Reaches of Indian Creek	• Reestablish riparian habitat to shade and buffer creek • Encourage reforestation and naturalization to enhance habitat along creek	• Opportunities to enhance fisheries habitat through stream morphology improvements • Remove/address barriers to fish movement i.e. culvert retrofit at North Shore Blvd.	• Opportunities to enhance water quality and decrease erosion through stream morphology improvements • Examine extent of remaining septic systems and explore opportunities to connect to municipal sanitary sewers.	• Opportunities to enhance natural areas, decrease encroachment and erosion through public education • Opportunities for interpretation.
	Estuary/Harbour Shoreline	• Encourage reforestation and naturalization to enhance habitat harbour shoreline • Improve connection to northeast shoreline fish and wildlife habitat	• Opportunities to enhance near shore fisheries and colonial nesting habitats	• Opportunities to enhance inshore fishery and colonial waterbird nesting habitat	• Opportunities to enhance shoreline through public education and stewardship • Opportunities to connect with existing tails
	Fisherman's Pier	• Encourage naturalization to enhance habitat	• Encourage naturalization to enhance fish and wildlife habitat		• Opportunities for public education and interpretation • Opportunities to connect with existing tails
SPECIAL STUDY					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Daylighting Feasibility Study	• Investigate habitat improvements, naturalization opportunities, stream morphology and riparian habitat reestablishment	• Investigate opportunity to enhance stream morphology and habitat and wildlife passage through potential creek daylighting	• Investigate opportunity to enhance water quality through potential creek daylighting	
	Bayview Park Monitoring			• Continue to monitor water quality from landfill	
	Farr Island		• Investigate opportunities to address nuisance cormorants		
	Former CN Lands	• Conduct further studies to refine the natural heritage system proposed in Ecoplans (1997) • Evaluate the wetland complex using the Ontario Wetland Evaluation System • Conduct further investigation of prairie-savannah flora		• Undertake a subwatershed study to fully document existing conditions and guide future land use decisions	
	Waterdown Urban Expansion			• Undertake a subwatershed study to fully document existing conditions and guide future land use decisions	

Figure 22

North Shore Watershed Regeneration Plan

Indian Creek Watershed



extraction. There is also a potential for salvaging and transplanting existing native plant materials for on-site rehabilitation. There is a need for on-site stormwater management to control sediment runoff.

Hanson Brick West Extraction Area
The Hanson Brick West extraction area has recently implemented stormwater management that has helped mitigate erosion problems and enhance the quality of stormwater runoff from the site. The site offers opportunities to implement progressive rehabilitation to renaturalize the site following extraction.

Future Industrial Development
The property associated with the CN lands located south of Highway 403 and west of King Road is proposed for a variety of industrial developments. The proposed development plans should incorporate stormwater management to address flooding issues associated with the site, while providing controls for storm water quality. Opportunities also exist to improve stream morphology, and to protect and enhance the riparian buffers, forest and remnant prairie habitat associated with the site.

Encroachment
Several sites adjacent to Indian Creek offer opportunities to work with landowners and other members of the public to enhance the natural areas associated with private and public properties. Public education and stewardship should be implemented to focus on encroachment and solutions to control erosion.

Project Opportunities

Hydro One
The lands associated with the Hydro One facility offer various prospects for naturalization efforts and opportunities for stormwater management to help enhance water quality, quantity and erosion issues on the site.

Bayview Park Master Plan
The former Bayview Landfill site offers potential opportunities for site rehabilitation and naturalization efforts. Water quality is a primary concern on the site and should continue to be monitored. The site also offers a unique opportunity to promote stewardship and naturalization through public education.

Indian Creek, Estuary & Harbour Shoreline
The reach of Indian Creek, from the harbour to Francis Road, offers many opportunities for enhancement. Water quality can be enhanced through improvements to stream morphology to decrease erosion. The site also offers opportunities to enhance fisheries habitat through improvements to stream morphology and the removal of a barrier to fish passage at North Shore Boulevard. Riparian plantings and naturalization will also enhance the quality of the creek and shoreline at the mouth of the creek. The project offers many opportunities for public education.

Fisherman's Pier
Opportunities exist for naturalization and enhancement of fish and wildlife habitat at the Fisherman's Pier site located along Eastport Drive.

CN Lands Protection
The natural areas associated with the CN lands are associated with future industrial development. Some significant natural features including a successional ash swamp and remnant prairie habitat should be protected. Opportunities also exist on the site to enhance fish and wildlife habitat through riparian plantings and naturalization.

Special Studies

Daylighting Feasibility Study
The possibility of daylighting (bringing above ground) reaches of Indian Creek along Francis Avenue should be investigated. Daylighting this reach offers the opportunity for habitat improvements, water quality improvements, naturalization and wildlife passage.

Bayview Park Monitoring
The Region of Halton should continue to monitor water quality associated with the landfill site.

Farr Island
Cormorants on Farr Island have become a nuisance due to the unpleasant smell associated with their use of the island for roosting in the late summer. Opportunities should be investigated to help alleviate the problem.

CN Lands

Edgewater Stillwater and Falcon Watershed Regeneration Plan (Figure 23)

Edgewater Stillwater Watershed	
Municipalities	
• City of Burlington (Region of Halton)	
Settlement Areas	
• Burlington	
Subwatershed Area & Gradient	
• **Total Area**	**1.8 km^2**
• **Gradient**	**1.4 %**
Physiological Features	
• Iroquois Plain - shale plain and sand plain low recharge/discharge capability	

Falcon Creek Watershed	
Municipalities	
• City of Hamilton • City of Burlington (Region of Halton)	
Settlement Areas	
• Burlington (Aldershot), Hamilton (Waterdown)	
Subwatershed Area & Gradient	
• **Total Area**	**3.6 km^2**
• **Gradient**	**2.4%**
Physiological Features	
• Waterdown Moraine – loam till, high recharge/discharge capability • South Slope - clay silt, low recharge/discharge capability • Iroquois Plain - shale plain and sand plain low recharge/discharge capability • Niagara Escarpment and Spillway - sand and gravel deposits, high recharge/discharge capability	
Significant Natural Features	
• Waterdown Escarpment Woods (ESA) (Provincially Significant Life Science ANSI) • Sassafras Woods (ESA) (Provincially Significant Life Science ANSI)	
Significant Forest Cover	
• Waterdown Escarpment Woods (ESA) • Sassafras Woods (ESA)	

The Falcon and Edgewater-Stillwater Watersheds Regeneration Plan identifies:

- six sites with specific stewardship recommendations;
- two site regeneration opportunities on public lands; and
- one area in need of special study.

Stewardship Opportunities

Waterdown Urban Expansion
There are many opportunities associated with the proposed urban expansion of Waterdown. Development plans should incorporate stormwater management and ensure that existing drainage patterns into cracks and fissures at the Escarpment brow continue to be maintained and protected. There are also opportunities for reforestation and naturalization to enhance interior forest habitat.

Sassafras Woods & Escarpment Linkages
Sassafras Woods and other Escarpment linkages offer many rehabilitation and education opportunities. Opportunities exist to naturalize, enhance and reforest habitat to strengthen the connection between Sassafras Woods and the Escarpment. Public education can be used to promote environmental awareness and stewardship within the park. Park users should also be encouraged to practice environmentally friendly trail usage such as limiting the creation of new trails and banning/limiting the use of harmful ATV and bicycle usage. Those areas that have been effected by improper ATV and mountain bike usage could be used as a public education/rehabilitation project.

Burlington Golf & Country Club
The golf course offers an opportunity for naturalization efforts to coincide with public recreation. Stewardship efforts should focus on encouraging Audubon (or equivalent) certification for the golf course and minimizing the impacts of the golf course on the natural environment by optimizing pesticide and fertilizer use, retrofitting or removal of on-line ponds and managing water taking in a sustainable manner. The golf course should also ensure that compostable materials are not placed over existing vegetation or within the natural areas. The golf course should continue implementing their public outreach program to work with adjacent landowners to decrease encroachment and pool discharge into the creek.

Light Industry
This site offers a chance to enhance the riparian habitat and naturalization the stream channel. By replacing the existing gabion baskets with natural channel design techniques and bioengineering, erosion can be reduced to enhance water quality.

Encroachment & Pool Discharge
The natural areas associated with the Falcon Creek valley have been subject to encroachment from adjacent landowners. Discharge of pool water directly into the Falcon creek has also been observed. Public education and stewardship should be implemented to encourage proper pool maintenance and to decrease encroachment and dumping. Naturalization and riparian enhancement should be encouraged and promoted.

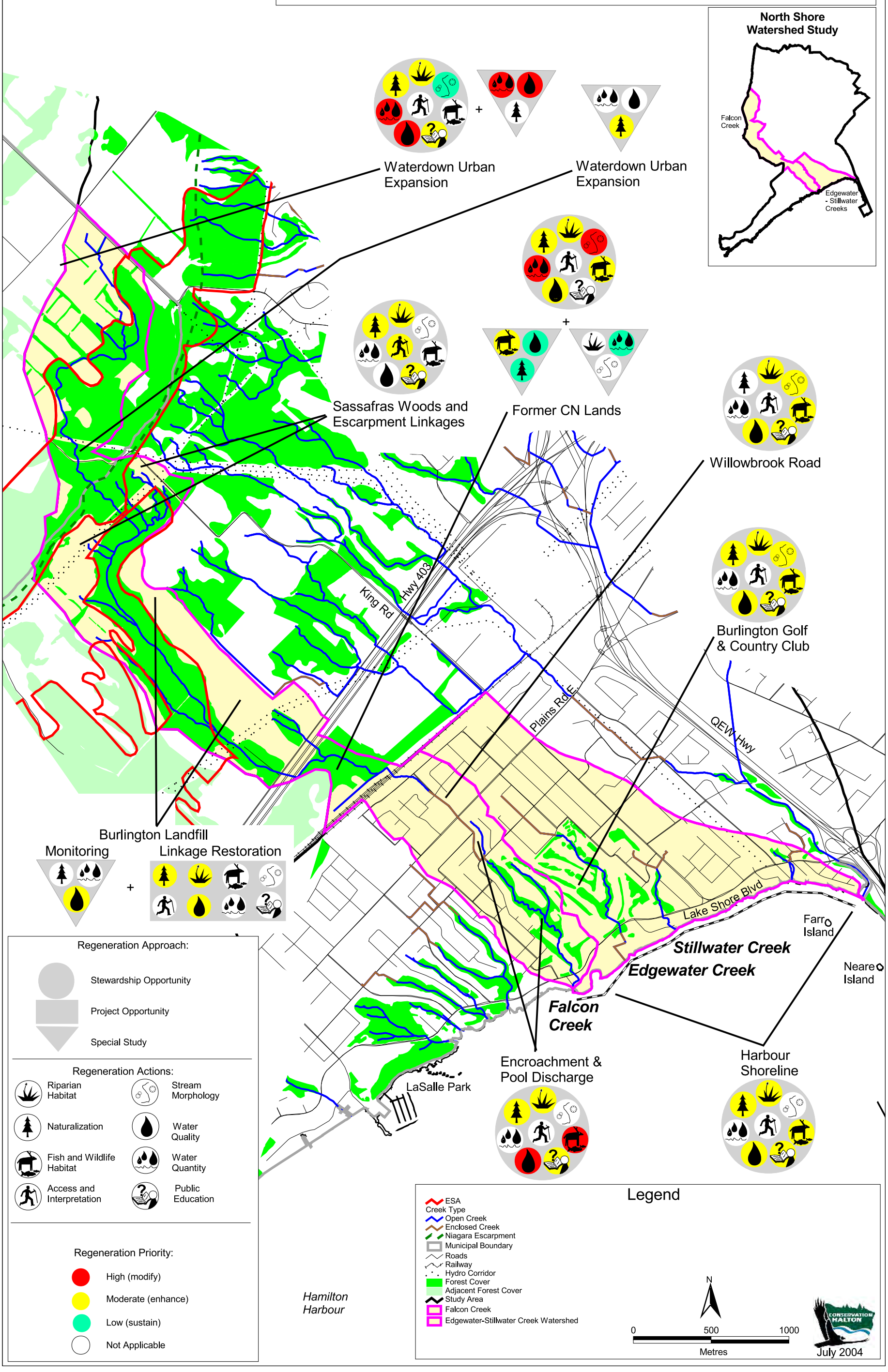
Table 18. Falcon and Edgewater-Stillwater Creeks Watershed Regeneration Actions

STEWARDSHIP OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Waterdown Urban Expansion	• Encourage reforestation and naturalization to enhance interior forest habitat	• Maintain existing drainage patterns as part of development plan	• Require water quality and quantity control through stormwater management • Ensure protection of existing drainage patterns into cracks & fissures at escarpment brow	• Promote significance of natural features, environmental awareness, protection and stewardship through public education and interpretive signage for future residence and public
	Sassafras Woods & Escarpment Linkages	• Reestablish riparian habitat to shade and buffer creek • Encourage reforestation and naturalization to enhance forest habitat and strengthen connection between Sassafras Woods and escarpment			• Promote environmental awareness, protection and stewardship through public education and interpretive signage • Control, restrict and discourage harmful ATV and bicycle usage to protect and rehabilitate sensitive natural areas
	Burlington Golf & Country Club	• Reestablish riparian habitat to shade and buffer creek • Rehabilitate or allow naturalization outside the area of play • Encourage proper disposal of compostable materials away from creek and valley slopes	• Opportunities to enhance stream morphology and fish and wildlife habitat	• Opportunities to enhance water quality through public education	• Opportunities to provide public education through interpretive signage to describe restoration efforts and natural heritage • Encourage Audubon Certification or equivalent
	Former CN Lands	• Reestablish riparian habitat to shade and buffer creek • Encourage naturalization to enhance buffer, existing forest and remnant prairie habitat	• Opportunities to improve stream morphology • Protect potentially significant natural features as part of development plan • Opportunities to enhance fish and wildlife habitat	• Require water quality and quantity control through stormwater management • Address flooding issue associated with railway	
	Encroachment & Pool Discharge	• Reestablish riparian habitat to shade and buffer creek • Encourage reforestation and naturalization to enhance	• Continue to monitor fisheries and benthic water quality	• Opportunities to enhance water quality through public education	• Opportunities to enhance water quality through public education, stewardship and interpretive signage to decrease encroachment • Encourage proper pool maintenance
	Harbour Shoreline	• Encourage shoreline naturalization and plantings	• Encourage shoreline naturalization and plantings to enhance near shore habitat for fish and wildlife	• Opportunities to enhance water quality through Remedial Action Plan	• Opportunities to enhance shoreline naturalization through public education and stewardship
	Willowbrook	• Reestablish riparian habitat to shade and buffer creek • Encourage naturalization to enhance habitat and decrease erosion • Enhance riparian habitat through replacement of gabion baskets and bioengineering	• Examine opportunities to enhance stream morphology and stormwater management to decrease erosion	• Examine opportunities to enhance stream morphology and stormwater management to decrease erosion and increase water quality	• Opportunities to enhance water quality through public education, stewardship and interpretive signage to decrease encroachment
PROJECT OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Burlington Landfill Linkage Restoration	• Continue to naturalize landfill and enhance linkages to Falcon Creek and escarpment • Enhance riparian habitat along Falcon Creek		• Opportunities to enhance water quality through riparian enhancement	
SPECIAL STUDY					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Burlington Landfill Monitoring			• Continue to monitor water quality leachate collection system	
	Former CN Lands	• Conduct further studies to refine the natural heritage system proposed in Ecoplans (1997) • Evaluate the wetland complex using the Ontario Wetland Evaluation System • Conduct further investigation of prairie-savannah flora		• Undertake a subwatershed study to fully document existing conditions and guide future land use decisions	
	Waterdown Urban Expansion			• Undertake a subwatershed study to fully document existing conditions and guide future land use decisions	
	Waterdown Escarpment Woods	• Evaluate the wetland complex using the Ontario Wetland Evaluation System			

Figure 23

North Shore Watershed Regeneration Plan

Falcon and Edgewater-Stillwater Creek Watersheds



Due to the poor water quality associated with Falcon Creek, regular fisheries and benthic macroinvertebrate monitoring should be implemented.

Harbour Shoreline
The shoreline should be enhanced through naturalization and riparian plantings. Riparian enhancement and naturalization will enhance fisheries habitat and water quality along the shoreline. The project further offers public education and stewardship opportunities.

Project Opportunities

Burlington Landfill Linkage Restoration
The Burlington Landfill site represents an opportunity to enhance linkages between Falcon Creek and the Escarpment. Naturalization, reforestation and enhancement of riparian habitat should continue to be part of the restoration efforts. Through the enhancement of riparian areas, water quality may be enhanced.

Willowbrook
The reach of creek associated with Willowbrook Road (both upstream and downstream) is subject to erosion that threatens landowner properties. Opportunities to enhance stream morphology, riparian habitat and stormwater management should be investigated to help decrease erosion and increase water quality. Public education and stewardship should focus on educating landowners on the benefits of reestablishing riparian habitat, stopping encroachment and increased naturalization.

Special Studies

Burlington Landfill Monitoring
The Region of Halton should continue to monitor water quality associated with the landfill site.

Aldershot greenhouses

West Aldershot Regeneration Plan (Figure 24)

West Aldershot Watershed	
Municipalities	
• City of Hamilton • City of Burlington (Region of Halton)	
Settlement Areas	
• Burlington	
Subwatershed Area & Gradient	
• **Total Area**	**4.4 km^2**
• **Gradient**	**1.6 %**
Physiological Features	
• Aldershot Bar – loam and sandy loam deposits, high recharge/discharge capability • Iroquois Plain - shale plain and sand plain low recharge/discharge capability	
Significant Natural Features	
• Willow Point • LaSalle Park • Woodland Cemetery • Holy Sepulchre Cemetery • Grove Park	
Significant Forest Cover	
• Willow Point • LaSalle Park • Woodland Cemetery	

The West Aldershot Watersheds Regeneration Plan identifies:

- four sites with specific stewardship recommendations;
- four site regeneration opportunities on public lands; and
- one area in need of special study.

Stewardship Opportunities

Encroachment & Pool Discharge
The natural areas associated with the smaller creek valleys within the West Aldershot Watershed have been subject to encroachment from adjacent landowners. Discharge of pool water directly into the creeks and stormsewers may be impacting aquatic life. Public education and stewardship should be implemented to encourage proper pool maintenance and to decrease encroachment and dumping. Naturalization, riparian enhancement and reforestation should also be encouraged.

Harbour Shoreline
The shoreline should be enhanced through naturalization and riparian plantings. Riparian enhancement and naturalization will enhance fisheries habitat and water quality along the

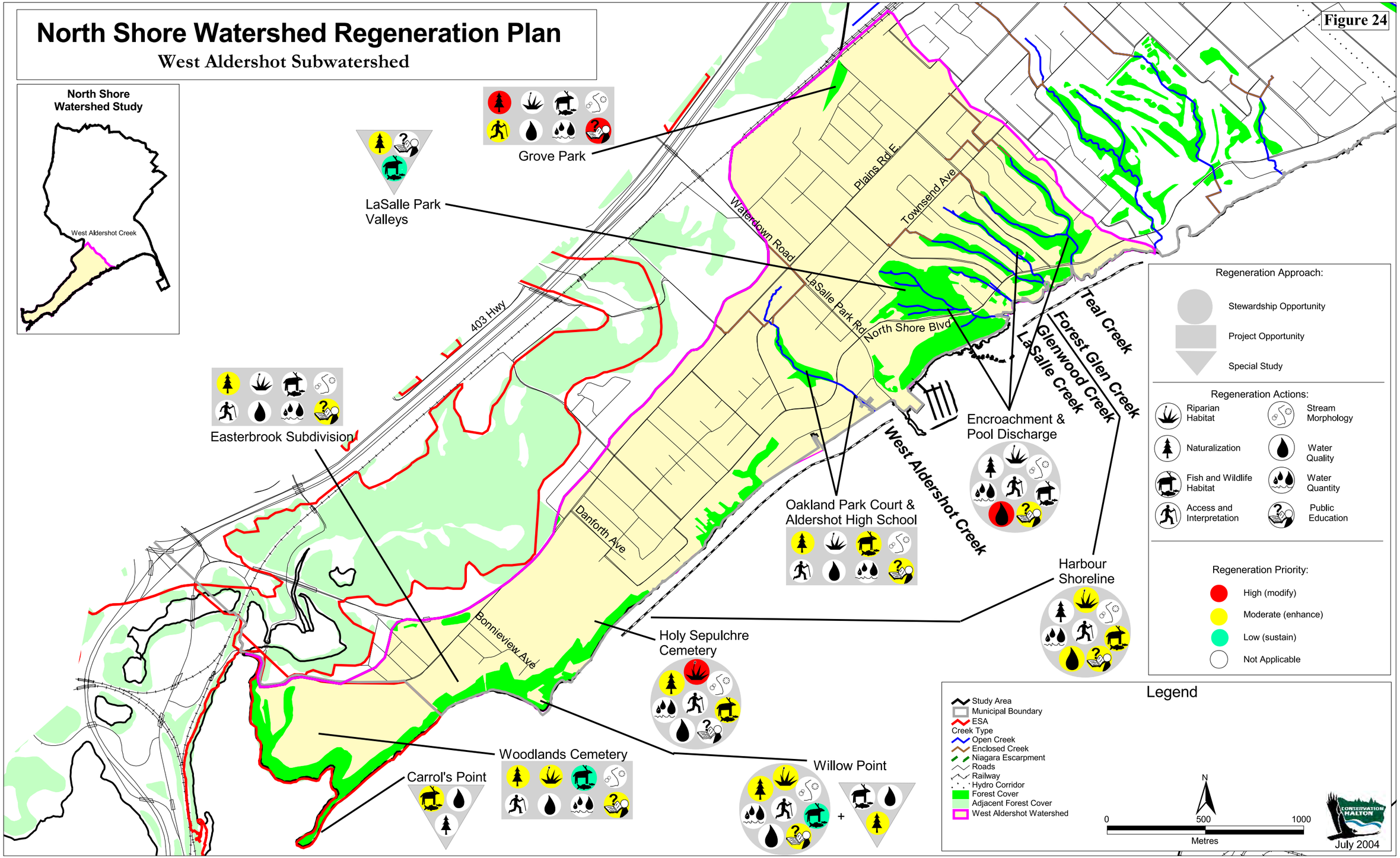
Table 19. West Aldersot Watersheds Regeneration Actions

STEWARDSHIP OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Encroachment & Pool Discharge			• Opportunities to enhance water quality through public education	• Opportunities to enhance water quality through public education, stewardship and interpretive signage to decrease encroachment and dumping • Encourage proper pool maintenance • Encourage landowners to decrease encroachment and dumping into valleys through stewardship and public education
	Harbour Shoreline	• Encourage shoreline naturalization and plantings	• Encourage shoreline naturalization and plantings to enhance near shore habitat for fish and wildlife	• Opportunities to enhance water quality through Remedial Action Plan	• Opportunities to enhance shoreline through public education and stewardship
	Holy Sepulchre Cemetery	• Rehabilitation or allow naturalization of habitats adjacent to valleys, natural areas and bluffs	• Encourage shoreline restoration and plantings to enhance near shore habitat for fish and wildlife		
	Willow Point	• Encourage enhancement/ maintenance of significant wetland and shoreline habitat	• Encourage enhancement /maintenance of significant habitat for fish and wildlife		• Educate public regarding site sensitivity
PROJECT OPPORTUNITIES					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	Grove Park	• Encourage naturalization and maintenance of oak savannah & prairie habitat			• Opportunities to provide public education through interpretive signage to describe restoration efforts, significance of features and natural heritage
	Easterbrook Subdivision	• Rehabilitation or allow naturalization of habitats adjacent to bluffs • Encourage rehabilitation of open oak woodlot			• Opportunities to provide public education regarding no dumping policy on slopes and natural areas
	Woodlands Cemetery	• Encourage shoreline naturalization and plantings • Rehabilitation or allow naturalization of habitats adjacent to valleys, natural areas and bluffs • Protection of significant bluff habitat	• Improve habitat through removal of debris and no dumping policy on slopes and natural areas		• Opportunities to provide public education through interpretive signage to describe restoration efforts and natural heritage
	Oakland Park/Aldershot High School	• Encourage naturalization to enhance habitat and rehabilitate woodlot	• Opportunity to enhance fish passage through culvert retrofitting		• Opportunities to provide public education, protection, clean-up and enhancement through high school programs
SPECIAL STUDY					
		Buffer Strips and Naturalization	**Stream Morphology, Fish /Wildlife**	**Water Quality & Water Quantity**	**Access, Interpretation & Public Education**
	LaSalle Park Valleys	• Sustain natural features of site • Investigate potential for inclusion as an Environmentally Sensitive Area	• Investigate potential for inclusion as an Environmentally Sensitive Area		
	Willow Point	• Evaluate the wetland using the Ontario Wetland Evaluation System			

North Shore Watershed Regeneration Plan

West Aldershot Subwatershed

Figure 24



shoreline. The project further offers public education and stewardship opportunities.

Holy Sepulchre Cemetery
The Holy Sepulchre Cemetery offers the opportunity to rehabilitate and naturalize important habitats located adjacent to valleys and bluff areas. There is also an opportunity to naturalize the shoreline habitat through the replacement and removal of the existing shoreline stabilization structures.

Willow Point
The Willow Point community encompasses significant natural areas that represent one of the last remaining natural wetlands along the Hamilton Harbour shoreline. Efforts should focus on educating the public regarding the site sensitivity. Landowners should be encouraged to enhance and maintain the significant habitats. The wetland associated with the site should be evaluated under the provincial wetland evaluation system to determine the significance of the site.

Project Opportunities

Grove Park
Grove Park represents a remnant of the oak woodland habitat that was common within the Aldershot area prior to colonization. A pocket of tallgrass prairie is also associated with the site which contains a number of rare prairie species. Naturalization and the maintenance of the oak savannah and prairie habitat should be encouraged. The site also offers the prospect for public education to describe the significance of the site and restoration efforts.

Easterbrook Subdivision
The Easterbrook subdivision offers the opportunity to rehabilitate and naturalize the open oak woodlot associated with the site.

Woodlands Cemetery
The Woodlands Cemetery site is associated with significant shoreline habitat. There are opportunities for the rehabilitation and naturalization of the valleys, natural areas and bluffs associated with the site. The significant bluff habitat should be protected. Fisheries habitat can be enhanced by the removal of debris and implementing a no dumping policy on the slopes and natural areas of the cemetery. There is also an opportunity for public education to describe the natural heritage and significance of the bluffs.

Oakland Park/Aldershot High School

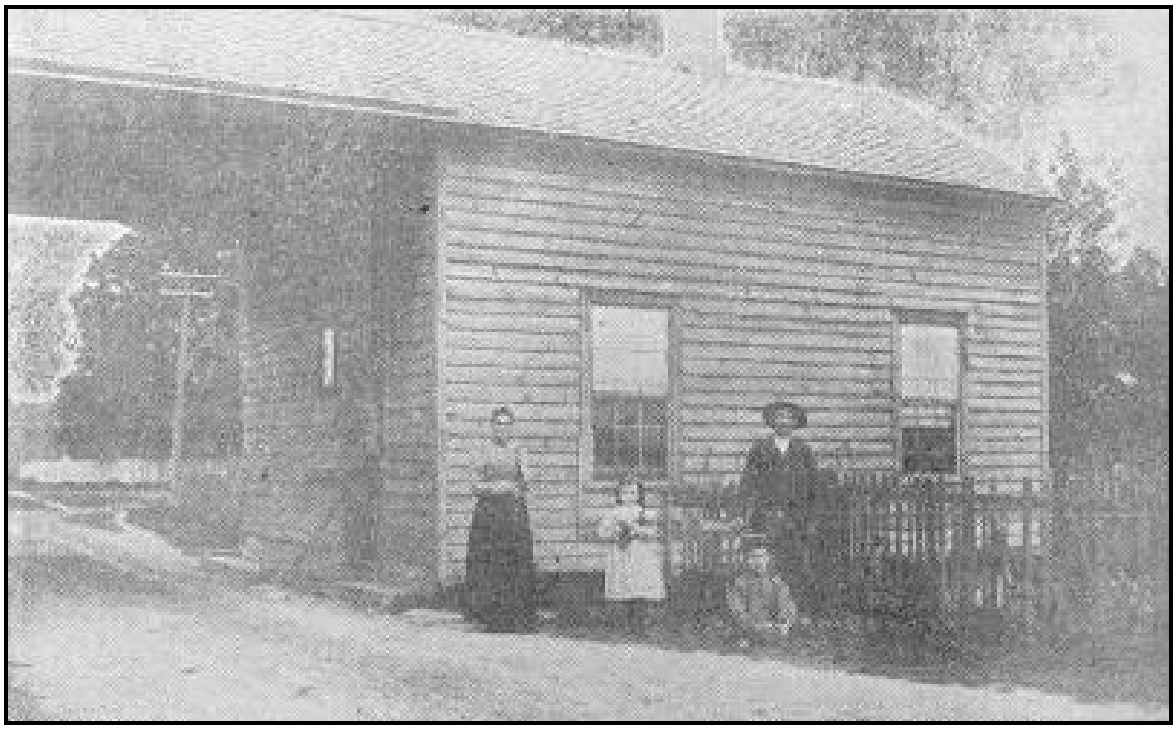
The site associated with Oakland Park and Aldershot Highschool offers the opportunity for site naturalization and rehabilitation. Fisheries can also be enhanced through the retrofitting of the culvert under North Shore Boulevard. Since the site is located adjacent to the Aldershot High School, opportunities exist for public education and naturalization focusing on the adjacent woodlot and creek.

Special Studies

LaSalle Park Valleys
The valleys associated with LaSalle Park, north of North Shore Boulevard represents a remnant of the mixed and deciduous forest and woodlands that once dominated the area. Portions of this forest have old-growth character-

istics with very large eastern white pine, red oak and eastern hemlock present within the stand. Adjacent landowner encroachment such as dumping of yard waste, concrete and garbage is prevalent. Invasive species, such as English ivy and periwinkle, spreading from adjacent gardens into the natural areas also threatens the natural communities of the site. The natural features should be sustained on the site and the site should be considered for inclusion as an Environmentally Sensitive Area. Public education should focus on encouraging landowners to decrease encroachment and teach local residence about the local significance of the natural areas.

LaSalle Park



19th Century Toll House

21st Century Housing

7.0 TAKING RESPONSIBILITY

Implementation Actions and Strategies

The Stakeholders have identified a series of implementation actions and strategies that pertain to the watershed as a whole. The groups or agencies responsible and the priority for their implementation have been identified below. Some actions will be implemented through the planning process, others will be accomplished through the enforcement of regulations, and others through projects on public lands. However, the most important of the partners are the landowners and citizens of the watershed who will undertake restoration projects on their own lands.

The regeneration actions can be simply divided into four groups:

- Planning and regulatory actions that are mandated and prevent the deterioration of the landscape.
- Project opportunities on public lands which can set an example and create a legacy for future generations
- Stewardship opportunities on private lands which may be undertaken if there is a desire to embrace regeneration.
- Studies that will assist groups of individual stakeholders to solve problems and the community to create opportunities.

Conservation Halton will oversee the implementation of the strategies and recommendations of the North Shore Watershed Study and report on progress on a regular basis, normally every five years.

Table 20 identifies a series of strategies and tasks necessary to accomplish the recommendations related to: caring for surface water, groundwater, nature, community and the Bay. It identifies the agencies or groups responsible for each strategy and the priority for implementation.

Grove Park

Table 20. North Shore Watershed Study Implementation Actions and Strategies

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR SURFACE WATER																
1	Protect and enhance surface water quality		○			○	○						○	●	Identify all point and non-point pollution sources.	O
			○			●	●			○				○	Educate residents & businesses in pollution control techniques, e.g. proper pool maintenance, proper disposal of household hazardous waste.	O
				○			○		○	○		○	●	○	Increase riparian buffers/habitat adjacent to watercourse.	O
						●	○					○	○	●	Implement regional Clean Water Program to assist with funding of stewardship initiatives.	I
			○	○		●	●	○					○	○	Encourage infiltration techniques to move water to groundwater to compensate for losses to impervious surfaces.	O
						○				○				●	Continue to monitor surface water quality.	O
			●			●	●				○	○	○		Encourage reduction/elimination of fertilizer and pesticide use for aesthetic purposes.	O
						●	●							○	Continue to retrofit existing storm water management facilities	O
							●		●	○			○	○	Implement Yellow Fish Road Program in urban areas.	I
2	Reduce sources of thermal Pollution			○		○	○					○		●	Inventory all dams and on-line ponds in watershed.	I
												○	○	●	Encourage landowners to remove/retrofit on-line ponds where significant benefits can be achieved.	O
		○		○		○	○							●	Prohibit new on-line ponds except where it can be justified for I management purposes.	I
						●	●	○				○	○	●	Encourage infiltration techniques as part of I management (eg. cooling trenches, French drains etc.)	L

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR SURFACE WATER																
3	Reduce and/or mitigate the impacts of erosion						○							●	Identify all erosion-prone areas.	O
							●					○	●	○	Remediate all priority erosion-prone areas.	O
						●	●							○	Enact, implement and enforce topsoil preservation/site alteration by-laws.	O
				○	○	●	●	○						○	Implement/enforce sediment and erosion control on developing sites	I
			○			●	●	○						○	Implement quality control on SWM facilities.	O
							●	○						●	Establish baseline data for compliance monitoring during subwatershed studies.	L
4	Protect areas of recharge and Discharge			○		●								●	Identify all areas of discharge/recharge.	O
					○	○	○	○	○	○		○	●	●	Protect areas of discharge/recharge through acquisition, donation, conservation easements, and stewardship agreements.	O
							○	○	○			○	●	○	Protect areas of discharge/recharge with protective buffers.	O
					○	●	●							●	Identify and protect drainage features associated with cracks and fissures along the brow of the escarpment as part of any development applications	O
				○	●	●	●							●	Protect all areas of discharge/recharge through Officials Plans, Site Plans and Zoning By-laws and the review of planning permit applications.	O

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR GROUND WATER																
1	Protect groundwater quality					●									Continue to monitor effectiveness of landfill site mitigation measures	O
			●			●						○	○	○	Ensure wellhead protection, capping of unused wells.	I
						○	○					○	●	○	Encourage capture/treatment of local runoff to protect areas of recharge and wells.	O
2	Protect groundwater quantity					●								○	Complete aquifer mapping.	I
			●			●	○							○	Update well water data base	I
			●			○	○							●	Update Permit To Take Water database, require renewal of expired permits.	I
			●			○	○							●	Revise/strengthen Permit To Take Water Process.	I
CARING FOR NATURE																
1	Protect wetlands				●	●	●	○				○		●	Protect all wetlands through Official Plans and Zoning By-laws.	O
				●										●	Evaluate all wetlands in the watershed using the provincial Wetlands Evaluation System	O
					○	○	○	○				○		●	Protect all wetlands through Conservation Authority regulations.	O
2	Improve quality of wetlands							○		○		○	●	○	Restore former wetlands/increase wetland areas.	O
3	Protect forest habitats				○	○	○	○		○	○	○	●	○	Maximize forest cover through stewardship opportunities.	O
				○	●	●	●	○				○		○	Protect significant woodlands through Official Plans and Zoning By-laws as per the Provincial policy statement.	I
					○	●	●			○		○	○	●	Protect forests through acquisition, donation, conservation easements, and stewardship agreements.	O
					○	●	○			○		○	○	●	Co-ordinate forest protection strategies/land acquisition between Regions, CA & private landowners.	I
						●							○	○	Enforce protection with existing tree cutting by-laws.	I
						●	○							○	Update/enact tree cutting by-laws	I
						●	●							○	Identify priority protection areas, significant woodlands, "core areas", "nodes" & embody in Official Plans, planning docs, secondary plans, etc.	O

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR NATURE																
3	Protect forest habitats (cont.)				○	●	●							○	Restrict /prevent development in forested areas	I
						●						○		●	Manage plantations to convert to mixed forests.	O
						●	●					○		●	Protect large and/or sensitive forested areas from all activities.	I
					●	●	●	○						○	Protect forests through development application process.	O
4	Protect/expand interior forest habitat					○	○		○	○		○	●	○	Encourage tree planting or natural succession to increase interior forest cover through stewardship opportunities.	O
						○	○		○				●	○	Restore/replant forest cover on marginal lands.	L
5	Protect/restore critical / sensitive habitat			○		○	○					○	○	●	Protect areas of critical/sensitive habitat.	O
				○		○	●			○		○		●	Active management of some sensitive areas (i.e. reduce mowing in savanna habitat, control burning of prairie areas).	O
						●	●							●	Protect existing and proposed ESAs, ANSIs, wetlands etc., from development	O
6	Protect/enhance natural corridors and linkages					●	○			○					Identify inter and intra watershed natural corridors	O
						○	●			○		○	●	●	Protect, enhance and restore linkages, including tableland linkages.	O
						●	●							●	Identify tablelands to be used in linkage plans.	I
						●	●			○		○		●	Limit access points to critical natural areas.	O
7	Protect/restore fish habitat						●		○	●			●	○	Restore/enhance riparian buffers through naturalization and planting of overhead cover	O
		○		○						○		○	○	●	Retrofit dams to reduce thermal impacts	L
		○		○						○		○	○	●	Remove barriers to fish movement	L
			○			●	●	○		○		○	○	●	Reduce/eliminate online ponds	I
												○		●	Extend moderate flow periods and enhance base flows.	O
		●					●		○			○	○	●	Enhance/restore estuaries at the mouths of creeks entering the bay.	O
						●	○	○	○			○		○	Manage stormwater/runoff through best management practices	O
						●	●	○				○		○	Reduce siltation/impacts of erosion.	O

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR NATURE																
8	Protect/enhance valley lands				○	●	●	○				○	○	●	Protect valley lands through dedication, donation, conservation easements, and stewardship agreements.	O
						●	●							●	Include policies in Official Plans to protect significant valley lands	O
9	Reduce/eliminate proliferation of non-native/invasive species					○	○	○				○	●	●	Limit reforestation/plantings to native/local species only.	O
								●		●			○	○	Create local seed banks through collections of local seeds to encourage plantings of locally native species and genetic stock (local nurseries, RBG)	O
						○	○						○	●	Survey all sensitive natural areas for invasive species & eliminate where possible.	I
						○	○	○				○	●	○	Minimize impacts of invasive species by decreasing edge effects	L
									○				●	○	Educate public on impacts of non-native/invasive species.	O
10	Reduce use/misuse of pesticides					○	○	○				○	●		Protect natural areas & creeks from herbicides/pesticides.	O
						●	●		○	○	○	○	○	○	Provide input into (Regional, Municipal) pesticide use guidelines (re: health and safety issues).	O
						○	○					○	●	○	Introduce buffers to prevent spraying near creeks or natural areas.	O
						○	○					○	●	○	Minimize impacts on non-target species.	O
			○	○		○	○		○			○	●	○	Educate the public on use/misuse of pesticides.	O
11	Protect/enhance non-forest habitats					○	○		○			○	●	●	Protect/enhance prairie and savannah habitats through public ownership, stewardship agreements, easements etc.	I
						○			○	○			●	●	Educate the public as to the significance of remnant habitats (eg. prairies and savannahs) and the need for their protection and enhancement.	I
						○				○				●	Undertake a botanical inventory of all grassland habitats to identify the presence of remnant prairie communities.	O
						○				○		○		●	Actively manage prairie and savannah habitats, etc.	L

RECOMMENDATIONS		AGENCIES / GROUPS RESPONSIBLE													STRATEGIES / TASKS	
		Federal Government	Min. of Environment	Min. of Nat. Resources	Niagara Escarpment C.	Hamilton, Halton	Burlington	Development Industry	BARC	Conservation Groups	Recreation Industry	Private Landowners	Stewardship	Conservation Halton	● Lead agency ○ Involved stakeholder	Priority (L) Low, (O) Ongoing, (I) Immediate
CARING FOR NATURE																
12	Protect/enhance wildlife populations					○	○			○			●	●	Enhance, restore and maintain the watershed to support the natural range of species expected to occur.	I
													○	○	Increase the diversity of breeding birds through habitat enhancement and restoration.	L
						○	○		○				○	○	Reduce/control incidence of nuisance wildlife.	L
				○						○			○	●	Protect specialized habitats for wildlife (e.g. snake hibernacula)	I
CARING FOR COMMUNITY																
1	Reduce and/or mitigate the impacts of urban development	○	○			●	●	●					○	○	Promote the goals of Smart Growth.	O
						●	●	○						●	Mitigate impacts of stormwater through best management practices, including quality and quantity controls for new development, retrofitting existing stormwater management facilities and improving outfalls.	O
						●	●	○				○		○	Maintain/increase creek, valley and natural area setbacks (eg. 7.5m from stable top of bank for minor watercourses and 15m from stable top of bank for major watercourses).	O
						●	●					○		○	Increase creek blocks in public ownership through creek block dedication with appropriate setbacks.	I
						●	●	○		○		○		○	Increase green spaces, recreational paths in urban areas.	I
						●	●							○	Enact and enforce municipal topsoil preservation, site alteration and tree cutting by-laws.	O
						●	●								Continue to require the preparation of Environmental Impact Assessments for proposed developments within and adjacent to ESAs and significant natural areas through the PPS and regional/ municipal official plans.	O

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CARING FOR COMMUNITY																
1	Reduce and/or mitigate the impacts of urban development (cont.)					●	●	○							Maintain Burlington and Waterdown urban boundary.	I
						●	●	○	○	○	○	○	●	○	Encourage naturalization of urban parks, properties and utility corridors.	O
			○			●	●	○				○	○	○	Promote infiltration; discourage uncontrolled runoff.	I
						○	○		○	○		○	○	●	Educate the public as to the importance of valley and creek protection from encroachment, dumping of yard wastes, pool water discharge, etc.	I
						●	●					○	○	●	Discourage encroachment into publicly owned valleys and natural areas (eg. fencing, education, enforcement).	I
						●	●		○		●	○	○	●	Encourage community clean up days of publicly-owned creek valleys and where permission has been obtained, on privately-owned valleylands.	I
						●	●	○						●	Require subwatershed studies for all future secondary plans	I
		○	○	○		●	●	○		○	○	○	●	●	Encourage water conservation programs	I
2	Reduce and/or mitigate the impacts associated with transportation		○			●	●					○			Reduce use/extent of road salting.	O
		○	○			●	●	○		○			○		Promote increased use of public transit	O
			○	○	○	●	●							○	Study proposed Mid Peninsula Hwy. to ensure no environmental impact	I
				○	○	●	●							○	Study proposed Waterdown Road/403 interchange, connections to Dundas Street and the South Service Road (King Rd., Kearns Rd.) to ensure no environmental impact	I
						●	●							○	Ensure roads/bridges are sensitive to natural features and minimize impacts to the natural environment.	O
						●	●	○							Ensure transportation routes do not result in the expansion of urban areas.	O
3	Reduce the threat of flooding					○	○							●	Ensure CA regulations are enforced.	O
							○							●	Identify flood susceptible areas and refine flood plain mapping through subwatershed study	O
					○	○	○	○			○			●	Prohibit development in flood plains as per Provincial Policy Statement	O

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CARING FOR COMMUNITY																
4	Reduce potential for loss of life/ property damage from natural hazards.					○	○						○	●	Public education on flooding and flood plain issues (eg. signage in parks as to the danger and risks associated with the flashiness of streams).	O
						○	●							●	Continue to implement and improve flood warning system.	I
				●		●	●							○	Ensure adequate resources for thorough flood warning system.	I
5	Maintain an urban separator of natural habitat and non-urban areas between Burlington and Waterdown.					●	●								Ensure Official Plans maintain an urban separator between Burlington/ Aldershot and Waterdown.	I
					○	○	○							○	Support Amendment 71 to the Niagara Escarpment Plan which brings the escarpment lands into the Niagara Escarpment Plan.	O
6	Protect valley lands, wetlands and harbour shoreline bluff.s			○		○	○							●	Identify fill regulated areas associated with the valley lands, wetlands and shoreline bluffs in the study area as part of the CA's new generic regulation.	I
7	Promote sensitive public use of natural areas						●							○	Control parking/access to significant natural areas.	O
							○							●	Designate sensitive areas off-limits to public use.	I
							○							●	Prohibit use of bicycles and ATVs in significant natural areas	I
						●	●			○					Develop regional trail linkages to Waterfront Trail, Bruce Trail, RBG	O
						●	●			●				●	Ensure trail planning avoids sensitive natural areas.	O
						●	●							○	Promote ecotourism and interpretation of the natural features in the watershed and harbour.	O
8	Protect existing agricultural usage within the watershed					●	●								Allow agriculture to continue as an interim use within the urban areas.	O
9	Reduce/mitigate impacts of aggregate extraction					○	○	○						●	Review final rehabilitation plans for aggregate extraction areas to ensure compatibility with surrounding natural areas and significant habitats.	I
						○	○	●						●	Enhance stormwater management to control sedimentation originating from aggregate extraction areas.	I

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CARING FOR COMMUNITY																
10	Reduce/mitigate impacts of golf course development.					○	●		○		●		●	○	Encourage all golf courses to obtain "Audubon" certification, or equivalent.	O
							●				●		●	○	Rehabilitate or allow naturalization of habitats outside the area of play.	O
							●				●		●	○	Investigate opportunities for water conservation and alternatives to on-line ponds.	O
							●		○		●		○	○	Reduce/eliminate use of pesticides and fertilizers.	O
11	Reduce/mitigate impacts of cemeteries					●		●					○	○	Rehabilitate or allow naturalization of habitats adjacent to valleys, natural areas, and bluffs.	O
						●		●	○				○	○	Reduce/eliminate use of pesticides and fertilizers.	O
						●		●	○				○	○	Encourage proper disposal of yard wastes and fill material to protect valley, bluffs and shoreline.	I
12	Improve stream morphology	○				○	●	○		○	○	○	●	●	Promote channel morphologies that are in balance with the natural tendencies of the reach.	O
		○				○	●	○		○	○	○	○	●	Use natural channel designs to rehabilitate stream reaches	O
							●	●						○	Establish appropriate standards for stream restoration within the urban area	O
							●			○			○	○	Examine opportunities to remove creek enclosures and day light former creeks.	L
							●							○	Retrofit storm sewer outfalls to reduce impacts on stream morphology	L
						○	●						●	○	Develop demonstration projects for public education.	O
13	Protect/enhance viewscapes into and from the watershed				○	○	●					○			Protect/enhance viewscapes while protecting natural features.	L
					●	●	●	○						○	Restrict development that mars viewscape.	L
					●	●	●	○				○		○	Restrict development near or on prominent or important natural features (eg. Earth Science ANSIs, Niagara Escarpment).	L

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CARING FOR THE BAY																
1	Net discharge of phosphorus meet loadings targets for creeks		●			○	○								Achieve an initial phosphorus target for all streams entering Hamilton Harbour of 90 kg/day (2003).	O
			●			○	○								Achieve a final phosphorus target for all streams entering Hamilton Harbour of 65 kg/day (2015).	O
2	Protect riparian buffers					○	○					○	●	●	Identify extent of riparian buffers within the urban and rural areas of the watershed and identify opportunities for restoration (2003).	O
						○	○					○	●	○	Increase linear extent of riparian buffers by at least 10%.	I
						○	●							○	Program/study to identify areas where it would be practical to implement riparian buffers within the urban area and appropriate standards.	I
						●	●						○		Suitable subsidies be made available to encourage landowners to implement erosion control measures and riparian buffers.	O
						●	●					○	○	○	All rural watercourses within the Hamilton Harbour watershed be buffered by a 15 metre vegetative riparian buffer adjacent to warmwater fish habitat	L
						●	●							○	Establish appropriate riparian buffering in urban watersheds (2015)	L
3	Remediate sources of sediment					●	●							○	Sources of sediment from inappropriate land management practices be prioritized and remediated.	I
4	Control of urban runoff					●	●							○	Urban storm runoff be controlled by municipalities through retention ponds, treatment monitoring systems or other means to prevent excessive bacterial and aesthetically deleterious discharges in sensitive areas of the Harbour (marshes, parks etc.).	O
5	Shoreline remediation/ naturalization	○					○	○	○			○	○	●	Decrease hardening of shoreline.	O
							○					○	●	●	Ensure activities that may destabilize the Burlington Bluffs or further harden the shoreline do not occur.	O
														●	Currently the shoreline falls under the jurisdiction of both Conservation Halton and Hamilton Conservation Authority. Consideration should be given to transferring jurisdication to one conservation authority to streamline shoreline planning.	O

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CARING FOR THE BAY																
5	Shoreline remediation/ naturalization								○			○	○	●	Promote the development of the Hamilton Harbour in line with the techniques contained in the recommendations of "Protecting our Shorelines Naturally: Shoreline Protection Ideas for Fish and Wildlife Enhancement".	O
6	Water Conservation Strategies					●	●		○			○	○	○	Evaluate the merits of water conservation programs (retrofit older homes, reduction in lawn watering) and develop an implementation plan.	O
						●	●								Produce a water conservation action plan.	O
7	Complete and implement watershed studies					○	○							●	Complete watershed plans for all creeks within the Hamilton Harbour watershed.	O
						○	○							●	Implement the recommendations of the watershed studies and where land development or secondary plans are proposed, undertake a subwatershed study in advance of development.	O
8	Implement stormwater management practices					●	●							●	Ensure all new greenfield and brownfield developments have proper stormwater management.	O
						●	●					○	○	●	Promotion of the concept of stormwater management plans for existing large–scale private landholdings.	O
9	Undertake groundwater studies and monitoring throughout the Hamilton Harbour watershed		●			●								○	Undertake groundwater studies and ongoing monitoring to identify significant groundwater sites and develop policies for their protection.	O
10	Goal of zero discharge of trace metals and organics					●		○							Review the status of leachate escaping landfill sites in 2002-2003 and prepare a strategy with timelines for containment, clean up or treatment of these toxic substances.	O
11	Reduction of pesticide use	●				●	●	●			●	●		●	All public and private organizations reduce their use of pesticides by at least 10% per hectare each year and review periodically.	I
		●				●	●							●	All public agencies identify opportunities to naturalize areas that are currently in grass cover (particularly those adjacent to watercourses, valleys and forests) to reduce their requirements for lawn maintenance. Formulate a naturalization plan for each location and initiate implementation of plan.	O

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CARING FOR THE BAY																
11	Reduction of pesticide use					●	●								Municipalities adopt policies banning the use of pesticides on public lands except in cases of emergency or exceptional circumstances.	O
		●				●	●	●			●	●		●	Complete elimination of the non-essential use of pesticides.	L
12	Restore ecosystems of the lower reaches of the Hamilton Harbour tributaries	●	○	●		○	●							●	Restore ecosystems of the lower reaches of the Hamilton Harbour tributaries by, improving stream morphology and hydrology, enhancing fish and wildlife habitat, restoring flood plain habitat and providing access for fish and wildlife, improving water quality by removing stresses resulting from discharges from the watershed.	O
		●		○		○	●							●	Develop habitat targets (riparian and stream morphology) for lower Indian Creek.	O
		●		○		○	●			○				●	Implement recovery for Indian Creek to meet defined habitat targets.	O
13	Habitat protection from overuse by the public	●					○		○	○					Develop a management plan for restored fish and wildlife habitats to protect them from overuse by the public interested in fishing, ecotourism, wildlife viewing, hiking and education.	
14	Provide more physical access to the shores of Hamilton Harbour					○	●							○	Municipalities and other authorities continue to acquire and develop lands for public use, to develop existing lands under their control and to identify new sites that provide more physical access to the shores of the Hamilton Harbour, its tributaries and significant related ecosystems.	O
						○	●								Contribute to the harbour-wide goal that 35% or more of the Hamilton Harbour shoreline be physically accessible to the public. Presently approximately 25% of the shoreline is accessible.	O
						○	●							○	Municipalities, in conjunction with the Conservation Authorities, prepare Master Plan(s) to improve trail linkages within and around the Hamilton Harbour and its watershed.	L
						○	●							○	Greater emphasis should be placed on initiatives to improve the amount and quality of access to riparian areas adjacent to watercourses.	O

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CARING FOR THE BAY																
15	Promotion of natural ecosystems appreciation throughout the entire watershed area								○	○			○	●	Develop outreach programs and pursue partnerships with non-profit community organizations.	O
						○	○		○			○		○	Identify through the budgeting process priorities for boardwalk and viewing platform construction.	L
16	Protection of views and vistas of the Harbour					○	○		○					○	Identify, protect, promote and enhance important views, vistas and cultural landscapes of the Hamilton Harbour	L
						○	○		○					○	Undertake a viewshed study to identify sites whose views are worth preserving and possibly enhanced. The study should also include methods for preserving the important viewpoints.	L
17	Develop, maintain and evaluate public education programs					○	○		●	○			○	●	Reactivate programs such as the Yellow Fish Storm Drain Marking Program and maintain markings of all urban watershed catchbasins.	I
										●					Continue programs such as the W.A.T.E.R. Stream Stewards.	I
						●									Develop and implement an education program about alternatives to hazardous waste products.	L
18	Distribution of information on Harbour and watershed conditions								●					○	Develop and implement a communications plan for the Harbour for the community at-large, elected officials and the media to promote the vision of a vibrant, healthy, accessible, multi-use harbour.	O
									●					○	Develop and implement an information program to inform the public on the water cycle throughout the Hamilton Harbour watershed including inputs, outfalls, landfills and the impact on water quality in the Harbour.	O
19	Initiate an adoption program for stream sections								●				○		Investigate the feasibility of establishing an "adoption program" to allow individuals, groups or organizations to assist public authorities in the upkeep, enhancement, and ongoing monitoring of specific sections of urban, publicly owned streams, waterfronts and watersheds.	L
									●				○		Initiate a pilot watershed adoption project.	L

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CARING FOR THE BAY																
20	Continue to implement the Hamilton-Halton Watershed Stewardship Program								○				●	○	All landowners adjacent to designated wetlands, creeks, streams, and other significant natural ecosystems be covered by the Stewardship Program.	O
									○				●	○	All private landowners that have part of their landholdings as "natural area" or are adjacent to "natural areas" will be contacted to make them aware of the importance of the natural environment.	O
21	Creek water quality monitoring		○			○	○							●	Enhance the collection of water quality monitoring information for creeks within the watershed using surveillance monitoring, performance monitoring, and special studies.	O
22	Continued surveillance and monitoring	○	○	○		○	○	○						○	All agencies, municipalities and industries continue their commitment and enhance where necessary the collection of the surveillance and monitoring data and analyses required for local decision making and ultimately presentation to the public and the International Joint Commission.	O

8.0 GLOSSARY

8.1 List of Acronyms

The following is a list of acronyms found in the report

Area of Concern (AOC)
Area of Natural and Scientific Interest (ANSI)
Environmentally Significant/Sensitive Area (ESA)
Important Bird Area (IBA)
Natural Heritage System (NHS)
Niagara Escarpment-Oak Ridges Moraine-Algonquin to Adirondak Heritage initiative (NOAH)
Niagara Escarpment Plan (NEP)
Parkway Belt West Plan (PBWP)
Remedial Action Plan (RAP)
United Nations Educational, Scientific and Cultural Organization (UNESCO)

8.2 Glossary of Technical Terms

The following is a list of definitions for technical and scientific terms found in the report.

Algae – Simple photosynthetic plants found in all aquatic ecosystems.

Aquatic - Relating to water. May be used to describe plants, animals and other life in streams, rivers and lakes.

Area of Natural and Scientific Interest (ANSI) – Areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education. The areas vary in their level of significance and their vulnerability to environmental stresses.

Bacteria - Group of unicellular or multicellular, microscopic organisms lacking chlorophyll found in all aquatic ecosystems. Some are disease-causing.

Barrier to Fish Passage – Term pertains to any natural or artificial obstruction to movement of fish upstream (i.e. waterfalls, dams, drop structures).

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

Bedrock - The solid rock underlying soils and the loose surface mantle of the earth.

Benthic Macroinvertebrate – Refers to "bottom dwelling" organisms that are associated with the bottom of a watercourse or water body for at least part of their life cycle. These organisms do not have a backbone and can be readily seen by the eye. Representative groups include aquatic insects such as stoneflies, mayflies, caddisflies, beetles, striders, sow bugs, scuds, crayfish, clams, snails and worms.

Benthic Organism – An organism that inhabits the bottom of a watercourse or body of water.

Biodiversity - The diversity of plant and animal species required for ecosystem health.

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

Buffer Strip – A band of permanent vegetation adjacent to a terrestrial natural area, wetland or watercourse that maintains or improves the ecological features and functions found therein by providing an element of separation and protection from adjacent land use impacts A naturally vegetated or potentially planted or revegetated area that borders natural areas wetlands or watercourses and provides ecological functions such as habitat, passage or buffering from adjacent negative impacts**.**

Carolinian Forest Zone - Deciduous forest community more commonly associated with the Southeastern United States. In Canada, this zone is restricted to southern Ontario, in particular the area south of an imaginary line drawn from Grand Bend to Toronto.

Coldwater Fish Habitat– Term that pertains to streams with thermal regimes which have the potential to sustain populations of salmonids (trout and salmon).

Conservation – The protection and rehabilitation of natural resources according to the principles that will assure their highest environmental benefits.

Conservation Tillage – Modified farming practices that emphasize preservation of soils and reduction of impacts on the natural environment through the use of such techniques as no-till and winter cover on agricultural fields. Such practices help reduce soil erosion and nutrient run-off.

Corridor – The areas that link or border natural areas and provide ecological functions such as habitat, passage, hydrological flow connection or buffering from adjacent impacts. They can also occur across or along uplands, lowlands or slopes.

Development – Means the creation of a new lot, a change of landuse or the construction of buildings and structures, requiring approval under the Planning Act; but does not include activities that create or maintain infrastructure authorized under an environmental assessment process; or works subject to the Drainage Act.

E. coli – *Escherichia coli*, a common type of bacteria found in the intestines of all warm-blooded animals. Because it does not reproduce outside the gut, *E. coli* are used as an indicator organism by the MOE for bacterial pollution.

Ecosystem – An ecosystem consists of the air, land, water and living organisms, including humans, and the interactions among them. It includes the community of living things and the complex of physical and chemical factors forming the environment.

Emergent Vegetation - Marsh vegetation which rises above the water surface. Robust emergents include cattails and bulrushes. Grasses and sedges are typical of narrow-leaved emergents.

Enclosure – A covered watercourse. Examples include storm sewers, buried streams and culverts.

Encroachment – Occurs when a person intrudes or alters the natural landscape adjacent to a natural area. Examples include dumping of yard/kitchen waste or other garbage into the waterway, building anti-erosion structures on channel walls, constructing fences up to the bank, and construction of other structures within the floodplain.

Environmentally Significant/Sensitive Area (ESA)- A regionally ecologically significant area, identified on the basis of its biophysical attributes and functions, that is given special policy consideration in municipal Official Plans.

Estuary – A partially enclosed embayment where river water and lake or water meet and mix.

Eutrophication – The unchecked growth of aquatic plants and algae due to excess nutrients.

Flood Plain -The area, usually lowlands, adjoining a watercourse that has been, or may be covered by flood water. The flood plain is a part of the river's natural space in times of flooding.

Fluvial - Relating to rivers and streams.

Gabion Basket – Stone filled wire mesh basket typically used in retaining walls and in the reinforcement of waterways to help prevent erosion.

Groundwater - Water that has infiltrated below the earth's surface. Like surface water, it moves in response to gravity, but its movement may be restricted by impermeable rock or clay layers.

Habitat - The place where an animal or plant naturally or normally lives. It is composed of food, water, shelter and space.

Headwater - The source area of a watershed.

Hummocky – Irregular, pitted, rolling terrain.

Hydrologic Cycle – The cycle of water movement from the atmosphere to the earth and back to the atmosphere through various stages or processes, as precipitation, interception, runoff, infiltration, percolation, storage, evaporation and transpiration.

Indigenous – Species that have originated naturally in a particular region or environment prior to European settlement.

Infrastructure - The collection of utilities and services that provide energy, communication and transportation.

Intermittent Tributaries - Watercourses that convey flows on a seasonal/event basis. Flows occur during the spring months but are intermittent during the remainder of the year. May provide fish habitat.

Land Stewardship - A land and water conservation program to assist watershed landowners and residents in becoming environmental stewards of their land.

Leachate - A solution or product created by the percolation of water through soil or waste material.

Marsh – Wetland dominated by robust emergent vegetation, such as cattails and sedges, and to a lesser extent, anchored floating plants and submergents.

Migratory Habitat - Aquatic and/or terrestrial linkages which support the unrestricted passage of fish or other wildlife between habitat types.

Mitigation - Includes the prevention, modification or alleviation of impacts on the natural environment. Also includes any action with the intent to enhance beneficial effects.

Monitor -- Procedures used to methodically inspect and collect data on changes in the watershed.

Moraine – A depositional feature whose form is independent of the underlying topography and is constructed by the accumulation of glacial deposits. There are several types of moraines including lateral, medial, ground and terminal. These moraines form from different processes and are composed of very different types of materials.

Natural Heritage -- Natural heritage is a concept used across North America as a framework and context for initiatives to conserve and steward natural areas, species and ecosystems at risk. Natural heritage includes geological features and landforms; associated terrestrial and aquatic ecosystems; their plant species, populations and communities; and all native animals species, their habitats and sustaining environment.

Neotropical Bird Species - Migratory bird species that overwinter in Central America and South America, migrating north in late spring for breeding. Warblers and scarlet tanagers are among the most visible of these species in southern Ontario.

On-Line Ponds – Ponds, usually man-made, located on a watercourse and controlled by a structure such as a dam, weir etc. Located so that all the water of the watercourse must pass through the pond as it passes from upstream to below the pond.

Pesticide – Organic or inorganic compounds used to control noxious "pests" that attack crops, animals and man. They are usually subdivided into chemical compounds sharing common characteristics.

Phosphorus – A non-metallic element that can occur in numerous organic or inorganic forms and is present in the aquatic ecosystem in dissolved or particulate form. It plays a major role in the biological process.

Polycyclic Aromatic Hydrocarbons (PAHs) – Byproducts of the combustion of fossil fuels, PAHs tend to concentrate in soils and sediments. They are delivered by airborne deposition or roadway runoff.

Provincially Significant Wetland – Wetlands classified by the Ontario Ministry of Natural Resources based on the Ontario Wetland Evaluation System 1994 Southern Manual, as amended from time to time.

Recharge Zone - Where runoff from precipitation and snow melt seeps into the soil and becomes groundwater.

Rehabilitation - The returning of land to its prior use or productivity.

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

Resource Management - The wise use of a particular natural resource to achieve specific ends.

Restoration - The altering or re-establishment of a site to a defined, indigenous, historic condition.

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

Sanitary Sewer – A pipe designed to transport wastewater from sanitary fixtures and floor drains to municipal treatment plants.

Savannah – A grassland containing scattered trees and drought-resistant undergrowth.

Sediment - Small particle of rock, sand and organic matter that is carried in water or settles to the bottom of a watercourse.

Septic Tile Bed – Private sewage treatment system made up of a settling/storage tank and treatment trench. Found on most rural properties, if properly designed and maintained, can have a service life of 15 – 30 years. Government studies estimate that up to 30 % of all septic systems in Ontario are not functioning properly or are failing.

Spawning and Nursery Habitat - Aquatic habitat which supports the reproduction and early life stages of fish.

Stakeholder - An individual who has a personal investment or interest in the watershed planning and management process.

Stewardship - The act of taking responsibility for the well-being of the natural environment.

Stress - A force acting on an object or system, resulting in a corresponding response.

Stormwater Management - The planned and engineered set of best management practices undertaken to regulate stormwater runoff under various specified conditions within various portions of the urban drainage system. In general, stormwater management is primarily concerned with limiting future flood damages and environmental impacts resulting from development.

Storm Sewer – A pipe designed to carry storm related water runoff. These pipes carry much larger loads than sanitary sewer pipes and drain to nearby creeks instead of treatment plants.

Subwatershed – Subunits of a watershed. It includes all the land and water that drains directly into individual tributaries within a watershed. Subwatershed boundaries are defined by the height of the land.

Swamp – Wooded wetlands in which water is near or above ground level.

Terrestrial - Of or relating to land, as distinct from water or air. May be used to describe plants, animals and invertebrates.

Threatened Species - Any indigenous species of fauna or flora that, on the basis of the best available scientific evidence, is indicated to be experiencing a definite non-cyclical decline throughout all or a significant portion of its Ontario range, and that it is likely to become an endangered species if the factors responsible for the decline continue unabated.

Urban runoff - Rain water and snowmelt, usually containing litter, organic and bacterial wastes, draining from city streets and gutters to storm sewers, ditches and local streams.

Warmwater Forage Fish Habitat – Refers to streams which are lacking warmwater sportfish, but, contain any combination of minnow species classified as baitfish by MNR. This typically includes streams with intermittent or low discharge.

Warmwater Sportfish Habitat – Refers to streams that contain any combination of smallmouth bass, largemouth bass, northern pike, walleye, yellow perch or panfish.

Water Quality - The chemical, physical and biological condition of water related to beneficial use.

Watershed - All the land and water that drains directly into a river, lake or bay. It includes hills, lowlands and the body of water into which the land drains, as well as its branches and tributaries. Watershed boundaries are defined by the height of the land.

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

Wetland - Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. The presence of abundant water causes the formation of hydric soils and favours the dominance of either hydrophytic or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens.

Winterkill – Oxygen reduction or anoxia resulting from excessive snow or ice cover in shallow, productive ponds or lakes leading to the death of fish.

9.0 ANNOTATED BIBLIOGRAPHY OF REPORTS, PAPERS AND PUBLICATIONS

1. Ambuel, B. and S.A. Temple. 1983. **Area-dependent changes in bird communities and vegetation of Southern Wisconsin forests.** Ecology 64:1057-1068 USA.

An examination of the relationship between bird community size and area in Southern Wisconsin.

2. Armour E.M., L. Lawrence, and M. White. 1979. **1979 Field Study of Environmentally Sensitive areas in Halton.** Regional Municipality of Halton Planning Department, Ecological and Environmental Advisory Committee. 107pp.

This report further documents the biological information for thirteen Environmentally Sensitive Areas that were described in the 1978 report entitled, "Halton Region Environmentally Sensitive Area Study".

3. Axon, B.K., Bradley, D., Krug, J., Newton-Harrison, S. 1989. **A Bio-Physical Inventory of the Niagara Escarpment and Grindstone Creek Public Open Space Areas. Volume 1. The Parkway Belt West Plan. Volume 2. Appendices.** Halton Region Conservation Authority. v1+147pp., v2+306pp.+Maps

   Vegetational Communities Map (Map of Reference 47).

A biological inventory of the Niagara Escarpment and Grindstone Creek Public Open Space Areas is provided in this document. This comprehensive study provides detailed information on the biological and physical environment, as well as recommendations for future use and protection.

The map provides a spatial description of vegetation communities along the Niagara Escarpment and Grindstone Creek public open space area.

4. Bakowsky, W. D. **Rare Communities of Ontario: Perched Prairie Fens**. NHIC Newsletter 3(1): 6-7.

This biannual newsletter from the Natural Heritage Information Centre (OMNR) give information about perched prairie fens in Ontario.

5. Bird and Hale Limited. 1986. **Halton Region Landfill Technical Study Biophysical Analysis Report, Site F. Schedule D – F.** Prepared for the Regional Municipality of Halton. 199pp.

"Site F" was a candidate site for the Regional Municipality of Halton's municipal landfill waste. This report details and analyzes Site F's biological resources as in terms of its suitability to support a landfill site.

6. Boyd, D. 1992. **A Summary of Metals and PAHs in Suspended Sediments at Sources to Hamilton Harbour.** Unpublished report prepared for the Ontario Ministry of Natural Resources. 1p + Appendices.

Boyd (OMNR, 1997) summarized existing Ministry of the Environment concentrations of metals and Polycyclic Aromatic Hydrocarbons (PAHs) data in suspended sediments at 10 sites in Hamilton Harbour.

7. Boyter, D and J. Struger. 1993. **Hamilton harbour Tributaries – Surface Water and Sediment Quality**. Unpublished paper. 5pp + appendices

This report prepared for Environment Canada provides data on metals concentrations from four Hamilton Harbour tributaries, including Grindstone Creek. The data is useful to gauge the relative degree of contamination of sediments being delivered from Grindstone Creek, as well as Spencer Creek, Indian Creek and Red Hill Creek.

8. Brobst, B.K. 1983. **A Biological Inventory of the Nelson Quarry, Burlington.** Halton Region Conservation Authority, Milton, Ontario. 31pp.

This biological inventory was generated to assist with the rehabilitation of the Nelson Quarry. A list of the flora and fauna is included, as well as recommendations for preservation and protection of sensitive areas.

9. Brownell, V.R. 1993. **Waterfront Natural Areas-Part 1: An Overview of Natural Areas along the Lake Ontario Waterfront from Burlington to Trenton.** 193pp.

This document details information on waterfront natural areas, with the intent of providing a means of identification of potential restoration and protection projects.

10. Bryant, M.A., M.A. Fleming, M.S. Tant, S.S. Varga. 1977. **Biological Documentation of Natural Features in Regional Municipality of Halton.** Ontario Ministry of the Environment. 74pp.

The purpose of this document was to provide further documentation of significant features in Halton's ESAs. The areas are described using EEAC criteria; current and potential human impacts are assessed and recommendations are provided.

11. Canadian Centre for Inland Waters. 1996. **Not Just a Drop in the Bucket; Summary of Proceedings; A workshop on Planning for the Hamilton Harbour Watershed.** 37pp.

This report examines the role watershed planning plays in the remediation of Hamilton Harbour. It discusses linking the Hamilton Harbour Remedial Action Plan to watershed planning, the importance of watershed planning and the status of watershed planning in the Hamilton Harbour Watershed. It concludes with workshop summaries and their action agenda.

12. Carolinian Canada, 2001. **The Big Picture.** Carolinian Canada. Canada.

A summary of the unique characteristics of a Carolinian Canada site.

13. Carolinian Canada. 2003. **Carolinian Species and Habitats**. (http://www.carolinian.org/SpeciesHabitats.htm). Accessed December 5, 2003.

The page of the web site contains general information on the species and habitats of the Carolinian zone with links to other pages and web sites for more specific information.

14. CEW (Citizens' Environment Watch). 2002. **Benthic Macroinvertebrate Data Analysis.** University of Toronto. (www.utoronto.ca/envstudy/cew/cew.htm)

This document details ten benthic indices that are commonly used and suggests a methodology to judge stream impairment based on these indices.

15. City of Burlington. 1979. **Rambo & Hager Creeks Drainage Study.**

This report assesses the Hager-Rambo diversion channel and offers a review of the recommendations made by M. M. Dillon, 1979.

16. City of Burlington. 2001. **Burlington Official Plan.** 220pp. + Appendices + Maps.

This report details the city of Burlington's policy guidelines for development within its jurisdiction.

17. City of Burlington. Road and Parks Maintenance Department. 2001. **Creek Encroachment.** 201pp.

Descriptions of creek encroachments for Sheldon, Appleby, Shoreacres, Tuck and Roseland Creeks are documented, and accompanying digital and aerial photos are included.

18. City of Burlington, Road and Parks Maintenance Department. 2001. **Creek Maintenance Inventory.** 201pp.

The entire length of Sheldon, Appleby, Shoreacres, Tuck, Roseland, and Indian Creek was assessed for disturbances (such as erosion, meander pattern, encroachments, structural condition of pipes and culverts, etc.). These conditions were documented and photographed.

19. City of Burlington. 2001. **Proposed Creek Improvements. West Branch of the Rambo Creek CNR Culvert to Fairview Street.**

An analysis of the west branch of Rambo Creek is provided as a result of a proposed development on the east bank of Rambo Creek.

20. Clavering, H. and B. Pomfret. 2003. **Rough draft: summary of turtle trapping project in Carroll's Bay, 2003**. Royal Botanical Gardens unpublished report.

The results of turtle trapping conducted from May to August 2003 in Carroll's Bay at the west end of Hamilton Harbour are presented. Species trapped included 22 red-eared sliders, 61 northern map turtles, 16 midland painted turtles, 15 common snapping turtles and one eastern spiny softshell turtle.

21. Corporation of the City of Burlington. 1999. **Zoning By-Law 2020.** 284pp. + Maps

A detailed report of zoning designations for the City of Burlington.

22. Credit River Anglers' Association. 2003. **www.craa.on.ca**.

23. D.W. Draper & Associates Limited. 1993. Hamilton Harbour Tributaries Storm Event Monitoring Study. **Unpublished report prepared for the Hamilton Region Conservation Authority**. 44pp. + Appendices.

A 1993 report , produced for the Hamilton Region CA, studies past storm events within the Hamilton Harbour tributaries. Data is provided on total phosphorus, suspended solids and zinc concentrations and the authors attempt to estimate sediment loads delivered to the Harbour.

24. Department of Commerce and Development. 1960. **Twelve Mile Creek Conservation Report**. 136pp

This document is an excellent historical review of the Bronte (Twelve Mile) Creek watershed prepared at the time the conservation authorities were created. It provides overviews and recommendations pertaining to the management of forestry and water resources, wildlife and recreation.

25. Dillon Ltd., 1981. **Rambo and Hager Creeks Hydrology Study**. Prepared for Halton region Conservation Authority. 33 pp + tables and appendices.

Hydrologic analysis of Hager and Rambo Creeks Watershed including impact assessment of the proposed Highway 403.

26. Dove, A., S. Painter and J. Kraft, 2003. **Sediment Quality in Canadian Lake Ontario Tributaries: Part One (West of the Bay of Quinte)**, Ecosystem Health Division, Ontario Region, Environmental Conservation Branch, Environment Canada, Report No. ECB/EHD-OR/03-01/I

This report discussed the results of screening-level surveys conducted at the mouths of tributaries draining into the Niagara River and Lake Ontario. This sampling is the first stage in identifying potential sources of contamination in lower Lake Ontario. This program is part of Canada's commitment to the Great Lake Water Quality Agreement.

27. Duncan, J. 1989. **Carolinian Canada Final Report Landowner Contact Program For Sassafras Woods and Beverly Swamp.** Halton Region Conservation Authority.

This document is a summary of the Halton Region Conservation Authority "Landowner Contact and Management Strategy Program". This document includes landowner lists, letters, meetings, summary, recommendations, statement of interest, and strategy.

28. Duncan, J. 1989. **Sassafras Woods, A Carolinian Canada Site.** Halton Region Conservation Authority. 34pp.

This document details the lead agencies for Sassafras Woods; its profile; its fauna and significant flora; and methods and reasons for its protection.

29. Dwyer, J.K. (ed.) 2003. **Nature Counts Project Hamilton Natural Areas Inventory Site Summaries. Hamilton Naturalists' Club.** In Press.

This document is an environmental appraisal of the Environmentally Significant Areas within the City of Hamilton.

30. Eagles, P.F.J. and T.J. Beechey. 1985. **Critical Unprotected natural Areas in the Carolinian Life Zone of Canada.** Nature Conservancy of Canada, The Ontario Heritage Foundation and the World Wildlife Fund. Canada.

31. Ecological Services for Planning. 1994. **GSA Lands Environmental Appraisal Document.** 36pp. + Appendices.

This document is an Environmental Appraisal of the Grindstone Settlement Area (GSA) and surrounding lands. It includes a description of ecosystem functions, potential development effects and mitigation options.

32. Ecoplans Limited. 1996. **Waterdown Urban Expansion Subwatershed Feasibility Study**. Prepared for Paletta International Inc.

This document details the feasibility of developing portions of Waterdown.

33. Environment Canada. 1991. **Canadian Water Quality Guidelines**. 1572 pp. Unpublished.

34. Environment Canada. 1993. **Arsenic and its Compounds, Priority Substances List Assessment Report**. Government of Canada, Environment Canada, Health Canada.

35. Environment Canada. 2003. **Species at Risk**. (http://www.speciesatrisk.gc.ca/default_e.cfm). Accessed December 5, 2003.

This web site contains general information on species at risk in Canada, with links to more specific information on other pages of the web site.

36. Environment Canada, Canadian Wildlife Service, Ontario Ministry of Natural Resources and the Ontario Ministry of Environment. 1998. **A framework for guiding habitat Rehabilitation in Great Lakes Areas of Concern.** Canada-Ontario Remedial Action Plan Steering Committee. Canada. 75pp.

This framework was developed for the remedial action plan (RAP) teams and public advisory committee (PACs) that are working to rehabilitate the 16 areas of concern (AOCs) along the Great Lakes basin. The report is designed to guide the choice of restoration targets related to fish and wildlife populations and to prioritize locations for wetland, riparian and forested habitat rehabilitation projects.

37. Environment Canada, Ontario Ministry of Natural Resources, and Ontario Ministry of Environment and Energy. 1996. **Identifying Habitat Rehabilitation Targets and Priorities in great Lakes Areas of Concern: Upland Systems**. 68pp.

This document was developed to assist Remedial Action Plan Teams in identifying priorities for rehabilitation and to help measure the degree of upland habitat rehabilitation that may be needed before the loss of fish and wildlife beneficial use impairment (BUI) can be considered restored.

38. Environmental Hydraulics Group. 1990. **Hydraulic Analysis of Highway 403 Culvert Indian Creek.** Prepared for the Geofcott Group, City of Burlington and the Regional Municipality of Halton. 5pp. + Appendices.

The report presents a hydraulic analysis of the culvert system at the Highway 403 crossing on Indian Creek and the surrounding area.

39. Environmental Hydraulics Group. 1990. **Storm Drainage Report for Proposed Office Buildings Geofcott Group.** 11pp.

This study presents a hydrologic analysis of the entire Indian Creek watershed and a hydraulic analysis of the impact of development on the Indian Creek.

40. ESG International Inc. 2001. **Review of NEC Amendment PH/71/90 Eastern Portion.** 31pp. + Appendices.

A report prepared on behalf on landowners whose lands are within the eastern section of the lands proposed to be shifted from the Parkway Belt to the Niagara Escarpment Plan area by Amendment 71 to the Escarpment Plan. The objective of the document is to look at background information and additional observations so as to determine whether the designations proposed are appropriate.

41. Falcone Smith Associates. 1990. **Creative Living Centre Job's Lane (Rosart Properties/Ikea) Industrial-Commercial Development Functional Drainage Report.** Prepared for Rosart Properties Inc. and IKEA Ltd. 31pp.

This report summarizes the formerly proposed stormwater management scheme for portions of Indian Creek. The report includes drainage constraints and proposes a stormwater management scheme to facilitate the proposed development in 1990.

42. Faulkenham, S. and Theysmeyer, T. 2001. **Nearshore Fish Community Trends Hamilton Harbour, 2001**. Royal Botanical Gardens, Science Department, Aquatic Ecology and Restoration Branch.

This document details the fisheries work completed during 2001 within the nearshore areas of Hamilton Harbour.

43. Featherstone, David. 1998**. Kerncliff Park Biophysical Inventory**. 13pp. + Map.

This report was a portion of the overall planning exercise to update the 1987 Master Plan for Kerncliff Park. The purpose of the report was to document changes to the biophysical environment within Kerncliff Park subsequent to the biophysical study undertaken by Landplan (1987) as part of the Master Plan. A description of the site topography, geology, watercourses, park vegetation and wildlife are included.

44. Fish and Wildlife Restoration Committee for Hamilton Harbour and Cootes Paradise. 1991. **Fish & Wildlife Habitat Restoration in Hamilton Harbour and Cootes Paradise: Concept Summary.** 54pp.

The purpose of this report is to summarize the Concept Plan for Fish and Wildlife Restoration of Hamilton Harbour and Cootes Paradise, funding options, and its development history. A description of present conditions and a historical perspective of fish and wildlife populations in the area are also provided.

45. Fish and Wildlife Restoration Committee for Hamilton Harbour and Cootes Paradise. 1992. **Fish & Wildlife Habitat Restoration in Hamilton Harbour and Cootes Paradise: Preliminary Scoping and Consultation.** 75pp. + Appendices.

This report is a continuance of the Concept Summary for Fish and Wildlife Habitat Restoration in Hamilton Harbour and Cootes Paradise report published in 1991. It describes the preliminary scooping, consultation, project justification and description, recommendations for individual projects and it outlines the next steps to be taken by the federal Environmental Assessment and Review Process (EARP).

46. Fish and Wildlife Restoration Committee for Hamilton Harbour and Cootes Paradise. 1992. **Fish & Wildlife Habitat Restoration in Hamilton Harbour and Cootes Paradise: Summary of Public Input.** 24pp. + Appendices.

This report summarizes responses that were received from the public to brochures and questionnaires. It is a broad representation of the public's views of the restoration project's proposed initiatives.

47. Gartner Lee Limited. 1992. **1991 Ground Water and Surface Water Monitoring Report for the Closed Burlington Landfill.** Prepared for the Regional Municipality of Halton. 30pp.

This report details the monitoring program for the Regional Municipality of Halton Landfill in Burlington. The aim was to assess any environmental impacts the landfill had on groundwater and surface water quality. The report further examines the leachate collection system and offers recommendations for future landfill monitoring programs.

48. Geomatics International Inc. 1995. **Regional Municipality of Halton Environmentally Sensitive Area Study 1995.** Prepared for The Regional Municipality of Halton. 323pp.

This document provides information that clarifies ESA policies, evaluates existing ESAs, updates and improves the ESA database, evaluates possible new ESAs, and modifies ESA boundaries.

49. Ghent, W. Undated (mid 1800's). Unpublished notes on Burlington Canal and Beach. Joseph Brant Museum, Burlington, Ontario.

50. Giffels Associates Limited. 1999. **Highway 407 Western Extension Hydrology, Drainage and Stormwater Management Report.**

This study presents the drainage and stormwater management strategy recommended for the section of Highway 407 between the QEW and Highway 403.

51. Godschalk, H.G., J.V. Jalava, M.J., Oldham and J.L. Riley. 1997. **Natural Heritage Resources of Ontario: Bibliography of Life Science Areas of Natural and Scientific Interest in Ecological Site Regions 6E and 7E, Southern Ontario. First Edition.** Ontario Ministry of Natural Resources, Natural Heritage Information Centre, Peterbourgh. 156 pp. + 3 Maps.

This bibliography provides published and unpublished information for documented natural areas in Southern Ontario. The focus is on provincial and regional life science ANSIs; however, general references and identified natural areas that are not ANSIs are also included.

52. Goodban, A.G., Bakowsky, W. and B. Bricker. 1999. **The Historical and Present Extent and Floristic Composition of Prairie and Savanna Vegetation in the vicinity of Hamilton, Ontario.** 15th North American Prairie Conference Proceedings. Canada.

Historical and recent information on prarie and savannah communities was collected and synthesized to compare their past and present extent and floristic composition. It provides the technical justification for the development of a conservation strategy for local prairie and savannah vegetation.

53. Gould, J. 1989. **Life Science Areas of Natural and Scientific Interest in Site District 7-3 Outside the Niagara Escarpment Planning Area: Review and Assessment of Significant Natural Areas.** Parks and Recreational Areas Section, Ontario Ministry of Natural Resources, Open File Ecological Report SR8901, Central Region, Richmond Hill, Ontario. 31pp.

This study identifies ANSIs in Site District 7-3 that lie outside the Niagara Escarpment Planning Area, 1976.

54. Golder Associates. 1985. **Geotechnical Investigation: Hager and Rambo Creeks Flood Control Burlington Ontario.** Prepared for Philips Planning and Engineering Limited.

This document presents the results of a study that investigated the subsurface conditions at various flood control structure locations along the Hager Rambo Creek flood control system.

55. Golder Associates Limited. 1995. **Phase II Environmental Site Assessment Lower East Rambo Creek Channelization Burlington, Ontario.** Prepared for Philips Planning and Engineering Limited.

This document provides an environmental assessment of a property adjacent to the Fairview Street GO Transit Station along the west bank of Rambo Creek. The primary purpose of the study was to characterize the fill materials on the site and characterize the composition of an unknown black organic soil as a possible source of seepage to Rambo Creek.

56. Great Lakes Section, Water Resources Branch. 1985. **Hamilton Harbour Technical Summary and General Management Options.** Ministry of the Environment, Ontario. 125pp.

The goal of this study was to generate management options for the control and improvement of water quality in Hamilton Harbour. This report examines water and sediment quality, oxygen depletion, trace contaminants and the relationships between phytoplankton biomass, bacteria, nutrients and physical factors in the harbour.

57. Green, Z.E. (ed.) 1995. **Toward Safe Harbours: Tracking the Implementation of the Remedial Action Plan for Hamilton Harbour.** Bay Area Restoration Council Monitoring Committee Members. 109pp.

This report includes a compilation of fifty recommendations of restoration options for Hamilton Harbour. It is the second report from the BARC Monitoring Committee.

58. Griffiths, R.W. 1998. **BioMAP How To Manual (Sampling and Evaluation, The Water quality of Streams in Southern Ontario).** Ministry of Municipal Affairs and Housing. Toronto, Ontario, Canada. 32pp.

The BioMAP training manual outlines the basic concepts and background of the BioMAP benthic invertebrate protocol. The manual further describes appropriate methods of analysis and includes index values various invertebrate taxa.

59. Halton Region Conservation Authority. 1989. **Lead Agency Strategy for Sassafras Woods.** A Carolinian Canada Site.

This report provides direction to agencies involved in the management of Sassafras Woods. Biological, ecological and landuse factors are considered before specific or general recommendations are proposed.

60. Halton Region Conservation Authority. 1991. **Statement of Conservation Interest for Sassafras Woods Area of Natural and Scientific Interest.** Parks and Recreation Areas, Ontario Ministry of Natural Resources. 6pp.

This paper describes the ANSI and recommends a short-term management approach to protect the areas natural features.

61. Hamilton Harbour Watershed Planning Network. (ed.) 2002. **Hamilton Harbour Watershed Policies.** 78pp.

This document is a synopsis of watershed policies concerning the Hamilton Harbour Watershed.

62. Hamilton Harbour Remedial Action Plan. 1992. **Remedial Action Plan for Hamilton Harbour: Environmental Conditions and Problem Definition. Stage 1 Report – 2nd Edition**. 247pp.

This report summarizes the remedial actions taken by the Hamilton Harbour RAP up to 1989 and also discusses key issues for the Harbour. Issues include water quality/eutrophication/water clarity, contamination from trace metals and trace organics, bacterial contamination, stresses on fish and wildlife, aesthetics and access, and planning and coordination.

63. Hamilton Harbour Remedial Action Plan. 1992. **Remedial Action Plan for Hamilton Harbour: Goals, Options and Recommendations. RAP Stage 2: Volume 2 – Main Report.** 327pp.

The assessments for the Hamilton Harbour up to 1992 are summarized in this report. This document lays the groundwork for assessing remedial options, establishing baseline conditions against which to gauge future trends and provides guidance in settling the delisting objectives for the Harbour.

64. Hamilton Harbour Remedial Action Plan. 2002. **Draft for Public Comment. Stage 2 Update**. 244pp.

This document is complementary to the 1992 Stage 2 Report and provides the current status future steps in the remediation process.

65. Harris, M.L., M.R van den Heuvel, J. Rouse, P.A. Martin, J. Struger, C.A Bishop, P. Takacs, 1998. **Pesticide Use in Ontario Agriculture: A critical Assessment of Potential Toxicity to Wildlife at Environmentally Relevant Concentrations with Special Consideration for Endocrine Disruption, Volume 1: Endosulfan, EBDC fungicides, Dinitroaline herbicides, 1,3-Dichloropropene, Azinphos-methyl and pesticide mixtures**. Canadian Wildlife Service, Environment Canada, Environmental Conservation Branch, Ontario Region.

66. Heagy, A.E. (ed.). 1993. **Hamilton-Wentworth Natural Areas Inventory. Volume II.** Hamilton Naturalists Club. Ontario, Canada.

This document is Volume II of a two volume report that provides a summary of the results of the Hamilton-Wentworth Natural Areas Inventoy (NAI) project. This project commenced in Janurary 1991 and involved the inventory and evaluation of the biophysical attributes of 92 natural areas within the Regional Municipality of Hamilton-Wentworth. Volume II provides information on the individual Site Summaries including a location map showing the general site boundaries.

67. Heagy, A.E. (ed.). 1995. **Hamilton-Wentworth Natural Areas Inventory. Volume I.** Hamilton Naturalists Club. Ontario, Canada.

This document is Volume 1 of a two volume report that provides a summary of the results of the Hamilton-Wentworth Natural Areas Inventory (NAI) project. Volume 1 is a three part report that includes a Summary Report, the Regional Context and the Watershed Summaries. The Summary Report includes a review of the background to the project, a summary of the project methodology and recommendations pertaining to the overall inventory project. The Regional Context section presents an overview of the physical, hydrological and biological features of Hamilton-Wentworth Region.

68. Heathcote, I.W., B. Koli, D.J. Poulton, K.J. Simpson and R.R. Weiler. 1986. **Impact of Hamilton Harbour on Western Lake Ontario.** Ontario Ministry of the Environment.

This report discusses coastal dynamics, the Burlington ship canal, plume tracking, polyaromatic hydrocarbons in sediments, water treatment plant intakes, and benthic invertebrates and heavy metals within Hamilton Harbour.

69. Henderson, Paddon Environmental Inc. 1995. **1994 Groundwater & Surface Water Monitoring Report for the Closed Burlington Landfill.** Prepared for the Regional Municipality of Halton.

This report details the annual monitoring efforts of the Burlington regional landfill. The report assesses the impact of the landfill on groundwater quality and surface water quality and evaluates the effectiveness of the drain collection system.

70. Hilts, S., T. Moull, J. Rzadki and M. Van Patter. 1988.**Carolinian Canada Landowner Contact Information Report – 1987.** Department of Land Resource Science, University of Guelph, Guelph, Ontario. Binder.

The objective of this report was to provide agencies that are involved with private stewardship activities within Carolinian Canada, with the necessary background to follow up with landowners.

71. Hills, G.A. 1959. **A ready reference to the description of the land of Ontario and its productivity.** Ontario Department of Lands and Forests. Canada.

A detailed description of various areas within Ontario and their associated productivity.

72. Holysh, S. 1995. **Halton Aquifer Management Plan – Phase 1 Background Hydrogeology Report**. Regional Municipality of Halton. 92pp

This report is the first phase in a series to provide an overall comprehensive understanding of the hydrogeology of Halton in order to best protest the Region's ground water supply and to identify constraints and opportunities for future development from a hydrogeological perspective. Through a thorough review of existing documentation and using advanced computer modeling, aquifers in the overburden have been defined along with their hydrogeological sensitivity. Recommendations are made for further studies to implement a wellhead protection program and further work to protect the water supplies for the eight existing rural settlements that lie within hydrogeologically sensitive areas. Also a future groundwater monitoring program and the development of a groundwater database and computer model is presented.

73. Holmes, J.A. and T.H. Whillans. 1984. **Historical Review of Hamilton Harbour Fisheries.** Canadian Technical Report of Fisheries and Aquatic Sciences No. 1257. 117pp.

Present Hamilton Harbour conditions are compared to its historical conditions in terms of fisheries, habitat, exploitation and interactions in order to determine the possibility of fisheries rehabilitation. Catch records are analyzed and compared to changes in aquatic macrophytes, benthic invertebrates, plankton, bottom materials, bathymetry and recreational fishing.

74. Hounsell, S.W. 1999. **Southern Ontario 2099, Planning with the end in sight. In: Southern Ontario Woodlands: The Conservation Challenge.** Federation of Ontario Naturalists. Ontario, Canada.13pp.

Contains an overview of southern Ontario during pre and early European settlement and contrasted to present day conditions and discussion of what can be done in the future.

75. House, L. and D. Carleton. 1988. **Life Science Inventory of Bronte Creek Provincial Park**. 42 pp. + Appendix.

The report provides a life science inventory of Bronte Creek Provincial Park, summarizing previously collected data and augmenting this information with further field work. It describes the vegetation communities, floristics, fauna, and significant features of the park, and provides management recommendations and conclusions. Detailed plant, bird, mammal, herptile, fish and insect species lists are included. The report contains significant features and vegetational community mapping.

76. H. Q. Golder & Associates Ltd. Soil and Foundation Engineers. 1968. **Report to James F. Maclaren Limited on Subsurface Investigation Proposed Diversion Channel Rambo Creek to Hamilton Harbour.** 17pp.

An investigation along the route of the proposed diversion channel between Rambo Creek and the Hamilton Harbour to the north of Burlington, was carried out to determine the channel's subsurface conditions.

77. Identification Subcommittee of Carolinian Canada, The. 1985. **Critical Unprotected Natural Areas in the Carolinian Life Zone of Canada.** 399pp.

This report identifies natural areas in Carolinian Canada for the purpose of developing protective strategies for the future. Developing conservation strategies and wildlife field projects are suggested.

78. Jalava, J.V., J.L. Riley, and S. Varga. 1996. **Ecological Survey of the Niagara Escarpment Biosphere Reserve. Volume I. Significant Natural Areas. Volume II. Technical Appendices.** Ontario Ministry of Natural Resources, Southcentral Region, Peterborough, Ontario. Open File Site Report SR 9601. vi +629 pp., vii +310 pp.

The study contains summaries of biological surveys of the most significant natural areas in the Niagara Escarpment Protection Area (NEPA); summarizes and standardizes site-specific information; and provides a framework for comparison among significant species, vegetation communities, and natural areas.

79. Jalava, J.V. and S. Varga. 1992. **Biological Inventory and Evaluation of the Sassafras Woods, Area of Natural and Scientific Interest.** Ontario Ministry of Natural Resources, Southern Region, Aurora, Ontario; Open File Ecological Report 8908. v +76pp. + 2 Maps.

The purpose of this report is to aid in resource management of Sassafras Woods and to interpret its ecology. This report is part of a series of reports that inventory the geological and ecological features of significant natural areas in Ontario.

80. James F. MacLaren Limited, Consulting Engineers. 1965. **Supplementary Report on Flood Control Works in the Town of Burlington for the Halton Region Conservation Authority.** 33pp.

This study is a supplementary report to the 1965 report entitled "Report on Flood Control Works in the Town of Burlington". It provides a cost-benefit analysis of the 1964 proposed Rambo diversion channel, the preliminary estimates of the associated land requirements, and the flood plan mapping for all recommended channel improvements.

81. Joint Board of Consolidated Hearings Act. 1997. **Waterdown Urban Boundaries Reasons for Decisions and Decisions.** Environmental Review Tribunal, Ontario.

Outlines the decision and reason for decision regarding Waterdown's urban boundaries. Three private landowners wished to redesignate from rural to urban.

82. Lake Systems Unit, Water Modeling Section. 1977. **Hamilton Harbour Study 1975.** Ministry of the Environment, Ontario.

This report documents any changes to water chemistry, sediments, methane production, oxidation, and phytoplankton-bacteria that occurred within Hamilton Harbour as a result of the installation of an artificial water-mixing device.

83. Lamond, W.G. 1994. **The Reptiles and Amphibians of the Hamilton Area- A Historical Summary and the Results of the Hamilton Herpetofaunal Atlas.** The Hamilton Naturalists Club. Hamilton, Ontario, Canada. 174pp.

84. Landplan. 1987. **Kerncliff Park Master Plan**. Volumes 1 and 2. Prepared for the Corporation of the City of Burlington, Department of Recreation Services.

Details the master plan for Kerncliff Park in Burlington.

85. Larson, B.M., J.L. Riley, E.A. Snell, and H.G. Godschalk. 1999. **The Woodland Heritage of Southern Ontario. A study of Ecological Change, Distribution and Significance**. Federation of Ontario Naturalists, Don Mills, Ontario, Canada.

86. Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. **Ecological Land Classification for Southern Ontario: First Approximation and Its Application.** Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

87. Lindsay, K. 1976. **Significant Natural Areas Along the Niagara Escarpment: A report on the Nature Reserve Candidates and other Significant Natural Areas in the Niagara Escarpment Planning Area.** 417pp.

This report identifies the life science component of a study undertaken by the Division of Parks during 1975-1976 to identify areas of high natural and ecological value. The natural areas are identified and evaluated based on their potential for a provincial nature reserve; while land areas that were not currently candidates for the classification of high natural and ecological value were assessed for their potential land use.

88. Lindsay, K.M. 1987. **Reconnaissance Biological Inventory of Sassafras Woods, Regional Municipality of Halton, Ontario (30M/5 920965).** 8pp.

This interim report on Sassafras Woods contains a summary of biological information gathered from research and fieldwork during 1986.

89. Mackie, G.L., 1998. **Applied Aquatic Ecosystem Concepts.** University of Guelph Custom Coursepack. 12 Chapters

This text reviews concepts related to aquatic ecosystems. Benthic invertebrates monitoring and analysis are described in detail.

90. MacLaren Plansearch Lavalin. 1988. **Indian Creek Erosion Control and Flood Plain Study Proposal.** Prepared for the Halton Region Conservation Authority. 23pp.

This proposal details the proposed hydrologic and hydraulic analyses for 1990 final report for the production of flood line maps for the main branch of Indian.

91. MacLaren Plansearch Inc. 1990. **Indian Creek CN Rail Hydraulic Analysis.** Prepared for Parker Consultants. 7pp.

This report describes the potential water level effects associated with the CN drainage works along the west branch of Indian Creek. The report includes analyses on flood elevations, potential filling, flow velocities and erosion protection.

92. MacLaren Plansearch Lavalin. 1990. **Indian Creek Erosion Control and Flood Plain Study.** Prepared for the Halton Region Conservation Authority. 40pp.

This report includes hydrologic and hydraulic analyses for the production of floodline mapping for the main branch of Indian Creek. The report also includes an analysis of erosion problems and offers several recommendations to alleviate the problems.

93. McCormick, Rankin. Consulting Engineers. 1979. **Highway 403 Rambo Creek Hager Creek Drainage Study.** Ministry of Transportation and Communications. 15pp.

A number of possible drainage diversions for Highway 403 were investigated in order to assist in easing drainage problems encountered in the City of Burlington.

94. McCormick, Rankin. Consulting Engineers. 1980. **QEW Highway 2 to Fairview Street. Study of Alternatives Rambo-Hagar Channel Crossings.** 5pp.

Reconstruction of a section of the QEW that crosses the Rambo-Hager Diversion Channel prompted this report which evaluates three alternative schemes for the channel crossing.

95. McCormick, Rankin. Consulting Engineers. 1989. **GO Train Expansion Program – Burlington to Hamilton.** Environmental Assessment Report. Volume 1. 247pp.

96. McIlwrick, K. 1996. **Shoreline Management Plan – Environmental Considerations.** Halton Region Conservation Authority. 84pp.

The purpose of this document is to describe and identify environmental components in the East Halton Waterfront and to prepare strategies that deal with their conservation, protection, enhancement, rehabilitation and management.

97. Minns, C.K. 1992. **Macrophyte Surveys in Hamilton Harbour, 1990 and 1991**. In correspondence to K. McIlwrick dated May 22, 1992.

98. Ministry of Environment and Energy. 1990. **The Niagara Escarpment Plan.** 80pp.

The purpose of this plan is to guarantee that the Niagara Escarpment and its immediate surrounding lands remains a continuous natural environment by ensuring that any development is compatible with that natural environment.

99. Ministry of Environment - Provincial Water Quality Monitoring Network. 1997. **Unpublished data from 1964-1996 and 1999-2001.**

Unpublished data in digital format supplied by the Ministry of the Environment.

100. Ministry of Natural Resources. 1979. **Forest Resource Inventory – Cambridge District East Flamborough**. Map.

The map was produced by the OMNR in 1979 for East Flamborough in the Cambridge District and details the forest types and tree species abundances within the forest stands of this area.

101. Ministry of Natural Resources, Parks and Recreation Section, Central Region. 1983. **A Summary Report of the Earth Science Areas of Natural and Scientific Interest in Cambridge District.**

This document compiles the earth science ANSI information for the Cambridge District and indicates site significance and provides recommendations for site protection.

102. Ministry of Natural Resources, Parks and Recreation Section, Central Region. 1983. **Regional and Local Earth Science Areas of Natural and Scientific Interest in Cambridge District.**

This document is a companion report to the 1983 report entitled, "A Summary Report of the Earth Science Areas of Natural and Scientific Interest in Cambridge District". This document is a list of file cards and checklists for regional and local earth science ANSIs.

103. Ministry of Natural Resources. 1992. **Biological Inventory and Evaluation of the Sassafras Woods Area of Natural and Scientific Interest**. 76pp. + Maps. (Reference Number 76)

This document provides background information on the Sassafras Wood and also reviews the vegetation and wildlife that can be found with the ANSI. This item maps the vegetation types within the Sassafras Woods.

104. Ministry of Natural Resources. 1993. **Ontario Wetland Evaluation System, Southern Manual**. NEST Technical Manual TM-002. Ontario, Canada.

105. M.M. Dillon Limited, Consulting Engineers & Planners. 1979. **Rambo and Hager Creels Watershed Study.** City of Burlington. 67pp.

This watershed study provides updated hydrological information for Rambo and Hager Creek upstream of the Rambo Hager Diversion Channel. The study further identifies the flood plain limits and storm drainage deficiencies and improvements.

106. M.M. Dillon Limited, Consulting Engineers and Planners. 1981. **Rambo and Hager Creeks, Hydrology Study.** Prepared for the Halton Region Conservation Authority. 33pp.

This study was prepared to assess the effects that the proposed highway 403 would have on Rambo and Hager creeks. It assesses and/or verifies previous flood protection alternatives for major storms, including the Regional Storm.

107. M.M. Dillon Limited, Consulting Engineers and Planners. 1982. **Falcon Creek Revegetation Report.** 18pp.

This report provides details on a program designed to revegetate the eroding slopes of Falcon Creek located on the west side of the Burlington Landfill Site and eventually have a stable forest community that is representative of the area before erosion.

108. M. M. Dillon Limited. 1987. **Roseland Creek Storm Water Management Study.** Prepared for the City of Burlington.

This report identifies the causes of flooding within the watershed and assesses alternative remedial measures to eliminate flooding and erosion at these locations.

109. M.M. Dillon Limited, Consulting Engineers & Planners. 1993. **Storm Water Management Summary Report. Cadesco Marketing Inc. West Rambo Creek Development.** 20pp.

This document gives an overview of the flood plain and storm water management issues that are related to the development site proposed for the West Rambo Creek.

110. M.M. Dillon Limited, Consulting Engineers & Planners. 1984. **Burlington Landfill Site Proposed Continued Use.** Prepared for Regional Municipality of Halton.

The scope of this report details the basis for the application for the Certificate of Approval for continued use of the Burlington Landfill site that includes the proposed plans for the site from 1984 to 1987.

111. Natural Heritage Work Group for the Waterfront Regeneration Trust. 1995. **A Natural Heritage Strategy for the Lake Ontario Greenway.**

This document identifies methods of regenerating the ecological integrity of the shoreline area while taking into consideration urban needs and expansion.

112. Newbury, R.W. and M.N. Gaboury. 1993. **Stream Analyses and Fish Habitat Design.** Newbury Hydraulics Ltd. and the Manitoba Habitat Heritage Corporation.

This document details methods to analyze streams and rivers and natural channel design methods.

113. Noss, R.F. 1987a. **Corridors in real landscape: a reply to Simberloff and Cox.** Conservation Biology 1:159-164 USA.

114. Noss, R.F. 1987b. **Protecting natural areas in fragmented landscapes.** Natural Areas Journal 7:2-13 USA.

115. O'Hara, P. 2000. **Preliminary Surveys and ELC Habitat Summaries for Red Mulberry (*Morus rubra* L.) in Dundas and Burlington, Ontario.** Royal Botanical Gardens. 20pp.

This report details first-stage monitoring of Red Mulberry along the slopes of the Niagara Escarpment in Dundas and Burlington. Results of surveys and preliminary Ecological Land Classification habitat summaries are also examined. Second-stage monitoring followed in 2001.

116. O'Hara, P. 2001. **Preliminary Surveys and ELC Habitat Summaries for Hoary Mountain Mint, *Pycnanthemum icanum* (L.) Michx. var. *incanum* on the Burlinton Bluffs in Hamilton and Burlington, Ontario.** Royal Botanical Gardens. 2.pp.

117. Parker Consultants. 1989. **GO Train Service Expansion Program, Oakville to Burlington, Environmental Status Statement Update.**

This report examines the proposed GO Train rail expansion and identifies and updates possible environmental effects. This report also examines the proposed expansion of the Aldershot storage yard used for CN freight operations.

118. Philips Planning and Engineering Limited. 2000. **West Rambo Creek, Fairview Street to CNR Oakville, Hydraulic Assessment, City of Burlington.** 10pp. + Appendices.

The condition of the West Rambo Creek was studied in order to document the conditions of the banks, the impact of proposed filling on the Regulatory flood lines and the sizing of a proposed local roadway crossing. Recommendations for a remedial slope stabilization work are also proposed.

119. Philips Planning and Engineering Limited. 1984. **Hager and Rambo Creeks Flood Control Pre-Design Study. Volume 1. Text and Figures. Volume 2. Appendices.** Prepared for Halton Region Conservation Authority. v1pp.48 + v2.

This document recommends an overall flood protection program for Rambo and Hager Creek south of the QEW.

120. Philips Planning and Engineering Limited. 1985. **Hager and Rambo Creeks Flood Control Diversion Crossing at CN Rail (Oakville Subdivision) at Mileage 32.57 Preliminary Engineering Report**. Prepared for Halton Region Conservation Authority. 9pp.

This technical report provides preliminary alternatives for reconstruction of a CNR culvert crossing in order to achieve design flow conveyance at this embankment

121. Philips Planning and Engineering Limited. 1995. **Ministry of Transportation Ontario Stormwater Management Study: Draft Drainage Study Report, Queen Elizabeth Way/ Guelph Line Interchange.** Prepared for the Ministry of Transportation, Ontario.

This study addresses the potential stormwater management impacts associated with the then proposed Queen Elizabeth Way/Guelph Line Interchange reconstruction. The report contains a review of existing and past conditions, hydrology and hydraulics and an analysis of current and future stormwater management for the site.

122. Philips Planning and Engineering Limited. 1997. **Technical Summary Updated Hydrology, Indian Creek, Hager-Rambo System, Roseland Creek.** Prepared for the City of Burlington. 11pp.

The purpose of this study was to update the overall system hydrology of the Indian Creek, Hager-Rambo diversion channel and Roseland Creek. An assessment of the existing and proposed stormwater management system is also included.

123. Planning Partnership, The (McCormick Rankin, GM Sernas and Associates Limited, LGL Limited). 1997. **South Aldershot 403 Corridor Secondary Plan Study Area – Background Report**. Prepared for the City of Burlington. 13pp + appendix

This document provides a summary of Stage 2 of this project, background report. Technical studies have been completed and background memos are provided on natural features, municipal servicing and stormwater management, and transportation. A design workshop and public meeting were conducted to discuss the findings of the technical studies and to develop three alternative land use concepts.

124. Proctor and Redfern Limited. 1978. **Core Area Study. Report on: Municipal Services and The Rambo and Hager Creeks.** The City of Burlington & The Regional Municipality of Halton. 65pp.

A study of improvements to the Municipal services in the City of Burlington's core area and clean up of Hagar and Rambo Creeks were discussed. This document includes assessment of sanitary sewers, storm sewers, watercourses and water mains in the core area.

125. Proctor and Redfern Limited. 1982. **National Sewer Pipe Limited Environmental Appraisal, Sanitary Landfill Proposal Burlington, Ontario.** Prepared for National Sewer Pipe Limited. 96pp.

This report examines the environmental suitability of the National Sewer Pipe Limited property for sanitary landfilling. The report includes an analysis of vegetation, soils, terrestrial fauna and the aquatic environment.

126. Province of Ontario. 1997. **Provincial Policy Statement** (revised February 1, 1997).

127. Regional Municipality of Halton, Ecological & Environmentally Advisory Committee. 1978. **Environmentally Sensitive Area Study.** 261pp.

This document provides information for the thirty-eight Environmentally Sensitive Areas that have been identified in Halton Region.

128. Regional Municipality of Halton. 1985. **Regional Sanitary Landfill Site, Burlington. Landfill Closure and After-Use Report.** 11pp + Maps.

The Regional Municipality of Halton was required to submit a plan for the closure, the long-term maintenance and monitoring, and the after-use policies for the property that the Regional Sanitary Landfill Site in Burlington occupies.

129. Regional Municipality of Halton. 1995. **The Regional Plan. Official Plan for the Halton Planning Area**. 92pp. + Appendices + Maps.

This report details the city of Regional Municipality of Halton policy guidelines for development within the region.

130. Regional Municipality of Hamilton-Wentworth. 1995. **Towards a Sustainable Region**. Hamilton Wentworth Official Plan. 65pp. + Appendices.

This report details the Regional Municipality of Hamilton – Wentworth policy guidelines for development within the region.

131. Regional Municipality of Hamilton-Wentworth. 1998. **Natural Heritage System Implementation Guide**. 79pp+ Appendix

The guide examines why it is important to protect natural areas through a Natural Heritage System (NHS). It lists and defines the components of the NHS: Core Areas, Linkages, and Restoration Opportunities. For each of these three components, sources of information and Regional Official Plan policies requiring their protection are described. An examination of the information resources available to agencies to assist them in implementing policies is included along with a summary of future directions for the NHS.

132. Reid, R. 1985. **Exploring Canada's Deep South**. Federation of Ontario Naturalists. Ontario Canada. Seasons 25:22-34.

133. Riley, J.L. and P. Mohr. 1994. **The Natural Heritage of southern Ontario's Settled Landscapes-A review of Conservation and Restoration Ecology for Land-Use and Landscape Planning.** Ministry of Natural Resources. Ontario, Canada.

134. Riley, J.L., Jalava, J.V. and Varga S. 1996. **Ecological Survey of the Niagara Escarpment Biosphere Reserve. Volume I. Significant Natural Areas.** Ontario Ministry of Natural Resources, South Central Region, Peterborough, Ontario. Canada. Open file Site report SR 9601. 629 pp.

135. Shelton, L.R. and P.D. Capel. 1994. **Guidelines for Collecting and Processing Samples of Stream Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water Quality Assessment Program**. United States Geological Survey Open-File 94-458. Sacramento, USA.

136. Smith, T.W. and C.E. Thuring. 2001. **Cenus Data and Ecological Land Classification Surveys for Red Mulberry (*Morus rubra* L.) in Hamilton and Halton Regions, Ontario.** Royal Botanical Gardens. 22pp.

This report documents the final stage of Red Mulberry monitoring in Hamilton and Halton Region. A detailed report of the habitat and the individual trees in the study area is included.

137. SNC-Lavalin Engineers and Constructors Inc. 1999. **Highway 407 West Section Freeman Interchange to Oakville Link with Highway 403 Fish and Fish Habitat 1999 Review of Existing Conditions.**

This document provides information on fish and fish habitat resources affected by the Highway 407 West Extension.

138. Stanley Consulting. 1998. **Aldershot/Waterdown Master EA Transportation Network Study**.

This document presents background data on east/west transporation corridor alternatives through the Waterdown area.

139. Stantec Cosulting Ltd. 1999. **Aldershot Waterdown Master EA Transportation Network Study. Master Plan Report Volume 1**. Prepared for the Town of Flamborough and City of Burlington.

An analysis of the existing transportation network in Aldershot/Waterdown along with potential solutions for future needs.

140. Stoneman, C.L. and M.L. Jones. 1996. **A simple method to evaluate the thermal stability of trout streams.** Department of Fisheries and Oceans and Ontario Ministry of Natural Resources Action Plan on Fish Habitat, Habitat Management Series. Ontario, Canada.

This document outlines a rapid assessment protocol for evaluating the thermal stability of streams in southern Ontario.

141. Theberge, J.B. 1989. **Legacy: The Natural History of Ontario**.

142. Thwaites, R.G. Ed. 1906. **The Jesuit Relations and Allied Documents**. Burrows Brothers. Cleveland, Ohio, USA.

143. Trotter, K., J. Hall and V. Cairns. 1998. **Northeastern Shoreline Fact Sheet.** Fish and Wildlife Restoration Project. 4pp.

A detailed summary of the fish and wildlife restoration projects occurring within the Northeastern shoreline.

144. Town of Flamborough. 1988. **Town of Flamborough Official Plan**. 128pp. + Maps

This report details the town of Flamborough policy guidelines for development within its jurisdiction.

145. V. Cairns, K. Trotter and J. Hall. 1998. **General Information Fact Sheet: Fish and Wildlife Habitat Restoration Project.** 4pp.

A summary of RAP's fish and wildlife habitat restoration projects.

146. Varga, S. and J. Jalava. 1992. **Biological Inventory and Evaluation of the Sassafras Woods Area of Natural and Scientific Interest**.

147. Waterfront Regeneration Trust. 1995. **Lake Ontario Greenway Strategy.** 215pp.

A list of objections and actions are presented in this document for the purpose of regenerating a healthy and sustainable waterfront.

APPENDIX 1

NATURAL HERITAGE

Table 21. List of Significant Flora/Fauna/Herpetofauna within Halton Region and Status

								ESA				
Common Name	Scientific Name	Affinity	Status	COSEWIC	MNR	Grank	Srank	WEW	SW	NEW	HH	Non-ESA
Big bluestem	Andropogon gerardii	S	R			G5	S4					X
Plantain-leaved pussytoes	Antennaria parlinii		U			G4G5	S5					X
Hairy rock-cress	Arabis hirsuta var. pycnocarpa		R			G5T5	S5	X				
Butterfly weed	Asclepias tuberosa	S	R			G5?	S4					X
Maidenhair spleenwort	Asplenium trichomanes		R			G5	S5	X				
Yellow false foxglove	Aureolaria flava	C	R			G5	S3	X				
Canada brome	Bromus pubescens		R			G5	S4	X	X			X
Sedge	Carex gracilescens	C	NPR			G5?	S3	X				X
Gray's sedge	Carex grayi		R			G4	S4	X				
Right-angled sedge	Carex normalis		R			G5	S4	X				X
Drooping sedge	Carex prasina		NPR			G4	S4	X				X
Umbel-like Sedge	Carex tonsa var. rugosperma		R			G5	S5		X			
Sweet pignut hickory	Carya glabra	C	NPR			G5	S3	X				
American chestnut	Castanea dentata	C	N or P	THR		G4	S3		X			
Buttonbush	Cephalanthus occidentalis		R			G5 S5						X
Purple clematis	Clematis occidentalis		R			G5	S4S5	X				
Hawthorn	Crataegus macrosperma		R			G5	S5			X		
Hawthorn	Crataegus scabrida		R			G5?	S3?	X		X		
Hawthorn	Crataegus succulenta		R			G5	S4S5			X		
Shining cyperus	Cyperus bipartitus		R			G5	S5				X	
Red-rooted cyperus	Cyperus erythrorhizos		NPR			G5	S3				X	
Large-bracted tick trefoil	Desmodium cuspidatum	S	NPR			G5	S3	X	X		P	
Panicled Tick-trefoil	Desmodium paniculatum var. paniculatum	S	R			G5T5	S4	X	X			
Yellow mandarin	Disporum lanuginosum	C	N or P			G5	S4	X	X	X		
Spike-rush	Eleocharis pauciflora		R			G5	S5	X				
Variegated horsetail	Equisetum variegatum		R			G5	S5	X				
Burning bush	Euonymus atropurpurea	C	N or P			G5	S3	X				
Honey locust	Gleditsia triacanthos	C	N or P			G5	S2		X			
Stickseed	Hackelia deflexa		R			G5	S5	X				
Water star-grass	Heteranthera dubia		R			G5	S5				X	
Green violet	Hybanthus concolor		R			G5	S2	X				
Red Cedar	Juniperus virginiana		R			G5	S5	X				
Pinweed	Lechea intermedia	S	R			G5	S4	X				
Poor-man's pepper-grass	Lepidium virginicum		R			G5	S5				X	

								ESA				
Common Name	Scientific Name	Affinity	Status	COSEWIC	MNR	Grank	Srank	WEW	SW	NEW	HH	Non-ESA
Hairy bush-clover	Lespedeza hirta	C, S	R			G5	S4	X	X			
Wandlike bush-clover	Lespedeza intermedia	S	R			G5	S4	X	X			
Red Mulberry	Morus rubra	C	NPR	END		G5	S2	X				
Pellitory	Parietaria pensylvanica		R			G5	S4	X				
Smooth cliff-brake	Pellaea glabella	E	R			G5	S4	X				
Ground cherry	Physalis heterophylla		R			G5	S4			X		
False dragonhead	Physostegia virginiana		R			G5	S4	X				
Whorled milkwort	Polygala verticillata	S	R			G5	S4		X			
Hoary mountain-mint	Pycnanthemum incanum	C, S	NPR	END	END	G5	S1				X	
Round-leaved Shinleaf (American wintergreen)	Pyrola americana		R			G5	S4?		X			
Swamp white oak	Quercus bicolor		R			G5	S4					X
Bristly Buttercup	Ranunculus hispidus var. hispidus		R			G5T5	S3		X			
Bristly crowfoot	Ranunculus pensylvanicus		R			G5	S5			X		
Fragrant sumac	Rhus aromatica	S	R			G5	S5	X	X			
Skunk currant	Ribes glandulosum		R			G5	S5	X				
Northern dewberry	Rubus flagellaris		R			G5	S4					X
Sassafras	Sassafras albidum	C	R			G5	S4		X			
Little Bluestem	Schizachyrium scoparium	S	R			G5	S4				X	X
American bulrush (common three-square)	Schoenoplectus pungens		R			G5	S5				X	
Goldenrod	Solidago arguta		N or P			G5	S3		X			
Indian grass	Sorgastrum nutans	S	R			G5	S4					X
Rue-anemone (windflower)	Thalictrum thalictroides		R			G5	S3	X	X			
Perfoliate bellwort	Uvularia perfoliata	C	N or P			G5	S1		X			X
Tape grass	Vallisneria americana		R			G5	S5				X	
Violet	Viola sagittata var. sagittata		R			G5T5	S4		X			
Dotted watermeal	Wolffia borealis		R			G5	S4S5			X		X
Jefferson salamander	Ambystoma jeffersonianum		N or P	THR		G4	S2	X				
Common map turtle	Graptemys geographica		R	SC		G5	S3				X	
Eastern spiny softshell turtle	Apalone spinifera		NPR	THR	THR	G5	S3				X	
Five-lined skink	Eumeces fasciatus		N or P	SC	VUL	G5	S3			X		
Snowy egret	Egretta thula		NPR			G5	SZB,SZN				X	
Black-crowned night-heron	Nycticorax nycticorax		R			G5	S3B,SZN				X	
Green-winged teal	Anas crecca		R			G5	S4B,SZN				X	

								ESA				
Common Name	Scientific Name	Affinity	Status	COSEWIC	MNR	Grank	Srank	WEW	SW	NEW	HH	Non-ESA
American black duck	Anas rubripes		R			G5	S5B,SZN				X	
Northern pintail	Anas acuta		R			G5	S5B,SZN				X	
Northern shoveller	Anas clypeata		R			G5	S4B,SZN				X	
American wigeon	Anas americana		R			G5	S4B,SZN				X	
Common moorhen	Gallinula chloropus		R			G5	S4B,SZN				X	
American coot	Fulica americana		R	NAR	NIAC	G5	S4B,SZN				X	
Caspian tern	Sterna caspia		R	NAR	NIAC	G5	S3B,SZN				X	
Yellow-billed cuckoo	Coccyzus americanus		R			G5	S4B,SZN				X	
Carolina wren	Thryothorus ludovicianus		N or P			G5	S3S4			X		
Henslow's sparrow	Ammodramus henslowii		N or P	END	END	G4	S1B,SZN			X		

Status	
N	Nationally Rare
P	Provincially Rare
r	Rare in Old Central Region
V	Nationally Vulnerable
R	Regionally Rare
T	Threatened
U	Regionally uncommon
Affinities	
C	Carolinian
S	Prairie/Savannah
A	Alvar
E	Escarpment

ESA Abbreviations	
WEW	Waterdown Escarpment Woods
SW	Sassafras Woods
NEW	Niagara Escarpment Woods
HH	Hamilton Harbour

APPENDIX 2

WATER QUALITY

Table 22. Watershed Data *E. coli*

North Shore Watershed Data - *ESCHERICHIA COLI* (*Ec*/100mL)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D			
20-Aug-01	W	4400	4800	7400
31-May-02	W			
31-Jul-02	W	1600	1200	2100
10-Sep-02	D			
31-Oct-02	D			
Geomean		2653	2400	3942
3rd Quart		3700	3900	6075
Max		4400	4800	7400
Min		1600	1200	2100
1st Quart		2300	2100	3425

Table 23. Watershed Data Conductivity

North Shore Watershed Data - CONDUCTIVITY (mmhos/cm)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		630	
20-Aug-01	W	600	200	200
31-May-02	W	590	700	700
31-Jul-02	W	1000	800	595
10-Sep-02	D	1500	800	1180
31-Oct-02	D	1000	820	750
Median		1000	750	700
3rd Quart		1000	800	750
Max		1500	820	1180
Min		590	200	200
1st Quart		600	648	595

Table 24. Watershed Data Copper

North Shore Watershed Data - COPPER (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D			
20-Aug-01	W			
31-May-02	W	0.010	0.007	BD
31-Jul-02	W	BD	BD	0.012
10-Sep-02	D	BD	BD	0.010
31-Oct-02	D	BD	BD	0.007
Median		0.01	0.01	0.01
3rd Quart		0.01	0.01	0.01
Max		0.01	0.01	0.01
Min		0.01	0.01	0.01
1st Quart		0.01	0.01	0.01

Table 25. Watershed Data Lead

North Shore Watershed Data - LEAD (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D			
20-Aug-01	W			
31-May-02	W	BD	BD	BD
31-Jul-02	W	BD	BD	0.021
10-Sep-02	D	BD	BD	BD
31-Oct-02	D	BD	BD	0.027
Median				0.02
3rd Quart				0.03
Max				0.03
Min				0.02
1st Quart				0.02

Table 26. Watershed Data Ammonium

North Shore Watershed Data - AMMONIUM (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		0.006	
20-Aug-01	W	0.090	0.150	0.380
31-May-02	W			
31-Jul-02	W	0.090	0.040	0.070
10-Sep-02	D			
31-Oct-02	D	0.020	0.020	0.050
Median		0.090	0.030	0.070
3rd Quart		0.090	0.068	0.225
Max		0.090	0.150	0.380
Min		0.020	0.006	0.050
1st Quart		0.055	0.017	0.060

Table 28. Watershed Data Nitrite

North Shore Watershed Data - NITRITE (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		0.062	
20-Aug-01	W	0.032	0.025	0.032
31-May-02	W	0.047	0.032	0.058
31-Jul-02	W			
10-Sep-02	D			
31-Oct-02	D	0.014	0.028	0.056
Median		0.0320	0.0300	0.0560
3rd Quart		0.0395	0.0395	0.0570
Max		0.0470	0.0620	0.0580
Min		0.0140	0.0250	0.0320
1st Quart		0.0230	0.0273	0.0440

Table 27. Watershed Data Nitrate

North Shore Watershed Data - NITRATE (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		1.01	
20-Aug-01	W	1.10	0.68	1.60
31-May-02	W	0.81	0.98	0.95
31-Jul-02	W	0.86	3.80	6.80
10-Sep-02	D			
31-Oct-02	D	1.30	2.90	5.60
Median		0.980	1.010	3.600
3rd Quart		1.150	2.900	5.900
Max		1.300	3.800	6.800
Min		0.810	0.680	0.950
1st Quart		0.848	0.980	1.438

Table 29. Watershed Data Nitrogen

North Shore Watershed Data - TOTAL KJELDAHL NITROGEN (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		1.24	
20-Aug-01	W	1.10	0.73	0.92
31-May-02	W	0.79	0.66	0.54
31-Jul-02	W	1.60	0.47	0.72
10-Sep-02	D			
31-Oct-02	D	0.52	0.37	0.40
Median		0.95	0.66	0.63
3rd Quart		1.23	0.73	0.77
Max		1.60	1.24	0.92
Min		0.52	0.37	0.40
1st Quart		0.72	0.47	0.51

Table 30. Watershed Data Disolved Oxygen

North Shore Watershed Data - DISSOLVED OXYGEN; (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		6.7	
20-Aug-01	W	6.6	6.3	6.1
31-May-02	W	8.1	7.9	8.7
31-Jul-02	W	9.8	8.1	7.7
10-Sep-02	D	7.5	9.2	6.4
31-Oct-02	D	16.6	12.0	13.0
Median		8.1	8.0	7.7
3rd Quart		9.8	8.9	8.7
Max		16.6	12.0	13.0
Min		6.6	6.3	6.1
1st Quart		7.5	7.0	6.4

Table 31. Watershed Data pH

North Shore Watershed Data - pH				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		7.6	
20-Aug-01	W	8.0	7.9	7.8
31-May-02	W	8.1	7.9	8.1
31-Jul-02	W			
10-Sep-02	D	8.5	8.5	8.6
31-Oct-02	D	9.2	8.7	8.7
Median		8.30	7.90	8.35
3rd Quart		8.68	8.50	8.63
Max		9.20	8.70	8.70
Min		8.00	7.60	7.80
1st Quart		8.08	7.90	8.03

Table 32. Watershed Data Phosphate

North Shore Watershed Data - PHOSPHATE (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		0.038	
20-Aug-01	W			0.350
31-May-02	W	BD	BD	BD
31-Jul-02	W	BD	BD	BD
10-Sep-02	D	BD	BD	BD
31-Oct-02	D	BD	BD	BD
Median			0.038	0.350
3rd Quart			0.038	0.350
Max			0.038	0.350
Min			0.038	0.350
1st Quart			0.038	0.350

Table 33. Watershed Data Total Phosphorus

North Shore Watershed Data - TOTAL PHOSPHORUS (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		0.110	
20-Aug-01	W	0.180	0.160	0.480
31-May-02	W	0.110	0.550	0.210
31-Jul-02	W	0.052	0.046	0.720
10-Sep-02	D	0.053	0.053	
31-Oct-02	D	0.032	0.053	0.450
Median		0.053	0.082	0.465
3rd Quart		0.110	0.148	0.540
Max		0.180	0.550	0.720
Min		0.032	0.046	0.210
1st Quart		0.052	0.053	0.390

Table 34. Watershed Data Temperature

North Shore Watershed Data - TEMPERATURE (ºC)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		21.8	
20-Aug-01	W	21.5	22.0	21.0
31-May-02	W	22.0	19.0	19.8
31-Jul-02	W	23.0	21.5	22.0
10-Sep-02	D	21.0	20.0	20.5
31-Oct-02	D	11.0	8.0	7.5
Median		21.5	20.8	20.5
3rd Quart		22.0	21.7	21.0
Max		23.0	22.0	22.0
Min		11.0	8.0	7.5
1st Quart		21.0	19.3	19.8

Table 36. Watershed Data Zinc

North Shore Watershed Data - ZINC (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D			
20-Aug-01	W			
31-May-02	W	0.065	0.064	0.026
31-Jul-02	W	0.018	0.010	0.038
10-Sep-02	D	0.045	0.008	0.019
31-Oct-02	D	0.014	0.014	0.019
Median		0.03	0.01	0.02
3rd Quart		0.05	0.03	0.03
Max		0.07	0.06	0.04
Min		0.01	0.01	0.02
1st Quart		0.02	0.01	0.02

Table 35. Watershed Data Total Suspended Solids

North Shore Watershed Data - SOLIDS; TOTAL SUSPENDED (mg/l)				
		SAMPLING STATIONS		
DATE	**E**	**HR**	**I1**	**F1**
28-Jul-97	D		688	
20-Aug-01	W	170	49	110
31-May-02	W	74	450	40
31-Jul-02	W		BD	
10-Sep-02	D	BD	3	BD
31-Oct-02	D	BD	BD	BD
Median		122.0	249.5	75.0
3rd Quart		146.0	509.5	92.5
Max		170.0	688.0	110.0
Min		74.0	3.0	40.0
1st Quart		98.0	37.5	57.5

APPENDIX 3

Fisheries Summary

Table 37. Fisheries Data Rambo Creek 1999 - 2001

	Map Reference Number	1	2	3	4	5	6
	UTM Easting (NAD27)	594686	594708	595929	595829	593664	593909
	UTM Northing (NAD27)	4800467	4800803	4798960	4799994	4800387	4801149
	Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek
	GIS_ID	179	180	17	18	19	20
	Report ID	WR-2	WR-3	R1	R2	R3	R4
	Year	1999	1999	2001	2001	2001	2001
	Author	SNC-Lavalin Engineers and Constructors Inc.	SNC-Lavalin Engineers and Constructors Inc.	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow						
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon						
Luxilus cornutus	Common Shiner						
Semotilus atromaculatus	Creek Chub			X			
Pimephales promelas	Fathead Minnow						
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch	X	X		X	X	X
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker						

Table 37. Fisheries Data Rambo Creek 1991

	Map Reference Number	7	8	9	10	11	12
	UTM Easting (NAD27)	597057	596662	596291	595348	595765	594727
	UTM Northing (NAD27)	4799670	4799063	4798637	4799450	4799144	4799828
	Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek	Rambo Creek
	GIS_ID	56	57	58	59	236	178
	Report ID	Sta 1	Sta 2	Sta 3	Sta 6	RD85 67	WR-1
	Year	1991	1991	1991	1991	1985	1999
	Author	MNR	MNR	MNR	MNR	ROM	SNC-Lavalin Engineers and Constructors Inc.
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow						
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon						
Luxilus cornutus	Common Shiner						
Semotilus atromaculatus	Creek Chub		X			X	
Pimephales promelas	Fathead Minnow					X	
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch	X		X	X		X
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker					X	

Table 38. Fisheries Data Rambo/Falcon Creek 1999-1998

	Map Reference Number	13	14	15	16	17	18
	UTM Easting (NAD27)	594678	594693	594772	594923	593140	593251
	UTM Northing (NAD27)	4801004	4800245	4801328	4795478	4796775	4796921
	Creek	Rambo Creek	Rambo Creek	Rambo Creek	Falcon Creek	Falcon Creek	Falcon Creek
	GIS_ID	181	182	183	167		
	Report ID	ER-1a	ER-1b	ER-2		15	16
	Year	1999	1999	1999	1993	1998	1998
	Author	SNC-Lavalin Engineers and Constructors Inc.	SNC-Lavalin Engineers and Constructors Inc.	SNC-Lavalin Engineers and Constructors Inc.	Cons. Halton-Mcilwrick	EcoTec for MTO	EcoTec for MTO
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow						
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon				X		
Luxilus cornutus	Common Shiner						
Semotilus atromaculatus	Creek Chub						
Pimephales promelas	Fathead Minnow						
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch	X	X	X		X	X
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker						

Table 39. Fisheries Data Falcon/Hager Creek 1982-2001

	Map Reference Number	19	20	21	22	23	24
	UTM Easting (NAD27)	594895	594929	594313	594923	594687	594324
	UTM Northing (NAD27)	4795364	4795480	4796228	4795478	4798346	4798594
	Creek	Falcon Creek	Falcon Creek	Falcon Creek	Falcon Creek	Hager Creek	Hager Creek
	GIS_ID	1	6	7	251		13
	Report ID		F1	F2		21	H1
	Year	1982	2001	2001	2001	1998	2001
	Author	Proctor and Redfern	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Sherwin Watson-Leung	EcoTec for MTO	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow	X					
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon						
Luxilus cornutus	Common Shiner					X	
Semotilus atromaculatus	Creek Chub					X	X
Pimephales promelas	Fathead Minnow	X					
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner	X					
No Catch	No Catch		X	X			
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner	X					
Cyprenid	Cyprenid				X		
Catostomus commersoni	White Sucker					X	

Table 40. Fisheries Data Hager Creek 2001-1992

	Map Reference Number	25	26	27	28	29	30
	UTM Easting (NAD27)	595028	595306	594417	594796	594990	594435
	UTM Northing (NAD27)	4799221	4797860	4798589	4799547	4799218	4798589
	Creek	Hager Creek	Hager Creek	Hager Creek	Hager Creek	Hager Creek	Hager Creek
	GIS_ID	14	53	54	177	55	238
	Report ID	H2	Sta 4	Sta 7	EH-1	Sta 5	
	Year	2001	1991	1991	1999	1991	1992
	Author	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	MNR	MNR	SNC-Lavalin Engineers and Constructors Inc.	MNR	Portt and Assoc.
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow						
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp	X					
Oncorhynchus tshawytscha	Chinook Salmon						
Luxilus cornutus	Common Shiner						
Semotilus atromaculatus	Creek Chub						X
Pimephales promelas	Fathead Minnow						
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch		X	X	X	X	
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker						

Table 41. Fisheries Data Indian Creek 1982-1983

	Map Reference Number	37	38	39	40	41	42
	UTM Easting (NAD27)	596472	596352	596191	596026	594432	596583
	UTM Northing (NAD27)	4796276	4796438	4796576	4796693	4797782	4796207
	Creek	Indian Creek	Indian Creek	Indian Creek	Indian Creek	Indian Creek	Indian Creek
	GIS_ID	48	49	50	51	52	168
	Report ID	Station 1	Station 2	Station 3	Station 4	Station 7	
	Year	1982	1982	1982	1982	1982	1993
	Author	Proctor and Redfern	Proctor and Redfern	Proctor and Redfern	Proctor and Redfern	Proctor and Redfern	Cons. Halton-Mcilwrick
Scientific Name	**Common Name**	**X**	**X**	**X**	**X**	**X**	
Rhinichthys atratulus	Blacknose Dace	X		X	X		
Pimephales notatus	Bluntnose Minnow	X	X	X			
Hybognathus hankinsoni	Brassy Minnow	X	X	X			
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon						X
Luxilus cornutus	Common Shiner	X					
Semotilus atromaculatus	Creek Chub	X	X	X	X	X	
Pimephales promelas	Fathead Minnow	X	X	X	X		
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch						
Phoxinos eos	Northern Redbelly Dace			X			
Lepomis gibbosus	Pumpkinseed	X					
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker	X	X	X			X

Table 42. Fisheries Data Indian/Teal/Forest Glen Creek 1998-2001

	Map Reference Number	43	44	45	46	47	48
	UTM Easting (NAD27)	593625	593707	593877	594160	594467	594181
	UTM Northing (NAD27)	4797414	4797534	4797760	4798015	4795292	4795248
	Creek	Indian Creek	Indian Creek	Indian Creek	Indian Creek	Teal Creek	Forest Glen Creek
	GIS_ID					5	4
	Report ID	17	18	19	20	T1	FG1
	Year	1998	1998	1998	1998	2001	2001
	Author	EcoTec for MTO	EcoTec for MTO	EcoTec for MTO	EcoTec for MTO	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle
Scientific Name	**Common Name**						
Rhinichthys atratulus	Blacknose Dace						
Pimephales notatus	Bluntnose Minnow						
Hybognathus hankinsoni	Brassy Minnow						
Cyprinus carpio	Carp						
Oncorhynchus tshawytscha	Chinook Salmon						
Luxilus cornutus	Common Shiner						
Semotilus atromaculatus	Creek Chub	X		X		X	
Pimephales promelas	Fathead Minnow					X	
Carassius auratus	Goldfish						
Lepomis cyanellus	Green Sunfish						
Couesius plumbeus	Lake Chub						
Rhinichthys cataractae	Longnose Dace						
Notropis volucellus	Mimic Shiner						
No Catch	No Catch		X		X		X
Phoxinos eos	Northern Redbelly Dace						
Lepomis gibbosus	Pumpkinseed						
Neogobius melanostromus	Round Goby						
Notropis hudsonius	Spottail Shiner						
Cyprenid	Cyprenid						
Catostomus commersoni	White Sucker						

Table 43. Fisheries Data LaSalle/West Aldershot/Stillwater/Falcon Creek 1997-2001

	Map Reference Number	49	50	51	52
	UTM Easting (NAD27)	593994	593300	596227	593597
	UTM Northing (NAD27)	4795061	4794698	4796091	4796766
	Creek	LaSalle Creek	West Aldershot Creek	Stillwater Creek	Falcon Creek
	GIS_ID	3	2	218	
	Report ID	L1	WA1		
	Year	2001	2001	2000	1997
	Author	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Conservation Halton S. Leung, D Featherstone, B. Morrison, R. Kettle	Cons. Halton-Featherstone	Ecoplans Ltd.
Scientific Name	**Common Name**				
Rhinichthys atratulus	Blacknose Dace				
Pimephales notatus	Bluntnose Minnow				
Hybognathus hankinsoni	Brassy Minnow				
Cyprinus carpio	Carp			X	
Oncorhynchus tshawytscha	Chinook Salmon				
Luxilus cornutus	Common Shiner				
Semotilus atromaculatus	Creek Chub		X		
Pimephales promelas	Fathead Minnow				
Carassius auratus	Goldfish				
Lepomis cyanellus	Green Sunfish				
Couesius plumbeus	Lake Chub				
Rhinichthys cataractae	Longnose Dace				
Notropis volucellus	Mimic Shiner				
No Catch	No Catch	X			
Phoxinos eos	Northern Redbelly Dace				
Lepomis gibbosus	Pumpkinseed				
Neogobius melanostromus	Round Goby				
Notropis hudsonius	Spottail Shiner				
Cyprenid	Cyprenid				X
Catostomus commersoni	White Sucker				

APPENDIX 4

Benthic Macroinvertebrate Study

Table 44. Summary of Water Quality Designations Associated with Various Benthic Indices

Indices	Impaired	Moderately Impaired	Unimpaired
% Oligochaeta	>30	10 - 30	<10
% Chironomidae	>40	10 - 40	<10
% Isopoda	>5	1 - 5	>5
% Gastropoda		0 or >10	1 - 10
Number of Taxa	<13		>13
% Dominant Taxa	>45	40 - 45	<40
%EPT	<5	5 - 10	>10
% Diptera	<15 or >50	15-20 or 45-50	20-45
% Insects	<40 or >90	40 - 50 or 80-90	50 - 80
HFI	>7	6-7	<6
Biomap D (Creeks)	<10	10 - 12	> 12
Biomap D (Streams)	<14	14 - 16	>16
BioMAP Q (Creeks)	<2.6	3 -2.6	>3.0
BioMAP Q (Streams)	<3.2	3.2-3.4	>3.4

Biotic Index	Index Scores				
	R1S1	R1S2	WA1S1	WA1S2	L1S1
#/Sample	248	433	562	97	236
# / m^2	276	481	625	108	262
% Oligochaeta	0.0	0.0	1.1	3.1	3.0
% Chironomidae	0.8	1.2	7.5	15.5	1.3
% Isopoda	88.7	95.4	75.4	38.1	12.7
% Gastropoda	0.0	0.0	0.9	10.3	0.0
Number of Taxa	5	6	18	16	9
Dominant Taxa #	220	413	424	35	179
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Caecidotea	Gammaridae
% Dominant Taxa	88.7	95.4	75.4	36.1	75.8
EPT CALC E	1	1	2	1	0
EPT CALC T	0	1	1	1	0
EPT	1	2	3	2	0
%EPT	7.3	0.9	0.7	5.2	0.0
% Diptera	1.2	1.2	20.1	34.0	8.1
% Insects	8.5	2.1	21.4	39.2	8.1
% scr	7.3	0.7	1.1	10.3	0.0
% prd	0.0	0.0	0.5	2.1	2.1
% c-g	91.5	98.2	79.0	51.5	91.9
% c-f	0.0	0.0	11.7	15.5	0.4
% shr	0.0	0.0	0.5	2.1	4.2
HFI	7.6	7.9	7.6	6.9	4.9
Biomap D	6.7	8.3	8.2	9.4	14.3
BiomapQ (entire site)	2.50	2.50	2.94	2.94	3.00
% Oligochaeta	U	U	U	U	U
% Chironomidae	U	U	U	PI	U
% Isopoda	I	I	I	I	I
% Gastropoda	PI	PI	U	PI	PI
Number of Taxa	I	I	U	U	I
% Dominant Taxa	I	I	I	U	I
%EPT	PI	I	I	PI	I
% Diptera	I	I	U	U	I
% Insects	I	I	I	I	I
HFI	I	I	I	PI	U
Biomap D	I	I	I	I	U
Biomap Q	I	I	PI	PI	PI
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Caecidotea	Gammaridae
Dominant Feeding	c-g	c-g	c-g	c-g	c-g
Count impaired	8	9	6	3	6
Count potentially impaired	2	1	1	5	2
count unimpaired	2	2	5	4	4
Water Quality	Impaired	Impaired	Moderately Impaired	Impaired	Impaired

Biotic Index	Index Scores			
	L1S2	**H1S1**	**H1S2**	**H2S1**
#/Sample	96	322	141	176
# / m^2	107	358	157	196
% Oligochaeta	3.1	0.0	0.7	0.0
% Chironomidae	3.1	2.8	2.8	21.0
% Isopoda	21.9	41.3	46.1	18.2
% Gastropoda	0.0	12.4	28.4	0.0
Number of Taxa	5	12	10	7
Dominant Taxa #	60	132	64	45
Dominant Taxa	Gammaridae	Caecidotea	Caecidotea	Simulidae
% Dominant Taxa	62.5	41.0	45.4	25.6
EPT CALC E	0	2	1	2
EPT CALC T	0	1	1	0
EPT	0	3	2	2
%EPT	0.0	39.4	16.3	30.1
% Diptera	12.5	3.1	7.1	46.6
% Insects	12.5	45.7	24.8	76.7
% scr	0.0	13.7	28.4	0.0
% prd	0.0	1.9	1.4	0.0
% c-g	87.5	93.2	91.5	23.3
% c-f	0.0	0.6	4.3	55.7
% shr	9.4	0.0	0.0	0.0
HFI	5.6	6.3	7.2	5.9
Biomap D	14.4	7.2	5.6	9.3
BiomapQ (entire site)	3.00	3.08	3.08	2.83
% Oligochaeta	U	U	U	U
% Chironomidae	U	U	U	PI
% Isopoda	I	I	I	I
% Gastropoda	PI	PI	PI	PI
Number of Taxa	I	I	I	I
% Dominant Taxa	I	PI	I	U
%EPT	I	U	U	U
% Diptera	I	I	I	PI
% Insects	I	PI	I	U
HFI	U	PI	I	U
Biomap D	U	I	I	I
Biomap Q	PI	U	U	PI
Dominant Taxa	Gammaridae	Caecidotea	Caecidotea	Simulidae
Dominant Feeding	c-g	c-g	c-g	c-g
Count impaired	6	4	7	3
Count potentially impaired	2	4	1	4
count unimpaired	4	4	4	5
Water Quality	Impaired	Impaired	Impaired	Moderately Impaired

Biotic Index	Index Scores			
	H2S2	**I3S1**	**I3S2**	**I4S1**
#/Sample	84	761	704	346
# / m^2	93	846	782	385
% Oligochaeta	2.4	0.0	0.0	0.3
% Chironomidae	20.2	8.7	1.8	0.6
% Isopoda	21.4	81.1	84.7	86.7
% Gastropoda	0.0	0.0	0.0	0.0
Number of Taxa	10	21	16	5
Dominant Taxa #	18	617	596	300
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Caecidotea
% Dominant Taxa	21.4	81.1	84.7	86.7
EPT CALC E	2	3	3	0
EPT CALC T	0	2	0	0
EPT	2	5	3	0
%EPT	22.6	3.3	3.4	0.0
% Diptera	42.9	10.1	3.0	0.6
% Insects	65.5	14.1	7.2	0.6
% scr	2.4	3.5	8.0	9.0
% prd	1.2	2.0	1.0	0.0
% c-g	31.0	82.7	84.9	90.5
% c-f	42.9	2.9	4.0	0.0
% shr	0.0	0.0	0.0	0.0
HFI	6.1	7.6	7.5	7.5
Biomap D	9.3	8.5	6.2	8.1
BiomapQ (entire site)	2.83	2.63	2.63	3.13
% Oligochaeta	U	U	U	U
% Chironomidae	PI	U	U	U
% Isopoda	I	I	I	I
% Gastropoda	PI	PI	PI	PI
Number of Taxa	I	U	U	I
% Dominant Taxa	U	I	I	I
%EPT	U	I	I	I
% Diptera	U	I	I	I
% Insects	U	I	I	I
HFI	PI	I	I	I
Biomap D	I	I	I	I
Biomap Q	PI	PI	PI	U
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Caecidotea
Dominant Feeding	c-g	c-g	c-g	c-g
Count impaired	3	7	7	8
Count potentially impaired	4	2	2	1
count unimpaired	5	3	3	3
Water Quality	Moderately Impaired	Impaired	Impaired	Impaired

Biotic Index	Index Scores				
	I4S2	I7S1	I7S2	F1S1	F1S2
#/Sample	171	874	550	42	63
# / m^2	190	971	611	47	70
% Oligochaeta	0.6	0.3	3.3	19.0	22.2
% Chironomidae	1.2	0.8	1.3	38.1	50.8
% Isopoda	87.1	88.4	84.0	2.4	0.0
% Gastropoda	0.6	0.5	0.0	14.3	6.3
Number of Taxa	8	16	15	7	5
Dominant Taxa #	149	772	462	16	32
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Chironomidae	Chironomidae
% Dominant Taxa	87.1	88.3	84.0	38.1	50.8
EPT CALC E	1	3	2	0	0
EPT CALC T	0	1	0	0	0
EPT	1	4	2	0	0
%EPT	0.6	7.1	1.3	0.0	0.0
% Diptera	1.2	1.1	2.2	45.2	52.4
% Insects	2.3	10.5	7.1	45.2	52.4
% scr	8.8	3.0	4.2	33.3	25.4
% prd	0.0	0.1	0.5	4.8	0.0
% c-g	89.5	89.5	92.4	35.7	28.6
% c-f	0.6	6.8	0.7	0.0	0.0
% shr	0.0	0.2	0.9	0.0	0.0
HFI	7.6	7.6	7.8	6.7	6.7
BioMAP D	5.7	7.2	7.4	1.8	1.0
BiomapQ (entire site)	3.13	2.75	2.75	1	1
% Oligochaeta	U	U	U	PI	PI
% Chironomidae	U	U	U	PI	I
% Isopoda	I	I	I	PI	U
% Gastropoda	U	U	PI	PI	U
Number of Taxa	I	U	U	I	I
% Dominant Taxa	I	I	I	U	I
%EPT	I	PI	I	I	I
% Diptera	I	I	I	PI	I
% Insects	I	I	I	PI	U
HFI	I	I	I	PI	PI
BioMAP D	I	I	I	I	I
BioMAP Q	U	PI	PI	I	I
Dominant Taxa	Caecidotea	Caecidotea	Caecidotea	Chironomidae	Chironomidae
Dominant Feeding	c-g	c-g	c-g	c-g	c-g
Count impaired	8	6	7	4	7
Count potentially impaired	0	2	2	7	2
count unimpaired	4	4	3	1	3
Water Quality	Impaired	Impaired	Impaired	Impaired	Impaired

Table 45. Benthic Macroinvertebrates Raw Data

	Station	**R1**	**R1**	**R1**	**WA1**	**WA1**	**WA1**	**L1**	**L1**	**L1**	**H1**	**H1**	**H1**	**H2**	**H2**	**H2**
	Sample	**S1**	**S2**	**D**	**S1**	**S2**	**D**	**S1**	**S2**	**D**	**S1**	**S2**	**D**	**H2S1**	**H2S2**	**H2D**
Order	**Family**															
Amphipoda	Gammaridae	7	9	1	7	4	23	179	60	42	2		5	5	6	32
	Talitridae															
Bivalvia	Sphaeriidae															
Coleoptera	Chrysomelidae															
	Cuiculionidae															1
	Dryopidae										4					
	Dytiscidae				2		9									1
	Elmidae				1											
	Haliplidae															
	Hydrophilidae															
Decapoda	Cambaridae															
Diptera	Athericidae							4								
	Ceratopogonidae															
	Chironomidae	2	5	35	42	15	102	3	3	2	9	4	28	37	17	4
	Culicidae				3		36						1			
	Dixidae						1	1								
	Empididae					1		1								
	Muscidae				1											
	pupae	1			3	2	7				1		2		2	2
	Simulidae				61	13	15					6		45	17	2
	Stratiomyidae															
	Tipulidae				3	2		10	9	1						
Ephemeroptera	Baetidae		1	172	2	3	7				1	1	17			
	Caenidae															
Gastropoda	Lymnaeidae					10										
	Physidae			4	5		32				40	40	73			
	Planorbidae						2									
Hemiptera	Corixidae															
	Gerridae												4			2
	Notonectidae															
	(blank)					1										
Hirudinea	Erpobdellidae														1	
	Glossiphoniidaee															
	Hirudinidae					1										
Isopoda	Asellidae	220	413	16	424	37	73	30	21	40	133	65	254	32	18	35
Megaloptera	Sialidae												3			
Nematoda			2			3	67	1						4		
Odonata	Aeshnidae			1			4						2			4
	Calopterygidae										6	2	6			1
	Coenagrionidae															
	Lestidae															
	Libdellulidae															
Oligochaeta	Lumbricidae						1	7	3	2		1	1		2	1
	Tubificidae				6	3	4									
Platyhelminthes (Phylum)	Turbellaria (Class)														2	1
Tricoptera	Hydropsychidae				2	2					2			53	19	3
	Hydroptilidae	18	3	2							124	22	11			
Grand Total		**248**	**433**	**231**	**562**	**97**	**383**	**236**	**96**	**87**	**322**	**141**	**407**	**176**	**84**	**89**

Table 46 Benthic Macroinvertebrates Raw Data

	Station	**I3**	**I3**	**I3**	**I4**	**I4**	**I4**	**I7**	**I7**	**I7**	**F1**	**F1**	**F1**
	Sample	**I2S1**	**I2S2**	**I2D**	**I3S1**	**I3S2**	**I3D**	**I4S1**	**I4S2**	**I4D**	**F1S1**	**F1S2**	**F1D**
Order	**Family**												
Amphipoda	Gammaridae	5	2	3	12	2	5		1	1			
	Talitridae									9			
Bivalvia	Sphaeriidae	1	1										1
Coleoptera	Chrysomelidae									2			
	Cuiculionidae												
	Dryopidae												
	Dytiscidae	1		5						3			
	Elmidae	1	2					19	20	1			
	Haliplidae			1									1
	Hydrophilidae		1	1									1
Decapoda	Cambaridae	1		1			3			1			
Diptera	Athericidae	5											
	Ceratopogonidae												
	Chironomidae	66	13	51	2	2	2	7	7		16	32	27
	Culicidae									2			
	Dixidae												3
	Empididae		1										
	Muscidae										2		
	pupae	2									1	1	
	Simulidae	4	7					1					
	Stratiomyidae									1			
	Tipulidae							2	5				
Ephemeroptera	Baetidae	2		107			6	1		47			
	Caenidae	1											
Gastropoda	Lymnaeidae												
	Physidae					1		4		17	6	4	1
	Planorbidae												
Hemiptera	Corixidae												2
	Gerridae		2	1		1	2	1		4			
	Notonectidae			2									
	(blank)												
Hirudinea	Erpobdellidae	5	3	10									
	Glossiphoniidaee	1	1	1				1	2				
	Hirudinidae								1				
Isopoda	Asellidae	617	596	51	300	149	139	773	462	48	1		
Megaloptera	Sialidae												
Nematoda		3		1				1	27				1
Odonata	Aeshnidae			1			5			5			
	Calopterygidae												
	Coenagrionidae	2	1	16									
	Lestidae									7			
	Libdellulidae	1		3						1			
Oligochaeta	Lumbricidae												
	Tubificidae				1	1	1	3	18	1	8	14	109
Platyhelminthes (Phylum)	Turbellaria (Class)	21	50	4	31	14	10				8	12	17
Tricoptera	Hydropsychidae	17	20			1		58	4				
	Hydroptilidae	5	4	1				3	3				
Grand Total		**761**	**704**	**260**	**346**	**171**	**173**	**874**	**550**	**150**	**42**	**63**	**163**

APPENDIX 5

INSTREAM TEMPERATURE SURVEY DATA

Table 47. Instream Temperature Survey Data

Watershed/Creek	Station	Date	Water Temperature	Air Temperature	Temperature Class
Rambo	R1	07/09/02	23	32	Cool
Hager	H1	07/09/02	27	32	Warm
	H2	07/09/02	22	32	Cool
Indian	I1	07/09/02	28	32	Warm
	I2	07/09/02	30	32	Warm
	I3	07/09/02	28	32	Warm
	I4	08/07/01	30	34	Warm
	I4	07/09/02	29	32	Warm
	I5	07/09/02	22	32	Cool
	I6	07/09/02	22	32	Cool
	I7	07/09/02	24	32	Marginal Cool
Falcon	F1	08/07/01	25	34	Marginal Cool
	F1	07/09/02	24	32	Marginal Cool
	F2	07/09/02	23	32	Marginal Cool
Teal Creek	T1	08/07/01	22	34	Cool
Forest Glen Creek	FG1	08/07/01	23	34	Cool
LaSalle Creek	L1	08/07/01	22	34	Cool
	L1	07/09/02	21	32	Cool
West Aldershot Creek	WA1	08/07/01	22	34	Cool
	WA1	07/09/02	22	32	Cool