1. Introduction

1.1 Overview

In order to prepare and plan for future urban development, Halton Region is developing a Secondary Plan for the Tremaine and Dundas Secondary Plan Study Area (TDSPSA) (Figure 1.1.1). The TDSPSA is 133 ha in size, and is bounded by Highway 407 to the north, Dundas Street to the south, Tremaine Road to the east, and Bronte Creek to the west. This report is the Tremaine and Dundas Secondary Plan Subwatershed Study (Subwatershed Study), developed in support of the Secondary Plan which provides a management strategy to assist in setting policy direction for future development in the subwatershed. Within the study area there are a number of catchment areas. Some are draining to the south towards Fourteen Mile Creek West, which outlets directly to Lake Ontario and the others are flowing westward into Bronte Creek. This Subwatershed Study presents the approach to manage resource use that will protect, rehabilitate, and enhance the environment within (and downstream of) the TDSPSA.

The purpose of a Subwatershed Study is to develop a plan that allows sustainable development while ensuring maximum benefits to the natural and human environments on a watershed basis. A series of goals and objectives have been developed as part of the Subwatershed Study process, which need to be met to achieve the overall study purpose. The goals and objectives relate to the management of the natural resources within the subwatershed, including aquatic resources, terrestrial conditions, fluvial geomorphology, flood and erosion protection, hydrologic, and hydrogeologic conditions. The goals and objectives consider the ecosystem within the catchments, and linkages to lands outside the catchments.

The goals and objectives identified for developing a strategy for the TDSPSA recognize the importance of developing a strong framework upon which a management strategy is based. This framework is comprised of an in-depth understanding of subwatershed conditions and the ecological, hydrologic and hydrogeologic processes that support and/or influence those conditions. The fundamental characteristics of a watershed are a result of all of the resource conditions and processes that occur. Parts of these processes are obviously linked to the activities taking place. These include not only ecologically based wildlife activities (aquatic and terrestrial) but also human activities (urban and agricultural). The analysis of a watershed to provide the understanding needed for an effective management approach must include an assessment of:

- Watershed characteristics (environmental and land use);
- Natural processes including:
  - Hydrology, hydraulics, and hydrogeology;
  - Fluvial geomorphology;
  - Terrestrial environment (vegetation and wildlife);
  - Aquatic environment (fisheries);
  - Water quality;
  - Riparian systems; and
- Human activities.
In order to develop a management strategy that sets the future direction of the catchments in a fashion that is feasible, it must reflect the needs of both the watershed ecosystem and the community. Sometimes these needs conflict, and as a result an approach based upon a sound understanding of the subwatershed is necessary to ensure that the strategy developed is balanced and sustainable.

The study team includes AECOM, North-South Environmental Inc., Parish Geomorphic, Coffey Ltd., Environmental Water Resource Group Ltd., and Weatherbe and Associates, with assistance from Halton Region, the City of Burlington and Halton Region Conservation Authority.

1.2 Study Approach

This Subwatershed Study provides a management strategy (within the context of land use changes) for the protection, enhancement and rehabilitation of natural environment features and their function. As outlined in Figure 1.2.1, there are four major phases in a subwatershed plan.

- **Phase I** – Involves establishing the form, function and linkages of the water and related environmental resources. This is done by examining environmental features and functions (e.g., soils, climate, groundwater, surface waters, river systems, habitats, and wildlife) and how they interrelate.
- **Phase II** – Further characterization of subwatershed, data collection (based on the focus provided by Phase I), and detailed analysis of processes that influence watershed characteristics. Impact analysis of land use changes and analysis of effectiveness of management scenarios is carried out.
- **Phase III** – Development of a management strategy and implementation plan.
- **Phase IV** – Implementation and monitoring plan and evaluation/modification of the management strategy.

The sections of this report follow the four phases outlined above, and are covered in the following sections: **Section 3.0 – Existing Conditions** focuses on Phase I; **Section 4.0 – Impact Analysis and Management Requirements** covers Phase II; **Section 5.0 – Management Strategy** discusses Phase III; and **Section 6.0 – Implementation of a Subwatershed Study** details Phase IV.

1.2.1 Subwatershed Study Goals and Objectives

A summary of the study goals and objectives that will be achieved during this study are outlined below.

**Study Goal**

- To develop a management plan for the TDSPSA which considers the natural resource features and provides for future uses in the subwatershed that recognize these features and will protect and enhance environmental conditions.
Tremaine and Dundas Secondary Plan Subwatershed Study

Legend

- **14W-17 Reach Designation**
- **Potential Development Areas**
- **Roads**
- **Watercourse**
- **Contour**
- **Study Area Boundary**
- **Wetlands**
- **Land Ownership (Address)**

Datum: NAD 83, Zone 17
Source: Town of Oakville

Figure 1.1.1

Study Area

1:6,000

September 2009
Figure 1.2.1. Subwatershed Planning Process

Study Objectives

- To develop a management plan for the TDSPSA such that the watershed goals and objectives can be met in view of the combined impacts of all land use and land use changes existing or expected in this watershed. Such impacts include urban development, regional/municipal service infrastructure, rural residential development, and recreation.
- To streamline land use planning and approvals by determining the boundaries of areas that are regulated or set aside from development based on Provincial and Municipal Policies and Legislation including:
  - Greenbelt lands;
  - Natural Heritage Sites
  - Cultural Heritage Sites;
  - Provincially Significant Wetlands (PSW);
  - Other evaluated and unevaluated wetlands;
  - Valleylands;
Halton Region
Tremaine and Dundas Secondary Plan Subwatershed Study

- Environmentally Sensitive Areas (ESAs);
- Floodplains; and
- Associated adjacent lands to the above areas.

- To assist in the development of a Natural Heritage System (NHS) intended to protect environmental features and functions, and local and regional linkages necessary to sustain native biodiversity.

- To integrate the subwatershed planning process with other related processes:
  - Secondary Plans;
  - Comprehensive Environmental Impact Studies (EIS) under the Provincial Policy Statements;
  - Evergreen Community Ltd. studies currently underway by Urbantach, Amec and LGL;
  - Class Environmental Assessments for Water Management and Municipal Works; and
  - Community Plans.

- To develop an integrated subwatershed plan that will provide guidance to local and regional governments in planning future land use, infrastructure, and resource development while at the same time protecting and enhancing the environment. The goals of such a plan will be refined through the subwatershed planning process and will include measures:
  - To protect, restore and enhance groundwater quantity and quality;
  - To conserve, protect and restore the natural land, water, forest, and wildlife resources of the TDSPSA;
  - To restore, protect and enhance water quality and associated aquatic resources and water supplies;
  - To minimize the threat to life and the destruction of property and natural resources from flooding and erosion, and preserve (or re-establish, where possible) natural floodplain hydrologic and fluvial geomorphologic functions;
  - To ensure public participation in the planning, development, implementation, and monitoring of the subwatershed management plan;
  - To provide information on natural heritage features and areas which assist municipalities in addressing the Provincial Policy Statements, while respecting the rights of individual landowners; and
  - To identify stewardship opportunities for the subwatershed.

Study Steps

The study approach is illustrated in Figure 1.2.2, and outlined as follows:

- Review background information and develop a summary including:
  - Topographic mapping, air photos, and resource maps;
  - Relevant study reports;
  - Servicing information;
  - Discussion with agencies - Available field information (e.g., environmental, streamflow, and groundwater);
- Prepare a list of reference material;
- Carry out site reconnaissance and collect field data;
- Carry out analysis to characterize subwatershed;
- Prepare a characterization report;
- Prepare an issues summary and vision;
- Carry out additional field work and detailed analysis of subwatershed conditions;
Figure 1.2.2. Study Approach

**PHASE I**
- Project Initiation
- Start Field Data Collection
- Background Review
- Issue Identification

**PHASE II**
- Analysis of Conditions
- Impact Analysis
- Set Objectives and Targets
- Alternatives and Recommended Plan
- Monitoring Strategy
- Final Plan
  - Strategy
  - Implementation
  - Monitoring

**PHASE III**
- Finalize Report
- Implement Plan (Adaptive Environmental Strategy)
- Final Report

Input to Secondary Planning Process and Associated Studies
• Prepare an analysis report;
• Develop a preliminary management strategy;
• Analyze potential impacts of urban land use conditions;
• Identify management needs;
• Develop a management strategy; and
• Prepare an implementation plan.

1.3 Report Structure

The sections and information provided in this report are as follows.

Section 1.0 Outline of Purpose of Study and Approach
Section 2.0 Discussion on Subwatershed Planning in General and Legislative Framework
Section 3.0 Provide Information of the Characterization of Conditions in the TDSPSA
Section 4.0 Describe the Watershed Impact Analysis Carried Out and Outline the Management Requirements
Section 5.0 Describe the Recommended Management Strategy
Section 6.0 Outline the Implementation Plan

1.4 Sources of Information

1.4.1 Introduction

During the initial phase of this Subwatershed Study, background information was collected and reviewed. This provided a portion of the information for characterization of the catchments. Through this review, the type and amount of additional information to permit the characterization of the catchments was determined and steps carried out to collect it as part of this Subwatershed Study.

1.4.2 Natural Environment Information

The background information collected and reviewed included reports and existing field data, as well as information collected through discussions with various agencies and other groups (e.g., university research groups).

The information collected and reviewed included:

• Topographic mapping;
• Aerial photography;
• Natural heritage and environmental mapping (terrestrial and aquatic);
• Geologic and hydrogeologic characterization maps and reports;
• Well records and other borehole data;
• Background reports related to:
• Watershed and subwatershed studies (e.g., Bronte Creek Watershed Study, Fourteen Mile Creek Subwatershed Study, and North Oakville Creeks Subwatershed Study);
• Environmental Characterization;
• Hydrogeology and geology;
• Fluvial geomorphology;
• Land use planning documents;
• Servicing reports;
• Landfill reports;
• Studies carried out by Urbantech, Amec and LGL on behalf of Evergreen Community Ltd.;
• Climate data;
• Past hydrologic models developed;
• Relevant flow data; and
• Information related to external ecological linkages.

Discussions were held with all involved external agencies and groups to collect relevant data. This included Conservation Halton; Halton Region; City of Burlington; Ministry of Natural Resources (MNR), and Department of Fisheries and Oceans Canada (DFO).

Independent field data was collected by the study team to enable the characterization and analysis of the catchments, including development of a management strategy.

1.4.3 Land Use

Information on planned land use is available from planning documents which are applicable to the City of Burlington. Available documents, including the Region of Halton and City of Burlington Official Plans (OP) and the North Oakville Secondary Plans were reviewed. The available information on planned land use has been used in the study as it relates to environmental background data. The information from this Subwatershed Study will aid in the development of a Secondary Plan for the TDSPSA.
2. **Subwatershed Planning**

2.1 **Subwatershed Management Strategy**

Watershed management is intended to augment the land use planning process, as well as provide for sound management of environmental conditions and natural resources. Watershed plans are based on natural drainage boundaries instead of political boundaries.

Watershed management is an evolving science. The evolution of the science is a response to the recognized need to manage our resources and guide future land use decisions. New management philosophies and tools are being developed to provide the most effective approach. The common thread through this evolution is that a broad perspective is needed to ensure that the plan meets environmental and societal needs. It is important that watershed management recognizes environmental, social and economic conditions to ensure that all three elements are included and provide a “balanced” approach.

A recent evolution of watershed management is the recognition of the need to provide an Adaptive Environmental Management (AEM) approach. Management strategies should encompass refinement of management tools and approaches, and changes in societal characteristics and needs. A management strategy must provide a direction to follow, but just as importantly it must have flexibility built in so that modifications and “fine tuning” can be carried out.

A monitoring plan is one of the critical elements of a management strategy with specific targets set to be monitored. This is then used to measure the effectiveness of the management strategy in meeting the goals (and targets set). If the targets are not being met, modifications can be made to ensure that the management strategy goals can be followed.

Given the comprehensive and complex nature of the watershed, an ecosystem approach is required in developing a management strategy. The watershed ecosystem is made up of wildlife, vegetation, people and physical landscape that occupies the watershed, and by the processes that link these components. Degradation of the quality of any of these components will affect the entire ecosystem. For example, if water is polluted and streamflows are depleted, it will have a negative impact on fish. If woodlots and wetlands are removed, there will be a loss of wildlife habitat.

The hydrologic cycle diagram (Figure 2.1.1) shows the major components of a watershed ecosystem, the linkages between components and the major functions or processes that control the shape and quality of watershed resources.

The major connecting link in a watershed ecosystem is the flow of water. This flow pattern is called the water budget. How and where the water flows determines the quality of the water, the shape and stability of streambanks, the health and diversity of the vegetation, and the availability of fish and wildlife habitat. In a relatively natural watershed, the flow of water is controlled by topography, soil type, and vegetation.
Figure 2.1.1
Hydrologic Cycle Components

- Evapotranspiration
- Surface Runoff
- Canopy Infiltration
- Sewers
- Water Taking
As human use of a watershed increases (e.g., through infrastructure development and changes in the permeability of the landscape), these characteristics can alter the water budget. The changed water budget then results in changes in the quality of ground and surface water, the size and shape of stream channels and the stability of streambanks, vegetation cover, and fish and wildlife habitat. These unintentional changes caused by the change in water budget often reduce the ability of the human population to use and enjoy the resources of the watershed.

The ecosystem approach requires description of ecosystems, description of stresses on the ecosystems, identification of indicators of the health of the ecosystem, and the impact of the stresses. An integrated set of policies and management practices must be developed which considers people as an integral part of ecosystems. This is in contrast to the more common approach of relating environmental resources to an independent human population and set of policies. Inherent in the ecosystem approach is the concept of carrying capacity. The application of the concept of carrying capacity requires an attempt to understand the limits of an ecosystem’s ability to support various life forms and land use activities. Human activities are then managed in a way that does not exceed these natural limits. When the carrying capacity is respected, the ecosystem remains healthy. When the natural limits are exceeded, the health of the ecosystem declines. The ecosystem approach used in this Subwatershed Study applies the concepts of carrying capacity and ecosystem health in evaluating land use scenarios and watershed management options.

The major requirement, as well as the major benefit, of the ecosystem approach is that the people planning for human modification of the ecosystem have a basic conceptual understanding of the way in which the ecosystem functions and can anticipate, with some degree of confidence, the impact of human activities on ecological functions.

2.2 Subwatershed and Municipal Planning

The following summary of planning directions (See Tremaine and Dundas Secondary Plan Background and Options Report for a detailed discussion of the planning framework) provide a context for understanding how the subwatershed planning objectives for the TDSPSA can be implemented:

- The Provincial government, and to a lesser extent the Federal government, have put in place a range of legislation that applies among other matters to the development and implementation of subwatershed plans, including Provincial legislation such as: Planning Act; Greenbelt Plan/Act; Environmental Protection Act, Environmental Assessment Act, and Conservation Authorities Act. The current framework for watershed planning is illustrated in Figure 2.2.1 and legislation related to specific management requirements is outlined in Table 2.2.1.

- There are also a range of Provincial policy statements, plans and regulations which provide additional direction. These include the Provincial Policy Statement (2005) and the Growth Plan for the Greater Golden Horseshoe.

- Within the subwatershed, growth and development is primarily controlled and directed by Halton Region and the City of Burlington Official Plans (OPs) and the City’s Zoning By-law. Among other matters, these policies and regulations, which must be consistent with or conform with Provincial
policies and plans, are designed to provide reasonable protection for significant natural areas such as floodplains, ESAs, PSWs, and valleyland and adjacent lands against changes in the use of land either in or adjacent to them.

- The current Halton Region Official Plan, which is under review through the Sustainable Halton process, designates the majority of the site as “Urban Area” on Map 1, Regional Structure. The exception is lands along Bronte Creek which are in a variety of designations related to the Region’s Greenlands System. The Halton Region OP polices protect a “Greenlands System” which extends beyond the lands actually designated as part of the Greenlands System in the Plan. Adherence to the Greenlands policies may be undertaken in one of two ways as part of the development of a Secondary Plan:
  - Identify a Greenlands System that includes areas that meet the OP criteria for designation as Greenlands A and Greenlands B and apply the applicable protection policies.
  - Identify a Greenlands System based on a systems approach that will achieve an enhancement to the original Greenlands System by incorporating linkages, buffers and other features that would improve the overall function and sustainability of the System (Halton Region, 2006).

This study will adhere to the Halton Region OP Greenlands policies by adopting a systems approach to the identification and protection of natural heritage features and functions as outlined in Point 2 above.

- The current City of Burlington OP (OPA 55) is under appeal for this site. However, both OPA 55 and the 1997 OP identify the need for an intermunicipal planning study to establish an overall development concept for the site. The Secondary Plan currently in progress reflects this direction. The final Secondary Plan is in part dependant on the outcome of this Subwatershed Study. The Secondary Plan, and its related OP amendment, will provide direction with respect to matters such as general development objectives, the types of development that may occur (e.g., employment, urban residential, commercial), planning period, phasing, planned population, and/or employment levels.
Figure 2.2.1

Legislative Framework

- FEDERAL FISHERIES ACT
  - DFO
- LAKES & RIVERS IMPROVEMENT ACT
  - MNR
- PLANNING ACT
  - Land Use
  - Flood Plain Planning
  - Wetlands
  - MMAHA
- ENVIRONMENTAL PROTECTION ACT
  - Provincial Water Quality Objectives
  - MOE
- ONTARIO WATER RESOURCES ACT
  - DFO
  - Water pollution (groundwater/surface & stormwater)
- CONSERVATION AUTHORITIES ACT
  - Fill Construction and Alteration to Waterways Regulations
  - Conservation Halton
- DRAINAGE ACT
  - OMAFRA
  - Site specific, when adopted under municipal by-laws
- LOCAL IMPROVEMENT ACT
  - Local Municipalities
- FEDERAL NAVIGABLE WATERS
  - For specific reach of certain water resources
  - Transport Canada
- PUBLIC LANDS ACT
  - MNR
Table 2.2.1. Ontario Policies and Regulations Related To Watershed Planning

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<th>Legislation/Policy Document</th>
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Agencies:
- MMAH - Ministry of Municipal Affairs and Housing
- MNR - Ministry of Natural Resources
- CA - Conservation Authority
- TC - Transport Canada
- OMAFRA - Ontario Ministry of Agriculture and Food
- EC - Environment Canada
- DFO - Department of Fisheries and Oceans
- MOE - Ministry of the Environment
- MTO - Ministry of Transportation

Note: The 2005 PPS was reviewed in the preparation of this study as well as the Natural Heritage Reference Manual.

*Subject to delegation and appeal rights as set out in the applicable legislation.
3. **Existing Conditions**

3.1 **Introduction**

The TDSPSA is bounded by Tremaine Road to the east, Highway 407 to the north, Dundas Street to the South and Bronte Creek to the west. An illustration of the existing conditions within the study area is shown in Figure 3.1.1. This Subwatershed Study focuses on the catchment areas within the study area. However, consideration is also given to the areas outside of the TDSPSA to provide for a comprehensive understanding of subwatershed conditions and processes.

A detailed discussion of the existing land uses, environmental features, and processes affecting those features are outlined in the following sections. This “characterization” is based on background data, field information collected, and initial analysis of that data and information.

3.2 **Land Use**

The TDSPSA is 133 ha in size. However, the total potential developable land is much smaller due to a number of constraints, which are mainly comprised of natural features. These features are predominantly in and adjacent to the Bronte Creek valley system (see Section 3.3). These lands are owned by the Province (and include a lot at 5361 Dundas Street), with the exception of the railway tracks (owned by Canadian National Railway) and a hydro corridor both which run parallel to each other in the northern portion of the study area.

One of the more significant features within the study area includes a large pond on land owned by the Ontario Reality Corporation (ORC). The lack of available documentation pertaining to the history of the pond has made it difficult to determine its origins, as well as details about its subsequent ownership and maintenance. It is believed to have been dug as an aggregate source ('borrow pit') during the construction of Dundas Street. After this use was completed, it may have been partially filled, but has subsequently formed a large pond (approximately 3 ha). There are anecdotal accounts of the use of the pond and surrounding lands to rear wildlife as it was believed the pond may have been stocked with fish at one point and there is evidence (remnants of a fine grid fence) that the site may have been used to raise waterfowl. A pump house with electrical service and in ground pump was observed on the south side of the pond, but its origin and the location of the water outlet once it is pumped is unknown. Anecdotal accounts suggest the outlet may be associated with the bus company property on Dundas Street and that the water was used to wash buses. The northwest edge of the pond is of concern since the bank is located about 2 m east of the top of bank for the Bronte Creek valley. The valley slope is very steep in this location and there has been severe failure and erosion in the valley wall as a result of water breaching the top of the pond bank. The ORC has attempted to alleviate this problem in the past through the use of large flexible plastic pipe running from the pond down the valley wall in an attempt to maintain lower water levels in the pond. Beaver have also built dams at various locations in the pond, including the site adjacent to the Bronte Creek valley to prevent water loss at this outlet and at the south side of the pond in the area of the earth berm which blocks the original channel bed and outlet from the
pond to Bronte Creek. In the fall of 2008, ORC installed additional water level control pipes intend to maintain lower water levels and which outlet to the latter channel. ORC has not been able to provide clear direction in regard to the future of the pond. In part this is because ORC has indicated they will be conducting an Environmental Assessment at some point to review flooding, erosion, bank stabilization, and water level control issues associated with the pond. However, for the purposes of this Subwatershed Study, it will be assumed that the pond will remain in its current location and form.

The potential developable land includes four blocks of land: 5421, 5453, 5463 Dundas Street and 3232 Tremaine Road (see Figure 1.1.1). These lands have a total area of approximately 67 ha and are represented by Evergreen Community Ltd. The properties are used for agriculture and include two farm dwellings and outbuildings primarily situated along Dundas Street. A large woodlot (approximately 8 ha) is located in the northern portion of these lands, and other natural features include significant woodlands in the southwest part of the site and some significant hedgerows, as well as two wetlands.

3.3 Designated Natural Features - Environmentally Sensitive Areas and Areas of Natural and Scientific Interest

The TDSPSA includes significant natural areas associated with the Bronte Creek valley (Figure 3.3.1). Within the study area the Bronte Creek valley forms part of a larger Life Science Area of Natural and Scientific Interest (ANSI), the Zimmerman Valley ANSI that extends northward off the property. As well the section of the Bronte Creek valley crossing the property forms part of a large ESA. In areas adjacent to the property are there are two additional ANSIs, the Bronte Creek Provincial Park Nature Reserve Zone Life Science ANSI and the Trafalgar Moraine Candidate Earth Science ANSI, and as well as a proposed extension of the Bronte Creek Valley ESA. Each of these areas are described in greater detail below.

Zimmerman Valley ANSI – Life Science (ANSI-LS)

The Zimmerman Valley ANSI is mapped along the Bronte Creek valley extending northward from the railway line that crosses the TDSPSA further north across and north of Highway 407. The Zimmerman Valley ANSI is designated based on representation of:

- The Ontario-Peel Plain valleys;
- A large meander valley with representative patterns; and
- Local geomorphological and floristic significance (Cuddy et al., 1976).

Valley rim/bluff prairie vegetation is reported from the Zimmerman Valley ANSI (OMNR, 2006). Prairie vegetation once more common in southern Ontario is found in isolated situations where a combination of conditions such as warm southern exposure, regular disturbance such as eroding valley rims/bluffs and occasional fires have maintained the open conditions necessary for the persistence of prairie species.
Figure 3.1.1
1:6,000

Legend
- Roads
- Watercourse (Existing)

Existing Land Use
Type
- Agriculture
- Developable Land
- Employment
- Road
- Water
- Woodlot

Datum: NAD 83, Zone 17
Source: Town of Oakville

Existing Conditions

Land use was created for modeling purposes.

Figure 3.1.1
1:6,000
September 2009
Bronte Creek Provincial Park Nature Reserve Zone ANSI – (ANSI-LS)

The Bronte Creek ANSI is located south of Dundas Street, south of the study area. The natural area report for the area states:

- It is representative of one of the best deciduous upland woodlands in the South Slope physiographic region of site district 7E-4, which is characterized by till plain; and
- It provides protection for a progression of site types, from floodplain to valley slopes with both southern and northern aspects, to upland terraces. (Larson et al., 1999).

Many of the vegetation communities that characterize the Bronte Creek ANSI are also present within the TDSPSA, including valley rim prairie, north slope hemlock forest, south slope oak-hickory forest and maple-beech forest.

Trafalgar Moraine Candidate ANSI – Earth Science (ANSI-ES)

The Trafalgar Moraine Candidate ANSI is located north of Highway 407 and east of Tremaine Road, outside the TDSPSA. The crest of the moraine runs from Zimmerman (Appleby Road and Side Road 1) eastwards to Trafalgar Road.

ESA 10 – Bronte Creek Valley and ESA 10 Additions

There are 48 ESAs identified in Halton Region. ESA 10 Bronte Creek Valley extends from the mouth of Bronte Creek at Lake Ontario northward to NO 2 Side Road in Burlington (Halton Region and North-South Environmental 2005). ESA 10 primarily includes the deeply incised river valley, with limited tableland areas. It meets eight primary ESA criteria, including criteria related to diverse and high quality native vegetation communities, rare plant and animal species, representative earth science features and significant surface and groundwater related features. The recently completed Natural Areas Inventory (Conservation Halton, 2006) has recommended two extensions to ESA 10: one extension northward to include additional portions of Bronte Creek to areas just above Britannia Road (NAI-10B); and a second extension to include tableland areas in the southeast quadrant of Tremaine Road and Dundas Street. This includes headwater areas of both Bronte Creek and Fourteen Mile Creek.

3.4 Physiography and Geology

3.4.1 Physiography and Drainage

The study area is located about 2.7 km south of the northeast–southwest trending Trafalgar Moraine. The site lies within the South Slope Physiographic Region (Chapman and Putnam, 1984), a strip of land in between the Lake Iroquois shoreline to the south and the Peel Plain to the north. This area is characterized as a weakly drumlinized till plain with low topographic relief. The surficial soil in the area is the Halton/Wildfield till complex, a red coloured clayey to silty till.
The region is relatively well drained by Fourteen Mile Creek, Bronte Creek and their tributaries. Overall, ground surface slopes gently southward towards Lake Ontario. Aerial photographs reveal some fluting of the Halton Till in a southeast-northwest direction across the region.

The study area is located along a surface water divide separating the Fourteen Mile Creek and Bronte Creek watersheds. Both creeks flow generally south-eastward and discharge into Lake Ontario. Drainage across the site varies from good to poor. Although there are some areas that are categorized as having poor drainage, these tend to be localized. Overall the site provides good drainage characteristics. Based upon investigations at the subwatershed level, the site does not appear to present any significant restrictions to serviceability or Stormwater Management (SWM) implementation.

The topography at the site was observed to be relatively flat to gently undulating with several swales noted. These swales collect seasonal runoff and water from precipitation events. This suggests that the underlying soils have low permeability, making infiltration of water difficult. The topographic highs in between the swales are typically orientated in a southeast-northwest direction.

Current land use in the study area is predominantly agricultural with residential properties, two wood lots and a ravine valley created by the stream-cutting erosion of Bronte Creek. An existing pond (approximately 2.7 ha in area) is also present in the central–western area of the site just east of Bronte Creek. This pond predates 1954, is reported to have been a former borrow pit and is thought to have a maximum depth of 4 m. Water from the pond now drains via a pipe as well as by seepage through a berm at the south side of the pond into a valley that connects to Bronte Creek.

During the site visit, pond water was observed to be overflowing the western wall of the pond, with the overflow dropping into a valley created by a former breach and erosion. The flow is then westward to Bronte Creek. Discharge from the pond was also observed at the south side of the pond. Erosional stream cutting of this outlet has now formed a permanent watercourse identified as subwatershed reach BCT-R1.

A low lying wetland area in the Bronte Creek valley (identified as SWD3-1), was noted toward the southern area of the site, immediately adjacent to the east side of Bronte Creek. At the time of the site visit, no groundwater seepage was observed emanating from the sides of the Bronte Creek Valley. Other than seasonal surface runoff concentrated in the low lying swales, and the existing pond, no other surface water features were observed onsite.

3.4.2 Geology

3.4.2.1 Bedrock

The bedrock beneath the subject site is interpreted to be Upper Ordovician-aged shale of the Queenston Formation, which is reddish brown in colour and is relatively uniform in character. Some limestone and dolostone layers may also be present (Bedrock Geology of Ontario, OGS Map 2544). Shale of the
Queenston Formation (also a Hydrogeologic Unit) does not fracture readily and is reportedly compact and dense with relatively poor interconnectivity of pore spaces (Singer et al., 2003). The upper three to five meters of the formation is generally weathered and may provide sufficient water supplies for domestic use.

The Ministry of the Environment (MOE) water well records (WWR) show that many of the private water supply wells in the study area have been completed in this red shale bedrock. However, the Queenston Formation is characterized in the region as having a low hydraulic conductivity and a poor water yielding capability (Singer et al., 2003).

Hydraulic testing at a site close to the study area resulted in reported hydraulic conductivity values between $3.7 \times 10^{-7}$ and $1.8 \times 10^{-12}$ m/s with a geometric mean of $1.1 \times 10^{-8}$ m/s (AMEC, 2008a). Borehole and WWRs indicate that the depth to bedrock in the vicinity of the site varies from 1 to 13 m below ground surface (mbgs), except in the valley where Bronte Creek has eroded through the overlying Halton Till, exposing the Queenston Shale. The elevation of the bedrock in the study area was found to range between 152.4 masl and 161.0 masl (AMEC, 2008a). Bedrock is reported to occur closest to the surface along the eastern edge of the site coinciding with topographic low points.

### 3.4.2.2 Overburden

Fieldwork conducted by AMEC in 2007 identified that surficial soil in the TDSPSA generally consists of clayey silt, with some sand and a trace of gravel. Fill was encountered at some drilling location to depths of up to 1.4 mbgs, particularly in the southernmost area of the site, Boreholes 23 and 27 (AMEC, 2007). The underlying soil consists predominantly of a clayey to sandy silt till with some gravel (see Figure 3.4.1). This till is known locally as the Halton Till but may include a surficial layer of a more clay-rich till known as the Wildfield Till. Till of the Halton Wildfield Till Complex will be referred to as the Halton Till in this investigation.

The Halton Till typically has a very low permeability and was found to extend to depths of up to 6 mbgs in the southern portion of the study area. Hydraulic testing of similar overburden soils at a site close to the TDSPSA has reported hydraulic conductivity values between $3.9 \times 10^{-7}$ and $3.6 \times 10^{-8}$ m/s with a geometric mean of $1.2 \times 10^{-7}$ m/s (AMEC, 2008a).

Occasional lenses of sand may be encountered in the overburden. However, these layers and lenses are generally limited in aerial extent and thickness. Streams and creeks within the study area contain deposits of recent alluvium. In general, the overburden is thin throughout the majority of the study area.

### 3.4.3 Topography

The topography in the study area is generally flat to gently undulating onsite, ground surface elevations range from approximately 154 to 170 masl. Bronte Creek lies within a steep walled valley at an elevation of approximately 130 masl. The existing pond is at about elevation 148 masl.
3.5 Groundwater Flow System Characterization

3.5.1 Regional Hydrostratigraphy and Groundwater Flow

Based on field work completed at the site by others and MOE WWRs, the hydrostratigraphy of the study area has been interpreted to include the following units:

- **Till** (sandy silt to clayey silt till) – In general the Halton Till is not a good aquifer and the relatively low permeability of the till restricts infiltration into the overburden and recharge to underlying aquifers. However, the till thickness is often not great and bedrock is exposed in places, particularly in the incised river valleys. The only reliable water supply sources are found in areas where the overburden thickens and where coarser soil layers are encountered. These more coarse grained units are generally discontinuous and relatively thin; and

- **Bedrock** – The upper 3 - 4 m of weathered shale are considered the local bedrock aquifer. Bedrock was encountered at depths as shallow as 1.2 mbgs onsite. The majority of private wells and all commercial, livestock and industrial wells within a 1 km radius of the site have been completed in the red shale bedrock. The hydraulic conductivity of the shale has been reportedly measured as high as $10^{-6}$ m/s in the upper weathered zone (Halton Region Aquifer Management Plan, 1997). Regional groundwater flow is interpreted to be to the southeast towards Lake Ontario.

3.5.2 Groundwater Flow in the Study Area

As part of a geotechnical investigation completed by AMEC in May 2007, a total of 27 boreholes were drilled to depths ranging from 4.6 to 9.6 mbgs. Twelve of these were converted to monitoring wells. At two locations (BH 19 & 27), well screens were placed at two levels to assess vertical hydraulic gradients. The locations of these monitoring wells are shown on Figure 3.5.1.

Water levels were measured in boreholes, private wells and monitoring wells from May to September 2007 by AMEC. Groundwater was found to occur between 0.13 and 5.28 m below ground surface (mbgs) and measurements indicate that shallow groundwater flow is generally to the southeast towards Lake Ontario. Figure 3.5.2 shows the interpreted groundwater flow regime. Historical groundwater monitoring has also shown that there is significant seasonal variation in the depth to water table at the site. This is consistent with the regional groundwater flow model that shows groundwater flow overall is southward toward Lake Ontario.

Profiles across the study area (see Figure 3.5.3) show that the water table is a subdued expression of the general bedrock and ground surface topography. In areas on the west side of the site, where there is a significant drop in ground surface elevation into the Bronte Creek valley, groundwater flow is expected to follow this same pattern.

In general, shallow groundwater discharge occurs in areas where the water table or potentiometric surface is at or above ground surface. This often occurs along the edges of water bodies or in low lying areas. In higher areas, where the water table is deeper, groundwater recharge is expected. Overall, the
site is generally considered a recharge area. This is confirmed by the lack of flowing wells in the area and overall presence of vertically downward hydraulic gradients. In areas where multiple wells were completed at different depths, there is an indication of downward vertical gradients into and in the bedrock.

Discharge of water from the pond was observed via the constructed overflow outlet at the south side of the pond. Water discharging from the pond was flowing towards Bronte Creek. Erosional stream cutting of this outlet has now formed a permanent watercourse identified as BCT-R1 (see Figure 1.1.1). A low lying area of swamp land (Classified as a SWD3-1 Natural Heritage feature, (see Figure 3.3.1), with poorly drained soils and swampy ground was observed adjacent to the east side of Bronte Creek. During the site visit, very little/ if any groundwater seepage was observed, along the constructed overflow outlet and associated BCT-R1. It is considered that shallow groundwater does not significantly contribute to baseflow in Bronte Creek. Groundwater contribution to the existing pond and health of the SWD3-1 swamp lands is also considered minor, with direct surface run-off from precipitation events and ice-melt thought to be the main contributors.

Seepage of groundwater is likely to occur from below to the floor of the valley in which Bronte Creek is situated. This is consistent with the valley being a relatively broad discharge zone in a clay/shale environment. Overall, groundwater discharge across the site is considered to occur from a more intermediate or regional groundwater flow system and the expected impact of the development on the deep flow system will be small and likely not measurable.

Other than the surface runoff concentrated in the low lying swales, BCT-R1, swamp lands and the existing pond, no other perennial surface water features were observed onsite. Toward the east side of the site, intermittent swales were observed. These features are interpreted to only flow as a result of receiving overland flow, including interflow, the component of infiltration considered runoff because it does not reach the water table.

3.5.3 Groundwater Use

Based on the MOE WWRs received, a total of nine existing water wells (PW-1 to PW-9) exist onsite and a number of wells are located within a 500 m radius of the study area. Water from these wells are used for both domestic and irrigation purposes. The location of these wells are shown on Figure 3.5.3.

Many of the MOE WWR data base could not be readily correlated with observed well locations. Of the onsite wells, one well appears to be associated with the property at 3287 Tremaine Road and three wells appear to be associated with the property at 5463 Dundas Street. Previous onsite investigations have identified that five of the wells were associated with buildings and that only two remained in use. From May to September 2008, only four of the wells (PW-1 to PW-4) were accessible for water level monitoring (AMEC, 2008a).

Several wells have been identified on properties adjacent to the site. Interviews with home owners by AMEC (2008a) indicated that many of these wells are unused and that a number of households rely on
cisterns for their water supply. Of the four wells that were reportedly still in service, two were not used as potable water supply sources.

### 3.5.4 Groundwater Quality

Groundwater quality in the region has historically been considered poor, with elevated concentrations of naturally occurring sulphate, chloride, calcium, sodium, magnesium, manganese, strontium, iron, hardness and total dissolved solids (TDS) in groundwater taken from the Queenston Shale. In addition elevated nitrate levels, an indication of impacts from either agricultural operations or nearby septic systems, have also been noted.

Based on data in the WWR’s, groundwater quality is generally reported as being fresh. However, three well records show that salty (i.e., mineralized) water was encountered. The absence of a significant overburden aquifer and the poor quality and quantity of groundwater from the bedrock suggest that the potential to develop a significant groundwater supply in the study area is low. The presence of the low permeability overburden does, however, offer protection for contaminant migration into the underlying bedrock aquifer.

Five of the 29 geotechnical boreholes drilled during May 2007 by AMEC, were advanced to address specific environmental concerns and were installed as monitoring wells. The location of these wells are shown on Figure 3.5.3. Groundwater sampling of these wells was done in June 2007 (AMEC, 2008c) and eight samples were submitted for chemical analysis of Volatile Organic Compounds (VOCs), Benzene, Toluene, Ethylbenzene, Xylene (BTEX), Petroleum Hydrocarbons (PHC) F1 (C6-C10) and F2 (C>10-C16) PHC (F1-F4), metals and Organo-Chlorine (OC) pesticides.

Groundwater samples exceeded MOE Ontario Regulation 153/04 Table 2 Guidelines *Full Depth Generic Site Condition Standards in a Potable Groundwater Condition* in two samples, BH27A for 1, 2-dichloroethane and BH27B for BTEX, PHC F1+F2 and 1, 2-dichloroethane. The remaining groundwater samples collected from the site had non-detectable or concentrations of the parameters tested below the Table 2 standards. As outlined in the Draft Phase II Report by AMEC in 2008, further work may be needed in the area within 30 m of the pond to determine the soil and groundwater quality in this area.

### 3.5.5 Regional Groundwater Balance

A regional groundwater balance for the area immediately east of the site, which includes the Fourteen Mile Creek Subwatershed north of Dundas Street, was developed during completion of the North Oakville Creeks Subwatershed Study. The groundwater balance was completed considering the geology and topography of the area and the conceptual hydrogeological model. The groundwater balance is based on the nearby study area. Since the physical conditions in that area are similar to the current study area, the results present a reasonable estimate for the region.

When precipitation occurs in the TDSPSA, some of the water evaporates, some is returned to the atmosphere through transpiration, some runs off as surface water flow, and some infiltrates into the ground. Of the total water entering the ground, a portion percolates downward to the water table. This
component is considered the recharge to the groundwater system. The remaining portion moves through the fractures in the thin overburden toward local surface watercourses.

Preliminary estimates of the total infiltration ranged from about 50 to 110 mm/year. The range is a function of the range of soil permeability that results from the drying and wetting periods during the year.

3.6 Surface Water – Hydrology

3.6.1 Design Flows

In preparation for undertaking an updated hydrologic analysis of the TDSPSA, previous reports completed by others (Urbantech, 2002) as well as the NOCSS work were reviewed to identify the design flow rates calculated as part of past work completed within the study area.

3.6.2 Hydrological Issues to be Addressed

As with most subwatershed studies, the key issues to be addressed (as applicable to each watercourse) include:

- Peak runoff quantity control;
- Maintenance of baseflow rates/water balance;
- Volume of surface runoff;
- Groundwater recharge/discharge;
- Erosion protection; and
- Runoff water quality control.

Measures in past studies recommended to address each of these issues (if applicable) are briefly summarized in the following section of this report.

3.6.3 Hydrologic Analysis Approach for the Analysis Phase

As part of the characterization phase, a review of the background reports, particularly for hydrologic and hydraulic analysis, was carried out. The investigation included a review of the scope of analysis and modelling, the resulting summary of conditions, design flows developed, and any identified requirements from SWM. The findings provided preliminary information on hydrologic conditions, watershed conditions, and the basis for developing a modelling approach in the analysis phase of this study.

The TDSPSA is drained by Fourteen Mile Creek in the east, and Bronte Creek in the west. The drainage divide between the two watersheds runs north to south approximately mid-way through the study area.

Runoff from the Fourteen Mile Creek portion of the Study area is drained under Tremaine Road via five culverts, and through one culvert under Dundas Street (Figure 4.1.1). The culverts under Tremaine Road
are numbered from FM-T1 through FM-T5. Culvert FM-T1 is located near Dundas Street West while culvert FM-T5 is located near Highway 407. The culvert under Dundas Street is numbered FM-D1.

Runoff from the Bronte Creek drainage area is conveyed partly in a northern ditch along Dundas Street and partly through a tributary that outlets into Bronte Creek, just upstream of Dundas Street. A large pond is located along the tributary approximately half way between Highway 407 and Dundas Street. Bronte Creek is contained within a 25 m deep trapezoidal shaped channel with a topwidth of approximately 175 m and a bottom width of 75 m.

Runoff conveyed by the Tremaine Road culverts drains in a west to east direction while runoff to the Dundas Street culvert drains in a northwest to southeast direction. The Bronte Creek Tributary drains in a northeast to southwest direction. Ground elevations are approximately 165 m along Highway 407 and approximately 155 m along Dundas Street, representing a drop of approximately 10 m across the site.

No climate stations are located in the TDSPSA. For the purposes of this study, the RBG gauge was used. Corresponding average annual precipitation across the study area is approximately 860 mm and is composed of 740 mm of rainfall and 120 cm of snowfall. Average daily July temperatures are approximately 22°C while average January temperatures is approximately -5°C.

Points of interest were used as the starting point for the discretization of the watershed. Points of interest were selected primarily along Tremaine Road and Dundas Street to provide for an assessment of existing conditions and potential impacts. The location and number of subcatchments selected are shown on Figure 1.1.1. Drainage boundaries were determined from field investigations, topographic mapping, and from aerial photographs.

Varieties of analytical techniques and models are, or have been, available for undertaking the required hydrological analyses for this Subwatershed Study. Furthermore, the general approach to modelling can be either single rainfall event driven or based on continuous, multi-event simulations over a long period of time. Both of these approaches have been utilized in various studies within the TDSPSA, completed by others. Other considerations when setting up an appropriate hydrologic model include the level of detail when drainage areas and sources of rainfall data are used to represent weather conditions.

In developing a modelling approach for the next phase of this study, the background reports and associated modelling were reviewed, as well as the need to address the issues in this Subwatershed Study. This review was carried out with City of Burlington and Conservation Halton staff to review the Subwatershed Study needs, as well as future needs by both agencies in the implementation phases. The overall needs of the modelling include:

- Provide a consistent approach across the watersheds (one model);
- Ability to address watershed analysis needs:
  - Model hydrologic response of watersheds for events;
  - Provide both event and continuous approach;
  - Provide for water balance analysis;
  - Provide information to geomorphologic analysis; and
- Provide for the long-term analysis of the watersheds, as well as the review process during implementation.
The modelling approach that has been adopted will include models to cover all of the needs of a water balance model and event model that can also be applied in continuous mode.

**Event Model**

As discussed with the City of Burlington and Conservation Halton, the current models for the TDSPSA will be converted to Guelph All-Weather Storm Event Runoff Computer Simulation Model (GAWSER). GAWSER is a physically based deterministic hydrologic model that incorporates the physical understanding of the involved processes. The GAWSER program is routinely used to model precipitation events for short and long-term periods. In addition, the program can simulate spring runoff and snowmelt events. They will be used for peak flow analysis to analyze response characteristics to storm events, the potential impact of land use changes, and effectiveness of SWM measures. The following characteristics will exist:

- The models will be developed for each drainage area;
- A full range of design events will be applied (bank full, 2, 5, 10, 25, 50, and 100-year, and Regional) for a flow regime analysis; and
- One selected drainage area will be applied in continuous mode to provide erosion verification with the water balance analysis.

A water balance model has been developed using the GAWSER model to obtain daily flow to analyze existing conditions, investigate potential impacts of land use and evaluate mitigative measures (i.e., SWM). The analysis focuses on runoff volumes, baseflows and overall water balance.

**Hydrologic Modelling Results**

Details of the hydrologic analysis is summarized in **Appendix A**. Peak flow rates for various points of interest are shown in **Table 3.6.1**. The peak flow rates were simulated using single event design storms. Hydrologic cycle water balance values are shown in **Table 3.6.2**.
Table 3.6.1 GAWSER Peak Flow Rates

<table>
<thead>
<tr>
<th>Location</th>
<th>Culvert No.</th>
<th>GAWSER Hyd. No.</th>
<th>Regional m³/s</th>
<th>100-year m³/s</th>
<th>50-year m³/s</th>
<th>25-year m³/s</th>
<th>10-year m³/s</th>
<th>5-year m³/s</th>
<th>2-year m³/s</th>
<th>Drainage Area ha</th>
<th>Basin No.</th>
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<tbody>
<tr>
<td>Bronte Creek Tributary</td>
<td>Outlet</td>
<td>7005</td>
<td>2.651</td>
<td>0.999</td>
<td>0.869</td>
<td>0.741</td>
<td>0.562</td>
<td>0.433</td>
<td>0.241</td>
<td>42.50</td>
<td>1005</td>
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<tr>
<td>Dundas Street West</td>
<td>----</td>
<td>6005</td>
<td>0.219</td>
<td>0.116</td>
<td>0.103</td>
<td>0.089</td>
<td>0.071</td>
<td>0.057</td>
<td>0.036</td>
<td>2.58 BC</td>
<td>1005</td>
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<td>Dundas Street West</td>
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<td>0.456</td>
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Notes: 2.651 Existing Land Use Conditions Peak Flow Rate

Table 3.6.2. GAWSER Water Balance Values

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<tr>
<th>Location</th>
<th>Culvert No.</th>
<th>GAWSER Hyd. No.</th>
<th>Land Use</th>
<th>Precip. mm</th>
<th>Evapo. mm</th>
<th>Runoff mm</th>
<th>Infiltr. mm</th>
<th>Drainage Area ha</th>
<th>Basin No.</th>
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<td>1005</td>
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<tr>
<td>Tremaine Road</td>
<td>FM-T3</td>
<td>8001</td>
<td>Exist.</td>
<td>785</td>
<td>532</td>
<td>131</td>
<td>122</td>
<td>6.72 FM 1102a</td>
<td>1005</td>
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<td>Tremaine Road</td>
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<td>8002</td>
<td>Exist.</td>
<td>785</td>
<td>521</td>
<td>169</td>
<td>95</td>
<td>11.87 FM 1102b</td>
<td>1005</td>
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<td>Tremaine Road</td>
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<td>8003</td>
<td>Exist.</td>
<td>785</td>
<td>507</td>
<td>218</td>
<td>60</td>
<td>4.24 FM 1102c</td>
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<tr>
<td>Tremaine Road</td>
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<td>9001</td>
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<td>10.37 FM 1104a</td>
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<td>Tremaine Road</td>
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<td>490</td>
<td>223</td>
<td>72</td>
<td>1.92 FM 1104b</td>
<td>1005</td>
</tr>
</tbody>
</table>

Notes: Exist. - Existing Land Use
### Table 3.7.1. Water Surface Elevations

<table>
<thead>
<tr>
<th>Cross-Section No.</th>
<th>Regional m</th>
<th>100-year m</th>
<th>50-year m</th>
<th>25-year m</th>
<th>10-year m</th>
<th>5-year m</th>
<th>2-year m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tremaine Road</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>4</td>
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<td>157.32</td>
<td>157.25</td>
<td>157.13</td>
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<td>156.88</td>
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<td>5</td>
<td>158.15</td>
<td>157.54</td>
<td>157.54</td>
<td>157.53</td>
<td>157.49</td>
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<td>6</td>
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<td>157.87</td>
<td>157.84</td>
<td>157.81</td>
<td>157.78</td>
<td>157.72</td>
</tr>
<tr>
<td>Q, m³/s</td>
<td>7.33</td>
<td>2.93</td>
<td>2.59</td>
<td>2.27</td>
<td>1.79</td>
<td>1.48</td>
<td>0.94</td>
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<tr>
<td><strong>Dundas Street West</strong></td>
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<td>16</td>
<td>155.81</td>
<td>155.58</td>
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<td>17</td>
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<td>156.15</td>
<td>156.15</td>
<td>156.14</td>
<td>156.12</td>
<td>156.10</td>
</tr>
<tr>
<td>18</td>
<td>157.07</td>
<td>156.94</td>
<td>156.93</td>
<td>156.92</td>
<td>156.90</td>
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<td>156.86</td>
</tr>
<tr>
<td>Q, m³/s</td>
<td>1.20</td>
<td>0.56</td>
<td>0.50</td>
<td>44.00</td>
<td>0.35</td>
<td>0.29</td>
<td>0.19</td>
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</tbody>
</table>

### 3.8 Physical Stream Conditions

#### 3.8.1 Headwater Drainage Network - Form and Function

A large portion of the TDSPSA is comprised of the headwaters of Fourteen Mile Creek, draining both to the east and south towards the main channel. The overall form of a headwater drainage network indicates the function of the system. Where swales (vegetated depressions lacking defined bed and banks) dominate a headwater area, it can be expected that flows are rarely high enough to erode sediment. The swales observed within this study area are vegetation-stabilized (i.e., vegetation retards the flow and the root matrix enhances the sediment's resistance to erosion). These systems are sensitive to land use changes that remove vegetation or increase the amount or intensity of discharge. This can increase the driving force and retard resisting forces, respectively. If these forces are pushed beyond a certain threshold, erosion occurs. This erosion initiates the development of rills, gullies, and a defined channel.

While the main branch of Bronte Creek flowing within the TDSPSA does not constitute a headwater system, several poorly defined swales were identified by aerial photography and in the field that drain to the existing wetland/pond feature. In addition, a steep and defined channel drains the wetland feature into Bronte Creek. This channel is more typical of a gully headwater channel, traversing the steep valley walls of the main system.

Defined headwater channels tend to be erosive, supplying sediment to downstream channels. They also tend to have storm-driven, flashy discharge regimes. Although each headwater channel provides only a small amount of sediment and water to the overall basin, the relatively high proportion of low order streams to high order receiving channels means that their cumulative contributions (both water and
sediment) are felt through the watershed. The study area contains portions of the Fourteen Mile Creek and Bronte Creek watersheds. In the case of Fourteen Mile Creek, much of the network within the study area consists of headwater swales without defined channels.

All of the streams within the study area were considered and/or investigated for the purposes of characterization for the NHS (Figure 3.3.1). Some of these streams however are located on public lands (Figure 1.1.1) and were not analyzed in detail. It is anticipated that the streams on public lands will be protected in the long-term. It is recognized that these streams, although not analyzed in detail, provide an important function as feeder streams to Bronte Creek.

3.8.2 Reach Morphology

Channel form is a product of the flow (magnitude) and the channel materials (sediment type, supply, and bed/bank strength). If one of these variables is altered, the channel adjusts its form to retain or find a new ‘dynamic’ equilibrium. The characteristics of the flow or channel materials can, and do, change along a watercourse. In order to provide channel measures from homogeneous sections of a watercourse, channels are separated into reaches. These are generally several hundred meters to several kilometres in length. In the delineation of reaches, the following measures are considered: sinuosity; gradient; hydrology; local geology; vegetative control; and degree of valley confinement using methods outlined in Parish Geomorphic Ltd. (2001). Degree of valley confinement is also indicative of floodplain extent as floodplains are generally defined as the flat valley floors adjacent to the channel which extend to the valley walls. In a regional context, this is usually defined as the 100-year flood line. Floodplains play an important role in the storage of water and sediment as well as energy dissipation. During high flow conditions, water overtops the channel margins and spreads along the relatively large surface area of the floodplain, reducing the concentration of erosive flows.

For the purposes of this study, reaches were delineated based on available topographic mapping and aerial photography. The results of this desktop mapping exercise were verified through a series of site investigations conducted on June 12 and July 9, 2008. Based on this assessment, while numerous drainage features can be visually observed based on aerial photography, five reaches were identified within the study area. Figure 3.8.1 outlines the reaches within the study area and Table 3.8.1 provides lengths, gradients and sinuosity measurements for each reach.

3.8.3 Field Investigations

In order to provide insight regarding existing geomorphic conditions a site reconnaissance was conducted on July 16, 2008. Rapid assessment techniques were applied to determine the dominant geomorphic processes affecting each site. A Rapid Geomorphic Assessment (RGA) documents has shown indicators of channel instability (MOE, 1999). Observations are quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, and channel widening and planimetric adjustment. The index produces values that indicate whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40) or adjusting (score >0.41). A Rapid Stream Assessment Technique (RSAT) provides a broader view of the system by also considering the ecological function of the stream (Galli, 1996). Observations include in-stream habitat, water quality, riparian
conditions, and biological indicators. Additionally, the RSAT approach includes semi-quantitative measures of bankfull channel dimensions, type of substrate, vegetative cover, and channel disturbance. RSAT scores rank the channel as maintaining a low (<20), moderate (20-35) or high (>35) degree of stream health. **Table 3.8.2** provides a summary of the rapid assessment results.

**Figure 3.8.1. Location of Geomorphic Detailed Field Sites (image courtesy of Google Earth)**

**BC-R1**

Reach BC-R1 is found to be in a stressed or transitional state, boasting a moderate degree of overall ecological health. Bankfull widths ranged from 17-25 m, while bankfull depths varied from 1-2 m. The reach is characterized by numerous valley wall contacts against exposed slopes, contributing to a high degree of channel entrenchment in these areas. Riparian vegetation consists of tall grasses and herbaceous species, transitioning to a mixed forest within the valley.
Table 3.8.1. Reach parameters for the TDSPSA

<table>
<thead>
<tr>
<th>Reach</th>
<th>Length (m)</th>
<th>Sinuosity</th>
<th>Gradient (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bronte Creek Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC-R1</td>
<td>1746</td>
<td>1.04</td>
<td>0.36</td>
</tr>
<tr>
<td>BC-R2</td>
<td>1243</td>
<td>1.01</td>
<td>0.40</td>
</tr>
<tr>
<td>BCT-R1</td>
<td>498</td>
<td>1.03</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>Fourteen Mile Creek Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14W-17*</td>
<td>150</td>
<td>1.01</td>
<td>0.99</td>
</tr>
<tr>
<td>14W-17C</td>
<td>332</td>
<td>1.02</td>
<td>0.59</td>
</tr>
</tbody>
</table>

* Portion of Reach 14W-17 within TDSPSA

Table 3.8.2. Rapid Assessment Results for Bronte Creek

<table>
<thead>
<tr>
<th>Reach</th>
<th>RSAT</th>
<th>Condition</th>
<th>RGA</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC-R1</td>
<td>29</td>
<td>Moderate</td>
<td>0.33</td>
<td>Transitional</td>
</tr>
<tr>
<td>BC-R2</td>
<td>32</td>
<td>Moderate</td>
<td>0.31</td>
<td>Transitional</td>
</tr>
<tr>
<td>BCT-R1</td>
<td>23</td>
<td>Moderate</td>
<td>0.09</td>
<td>In Regime</td>
</tr>
<tr>
<td>14W-17</td>
<td>22</td>
<td>Moderate</td>
<td>0.00</td>
<td>In Regime</td>
</tr>
<tr>
<td>14W-17C</td>
<td>--</td>
<td>Swale</td>
<td>--</td>
<td>Swale</td>
</tr>
</tbody>
</table>

Geomorphic processes affecting the reach include aggradation, planform adjustment and channel widening. These processes are evident through the formation of bars, cut-off channels and islands, as well as fallen and leaning trees, and toe erosion.

**BC-R2**

Reach BC-R2 is also deemed to be in a stressed or transitional state, with a moderate degree of ecological integrity. Bankfull dimensions measured 8-15 m in width and 0.60-1.0 m in depth. Entrenchment was moderate overall, primarily driven by valley wall contacts along the reach. Channel disturbances included the rail line and Highway 407 crossings. Dominant geomorphic processes impacting the reach included channel widening, aggradation, degradation, and planform adjustment. These processes manifested in the form of basal scour, bar formation, cut face on bar forms, and island formation.

**BCT-R1**

BCT-R1 is a steep, deeply entrenched tributary to Bronte Creek. The channel itself is identified as being undersized for the valley and is receiving minimal flow in the form of seepage from the existing pond. Bankfull widths range from 6-8 m, with bankfull depths in the range of 0.65-1.0 m. The channel is situated within a well-established riparian community consisting of herbaceous species and mixed forest. The tributary scored as being stable or 'in regime' with only minor evidence of widening observable in the form of exposed tree roots and toe erosion.
14W-17

This section of channel is an extension of Reach 14W-7 originating east of Tremaine Road, extending upstream to Highway 407. This reach was originally delineated through the North Oakville Creeks Subwatershed Study (TSH, 2006) as a medium constraint stream. The portion of 14W-17 within the TDSPSA consists of a constructed channel that has been realigned in association with the construction of Highway 407. Channel substrate is largely dominated by rip-rap, with fine silts and sands overlain. In-stream vegetation is present in the form of cattails, transitioning to tall grasses and herbaceous species. Due to the engineered nature of the channel, it is found to be stable; however, given the lack of geomorphic diversity it scored low with respect to ecological health.

14W-17C

Reach 14W-17C was identified as a vegetated swale or depression draining the south-eastern portion of the TDSPSA. Since the reach did not display a defined morphology (bed and banks), rapid assessments were not applicable for this reach.

Building on the results of the rapid assessment work, detailed field work was conducted at three locations within the TDSPSA. The location of the detailed field sites was driven by the need to provide geomorphological targets to guide future SWM requirements within the study area. Based on a review of existing drainage patterns, and in consideration of future potential land use scenarios within the study area, detailed field work was conducted downstream of proposed SWM pond locations within the most sensitive receiving watercourse. As illustrated in Figure 3.8.1, detailed field sites were established within Reach BCT-R1 to address future flows from a SWM pond out letting in vicinity of the existing wetland feature. The remaining field sites were located beyond the actual study area boundaries, as the post-development scenario identified the outlet of all remaining SWM ponds at Tremaine Road and Dundas Street. Consequently, a field site was established downstream of Dundas Street within Reach 76c (as characterized through the Oakville Erosion (2006) study) and downstream of Tremaine Road within Reach 14W-12 (as characterized through the North Oakville Creeks Subwatershed Study (2006) to address these flows.

As part of the detailed field assessment, standard protocols and known field indicators were used to quantify bankfull cross-sectional dimensions (e.g., bankfull depth and width) along a minimum of five transects. A modified Wolman pebble count was used to characterize the channel bed substrate materials. In addition to noting bank characteristics, an in-situ shear stress test was performed on bank materials. A level survey of the detailed site provided a measure of the local energy gradient. Long-term monitoring sites were also established at each site in the form of a top-of-bank monitoring cross-section and erosion pins. The location of each control cross-section was recorded by GPS coordinate. A summary of the detailed field results has been provided in Table 3.8.3.

3.8.4 Channel Function – Data Analysis and Results

The results of the field assessment indicate that the landscape of the TDSPSA is dominated by two distinct geomorphic zones: the Bronte Creek valley lands and the headwaters of Fourteen Mile Creek.
Table 3.8.3. Summary of Results for Detailed Geomorphic Field Sites

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BCT-R1</th>
<th>14W-12</th>
<th>76c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Bankfull Width (m)</td>
<td>8.92</td>
<td>8.95</td>
<td>2.93</td>
</tr>
<tr>
<td>Average Bankfull Depth (m)</td>
<td>0.60</td>
<td>0.44</td>
<td>0.16</td>
</tr>
<tr>
<td>Average Bankfull Gradient (%)</td>
<td>5.18</td>
<td>0.81</td>
<td>1.00</td>
</tr>
<tr>
<td>Bed Material $D_{50}$ (cm)</td>
<td>0.79</td>
<td>0.34</td>
<td>0.02</td>
</tr>
<tr>
<td>Bed Material $D_{84}$ (cm)</td>
<td>14.2</td>
<td>8.6</td>
<td>0.53</td>
</tr>
<tr>
<td>Bank Materials</td>
<td>Clay/Silt</td>
<td>Clay/Silt</td>
<td>Silt/Clay</td>
</tr>
<tr>
<td>Manning’s ‘n’ at Bankfull*</td>
<td>0.037</td>
<td>0.031</td>
<td>0.028</td>
</tr>
<tr>
<td>Average Bankfull Velocity (m/s)</td>
<td>4.11</td>
<td>1.81</td>
<td>0.96</td>
</tr>
<tr>
<td>Average Bankfull Discharge (m³/s)</td>
<td>29.9</td>
<td>8.81</td>
<td>0.49</td>
</tr>
<tr>
<td>Stream Power (W/m²)</td>
<td>15186</td>
<td>899</td>
<td>48.1</td>
</tr>
<tr>
<td>Stream Power per Unit Width (W/m)</td>
<td>1666</td>
<td>99.0</td>
<td>19.1</td>
</tr>
</tbody>
</table>

* Visual estimate

The Bronte Creek valley is characterized by steep tributaries situated in a deeply incised valley setting, along with the main branch of Bronte Creek. The eastern portion of the study area is typical of headwater systems, with numerous undefined drainage features carrying surface runoff downstream to the main branch of Fourteen Mile Creek. These features display more moderate gradients characteristic of the underlying Halton Till Plain. Rapid assessment results found only the main branch of Bronte Creek to be exhibiting signs of geomorphic instability. The remaining reaches within the study area were identified as stable. This is not surprising given the engineering nature of Reach 14W-17, and the undefined and actively maintained nature of Reach 14W-17C. Bronte Creek tributary BCT-R1, meanwhile, has not been experiencing regular flow contributions from the upstream wetland feature until recently which could have contributed to erosion.

Results of the detailed field investigation highlighted the much steeper nature of the Bronte Creek tributary, with associated higher bankfull or effective flows and stream power. Reach 14W-12 represented the first appearance of a true defined channel downstream of Tremaine Road. As such, this reach was used to develop targets for stormwater management downstream of Dundas Street. While bankfull dimensions were within range of the Bronte Creek tributary, channel gradient was much lower. Site 76c also represented the first appearance of a first defined channel downstream of Dundas Street, leading it to be selected for geomorphic assessment. The small scale of the channel, fine substrate and moderate gradient are reflective of typical headwater conditions within Southern Ontario. Notable, all three sites displayed similar bank materials reflective of the Halton Till overburden within the area.

3.9 Natural Environment Existing Conditions

The description of existing conditions of the natural environment outlined below is based on fieldwork completed by LGL in 2007 (LGL, 2008), supplemented by fieldwork completed by North-South Environmental in 2008. A summary of field evaluations is provided in Table 3.9.1.
Table 3.9.1. Field Inventory Investigations Undertaken within the TDSPSA in 2007 and 2008

<table>
<thead>
<tr>
<th>Field Evaluation</th>
<th>Date*</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation of Dripline Limits</td>
<td>April 2007</td>
<td>May 11th – sunny; slight breeze from east &lt; 5 km/hr; 25°C</td>
</tr>
<tr>
<td>Tree Inventory</td>
<td>May 11 to June 15, 2007</td>
<td></td>
</tr>
<tr>
<td>Botanical Survey</td>
<td>May 30, May 31, and July 16 to 18, 2007</td>
<td></td>
</tr>
<tr>
<td>Frog Call Survey</td>
<td>April 25, 2007</td>
<td>Partly cloudy, 8°C</td>
</tr>
<tr>
<td></td>
<td>May 24, 2007</td>
<td>Calm, 23°C</td>
</tr>
<tr>
<td></td>
<td>June 27, 2007</td>
<td>15 km/hr wind, 25°C</td>
</tr>
<tr>
<td>Incidental Wildlife Survey</td>
<td>July 7, 2007</td>
<td>Partly sunny, little wind, 10°C</td>
</tr>
<tr>
<td></td>
<td>July 19, 2007</td>
<td>Overcast, little wind, 18°C</td>
</tr>
<tr>
<td>Breeding Bird Survey</td>
<td>July 7, 2007; 6:00 to 9:00 am</td>
<td>Partly sunny, little wind, 10°C</td>
</tr>
<tr>
<td></td>
<td>July 19, 2007; 6:00 to 9:00 am</td>
<td>Overcast, little wind, 18°C</td>
</tr>
<tr>
<td>ELC Survey</td>
<td>June 11, July 11, July 16, Sept 17, and Oct 1, 2008</td>
<td></td>
</tr>
<tr>
<td>Amphibian Survey</td>
<td>May 28, 2008; 9:00 to 10:30 pm</td>
<td>Little wind, mild temperature</td>
</tr>
<tr>
<td>Breeding Bird Survey</td>
<td>June 8, 2008; 6:00 to 9:00 am</td>
<td>Overcast, light breeze, 24°C</td>
</tr>
<tr>
<td></td>
<td>June 16, 2008; 6:00 to 9:00 am</td>
<td>10% cloud, light breeze, 15°C</td>
</tr>
<tr>
<td></td>
<td>July 16, 2008; 6:00 to 9:00 am</td>
<td>Clear, calm, 18°C</td>
</tr>
</tbody>
</table>


Vegetation

Vegetation communities within the TDSPSA are mapped (Figure 3.3.1) and classified following Ecological Land Classification (ELC) for Southern Ontario (Lee et al., 1998). The work undertaken for this study reviewed the ELC communities mapped for a portion of the TDSPSA by LGL (2008), leading to a refinement of some vegetation community boundaries and a revision of the ELC vegetation community names, to follow the naming protocols in Lee et al. (1998). Table 3.9.2 provides a list of all ELC communities mapped in Figure 3.3.1 and shows the ELC names used in this report and in LGL (2008). Vegetation community boundary refinement was undertaken by Conservation Halton staff on the eastern and northern boundary of the wetland thicket (ELC community SWT2-2) associated with the pond. The boundary was staked on June 12, 2008 and then surveyed to provide the final wetland boundary as shown on Figure 3.3.1.

Forest and Savannah

Coniferous

FOC3-1 = Fresh-Moist Hemlock Coniferous Forest

This coniferous forest community is located along the upper half of a northeast facing slope along Bronte Creek. Eastern hemlock (Tsuga canadensis) dominates the canopy of the community. The canopy ranges from 10-15 m in height and covers greater than 60% of the community. Due to the dense canopy, there is no sub-canopy and very little understory. The understory primarily consists of the occasional maple-leaved dogwood (Viburnum acerifolium). The ground layer is sparsely vegetated (10-25% cover) with species such as herb-robert (Geranium robertianum) and enchanter’s nightshade (Circaea lutetiana ssp. canadensis), and bluestem goldenrod (Solidago caesia).
### Table 3.9.2. Tremaine and Dundas Secondary Plan Subwatershed Study Ecological Land Classification Vegetation Communities with Cross-Reference to Nomenclature Used by LGL (2008)

<table>
<thead>
<tr>
<th>ELC</th>
<th>ELC Vegetation Community Name</th>
<th>ELC (LGL 2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest/Savannah Communities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOC3-1</td>
<td>Fresh-Moist Hemlock Coniferous Forest</td>
<td>*n/a</td>
</tr>
<tr>
<td>FOM6-1</td>
<td>Fresh-Moist Sugar Maple – Hemlock Mixed Forest</td>
<td>FOMM6-1</td>
</tr>
<tr>
<td>FOD2-2</td>
<td>Dry-Fresh Oak – Hickory Deciduous Forest</td>
<td>FODM2-2</td>
</tr>
<tr>
<td>FOD2-4</td>
<td>Dry-Fresh Oak – Hardwood Deciduous Forest</td>
<td>n/a</td>
</tr>
<tr>
<td>FOD5-2</td>
<td>Dry-Fresh Sugar Maple – Beech Deciduous Forest</td>
<td>FODM5-2</td>
</tr>
<tr>
<td>FOD5-3</td>
<td>Dry-Fresh Sugar Maple – Oak Deciduous Forest</td>
<td>FODM5-3</td>
</tr>
<tr>
<td>FOD7-2</td>
<td>Fresh-Moist Ash Lowland Deciduous Forest</td>
<td>FODM7-2</td>
</tr>
<tr>
<td>FOD9</td>
<td>Fresh-Moist Oak – Maple – Hickory Deciduous Forest</td>
<td>FODM9</td>
</tr>
<tr>
<td>TPS1</td>
<td>Dry Tallgrass Savannah</td>
<td>n/a</td>
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<tr>
<td>Wetland Communities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWT2-2</td>
<td>Willow Mineral Thicket Swamp</td>
<td>SWTM3-6</td>
</tr>
<tr>
<td>MAM2-2</td>
<td>Reed-canary grass Mineral Meadow Marsh</td>
<td>MAMM1-3</td>
</tr>
<tr>
<td>MAS2-1</td>
<td>Cattail Mineral Shallow Marsh</td>
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</tr>
<tr>
<td>SAF1-1</td>
<td>Water Lily – Bullhead Lily Floating-leaved Shallow Aquatic</td>
<td>SAS1-8</td>
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<tr>
<td>Cultural Communities</td>
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<td>Mineral Cultural Meadow</td>
<td>MEGM4-1 &amp; MEFM4-1</td>
</tr>
<tr>
<td>CUT1-4</td>
<td>Gray Dogwood Cultural Thicket Type</td>
<td>THDM2-4 (mapped as MEFM4-1)</td>
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<td>CUS1</td>
<td>Mineral Cultural Savannah</td>
<td>SVDM3</td>
</tr>
<tr>
<td>CUW1</td>
<td>Mineral Cultural Woodland</td>
<td>WODM4a/4b/4-4/4-5/5/5-5</td>
</tr>
</tbody>
</table>

Notes: *n/a indicates a community that was not mapped by LGL (2008)

Mixed

**FOM6-1 Fresh-Moist Sugar Maple – Hemlock Mixed Forest**

This mixed forest type is dominated by sugar maple (*Acer saccharum* ssp. *saccharum*) and eastern hemlock. The mixed forest is located in upland areas, typically at the crest of a slope which leads down towards Bronte Creek. The canopy is densely vegetated (greater than 60% cover) with trees which are 10-20 m in height. Some of these hemlock trees are quite large in size, ranging up to 50 cm in diameter. With the dense canopy, the sub-canopy (2-10 m) is less dense (35-60% cover) with the same species as the canopy. The understory is also quite sparse (25-35% cover) with species such as the occasional red-berried elderberry (*Sambucus racemosa* ssp. *pubens*) and tartarian honeysuckle (*Lonicera tatarica*). The ground layer is equally-sparse with 10-25% herbaceous ground cover including herb-robert, enchanter’s nightshade, and climbing nightshade (*Solanum dulcamara*). This mixed forest contributes to a large forest tract which follows the banks of Bronte Creek and provides interior forest which is habitat for area sensitive bird species (see **Section 3.9.5**). This is a sensitive community due to the large trees and interior habitat.

Deciduous

**FOD2-2 Dry-Fresh Oak – Hickory Deciduous Forest (was FODM2-2)**

Red oak (*Quercus rubra*) and shagbark hickory (*Carya ovata*) dominate this deciduous forest community. The canopy trees are 10-20 m in height and cover greater than 60% of the forest. The sub-canopy is predominantly shagbark hickory. These trees are 2-10 m in height and cover greater than 60% of the sub-canopy layer. The understory and ground layer are sparsely vegetated due to the dense canopy and sub-canopy, both covering approximately 50% of their respective layers. The understory primarily
contains sugar maple and white ash (Fraxinus americana) saplings. Large patches of the ground layer is dominated by garlic mustard (Alliaria petiolata). However, other vegetation growing in this layer include: bluestem goldenrod, false solomon’s seal (Maianthemum racemosum), and large-leaved avens (Geum macrophyllum).

**FOD2-4 = Dry-Fresh Oak – Hardwood Deciduous Forest (new community)**
This community is dominated by red oak in the canopy and sub-canopy. The canopy ranges from 10-20 m in height, while the sub-canopy trees are 2-10 m tall. Each of the canopy layers has greater than 60% tree cover. The sub-canopy consists of a variety of hardwood deciduous trees including the occasional sugar maple, American beech (Fagus grandiflora), hop-hornbeam (Ostrya virginiana), and basswood (Tilia americana). The understory and herbaceous layers have very little vegetation cover (10-25%). Such vegetation in the understory and ground layer includes witchhazel (Hamamelis virginiana), holmes’ hawthorn (Crataegus holmesiana), Pennsylvania sedge (Carex pensylvanica), bluestem goldenrod, false solomon’s seal, and poison ivy (Rhus rydbergii).

**FOD5-2 = Dry-Fresh Sugar Maple – Beech Deciduous Forest (was FODM5-2)**
This vegetation community type covers a large proportion of the southern forest tract and in the square woodlot to the east. This forest is located in dry upland areas. Sugar maple and American beech equally dominate the canopy and sub-canopy of this community. Eastern hemlock also grows occasionally in the canopy. The canopy typically ranges from 10-25 m in height and the vegetation covers greater than 70%. The sub-canopy trees range from 2-10 m in height and cover greater than 60% of that layer. Due to the dense canopy and sub-canopy, the understory is less densely vegetated with species such as tatarian honeysuckle, maple-leaved viburnum (Viburnum acerifolium), white elderberry (Sambucus canadensis), and gray dogwood (Cornus foemina ssp. racemosa). The understory cover is variable, depending on the canopy cover; the greater the canopy cover, the less vegetation growing below. Therefore, most of the understory vegetation in this community is located under canopy gaps. The ground layer is similarly variable (in terms of vegetation cover), ranging from 50-60% cover. The predominant species in the ground layer includes white lettuce (Prenanthes alba), false solomon’s seal (Maianthemum racemosum), zig-zag goldenrod (Solidago flexicaulis), and enchanter’s nightshade.

**FOD5-3 = Dry-Fresh Sugar Maple – Oak Deciduous Forest (was FODM5-3)**
This community is dominated by sugar maple in the canopy and sub-canopy. However there is also the occasional red oak and American beech in these layers. The canopy trees are 10-20 m high, and cover greater than 60% of the layer. The sub-canopy has equal coverage; however the trees in this layer are 2-10 m in height. The understory (0.5-2 m) is quite sparsely vegetated (25-35% cover) containing species such as witchhazel and tatarian honeysuckle (Lonicera tatarica). The ground layer is also sparingly vegetated with species such as wild coffee (Triosteum aurantiacum).

**FOD7-2 = Fresh-Moist Ash Lowland Deciduous Forest (was FODM7-2)**
Green ash (Fraxinus pennsylvanica) dominates this lowland forest community. Located adjacent to the pond on the site, this community has fresh to moist soils and supports vegetation species which can grow in such conditions. The canopy in this community is 10-15 m in height and covers greater than 60% of this layer. The sub-canopy is similarly dense with green ash growing 2-10 m high. The understory is
3.7 Hydraulics

The hydraulic analysis included the development of floodlines along selected reaches. Watercourses were selected based upon the watercourse definition and overall drainage area. The one-half square mile limit was a factor used in the selection of the watercourse reach for developing floodlines, but was not the sole determinant.

The objective of the hydraulic analysis is to calculate water surface elevations at selected points (cross-sections) along the watercourses for the 2, 5, 10, 25, 50, and 100-year, and Regional return period floods. Water surface elevations were calculated with the aid of a computer program called HEC-RAS. The HEC-RAS program calculates water surface profiles for steady gradually varied flow for both subcritical and supercritical flow conditions. The program requires as input the following information:

- A watercourse description;
- Energy loss coefficients;
- Flow rates; and
- Starting and ending water surface elevations.

Two watercourses within the study area were modelled. Both are tributaries to Fourteen Mile Creek. The modelled watercourses are located in the northeast corner of the Study area and in the southeast corner of the Study area.

Watercourse Description

Watercourses are described in the HEC-RAS model by a series of cross-sections and the distances separating the sections. The cross-sections are located where changes in the slope, geometry, or roughness occur. Changes in channel geometry include road and railway crossings. Each cross-section is described by a table of elevations and distances from a common point outside the flood plain. The cross-section data were input to the HEC-RAS model looking downstream with the common point for the measurement of all distances being located to the left side of the main channel.

The simulated HEC-RAS water surface elevations for the 2, 5, 10, 25, 50, and 100-year, and Regional return period storms for existing land use conditions are shown in Table 3.7.1.
sparsely vegetated (10-25% cover) with species such as green ash, riverbank grape, and red-osier dogwood (*Cornus stolonifera*). The ground layer contains a mixture of upland and wetland species such as fowl manna grass (*Glyceria striata*), poison ivy (*Rhus rydbergii*), wild mint (*Mentha arvense*), and jack-in-the-pulpit (*Arisaema triphyllum* ssp. *triphyllum*).

**FOD9 = Fresh-Moist Oak – Maple – Hickory Deciduous Forest (was FODM9)**
This forest community is located at the corner of a woodlot and is surrounded on two sides by agricultural field. This forest is dominated by three species in the canopy and sub-canopy, red oak, sugar maple, and shagbark hickory. The canopy is 10-20 m in height while the sub-canopy trees are 2-10 m. However, both canopy layers are equally dense, having greater than 60% vegetative cover. The understory (>60% cover) contains an abundance of tatarian honeysuckle and riverbank grape vine (*Vitis riparia*). The ground layer is composed mainly of herbaceous species such as Canada goldenrod (*Solidago canadensis*).

**Dry Tallgrass Savannah (TPS1)**
This globally rare vegetation community is located in two locations along the upper slopes along Bronte Creek. These are small remnant patches (each approximately 25 m²) of habitat which previously existed on these slopes. Both slopes are roughly south-facing. Adjacent to these communities are widely spaced open grown bur oak (*Quercus macrocarpa*) which were likely part of a cultural savannah community at one point, however, over time forest and non-native plant species have invaded the ground layer and have become the predominant species. Signature savannah species remain in these small patches. Such species include: seneca snakeroot (*Polygala senega*), hairy beard-tongue (*Penstemon hirsutus*), yellow pimpernel (*Taenidia integerrima*), and new jersey tea (*Ceanothus americanus*).

**Wetland Communities**

**SWT2-2 = Willow Mineral Thicket Swamp (was SWTM3-6)**
This wetland community has a total size of 1 ha and is present as several patches along the edges of the large pond on the subject property. The canopy (4-5 m) covers only 45% of the community. Such species growing in the canopy of the swamp includes heart-leaved willow (*Salix eriocephala*) and crack willow (*Salix fragilis*). However, the dominant vegetation layer in the community is the dense layer of willows in the sub-canopy (1-2 m). The dominant species in the sub-canopy are slender willow (*Salix petiolaris*), heart-leaved willow (*Salix eriocephala*), and the occasional beaked willow (*Salix bebbiana*). The sub-canopy can be very dense in areas which causes very little understory and ground layer in those areas. However, areas which have less dense willow cover contain species such as reed-canary grass (*Phalaris arundinacea*) and soft rush (*Juncus effusus*) in the understory and rice cut grass (*Leersia oryzoides*) and American bugleweed (*Lycopus americana*) in the ground layer.

**MAM2-2 = Reed-canary grass Mineral Meadow Marsh (was MAMM1-3)**
This wetland community is present in three locations. One location is a small wetland (0.1 ha) situated on one side of the bank along a section of Bronte Creek. A second location is a small wetland (0.5 ha) associated with a tributary of Fourteen Mile Creek crossing the northern corner of the property at Highway 407 and Tremaine Road. A third location is a small wetland (0.3 ha) located approximately 50 m
to the east of the large pond. Herbaceous grasses are the dominant vegetation and mainly consist of reed canary grass (*Phalaris arundinacea*). Other species growing occasionally in the canopy include joe-pye weed (*Eupatorium maculatum ssp. maculatum*), stinging nettle (*Urtica dioica*), and policeman's helmet (*Impatiens glandulifera*). The canopy vegetation covers greater than 60% of the community and grows between 0.5 to 2 m in height. Other herbaceous vegetation growing in a layer below the canopy include species such as water hemlock (*Cicuta virosa*), water parsnip (*Sium suave*), and yellow rocket (*Barbarea vulgaris*). These species sporadically cover the herbaceous layer which includes all species in the community less than 0.5 m in height. These species cover approximately 60% of the community. Along Bronte Creek this marsh contains an abundance of debris (e.g., logs and branches) which have washed up from the creek. In addition, at the edge of this community (where the marsh borders the creek) the ground is stony/rocky with very little vegetation growing among the rocks. Along the Fourteen Mile Creek tributary portions of this community have a substrate which consists of large, angular armour stone.

**MAS 2-1 = Cattail Mineral Shallow Marsh**

This small wetland (0.4 ha), located at the western corner of the intersection of Tremaine Road and Dundas Street, is a cattail shallow marsh. This marsh follows a wet swale which runs through an agricultural field. The canopy is dominated by narrow-leaved cattail (*Typha angustifolia*), as well as the occasional purple loosestrife (*Lythrum salicaria*) and wild teasel (*Dipsacus fullonum ssp. sylvestris*). The canopy covers greater than 60% of the community and the vegetation in this layer is 0.5-1 m in height. Vegetation growing below the canopy primarily consists of species such as lance-leaved aster (*Symphyotrichum lanceolatum*), tall goldenrod (*Solidago altissima*), and purple-stemmed aster (*Symphyotrichum puniceum*). However there are also a variety of non-native cultural species located near the edges of this community, including yellow sweet clover (*Melilotus officinalis*), chicory (*Cichorium intybus*), and butter-and-eggs (*Linaria vulgaris*).

**SAF1-1 = Water Lily – Bullhead Lily Floating-leaved Shallow Aquatic**

The entire open water area of the pond (2.7 ha) is classified as a shallow aquatic wetland with the occasional floating-leaved plant growing near the edge of the pond. Such aquatic vegetation includes water lily (*Nymphaea odorata*) and bullhead lily (*Nuphar variegata*). This vegetation covers 25-35% of the community.

**Cultural Communities**

**CUM1 = Mineral Cultural Meadow**

This meadow community has been influenced in the past by a human cultural disturbance. This has caused a greater number of non-native species to grow within the meadow. The canopy of the community contains a variety of species such as smooth brome (*Bromus inermis ssp. inermis*), quack grass (*Elymus repens*), teasel (*Dipsacus fullonum ssp. sylvestris*), and wild carrot (*Daucus carota*). The canopy layer covers greater than 60% of the community and ranges from 0.5 to 1 m in height. The understory contains an abundance of herbaceous species such as bittersweet nightshade (*Solanum dulcamara*), field bindweed (*Convolvulus arvensis*), and redtop (*Agrostis stolonifera*). The understory
includes all vegetation under 0.5 m in height and this vegetation covers greater than 60% of the meadow community.

**CUT1-4 = Gray Dogwood Cultural Thicket Type (was THDM2-4)**
This community is highly variable in terms of which vegetation layer is the dominant form. The majority of the community is dominated by densely-growing grey dogwood (*Cornus foemina* ssp. *racemosa*), however dispersed between these dense patches of shrubs is a dense layer of herbaceous species. There is also a small woodland inclusion in the northeast corner of this community. The predominant species in this woodland include shagbark hickory, basswood, and white elm. In addition to grey dogwood in the canopy (1-2 m), there is also an abundance of holmes' hawthorn. The understory (0.5-1 m) is densely vegetated with an abundance of grey dogwood as well as smooth brome (*Bromus inermis*), wild teasel (*Dipsacus fullonum* ssp. *sylvestris*), and wild carrot (*Daucus carota*). The ground layer (less than 0.5 m) contains an abundance of Kentucky bluegrass (*Poa pratensis*) and poison ivy, as well as a variety of other herbaceous meadow species.

**CUS1 = Mineral Cultural Savannah (was SVDM3)**
The cultural savannah is dominated by black walnut (*Juglans nigra*) in the canopy and sub-canopy. Both the canopy (2-4 m) and sub-canopy (1-2 m) are very sparsely vegetated, each having approximately 10-35% cover. Also growing in the sub-canopy is the occasional red-osier dogwood shrub. The understory (0.5-1 m) is densely vegetated with grasses such as smooth brome and reed-canary grass. The ground layer contains an abundance of non-native herbaceous species such as common milkweed (*Asclepias syriaca*), rough-fruited cinquefoil (*Potentilla recta*), and cow vetch (*Vicia cracca*).

**CUW1 = Mineral Cultural Woodland**
There are a variety of cultural woodland communities on the subject property. These vegetation types include:

- Black Walnut Deciduous Cultural Woodland;
- Black Walnut – Hawthorn Deciduous Woodland;
- Ironwood – Trembling Aspen Deciduous Cultural Woodland; and
- Ash Deciduous Cultural Woodland.

These woodland communities essentially contain the same understory and ground layer vegetation. However the canopy and sub-canopies contain different abundances and dominance of tree species. This dominance is reflected in the name of the community (i.e., black walnut, black walnut and hawthorn, or ironwood and trembling aspen) however, the canopy cover and height in these communities is all relatively the same, 35-60% cover and 10-15 m high. The understory and ground layer are both densely vegetated with species such as those found in cultural meadow communities. Such vegetation includes grey dogwood, red-osier dogwood, Kentucky bluegrass, smooth brome, Canada goldenrod (*Solidago canadensis*), wild carrot, and wild teasel.

**Hedgerows**
There are 16 hedgerows present within the study area and hedgerow numbering follows the format used by LGL (2008). Tree species lists for hedgerows are available in Appendix A of LGL (2008). For this
report five hedgerows (H4, H5, H6, H7, and H8) are identified as significant hedgerows based on the dominant mature, healthy native hardwood tree species present, including: bur oak (*Quercus macrocarpa*); red oak (*Quercus rubra*); sugar maple (*Acer saccharum*); bitternut hickory (*Carya cordiformis*); shagbark hickory (*Carya ovata*); and white ash (*Fraxinus Americana*) (see Figure 3.3.1). LGL (2008) did not identify hawthorn (*Crataegus spp.*) species in hedgerows. Therefore plant samples were taken from hedgerows dominated by mature, healthy hawthorn trees and sent to Dr. James Phipps, University of Western Ontario, to obtain accurate species determinations and to verify if provincially rare hawthorn species were present. Results showed the hawthorns present within hedgerows of the TDSPSA are three common species: *Crataegus holmesiana*; *Crataegus punctata*, and *Crataegus pruinosa*.

### 3.9.1 Floristics

A total of 292 plant species was noted on the site. A complete list of plant species can be found in Appendix B, Table B-1. This includes 206 native species (70.5%), 76 non-native species (26%), and 10 (3.5%) unknown species that were only identified to genus. Table 3.9.3 provides statistics that indicate the quality of the flora on the site. The proportion of native plants indicates the amount of disturbance within the plant community, as non-native plants tend to invade disturbed plant communities. A high Floristic Quality Index (FQI) and Native Mean Coefficient of Conservatism (Native Mean C) indicate the tendency of the species within a plant community to require specific habitats. The FQI is derived from the assignment of a number between 1 and 10 to each native plant according to its habitat requirements (the Coefficient of Conservatism). Plants found in a diversity of habitats have low scores (1), and plants found only in a few, highly specific habitats have high scores (10). The scores are averaged to obtain the Native Mean C and summed and divided by the square root of the number of species to obtain the FQI. Therefore, very high quality habitats with a high diversity of species have higher FQIs and mean Coefficients of Conservatism (mean Cs). FQI and Native Mean C is not calculated for communities with less than 30 species as there are not enough species to provide an accurate measurement of the floristic quality of the site.

The highest vegetation quality, as indicated by the lowest proportion of non-native plants and the highest FQI and Mean C, is found within the deciduous forest and meadow marsh communities. In addition to floristic quality, other factors such as community age or rarity can indicate a significant community within the study area. For example, even though the mixed forest community has low species diversity, it should be noted that it is a significant community in the study area due to the mature hemlock trees, many of which are greater than 50 cm in diameter. In addition, there are small pockets of remnant savannah communities, which are located in two small areas along top of the slopes surrounding Bronte Creek (Figure 3.3.1). Few species are recorded for this community type due to the small size of the patches, however it is a globally rare vegetation community, and as such is also of great significance within the study area.

The vegetation community with the lowest quality on the site is predominantly the cultural communities (meadow, thicket, woodland) however; the thicket swamp around the pond also has a low floristic quality.
Table 3.9.3. Floristic Quality Analysis of the TDSPSA

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<th>Native Mean C</th>
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<td>141</td>
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3.9.2 Wildlife

In addition to the site visits conducted by LGL in 2007, North-South conducted site visits on several occasions throughout the spring and summer of 2008 (see Table 3.9.1). In 2008 the first visit was conducted on May 28 to survey the large pond on the site for breeding amphibians. This was an evening visit beginning at 9:00 p.m. and ending at approximately 10:30 pm, conducted in mild temperatures with little wind, as recommended by Canadian Wildlife Service Marsh Monitoring protocols (Canadian Wildlife Service, 2008).

The focus for the amphibian survey was on those frogs that migrate between aquatic and terrestrial environments such as spring peepers, as these species require protection of functional ecological linkages between aquatic and terrestrial habitat that may be impacted by development. Additional surveys were not undertaken to record bullfrog, a more strictly aquatic species and green frog which are more tolerant of development.
Three visits were conducted to obtain information on bird species within the study area. The visits occurred on June 16, June 8, and (as soon as permission was obtained to enter the eastern portion of the site) on July 16. The first two visits were within the recommended time period for breeding bird abundance surveys recommended by Canadian Wildlife Service protocols (May 24 to July 10), and the third visit was within the time period recommended for collecting evidence of breeding (Bird Studies Canada, 2001).

Ninety-six wildlife species were noted in the TDSPSA: 75 bird species; 12 mammals; five amphibians; and four reptiles. Reptiles and amphibians were associated mainly with the pond on the central part of the property. Mammal species were noted throughout the property, except for beaver, which was associated with the pond. Birds occurred in all vegetation types throughout the property. A complete list of animal species can be found in Appendix B, Table B-2.

Results provided in this Subwatershed Study are primarily from surveys conducted during the course of this study. However, where relevant, results from previous surveys on the property in 2007 (LGL, 2008) are also provided.

**Amphibians**

Surveys for breeding amphibians were conducted on the pond on May 28, 2008, a date when gray treefrogs, green frogs, a few spring peepers, and bullfrogs are most likely to be vocalizing. Only one individual gray treefrog and one spring peeper were heard. However, because of the timing of this study, the survey was conducted past the main period of breeding for early- to mid-season breeders, such as spring peeper and wood frog.

One spring peeper was heard adjacent to a small area of meadow marsh (which showed evidence of occasional standing water) in the smaller, square woodlot between Bronte Creek and Tremaine Road (these small meadow marshes are shown in Figure 3.3.1). It is possible that small numbers of spring peepers may occasionally attempt to breed in these small marshes when they are full of water in the earliest part of the spring. However, standing water was not present in any of the marshes at the time of the field survey (July 17), indicating that these small areas likely dry up too soon in most years to provide important breeding habitat for amphibians.

LGL (2008) also recorded the four amphibians noted above and their earlier field survey recorded an additional amphibian specier, wood frog.

**Reptiles**

Occasional snapping turtles were noted adjacent to the pond, and two painted turtles were noted basking on logs and rocks at the pond edge. Garter snakes were noted in forest along Bronte Creek. Snakes are cryptic and elusive, and were likely overlooked in this study. It is likely that other common snake species inhabit this area, such as Dekay’s snake and eastern smooth green snake. LGL (2008) recorded Dekay’s snake.
Birds

The 75 bird species recorded represent the most diverse group of fauna noted on the site, with 53 of the 55 species noted by North-South considered at least possible breeding species. Two of the species observed were likely only foraging on the site (black-crowned night heron and great blue heron) as these species generally nest in colonies and no evidence of colonial breeding was found.

3.9.3 Wildlife Habitat Characteristics

The largest proportion of bird species was associated with deciduous and mixed forest along Bronte Creek (Table 3.9.4). However, large species numbers were also associated with the pond, as well as successional forests (cultural meadow and cultural thicket) at the south end of the study area. The fewest species were observed in cropland.

Late-successional vegetation occurred mainly at the south end of the site, east of Bronte Creek, surrounding the industrial development north of Dundas Avenue. This habitat consisted of abundant young trees. Smaller linear patches of successional habitat were found at the edges of the forest along Bronte Creek.

<table>
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<th>Habitat</th>
<th>Number of Bird Species</th>
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</thead>
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<tr>
<td>Cropland</td>
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</tr>
<tr>
<td>Pond (including aquatic, meadow marsh and thicket swamp)</td>
<td>29</td>
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<tr>
<td>Bronte Creek Valley Forest (including deciduous and mixed forest)</td>
<td>36</td>
</tr>
</tbody>
</table>

The most common species noted in cultural vegetation were those adapted to a wide variety of forested habitats, including small patches of forest, forest edges and hedgerows, including indigo bunting, house wren and American robin. A few common species were present that are adapted specifically to successional habitat, such as eastern kingbird.

Cultural Meadow/Cultural Thicket

Vegetation in an earlier stage of succession (more open, with fewer trees and more shrubs) is concentrated at the north end of the study area south of Highway 407, adjacent to the hydro line, because it is associated with the woodland edge, the hydro line and the edge of the railway. Several birds specific to successional habitat were noted in this location. Field sparrow, one of the few species of conservation priority interest specific to successional habitat, was noted near the hydro line, as well as in open thicket on the west side of the creek outside the study area. Orchard oriole, a species restricted to southern Ontario successional habitats, was also noted here. Species of conservation priority interest
are discussed in Section 3.9.5. One provincially significant species (also restricted to southern Ontario successional habitats), yellow-breasted chat, was observed in successional habitat in this area.

**Cropland**

Cropland consisted of open ploughed fields surrounded by hedgerows. This type of habitat supported the fewest species within the study area. There were no species noted in cropland that are specific to open habitats; most species noted in this habitat were associated with hedgerows.

**Meadow Marsh, Thicket Swamp and Cultural Woodland Associated with Pond Habitat**

This habitat consisted of a pond, dominated by floating-leaved aquatic species, rimmed by willows and scattered large trees. The complex of habitats around the pond supported a diversity of adaptable species adapted to successional habitat and small forests (such as American robin) but also supported species specific to successional habitat (yellow warbler, yellow-billed cuckoo and least flycatcher, both the latter being species of conservation concern) and several species adapted to wetland habitat. Species generally associated with wetlands were common yellowthroat, willow flycatcher, alder flycatcher, and northern rough-winged swallow. The pond was used by swallow species for foraging and nesting, as there was evidence that they were using holes in the steep bluff at the outlet of the pond. Some species were also nesting in cavities in dead trees next to the pond. The EIS (LGL, 2008) noted wood duck associated with the pond, a species that also uses cavities for nesting. Black-crowned night heron and great blue heron were also noted foraging at the edge of the pond.

**Forest**

A wide band of forest is present along the slopes leading to Bronte Creek, and also in as a square tableland woodlot located to the east, between the Bronte Creek corridor and Tremaine Road. The forest was relatively mature, with a rich diversity of understory species and a well-stratified canopy and subcanopy. A trail along the creek though this forest was heavily used, with portions disturbed by mountain bikes. Most of the forest consisted of deciduous species, interspersed with occasional coniferous trees. A patch of coniferous (hemlock) forest in the centre of the riparian corridor contained trees that were unusually tall, with a much sparser understory. Mountain bike paths were more frequent within the hemlock forest as bikers looped throughout the area.

Bird species noted in the riparian corridor included a diversity of species, both those adapted to small and large patches and woodland edges (such as American robin) and also those more specifically associated with extensive tracts of mature forest, such as scarlet tanager, hairy woodpecker, black-throated green warbler and brown creeper. These species are shown in Figure 3.3.1. Many of these forest area-sensitive species were associated with the northern part of the forest, possibly because it is more mature and less disturbed by urban influences than forests along the creek near Dundas Avenue.
3.9.4 Significant Species

Significant species are plant or animal species at greater risk from the impact of land use change and development. They are species that are known to have declining populations and/or which have more demanding habitat requirements. For these reasons where significant species are known to be present a greater effort is made to ensure the protection of their habitat, and where possible recommendations are made to enhance areas of degraded habitat. These actions are intended to increase the survivorship of future populations. In Ontario significant species may be protected by the Endangered Species Act (2007) and by the Provincial Policy Statement (2005). The management strategy in Section 5.0 considers long-term protection for significant species through the development of a NHS for the TDSPSA.

Provincially Significant Species

A yellow-breasted chat was noted just south of Highway 407, in open habitat dominated by open-grown oak trees near the hydro line, along the creek corridor. This species is considered a Species at Risk, with a status of Special Concern, both federally and provincially. It is associated with regenerating old fields, forest edges, railway and hydro rights-of-way, young coniferous reforestations, and occasionally wet willow-ash-elm thickets bordering wetlands. It avoids mature forest and open grassland. It is generally restricted to the southern part of the province, being found during the most recent breeding bird atlas studies only in the Carolinian region in 27 squares in eight 100 m blocks, an 86% reduction over its distribution indicated by the first Ontario breeding bird atlas from 1981 to 1985. Atlas data indicated a population of approximately 42 to 50 pairs (Cadman et al., 2007).

Butternut is tree species listed as Endangered by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and by MNR and the Committee on the Status of Species At Risk in Ontario (COSSARO). In Ontario butternut is protected by the Endangered Species Act (2007). The approximate location where individual butternut trees were recorded is shown on Figure 3.3.1.

Species of Conservation Concern

Eight bird species noted on the site are considered area-sensitive. Area sensitive species can be indicators of Significant Wildlife Habitat that would be protected under the Provincial Policy Statement (2005) (MNR, 2000). They are generally associated with large tracts of habitat and have therefore become rarer in southern Ontario because of habitat fragmentation. Most of these are species of extensive mature forest. However, two of the bird species are associated with other habitats: alder flycatcher is associated with wetland thickets; and least flycatcher is associated with open woodlands.

Snapping turtle, recorded within the site adjacent to the pond, has been listed by the COSEWIC as a species of Special Concern in November 2008. The MNR and COSSARO have not yet made a recommendation for listing snapping turtle in Ontario. The presence of snapping turtle suggests the presence of a diverse, healthy environment. It also emphasizes the need to protect environments such as this because of the habitat they provide for significant species such as snapping turtle. The pond and adjacent areas are part of the Greenbelt NHS. These are areas that will be protected and will help to
prevent further population declines that may result in snapping turtles being listed as threatened or endangered.

**Species of Conservation Priority Interest**

Fourteen species are considered local species of conservation priority interest in Halton Region (Couturier, 1999). These species are designated on the basis of a scoring system that sums individual scores for a number of factors that have been found to be associated with a species’ future presence in the landscape, including population trends, habitat specificity, area-sensitivity and reproductive capacity, as well as the region’s jurisdictional responsibility for the species. **Table 3.9.5** shows an analysis of the habitat of species of the three (of five) highest ranks of conservation priority in the study area (L1 to L3). As might be expected, two species are associated with mature forest habitat (many of these are area-sensitive species). However, seven of the species are associated with more open habitats.

**Table 3.9.5. Breeding Species of Conservation Priority within the Study Area**

<table>
<thead>
<tr>
<th>Species</th>
<th>Conservation Priority L1 to L3</th>
<th>Habitat in Southern Ontario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black-billed Cuckoo</td>
<td>L2</td>
<td>Cultural woodland, young forest</td>
</tr>
<tr>
<td>Yellow-billed Cuckoo</td>
<td>L3</td>
<td>Cultural woodland, young forest</td>
</tr>
<tr>
<td>Eastern Phoebe</td>
<td>L3</td>
<td>Forest and forest edge, often near water</td>
</tr>
<tr>
<td>Northern Rough-winged Swallow</td>
<td>L2</td>
<td>Cavities in banks, occasionally bridges; forages in open areas</td>
</tr>
<tr>
<td>Bank Swallow</td>
<td>L2</td>
<td>Cavities in banks, forages in open areas</td>
</tr>
<tr>
<td>Brown Creeper</td>
<td>L2</td>
<td>Forests; area-sensitive</td>
</tr>
<tr>
<td>Mourning Warbler</td>
<td>L2</td>
<td>Shrubby riparian areas</td>
</tr>
<tr>
<td>Yellow-breasted Chat</td>
<td>L1</td>
<td>Shrubby successional areas</td>
</tr>
<tr>
<td>Scarlet Tanager</td>
<td>L2</td>
<td>Mature deciduous and mixed forest</td>
</tr>
<tr>
<td>Field Sparrow</td>
<td>L3</td>
<td>Shrubby fields</td>
</tr>
</tbody>
</table>

**Species rare in Halton Region**

The rarity status of fauna and flora in Halton Region was based on data in the Halton Natural Areas Inventory (Dwyer 2006). The HNAI identifies species considered rare (HR) which are known from five or fewer sites, species considered uncommon (HU) are known from six to fifteen sites, and species potentially rare or uncommon (H?) which require further review.

Within the TDSPSA twenty-four plant species and nineteen bird species have a HNAI rarity status (see **Appendix B, Table B-1 and Table B-2**)

**3.9.5 Significant Wildlife Habitat**

The *Provincial Policy Statement* (2005) protects the features and functions of significant wildlife habitat from the negative impacts of development. The significance of wildlife habitat is based on the ecological importance of features and functions and their contribution to a NHS. The *Natural Heritage Reference*
Manual (MNR, 1999) and the Significant Wildlife Habitat Technical Guide (MNR, 2000) provide guidance in identifying significant wildlife habitat to be protected from development. As with significant species, long-term protection of significant wildlife habitat is achieved through the development of a NHS for the TDSPSA.

Bronte Creek Corridor

The Bronte Creek corridor is one of the most significant blocks of wildlife habitat in southern Ontario, both in terms of its connectedness with the landscape both to the north and to the south, and in terms of its size and diversity. The size and connectedness of the Bronte Creek corridor lends additional value to the adjacent habitats within the TDSPSA, a value that is enhanced by what is currently a relatively permeable landscape adjacent to the Bronte Creek corridor that allows species movement among the remaining natural areas. For example, the square block of forest surrounded by agricultural fields sustained at least one species, spring peeper, which is dependent on both forest and standing water (located in the nearby pond) and is vulnerable when crossing open areas. The forest block also provides habitat for scarlet tanager, a forest area-sensitive species that is generally associated with larger tracts of forest but will also incorporate smaller patches into its home range within agricultural areas. The ability of natural areas within the agricultural landscape to support significant biodiversity was also borne out of an EIS carried out by LGL (2008), which noted that there is a large number of breeding bird species representing a diverse group of habitats within their study area, which incorporated the eastern portion of the TDSPSA.

Pond and Wetland Habitat

The variety of habitats associated with the pond (open water, graminoid and shrub-thicket wetland, and adjacent woodlands) make this one of the most critical areas for breeding birds, as well as contributing to foraging habitat for species such as swallows and herons. It is also a significant habitat for early-breeding amphibians which require forested areas as well as ponds to complete their life cycle. Surveys for breeding amphibians (LGL, 2008) were conducted earlier than those carried out as part of this study, during the optimum time to detect spring peepers (April 28, 2007). LGL Limited (2008) noted the highest level of calling activity for spring peepers in the pond (abundance code 3 according to Canadian Wildlife Service Marsh Monitoring Protocols, indicating calls too numerous to count). This survey noted only a few wood frogs, but this species is one of the earliest breeding frogs in Ontario, and is an “explosive” breeder, usually completing its breeding cycle very quickly only a few weeks after snow melt in late March. It is likely that the main period for breeding activity of early breeding amphibian species was missed by both the 2007 and 2008 surveys. The pond in the central part of the site is considered an important breeding site for spring peepers, and is likely important for earlier-breeding species such as wood frog as well. Spring peepers and wood frogs both require woodlands as well as ponds to complete their life cycle. During a daytime site visit in July it was noted that green frogs were abundant in the pond. Green frogs are an adaptable species that inhabit a wide variety of habitats such as SWM ponds. The pond also provides critical open water habitat for snapping turtle, designated a species of concern by COSEWIC.
Successional Habitats

The connectedness and abundance of successional habitat within the study area has also contributed to a high diversity and abundance of wildlife species. Successional habitat includes areas that have likely been maintained as open areas by natural, as well as human-made disturbances. The persistence of prairie remnants and the open grown structure of some oak and hickory trees within the TDSPSA (along the top of the Bronte Creek valley), indicates that portions of the study area were historically more open savannah ecosystems, likely maintained by fire, possibly due in part to the rail line that at one time had steam locomotives known throw sparks and set fires along rail lines. A number of species with requirements for successional habitat were recorded, including two bird species, orchard oriole and yellow-breasted chat, that are restricted to the southern part of the province and which have highly specific requirements for successional habitat. One species, the yellow-breasted chat, is a provincially significant Species at Risk, with a status of Special Concern.

Maintaining the connectedness of all habitats within the TDSPSA will be critical to maintaining the diversity of species within these habitats. In addition, it is important to maintain more open successional habitats within the TDSPSA, particularly at the north end of the area within the vicinity of the Bronte Creek corridor. Of particular importance will be the maintenance of corridors that enhance and broaden hedgerows associated with Bronte Creek, the pond and the woodlot located within the agricultural fields as an effective strategy protecting the ecological features and functions associated with these habitats.

3.9.6 Aquatic Resources

Four watercourses occur within the study area, including Bronte Creek, two tributaries to the west branch of Fourteen Mile Creek, and a pond. The aquatic resources of Bronte Creek are well documented (see Conservation Halton, 2002) and characterization of the two Fourteen Mile Creek tributaries has been undertaken for reaches downstream of the study area (see Philips, 2002; TSH et al., 2006a). Aquatic habitat and communities within the study area are discussed by LGL (2008).

Site specific aquatic habitat surveys were undertaken for the Fourteen Mile Creek tributaries and the pond on June 12, July 9, and September 4, 2008. Due to the fact that the aquatic resources of Bronte Creek are well documented, no site specific surveys of that watercourse were undertaken. There are several surface drainage features within the TDSPSA. These features provide runoff for agricultural fields during spring snowmelt and heavy rainfall events, and do not provide aquatic habitat.

Bronte Creek

Bronte Creek is situated along the south-western edge of the study area and is the largest watercourse, with a watershed area of approximately 312 km². It consists of ten subwatersheds and extends across portions of the Halton Region (City of Burlington, Town of Oakville, and Town of Milton), the City of Hamilton (formerly Region of Hamilton-Wentworth) and Wellington County (Puslinch Township).

Coldwater habitats which support resident salmonids, including brook trout (Salvelinus fontinalis), brown trout (Salmo trutta) and rainbow trout (Oncorhynchus mykiss), are typically associated with portions of
the watershed flowing through the well-vegetated, coarse-grained physiographic features along, or lying above, the Niagara Escarpment (Conservation Halton, 2002). Warmwater habitat conditions are generally associated with portions of the watershed flowing through the sparsely vegetated, finer-textured till plain features located below the Escarpment.

Two fish species at risk, redside dace (*Clinostomus elongatus*) and silver shiner (*Notropis photogenis*), are present within the Bronte Creek watershed. Redside dace are reported from Bronte Creek, upstream of Progreston, while silver shiner is common in the lower reaches of Bronte Creek (Conservation Halton, 2002). Redside dace and silver shiner are designated nationally as Endangered and of Special Concern, respectively (COSEWIC, 2007). Provincialy redside dace and silver shiner are assigned a status of Threatened and Special Concern, respectively (MNR, 2008).

Within the study area, Bronte Creek has been classified as providing warmwater sportfish habitat with high aquatic ecosystem health (Conservation Halton, 2002). This portion of Bronte Creek supports a diverse resident warmwater fish community and provides a migratory corridor/spawning area for Lake Ontario salmonids. Runs of rainbow trout occur from early to mid-spring while chinook salmon (*Oncorhynchus tshawytscha*) and brown trout migrate upstream through the fall. Young-of-the-year rainbow trout have also been observed through this reach; however it is likely that high in-stream temperatures during the summer months limit juvenile production. Other species migrate from Lake Ontario into Bronte Creek to spawn during mid to late-spring include white sucker (*Catostomus commersonii*) and smallmouth bass (*Micropterus dolomieu*).

Bronte Creek supports a high diversity within its lower reaches with 44 species reported between 1990 and 2002 (Table 3.9.6). Common resident species include Northern Hog Sucker (*Hypentelium nigricans*), River Chub (*Nocomis micropogon*), Rock Bass (*Ambloplites rupestris*), Pumpkinseed (*Lepomis gibbosus*), Common Shiner (*Luxilus cornutus*), Bluntnose Minnow (*Pimephales notatus*) and Creek Chub (*Semotilus atromaculatus*). The Silver Shiner has been collected from Bronte Creek within the study area, in addition to reaches upstream and downstream (Conservation Halton, 2002).

**Fourteen Mile Creek Tributaries**

Fourteen Mile Creek is a direct tributary of Lake Ontario and drains a watershed area of approximately 40 km$^2$. It is comprised of several tributaries, including west, east and main branches, which generally originate north of Highway 407 ETR. Two tributaries to the west branch of Fourteen Mile Creek (Reaches 14W-17, 14W-17Ca and 14W-17Cb) occur within the study area (see Figure 1.1.1).

The tributary situated at the southeastern corner of the property (Reaches 14W-17Ca and 14W-17Cb) is intermittent and was found to be dry during each of the three site surveys. A pool of water was observed just upstream of the property boundary during the June site visit, but this pool was dry during July and September. Reach 14W-17Ca, upstream of the existing laneway, does not have a defined channel and is ploughed and planted. Reach 14W-17Cb does have a defined stream bed and appears to convey enough water, at least during certain periods of the year, to prevent vegetation from growing in the channel. Although this portion of the watercourse provides no direct aquatic habitat within the study area, it has a medium constraint classification. Downstream of the study area the watercourse has been characterized as intermittent with much of its length channelized or straightened, and providing no fish...
habitat (Philips, 2002). An online pond occurs within the lower reaches of this tributary and the outlet control structure has been identified as a barrier to upstream fish migration.

Reach 14W-17, at the northeast corner of the property, is perennial. Water was observed during all three surveys but baseflow was found to be little more than a trickle on each occasion. Along the property, the channel is undefined, completely overgrown with terrestrial vegetation with no visible surface water flow. However, isolated pools occurred below the culverts at Tremaine Road and Highway 407. Spot water temperatures measured in the early afternoon during the surveys were <20°C (e.g., 17.5, 19.6 and 18.2°C), while air temperatures were generally >25°C. Fish were sampled by electrofishing within each of the pools. Adult and juvenile brook stickleback (*Culaea inconstans*), juvenile fathead minnow (*Pimephales promelas*) and young-of-the-year white sucker were collected from the pool downstream of the Tremaine Road crossing. No fish were found at this location in April 2003 by the MNR (MNR, 2003). Adult and juvenile creek chub and adult brook stickleback were collected from the pool downstream of and within the culvert below Highway 407. Within the TDSPSA, this tributary provides important aquatic habitat and has a medium constraint classification. Downstream of the study area the watercourse has been classified as warmwater baitfish/forage fish and characterized as medium constraint with marginal to important aquatic habitat (TSH *et al.*, 2006a). Similar to the study area, the west branch flows through agricultural fields and aquatic habitat consists primarily of a channel inhabited by terrestrial vegetation and isolated pools downstream of Tremaine Road. The substrate consists of silt and muck and the channel is undefined with little to no buffer. In some areas, tributaries of the west branch are channelized. In the lower reaches near Dundas Street, the aquatic habitat substantially improves.
Table 3.9.6.  Fish Species Reported from Lower Bronte Creek 1990-2002

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>sea lamprey</td>
<td>Petromyzon marinus</td>
</tr>
<tr>
<td>alewife</td>
<td>Alosa pseudoharengus</td>
</tr>
<tr>
<td>gizzard shad</td>
<td>Dorosoma cepedianum</td>
</tr>
<tr>
<td>spotfin shiner</td>
<td>Cyprinella spioptera</td>
</tr>
<tr>
<td>common carp</td>
<td>Cyprinus carpio</td>
</tr>
<tr>
<td>striped shiner</td>
<td>Luxilus chrysocephalus</td>
</tr>
<tr>
<td>common shiner</td>
<td>Luxilus comutus</td>
</tr>
<tr>
<td>hornypead chub</td>
<td>Notonemus biguttatus</td>
</tr>
<tr>
<td>river chub</td>
<td>Notonemus micropogon</td>
</tr>
<tr>
<td>emerald shiner</td>
<td>Notonemus atherinoides</td>
</tr>
<tr>
<td>spottail shiner</td>
<td>Notonemus hudsonius</td>
</tr>
<tr>
<td>silver shiner</td>
<td>Notonemus photogenis</td>
</tr>
<tr>
<td>rosyface shiner</td>
<td>Notonemus rubellus</td>
</tr>
<tr>
<td>bluntose minnow</td>
<td>Pimephales notatus</td>
</tr>
<tr>
<td>fathead minnow</td>
<td>Pimephales promelas</td>
</tr>
<tr>
<td>eastern blacknose dace</td>
<td>Rhinchthys atratulus</td>
</tr>
<tr>
<td>longnose dace</td>
<td>Rhinchthys cataractae</td>
</tr>
<tr>
<td>western blacknose dace</td>
<td>Rhinchthys obtusus</td>
</tr>
<tr>
<td>creek chub</td>
<td>Semotilus atromaculatus</td>
</tr>
<tr>
<td>white sucker</td>
<td>Catostomus commersonii</td>
</tr>
<tr>
<td>northern hog sucker</td>
<td>Hypentelium nigricans</td>
</tr>
<tr>
<td>shorthead redhorse</td>
<td>Moxostoma macrolepidotum</td>
</tr>
<tr>
<td>brown bullhead</td>
<td>Ameiurus nebulosus</td>
</tr>
<tr>
<td>stoncat</td>
<td>Noturus flavus</td>
</tr>
<tr>
<td>tadpole madtom</td>
<td>Noturus gurnius</td>
</tr>
<tr>
<td>coho salmon</td>
<td>Oncorhynchus kisutch</td>
</tr>
<tr>
<td>rainbow trout</td>
<td>Oncorhynchus mykiss</td>
</tr>
<tr>
<td>chinook salmon</td>
<td>Oncorhynchus tshawytscha</td>
</tr>
<tr>
<td>atlantic salmon</td>
<td>Salmo salar</td>
</tr>
<tr>
<td>brown trout</td>
<td>Salmo trutta</td>
</tr>
<tr>
<td>trout-perch</td>
<td>Percopsis omiscomaycus</td>
</tr>
<tr>
<td>brook stickleback</td>
<td>Culaea inconstans</td>
</tr>
<tr>
<td>threespine stickleback</td>
<td>Gasterostes sculeatus</td>
</tr>
<tr>
<td>rock bass</td>
<td>Ambloplites rupestris</td>
</tr>
<tr>
<td>green sunfish</td>
<td>Lepomis cyanellus</td>
</tr>
<tr>
<td>pumpkinseed</td>
<td>Lepomis gibbosus</td>
</tr>
<tr>
<td>bluegill</td>
<td>Lepomis macrochirus</td>
</tr>
<tr>
<td>smallmouth bass</td>
<td>Micropterus dolomieu</td>
</tr>
<tr>
<td>largemouth bass</td>
<td>Micropterus salmoides</td>
</tr>
<tr>
<td>rainbow darter</td>
<td>Etheostoma caeruleum</td>
</tr>
<tr>
<td>fantail darter</td>
<td>Etheostoma frabellare</td>
</tr>
<tr>
<td>johnny darter</td>
<td>Etheostoma nigrum</td>
</tr>
<tr>
<td>yellow perch</td>
<td>Perca flavescens</td>
</tr>
<tr>
<td>logger perch</td>
<td>Percina caprodes</td>
</tr>
</tbody>
</table>
Fish species reported from the west branch of Fourteen Mile Creek include creek chub, western blacknose dace (*Rhinichthys obtusus*), white sucker, fathead minnow, brook stickleback, brown bullhead (*Ameiurus nebulosus*), and redside dace. Reside dace are designated nationally as Endangered and provincially as Threatened (COSEWIC, 2007; MNR, 2008), and are reported from the west branch of Fourteen Mile Creek in the vicinity of Dundas Street, as well as downstream (TSH et al., 2006a; Philips, 2002; MNR, 2003). These reaches are classified as having high constraints and critical aquatic habitats.

**Pond**

An approximately 2.7 ha pond is situated within the study area adjacent to Bronte Creek. The pond is fed entirely by surface water runoff from adjacent agricultural fields. There are no direct outlets from the wetland, although perennial seepage was noted from the foot the earthen berm situated at the southeast end of the pond. This seepage flows for several hundred meters within a well-defined valley to its confluence with Bronte Creek. This outlet channel is densely vegetated with jewelweed (*Impatiens capensis*) and provides marginal aquatic habitat but has a high constraint classification.

In addition, overflow from the pond, likely associated with beaver activity, has resulted in significant erosion of the Bronte Creek valley slope along the south-western edge of the pond. Presently the gully is less than 2 m from the edge of the wetland and there appears to be a high risk of slope failure.

The majority of the pond itself is shallow (<2 m) and supports dense submergent aquatic macrophytes comprised primarily of milfoil (*Myrophyllum* sp.). Dense algal blooms were observed overlying the submergent macrophyte beds during July and September. Patches of emergent macrophytes including cattail (*Typha* sp.) and bulrush (*Scirpus* sp.) occurs near the shore. Riparian vegetation is comprised of shrubs and trees. Pond sediment consists primarily of black organic silt, with a strong anaerobic odour. During the September 2008 survey, maximum observed depth was about 4 m and Secchi depth was 1.2 at 14:05. A dissolved oxygen/temperature profile was undertaken with the deepest portion of the basin. Dissolved oxygen within the top 1 m was supersaturated (>130%) and water temperature was near 24°C. At a depth of 1.5 m the water temperature was near 22°C and dissolved oxygen dropped to 22% saturation. At the 2 m depth interval, oxygen was at 7% saturation and below 2 m the water was anoxic. The water temperature at a depth of 4 m was 16°C.

Historical fisheries information relating to the pond is limited. Conservation Halton and the MNR (Aurora District) did not have any data on file. Ben Davies (Urbantech) indicated that bass (*Micropterus* sp.) were reportedly stocked by a local landowner some time in the past; however, efforts to catch any by angling during 2007 were unsuccessful. During the June 2008 survey, no bass spawning nests were visually observed along the nearshore of the pond, suggesting that bass no longer occurred the area.

Three experimental gillnets (6’ x 75’) with mesh sizes ranging from 1.5” to 5” were set in the pond at various depths for approximately 4 hours during September 2008. No fish were collected. Electrofishing along the shore of the pond also produced no fish.

Based upon the data collected, it appears that the pond does not support fish. A possible explanation for this finding relates to the high likelihood of anoxic conditions occurring throughout the entire water
column during the winter, below ice cover. If fish were introduced to the wetland, winter-kill of fish would probably occur, preventing the establishment of a fish community.

3.9.7 Ecological Linkages

Within the fragmented landscape characteristic of southern Ontario, large regional ecological corridors such as Bronte Creek form some of the most significant remaining wildlife habitat in southern Ontario. This occurs both in terms of its connectedness within the regional landscape and in terms of the size, diversity and relative lack of disturbance of the natural areas present. In addition, the size and connectedness of the high quality habitats present within Bronte Creek play an important supportive role that enhances species diversity and ecological integrity of adjacent tableland habitats.

Within the tableland areas of the study area, the existing matrix of open habitat consisting of cultural meadows, shrub thickets, hedgerows and agricultural land use with interspersed areas of woodland and wetland results in a relatively permeable landscape that facilitates species movement among the remaining habitat patches. An example of the ecological functioning of the tableland area is demonstrated by the large square block of forest (FOD 5-2) which is surrounded by agricultural land uses. This forest supports amphibian species, spring peeper and likely wood frog, that are dependent on both forest and standing water habitats. While these two habitats are separated in the landscape, seasonal movement by amphibians is facilitated by the relative permeability of the intervening agricultural land. Amphibians will therefore be one of the species vulnerable to a land use change which impedes wildlife movement between the forest block and the adjacent pond and Bronte Creek corridor.

Maintaining the connectedness of the habitat patches is critical to long-term ecological functioning and integrity essential to maintaining the diversity of species within all habitats. Maintaining functional ecological linkages will rely, in part, on maintaining existing areas of open habitat that is currently present between areas of tableland woodland and the Bronte Creek corridor and maintaining and enhancing the more significant hedgerows. Figure 3.3.1 identifies linkage corridors and significant hedgerows that perform ecological linkage functions.

3.10 Water Quality

The site drains to two watersheds - Fourteen Mile Creek and Bronte Creek. A review of the reports from these watersheds (add reference) indicates the following:


“Results of historical data, related studies and the Bronte Creek Water Quality Monitoring Program indicate that while most water quality parameters meet MOE objectives, several are a source of concern. Based on all available data, total phosphorus and bacteria concentrations are often elevated throughout the watershed.” (Conservation Halton, 2002, p.12).

- Total phosphorus is at or above the Provincial Water Quality Objective more than 50% of the time.
- Concentrations of E. coli throughout the watershed since 1964 consistently exceed the PWQO for recreational use.
Recommendations:

- Reduce mean levels of total phosphorus
- Reduce mean levels of *E. coli*.
- Reduce sedimentation from channel erosion, urban construction sites and agricultural runoff
- Maintain and enhance riparian cover by stream plantings and watercourse buffer strips
- Promote channel morphologies that are in balance with the natural tendency of a particular reach
- Restrict livestock access to the creek
- Continue to monitor surface water quality throughout the watershed.

Fourteen Mile Creek (Fourteen Mile Creek Main and West Branches Subwatershed Plan, Philips Engineering Ltd, 2002)

- Total phosphorus is at or above the PWQO.
- Total suspended solids (TSS) and turbidity are high in runoff events
- Chlorides are generally below a reference guideline level of 250 mg/L (with 5% of samples above)
- Presence of redside dace in the watershed justifies an enhanced level of protection for stormwater management

Analysis carried out in the Oakville North Subwatershed study indicated that use of the enhanced level of stormwater facility at the end-of-pipe would meet the target of no-net increase in phosphorus loadings from pre-development conditions. This may be also achieved by a combination of source, conveyance and end-of-pipe measures (treatment train approach).

Overall it is concluded that an enhanced level protection is justified on the basis of phosphorus levels in the two receiving streams and the fishery in Fourteen Mile Creek.

### 3.11 Servicing

The TDSPSA is shown on the Halton Region Master Servicing Plan as being serviced (sanitary) into the Mid-Halton Wastewater Treatment Plant, through the City of Oakville (Urbantech, 2008; AECOM, 2009). Currently there are no connections to the sanitary sewer outfall directly adjacent to Dundas Street and Tremaine Road along the study area. However a 450 mm diameter trunk sanitary sewer constructed on Dundas Street was proposed by Capital Works Project Number 3706 (carried out by the developer of the lands as part of their proposal for residential development of the area), to connect to the existing 900 mm diameter regional trunk sanitary sewer at Colonel William Parkway (Urbantech, 2008). AECOM (2009) is considering a 250 or 375 mm trunk sewer on Dundas Street leading to the TDSPSA.

The water main pressure of the study area is located within the Halton Region water main pressure zone 3. Trunk water mains would be required. Several water mains and sanitary sewers would be constructed at locations in proximity to local watercourses. The extent of the potential impacts of these proposed works will need to be established. Furthermore, a more complete review of these crossings after obtaining the Water and Wastewater Master Plan would be required. Appropriate mitigative measures will need to be identified and implemented to address potential impacts on surface water and groundwater associated with each servicing project at the time of construction.
Additional details on the proposed sanitary and water main servicing can be found in the *Functional Water, Wastewater and Stormwater Drainage Report* (Urbantech, 2008) and the *Tremaine Road Secondary Plan – Water/Wastewater Servicing Assessment* concurrently being carried out by AECOM.

### 3.12 Characterization Summary

The existing conditions that characterize the TDSPSA, based upon background review and collected field data, are outlined in the preceding sections. This information provided the basis of the analysis (*Section 4.0*) which was carried out to further detail the subwatershed processes (function) that influence the subwatershed form as well as the potential impacts of land use and activity changes and potential management opportunities.

A brief summary of key items identified during the characterization is provided in this section.

- Drainage within the study area took two distinct forms: the well-defined, glaciated valley system of Bronte Creek and its tributary, and the poorly-defined headwater drainage network of Fourteen Mile Creek.
- Due to the undefined nature of the drainage network within the TDSPSA and the need to provide SWM targets, detailed field work was conducted on the most sensitive defined channel downstream of Tremaine Road and Dundas Street. These areas were often associated with low gradient, agricultural areas and generally showed signs of instability. A field site was also established for the tributary to Bronte Creek.
- Streams were investigated and characterized for the purpose of classification.
- Diverse high quality habitat is present along the deep and wide Bronte Creek valley which flows through the TDSPSA.
- Bronte Creek has a high aquatic ecosystem health supporting a diverse assemblage of fish, some of which are significant species.
- Natural areas along the Bronte Creek valley contribute to a regional ecological corridor.
- Areas of significant woodland are present above the Bronte Creek valley on tableland areas.
- Healthy mature hardwood trees are present within some hedgerows.
- Significant wildlife and significant wildlife habitat is present within the TDSPSA.
- The topography in the till plain of the Fourteen Mile Creek watershed is gently flat to undulating with low relief and poor to moderate drainage. Drainage in the study area has a linear pattern, likely a reflection of drainage courses developing in the lower areas in the locally fluted topography.
- The Trafalgar Moraine is located to the north of the study area.
- In general, shallow groundwater discharge occurs in areas where the water table, or potentiometric surface, is at or above ground surface. This often occurs along the edges of water bodies or in low lying areas. Groundwater flow is generally directed south-eastward towards Lake Ontario.
- Groundwater discharge has not been observed during this study. However it is judged that discharge does occur near the bottom of the Bronte Creek valley.
- There are no aquifers in the study area suitable for development of large groundwater supplies. Although wells have been established in more permeable zones in the overburden or in the upper few meters of the bedrock, well yields are low and not reliable (too low during the summer) and groundwater quality is poor.
• The available background reports recognize the need for SWM for water quantity, quality and erosion control.
• Phosphorous has been identified as a concern in receiving watercourses. Enhanced level of control is needed for water quality control.

3.13 Preliminary Subwatershed Management Goals and Considerations

The preliminary subwatershed goals are outlined Table 3.13.1. The preliminary considerations that will affect the strategy development based on the findings to date are also included.

Table 3.13.1. Preliminary Goals and Analysis Considerations Based Upon Characterization (Phase I)

<table>
<thead>
<tr>
<th>Goals</th>
<th>Preliminary Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) To minimize the threat to life and the destruction of property and</td>
<td>• Flow controls will be required to mitigate impacts to flow and flow regime conditions.</td>
</tr>
<tr>
<td>natural resources from flooding and erosion, and preserve (or re-</td>
<td>• Stream reaches with a developed valley system are minimal on site, except for the stream</td>
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<tr>
<td>establish, where possible) natural floodplain hydrologic and fluvial</td>
<td>outletting from the pond east of Bronte Creek.</td>
</tr>
<tr>
<td>geomorphologic functions.</td>
<td>• Erosion control will be needed to prevent erosion on receiving system.</td>
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<tr>
<td></td>
<td>• Unconfined and confined valley systems require protection from development.</td>
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<tr>
<td>2) To restore, protect, and enhance water quality and associated</td>
<td>• Groundwater infiltration processes and related quality are primarily influenced by soils</td>
</tr>
<tr>
<td>aquatic resources and water supplies for watercourses, including</td>
<td>of relatively low imperviousness; nonetheless the linkage between streamflows (baseflow)</td>
</tr>
<tr>
<td>their associated hydrologic and hydrogeologic functions.</td>
<td>and groundwater conditions needs to be evaluated.</td>
</tr>
<tr>
<td></td>
<td>• Aquatic conditions associated with Bronte Creek are relatively high quality and should</td>
</tr>
<tr>
<td></td>
<td>be protected.</td>
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<td></td>
<td>• Headwater streams of Fourteen Mile Creek must address both conditions in the study area</td>
</tr>
<tr>
<td></td>
<td>and the conditions that exist in the downstream reaches.</td>
</tr>
<tr>
<td></td>
<td>• Enhanced level of water quality control is needed.</td>
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<tr>
<td>3) To restore, protect, develop, and enhance the Natural Heritage,</td>
<td>• Terrestrial and wetland features will be assessed in the context of identifying a NHS</td>
</tr>
<tr>
<td>historic, cultural, recreational, and visual amenities of rural and</td>
<td>resilient to land use change and able to protect native biodiversity over the long-term.</td>
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<td>urban stream corridors.</td>
<td></td>
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</tbody>
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