Scoped Subwatershed Study, Part A: Existing Conditions and Characterization (Final Report)

Settlement Area Boundary Expansion
The Regional Municipality of Peel
Project #198127

Prepared for:

The Regional Municipality of Peel
10 Peel Centre Drive, Suite A and B, Brampton, ON L6T 4B9

1/11/2022

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Prepared for:

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10 Peel Centre Drive, Suite A and B, Brampton, ON L6T 4B9

Prepared by:

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5 Canada
T: 905-335-2353

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1.0 Introduction

The Regional Municipality of Peel (Peel Region) has initiated an Environmental Screening and Scoped Subwatershed Study to provide water resources and natural heritage input to support a Settlement Area Boundary Expansion (SABE) Study that will determine where new settlement area growth is proposed in Peel Region. The Environmental Screening and Scoped Subwatershed Study (Scoped SWS) is one of several technical studies that will inform the SABE. The results of the Environmental Screening and Scoped SWS Study will be used to develop a Regional Official Plan Amendment (ROPA) for the settlement area boundary expansion. Formal consultation will occur as part of the Regional Official Plan Review (Peel 2051) and Peel Region is updating the Regional Official Plan to be in conformity with provincial plans and policy. The original branding of the Region's Official Plan Review was identified as Peel 2041 then after June 2020, with new population growth management numbers from the Province to the year 2051, it became known as the Peel 2041+ Official Plan Review. As of July 2021, the Region of Peel's Official Plan review is now referred to as the 'Peel 2051 Official Plan Review' or 'Peel 2051' to correspond with any other documents that may not get changed. The SABE Study and ROPA will define the area of planned growth in Peel Region and the related environmental management policies, at a level sufficient to confirm the principle of development at a regional scale. This approach will ensure that water resources and natural heritage features are protected, restored or improved, and will set the basis for future local municipal official plan amendment(s) (LOPA), led by the Town of Caledon. The LOPA is proposed to be supported by detailed subwatershed study(s) to be completed at a time appropriate to the anticipated timing of the LOPA.

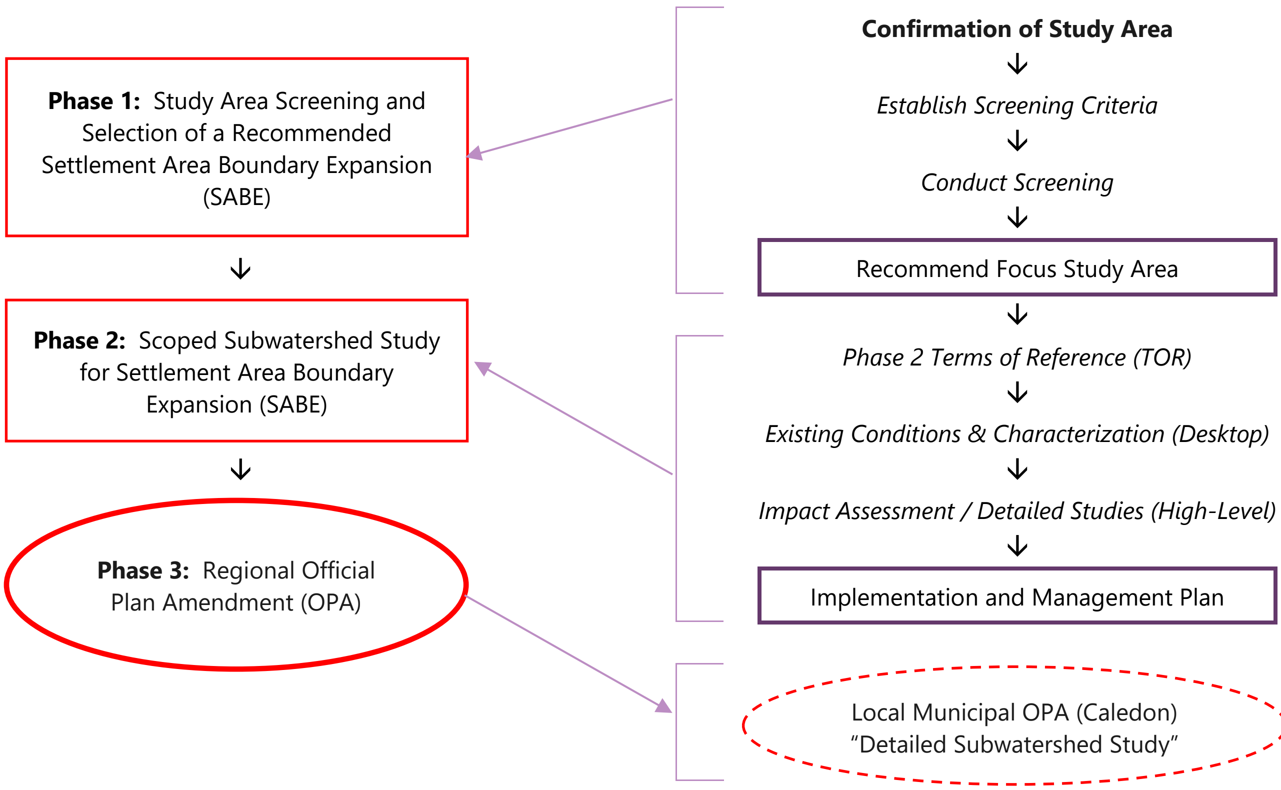
The **Initial Study Area** is defined as the Agricultural and Rural lands in Caledon excluding lands within the Greenbelt. Within this area, a **Focus Study Area (FSA)** has been established, which is described as "a broad area in the southern part of Caledon that serves as the basis for SABE technical studies", within which the Settlement Area Boundary Expansion (SABE) will be identified. The **Settlement Area Boundary Expansion Study** is the study being undertaken by Peel Region to identify expansions to settlement areas (defined in the growth plan below) to accommodate population and employment growth to 2051 after accounting for intensification in the built up areas. The feasibility of any proposed expansion will be determined and the most appropriate location for any proposed expansion will be identified with reference to the results of comprehensive technical studies.

Settlement Areas are defined per the 2019 Growth Plan as follows:

> "Urban areas and *rural settlements* within municipalities (such as cities, towns, villages and hamlets) that are:
>
> - built up areas where development is concentrated and which have a mix of land uses; and
> - lands which have been designated in an official plan for development in accordance with the policies of this Plan.
>
> Where there are no lands that have been designated for development, the *settlement area* may be no larger than the area where development is concentrated."

The graphic below illustrates the various phases and associated primary steps to initially assess, screen and select a recommended SABE location (based in south Caledon), followed by the Scoped SWS (tailored to the needs of Peel Region's OPA) and ultimately to provide technical recommendations for the ROPA, setting the ground work for the detailed local study of water resources and natural systems (future detailed Subwatershed Study).

Process Flow Diagram



Phase 1 of the Environmental Screening and Scoped Subwatershed Study was completed in mid-2020 and a report submitted to Peel Region to provide input to defining the Focus Study Area (ref. Wood et. al., May 29, 2020). The analyses and recommendations provided in that report focused on identifying key environmental features and constraints within the overall study area, related to the terrestrial features, aquatic features, hydrogeologic and surface water systems. The environmental features and systems identified through this screening exercise have been integrated with the findings from a parallel study process led by the Hemson Team working on behalf of Peel Region, involving additional technical studies such as servicing, transportation, agricultural, cultural heritage, and climate change, to identify further constraints, needs, and opportunities, to define a Focus Study Area (FSA). The Phase 1 Environmental Screening study included an assessment of a sufficient extent of land to ensure the FSA identified for the SABE provides adequate area, accounting for natural heritage and water resource system requirements, to accommodate the Region's growth requirements to 2051 and enable one or more settlement area expansions.

Phase 2 of the Environmental Study entails completion of a Scoped Subwatershed Study (Scoped SWS) to define and support the selection of the SABE. The Scoped SWS builds upon the findings from Phase 1 of the Environmental Study, further characterizes the environmental and water resources features and systems within and bounding the FSA, identifies limitations and constraints to development potential by location within the FSA, and thereby informs refinement of the FSA to establish the SABE. The Scoped SWS also includes conducting an impact assessment for the influence of future urban uses in the SABE, and identifying guidance for management opportunities and requirements for future environmental studies to support subsequent stages of land use planning. The Scoped SWS is being completed at a "scoped" level of detail to address the Region's specific needs with respect to its ROPA., recognizing the opportunity to leverage this scoped level of detail, toward completing future "local" detailed Subwatershed Studies at subsequent stages of planning.

The following summarizes the components (parts) of the Scoped SWS:

Part A: Existing Conditions and Characterization

Part B: Impact Assessment and Detailed Studies

Part C: Implementation Plan

This report presents the findings of Part A of the Scoped SWS regarding the existing conditions and characterization of the natural and water resources features and systems within the FSA. The findings presented herein will be used in conjunction with the findings from the parallel studies being completed by the Hemson Team, to establish the SABE and corresponding land use concept(s) for input to the Part B Impact Assessment and Detailed Studies. Part C will be informed by the Impact Assessment completed in Part and provide guidance for implementation of the goals, objectives and recommendations for management of groundwater, streams (surface water, geomorphology), and the Water Resource and Natural Heritage Systems.

2.0 Part A: Existing Conditions and Characterization

The SABE Study Team (Hemson) has led the initial identification and selection of the Focus Study Area (FSA). As noted earlier, numerous technical disciplines are engaged through Hemson on behalf of Peel Region to provide input to the project process (e.g., Agriculture, Transportation, Servicing, etc.). As a separate, but inter-related project, the Environmental Team (Wood) has been working in parallel and close consultation to ensure that technical inputs to the FSA, and ultimately the SABE Study, are provided accordingly.

2.1 Selection of Study Area

The results from the environmental constraint assessment have been used as part of the Phase 1 Environmental Screening to identify the initial representation of the geographic extent of "high", "moderate", and "low" constraint areas within the FSA. The constraint categories (i.e. "high", "medium", and "low") were assigned by the Environmental Study Team based on Provincial and Regional policy requirements and use of 'best available' secondary source information (e.g., provincial plan and policy requirements, Regional and local official plan policy direction, mapped provincial, regional and conservation authority data). As part of the data geoprocessing, unique constraint layers have been created to simplify the representation of each constraint class based on the areas and features identified in accordance with Provincial and Regional policy; where overlap existed among constraint classes, the highest constraint class has taken precedence in the screening assessment.

These consolidated natural environment data layers have been provided to the Region as a key input to identification of the FSA. For the purposes of defining the FSA, only high constraint features have been employed as these represent known constraints to development; these data were combined with other policy and technical considerations by the Hemson Team to delineate the FSA; the policy drivers, planning justification and technical inputs to the FSA delineation process are documented in the Hemson Report (Hemson 2020).

The preliminary constraints assessment is shown on Figure 2 of the Phase 1 Report; a copy is included in Appendix A of this report. A summary of the constraints assessment is included in and summarized in Table 2.1.1. The screening Study Area encompasses ~69,600 ha of land area located within the Town of Caledon. The Study Area includes several areas that are not suitable for consideration in identification of the FSA:

Table 2.1.1. Summary of Preliminary Constraints Assessment Outcomes and General Implications for Land Use Planning

Constraint Category	Land Area[1] (ha [% FSA[2]])	Cumulative Land Area (ha [% FSA])	Implications for Land Use Planning
High	~1,452 ha (14%)	~1,452 ha (14 %)	Features and areas in this category represent 'take-outs' in terms of development potential. Some minor modifications may occur (e.g., through field-confirmation of feature boundaries).
Moderate	~308 ha (3%)	~1,760 ha (17%)	Features and areas in this category are not currently known to represent a high constraint to development. Through additional study, some of these areas may be identified as High Constraint and would then represent a 'take-out' to future development areas. Updates to some of these areas may be identified through the Scoped Subwatershed Study or subsequent local studies.
Low	~3,343 ha (32%)	~5,103 ha (49%)	Features and areas in this category are not currently known to represent a high or moderate constraint to development, and thus are not expected to result in future development 'take-outs'. It may, however, be determined that special design considerations are required for some of these areas through additional study, which in turn, may affect land-use type and density targets.

The Environmental Study Team has conducted a simple validation exercise to confirm that the FSA as developed by the Hemson Team provides enough flexibility within its defined area to meet the natural environment criteria used to inform its delineation. The validation exercise has been completed based on two scenarios:

- **High Constraint** | This scenario is consistent with the approach taken by the Hemson Team in its delineation of the FSA. It treats the High Constraint features as 'take-outs' and assumes that all other areas have development potential.

[1] Constraint categories overlap in many areas. As such, the area calculations (ha) and percent (%) FSA will not equal the total area of the Study Area Where categories overlap, it is the most constraining category that takes precedence in the assessment.
[2] FSA land area is based on the reduced Study Area which removes lands within the Greenbelt and existing development and planned developments.

- **High Constraint and Moderate Constraint** | This scenario explores the potential impact of conservatively assuming all Moderate Constraint features being re-classified as High Constraint features through further study. It treats both High and Moderate Constraint features as 'take-outs' and assumes that all other areas have development potential.

Under both scenarios the constraint categories included have been considered as 'take-outs' and the total available area has been considered against the stated needs of the SABE. No scenario has been examined with the Low Constraint category as take-outs, as these are anticipated to represent management and land use related constraints only (i.e., will not prohibit development).

These constraint scenarios are an iterative review as lands needs assessment are refined. Further work will be completed to consider whether the recommended Preliminary NHS developed through the current scoped Subwatershed Study is used in the Region's Environmental Take-Outs methodology as a final iteration of the land need assessment.

2.1.1 High Constraint Scenario Results

Within the FSA, high constraint areas encompass ~1,452 ha (~18% of the FSA land area). Based on the current land needs assessment (to 2014), the SABE will require ~4,300 ha. Excluding the high constraint areas, the current SABE requirements represent ~65% of the remaining land area within the FSA; this indicates that there would be sufficient flexibility in the FSA to allow for multiple options in delineating the SABE to accommodate these growth requirements and provide for protection of natural features and areas.

2.1.2 High and Moderate Constraint Scenario Results

The conservative addition of moderate constraint features to this second scenario would have a small impact on total land availability. Moderate constraint features represent ~308 ha (4%) of the land area within the FSA. When considered cumulatively with the high constraint areas, this constraint scenario encompasses ~1,760 ha (22% of the FSA land area). Based on the current land needs assessment (to 2051), the SABE will require ~4,300 ha. Excluding the high and moderate constraint areas, the current SABE requirements represent 68% of the land area within the FSA; this indicates that there would be sufficient flexibility in the FSA to allow for multiple options in delineating the SABE to accommodate these growth requirements and provide for protection of natural features and areas.

2.2 Summary Overview of Background Information

A broad range of geospatial data were obtained through the data request process with the intention of informing both the screening and future Scoped Subwatershed Study processes. A summary of datasets provided for use in the Environmental Screening and Scoped SWS is provided in Appendix B. For all data used in this assessment mapped features and areas are intended as a preliminary input to inform approximate areas that may constrain development. Therefore, the data included in the assessment and maps should not be used to interpret the exact site-level boundary and extent of features and the associated constraints that they represent. The limits of features and areas to be confirmed will be undertaken during subsequent studies and will be used to update the site-specific final development limits and inform site-specific or area-specific planning, as appropriate. The following provides an overview of key information used to characterize the environmental features and systems within the FSA.

Resources used in the geotechnical and Slope Stability Assessment:

- Technical Guide – River and Stream Systems: Erosion Hazard Limit, OMNR, 2002
- Geotechnical Principles for Stable Slopes, OMNR, 1997
- Ontario Geological Survey – surficial mapping and borehole database

- Topographic Mapping as provided by Peel Region
- TRCA Reference Manual – Determination of Regulation Limits, 2005
- TRCA Planning and Development Procedural Manual, 2008
- CVC – Watershed Planning and Regulations Policies, 2010

Groundwater

Groundwater Modelling of the Oak Ridges Moraine Area (EarthFx 2006). This report provides a summary of the hydrogeologic setting of the Oak Ridges Moraine area, as well as a description of the development of groundwater flow models for the area.

Humber Watershed Plan (TRCA 2008). This document describes a plan for the Humber River watershed, including an overview of current conditions (including overview of geology and hydrogeology), possible future land use and environmental management scenarios, and management strategies and action recommendations.

Etobicoke and Mimico Creeks Watersheds – Technical Update Report (TRCA 2010). This report provides technical updates on the geology, hydrogeologic setting, groundwater quantity and quality, groundwater use, groundwater recharge and discharge.

Peel Scoped Subwatershed Study (SWS) Area – Groundwater "Areas of Concern" (ORMGP 2020). This technical memorandum compiles a number of different hydrogeological datasets from the Oak Ridges Moraine Groundwater Program (ORMGP) to provide an overall assessment of potential groundwater "Areas of Concern" related to groundwater levels for the regional scoped subwatershed area.

Oak Ridges Moraine Groundwater Program (ORMGP). 2018a. Oak Ridges Moraine Groundwater Program Website [Oakridgeswater.ca]. This website provides a number of different types of hydrogeological datasets that are relevant to building a conceptual hydrogeological understanding of the FSA, including, but not limited to, mapping layers, water quality and water level data, a cross-section tool, and a water budget tool. The site also provides links to a library of site-specific technical reports. Reports that refer to site investigations within the FSA have been reviewed and relevant technical information has been added to the characterization discussion. The majority of the reports were geotechnical in nature and were focused on overburden depths of 0-10 m providing water levels and stratigraphic information.

IWA Landfill Site Search Peel Region- Step 6 Site C-34B Appendix C Geology/Hydrogeology (Golder Associates Ltd., 1994). This report provides geological and hydrogeological characteristics including water levels, stratigraphy and groundwater age dating.

Methodology for Delineation of Ecologically Significant Groundwater Recharge Areas - Technical Memorandum (TRCA, August 2019). This memorandum provides the technical methodology for connecting potential groundwater dependent ecological features to the recharge areas that potentially provide the source water. Mapping of the Ecologically Significant Groundwater Recharge Areas (ESGRAs) is provided.

In addition, the following mapping was used for the groundwater characterization and functional analysis:

- Highly Vulnerable Aquifers
- Wellhead Protection Areas
- Significant Groundwater Recharge Areas
- Seeps and Springs

Surface Water

The characterization of the surface water systems within the FSA and surrounding areas has been based upon a desktop review of available information sources, either received from the Region of Peel, TRCA, CVC for use in this study or sourced from other legacy studies. The characterization of hydrologic and hydraulic conditions for the FSA and surrounding areas have been based on review of reports and associated models for the respective watersheds and associated tributaries.

The reports and models used in this background review include the following:

Reports:

- Humber River Hydrology Update, Civica Infrastructure Ltd, 2018
- Etobicoke Creek Hydrology Update, MMM Group Ltd, 2013
- Etobicoke Creek FPMU, Aquafor Beech Ltd, 2016
- Humber River FPMU, Wood PLC, 2017
- Humber River FPMU in Peel Region, Cole Engineering Group Ltd, 2017
- Downtown Brampton Flood Protection Feasibility Study, Amec Foster Wheeler, 2016
- Downtown Brampton Flood Protection Feasibility Study, Amec Foster Wheeler, 2016
- Mayfield West, Phase 2 Secondary Plan Comprehensive Environmental Impact Study & Management Plan, AMEC, 2014
- North West Brampton Subwatershed Study for the Huttonville and Fletcher's Creeks, AMEC, 2011

Models:

- Humber River Hydrology Model – Visual OTTHYO, Civica Infrastructure Ltd, 2015
- Etobicoke Creek Hydrology Model – Visual OTTHYMO, MMM Group Ltd, 2013
- Etobicoke Creek Hydraulic Model – HEC-RAS, Aquafor Beech Ltd, 2016
- Etobicoke Creek – Brampton SPA – Hydraulic Model – HEC-RAS, Amec Foster Wheeler, 2014
- West Humber Hydraulic Model – HEC-RAS, Cole Engineering Group Ltd, 2017
- Lower Main Humber Hydraulic Model – HEC-RAS, Wood PLC, 2017
- Upper Main Humber Hydraulic Model – HEC-RAS, 2018
- Bolton SPA – HEC-RAS

In addition to the reports and models outlined above, supplemental mapping and data have been used to characterize the FSA, outline potential constraints to development and identify future data needs for subsequent studies. In addition to the base mapping data, the following has been used in the surface water system characterization:

- Digital Elevation Model (DEM)
- Surficial Soil and Geology Mapping
- Land Use Mapping
- Floodlines / Floodplains Mapping
- Hydrologic Modelling Subcatchments
- Monitoring Data Locations & Associated Data – TRCA, CVC and Environment Canada

Stream systems

A background review was undertaken to gather information on the surface water features located within the Study Area. Reviewed data included previous reports, historic aerial photos, and spatial data (topography, watercourse mapping), including information regarding physiography and surficial geology and land use. This information formed the foundation of the feature characterization work which then informed the "windshield" assessment. The Study Area is primarily within the Humber River watershed, with portions of the FSA extending into the Credit River (Fletchers Creek and Huttonville Creek), and the

Etobicoke Creek watersheds. The Toronto and Region Conservation Authority holds jurisdiction over the Humber River and Etobicoke Creek watersheds, while Credit Valley Conservation regulates the Credit River and its subcatchments. The following summarizes data utilized in the site characterization for area surface water features.

Reports:

- Mayfield West, Phase 2 Secondary Plan Comprehensive Environmental Impact Study and Management Plan (AMEC, 2011)
- Huttonville and Fletcher's Creek Subwatershed Study (AMEC, 2010)
- Credit River Watershed Natural Heritage System Final Technical Report (CVC 2015)
- Environmental Implementation Report Mount Pleasant Sub-Area 51-1 within the Mount Pleasant Secondary Plan Area North West Brampton (Stonybrook et al, 2011).

The above reports provide characterization and evaluation background for valley features, watercourses and headwaters within and downstream of the study area. Of those reports, the Mayfield West study provides characterization and evaluations for features within the current FSA. Information utilized from these reports to provide context and comparison to the current study includes:

- Reach delineation and nomenclature
- Historical analysis
- Erosion hazards – meander belt (Parish Geomorphic) and long-term stable top of slope (Terraprobe)
- Headwater characterization and drainage density
- Rapid geomorphic assessments (RGA) and rapid stream assessment technique (RSAT)
- Implementation of natural channel design (downstream of study area)

In the Mayfield West study area, additional details on channel form and function were captured through detailed field surveys, and site monitoring which is relevant to the current study, and will be evaluated during the impact assessment as appropriate.

Geomorphic constraint rankings for watercourses are presented in the Mayfield West, and Huttonville and Fletcher's Creek studies that are useful for comparison and evaluation within the present study, However, the proposed constraint rankings for watercourse features within and adjacent to the FSA will be presented as an integration of constraints by each discipline (i.e. hydrology, geomorphology, aquatics, terrestrial, and hydrogeology), which provides a better basis for the impact assessment and feature based planning and recommendations (ref. Section 2.3.5 for discussion).

Spatial Data – GIS/Mapping:

- 2018 Caledon Orthophotography
- 1m contour mapping – Peel Region
- Meander Belt and Crest of Slope Layers - TRCA
- Stream Layers – Peel Region and TRCA
- Parcel Based Land Use – Peel Region

Natural Systems

The primary sources of information with respect to aquatic habitat and fisheries are:

- Subwatershed Study for the Huttonville and Fletcher's Creeks North West Brampton Phase 1 Characterization (AMEC et al, 2010) - This report summarizes the fish habitat information in the Credit River Fisheries Management Plan and reports on fish sampling that was conducted in small watercourses which flow south into Brampton.

- Humber River Fisheries Management Plan (Ontario Ministry of Natural Resources and Toronto and Region Conservation Authority, 2005 draft) – The fisheries management plan characterizes existing conditions with respect to fish habitat and fish communities and classifies watercourses according to their size and thermal regime. Management direction and implementation recommendations are provided.
- GTAA Living City Project: Etobicoke Creek, the Aquatic Ecosystem (Toronto and Region Conservation Authority, 2006 draft) – This report is a fisheries management plan that characterizes existing conditions with respect to fish habitat and fish communities and classifies watercourses according to their size and thermal regime. Management direction and implementation recommendations are provided.
- Fisheries and Oceans Canada mapping of critical habitat and distribution data aquatic species at risk (https://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html).

The primary sources of information with respect to the terrestrial features and species occurrences included:

- TRCA ELC layer
- CVC ELC layer
- TRCA flora records
- TRCA fauna records
- CVC flora records
- CVC fauna records
- NHIC species at risk and rare species element occurrences

The ELC layers provided by the respective conservation authorities represents a mix of orthophoto-interpreted and field-determined land cover data within the jurisdiction of CVC and TRCA. Data from both jurisdictions was compiled in a GIS database to provide coverage for the Subwatershed areas associated with the FSA within the Region of Peel. Ecological Land Classification for Southern Ontario is used as the basis for classification vegetation communities, primarily to the level of community series.

Meta data for the species occurrence records was not available, but it is understood that the records provided represent field-confirmed occurrences of plants and wildlife documented at monitoring locations within the respective jurisdictions.

Data from the NHIC includes element occurrence records for Species at Risk, rare species, and rare plant communities documented within the FSA.

2.3 Existing Conditions Characterization

2.3.1 Groundwater

2.3.1.1 Physiography

The physiographic description of an area commonly includes summaries of topography, landform, drainage and the occurrence of surface soil types along with an overview of the depositional and erosional history that created the landform. Geologic descriptions commonly detail the overburden and bedrock composition and form below the surface as well as the relationship of the geology to the physiography of that area. Together these two descriptions are used to characterize the physical setting of a study area and form the basis of any groundwater interpretation. Within the study area, the physiography and geology are so closely related, that for the purposes of this study, the physical setting overview is considered a synthesis of both overall characteristics

The FSA is situated almost completely within the South Slope physiographic region that is characterized by till plains, except for a small area just north of Mayfield Rd. in the east where a small portion of the bevelled till plains of the Peel Plain region, enters the FSA from the south as shown on Drawing GW-1 in Appendix C (Chapman and Putnam 1984). The shape of the bedrock surface as well as the occurrence of the overburden units, which make up the above regions, is a result of the repeated glacial advances and retreats which have occurred in southern Ontario. The most recent glacial advance and retreat formed much of the land surface and geology present in the area today. This event is referred to as the Wisconsin Glaciation, and was accompanied by various meltwater lakes and channels. The last glacial retreat ended between 10,000 and 20,000 years ago, blanketing the area in glacial till sediments.

The gently sloping glacial till plain of the South Slope represents the southern slope of the elevated Oak Ridges Moraine found north of the FSA and is characterized by finer grained, silty to clayey till (Chapman and Putnam 1984; TRCA 2008). The Brampton Esker is found within the South Slope region, just south of the FSA, located along, and just west of Heart Lake Road (Drawing GW-1, Appendix C). References have been made (Golder, 1993) that eastern portions of the FSA are mapped as the Gooseville Moraine with a gently undulated till surface and occasional small kettle depressions and ponds. It is also noted that this feature is only an expression of the topography and does not reflect the underlying stratigraphy. This moraine is not currently represented on the most recent surficial geology layer. The Peel Plain is generally characterized as flat glacial till plain, but in the FSA, is represented at surface by fine-grained lacustrine sediments (Chapman and Putnam 1984; TRC 2008). Regionally, the ground surface slopes from west and north, from the topographic highs related to the Niagara Escarpment and Oak Ridges Moraine, towards the south and southeast towards Lake Ontario. Within the FSA the ground surface generally slopes from 285 masl in the northwest to a low of 215 masl in southeast. Surface drainage networks of the Etobicoke Creek in the western portion of the FSA and the Humber River through the central and eastern portions of the FSA, originate from the west and north and drain south and east. Due to the fine-grained nature of the surficial soils, runoff is relatively high and infiltration is relatively low.

The next closest physiographic landforms found further west and north of the FSA include the spillways and till moraines associated with Niagara Escarpment (limestone ridge) physiographic region, and the hummocky sand and gravel kame moraines associated with the Oak Ridges Moraine region (Drawing GW-1, Appendix C; Chapman and Putnam 1984; TRCA 2008).

2.3.1.2 Bedrock Geology and Bedrock Topography

Paleozoic bedrock in the FSA includes the Queenston Formation shales found at the bedrock surface in the western and central parts of the FSA, and Georgian Bay Formation shales that are found beneath the Queenston Formation and are at the bedrock surface in the eastern portion of the FSA. These formations are presented on Drawing GW-2 in Appendix C (Bond and Telford 1976). The Queenston Formation is known for its characteristic soft red shale, which allows small streams to easily erode into it. This unit is described as a silty, calcareous shale and clay shale with thin interbeds of grey to green silty limestones and calcareous siltstones. The Georgian Bay Formation is described as thin beds of grey-green and grey-blue shales, calcareous siltstones and silty to argillaceous limestones. The Georgian Bay Formation is underlain by older limestones of the Simcoe Group (Verulam Formation) and deeper and much older Precambrian shield rocks (EarthFx 2006; Eyles 2002). The sequence of limestones underlying shales suggests a change in depositional environment from shallow to deep waters (EarthFx 2006).

The bedrock topography is shown on Drawing GW-3 in Appendix C (ORMGP 2018a) and represents a regional erosional unconformity. The elevation of the bedrock surface ranges from a local high of 425 masl west of the FSA on the Niagara Escarpment, to a local low of 77 masl along the thalweg of a valley that was eroded into the bedrock north of the FSA. This valley also coincides with the thalweg of a tunnel channel identified by the ORMGP (2018a). Other smaller scale bedrock valleys have been identified by the ORMGP in and surrounding the FSA, including features mapped west of the FSA, within the FSA just west of Heart Lake Rd., west of Sandhill, and around Bolton (Drawing GW-3, Appendix C). These bedrock valleys contain thicker sequences of overburden sediments and where connected, these valleys can act as preferential pathways for groundwater flow (EarthFx 2006). The valleys can also be associated with conditions of upward hydraulic gradients and groundwater levels found at or above ground surface (e.g., note clusters of wells located west of Bolton and south of the FSA near bedrock valley thalwegs; Drawing GW-3, Appendix C). More on this topic will be discussed in later sections as it relates to groundwater "Areas of Concern". Regionally, the Paleozoic bedrock units dip to the southwest (Johnson et al. 1992).

2.3.1.3 Surficial Geology, Overburden Thickness and Stratigraphy

The surficial geology in the FSA, as mapped by the Ontario Geological Survey (OGS) consists primarily of fine-grained sediments characterized by the sandy silt to silty clay sediments associated with the Halton Till and Wildfield Till (Drawing GW-4, Appendix C). Two small, localized surficial patches of sand and gravel deposits are found overlying these till units in the central part of the FSA, as well as small areas of fine-grained glaciolacustrine deposits found near Mayfield Rd. in the western and eastern extents of the FSA. Surficial patches of sand and gravel deposits are also found along and north of King Street adjacent to the FSA. Modern silt, sand and gravel deposits can be found along the watercourses in the FSA (Drawing GW-4, Appendix C).

These surficial deposits overlie a sequence of unconsolidated Quaternary sediment consisting of six interpreted units. The thickness of these overburden units combined varies across the FSA from less than 5 m along some watercourses, to 160 m thick in the northern part of the FSA where overburden sediments fill in a deep bedrock valley (Drawing GW-3 and GW-5, Appendix C; ORMGP 2018a). North of the FSA, overburden thickens to over 200 m along parts of the bedrock valley thalweg.

The six overburden units, their distribution and interpreted thicknesses are shown in a set of cross-sections across the FSA (Drawing GW-4 and GW-6A to -6L, Appendix C) that were generated using the ORMGP Cross-Section Application (ORMGP 2018a) and included wells within 50 m of the section. Note that while this cross-section tool represents these units as vertically continuous layers, smaller, localized pockets, layers, and lenses of other materials may be present within these units. A description of each unit from youngest to oldest is provided in the following text.

Halton Till – As described previously, the Halton Till occurs at surface across the majority of the FSA as a primarily fine-grained till unit consisting of sandy silt to clayey silt. The till ranges in thickness from zero thickness where it has been eroded along watercourses (e.g., Drawings GW-6B, -6C, and -6D, Appendix C) to thicknesses exceeding 30 m and approaching 50 m in areas of inferred bedrock valleys (e.g., Drawings GW-6B, GW-6C, GW-5L, Appendix C). Drawing GW-5a presents areas where the till is less than 3 m thick and fracturing may be more prevalent, the significance of which is discussed further in Section 2.3.1.4. These areas small surficial patches of coarser sands and gravels mapped on Drawing GW-4 are not represented in the Halton Till layer found in Drawing GW-6A through -6L (ref. Appendix C). The study for IWA site C-34B, located just south of King Street and east of The Gore Road, (Golder, 1994) defined 4 distinct units, with varying thicknesses, within this till. These units include:

- Upper Till Unit – this correlates with the Halton Till. This unit is described as sandy silty clay to clayey silt with sand. Small amounts of gravel and cobbles were noted. The till was described as massive and generally weathered through its entire thickness (up to 5 m). Vertical fractures were noted extending beyond the base of the unit.

- Middle Till Complex –individual, poorly correlated massive till layers with interbeds of stratified silt to sand and gravel. The layers and interbeds, generally in the range of less than 4 m thick, are interpreted to be discontinuous but may extend tens to hundreds of metres. Weathering, to varying extents, occurs within the Middle Till.
- Glaciolacustrine Deposits – layers of fine grained glaciolacustrine clayey silts and silty clays were encountered at the base of the Middle Till. Although these layers were generally less than 1 m, varved (rhythmically layered) sequences may be much thicker.
- Lower Till Complex – this till is similar to the Middle Till but not as variable. Gravel was observed in all till samples. and shale fragments were more common closer to the bedrock surface. Sand and gravel at the bedrock contact was common though inconsistent.

The actual thicknesses of these individual units are expected to vary across the FSA.

Oak Ridges Moraine Deposits – The coarser sediments of the elevated Oak Ridges Moraine are found at ground surface north of the FSA where the moraine extends 160 km in length east to west, 5 to 20 km in width north to south (EarthFx 2006). The Oak Ridges Moraine is predominantly comprised of fine sands and silts but coarser sands and gravels can dominant local areas (EarthFx 2006). The deposits of the Oak Ridges Moraine are interpreted to be thickest (approximately 80 m thick) in the FSA along the northwest boundary of the FSA in the area of bedrock valleys. The deposits thin downslope towards the southeast where they are inferred to become discontinuous approaching Mayfield Rd. (e.g., Drawing GW-6A, -6I and -6J, Appendix C).

Newmarket Till – The Newmarket Till is found below the Oak Ridges Moraine deposits and the Halton Till where the Oak Ridges Moraine is absent. This till is a regional marker unit characterized as a massive, and frequently overconsolidated, stony and dense silty sand diamicton, however, there are windows in the unit where it has been eroded by glacial meltwater (EarthFx 2006; Gwyn 1976; Barnett et al. 1991 and Sharpe et al. 2002). The top of the till is considered a regional unconformity, often containing erosional features called tunnel channels that are interpreted to form from subglacial meltwaters that erode into or through the Newmarket Till. For the purposes of this Scoped SWS and to be consistent with interpretations captured in the ORMGP cross-section tool, this till is conceptualized as one unit; however, more recent interpretations by the ORMGP consider subdividing this until into upper and lower Newmarket Till units, separated by inter Newmarket sediments. The Newmarket Till is interpreted to be discontinuous across the FSA, with thickest accumulations occurring within bedrock valleys (e.g., 30 m thick; Drawing GW-6B, Appendix C). Tunnel channels, as identified by the ORMGP (2018a), are not present within the FSA, however, the closest feature is mapped just north of the FSA, roughly aligned with a southwest-northeast trending bedrock valley (Drawing GW-3, Appendix C).

The Thorncliffe Formation, Sunnybrook Drift, and Scarborough Formation are found below the Newmarket Till and are often collectively referred to as the “lower sediments” (EarthFx 2006).

Thorncliffe Formation - The Thorncliffe Formation is generally considered a relatively coarser unit comprised of glaciofluvial sands and silty sand; however, towards the south this unit is mainly comprised of glaciolacustrine silts, sands, and clay. Facies changes over short distances have been observed in this unit (EarthFx 2006). The Thorncliffe Formation is interpreted to be discontinuous across the FSA, with occurrences interpreted primarily in bedrock valleys and occasionally overlying bedrock where the deeper units are absent. It is thickest (approaching 60 m thick) at the north end of the FSA (Drawing GW-6K, Appendix C) within a bedrock valley.

Sunnybrook Drift - The Sunnybrook Drift is interpreted to be a relatively finer grained unit comprised of silts and clays. It is interpreted to be largely absent across the FSA (Drawing GW-6A through -6L, Appendix C), occasionally occurring with greater thickness (generally 20 m or less) within inferred bedrock valleys (e.g., Drawing GW-6C, -6J, and -6K, Appendix C).

The Scarborough Formation – The sediments of the Scarborough Formation are considered the oldest that may be found before encountering bedrock. They consist of organic sands overlying silts and clays that have originated from a fluvio-deltaic system (EarthFx 2006; Karrow 1967; Eyles 1997). Where present, the Scarborough Formation is interpreted as a thin layer on bedrock, except for thicker accumulations 50 m to 60 m thick in bedrock valleys (e.g., Drawing GW-6D and -6J, Appendix C).

2.3.1.4 Hydrogeologic Setting

Conceptually, water from precipitation percolates or infiltrates into the ground until it reaches the water table. Areas where water moves downward from the water table are known as recharge areas. These areas are generally in areas of topographically high relief. Areas where groundwater moves upward to the water table are known as discharge areas. These generally occur in areas of topographically low relief, such as stream valleys and discharge can occur in significant quantities when the stream valleys cut into permeable sediments. Groundwater that discharges to streams is the water that maintains the baseflow of the stream. Wetlands may be fed by groundwater discharge.

There are different types and rates of recharge and discharge. Water percolating into the ground at a specific location may discharge to a small stream a short distance away. This is local recharge and local discharge. Some water may recharge in a certain area and discharge to a larger river basin, a long way from the source of recharge. This is known as regional recharge and regional discharge.

Hydrostratigraphic units are developed by lumping or splitting stratigraphic units based on their hydrogeologic properties. The delineation of hydrostratigraphic units is completed using knowledge of the regional and local understanding of the spatial distribution of stratigraphic units where higher quality data is available, and carrying this interpretation outwards using lower quality data. Permeable geologic materials that can transmit significant quantities of water are known as aquifers. Aquifers are "water bearing" formations, meaning that water can be easily extracted from these units. The less permeable units are known as aquitards, and although water can move through these units, it moves slowly and it is difficult to extract water from these units. How these aquifers are connected within a hydrogeologic setting is what controls much of the movement of groundwater.

The delineation of the flow system will identify where groundwater originates, where it discharges, and the most prominent paths it travels between these points (e.g., pathways through aquifers or more permeable hydrostratigraphic units). From this delineation, the relative sensitivity of the linkage from the groundwater system to the aquatic or terrestrial systems can be assessed. Knowing the level of sensitivity of the receptor, the impacts of particular types and scales of land uses or land use changes on the groundwater flow system and other linked ecosystem components can also be assessed. Best management practices can then be developed to prevent unacceptable impacts from occurring.

2.3.1.4.1 Hydrostratigraphy

As mentioned, hydrostratigraphic units are developed by lumping or splitting stratigraphic units based on their hydrogeologic properties. Hydraulic conductivity is the main property of a stratigraphic unit that describes how easily water can move through it. Stratigraphic units are considered aquifers where the hydraulic conductivity is relatively high. Conversely, they are considered aquitards where the hydraulic conductivity is relatively low. Aquifer units are defined solely on the basis of the estimated ability of the unit to yield water and do not consider water quality or vulnerability to surficial sources of contamination. Table

2.3.1.1 lists the hydrostratigraphic units identified within the FSA (EarthFx 2006; TRC 2008). The main aquifer units interpreted include the Oak Ridges Moraine Deposits, Thorncliffe Formation and Scarborough Formation. Conversely, the main aquitards are conceptualized as the Halton Till, Newmarket Till, and Sunnybrook Drift. The Paleozoic bedrock units are generally interpreted to be poor aquifers except where they are sufficiently weathered or fractured. The extent and continuity of these units in the FSA are described above in the bedrock and surficial geology sections.

Estimates of hydraulic conductivity for these hydrostratigraphic units in the FSA were noted where that information was available in reviewed reports and datasets. Four estimates of hydraulic conductivity were available online for Well IWA C-34B-6 located west of Bolton through the ORMGP Monitoring Data portal. Estimates ranged from 2×10^{-8} to 6×10^{-7} m/s for well intervals completed in the Oak Ridges Moraine deposits and 2×10^{-6} m/s for the deepest well interval completed within the lower Newmarket Till. Additional estimates for IWA Site C-34B from Golder (1994), for the Halton Till and associated units described in Section 2.3.1.3, range from 10^{-6} m/s to 10^{-10} m/s. The value within the upper till had a geometric mean of 3×10^{-10} m/s. This same study provided hydraulic a conductivity measurement for the 'basal aquifer complex' (presumed Thorncliffe Aquifer) of 2×10^{-5} m/s. Additional values within various geotechnical report include ranges of 10^{-6} to 10^{-5} m/s for the Oak Ridge Moraine deposits and 3×10^{-9} to 10^{-8} m/s for the Halton Till. The hydraulic conductivity in the Georgian Bay Formation ranged from 3×10^{-8} m/s to 2×10^{-7} m/s. The upper portions of the Georgian Bay and Queenston Formations at the overburden contact tend to be fractured giving rise to relatively greater hydraulic conductivities.

The ranges in hydraulic conductivity represent the variation in the distribution of grain size and compaction within the various units and the location of the area being sampled. The above values generally represent the horizontal hydraulic conductivity. The physical layering within the units during deposition and can give rise to differences in the vertical hydraulic which in some cases can present vertical conductivities that are an order of magnitude less than the horizontal hydraulic conductivity.

Table 2.3.1.1. Hydrostratigraphic Units

Unit Number	Geologic Unit	Lithology	Aquifer/Aquitard
1	Halton Till	Sandy silt to clayey silt	Aquitard
2	Oak Ridges Moraine Deposits	Fine sands and silts with coarser sands and gravels that can dominate local areas	Aquifer
3	Newmarket Till	Massive and frequently overconsolidated stony and dense silty sand diamicton	Aquitard
4	Thorncliffe Formation	Glaciofluvial sands and glaciolacustrine silts, sands and clay	Aquifer
5	Sunnybrook Drift	Silts and clays	Aquitard
6	Scarborough Formation	Organic sands overlying silts and clays.	Aquifer
7	Queenston Formation	Red, silty calcareous shale and clay shale with thin interbeds of grey to green silty limestones and calcareous siltstones	Poor aquifers except where sufficiently weathered or fractured
8	Georgian Bay Formation	Thin beds of grey-green and grey-blue shales, calcareous siltstones and silty to argillaceous limestones	
9	Simcoe Group (Verulam Formation)	limestones	

2.3.1.4.2 Groundwater Levels and Groundwater Flow

A map of the groundwater table is provided on Drawing GW-7, Appendix C (ORMGP 2018a). According to the ORMGP mapping portal (ORMGP 2018a) and associated metadata, the water table was developed using static water level data from relatively shallow wells (less than 20 m deep), the elevations of large water bodies (e.g., Lake Ontario, Georgian Bay and Lake Simcoe), and water courses where the Strahler stream order was greater than 3. This interpreted groundwater table represents an average water table elevation using water level observations collected in different years, different seasons, and in some cases, may represent a recovering water level, where a well was just drilled. As such, the actual groundwater table may be +/- 3 m from that shown on Drawing GW-7 (ref. Appendix C). Regionally, the groundwater table ranges from a high of approximately 430 masl in the west associated with the Niagara Escarpment, to a low of approximately 170 masl to the east along the Humber River valley. Across the FSA, shallow groundwater is interpreted to flow from northwest to southeast following ground surface topography and discharge towards surface water features, especially towards the eastern part of the FSA with watercourses and tributaries associated with the Humber River (Drawing GW-7, Appendix C). Shallow groundwater divides appear to exist to the west of Mississauga Road and east of Coleraine Drive. Within the FSA, the groundwater table ranges in elevation from approximately 280 to 220 masl. As mentioned previously, some wells record water levels at or above ground surface, indicating flowing groundwater conditions (Drawing GW-7, Appendix C). Most of these wells are clustered in the northern part of the FSA, in the area of King St., and may be associated with bedrock valleys as well as the thickness and continuity of the Oak Ridges Moraine Deposits as discussed below. Groundwater in deeper aquifer systems also generally flows from the Niagara Escarpment eastward and from the Oak Ridges Moraine southeastward within the FSA (TRC 2008; Drawing GW-6J, Appendix C) and as previously mentioned, the bedrock valleys may act as preferential flow pathways with groundwater moving toward and along them. Where permeable layers thin out along the direction of groundwater flow the hydraulic heads tend to increase where the hydraulic conductivity of the sediments remains constant to maintain groundwater flux. This, in part, can explain the flowing wells. In addition, flowing wells can exist as a result of being located in units that are hydraulically connected to recharge areas that are regionally upgradient.

Available long-term water level monitoring data within the FSA is limited to Well W0000327 (W327) that is part of the Provincial Groundwater Monitoring Network. This well is located on the western edge of Bolton (Drawing GW-7, Appendix C) and provides transient water level data for three monitoring intervals completed in the Halton Till, Thorncliffe Formation, and Scarborough Formation according to ORMGP (2020). Groundwater levels for this well are provided on Drawing GW-8 (ref. Appendix C) and since 2003 these water levels vary seasonally by approximately 1 m or less from relatively high in the spring, to relatively low in the fall. Since the early 1990s; however, groundwater levels have been observed to rise, especially in the deep monitoring interval (W327-4; Drawing GW-8, Appendix C) where water levels rose by more than 10 m between 1994 and 2003. The observed increase in groundwater levels may be due to the community of Bolton changing its source of municipal water supply from groundwater to lake-based water starting in 2002 (ORMGP 2020). Between 2003 and 2020, groundwater levels in the Thorncliffe Formation have continued to slowly rise by approximately 1.3 m on average over this period. The water levels also show a downward vertical gradient between the Halton Till, Thorncliffe Formation and Scarborough Formation. The water table within the Halton Till is generally within the upper 3 m of ground surface based on the geotechnical studies reviewed for this study and is also common in studies done in similar Halton Till settings (i.e., Brampton, Milton). Monitoring wells installed in the lower portions of this till complex may show lower static water levels demonstrating potentially strong downward hydraulic gradients.

Adjacent to the FSA, the ORMGP has reported on other long-term groundwater monitoring in the area. The following summary is provided from ORMGP (2020). Seasonal groundwater fluctuations in the shallow overburden (e.g., Halton Till and Oak Ridges Moraine deposits) are observed to vary by 1 to 1.5 m, while groundwater levels in the deeper overburden are observed to vary by less than 1 m. In general, the monitoring data reviewed by ORMGP (2020) do not suggest any significant long-term trends in groundwater levels, except at PGMN-W329 (Drawing GW-7, Appendix C) where water levels rose by approximately 1.5 m between 2003 and 2018. This may be due to municipal groundwater pumping stopping in Centreville in 2002. A lack of observed long-term groundwater level variation trends in the shallow overburden is supported by hydrographs from Cold Creek near Bolton, West Humber River at Highway 7, and Etobicoke Creek at Brampton, that similarly show a lack of trends in estimated baseflow, especially in the last 15 years.

The Halton and associated till units will generally control the shallow groundwater components of horizontal and vertical flow and subsequent local recharge to the underlying aquifer units. The horizontal component of groundwater flow will be relatively weak due to the low permeability of the silt/clay sediments, but the weathered, fractured portions of the till unit are expected to transmit more significant quantities of water but on a more local scale. The following hydrogeologic factors relate to the Halton Till in the study area:

- Frequency and depth of fractures can depend on the clay/silt/sand content, average precipitation and temperature.
- Fractures can occur up to a depth of 6 m but they are likely more prevalent within the upper 2-3 m (Upper Fractured Till). Drawing GW-5a (ref. Appendix C) presents areas where the Halton is less than 3m thick.
- Root channels can provide pathways for enhanced flow.
- The lateral hydraulic connection within the Upper Fractured Till can be relatively significant compared to the more massive till units.
- Horizontal flow patterns in the Upper Fractured Till will be controlled by local depressional topography and restricted by underlying more massive and less permeable till.
- Vertical groundwater flow below the Upper Fractured Till is generally low unless more permeable, interconnected lenses exist.
- Evapotranspiration will significantly reduce water levels in the Upper Fractured Till.
- Lateral flow in the Upper Fractured Till reduces more quickly as the water levels drop due to less fractures and related hydraulic connection with depth.
- Gradients can be reversed within the underlying massive till (downward to upward) as water levels in the Upper Fractured Till lower thereby reducing recharge to depth.

It is currently proposed that the Upper Fractured Till is a relatively active groundwater flow zone mainly due to the permeability contrast (2-3 orders of magnitude) between it and the underlying more massive till. It is interpreted that lateral flow in the Upper Fractured Till will be directed to the depressional features. Where water levels in the Upper Fractured Till are high enough and where depressional features are connected at surface, (i.e. a ridge/swale system) groundwater discharge and overland flow may occur. The extent and distance of overland flow will vary. This flow may be more dominant immediately following a precipitation event and may only last for a short period of time. It is more common for the water to exist as shallow ponding within these depressions or for the water table to be closer to ground surface within the depressional areas where the depth of the depressional features is on the order of the thickness of the Upper Fractured Till layer. This more common scenario would lead to greater evapotranspiration within the depressional features. In this setting, although precipitation would infiltrate to the water table and be considered recharge, local shallow flow would deliver it to depressional areas where it could be considered groundwater discharge but would be lost to evapotranspiration and not manifest as overland flow. This conceptual flow may be reflected in air photos as darker (i.e. wetter) areas. Where stream reaches are more incised within the till, ephemeral discharge may occur. Where reaches have incised through the entire till sequence into the upper Oak Ridges Moraine deposits, more permanent groundwater discharge may occur.

Where the underlying till is massive both vertical and horizontal groundwater flow is restricted. The vertical hydraulic gradients within the massive till are generally higher than the horizontal gradients. Some level of fracturing may occur in the more massive till, as well as interconnected, more permeable layers which may transmit more groundwater to depth.

Groundwater flow within the discontinuous sand lenses may also be significant on a local scale where these sand lenses intercept surface water features. It was presented in the IWA study (Golder, 1994) that some of these sand lenses may be on the order of 100 m by 100 m in areal extent. These lenses could provide discharge for extended periods of time during the drier season and also are the likely sources for the relatively higher capacity overburden wells.

The organic sediments within the forested areas could provide significant storage of water on a local scale which could provide local recharge to the upper fractured till or could drain slowly to local reaches where connected.

<u>Groundwater Areas of Concern (AOC)</u>

The ORMGP staff has prepared a Draft Technical Memorandum (ORMGP 2020) with mapping of potential groundwater "Areas of Concern" (AOC) for the area surrounding the FSA (Drawing GW-8a, Appendix C) as part of an overall goal to identify areas where groundwater levels may pose an issue for subsurface construction or maintenance beyond what would be considered typical. Dealing with significant dewatering quantities can lead to logistical issues related to discharge and general construction concerns. In addition, there may be a related significant reduction in groundwater levels and subsequent water levels in surface water features, groundwater discharge and available water in water supply wells, particularly when dewatering a confined hydrostratigraphic unit. A hydrogeologic setting that may relate to AOC for the regional study area, was identified by ORMGP (2020), which includes areas where the upper aquifer (Oak Ridges Moraine Aquifer Complex; ORMAC) may pinch out along the south slope of the Oak Ridges Moraine, causing groundwater discharge or restricting discharge where the overlying Halton Till may create confining conditions.

Ultimately, the key factors that were considered by ORMGP (2020) as part of its AOC mapping were:

- where the Oak Ridges Moraine Aquifer Complex (ORMAC; found within the Oak Ridges Moraine sediments) is greater than 5 m thick,
- where groundwater levels of the shallow aquifer system (ORMAC) are within 4 m (approximate depth of subsurface excavations) of ground surface or above ground surface,
- where there are known artesian wells (water levels at or above ground surface),
- where there are anecdotes of known areas of groundwater issues requiring control measures
- consideration of longer-term groundwater level trends.

The mapping (Drawing GW-8a, Appendix C) suggests that the majority of the FSA may be considered groundwater AOC, as most of the area is interpreted to be underlain by a sufficiently thick Oak Ridges Moraine deposit and/or have a sufficiently shallow water table. Areas that have a concentration of wells with groundwater levels above ground surface are evident along, and south of King Street between Torbram Road and Humber Station Road (Drawing GW-8a, Appendix C). This area corresponds to where the ORMAC sediments are thick and then begin to pinch out to the south (Drawings GW-6H through GW-6K, Appendix C). The driving groundwater hydraulic heads for these wells are assumed to be provided by a continuous connection to the regional ORMAC unit and associated topographic highs further to the northwest. Larger areas that are interpreted to have a deeper water table or thinner aquifer deposits are mapped between Dixie Rd. and Torbram Rd., and between Centreville Creek Road and The Gore Road, and hence not a groundwater AOC (Drawing GW-8a, Appendix C).

The factors discussed above also relate, in part, to the potential for groundwater discharge. This is discussed in Section 2.3.1.4.4.

As with any regional scale mapping, additional local-scale investigations should be conducted to confirm the existence of these conditions locally. Confining conditions may exist with smaller localized discrete aquifer units. As mentioned above, shallow groundwater conditions within the upper Halton Till likely exist throughout the FSA and both of these conditions will likely warrant some level of dewatering during construction and potentially longer term depending on the extent of the confining units and the depth of the building foundation.

2.3.1.4.3 Groundwater Recharge

As mentioned previously, groundwater recharge is where water infiltrates the ground, often in topographically high relief areas, until it reaches and moves down from the groundwater table. A map of the interpreted spatial distribution of groundwater recharge is found on Drawing GW-9 (ref. Appendix C). This map was created from a model developed as a water budget tool by the ORMGP (ORMGP 2018a) and based on a 10-year climate record from 2004 to 2014. The ORMGP considers the values to be preliminary and will eventually be verified against other hydrological data (e.g., streamflows and groundwater levels; ORMGP 2018a).

Infiltration rates are governed to a large extent by the surficial geology and associated permeability. Other factors include vegetative cover, topography, spatial and temporal distribution of precipitation events and temperature. A long-term variation in frequency of the low intensity events may affect the overall recharge.

Regionally, groundwater recharge is interpreted to range from upwards of 600 to 700 mm/year on topographic highs associated with the Niagara Escarpment and Oak Ridges Moraine, to lows approaching 0 mm/year in urban areas where there is a greater proportion of impervious surfaces. Within the FSA, recharge ranges between approximately 20 and 125 mm/year due to the predominance of finer-grained surficial deposits associated with the Halton and Wildfield tills. Higher recharge correlates with the more permeable deposits along King Street, north of Macville, along Bramalea Road North of Mayfield Road and at the intersection of Kennedy and Old School Road (Drawings GW-4 and GW-9, Appendix C). Recharge is also graphically presented along various stream reaches as this would reflect the 'net recharge' within the model where annual recharge along and adjacent to the stream channel is greater than the annual reach specific groundwater discharge to the stream.

Significant Groundwater Recharge Areas (SGRAs) in the Region of Peel developed through the Source Water Protection program are also provided on Drawing GW-9 (ref. Appendix C). SGRAs represent areas of relatively higher groundwater recharge rates that are important for providing groundwater recharge to an aquifer. SGRAs are interpreted extensively north of the FSA in the areas of the Niagara Escarpment and Oak Ridges Moraine. Within the FSA, SGRAs are interpreted in small, localized areas that coincide with small pockets of sands and gravels mapped at ground surface (Drawing GW-4, Appendix C).

Drawing GW-9 (ref. Appendix C) also provides the interpreted distribution of Ecologically Significant Groundwater Recharge Areas (ESGRAs) from the TRCA (TRCA 2019). ESGRAs represent areas of land where groundwater recharge occurs that may directly support groundwater-dependent features such as coldwater streams, wetlands and their ecological functions (TRCA 2019). The TRCA ESGRAs were delineated by carrying out reverse particle tracking within the regional-scale groundwater flow modelling using the TRCA Expanded Groundwater Flow model (ORMGP 2018b). ESGRAs were simulated across the FSA, especially in the southwestern portion and in some areas of the north part of the northeastern portion of the FSA. It is important to acknowledge the following assumptions in creating the ESGRA layer:

- As with all modeling the extent of the subsurface data may limit the accuracy.
- The reverse particle tracking shows the best estimate of groundwater flow linkage of a recharge area to a potential groundwater discharge area but the actual volume of groundwater is not represented. This is important to note given the low permeability till in the areas where these ESGRA's are presented.
- Various ecological and stream features that may potentially have groundwater discharge associated with them were defined as endpoint for this modeling. It is the Team's understanding that features have not been completely field verified to confirm whether they receive groundwater discharge.
- The model is limited to a 100 m grid separation and as a result groundwater recharge within 100 m of the feature may be associated with the discharge but is not reflected in the mapping.

2.3.1.4.4 Groundwater Discharge

As mentioned previously, areas where groundwater moves upward to the water table are known as groundwater discharge areas. These areas can include wetlands and streams and is particularly important where the discharge is critical to maintaining ecological function. Regionally, groundwater is inferred to discharge along the southern slope of the Oak Ridges Moraine (TRCA 2008). Drawing GW-10 (ref. Appendix C) presents interpreted areas of groundwater discharge in and surrounding the FSA. One available dataset, 'Seepage Areas and Springs', represents a simulated output from the TRCA Expanded Groundwater Flow Model that represents where groundwater discharge equals or exceeds the median discharge rate (ORMGP 2018b). The intent of this layer is to show areas where groundwater discharge may be occurring year-round. The model predicts that groundwater is likely to discharge along the majority of the higher order watercourses found in the FSA.

The ORMGP GIS Mapping Portal (ORMGP 2018a) provides mapping of potential discharge areas, which was created in a similar manner to the water table surface (Drawing GW-7, Appendix C) described previously except that only shallow water levels were used to develop the layer; there were no corrections for surface water locations or ground surface. The layer represents areas where the interpolated water table elevation (without constraints) is greater than ground surface elevations. The distribution of these discharge areas (Drawing GW-10, Appendix C) is similar to that of the seepage and springs layer in that it follows many of the higher order streams in the FSA, but also includes some areas away from the streams. A comparison of a number of the potential discharge areas and simulated seepage and spring areas on Drawing GW-10 (ref. Appendix C) correlates with the stream habitat categories presented on Drawing F1 (ref. Appendix C) reflecting varying extents of potential groundwater discharge. A number of the reaches shown on Drawing F1 may also reflect groundwater discharge in the upper reaches of the respective watercourse where groundwater discharge originates closer to the Oak Ridges Moraine. Some of these areas are also consistent with wells with observed groundwater levels at or above ground surface (Drawing GW-8a, Appendix C).

Groundwater discharge is expected to occur where stream reaches have incised through the Halton Till and into the Oak Ridges Moraine sediments as well as where the Halton Till is thin such that the till is sufficiently fractured to be hydraulically active (Section 2.3.1.4.2) and connected with Oak Ridges Moraine sediments. Drawing GW-5a (ref. Appendix C) presents areas where the Halton Till is less than 3m thick. A comparison of GW-5a with the discharge areas shown on Drawing GW-10 (ref. Appendix C) shows various areas where they correlate, particularly within the stream valleys

Wetland areas that coincide with the potential groundwater discharge areas shown on Drawing GW-10 (ref. Appendix C) may indicate a more relevant groundwater function compared with overland flow to the feature. Note, that similar to simulated groundwater recharge mapping, the simulated discharge mapping should be field-verified through more local studies.

2.3.1.4.5 Water Balance

The existing conditions water balance of the FSA shows that average evapotranspiration (ET), recharge and runoff represent 66, 15, and 19% of the total average precipitation, respectively, based on current climate and land use conditions (Table 2.3.1.2). Future development and transition from rural agricultural land use to urban land use without mitigation has the potential reduce ET and recharge and increase runoff. Increased runoff can result in increased flooding risk and reduction in recharge can reduce groundwater discharge that supports aquatic and terrestrial habitats. The existing water balance informs the stormwater management plans that seek to maintain the pre-development water balance at a subcatchment to subwatershed level, based on an understanding of the factors (e.g., variability in hydraulic conductivity) that influence the spatial and temporal variability in runoff and groundwater flow/discharge. Areas that currently have a higher percentage of precipitation that supports recharge (e.g., areas that are sandier with higher hydraulic conductivity) may require more infiltration management/mitigation measures where these recharge areas support aquatic or terrestrial habitats compared to less permeable areas.

The Oak Ridges Moraine Groundwater Program Website (Oakridgeswater.ca) provides a water balance tool that estimates water balance parameters (i.e., ET, runoff, recharge [see Drawing GW-9], and precipitation) across their jurisdiction. The water balance values were estimated from a model developed by the ORMGP (ORMGP 2018a) and based on a 10-year climate record from 2004 to 2014. The ORMGP considers the values to be preliminary and will eventually be verified against other hydrological data (e.g., streamflows and groundwater levels; ORMGP 2018a). Precipitation is estimated to vary by up to 25 mm/year among the smaller catchments within the FSA and this variation is due to the spatial resolution of the precipitation data applied by ORMGP (~10km grid). The water balance tool was applied for the purposes of the scoped subwatershed study for determining the water balance for each portion of the seven subwatersheds that are present within the FSA (Table 2.3.1.3).

Water balance values were quite similar among the seven subwatersheds (i.e., within 25 to 40 mm of each other; Table 2.3.1.2) as a result of the similarity of the physical conditions throughout the FSA (e.g., similar surficial geology [largely finer grained till], land use [non-urban], and ground surface topography). The water balance will be revisited in later stages of the study for both pre- and post- development conditions once the SABE is defined. Therefore, the level of infiltration or runoff mitigation will be similar throughout all areas in the FSA.

Table 2.3.1.2. Existing Conditions Water Balance (Focus Study Area)

Authority	Watershed	Subwatershed	Total Area in FSA (km^2)	P	ET	RO	R	ΔS
				(mm/year)				
CVC	Credit River	Credit River - Glen Williams to Norval	0.23	810	545	140	120	5
		Fletcher's Creek	1.91	810	535	150	120	5
		Huttonville Creek	0.43	810	515	175	115	5
TRCA	Humber River	Main Humber	4.31	785	520	150	105	10
		West Humber	53.39	790	530	135	120	5
	Etobicoke Creek	Spring Creek	0.07	790	520	155	105	10
		Upper Etobicoke	20.25	800	520	140	135	5
			Average	**799**	**526**	**149**	**117**	**6**
			% of Average Precipitation	**100%**	**66%**	**19%**	**15%**	**1%**

P – Precipitation
ET – Evapotranspiration
RO – Runoff
R – Recharge
ΔS – Change in Storage

2.3.1.4.6 Groundwater Use

As summarized by ORMGP (2020), groundwater has been a source of municipal water supply for many communities near the FSA. Currently, groundwater-sourced water is supplying the communities of Cheltenham, Inglewood and Caledon East in the Town of Caledon, and Kleinburg in the City of Vaughan (Drawing GW-11, Appendix C) located northwest and east of the FSA. Previously, groundwater was also supplying other communities near the FSA, including the community of Bolton prior to 2002 that drew water from a deep sand and gravel aquifer.

Non-municipal takings located near the FSA consist of Permits to Take Water (PTTWs) and non-permitted takings (e.g., domestic takings). While there are no active groundwater PTTWs within the FSA itself, there are three PTTWs that are within 2 km of the FSA boundary (Drawing GW-11, Appendix C). These include:

- a permit for recreational purposes (PTTW# 6458-A3NP8A; maximum permitted taking = 576 m^3/day) located north of King St. and south of Castlederg Rd. The closest water well records to this PTTW from the Water Well Information System (WWIS) indicate this taking is likely from sandy overburden deposits.
- an agricultural permit for field and pasture crops (PTTW# 8343-A6QM2P; maximum permitted taking = 600 m^3/day) located west of The Gore Rd. and south of Castlederg Rd. This taking is recorded as being source from a pond which may be partially sourced by groundwater.
- a permit for dewatering purposes (PTTW# 4125-A6AQ6D; maximum permitted taking = 6,546 m^3/day) located within Bolton. This taking is from Bolton Well 5 which is known to be completed in a deep overburden aquifer.

Non-municipal, non-permitted takings surrounding the FSA, such as those for domestic purposes, are inferred through data from the provincial WWIS (Drawing GW-11, Appendix C). WWIS wells were further subdivided into those that are interpreted to be completed within overburden or bedrock based on whether a depth to bedrock was flagged for that record (Drawing GW-11, Appendix C). Where no depth to bedrock was flagged, the well was inferred to be completed in overburden. Where a depth to bedrock was flagged, the well was presumed to be completed in bedrock for the purposes of this assessment. These data indicate that the majority of the wells in the FSA are completed within the overburden as opposed to bedrock.

The capacity or quantity of water that a well can provide depends on the hydrostratigraphic unit the well is installed in, the nature of the sediments adjacent to the well, the lateral extent and thickness of the unit and the size of the well bore and screen length among other characteristics. Generally, the Oak Ridges Moraine aquifer unit can provide large capacity wells. The Thorncliffe and Scarborough Aquifers can provide large capacity wells although these aquifers may be more limited in extent within the FSA. Capacities are also reduced if more fine-grained material is prevalent in the vicinity of the well screen. Wells are also found within the Halton Till complex either in the discrete sand lenses or as large diameter bored/dug wells in the less permeable clay/silt. Capacities within the major aquifer units can range from 4 gallons per minute (gpm) to 100’s of gpm or 26 m^3/day to greater than 654 m^3/day. Wells within the Halton Till are generally less than 1 gpm (6.54 m^3/day).

2.3.1.4.7 Groundwater Quality

The quality of a groundwater sample can inform the overall potability of the water, and also has the potential to infer the source of that water. The ORMGP maintains an online repository of groundwater quality data associated with the wells in its database. Wells with water quality information within the FSA are shown on Drawing GW-12 in Appendix C, along with the inferred deposit that the well is completed within. Select water quality parameters and concentrations have been extracted from ORMGP (2018a) and are summarized in Table 2.3.1.3, along with the Ontario Drinking Water Quality Standard (ODWQS; Government of Ontario 2006).

Table 2.3.1.3. Groundwater Quality (ORMGP 2018a)

Parameter	ODWQS[1]	Concentration Range (mg/L for all parameters except T.U. for Tritium)				
		Halton Till	Oak Ridges Moraine	Newmarket Till	Thorncliffe Fm.	Undifferentiated Bedrock
Tritium	NS	n/a	n/a	n/a	n/a	0.8
TDS	500 [AO,+]	n/a	180 to 280	280	n/a	370 to 1,574
Iron	0.3 [AO,+]	0.05	0.09 to 0.17	0.04	0.4 to 1.2	0.02 to 0.44
Calcium	NS	59	12.0 to 14.0	43	35.5 to 98.0	19.9 to 135.1
Chloride	250 [AO,+]	12	1.8 to 16.0	2.5	15.0 to 174.0	24.2 to 748
Magnesium	NS	38	4.3 to 6.1	22	16.4 to 30.0	21.0 to 53.0
Nitrate	10 [MAC]	0.5	n/a	n/a	<0.005 to 0.6	0.1 to 2.6
Potassium	NS	2.9	1.0 to 2.5	1.5	1.6 to 7.4	2.4 to 11.6
Sodium	200 [AO,Na,+]	18	25.0 to 34.0	6.5	16.1 to 190.0	33.4 to 388.0
Sulphate	500 [AO,SO4,+]	30	3.6 to 18.0	8.3	2.1 to 440.0	13.8 to 184.3
Total Phosphorus	NS	n/a	0.1 to 0.5	0.4	0.02 to 0.2	n/a

n/a - data not available
NS – not specified
[1] - Ontario Drinking Water Quality Standard. Ontario Regulation 169/03 Ontario Drinking Water Quality Standards (Government of Ontario 2006) - Latest amendment as of Jan, 2018
[AO] - Aesthetic Objective
[Na] - the local Medical Officer or Health should be notified when sodium concentrations exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets
[SO4] - when sulphate levels exceed 500 mg/L, water may have a laxative effect on some people
[MAC] – maximum acceptable concentration
[+] - Technical Support Document for Ontario Drinking Water Quality Standards, Objectives and Guidelines (MOE 2006)

Policies exist within Wellhead Protection Areas (WHPAs) that have been delineated around municipal wells as part of the Source Water Protection program to protect the long-term quality of the groundwater supply. It may be necessary to restrict or even prohibit certain land uses in these areas due to the potential to impact groundwater as presented in Official Plans. WHPAs that have been delineated for the municipal wells located closest to the FSA are provided on Drawing GW-12 (ref. Appendix C); however, none of these WHPAs fall within the FSA. The WHPAs shown on Drawing GW-12 within the Region of Peel have been provided by the Region of Peel. The WHPAs outside of the Region of Peel were provided by the TRCA (Kleinburg Wells; Drawing GW-12, Appendix C).

Highly Vulnerable Aquifers (HVAs) have also been delineated as part of the Source Water Protection program. These refer to aquifers that are highly susceptible to contamination from both human and natural sources and, similar to WHPAs, certain land uses may be restricted within these areas as presented in Official Plans. The designations are based on factors such as soil types, depth and thickness of aquifer and overlying aquitard, groundwater velocity and potential man-made transport pathways. The distribution of HVAs in the FSA is shown on Drawing GW-12 (ref. Appendix C). Regionally, HVAs are predominant north of the FSA; however, some patches of HVAs are present throughout the FSA.

2.3.2 Surface Water

2.3.2.1 Site (FSA) Conditions

A baseline characterization of the hydrologic features and systems within the FSA has been developed based upon a desktop review of the background information provided for this study. This review has characterized the existing drainage systems, soils, slopes, and land use conditions within the FSA as well as the surrounding lands, and has established baseline return period peak flows and flood hazard mapping based upon currently approved modelling and mapping provided by TRCA and CVC.

Drainage Systems

The FSA primarily extends across the headwaters of the Upper Etobicoke Creek Subwatershed, West Humber River Subwatershed and the Main Humber Subwatershed within TRCA jurisdiction. Toward the west, the FSA lands fall within headwater reaches of the Credit River Watershed, encompassing the upstream limits of three (3) subwatersheds, namely the Credit River (Glen Williams to Norval) Subwatershed, Huttonville Creek Subwatershed and Fletcher's Creek Subwatershed. The subwatershed boundaries with respect to the FSA have been summarized on Drawing WR1 (ref. Appendix D). The approximate contributing drainage areas of the FSA within each subwatershed are summarized in Table **2.3.2.1**.

Table 2.3.2.1. Summary of Contributing Drainage Areas by Subwatershed

Watershed	Subwatershed	Total Subwatershed Drainage Area (ha)	FSA Contributing Lands	
			Area (ha)	% of Total
Credit River	Credit River – Glen Williams to Norval	2353	23	1.0 %
	Huttonville Creek	1510	43	2.8 %
	Fletcher's Creek	4169	186	4.5 %
Etobicoke Creek	Upper Etobicoke Creek	9978	2027	20.3 %
Humber River	West Humber River	20223	5335	26.4 %
	Main Humber River	35781	438	1.2 %

The portions of the FSA within the Etobicoke Creek and Humber River Watersheds discharge toward well-defined riverine systems and open watercourses, which extend throughout the respective portions of the FSA within each subwatershed. The portions of the FSA within the Credit River Watershed are within the upstream and eastern borders of the respective subwatersheds and drain towards watercourse features directly outside of the FSA limits.

Runoff from the FSA within the Upper Etobicoke Creek Subwatershed, West Humber River Subwatershed and Main Humber River Subwatershed is conveyed toward the main branches of the respective watercourses via several headwater drainage features and agricultural tile drains, and/or in the form of direct surface runoff and upper soil layer interflow. The primary watercourses through the FSA also receive and convey runoff from lands upstream and external to the FSA.

Soils

Surficial soils within the FSA and the surrounding areas have been characterized based upon a review of the GIS database (.dbf) and graphical (.shp) files for the surficial soil mapping, provided for use in this study. Surficial geology mapping for the FSA has been sourced online from the Ontario Geological Survey (MRD128 Revised, 2010). The surficial soil and geology mapping are presented in Drawing WR2-a and WR2-b respectively (ref. Appendix D).

The information on Drawing WR2-a indicates that the surficial soils present within the FSA consist primarily of Clay Loam, Sandy Loam and Clay. This blend of soils is noted to be also largely consistent with the lands external to the FSA, with some higher deposits of Loam in the northern part of the West Humber Subwatershed, and higher deposits of Clay moving downstream of the FSA in both the Etobicoke Creek and Humber River Watersheds.

The information on Drawing WR2-b indicates that the surficial geology within the FSA consists primarily of diamicton, which is a poorly sorted sediment containing a range of particle sizes. There are local occurrences clay, silt and sand, however the mapping suggests the FSA is predominantly diamicton. Similarly, areas to the north of the FSA consist of diamicton and local occurrences of clay, silt and sand. The areas of the Humber River Watershed located downstream of the FSA are largely clay and silt, which is similar to the findings of the surficial soil mapping. Overall, the soils within the FSA are considered to exhibit relatively low infiltration and comparatively high runoff potential.

Slopes / Topography

The ground slopes at the surface within the FSA have been characterized based upon the 1 m DEM file provided by TRCA for use in this study. The information in the DEM mapping indicates that the surficial slopes within the FSA are relatively steep and are generally greater than 2 % with some areas approaching slopes as high as 15 % or greater on the tableland near the open watercourses.

Land Use

Land use information provided by the Region of Peel has been used to characterize the existing land use condition within the FSA and surrounding area within the respective watersheds. The existing land use mapping is presented on Drawing WR3 (ref. Appendix D).

The existing land use conditions within the FSA are primarily agricultural, with the exception of land designated as an airport for the Brampton Flight Centre and Flying Club, two greenspace areas between Dixie Road and Airport Road in the West Humber River Subwatershed which represent two Golf Courses, the Banty's Roost Golf Course and the Mayfield Golf Course, as well as local occurrences of low-density residential land uses.

The lands toward the west and south of the FSA are primarily residential, with some institutional, commercial, and recreational land uses. The existing developments external from the FSA lie toward the south, within the Fletcher's Creek Subwatershed as well as the Etobicoke Creek Watershed and the West Huber Subwatershed. The existing development within the Fletcher's Creek Subwatershed and the West Humber subwatershed include stormwater management facilities which provide stormwater quality and quantity control for the existing developments within the respective watersheds. The lands toward the north, which lie upstream and external to the FSA, are primarily agricultural, with some forests and natural areas, and some isolated commercial, recreational, and estate residential land uses.

2.3.2.2 Climate and Monitoring Data

A desktop review of publicly available information from Environment Canada, TRCA and CVC has been completed to inventory the existing hydrometeorological datasets available for the FSA and the subwatersheds, as well as to provide a high-level characterization of the climate.

Climate Data

Climate data are critical to validating and calibrating the hydrologic and hydrogeologic/groundwater system modelling for characterization of the surface and subsurface water conditions, as well as the respective interactions for the three (3) primary watersheds, and the respective subwatersheds, potentially impacted by urban development in the FSA: Credit River, Etobicoke Creek and Humber River. Depending upon the available datasets, more robust analyses may be completed (i.e. long-term continuous simulation and frequency analyses), rather than the use of synthetic design storm events. Long-term and short-term meteorological data sets have been identified and reviewed for potential use in completing multi-seasonal, multi-year assessments for each of the watersheds as part of future studies.

A desktop review of available climate stations operated by Environment Canada (EC) and TRCA has been completed in order to provide an inventory of locations and durations of data collection (Note: no climate gauge data was provided by CVC). As noted above, this review of available sources allows for an assessment of data which would be required for conducting long-term continuous simulation of surface and groundwater movement through the system. The available gauge locations were provided in GIS shapefile format from TRCA, and coordinates for the EC gauges have been sourced from the online database. The available gauge locations with respect to the FSA have been summarized on Drawing WR7 (ref. Appendix D). It should be noted that any municipally owned/operated meteorological stations (i.e. Caledon, Bolton, Brampton), if available, have not been requested or reviewed as part of the current study, and may be utilized, if available, as part of future studies to augment the current dataset. The available meteorological datasets have been reviewed with respect to coverage in the FSA, in order to determine the type of data available, period of record, and time step of the data based upon publicly available databases. The results of this review are summarized in Table 2.3.2.2.

Table 2.3.2.2. Climate Monitoring Gauges and Sources

Ownership	Station ID	Data Type	Period of Record[1]	Time Step
Environment Canada	Sandhill (6157431)	Precipitation (Rain / Snow)	1981 – 2010 (retired)	Daily, Monthly
	Georgetown WWTP (6152695)	Precipitation (Rain / Snow) Temperature (Max / Min)	1962 – 2020 (active)	Daily, Monthly
	Toronto Pearson Airport (6158731)	Precipitation (Rain / Snow) Temperature (Max / Min) Windspeed	1953 – 2020 (active)	Hourly, Daily, Monthly
TRCA	Sue Grange Farms (HY061)	Precipitation (Rain / Snow)	2005 – 2019	N/A
	Heart Lake CA (HY033)	Precipitation (Rain / Snow) Temperature	2005 – 2020	N/A

Ownership	Station ID	Data Type	Period of Record[1]	Time Step
	Laidlaw Bus Depot / Tullamore (HY041)	Precipitation (Rain / Snow)	2013 – 2020	N/A
	Caledon East Soccer Complex (HY096)	Precipitation (Rain / Snow)	2015 – 2019	N/A
	King and Albion – Vaughn (HY037)	Precipitation (Rain / Snow)	2004 – 2020	N/A

Note: [1] Period of record may be not all inclusive – a completeness of record review is to be completed.

The information in Table 2.3.2.2 indicates that the Toronto Pearson Airport gauge provides the longest period of record of all stations. Recognizing that continuous simulation and frequency analysis requires a minimum of 20 years of rainfall for the hydrologic modelling, the Georgetown WWTP and Toronto Pearson Airport gauge represent the only stations with a sufficient period of record; it should be noted that the Toronto Pearson Airport gauge has an appropriate time-step (hourly) for use in continuous simulation, whereas the Georgetown WWTP has a daily time-step. Although the use of a single station would not account for the spatial and temporal variability of the rainfall within the study area, this is considered to be less significant for the purpose of conducting long term continuous simulation for subwatershed-scale analyses, recognizing the size of the study area.

As outlined in Table 2.3.2.2, the majority of the rainfall data proximate to the FSA is available through the monitoring network maintained by TRCA. As noted, the period of record of this dataset is of relatively short duration and is considered insufficient for conducting long-term continuous simulation. The period of record for these data is considered adequate for conducting hydrologic analysis for recent and shorter periods to support hydrologic model validation and refinement (pending confirmation of recorded time-step and quality of recorded data). Furthermore, the number of stations available is considered to adequately address the spatial and temporal variability of rainfall, which is of potential importance for model calibration and/or validation to observed streamflow data. It should be noted that while there are a number of precipitation gauges throughout the watersheds, there are no climate stations gauges located within or proximate to the FSA in the Fletcher's Creek and Huttonville Creek Subwatersheds. Furthermore, although precipitation gauges are located proximate to the FSA within the Etobicoke Creek Watershed and the Humber River Watershed, additional monitoring is recommended as part of future studies local to, and preferably within, the FSA to collect local meteorological data for calibrating and validating hydrologic modelling of the FSA.

Characterization and Interpretation

The Toronto Pearson Airport gauge Climate Normals (1981-2010) have been used to characterize the climatic condition within the FSA. Based upon the historical record from the Toronto Pearson Airport gauge, the mean annual precipitation in the FSA is approximately 786 mm. The winter months (i.e. December, January and February) tend to be the driest months, with mean monthly precipitation values ranging from 47.7 mm to 51.8 mm. The late spring and summer months (i.e. May through September) tend to be the wettest months, with mean monthly precipitation values ranging from 71.5 mm to 78.1 mm. High runoff conditions may occur during the months of November, December, February and March, when the ground is saturated or frozen and runoff conditions may be augmented by snowmelt.

As noted, the FSA lies within the headwaters of three (3) main watersheds, the Credit River, Etobicoke Creek and Humber River watersheds. The climatic conditions within the FSA are characteristic of the conditions elsewhere in southern Ontario, exhibiting cool winters and hot summers, with precipitation patterns exhibiting a seasonal variation of snowfall and rainfall depending upon temperatures.

It is recognized that precipitation patterns are evolving with climatic changes. Southern Ontario in the last 5 years has seen a number of '100 year storm events'. The frequency of the larger storm events appears to be increasing and meteorological data collected prior to the year 2000 may not provide an accurate basis of the precipitation trends to come.

It is also recognized that precipitation may be impacted by changes in daily temperatures. Southern Ontario has been noted to be generally trending toward milder winters. The results of milder temperatures are understood to be reduced snow pack depths, more frequent runoff events when precipitation occurs as rainfall during 'winter' and a reduced spring freshet.

Streamflow Monitoring Data

In addition to climate data, stream flow monitoring is required for hydrologic model calibration/validation, as well as overall characterization of the area watersheds. Similar to the climate data, stream flow monitoring networks operated by Environment Canada, TRCA and CVC have been reviewed and summarized for data type, method of collection, period of record and time steps in order to assess the quality of the data source for future modelling exercises, and identify any gaps accordingly. This information is summarized on Drawing WR7 and Table 2.3.2.3.

Table 2.3.2.3: Stream Flow Monitoring Gauges and Sources

Ownership	Station ID	Data Type	Collection Method / Notes	Period of Record[1]	Time Step
Environment Canada	Etobicoke Creek at Brampton (02HC017)	Flow & Water Level	Continuous / Recorder from 2003 – 2020	1957 – 2020 (active)	5 mins (real time)
	West Humber at Hwy 7 (02HC031)	Flow & Water Level	Continuous / Recorder from 2002 – 2020	1965 – 2020 (active)	5 mins (real time)
	Cold Creek near Bolton (02HC023)	Flow & Water Level	Continuous / Recorder from 2004 – 2020	1962 – 2020 (active)	5 mins (real time)
TRCA	Etobicoke @ 410 (HY101)	Water Level	Sensors	2017 – 2020	N/A
	Etobicoke at Brampton[2]	Water Level	Sensors	2007 – 2020	N/A
	Etobicoke at Dixie and Derry[2]	Flow & Water Level	Sensors	2012 – 2020	N/A
	Humber at Goreway[2]	Flow & Water Level	Sensors	2012 – 2020	N/A
	West Humber at HWY 7[2]	Flow & Water Level	Sensors	2007 – 2020	N/A
	Claireville Dam[2]	Water Level	Sensors	2007 – 2020	N/A
	Bolton McFall Dam (HY006)	Flow & Water Level	Sensors	2007 – 2020	N/A
CVC	EM7	Flow & Water Level	N/A	2012 – 2019	15 mins

Ownership	Station ID	Data Type	Collection Method / Notes	Period of Record[1]	Time Step
	EM8	Flow & Water Level	N/A	2012 – 2019	15 mins
	Fletchers Cr @Hwy7	Water Level	N/A	2010 – 2019	15 mins
	Fletchers Cr @Hwy7	Flow	N/A	2015 – 2018	Daily Avg
	Fletchers Cr @ 2ndLine	Water Level	N/A	2010 – 2019	15 mins
	Fletchers Cr @ 2ndLine	Flow	N/A	2015 – 2019	Daily Avg
	Huttonville Creek @ Lionhead Golf Course	Water Level & Air Temp	N/A	2013 – 2019	15 mins

Note: [1] Period of record may be not all inclusive – a completeness of record review is to be completed.
[2] These stream flow gauges have been identified by Wood Staff and sourced from TRCA's Real Time Data Explorer website, as these locations were not included in the provided shapefile; therefore, the IDs are currently unknown.

The stream flow monitoring stations within CVC jurisdiction indicate reasonable spatial coverage within the headwaters, with two (2) stream flow and water level gauges within Huttonville Creek, capturing the two primary tributaries, and one (1) stream flow and water level gauge located within Fletcher's Creek, capturing four (4) tributaries. The small western portion of the FSA which drains to the Credit River (Glen Williams to Norval) does not appear to have a stream flow monitoring station, which would indicate a potential gap for characterizing the lands draining to this local tributary.

As for the Etobicoke Creek systems, there are several stream flow monitoring locations located further downstream within the Watershed which are owned/operated by both TRCA and Environment Canada. The most upstream station is located north of Mayfield Road at the Highway 410, which captures all headwater drainage, including four (4) main and several smaller tributaries, since 2017. This flow station is sufficiently resolute to characterize the larger headwaters system in recent years, however, is not sufficiently resolute to characterize the hydrology within the FSA or to parameterize the hydrologic model locally within the FSA.

Similar to Etobicoke Creek, the monitoring stations within the Humber River Watershed are primarily located further downstream, at larger confluence points and would be insufficient to characterize the hydrology or parameterize the hydrologic model locally within the FSA. This indicates that the potential impact on the various tributaries which flow throughout the FSA may be missed as a result of the insufficient resolution of stream flow within the headwaters. This is particularly prevalent for the West Humber River, which has the largest proportion of FSA lands within the headwater drainage areas.

In addition to the stream flow monitoring locations outlined in Table 2.3.2.3, TRCA provided a number of baseflow monitoring locations throughout the Upper Etobicoke Creek and West Humber River Subwatersheds (ref. Drawing WR7, Appendix D), for which baseflow (low flow) spot measurements have been collected. This information indicates a sufficiently resolute data set for baseflow measurements, as there are a number of sites both within the FSA limits and further downstream. This information can also be used in hydrologic model validation/calibration to characterize low flow conditions and provide further insight into groundwater and surface water interactions, although additional streamflow monitoring local to the FSA should be conducted to provide a local calibration and/or validation of hydrologic modelling for the FSA. The lack of flow data local to the FSA is noted for all watersheds and subwatersheds, hence this information should be collected as part of future studies to inform the local calibration and validation of the hydrologic modelling for future studies for the FSA.

Surface Water Quality Monitoring

The purpose of the surface water quality assessment has been to review the existing and available surface water quality monitoring data available to characterize the aquatic health of the subwatersheds and tributaries with respect to contaminant loadings under existing land use conditions. Additionally, this review has included a preliminary characterization of the surface water chemistry and quality, and has identified potential data gaps for establishing future surface water quality monitoring plans to develop a thorough baseline condition for the FSA, which would be used in subsequent study phases.

Available surface water quality monitoring data have been provided by TRCA and CVC for twelve (12) locations in close proximity to the FSA. An additional eight (8) surface water monitoring locations in proximity to the FSA have been sourced from the Provincial Water Quality Monitoring Network (PWQMN), which is owned and operated by the Ministry of Environment, Conservation and Parks (MECP). The surface water quality monitoring station locations are shown in Drawing WR8 (ref. Appendix D), and Table 2.3.2.4 provides a summary of the monitoring stations in each subwatershed and the associated period of record.

Table 2.3.2.4. Surface Water Quality Monitoring Gauges and Period of Record

Ownership / Provider	Watershed	Station ID	Monitoring Condition	Period of Record
TRCA	Etobicoke Creek	Mayfield	Unknown	2015-Jan to 2018-Mar
	Etobicoke Creek	Mayfield-EC1	Unknown	2016-Jan to 2018-Mar
	Etobicoke Creek	Mayfield-EC3	Unknown	2016-Jan to 2018-Mar
	Etobicoke Creek	Mayfield-EC4	Unknown	2016-Jan to 2018-Mar.
	Etobicoke Creek	Mayfield-EC6	Unknown	2016-Jan to 2018-Mar.
	Humber River	6008300902	Unknown	2015-Jan to 2018-Dec.
	Humber River	6008301802	Unknown	2015-Jan to 2018-Dec.
CVC	Fletcher's Creek	501050001 (Fletcher's Creek d/s Hwy 7)	Unknown	2015-Jan to Nov. 2017-Jan to Nov. 2019 -Jan to Sep.
	Fletcher's Creek	501050002 (Fletcher's Creek d/s Steeles Ave)	Unknown	2008-Jan to 2019 Apr.[1]
	Fletcher's Creek	501050005 (Fletcher's Creek u/s 2nd Line)	Unknown	2014-Aug to Nov. 2015-Jan to 2019 Sep.[1]
	Huttonville Creek	501070008 (Huttonville Creek @ Lionhead Golf & Country Club)	Unknown	2014-Aug to Nov. 2016-Jan to Nov. 2018 -Jan to Nov.
	Huttonville Creek	EM7	Wet and Dry weather condition	2013-May to Oct. 2015-June to Aug.
	Huttonville Creek	EM8	Wet and Dry weather condition	2013-June to Oct. 2015-June to Aug.
MECP	Etobicoke Creek	06008000602	Unknown	2002 – 2016[2]

Ownership / Provider	Watershed	Station ID	Monitoring Condition	Period of Record
	Etobicoke Creek West	06008000702	Unknown	2002 – 2016[2]
	Humber River	06008301902	Unknown	1979 – 2016[2]
	Humber River West	06008310302	Unknown	2002 – 2016[2]
	Cold Creek	06008300902	Unknown	1969 – 2016[2]
	Credit River	06007600302	Unknown	1965 – 2016[2]
	Credit River	06007601702	Unknown	1975 – 2016[2]
	Fletchers Creek	06007601602	Unknown	1975 – 2016[2]

Note: [1] No samples were taken in December.
[2] A period of record check for the MECP PWQMN stations has not yet been completed, therefore the inclusivity of the noted period of record is currently unknown.

The data in Table 2.3.2.4 indicate that all monitoring locations, except for EM7 and EM8, consist of grab samples collected on a monthly basis and have not distinguished the sampling conditions as either wet or dry weather conditions. Further details regarding the conditions under which the sampling was conducted would be required prior to assessing the adequacy of the data and providing recommendations for supplemental monitoring. As for monitoring locations EM7 and EM8, located along Huttonville Creek, these sampling records have distinguished between wet weather and dry weather sampling, according to the condition under which the samples were collected. The water quality parameters tested at each of the monitoring locations are summarized in Table 2.3.2.5.

Table 2.3.2.5. Water Quality Parameters

Ownership/Provider	Class	Parameters
TRCA	Materials	Boron, Magnesium, Beryllium, Silver, Cobalt, Iron, Chromium, Copper, Molybdenum, Mercury, Strontium, Vanadium, Barium, Zinc, Lead, Titanium, Aluminium, Arsenic, Cadmium, Nickel, Selenium, Manganese
	Nutrients	Potassium, Nitrite, Nitrogen, Kjeldahl (TKN), Nitrate, Ammonia, Phosphorus, Phosphate (SRP/Orthophosphate)
	Bacteria	Escherichia coli (E. coli)
	General	Dissolved Solids (TDS), Bromide, Biochemical Oxygen Demand (BOD), Alkalinity, Conductivity, Temperature, Turbidity, Hydraulic Head (Field), Sodium, Chloride, Dissolved Oxygen, Calcium, pH, Suspended Solids (TSS), Hardness, Sulphate
CVC – (Station 501050001, 501050002, 501050005 and 501070008)	Materials	Aluminum, Copper, Iron, Zinc
	Nutrients	Ammonia, Nitrate + Nitrite, NO2, Total Phosphorus
	Bacteria	-
	General	Chloride, pH, TSS
CVC – Station EM7 and EM8	Materials	Aluminum, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Dissolved Magnesium, Magnesium, Manganese, Antimony, Molybdenum, Nickel, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Arsenic, Thallium , Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc, Zirconium, Barium,

Ownership/Provider	Class	Parameters
		Tellurium, Beryllium, Bismuth, Boron, Cadmium, Dissolved Calcium, Calcium, Organic Carbon
	Nutrients	Nitrite, Orthophosphate, Kjeldahl Nitrogen, Nitrate + Nitrite, Nitrate, Dissolved Phosphorus, Phosphorus, Ammonia-N
	Bacteria	Escherichia coli
	General	Hardness, Alkalinity, BOD, pH, Conductivity, Dissolved Chloride, Suspended Solids, Dissolved Solids
MECP (PWQMN)	Nutrients	Nitrates, Phosphorous
	General	Chloride, Suspended Solids

The information in Table 2.3.2.5 indicates that all surface water quality sampling in TRCA's jurisdiction and two (2) stations (i.e. EM7 and EM8) in CVC jurisdiction have been analyzed for a wide range of water quality parameters. The monitoring conducted in the Fletcher's Creek Subwatershed in CVC jurisdiction has only evaluated twelve (12) water quality parameters.

Statistical analyses have been completed based upon the wet weather monitoring data to determine the range, mean, and median concentrations for representative indices of surface water chemistry. As mentioned previously, only the dataset received from CVC for monitoring locations EM7 and EM8 (Huttonville Creek) distinguished between wet weather and dry weather condition water samples for the monitoring periods of 2013 and 2015, hence have been used for this assessment. The events for which grab samples have been obtained at these locations, as well as the conditions under which the samples have been obtained, are summarized in Table 2.3.2.6.

Table 2.3.2.6. Summary of Events Monitored for Water Quality by Grab Sampling at EM7 and EM8

Sample Date	Monitoring Condition	Monitoring Station	
		EM7	EM8
May 28, 2013	Wet	X	-
May 29, 2013	Wet	X	-
June 10, 2013[1]	Wet	X	X
June 11, 2013	Wet	X	X
July 3, 2013	Wet	-	X
July 4, 2013[1]	Wet	X	X
July 16, 2013	Dry	X	X
July 31, 2013	Wet	-	X
August 1, 2013	Wet	-	X
August 19, 2013	Dry	X	X
September 6, 2013	Dry	X	X
September 20, 2013	Wet	X	-
September 21, 2013	Wet	-	X
September 22, 2013	Wet	X	-
September 23, 2013	Wet	-	X
October 7, 2013	Wet	X	X
October 8, 2013	Wet	X	X
June 22, 2015	Dry	X	X
July 13, 2015[1]	Dry	X	X
August 31, 2015[1]	Dry	X	X

Note: [1] Two samples were taken.

The information in Table 2.3.2.6 indicates that the monitoring station EM7 has a total of 16 samples (6 dry weather and 10 wet weather) and the station EM8 has total of 19 samples (8 dry weather and 11 wet weather samples). The information also indicates that all the wet weather samples were taken in 2013 while the dry weather samples were taken in 2013 as well as in 2015. It should be noted that typically, one year of water quality monitoring (wet conditions) is insufficient to provide a reliable characterization; however, this data can be used to provide potential indication of the surface water chemistry for the area.

Statistical analyses have been completed and the computed range, mean, and median concentrations for representative indices of surface water chemistry based upon wet weather monitoring data at EM7 and EM8 in the Huttonville Creek Subwatershed, are presented in Table 2.3.2.7.

Table 2.3.2.7: Summary of the Wet Weather Condition Event Mean Concentrations (EMC's) at EM7 and EM8 (mg/L unless otherwise noted)

Contaminant	EM8			EM7		
	Range	Mean	Median	Range	Mean	Median
Total BOD	<2 - 6	6	6	<2 - 3	2.5	2.5
Escherichia coli (CFU/100mL)	N/A	N/A	N/A	N/A	N/A	N/A
Total Kjeldahl Nitrogen (TKN)	0.6 - 4.4	1.393	1.045	1.3 - 7	2.6	1.9
Total Phosphorus	0.043 - 0.45	0.195	0.0895	0.25 - 3.5	0.92	0.49
Total Copper (Cu)	0.008 - 0.032	0.0155	0.0105	0.0097 - 0.058	0.0652	0.033
Total Zinc (Zn)	0.006 - 0.058	0.023	0.014	0.013 - 0.84	0.197	0.074
Total Lead (Pb)	0.00055 - 0.0085	0.0031	0.0010	0.0019 - 0.25	0.0561	0.02
Nitrate + Nitrite	1.3 - 5.9	2.70	2.05	1.1 - 5.3	3.21	3
Total Suspended Solids	18 - 300	104.8	50.5	28 - 2100	485	260

The results in the Table 2.3.2.7 indicate that the mean and median concentrations of metals (i.e. Copper, Zinc, and Led) for EM7 are higher than that for EM8. Based on the existing condition land use (ref. Drawing WR3), most of the contributing drainage area to EM7 is undeveloped agricultural lands while EM8 receives drainage from undeveloped land as well as urbanized/developing lands.

The median concentration values for the observed data at the above mentioned stations have been compared to the values reported in areas with similar physiographic conditions, as well as to the values documented in the Toronto Wet Weather Flow Study and Red Hill Creek Watershed Plan in the City of Hamilton, as well as findings from other water quality monitoring programs completed within the GTA for areas of similar land use and physiography. This comparison is shown in Table 2.3.2.8

Table 2.3.2.8. Comparison of Wet Weather Condition Median Water Quality Parameter Values at EM8 and EM7 with Literature Values from Water Quality Models/Studies for Similar Physiographic Conditions (mg/L unless otherwise noted)

Contaminant	Observed Data (2013)		Water Quality Models (Wet Weather Data)		Sixteen Mile Creek Subwatershed Update Study (2015)	Premier Gateway Study	Milton MESP Study	Mayfield West CEIS & MP (2014)			City of Bampton Subwatershed Study - 2011Huttonville Creek		
	EM8	EM7	TWWF	RHCWP				Q1	Q2	Q3	H1	H2	H3
BOD/CBOD	6	2.5		2	3	-	5.0	<2	<3	<2	2.7	1.2	2.4
E. coli (#/100mL)	-	-	100,000	-	126	-	990	300	210	490	>10,947	>16,179	>10,348
TKN	1.045	1.9	1	2.8	1.2	0.47	0.8	0.90	2.55	0.90	1.7	1.5	1.8
Total P	0.0895	0.49	0.2	0.5	0.20	0.031	0.1	0.09	0.22	0.07	0.4	0.3	0.45
TSS	50.5	260	100	400	10	6	17.5	<33	65	<19	54.6	135.4	88.2
Copper (ug/L)	10.5	33	8	5	3	0.99	4.5	2	3.5	2.0	10	11	12
Zinc (ug/L)	14	74	18	10	8	0.98	9.7	<5	<5	<8.5	30	38	32
Lead (ug/L)	1	20	4	-	0.6	3.95	1.4	<0.8	<0.5	<0.7	4	5	4
Nitrate + Nitrite	2.05	3	2.5	-	0.25	0.17	0.2	0.4	1.15	0.30	0.8	6.2	2.6

The results in Table 2.3.2.8 indicate that the median concentrations of key water quality indicators except for metals (i.e. Copper, Zinc, and Led), are comparable to the reported values elsewhere with similar physiographic conditions. It is also noted that the values reported in the North-West Brampton Subwatershed Study for the Huttonville and Fletcher's Creeks (AMEC, 2011) are comparable with computed mean contaminant loadings under wet weather conditions at both EM8 and EM7. The Total Suspended Solids (TSS) measured at both EM7 and EM8 indicate higher than normal levels when compared to other reported values, which is an important indicator in overall water quality, and is the key parameter in sizing and assessing SWM performance.

The surface water quality monitoring results have been compared to the current Provincial Water Quality Objectives (PWQO) for various contaminants, in order to determine the number of exceedances under existing land use conditions. As previously mentioned, the majority of the water quality data provided do not specify the sampling condition; therefore, the PWQO exceedances analysis has been conducted for all available samples, regardless of weather conditions. The results of these analyses for the monitoring locations in each subwatershed are presented in Table 2.3.2.9 to Table 2.3.2.12.

Table 2.3.2.9. Water Quality Objective (PWQO) Exceedances for Monitoring in Huttonville Creek Subwatershed

Contaminants	Limit	Monitoring Site ID		
		EM8	EM7	501070008
Arsenic	100 ug/L	0 (19)	0 (16)	-
Beryllium	1100 ug/L	0 (19)	0 (16)	-
Cadmium	0.2 ug/L	0 (19)	3 (16)	-
Cobalt	0.9 ug/L	6 (19)	9 (16)	-
Copper	5 ug/L	11 (19)	10 (16)	1(27)
Iron	300 ug/L	14 (19)	10 (16)	7(27)
Lead	25 ug/L	0 (19)	2 (16)	-
Nickel	25 ug/L	0 (19)	2 (16)	-
Selenium	100 ug/L	0 (19)	0 (16)	-
Silver	0.1 ug/L	1 (19)	3 (16)	-
Zinc	20 ug/L	5 (19)	8 (16)	0(27)
Nitrite	0.06 mg/L	4 (16)	4 (16)	-
Nitrate	2.9 mg/L	1 (16)	12 (16)	-
Fecal coli (including E. Coli)	100 CFU/100mL	5 (6)	6 (6)	-

Note: The number in the brackets represents the total number of samples.

Table 2.3.2.10. Water Quality Objective (PWQO) Exceedances for Monitoring in Fletcher's Creek Subwatershed

Contaminants	Limit	Monitoring Site ID		
		501050001	501050002	501050005
Arsenic	100 ug/L	-	-	-
Beryllium	1100 ug/L	-	-	-
Cadmium	0.2 ug/L	-	-	-
Cobalt	0.9 ug/L	-	-	-
Copper	5 ug/L	1(31)	41(125)	7(57)
Iron	300 ug/L	20(31)	64(125)	-
Lead	25 ug/L	-	-	-
Nickel	25 ug/L	-	-	-
Selenium	100 ug/L	-	-	-
Silver	0.1 ug/L	-	-	-
Zinc	20 ug/L	0(31)	36(125)	3(57)
Nitrite	0.06 mg/L	-	-	-
Nitrate	2.9 mg/L	-	-	-
Fecal coli (including E. Coli)	100 CFU/100mL	-	-	-

Note: The number in the brackets represents the total number of samples.

Table 2.3.2.11. Water Quality Objective (PWQO) Exceedances for Monitoring in Etobicoke Creek Subwatershed

Contaminants	Limit	Monitoring Site ID				
		Mayfield	Mayfield-EC1	Mayfield-EC3	Mayfield-EC4	Mayfield-EC6
Arsenic	100 ug/L	0(51)	0(30)	0(30)	0(30)	0(30)
Beryllium	1100 ug/L	0(51)	0(30)	0(30)	0(30)	0(30)
Cadmium	0.2 ug/L	1(51)	5(30)	8(30)	4(30)	8(30)
Cobalt	0.9 ug/L	1(51)	0(30)	1(30)	0(30)	4(30)
Copper	5 ug/L	1(51)	0(30)	2(30)	0(30)	2(30)
Iron	300 ug/L	15(51)	9(30)	21(30)	10(30)	30(30)
Lead	25 ug/L	0(51)	0(30)	0(30)	0(30)	0(30)
Nickel	25 ug/L	0(51)	0(30)	0(30)	0(30)	0(30)
Selenium	100 ug/L	0(51)	0(30)	0(30)	0(30)	0(30)
Silver	0.1 ug/L	0(43)	0(20)	0(20)	0(20)	0(20)
Zinc	20 ug/L	0(51)	0(30)	1(30)	0(30)	1(30)
Nitrite	0.06 mg/L	1(51)	0(30)	1(30)	1(30)	1(30)
Nitrate	2.9 mg/L	11(51)	4(30)	7(30)	7(30)	3(30)
Fecal coli (including E. Coli)	100 CFU/100mL	18(51)	12(30)	14(30)	11(30)	16(30)

Note: The number in the brackets represents the total number of samples.

Table 2.3.2.12. Water Quality Objective (PWQO) Exceedances for Monitoring in Humber River Watershed

Contaminants	Limit	Monitoring Site ID	
		6008300902	6008301802
Arsenic	100 ug/L	0(16)	0(18)
Beryllium	1100 ug/L	0(48)	0(50)
Cadmium	0.2 ug/L	27(48)	28(50)
Cobalt	0.9 ug/L	8(48)	5(50)
Copper	5 ug/L	0(48)	0(50)
Iron	300 ug/L	36(48)	11(50)
Lead	25 ug/L	0(48)	0(50)
Nickel	25 ug/L	0(48)	0(50)
Selenium	100 ug/L	0(16)	0(18)
Silver	0.1 ug/L	1(45)	1(46)
Zinc	20 ug/L	1(48)	0(50)
Nitrite	0.06 mg/L	0(16)	0(18)
Nitrate	2.9 mg/L	0(16)	0(18)
Fecal coli (including E. Coli)	100 CFU/100mL	16(48)	13(49)

Note: The number in the brackets represents the total number of samples.

The results in Table 2.3.2.9 to 2.3.2.12 indicate the following:

- The data indicate several PWQO exceedances across all subwatersheds with respect to certain metals, such as Cadmium, Cobalt, Copper and Iron.
- The Huttonville Creek and Upper Etobicoke Creek Subwatersheds were both found to have PWQO exceedances of Nitrite and Nitrate.
- All subwatersheds, with the exception of Fletcher's Creek (not monitored), have measured PWQO exceedances with respect to E. Coli.

The results of the above assessment indicate that the surface water quality along the reaches of the Upper Etobicoke Creek, Humber River, and Huttonville Creek through and downstream of the FSA is generally good, compared to current PWQO standards and surface water chemistry reported in literature. The water quality varies among the evaluated parameters and across the available sites, with local exceedances shown with regards to metals, nutrients, microorganisms and TSS. Although it should be noted, that

It should be noted that this assessment has been based upon desktop review of the water quality data available for this study; as such there are limitations relating to the data and resulting assessment, based upon the duration of record and sampling conditions at certain locations. Further analysis and comparison between wet weather and dry weather, as well as multi-year / seasonal samples will help to better characterize the FSA and identify trends in water quality.

The following have been noted and should be taken into consideration for future study / data needs:

- The water quality dataset received for Fletcher's Creek Subwatershed does not have a sufficient number of water quality parameters in order to properly characterize the water quality condition of the subwatershed under existing land use. The only water quality monitoring stations within the bounds or in close proximity to the FSA belong to the Mayfield monitoring network in the Upper

Etobicoke Creek system. This demonstrates a data gap within the other hydrologic systems in the FSA, including both the upper Humber River and Huttonville/Fletchers Creek systems.

- In the information provided, there was no detailed water quality data and/or monitoring locations for the West Humber Subwatershed; seeing as a significant portion of the FSA is located within the West Humber Subwatershed, water quality monitoring data is a crucial element in order to properly characterize the subwatershed under existing land use conditions.
- Of the water quality data provided, there is visible variability across all sources – this includes the materials included in the lab analysis, the period of record and the conditions for which the samples were collected. A further review across all sources should be completed to ensure harmonious data collection and analysis, in order to provide a consistent characterization and baseline condition across the FSA.
- Further details are required regarding the weather conditions for which the samples were conducted; this will allow for further analysis and characterization of both wet and dry water quality conditions. Although the available water quality data captures the overall health of the system, and is thus useful for holistic monitoring programs, the information within and proximate to the FSA is considered insufficient to characterize the surface water chemistry locally.

The locations of the water quality monitoring are considered sufficient for characterizing the surface water chemistry within the Fletcher's and Huttonville Creek Subwatersheds, and for providing a local and holistic characterization of the surface water chemistry within and downstream of the FSA for the Etobicoke Creek Watershed. However, the current surface water quality monitoring locations are not considered sufficient for characterizing the local surface water chemistry for the FSA within the Fletcher's and Huttonville Creek Subwatersheds, nor are any locations provided within the Humber Watershed for providing a local or holistic characterization of the surface water chemistry for the FSA. Furthermore, as indicated previously, the water quality parameters evaluated vary among the monitoring stations, and there is no clear distinction between wet weather and dry weather conditions during sampling. As such, these gaps and inconsistencies among the datasets should be addressed as part of future water quality monitoring programs for studies supporting development within the FSA.

2.3.2.3 Hydrology and Hydraulics

The purpose of developing hydrologic and hydraulic models for urbanizing subwatersheds is to provide a better understanding of the operative factors which influence the amount and rate of water movement in the system both under existing land use and proposed future land use conditions. By developing representative models, which reasonably predict seasonal and storm-based runoff response, the impacts of proposed future urbanization can be better quantified and thereby appropriate management strategies can be established in the future, as part of integrated water and ecological management plans.

Hydrologic and hydraulic modelling for both the Etobicoke Creek and Humber River Watersheds have been provided by TRCA for review and scoped use within the current study; these Watersheds represent the primary systems/receivers, as the FSA is primarily within these two watersheds. The Credit River Watershed and associated tributaries have been characterized from a review of legacy studies for the Huttonville Creek and Fletcher's Creek receivers. A high-level review of the existing hydrologic and hydraulic modelling has been completed in order to identify key components relating to the characterization of the FSA, and also provide guidance with respect to any gaps and future needs.

Hydrologic Model Review

As part of the baseline characterization of the hydrologic conditions within the FSA, a desktop review of the previously completed hydrologic models for the Etobicoke Creek, Humber River and Credit River Watersheds has been completed to summarize the current level of modelling and the applicability to the FSA, and to thereby identify any gaps and potential needs for future modelling refinements or updates.

Etobicoke Creek

The most recent hydrology study for the Etobicoke Creek Watershed was completed by MMM Group Limited in April 2013, which utilized Visual OTTHYMO Version 2.4 (VO 2.4) as the primary modelling platform (ref. Etobicoke Creek Hydrology Update, MMM Group, April 2013). This work included updating the previous VO hydrologic models, originally developed in 1996 and subsequently updated in 2003 and 2007, and development of stormwater management quantity control criteria to inform management and planning for existing and future developments.

The study area for the April 2013 hydrologic update encompassed the entire Etobicoke Creek Watershed, which spans over 200 km^2 in area. This modelling area was divided into eight (8) subwatersheds, represented by twelve (12) sub-basins. The subcatchment discretization resulted in a total of 280 subcatchments, ranging in area from 2 ha (i.e. small development site) to 500 ha (undeveloped rural areas of the headwaters), with an average drainage area of approximately 80 ha. Consistent with the legacy models for the Etobicoke Creek watershed, the SCS Curve Number method was used to model the rainfall-runoff relationship. The subcatchment boundaries corresponding to the April 2013 Etobicoke Creek model update are presented on Drawing WR4a.

The model included a total of 143 routing elements, representing the open watercourse reaches within the watershed. The Etobicoke Creek Watershed has three (3) unique hydrological features which required specific methodology (additional routing, rating curves and storages), for inclusion in the modelling; these features included the Brampton Esker system, the Downtown Brampton by-pass channel and the City of Toronto storm sewer system (major/minor split).

Additionally, a number of online storage and stormwater management (SWM) facilities were included in the modelling based upon design records; a total of 57 storage elements were incorporated in the model, including 33 SWM facilities designed for storm events up to the 100-year event, and 24 SWM facilities only providing quality control and erosion control storages. These SWM facilities were removed from the modeling as part of the Regional Storm simulation, in accordance with MNRF protocols. The SWM facilities within the watershed are presented on Drawing WR9, based upon registered waterbody mapping data.

As a result of the modelling software chosen for the study [i.e. Visual OTTHYMO (VO)], the hydrologic analyses completed for the April 2013 study applied a synthetic design storm methodology. The synthetic design storm simulation included the 2-year through to the 100-year event, as well as the 350 year and Regional Storm. Various storm distributions of different durations were evaluated to determine the most conservative design storm simulation for the watershed, including Chicago (3, 4, and 12 hours), AES (1, 6, 12 and 24 hours) and SCS Type II (6, 12 and 24 hours). The 12-hour AES rainfall distribution, was ultimately applied for the April 2013 study, which is consistent with TRCA protocols for other urban watersheds (i.e. Humber and Rouge River watersheds), as this was found to generate the most conservative peak flows for the study area.

Table **2.3.2.13** summarizes the existing conditions design storm peak flows for the primary nodes along the Etobicoke Creek from the headwaters (FSA) downstream to Downtown Brampton. The primary flow nodes from the previous hydrologic study are shown on Figure WR-4a.

Table 2.3.2.13. Etobicoke Creek - Existing Conditions Peak Flows (Synthetic Design Storms)

Key Flow Node	Node ID	Drainage Area (ha)	12-hour AES – Peak Flow Rates (m³/s)					
			2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	1.265	1471	1.45	2.53	3.39	4.54	5.45	6.4
B	1.285	2096	2.05	3.61	4.82	6.45	7.75	9.03
C	1.615	2307	2.32	4.06	5.42	7.31	8.84	10.45
D	1.62	4716	4.7	8.27	10.99	14.71	17.65	20.76
E	2.03	5241	5.16	9.08	12.06	16.03	19.21	22.57
F	2.09	6479	30.27	40.59	47.99	57.38	64.66	72.02
Brampton	2.14	6912	26.81	38.54	47.29	58.16	66.76	75.69

For the simulation of the Regional Storm event, the saturated antecedent moisture condition (AMC III) was applied in the April 2013 hydrology study to account for the increase in soil moisture caused by the first 36 hours of the storm. In accordance with the MNR Technical Guide, 2002, all SWM facilities were removed for the Regional Storm simulation and areal adjustment factors were applied based on the equivalent circular area method. The existing conditions peak flow results and areal reduction factors for each of the primary headwater flow nodes are summarized in Table 2.3.2.14.

Table 2.3.2.14. Etobicoke Creek - Existing Conditions Peak Flows (Regional Storm)

Key Flow Node	Node ID	Drainage Area (ha)	Aerial Reduction Factor (%)	Hurricane Hazel Peak Flow (m³/s) – Without Ponds
A	1.265	1471	100	30.9
B	1.285	2096	100	44.1
C	1.615	2307	100	51.4
D	1.62	4716	99.2	100.8
E	2.03	5241	97.1	106.2
F	2.09	6479	94.8	149.5
Brampton	2.14	6912	93.5	171

Flow nodes A, B and C represent the headwater tributaries, which combine further downstream at the confluence node D, located at Hurontario Street, north of Highway 410. Flow node A appears to be the primary contributor to the downstream node B, by representing over 60% of the contributing drainage area and the resulting peak flow. The peak flows at the confluence further downstream (node D) demonstrate an approx. equivalent influence from both the B and C drainage areas, indicating a similar time to peak for both contributing systems.

Further downstream, large increases in peak flow can be seen from node E to F and Downtown Brampton under both the design storms, and Regional event simulations. The drainage area increase from node E to F is not as significant as those in the headwaters, therefore demonstrating that the increase in peak flow is largely attributed to the urbanization occurring within the local area and upper/central watershed. This suggests that the increased peak flows and associated flood risks may be more heavily influenced by the local urban drainage area, rather than the flows generated in the headwaters. Nonetheless, appropriate SWM design and implementation will be required to ensure control to existing conditions and minimize any timing/peak flow impacts further downstream.

Humber River

The most current hydrology study for the Humber River Watershed was completed by Civica Infrastructure Ltd. (ref. Humber River Hydrology Update, Civica Infrastructure, April 2018). This work included updating the future conditions modelling, building upon the previous existing conditions study completed by Civica in June 2015 (ref. Humber River Hydrology Update, Civica Infrastructure Ltd, June 2015). The focus for the 2018 study was to resolve inconsistencies in the future conditions land use scenario, and to update stormwater management quantity control criteria to inform management and planning for future developments.

The existing conditions model, developed as part of the 2015 study, represents the 2014 land use conditions for the Humber River Watershed, which spans across over 900 km^2 of land, reaching from the headwaters at the Niagara Escarpment and Oak Ridges moraine, down through flat plains to the marshes and river mouth at Lake Ontario. The hydrologic model for the watershed was built using Visual OTTHYMO Version 4 (VO4) with subsequent future conditions updates using Version 5 (VO5). The existing conditions model developed in 2015 was discretized into 714 subcatchments, of which 410 were modeled as rural areas (less than 20% impervious). The rainfall-runoff relationship was calculated using the SCS Curve Number method, based upon land use. The subcatchments delineated for the Humber River hydrology update are presented on Drawing WR4a.

The VO model contains a total of 768 routing elements (river segments) which convey runoff from the subcatchments throughout the river system. This model also contains 81 storage elements, which model stormwater management ponds, reservoirs, and lakes throughout the watershed. The SWM facilities within the Humber River watershed are presented on Drawing WR9, based upon registered waterbody mapping data.

The calibrated existing conditions model developed in 2015 was run using the 6, 12 and 24-hour AES synthetic design storms in order to evaluate the current (2015) requirements for quantity control in the Humber River. The results concluded that the 6 and 12-hour AES storms were the critical durations in terms of flooding throughout the watershed. Additional storms such as the 350-year and 500-year events were also simulated, although not recognized as regulatory events. The peak flows for nodes at the southern boundary of the FSA and select locations downstream under the design storm events are summarized in Table 2.3.2.15. The primary flow nodes from the previous hydrologic study are shown on Figure WR-4a.

Table 2.3.2.15: Humber River Watershed - Existing Conditions Peak Flows (Synthetic design storms)

Key Flow Node	Description	12-hour AES – Peak Flow Rates (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
43.20	West Humber – Mayfield between Coleraine and Humber Station	6.2	9.81	19.87	25.3	29.73	34.13
41.30	West Humber – Mayfield southwest of Humber Station	2.5	4.28	9.24	11.66	13.52	15.43
38.30	West Humber – Mayfield northeast of The Gore	2.1	3.72	29.64	38.38	45.25	52.32
35.70	West Humber – Mayfield southwest of Innis Lake	2.03	2.92	17.84	23.36	27.69	31.95
32.42	West Humber – Mayfield northeast of Torbram	1.88	3.41	28.46	37.25	43.99	51.07
29.50	Main Humber – Mayfield southwest of Bramalea	0.83	1.5	10.99	14.77	17.56	20.44

Key Flow Node	Description	12-hour AES – Peak Flow Rates (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
10.10	West Humber – Mayfield between Coleraine and Humber Station	3.08	4.88	25.02	34.35	42.27	51.15
40.30	Downstream Point of West Humber River	16.82	23.83	115.17	151.43	178.18	206.67
27.60	Downstream Point of Upper Main Humber River	53.68	77.44	113.47	147.95	176.02	208.31
49.70	Confluence Point - West and Main Humber River	74.09	109.51	238.34	303.01	361.1	419.79

For the simulation of the Regional Storm event, the saturated antecedent moisture condition (AMC III) was applied to account for the increase in soil moisture caused by the first 36 hours of the storm. In accordance with the MNR Technical Guide, 2002, all SWM facilities were removed for the Regional Storm simulation and areal adjustment factors were applied based on the equivalent circular area method. The existing conditions peak flow results and areal reduction factors for each of the primary headwater flow nodes and select nodes downstream are summarized in Table 2.3.2.16.

Table 2.3.2.16. Humber River - Existing Conditions Peak Flows (Regional Event)

Key Flow Node	Description	Areal Reduction Factor (%)	Hurricane Hazel Peak Flow (m^3/s) – Without Ponds
43.20	West Humber – Mayfield between Coleraine and Humber Station	100	71.33
41.30	West Humber – Mayfield southwest of Humber Station	100	40.85
38.30	West Humber – Mayfield northeast of The Gore	97	163.6
35.70	West Humber – Mayfield southwest of Innis Lake	97	100.62
32.42	West Humber – Mayfield northeast of Torbram	98	161.45
29.50	Main Humber – Mayfield southwest of Bramalea	97	73.94
40.30	Downstream Point of West Humber River	89	636.63
27.60	Downstream Point of Upper Main Humber River	77	817.99
49.70	Confluence Point - West and Main Humber River	73	1197.26

In addition to peak flows, the simulated hydrographs for all design storm events and the Regional Storm event have also been reviewed in order to determine the influence of timing throughout the subwatershed, which may impact the appropriate selection and design of SWM in the headwaters. This review has focused upon three (3) primary nodes, which represent the downstream extent of the West Humber River, Upper Main Humber and the confluence point further downstream. The area surrounding the confluence point is known to be a flood damage center, or flood vulnerable area (FVA), which is highly susceptible to flooding and associated damages. Further discussion regarding the FVAs relative to the FSA can be found in subsequent sections.

The time to peak for the three (3) primary nodes within the Humber River Watershed are summarized in Table 2.3.2.17 below.

Table 2.3.2.17. Time to Peak at Primary Nodes throughout the Humber River Watershed

Key Flow Node	Location Description	Time to Peak (hrs)						
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
40.30	D/S Extent of West Humber	9.083	8.5	12.083	11.833	11.583	11.333	11.583
27.60	D/S Extent of Upper Main Humber	7.333	7.25	6.333	17.083	15.583	17.167	18.667
49.70	Confluence Point – FVA	11.083	9.75	17.083	16.583	16.083	15.75	11.917

The time to peak results summarized in Table 2.3.2.17 indicate that under the synthetic design storm events, the peak flow at the downstream extent of the West Humber River occurs earlier than that of the confluence point further downstream. This suggests that traditional SWM applied in the headwaters, which provide a controlled and lagged release of stormwater (i.e. SWM facilities), may have the potential to increase the peak flows at the confluence should the timing of release coincide with the time to peak further downstream. As for the Regional Storm event, the peak flow at the downstream extent of the West Humber River and the confluence point of the West Humber and Main Humber River occur at approximately the same time.

Discussion

The previously completed hydrologic studies for the Etobicoke Creek and Humber River watersheds were both completed on behalf of TRCA, using the modelling software Visual OTTHYMO (VO). This suggests similar methodology in subcatchment parameterization, routing and storage elements included in the respective modelling. Both studies applied the synthetic design storm methodology, and generated peak flow rates for events ranging from the 2 through to 100-year return period as well as for the 350-year, 500-year return period and the Regional Storm event. These studies did not include a continuous simulation assessment, as the versions of VO used in those assessments were specifically intended for event-based modelling only. Therefore, neither study characterized existing conditions land use or assessed the impact of future land development on regional water balance or erosion of downstream receivers; the impact assessment and analysis of the recommended management plan for future development within the FSA should be conducted as part of future studies. In addition, future studies should apply continuous simulation for the hydrologic analyses, to allow for assessment of flood risk (i.e. frequency analysis), erosion assessment (i.e. duration analysis) and water budget assessment using long-term continuous meteorological datasets, and thereby allow for a fulsome impact assessment and evaluation of the recommended stormwater management plan including application of low impact development best management practices (LID BMPs).

Through the mapping of the existing subcatchments for the current study, it was found that there are a number of discrepancies between the boundaries of the Credit River, Etobicoke Creek, and Humber River watersheds. As presented on Drawing WR4b, there are a number of areas which are either overlapping or unaccounted for as part of the separate studies; this suggests further investigation and refinement of the subcatchment boundaries will be required in order to accurately identify the lands within the FSA contributing to each independent watershed.

Credit River Watershed – Huttonville Creek & Fletcher's Creek

The limits of the FSA extend within the headwaters of the Credit River Watershed, with small portions (i.e. less than 5%) contributing to the headwaters of the Huttonville Creek and Fletcher's Creek Subwatersheds, along the eastern limit of the Credit River Watershed. The Huttonville and Fletcher's Creek systems were assessed as part of the North West Brampton Subwatershed Study, completed by AMEC in June of 2011. This study included three (3) separate phases, focusing on Subwatershed Characterization, Subwatershed Impact Analysis, and Management Strategies and Implementation.

The hydrologic analytic characterization employed in the 2011 study was facilitated by the use of the Hydrologic Simulation Program-Fortran (HSP-F) hydrologic model to provide an indication of subwatershed response to rainfall and snowmelt. HSP-F is both an event based and continuous hydrologic model, although it is more commonly used for continuous modelling. HSP-F incorporates meteorological data, such as precipitation data, air temperature, evapotranspiration, solar radiation, wind, and dew-point temperature. The HSP-F hydrologic model provides a continuous flow time series for use in characterization of surface runoff, baseflows and surface and groundwater interaction.

The HSP-F model utilized for the 2011 study was based upon previously completed modeling exercises / studies for the Huttonville Creek (2003 Subwatershed Study), Fletcher's Creek (1997 Subwatershed Study) and the 2007 Credit River Flow Management Study which encompassed those contributing systems. The resulting hydrologic analysis adopted focused upon continuous simulation, generating frequency flows for the study area.

The subcatchment boundaries and subsequently the model schematics have been developed based upon review of background reports, the 1994 topographic mapping, 2005 aerial photography and field verification. The base parameters of land use, soil types and slopes were sourced from the CVC's Water Quality HSP-F model, which was developed for the evaluation of BMP's within the Credit River Watershed, as opposed to conventional hydrologic analysis of flood and erosion assessments.

Routing elements within Huttonville Creek and Fletcher's Creek exist in the form of surface drainage features such as creeks, ditches roads, and on-line stormwater management facilities. These elements are incorporated into the HSP-F hydrologic model in the form of rating curves, which define the storage-discharge relationship of the specific element.

The routing elements for the watercourses were determined using the associated up to date HEC-RAS hydraulic models which were developed for the hydraulic analyses within the Fletcher's Creek and Huttonville Creek Subwatersheds. For the purpose of hydrologic calibration, the hydraulic structures within the watercourses were included in the rating curve generation. As part of the subsequent continuous simulation, the rating curves were then updated to remove any influence and artificial storage generated from the hydraulic structures.

A component of the Subwatershed Characterization completed in 2011, a review of existing/proposed stormwater management facilities was completed, for inclusion in updated hydrologic modelling. Four (4) stormwater management facilities were proposed within the North West Sandalwood Parkway Secondary Planning Area in the Fletcher's Creek Subwatershed, in order to provide stormwater quantity control for that development. A total of seventeen stormwater management facilities for stormwater quantity control have been constructed/approved within the Fletcher's Meadows Secondary Planning Area, plus the Fletcher's Village facility located between Highway 7 and the CN Railway, west of the Fletcher's Creek.

The calibrated continuous hydrologic models were used to determine frequency flows for the 1.05 to the 100 year storm event, based upon a 39 year continuous simulation (1960 – 1998). The frequency analysis was conducted using the Consolidated Frequency Analysis (CFA) program. Two distributions were assessed: Three Parameter Lognormal Distribution and Log Pearson Type III Distribution. As per the Ministry of

Natural Resources guidelines for conducting frequency analysis, the Coefficient of Skew was checked to determine which distribution is the most appropriate. Frequency analysis testing of both distributions was conducted at various locations within the subwatersheds. In the Huttonville subwatershed the Log Pearson Type III Distribution was selected based on best fit of data within the scatter graphs, although the Coefficient of Skew is positive. In the Fletchers Creek subwatershed the Log Pearson Type III Distribution was selected based on best fit and positive Coefficient of Skew.

The results of the baseline land use assessment for both the Huttonville and Fletchers Creeks headwaters are summarized in Table **2.3.2.18**.

Table 2.3.2.18: Huttonville Creek and Fletchers Creek Frequency Flows (m^3/s) for Baseline Land Use

Subwatershed	Node	Frequency (years)								
		1.05	1.25	2	5	10	20	50	100	Regional
Huttonville Creek	7.350	0.06	0.1	0.18	0.38	0.57	0.82	1.2	1.73	2.71
	7.340	0.15	0.25	0.47	0.95	1.41	1.99	2.99	3.97	6.22
	7.320	0.18	0.29	0.52	1.03	1.54	2.19	3.36	4.54	8.04
	7.310	0.35	0.55	0.98	1.92	2.86	4.09	6.28	8.51	14.3
	7.290	0.53	0.76	1.12	1.66	2.05	2.44	2.98	3.41	12.4
	7.260	0.74	1.06	1.62	2.66	3.55	4.58	6.19	7.65	21.7
	7.231	0.92	1.34	2.14	3.72	5.16	6.89	9.75	12.5	28.4
	7.230	0.93	1.35	2.09	3.45	4.61	5.94	8.04	9.94	28.7
Fletchers Creek	5.420	0.11	0.15	0.24	0.39	0.51	0.66	0.88	1.08	1.83
	5.410	0.13	0.2	0.34	0.62	0.87	1.18	1.67	2.14	3.73
	5.390	0.18	0.29	0.51	0.95	1.35	1.83	2.63	3.37	6.26
	5.380	0.19	0.27	0.43	0.75	1.05	1.43	2.07	2.71	6.02
	5.470	0.044	0.069	0.12	0.24	0.35	0.5	0.78	1.05	2.12
	5.460	0.07	0.11	0.19	0.35	0.49	0.67	0.97	1.25	2.93
	5.450	0.12	0.19	0.34	0.66	0.96	1.35	2.01	2.66	4.58
	5.430	0.36	0.55	0.87	1.44	1.91	2.44	3.24	3.95	14.78
	5.490	0.087	0.14	0.26	0.53	0.8	1.15	1.8	2.46	4.26
	5.480	0.14	0.23	0.43	0.83	1.22	1.7	2.5	3.27	5.65
	5.570	0.045	0.077	0.14	0.3	0.45	0.65	1.01	1.37	2.19
	5.500	0.088	0.14	0.25	0.5	0.74	1.05	1.61	2.17	3.91
	5.550	0.18	0.3	0.57	1.17	1.78	2.57	3.99	5.43	8.65
	5.540	0.2	0.31	0.51	0.93	1.3	1.75	2.5	3.2	8.23
	5.520	0.3	0.43	0.66	1.1	1.48	1.92	2.62	3.26	12.26
	5.580	0.04	0.067	0.12	0.25	0.38	0.56	0.86	1.18	1.94
	5.820	0.061	0.1	0.19	0.38	0.56	0.8	1.22	1.63	2.62

Subwatershed	Node	Frequency (years)								
		1.05	1.25	2	5	10	20	50	100	Regional
	5.590	0.029	0.046	0.082	0.16	0.23	0.33	0.49	0.66	1.42
	5.560	0.37	0.56	0.9	1.57	2.17	2.87	4.02	5.08	15.63
	5.610	0.17	0.27	0.49	1	1.52	2.2	3.42	4.67	8.22
	5.600	0.22	0.34	0.6	1.11	1.6	2.19	3.18	4.13	8.96
	5.370	0.78	1.16	1.77	2.8	3.59	4.44	5.68	6.72	32.75

The results of the 2011 hydrologic analysis and the associated flow monitoring found that Huttonville Creek is typically dry, with intermittent flows resulting only from precipitation events. The headwater areas of Fletchers Creek are also dry, with flow resulting only from precipitation events. The location of the FSA being in the headwaters of both systems indicates minimal limitations for future SWM design and implementation with regards to timing influences or upstream influences. The findings and modelling files from this study can be utilized in subsequent studies related to the FSA and headwater development.

Hydrologic Modelling Summary

In summary, the hydrologic modeling completed to date for the Etobicoke Creek, Humber River and Credit River Watersheds range in both modeling software, type of assessment and vintage. These sources can be utilized and built upon as part of subsequent studies related to the FSA but will require integration and refinement to ensure consistent discretization of the study area within the respective Watersheds, and should apply a consistent modelling platform and methodology for establishing stormwater management criteria for the FSA and proposed development as part of future studies.

The details of each source are summarized in Table 2.3.2.19.

Table 2.3.2.19. Hydrologic Modeling Summary

Watershed	Hydrologic Model	Type of Assessment	Year Completed	Source
Humber River	Visual OTTHYMO Version 4	Synthetic design storms	2015	Humber Hydrology Update Report, Civica
Etobicoke Creek	Visual OTTHYMO Version 2.4	Synthetic design storms	2013	Etobicoke Creek Hydrology Update, MMM
Credit River (Huttonville Creek / Fletcher's Creek)	HSP-F	Continuous Simulation	2011	North West Brampton Subwatershed Study, AMEC

Hydraulic Conditions

Hydraulic Modelling & Floodline Generation

Hydraulic analyses of open watercourses are predominately completed using the HEC-RAS hydraulic model. The HEC-RAS tool has been developed based on the U.S. Army Corp of Engineers HEC-2 hydraulic model and uses energy and momentum equations to determine water surface elevations for given channel geometric cross-sections, crossings and boundary conditions.

The primary watercourses which run throughout the FSA are headwater tributaries contributing to the Upper Etobicoke Creek and the Upper West Humber River; these systems continue to flow south outside of the FSA and outlet at Lake Ontario. These watercourse systems are constraints to potential development due to their physical traits (steep banks, watercourse width, ecological value etc.) but also the limits of the regulated floodplains which are prone to inundation during a variety of storm events, and represent formal hazards.

Previously completed hydraulic analyses and approved floodlines have been provided for the watercourses throughout the FSA and surrounding areas downstream, as approved by the respective regulatory authority (TRCA and CVC). The regulated floodlines have been generated based upon the results from the approved HEC-RAS models simulating the Regulatory event (greater of Regional Storm or 100-year event). The floodlines respective to the FSA and downstream areas are depicted on Drawing WR5.

The floodline mapping provided indicates two (2) main categories of floodlines: *engineered* and *estimated*. Engineered floodlines are understood to have been developed from engineered hydraulic models, which were built using detailed data collection for channel / floodplain geometry and includes hydraulic structures (i.e. culverts, bridges, weirs, etc.) based upon best available sources (field survey, as-built drawings, etc.). Estimated floodlines are understood to have been developed from simplified hydraulic models, generally based upon basic channel topography (i.e. from an available DEM source only) and do not include hydraulic structures. These are noted to be primarily generated for smaller headwater tributaries / drainage features which feed into the larger systems downstream; this methodology has been applied for majority of the floodplain delineation within the FSA, as part of the Upper West Humber River Subwatershed.

Flood Vulnerable Areas

In 1980 Toronto and Region Conservation Authority (TRCA) developed a Flood Control Program which integrated flood protection works, property acquisition and TRCA's regulations to reduce and manage flood risk. This program was restricted by various conditions and technologies of the day, hence only 210 total flood sites, along with 31 damage centers, were identified in the program. These damage centers located throughout TRCA's jurisdiction are also known as Flood Vulnerable Areas (FVAs), which contain flood vulnerable sites such as buildings, as well as flood vulnerable roads (FVRs).

As part of the current study, TRCA has provided a GIS mapping shapefile indicating the limits of existing FVAs, as defined through hydraulic modeling and floodline mapping (ref. Drawing WR5). Notably, for the current study there are four (4) FVAs which are located downstream of the FSA; these areas are located along the Upper Etobicoke Creek in Downtown Brampton, Main Humber in Bolton and further downstream in Vaughn, as well as the confluence of the West Humber and Lower Main Humber branches in northern Etobicoke. These FVAs are reviewed further in subsequent study components, as part of the Part B: Impact Assessment for potential development of the FSA.

Upper Etobicoke Creek FVA – Downtown Brampton SPA

The Etobicoke Creek flows throughout Downtown Brampton and has historically caused significant flooding throughout the downtown core. In response to the frequent flooding, a concrete-lined by-pass channel was constructed between Church Street and Wellington Street in 1952, which subsequently facilitated development and protected Downtown Brampton from riverine flooding since its construction. The by-pass channel extends from Church Street to just downstream of the CN railway crossing of Etobicoke Creek. The channel is of trapezoidal shape with an approximate top width of 21 meters, including a 5 m wide by 1 m deep low flow channel, and is constructed of reinforced concrete.

However, the downtown core remains within the Regulatory (Regional Storm) floodplain due to a simulated spill condition. This would be caused when flood waters leave Etobicoke Creek at the upstream limit of the by-pass channel and flow through the 'remnant' valley associated with the original watercourse plan form (i.e. prior to construction of the by-pass channel), eventually rejoining the original unaltered Etobicoke Creek, just downstream of the by-pass channel.

To recognize the need for flexibility with regard to development in key socio-economic areas impacted by flood hazards, Provincial flood management policies allow for the designation of a Special Policy Area (SPA). Downtown Brampton was recognized as such an area and designated a Special Policy Area (SPA 3, Secondary Planning Area 7) in 1986, as part of the Brampton Central Secondary Plan. The SPA3 policies were then incorporated into the Downtown Brampton Secondary Plan (1998).

Amec Foster Wheeler conducted a Flood Protection Feasibility Study for Downtown Brampton on behalf of TRCA with support from the City of Brampton (ref. Downtown Brampton Flood Protection Feasibility Study, Amec Foster Wheeler, July 2016). This study reviewed and evaluated numerous flood mitigation options for Downtown Brampton to align the mandate of TRCA to reduce risk to life and property (from flooding) with the goals of the City of Brampton to support development potential in SPA3.

The preferred short/long term flood mitigation options resulting from the 2016 study include the following:

- **Rosalea Park Flood Berm**
- Combined Flood Protection Landform
- Lower By-pass Channel
- Downstream Channel Improvements
- Tailwater Flood Protection Landform
- **Clarence Street Bridge Improvements**
- Greenfield Stormwater Management
- Floodproofing
- Combination Approaches

Any subsequent studies completed for the Downtown Brampton SPA should be reviewed further to determine if any updates or refinements to the proposed mitigation alternatives have been made since the 2016 study. These recommendations will help to provide further context and design guidance for any development upstream (i.e. FSA) to ensure mitigation of downstream impacts. This FVA has been reviewed in further detail as part of the off-site hydraulic impact assessment, discussed further in a subsequent section.

Main Humber River FVAs – Bolton and Vaughn

The FVAs located along the upper portions of the Main Humber River include one in the community of Bolton, at the confluence with Cold Creek, and another additional FVA further downstream at the confluence of the Main Humber River and the East Humber River, in the City of Vaughan.

The FSA lands represent a small portion of the Main Humber Watershed drainage area, of only approximately 1%. Therefore, it is expected that should development occur within the headwaters, the appropriate SWM designs should be capable of mitigating potential negative impacts on the downstream FVAs. Nonetheless, detailed studies for these FVAs (if available) should be reviewed further to determine if any special circumstances would need to be incorporated into the SWM design and criteria for the subject FSA lands draining to these FVAs. Detailed reports for these FVAs have not been provided for the current study and should therefore be reviewed further in subsequent study components.

Main Humber River FVA – Confluence with West Humber River

The FVA with the greatest area located downstream of the FSA is the Albion Road community, located along the confluence of the West Humber River and Main Humber River, in the City of Toronto. This FVA could be significantly impacted by the FSA development, given that the FSA lands occupy approximately 26% of the drainage area within the West Humber River Subwatershed. Based on review of the time to peak results from the Humber River Hydrologic Model, the timing influences may be unfavorable for traditional SWM in the headwaters, which may lead to increases in peak flows further downstream, due to lagged release of outflows. Detailed studies for this FVA (if available) have not been provided for the current study, however if such studies have been completed for this area, the outcomes and findings should be reviewed. This FVA has been reviewed in further detail as part of the off-site hydraulic impact assessment, discussed in the following section.

Off-Site Hydraulic Impact Assessment – Baseline Conditions

As part of the subsequent impact assessment for the FSA lands, an off-site hydraulic impact assessment is to be completed for the Etobicoke Creek and Humber River FVAs located downstream of the FSA, in order to evaluate anticipated flood risk impacts resulting from future urbanization within the designated whitebelt areas of the Etobicoke Creek and Humber River Watersheds.

This is to be completed using the as-approved HEC-RAS models for both FVAs, as follows:

- Etobicoke Creek – Brampton SPA, Wood, March 2014
- Humber River – Humber in Toronto, Wood, 2017

The primary input for the off-site hydraulic assessment is the results of the hydrologic impact assessment completed by TRCA (ref. Hydrologic Assessment Memo, TRCA, November 2019), which identified the changes in peak flow rates associated with a "50% Whitebelt build-out" and "100% Whitebelt build-out" scenarios for the Humber River Watershed. The hydrologic assessment completed by TRCA did not include updated modelling for the Etobicoke Creek Watershed, therefore the "Ultimate" future land use condition from the 2013 Etobicoke Creek Subwatershed Study is to be utilized in the future land use hydraulic impact assessment (ref. Etobicoke Creek Hydrology Update, MMM Group, April 2013). Further details regarding the whitebelt land use changes and impact assessment is to be provided in subsequent study phases (i.e. Part B Report).

The change in flood risk within the FVAs is to be summarized in two different ways: the first being the change in hydraulic performance related to both water surface elevation and wetted width/floodline limits, and the second being the potential increase in flood damage costs within the affected FVAs. The flood damage costs are to be estimated using Flood Damage Curves as provided in the National Flood Damage Guidelines (ref. Canadian Guidelines and Database of Flood Vulnerability Functions, March 2017). The damage curves provided in these guidelines vary based upon the building type, structure/contents, number of stories, etc. The damage curves provide a flood damage cost per building footprint ($/m^2) which can be used to estimate the associated damages with respect to a certain flood depth at the affected building.

The details regarding the flood vulnerable sites located within the affected FVAs have been sourced from a previous study completed by AMEC in 2014 on behalf of TRCA (ref. TRCA Flood Protection and Remedial Capital Works Program, AMEC, 2014). This study included the development of a Query Processing Tool (QPT) which determined the flood damage costs and associated risk to life for all FVAs within TRCA's jurisdiction. The QPT is built upon a large database including details of all flood vulnerable sites (buildings and roads), hydraulic model results, and flood damage curves. It should be noted that the flood vulnerable sites for both the Etobicoke Creek and Humber River FVAs consist of both buildings and roadways; however, flood vulnerable roads (FVRs) have not been included in the current flood damage cost estimations.

Given the scope of the current assessment, a simplified spreadsheet approach has been applied for the flood damage cost estimation, in order to utilize the most recent (2017) publication of the flood damage curves, and hydraulic modelling from both the 2014 and 2017 studies. The data related to the flood vulnerable sites has been sourced directly from the QPT databases and GIS shapefiles generated as part of the previous study on behalf of TRCA (ref. TRCA Flood Protection and Remedial Capital Works Program, AMEC, 2014).

A GIS point shapefile of the flood vulnerable buildings within the FVAs has been sourced from the 2014 AMEC study, which has been used in conjunction with the results from the as-approved HEC-RAS models for both the Etobicoke Creek and Humber River FVAs. Both models have been executed for all storm events (2- through 100-year, and Regional) with the as-approved steady flows in order to represent the baseline condition for comparison with the future whitebelt development condition. However, only the 100-year and Regional events are included in any updated mapping.

The mapping function in HEC-RAS (RAS-Mapper) has been used to generate water surface elevation (WSE) maps in a raster format using the DEM/Terrain file associated with the respective hydraulic model. The resulting maps provide estimated flood inundation limits and have been used to extract the resulting maximum WSE surrounding the flood vulnerable buildings; seeing as the GIS shapefile for the building locations is a point file, the maximum WSE result has been extracted using a buffer area of 5 m surrounding the building point location. The 100-year and Regional event WSE maps and the susceptible buildings within the Etobicoke Creek and Humber River FVA systems are presented on Drawing WR10a and Drawing WR10b, respectively.

The extracted WSE is then used against the "lowest elevation" associated with the building, which was previously determined through the 2014 AMEC study with TRCA, in order to establish a water depth result at each affected building. This resulting water depth can then be used to determine the estimated damages resulting from the floodplain inundation, based upon the associated flood damage curve and the building footprint area.

It should be noted that if a building footprint is unavailable in the existing databases, a placeholder area has been applied in order to utilize the flood damage curve; given the nature of the current comparative assessment, this gap filling approach will not change the outcome and/or conclusions of the baseline and future whitebelt development conditions comparisons.

For the purpose of the current assessment, the flood damage curves have been simplified into three (3) general building types/categories listed below. The damage curves utilized in the current assessment can be found in Appendix D.

- Commercial (assuming Non-Residential Retail – Class C6, surface level damages only)
- Miscellaneous (assuming Non-Residential Institution – Class N1, surface level damages only)
- Residential (assuming Residential Class B – Single Unit Dwellings, average between single- and two-story units, allows for calculation of basement flood damages)

The distribution of flood vulnerable buildings within the downstream FVAs are summarized in Table **2.3.2.20**.

Table 2.3.2.20. Number of Buildings within Flood Vulnerable Areas downstream of FSA

Building Type	Etobicoke Creek FVA	Humber River FVA
Commercial (Retail)	110	0
Miscellaneous (Institutional)	13	3
Residential	68	63
Total	**191**	**66**

The Etobicoke Creek FVA is located within Downtown Brampton and has a significant number of flood vulnerable buildings, with over half being designated commercial uses. The Humber River FVA is within a less dense urban community, with primarily residential properties located within the floodplain.

The resulting flood damage curves for the baseline (as-approved model) conditions for each FVA has been summarized in Table 2.3.2.21.

Table 2.3.2.21. Direct Flood Damage Estimations for Downstream FVAs - Baseline Conditions

FVA	2-yr to 50-yr	100-yr	Regional	Average Annual
Etobicoke Creek	-	$ 9,044	$ 125,938,520	$ 576,481
Humber River	-	-	$ 18,359,764	$ 84,026

The resulting flood damage estimates under baseline conditions result in average annual damages of $576K and $84K for the Etobicoke Creek and Humber River FVAs, respectively. No damages are seen to occur as a result of riverine flooding under the 2- through 50-year events, with the primary source of damages occurring under the Regional storm for both systems. These damage estimates will be used as the baseline condition for comparison to the future whitebelt land use conditions, in order to estimate the change in flood risk and associated potential damages.

Hydraulic Structures / Constraints

Hydraulic structures and their embankments have the potential to impose constraints upon proposed development, by undersized crossings (bridges/culverts) creating a backwater effect and/or overtopping during high flow events such as the Regional Storm. These structures also have the potential to exacerbate flood conditions within the floodplain with increased development runoff in the headwaters. Identifying the susceptible structures can allow for potential solutions to be determined to improve conveyance and reduce the likelihood of increased flooding should development occur.

Various hydraulic models (HEC-RAS) consisting of both the Etobicoke Creek and Humber River tributaries have been reviewed in order to identify potential capacity constraints associated with the hydraulic structures, which may result in a backwater condition and/or overtopping of the structure during the Regional Storm event. The hydraulic models reviewed in detail focused upon the FSA and the FVAs located downstream of the proposed development; these included the following:

- Upper and West Humber, Cole Engineering, June 2017
- Etobicoke Creek – Brampton SPA, Wood, March 2014
- Humber in Toronto, Wood, 2017

The structures experiencing backwater and/or overtopping during the Regional Storm event within the FSA and the existing FVAs located directly downstream have been identified as potential constraints; these hydraulic structures are summarized in the following Table **2.3.2.22** and Drawing WR6.

Table 2.3.2.22. Hydraulic Structure Constraints - FSA and FVAs

Hydraulic Structure ID	HEC-RAS Coding	Structure Type	Span (m)	Rise (m)	Length (m)	U/S Inv (m)	D/S Inv (m)	Spill Elevation (m)
Etobicoke Creek-26.795	Bridge	Open Bridge	21.10	2.70	18.00	213.00	213.20	217.24
Etobicoke Creek-26.735	Multiple Opening	Open Bridge	21.70	4.90	8.70	209.30	209.29	213.34
Campbell's TribA-812.124	Culvert	Concrete Box	3.70	1.60	24.53	263.79	263.43	267.42
Campbell's TribA-811.699	Culvert	Concrete Box	5.10	3.00	44.04	260.46	260.43	264.93

Hydraulic Structure ID	HEC-RAS Coding	Structure Type	Span (m)	Rise (m)	Length (m)	U/S Inv (m)	D/S Inv (m)	Spill Elevation (m)
Campbell's TribA-809.432	Culvert	Concrete Box	4.90	1.80	22.90	245.76	245.43	248.41
Campbell's TribA-807.008	Culvert	CSP Ellipse	8.00	4.40	17.69	232.08	231.99	238.26
Campbell's TribA-806.128	Culvert	CSP Arch	8.42	3.69	28.50	224.80	224.60	231.54
Gore Road Trib-1414.268	Culvert	Concrete Box	6.05	1.49	20.90	220.35	220.35	222.33
Campbell's Crk-513.682	Culvert	Concrete Box	3.70	2.40	21.36	264.57	264.54	268.49
Campbell's Crk-512.088	Culvert	CSP Arch	3.73	2.30	33.05	262.44	262.44	265.93
Campbell's Crk-509.895	Culvert	Concrete Box	5.10	3.00	33.98	256.59	256.47	260.28
Campbell's Crk-507.641	Culvert	Concrete Box	10.67	2.44	41.73	246.33	246.24	250.20
Salt Creek-1012.466	Culvert	Concrete Box	5.50	2.00	15.28	249.87	249.87	252.17
Salt Creek-1009.981	Bridge	Open Bridge	10.90	2.30	13.58	237.69	237.09	240.45
Salt Creek-1007.277	Bridge	Open Bridge	9.15	2.39	11.84	223.92	223.80	226.51
West Humber-1380.675	Culvert	CSP Arch	3.80	2.60	23.03	241.32	240.45	245.12
West Humber-1355.061	Culvert	CSP Arch	7.20	4.60	35.37	227.16	226.98	237.30
West Humber-1353.874	Culvert	CSP Arch	8.90	3.92	28.87	222.69	222.60	229.08
West Humber-1304.84	Culvert	CSP Arch	8.80	4.23	25.25	211.30	211.18	218.16
West Humber Crk-679.4845	Bridge	Open Bridge w/ Pier	42.35	2.16	28.00	125.41	125.07	129.40
Lower Humber-148.4585	Bridge	Open Bridge w/ Pier	53.60	5.80	16.00	120.80	120.80	127.30
Lower Humber-75.84924	Bridge	Open Bridge w/ Pier	50.40	6.74	20.00	120.73	120.60	128.02
Lower Humber-4264.165	Bridge	Open Span Bridge w/ Pier	~130	~9.5	9.00	120.50	120.46	130.09
Lower Humber-4201.13	Bridge	Open Span Bridge w/ Pier	~100	~5.8	87.00	120.54	120.30	127.85
Lower Humber-4098.95	Bridge	Open Span Bridge w/ Pier	~92	~6.1	10.00	120.30	120.30	128.34

The identified structures range in opening type and size, with primarily culverts and smaller span bridges being located within the FSA boundary, whereas the existing bridges within the FVAs and directly downstream include highway crossings with spans ranging upwards of 100 m. These areas and structures are to be reviewed further as the FSA is refined and assessed in subsequent study phases.

Hydraulic Modelling Summary

In summary, the hydraulic modelling completed to date for the Etobicoke Creek, Humber River and Credit River Watersheds are consistent in the modelling software, but range in age/vintage. Those with older vintage will require review and updating should bridges/culverts be replaced or changes in the floodplain/terrain have occurred. Nonetheless, these models will serve as a strong basis for characterizing hydraulic conditions relative to the FSA and downstream areas as part of subsequent studies. The various sources are summarized in Table 2.3.2.23.

Table 2.3.2.23. Hydraulic Modelling Summary

Watershed	Subwatershed / Study Limits	Hydraulic Model	Year Completed	Source
Humber River	West Humber	HEC-RAS	2017	Cole Engineering Ltd
	Bolton SPA	HEC-RAS	N/A	N/A
	Upper Main Humber	HEC-RAS	2018	N/A
	Lower Main Humber	HEC-RAS	2017	Wood
Etobicoke Creek	Etobicoke Creek	HEC-RAS	2016	Aquafor Beech Limited
	Downtown Brampton SPA	HEC-RAS	2014	Amec Foster Wheeler
Credit River[1]	Huttonville Creek	HEC-RAS	2011	AMEC
	Fletcher's Creek	HEC-RAS	2011	AMEC

Note: [1] Hydraulic models have not been provided for the Credit River Watershed – HEC-RAS models from the North West Brampton Subwatershed Study, completed by AMEC in 2011, are available for scoped use in the current study, if required.

As noted in the above, the Regulatory Floodline Mapping has been estimated along some reaches, hence has not been developed based upon field verified hydraulic structures and topographic mapping. Furthermore, the extent of floodline mapping will need to be extended along various reaches through the FSA to establish that floodline mapping for all regulated watercourses within the area (i.e. generally watercourses with contributing drainage areas greater than 50 ha). As such, future studies for the FSA will be required to populate the hydraulic structure inventory to include as-built or field-surveyed information, and to extend the hydraulic modelling to encompass all regulated watercourses. In addition, the geometry data within current models should be verified against topographic mapping for the area, to confirm that the geodetic datum for topographic mapping is consistent with that used for the current modelling, and the modelling and/or mapping revised as appropriate to apply a consistent datum for the hydraulic analyses.

2.3.2.4 Surface Water System Constraints

Based upon the preceding sections and characterization of the FSA established from the received data, the surface water system constraints to development include the following:

- Floodlines / Floodplains
- Hydraulic Structures in FSA (Backwater / Overtopping)
- Drainage Areas to FVAs Downstream (Etobicoke Creek and Humber River) – Timing Influences on SWM Criteria, Design and Performance

The findings from the foregoing information will be used to determine anticipated impacts from future development within the FSA, develop a list of alternatives to manage impacts to surface water quality, offsite flood risk, and manage water budget, and provide direction for future studies to further evaluate the list of alternates and establish a recommended stormwater management plan.

As noted in the above, the Regulatory Floodline Mapping has been estimated along some reaches, hence has not been developed based upon field verified hydraulic structures and topographic mapping. Furthermore, the extent of floodline mapping will need to be extended along various reaches through the FSA to establish that floodline mapping for all regulated watercourses within the area (i.e. generally watercourses with contributing drainage areas greater than 50 ha). As such, future studies for the FSA will be required to populate the hydraulic structure inventory to include as-built or field-surveyed information, and to extend the hydraulic modelling to encompass all regulated watercourses. In addition, the geometry data within current models should be verified against topographic mapping for the area, to confirm that the geodetic datum for topographic mapping is consistent with that used for the current modelling, and the modelling and/or mapping revised as appropriate to apply a consistent datum for the hydraulic analyses.

2.3.3 Stream Systems

At a scoped level of study, the primary purpose of the fluvial geomorphology assessment and characterization component is to identify surface water feature types and extents, general form and function, erosion hazards, and erosion sensitivity for features within and adjacent to the FSA that may be impacted by development. An understanding of feature constraints and opportunities, through integration with other disciplines can be developed for guiding general land use decisions, and requirements for future study.

In order to identify and characterize watercourses and headwater drainage features (HDFs), a clear understanding on their definitions is required. The following definitions have been adapted those from the guidance document *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* (TRCA/CVC, 2014), and based on the existing understanding of drainage features within the FSA from the background review, and professional experience in other jurisdictions.

Watercourses

Watercourses are defined as permanently to intermittently flowing drainage features with defined bed and banks. They exhibit clear evidence of active channel process including planform, profile, and material sorting, with evidence of a balance between erosion and deposition throughout the reach. They are often second-order or greater, but may be first order when verified by the practitioner(s). Watercourses are regulated features by the Conservation Authority, and fish are typically found within these features.

Headwater Drainage Features (HDFs)

Non-permanently flowing drainage features that may not have defined bed or banks are designated as HDFs. The presence of bed and bank definition within these features may be attributed to anthropogenic intervention (e.g. cutting a drainage feature into the surface), or seasonally as spring freshet concentrates flows in depressions, causing channel development into surfaces lacking vegetated cover. HDFs are first order intermittent and ephemeral channels, swales and connected headwater wetlands, but do not include rills or furrows. They are typically not identified as regulated features, and fish may or may not be found within the feature.

Previous work in other jurisdictions has utilized a threshold contributing area to surface water features to help scope HDFs and Watercourses, prior to more detailed assessment. This has not been applied under the current study, and HDFs and low-order watercourses will require field confirmation at future planning stages.

2.3.3.1 Reach Delineations and Feature Types

The parameters that influence channel form, amount and size of sediment inputs, valley shape, land use or vegetation cover vary over the length of a feature. Lengths of channel that exhibit similar characteristics with respect to these parameters are referred to as reaches. Reach lengths vary with the scale of the channel, often longer for a larger watercourse, while smaller watercourses and headwater drainage features (HDFs) exhibit more variability resulting in shorter reaches. Delineation of reaches is beneficial as it enables grouping and identification of general channel characteristics.

The process of delineating reaches considers external parameters such as local geology, topography and valley setting, drainage area, hydrology, riparian vegetation, and land use. Consideration is also given to those characteristics that reflect these external influences, such as sinuosity, gradient, and dimensions. Field confirmation is typically completed to confirm and update the feature identification and reach delineation as appropriate. To support the desktop analysis for this study, a scoped windshield assessment was conducted to provide an initial confirmation of feature presence/absence and type. Further discussion on the windshield assessment is included in a sub-section which follows.

Reach nomenclature from Mayfield West (AMEC, 2012) was maintained in the current study where there is overlap. However, the reach delineation has been updated based on current observations and the scoped level of study.

Map SM-1 (plates to 1-24) in Appendix E provide an overview of feature type (watercourse or HDF) and reach breaks within and adjacent to the FSA based on a desktop review and confirmation through the windshield assessment. The mapping presented has been updated based on field confirmation of the presence/absence of features as observed during the windshield assessment. Several previously unmapped features were also identified during windshield assessments and were mapped and evaluated accordingly. In total, 418 reaches have been delineated for this study, of those 182 are classified as watercourse, and the remaining 236 are considered HDFs. Due to the limited fieldwork scope, feature type and reach breaks will be finalized through future detailed geomorphic studies, which will be carried out in subsequent planning stages.

Additional headwater drainage features may be present on the landscape that could not be identified in the desktop study or were not observed during the windshield assessment (see Field Program section).

The delineated watercourse reaches have been further characterized as being 'unconfined' or 'confined' systems based on their overall valley geometry. This type of classification will further assist during the delineation of erosion hazard limits: meander belt widths (unconfined) and stable top of slope (confined). Unconfined watercourse systems have no discernable valley slope from the surrounding landscape either by field investigation aerial photography and/or map interpretation. Typically, these types of systems are found in flat or gently rolling landscapes, on table lands, and can often be located within the headwater areas of drainage basins. Confined watercourses are those in which the physical presence of visibly discernible valley walls, with heights where the channel and its floodplain, are limited in lateral extent by the presence of these relatively steep, well-defined valley slopes. For confined valleys, the location of the watercourse may be located at the base of a valley slope or in close proximity to it (MNR, 2002).

Field Program - Windshield Assessments

A detailed field program was not required as part of this Scoped SWS as per the Terms of Reference. Furthermore, due to the size of the Study Area (> 8000 ha) and limited Permission to Enter on private property, it was not feasible to walk every reach. Instead, rapid windshield assessments were conducted to confirm presence/absence or characterize features within the FSA, which were primarily watercourses but also included HDFs, to confirm their presence on the landscape.

Windshield assessments were completed to confirm site characteristics at locations where features were visible from the road (e.g., crossings).

At every assessment site, the following data were collected:

- Confirm presence/ absence and type of feature (watercourse or HDF)
- HDF Type (e.g., swale, defined channel)
- Representative photographs were taken
- Confirm valley setting
- Note signs of active erosion or instability
- Other notable observations (such as fish or wildlife)

Overall, the windshield assessments allow for a cursory confirmation of the FSA and its features in support of the desktop analysis and provides some supplementary information. Mapping and characterization have been updated based on the results of the windshield assessment, including the re-characterization of feature type, and the addition/removal of features from the mapping. Where watercourses or HDFs were not field verified, nor could the mapping exercise confidently provide an identification, the feature has been conservatively maintained as a watercourse. Since field assessments were limited to roadside observations, feature types and the reach delineation are subject to future refinement at subsequent planning stages through the collection of detailed field data.

2.3.3.2 Reach Summaries

General reach summaries, including feature type, reach name, legacy reach names, length, confinement, vegetation, substrate, signs of erosion or deposition, and notes from the windshield assessment are available in Table 1 in Appendix E. Rapid Geomorphic Assessments are not being completed under the current study, however, where they have been completed from previous studies, their degree of stability is noted in the summary table: In Regime (Stable), Transitional (Moderately Stable), or In Adjustment (Unstable). It is recommended that detailed reach walks and surveys be completed to guide future planning studies and watercourse management.

For headwater drainage features, future studies are required to fully characterize their form and function. HDFs should be assessed as per the TRCA/Credit Valley Conservation (CVC) guidelines for the "Evaluation, Classification, and Management of Headwater Drainage Features" (TRCA and CVC 2014) which define HDFs and allows preliminary management classifications to be determined. The current study provides preliminary mapping of the locations of HDFs but does not provide management recommendations for these features without further study. For headwater drainage features, future studies are required to fully characterize their form and function. HDFs should be assessed as per the TRCA/Credit Valley Conservation

(CVC) guidelines for the "Evaluation, Classification, and Management of Headwater Drainage Features" (TRCA and CVC 2014) which define HDFs and allows preliminary management classifications to be determined. The current study provides preliminary mapping of the locations of HDFs but does not provide management recommendations for these features without further study.

2.3.3.3 Erosion Hazard Delineation – Meander Belt and Stable Top of Slope

The meander belt width defines the area that a watercourse currently occupies or can be expected to occupy in the future. Meander belt delineation is commonly used as a planning tool in order to protect private property and structures from future erosion due to fluvial action or geotechnical instability. Within a scoped subwatershed study context, studies require the general identification of meander belt widths to facilitate the planning process. Therefore, for the purposes of this study, meander belt widths have been developed from a broad scale and are subject to refinement as part of future, more detailed, studies. For this study, meander belt widths are only delineated for unconfined stream reaches that have defined bed and banks. For unconfined watercourses, limits of the meander belt have been defined by parallel lines drawn tangential to the outside bends of the laterally extreme meanders of the planform for each reach. Due to the broad-scale nature of this study, in lieu of calculating the 100-year migration rate for each reach, a factor of safety was generally calculated as 20% of the meander belt width (10% applied on either side of the meander belt width).

In addition to meander belt delineations for unconfined watercourse reaches, an erosion hazard limit has been determined for confined channel systems – the stable top of slope. For the confined systems within the Study Area, a stable top of slope limit has been delineated following Provincial Policy Statement (PPS) technical guidelines. Within the confined reaches of the FSA, the watercourses typically meander back and forth between valley wall contacts, but some are more confined than others, and few are semi-confined on the reach scale with portions of the reach exhibiting confinement. The PPS requires that a toe erosion setback be applied where a watercourse is within 15m of the valley toe (MNR, 2002), plus a stable slope allowance (3:1, H:V), and erosion access allowance of 6m.

Given the limited field reconnaissance under the current study, results from the geotechnical assessment for Mayfield West (AMEC, 2014) were used to determine an appropriate, yet conservative value for the toe erosion allowance. The work in the Mayfield West study utilized recommended toe erosion allowance values from the PPS that ranged from 1m to 8 m. This was based on bank materials of "clayey silt till" and "sands and silt", and whether there was evidence of active erosion. To be conservative, the current study has utilized values for "sands and silt" from the PPS whereby a toe erosion setback of 2m is required where there is no evidence of active erosion, and a setback of 8 m where there is evidence of active erosion. In lieu of noting active erosion through field observations, the 8 m setback has been applied where the channel appears to be in direct contact with the valley toe and the assumption of active erosion.

Where the channel was within 15 m of the valley toe, the toe erosion allowance was projected horizontally outward from the valley toe. then stable slope was then extended until it daylighted along the tablelands at the top of the valley (MNR, 2002). From this a 6 m offset has been delineated for the erosion access allowance. For confined settings where the existing slope exceeds 3:1, a stable slope projection has not been included rather the "crest of slope" mapping by TRCA has been utilized, from which the 6 m erosion access allowance has been offset.

Delineation of the meander belt width and long term stable top of slope stable slope should be refined as part of future detailed studies that includes a robust field program, confirmation of feature type and reach delineation, confirmation of valley setting and feature stability, documentation of channel geometry, updated site topography, and, if available detailed geotechnical analysis. As a result, hazard corridor delineation values and mapping will likely change, in terms of both upstream and downstream extent, and overall size. The geotechnical analysis by Wood in the current study is limited to slope stability and does not include the projection of a stable top of slope.

Map SM-2 (plates to 1-24) in Appendix E display erosion hazard limits for reaches within the study area. Erosion hazards are subject to confirmation and/or refinement, and finalization through future planning stages (i.e., MESP). Table 2 in Appendix E summarizes the hazard delineation for each watercourse reach.

Future study requirements to complete detailed field analyses to confirm feature type, evaluate stability, and document geomorphic parameters of channel form, and function will likely result.

2.3.3.4 Desktop Erosion Assessment

An assessment of erosion sensitivity was completed primarily through air photo interpretation and limited field investigations (windshield assessments). Additionally, available background data from previous subwatershed studies has been reviewed and included for the purpose of providing additional characterization on area watercourses and their stability, and results from the detailed erosion threshold assessment. Through the impact assessment, in-stream erosion analyses will seek to determine any applicability of the erosion threshold values (i.e. critical discharge) from these prior studies, and additionally, further topographical processing may be evaluated to determine areas of relative erosion sensitivity (e.g. stream power or slope mapping).

Map SM-3 in Appendix E presents mapping of sites undergoing what is considered excessive erosion, based on observations made during the windshield assessments. Windshield assessments were completed at every road crossing within the study area except where roads were closed due to construction. Thus, SM-3 depicts the subset of watercourse crossings where excessive erosion was observed and does not capture areas that could not be observed from the roadways. Field walks would need to be completed in future studies to confirm reach-scale erosion processes in areas away from road crossings. Erosion sites were observed in both watercourse and HDF reaches and were dispersed throughout the stream networks within the study area. Erosion sites occurred primarily where the channel had been locally modified and were often found on previously straightened reaches.

Additional work to detail areas of erosion concern within, and downstream of, the study area is ongoing and will be presented in an updated iteration of the current report. This includes migration analysis at areas of expected migration (i.e. outer banks at meander bends) and quantification of migration rates.

Earlier erosion mapping and erosion threshold studies that were completed within and downstream of the study are were reviewed. These include the Mayfield West EIS and the Northwest Brampton subwatershed studies. The findings of these studies are summarized below.

Mayfield West, Phase 2 Secondary Plan Comprehensive Environmental Impact Study and Management Plan, Part A: Existing Conditions and Characterization, Final Report, Town of Caledon, December 2014

Erosion thresholds were determined for the Mayfield West Study Area by identifying the most sensitive or least stable reach within representative portions of the study area through Rapid Field Assessment field work. Detailed field work was completed on the selected reaches to allow a range of hydraulic analyses to be completed. The erosion thresholds were then selected through the application of a suit of analytical techniques including substrate and bank shear stress and permissible velocity. The erosion threshold value was selected based, in part, on technical experience as well as being representative of field conditions.

Erosion thresholds were determined for sites MEC-R1, MEC-R2, MEC-R5, MEC-R8, MEC-R25 and MFC-R3. The critical velocities determined for these reaches ranged from 0.41 m/s (MEC-R5) to 1.13m/s (MEC-R25). Critical discharge rates ranged from 0.06 m^3/s (MFC-R5) to 2.15 m^3/s (MEC-R1). These values were initial, conservative values and would be subject to refinement through future monitoring.

Table 2.3.3.1. Summary of Mayfield West SWS Erosion Threshold Results

Reach Name, Mayfield West SWS	Critical Discharge (m^3/s)	Critical Velocity (m/s)	Reach Name, Peel Settlement Expansion Scoped SWS
MEC-R1	2.15	0.90	MEC-R1
MEC-R2	0.68	0.72	MEC-R2
MEC-R5	0.56	0.41	MEC-R3
MEC-R8	1.16	0.63	-
MEC-R25	1.64	1.13	MEC-R4(2)
MFC-R3	0.06	0.74	MEC-R2

The Rapid Geomorphic Assessment results indicated that most reaches within the Mayfield West study area were swales or were watercourses that were In Regime. Four watercourse reaches were determined to be Transitional. These are listed in Table 2.3.3.2. Mayfield West reach locations and mapped Rapid Geomorphic Assessment results are included in Appendix E2.

Table 2.3.3.2. Mayfield West RGA Results – Transitional Reaches

Reach Name, Mayfield West SWS	RGA Score	RGA Condition	Reach Name, Peel Settlement Expansion Scoped SWS
MEC-R02	0.34	Transitional	MEC-R2
MEC- R03	0.34	Transitional	MEC-R2
MEC- R06	0.23	Transitional	MEC-R4
MEC- R09	0.23	Transitional	-

North West Brampton Urban Development Area - Huttonville And Fletcher's Creeks Subwatershed Study, Phase 1: Subwatershed Characterization and Integration, City of Brampton, December 2010

Erosion thresholds were determined as part of the North West Brampton Urban Development Area Phase 1 – Subwatershed Characterization and Integration fluvial geomorphology study. Initially, detailed geomorphic field assessments were completed at sites HV6, HV24 and F15. One site was selected within the Fletcher's Creek watershed where there was a defined channel (F15). Two sites were selected from East Huttonville Creek (HV24) and West Huttonville Creek. Each of the three sites was located within the study area. Following further consultation with CVC, detailed field collection sites used for the erosion threshold calculations were located downstream of the North West Brampton Study Area. These were sites EM10 and SW4, which are part of the CVC Effectiveness Monitoring and Fletchers Creek Monitoring programs respectively, both located downstream of Bovaird Drive. Table 2.3.3.3 presents the critical discharge rates and velocities that were used in the durational assessment to inform stormwater management criteria.

Table 2.3.3.3. Summary of Northwest Brampton Erosion Threshold Results

Reach Name, Mayfield West SWS	Critical Discharge (m^3/s)	Critical Velocity (m/s)	Reach Name, Peel Settlement Expansion Scoped SWS
EM10	0.59	0.65	-
SW4 – Bed	0.91	0.54*	-
SW4 – Bank (6.5N/m^2)	0.39	0.55*	-

*Average Velocity at Critical Discharge

2.3.4 Natural Systems

2.3.4.1 Aquatic/Fisheries

The entire FSA is in the Lake Ontario drainage basin. The eastern portions of the FSA are in the Humber River watershed, while the western portions are primarily in the Etobicoke Creek watershed, but a small area along the southern boundary is in the Credit River watershed.

Stream Habitat Characterization

Watercourses in the Humber River and Etobicoke Creek watersheds have been characterized based on their thermal regime (coldwater or warmwater) and size (TRCA and MNRF, 2005; TRCA, 2006). The watercourses in the Credit River watershed were similarly classified for this report, based on information presented in the Fletchers Creek and Huttonville Creek subwatershed study (AMEC et al, 2010).

Most of the watercourses in the study area are small warmwater streams (ref. Map F1 – Appendix F). Multiple small warmwater streams coalesce to form intermediate warmwater streams, as the drainage areas increase (Figure F1). Small coldwater streams are present in three areas (Map F1):

- the headwaters of Etobicoke Creek in the western portion of the study area;
- Campbells Cross Creek, which is the most westerly tributary in the West Humber subwatershed;
- several small watercourses in the north-east portion of the study area in the Main Humber subwatershed.

Although there are several small tributaries in the headwaters of Etobicoke Creek that are classified as coldwater based on temperature data, unlike the coldwater streams in the Humber River watershed, the signature fish species of coldwater stream habitat in southern Ontario, Brook Trout (*Salvelinus fontinalis*) and Mottled Sculpin (*Cottus bairdii*), are not present (TRCA, 2006).

Redside Dace (*Clinostomus elongatus*), considered an endangered fish species both provincially and federally (https://www.ontario.ca/page/species-risk-ontario#section-2; https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/redside-dace-2017.html), is the only aquatic species at risk known to occur within or in the immediate vicinity of the study area. Stream reaches that are considered Redside Dace occupied habitat, based on Fisheries and Oceans Canada species at risk mapping (https://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html; July 27, 2020) are shown on Map F2. These include the four largest tributaries in the West Humber subwatershed. Redside Dace occupied reaches are also present downstream from the study area in the Huttonville and Fletchers Creek subwatersheds of the Credit River watershed. Redside Dace were historically present in Etobicoke Creek, but the most recent capture was in 1940 and it is likely extirpated from that watershed.

Watercourses that contribute base flow or sediment to occupied Redside Dace habitat are considered to be Redside Dace contributing habitat. This is determined on a site-specific basis, which is beyond the scope of this study, but will need to be considered part of future more detailed studies.

2.3.4.2 Terrestrial

Ecological Land Classification

Ecological Land Classification (ELC) within the FSA is presented on Map DA1; the number and area coverage of ELC types is summarized in Appendix F. A general summary of the various vegetation community series types is provided Table 2.3.4.1 below.

Overall, the Peel FSA is dominated by agricultural, anthropogenic, and cultural vegetation communities, covering 5896 ha, 981 ha, and 730 ha of the FSA, respectively. However, the natural areas within the FSA also contain a diverse range of communities from Deciduous Swamp to Open Bluff. A total of 21 Communities Series and 11 Community Classes have been mapped.

Table 2.3.4.1. Ecological Land Classification Series Summaries – FSA

Community Series	Summary Description - FSA
Forest	
Deciduous Forest (FOD)	Deciduous forests are relatively abundant across the FSA, represented by 139 features totaling 199 ha of area. Typical dominant species for these communities include Basswood, Willow Species, Sugar Maple, American Beech, and Bur Oak. Soil and drainage in deciduous forest communities can be variable, although most are dry-fresh or fresh-moist. These communities are slightly more abundant in the western and central sections of the FSA, often associated with larger natural areas located along riparian corridors.
Coniferous Forest (FOC)	Coniferous forests are less abundant than deciduous, with only a single feature 0.66 ha in size within the FSA. This feature is a fresh-moist Hemlock coniferous forest, located in a block of forest in the western section of the FSA, also containing mixed and deciduous forest communities adjacent to an agricultural area. Typical species for this community include Hemlock as the dominant species, with associations of White Pine, Balsam Fir, and Eastern White Cedar. Shrub and fern richness is more diverse on moist sites, including more northern species such as Wood ferns, Bluebead Lily, Starflower, and Goldthread.
Mixed Forest (FOM)	Mixed forest communities account for 18 features across the FSA, totaling 20 ha in size. These communities are mostly found in the western portion of the FSA, although they are evenly distributed within that section. Typical dominant species found in these mixed forest communities include Hemlock, Sugar Maple, Eastern White Cedar, Poplar, and Ash. Soils and drainage of these communities are often Fresh-Moist or Dry-Fresh.
Wetlands	
Shallow Marsh (MAS)	Shallow marsh communities account for 93 features across the FSA, totaling 23.2 ha in size. These features occur across the FSA landscape, often larger MAS features being associated with natural riparian corridors. Some common species in these areas include broad-leaved sedge species, Reed Canary Grass, and both Broad and Narrow-leaved Cattail. Where soil type is known, it is often mineral in nature rather than organic.
Meadow Marsh (MAM)	A total of 159 features are classified as meadow marsh in the FSA. These features combined total 115.8 ha in size. Similar to shallow marsh communities, they are evenly distributed across the landscape with large features occurring along riparian corridors. A majority of these features are dominated by Reed Canary Grass or broad-leaved sedges, and can be mineral or organic in nature.

Community Series	Summary Description - FSA
Thicket Swamp (SWT)	Only 25 features are classified as thicket swamp within the FSA, for a combined total of 16.6 ha. Although sparse, these features are distributed evenly across the FSA. Dominant species in these mineral thicket swamp communities include willow species, Red-osier Dogwood, and Silky Dogwood. These communities often occur as small pockets within agricultural fields, although some larger features do occur along riparian corridors.
Deciduous Swamp (SWD)	Deciduous swamps account for 54 features across the FSA, for a total of 48.6 ha. Typical dominant species in these areas include Red Elm, Willow, Green Ash, Black Ash, Paper Birch and Silver Maple. Soil type in these swamps is mineral rather than organic. Similar to other wetland types in the FSA, larger deciduous swamps occur along riparian corridors, with smaller pockets within woodlots adjacent to agricultural fields.
Aquatic	
Open Aquatic (OA or OAO)	These features are distributed fairly evenly across the FSA with the most occurring withing the West Humber Subwatershed. These communities are often associated with natural river features or SWM ponds. A portion of the FSA contains open aquatic areas, with 106 features totaling 24.2 ha in size.
Shallow Aquatic (SA)	A small portion of the FSA is classified as shallow aquatic, with only 3 features totaling 0.1 ha in size across the area. These features are confined to the eastern and central sections of the FSA, and are described as small, shallow depressions adjacent to agricultural fields.
Mixed Shallow Aquatic (SAM)	Only 4 features across the FSA are classified as mixed shallow aquatic, for a total of only 0.4 ha of area. These features are confined to small, isolated features within or adjacent to agricultural fields, and are often dominated by Bur-reed or Pondweed species.
Submerged Shallow Aquatic (SAS)	Submerged shallow aquatic communities are found in 9 features across the FSA, with a few features in each section of the area (western, central and eastern). The combined area of these features is approximately 2.3 ha. These areas are often dominated by Pondweed, Coon-tail, or Stonewort species, and can be found in natural areas, adjacent to agricultural field, and in in anthropogenic areas such as residential properties and gold courses.
Floating-leaved Shallow Aquatic (SAF)	Floating-leaved shallow aquatic communities occur across the FSA as 7 small features within natural woodlots or forests. These areas total in size to 0.7 ha and are often dominated by Duckweed.
Cultural	
Cultural Meadow (CUM)	Cultural meadows are found fairly extensively across the FSA, with 294 features at a total of 511 ha. These communities are sometimes found as old, unused farm fields, but can also be present as open areas in more natural sites along rivers. Cultural meadows are often dominated

Community Series	Summary Description - FSA
	by non-native plant species, with mineral soil types that are dry to moist.
Cultural Plantation (CUP)	Cultural plantations are found throughout the FSA, with 65 features at a total of 51 ha. The species present and site conditions for these types of communities can be variable, but they are all the result of anthropogenic-based disturbances which may or may not be maintained. These communities often have parent mineral material or mineral soil.
Cultural Savannah (CUS)	Cultural savannahs are mostly found in the western and central sections of the FSA, with 37 features for a total of 45.5 ha of area. These communities are often found on the edge of natural forests or agricultural fields. Like most cultural community types, non-native species are mainly dominant, although a few features have native deciduous or hawthorn species present as well. These communities often have parent mineral material or mineral soil.
Cultural Thicket (CUT)	Cultural thickets represent 69 features on the landscape, covering a total of 71.1 ha. They tend to be found in the central and southern half of the eastern section of the FSA, typically as denser, overgrown edges of agricultural fields. As is typical of cultural communities, dominant species tend to be non-native such as Buckthorn or other exotic mixes of species. These communities often have parent mineral material or mineral soil.
Cultural Woodland (CUW)	A total of 49 features covering 52.8 ha in the FSA are classified as cultural woodland. Most of these are found clustered in the central FSA, with some scattered through the western section and only occurring a few times in the eastern portion. Although often associated with non-native species dominance, a few communities are regenerating native dominated deciduous forests and woodlands. These communities often have parent mineral material or mineral soil.
Other Terrestrial	
Hedgerow (HR)	Hedgerows are fairly limited on the landscape, with only 14 features occurring in the FSA. These features combined total of 3.7 ha in size and are confined to narrow edges of agricultural fields.
Open Bluff (BLO)	A single open bluff community occurs in the FSA and falls in the central portion. This community is only 0.03 ha in size and occurs within a larger natural area adjacent to two golf courses. Typical characteristics of this community include low tree and shrub cover, mineral soil, and species such as Field Horsetail, Coltsfoot, Canada Goldenrod, and Sweet White Clover.
Shrub Bluff (BLS)	A single shrub bluff also occurs in the FSA, this time in the western section. This community is only 0.04 ha in size and occurs within a cultural meadow adjacent to agricultural fields. Typical characteristics of this community include low tree cover, mineral soil, and species such as Field Horsetail, Coltsfoot, Canada Goldenrod, and Sweet White

Community Series	Summary Description - FSA
	Clover, although it is likely dominated by non-native exotic species similar to the cultural meadow surrounding it.
Open Clay Barren (CBO)	A single open clay barren 0.1 ha in size occurs on the FSA landscape, on the southern edge of the central section of the FSA.
Anthropogenic	
Anthropogenic (ANTH)	A total of 506 features are classified as anthropogenic communities, for a total of 980.1 ha of area across the FSA. These areas are largely roads and private residential, but can also include areas such as golf courses.
Agricultural (AG)	Agricultural fields are dominant across the FSA, with 273 features covering 5893.3 ha.

Wetlands

Coverage of wetland features within the FSA and adjacent 120m is presented on map DA3a-c. Wetland units have been identified based on their location within the west, central, or east FSA terrestrial areas; attribute information relating to status, policy areas, and depth to groundwater are presented in Appendix F.

Based on the available ELC data, 335 ELC wetland polygons were identified within the FSA + 120m. Polygons were represented by eight plant community types, including:

- Meadow marsh (MAM)
- Shallow marsh (MAS)
- Shallow aquatic (SA)
- Floating-leaved shallow aquatic (SAF)
- Mixed shallow aquatic (SAM)
- Submerged shallow aquatic (SAS)
- Deciduous swamp (SWD)
- Thicket swamp (SWT)

In total, ELC wetland polygons accounted for 205.8 ha (~3%) of the FSA and adjacent 120m area.

Among the seven subwatersheds within the FSA, the West Humber River SWS had the most wetland features and largest coverage of wetland area followed in order (based on area coverage) by Upper Etobicoke Creek, Main Humber, Fletchers Creek, and the Credit River subwatersheds; there were not wetland features identified in the Huttonville Creek or Spring Creek subwatersheds within the FSA (Table 2.3.4.2).

Table 2.3.4.2. FSA Wetland Summary

ELC Description	ELC Code	Number of features in FSA	Wetland area (ha) in FSA	Relative to ELC type in SWS (%)	Relative to ELC type FSA (%)
Credit River					
Meadow marsh	MAM	1	0.02	100	0.01
Deciduous swamp	SWD	2	2.41	8.6	4.96
Fletchers Creek					

ELC Description	ELC Code	Number of features in FSA	Wetland area (ha) in FSA	Relative to ELC type in SWS (%)	Relative to ELC type FSA (%)
Meadow marsh	MAM	1	0.51	8.57	0.44
Upper Etobicoke Creek					
Meadow marsh	MAM	35	35.03	41.5	31.23
Shallow marsh	MAS	13	5.33	14.4	25.9
Floating-leaved shallow aquatic	SAF	1	0.09	3.4	12.07
Mixed shallow aquatic	SAM	1	0.05	3.48	12
Deciduous swamp	SWD	28	31.32	45.48	64.52
Thicket swamp	SWT	4	3.78	15.19	22.72
West Humber River					
Meadow marsh	MAM	113	79.16	52.92	67.49
Shallow marsh	MAS	71	14.57	36.57	67.62
Shallow aquatic	SA	2	0.07	100	75.27
Floating-leaved shallow aquatic	SAF	6	0.65	66.49	87.93
Mixed shallow aquatic	SAM	2	0.16	13.42	36.67
Submerged shallow aquatic	SAS	8	2.24	96.11	98.38
Deciduous swamp	SWD	21	14.74	14.83	30.36
Thicket swamp	SWT	20	12.75	27.88	76.7
Main Humber River					
Meadow marsh	MAM	8	1.09	0.69	0.82
Shallow marsh	MAS	9	1.33	0.71	6.48
Shallow aquatic	SA	1	0.02	100	24.73
Mixed shallow aquatic	SAM	1	0.22	0.48	51.33
Submerged shallow aquatic	SAS	1	0.04	0.06	1.62
Deciduous swamp	SWD	3	0.08	0.04	0.16
Thicket swamp	SWT	1	0.1	0.04	0.58

Table notes:

- There were no wetland features in the Huttonville Creek SWS or Spring Creek SWS within the FSA.
- ELC types present within the broader SWS areas, but not within the FSA included: Shrub bog (BOS), Treed bog (BOT), Open fen (FEO), Shrub fen (FES), Treed fen (FET), Marsh (MA), Coniferous swamp (SWC), and Mixed swamp (SWM).

Woodlands

Coverage of woodland features within the FSA and adjacent 120m is presented on map DA4a-c. Woodland units have been identified based on their location within the west, central, or east FSA terrestrial areas; attribute information relating to status and policy areas are presented in Appendix F.

Based on the available ELC data, there were 362 woodland features identified within the FSA and adjacent 120m. Polygons were represented by seven ELC community series types including:

- Cultural plantation
- Cultural savannah
- Cultural woodland

- Coniferous forest
- Deciduous forest
- Mixed forest
- Deciduous swamp

In total, woodland ELC polygons accounted for 418.5 ha (~5%) of the FSA and adjacent 120m.

Among the seven subwatersheds within the FSA, the West Humber River SWS had the most woodland features and largest coverage of woodland area followed in order (based on area coverage) by Upper Etobicoke Creek, Fletchers Creek, the Credit River, and Main Humber subwatersheds; there were no woodland features identified in the Huttonville Creek or Spring Creek subwatersheds within the FSA (Table 2.3.4.3).

Table 2.3.4.3. FSA Woodland Summary

ELC Description	ELC Code	Number of features in FSA	Woodland area (ha) in FSA	Relative to ELC type in SWS (%)	Relative to ELC type FSA (%)
Credit River					
Deciduous forest	FOD	2	1.65	4.3	0.83
Deciduous swamp	SWD	2	2.41	8.6	4.96
Fletchers Creek					
Cultural plantation	CUP	4	2.54	80.43	4.93
Cultural woodland	CUW	1	0.79	1.98	1.53
Mixed forest	FOM	1	0.95	59.6	4.67
Upper Etobicoke Creek					
Cultural plantation	CUP	8	6.74	21.97	13.06
Cultural savannah	CUS	12	15.3	31.85	33.61
Cultural woodland	CUW	16	12.64	14.57	24.32
Coniferous forest	FOC	1	0.66	15.32	100
Deciduous forest	FOD	69	106.61	41.65	53.57
Mixed forest	FOM	11	17.16	29.78	84.46
Deciduous swamp	SWD	28	31.32	45.48	64.52
West Humber River					
Cultural plantation	CUP	51	42.07	33.03	81.53
Cultural savannah	CUS	22	29.92	17.57	65.73
Cultural woodland	CUW	29	38.38	21.85	72.21
Deciduous forest	FOD	66	89.05	13.42	44.74
Mixed forest	FOM	3	1.55	1.88	7.63
Deciduous swamp	SWD	21	14.74	14.83	30.36
Main Humber River					
Cultural plantation	CUP	2	0.25	0.01	0.48
Cultural savannah	CUS	3	0.3	0.05	0.66
Cultural woodland	CUW	3	1.01	0.17	1.94
Deciduous forest	FOD	2	1.71	0.08	0.86

ELC Description	ELC Code	Number of features in FSA	Woodland area (ha) in FSA	Relative to ELC type in SWS (%)	Relative to ELC type FSA (%)
Mixed forest	FOM	3	0.66	0.06	3.24
Deciduous swamp	SWD	3	0.08	0.04	0.16

Flora

The extent of flora records are presented on Map DA2. A detailed list of flora records associated with the various Subwatershed areas within in the FSA are presented in Appendix F.

In total 125 unique plant species records occurred within the FSA based on available secondary source data (Table 2.3.4.4); this compares to 760 unique records associated with the broader seven Subwatershed areas within the Region of Peel. Within the SWS areas in the FSA, the Upper Etobicoke Creek and West Humber Subwatersheds had the highest number of records (73 and 93, respectively). The remaining four Subwatershed areas had eight or fewer records, with Spring Creek and Huttonville Creek having no available records.

In general, the number of flora records within the FSA area is low. In part, this reflects a combination of sampling of a limited number of vegetated areas within FSA, some SWS areas within the FSA being relatively small (e.g. Credit River, Fletcher's Creek, and Spring Creek, and Main Humber), and that the vegetation cover may be limited within these areas (e.g. Credit River, Spring Creek, Huttonville Creek).

Table 2.3.4.4. Flora Summary

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	6	12
Huttonville Creek	0	140
Fletcher's Creek	4	329
Main Humber	8	477
Spring Creek	0	230
Upper Etobicoke	73	186
West Humber	93	271
Total Unique Records	**125**	**760**

The flora species records available within the FSA are reflective of the inventories being undertaken relatively in high-quality natural areas (Table 2.3.4.5; Map DA2). Species occurrence data was available from and provided by TRCA and CVC watershed monitoring programs; as such it reflects a sub-set of species occurrence tied to the sites selected for and available to these monitoring activities. Therefore, the species records presented here are not representative of the general characteristics of vegetated areas across the FSA; in particular they are not anticipated to reflect the composition of natural features that are located in areas that have received high levels of disturbances and/or are represented by cultural type features.

Table 2.3.4.5. Flora Species List Sorted by Most Common Occurrence Records

Scientific Name	Common Name	Number of Occurrence Records within FSA
Euonymus obovatus	running strawberry-bush	49
Picea glauca	white spruce	26
Claytonia caroliniana	broad-leaved spring beauty	21
Carex crinita	fringed sedge	21
Carya ovata	shagbark hickory	20
Cardamine concatenata	cut-leaved toothwort	18
Lilium michiganense	Michigan lily	17
Dicentra canadensis	squirrel-corn	17
Carex lupulina	hop sedge	16
Polystichum acrostichoides	Christmas fern	15
Hepatica acutiloba	sharp-lobed hepatica	14
Carex tuckermanii	Tuckerman's sedge	14
Trillium erectum	red trillium	13
Trillium grandiflorum	white trillium	12
Iris versicolor	blue flag	11
Spiraea alba	wild spiraea	11
Sparganium eurycarpum	great bur-reed	10
Uvularia grandiflora	large-flowered bellwort	9
Allium tricoccum	wild leek	9
Scirpus cyperinus	woolly bulrush	9
Claytonia virginica	narrow-leaved spring beauty	8
Hypopitys monotropa	pinesap	8
Anemone quinquefolia var. quinquefolia	wood-anemone	8
Ceratophyllum demersum	coontail	7
Dicentra cucullaria	Dutchman's breeches	7
Potamogeton natans	floating pondweed	7
Viola affinis	Le Conte's violet	7
Viola canadensis	Canada violet	6
Taxus canadensis	Canada yew	6
Wolffia columbiana	Columbia water-meal	6
Carex alopecoidea	foxtail wood sedge	6
Carex gracillima	graceful sedge	6
Cystopteris tenuis	Mackay's fragile fern	6
Pinus resinosa	red pine	6
Persicaria amphibia	swamp smartweed (sensu lato)	6
Geum fragarioides	barren strawberry	5
Sisyrinchium montanum	blue-eyed grass	5
Streptopus lanceolatus var. lanceolatus	rose twisted-stalk	5

Scientific Name	Common Name	Number of Occurrence Records within FSA
Cornus obliqua	silky dogwood	5
Salix petiolaris	slender willow	5
Chelone glabra	turtlehead	5
Ilex verticillata	winterberry	5
Prunus nigra	Canada plum	4
Geum laciniatum	cut-leaved avens	4
Equisetum sylvaticum	woodland horsetail	4
Polygonatum pubescens	downy Solomon's seal	3
Carex communis	fibrous-rooted sedge	3
Spirodela polyrhiza	greater duckweed	3
Carex lacustris	lake-bank sedge	3
Potamogeton foliosus	leafy pondweed	3
Crataegus coccinea var. pringlei	Pringle's hawthorn	3
Cardamine douglassii	purple cress	3
Myosotis laxa	smaller forget-me-not	3
Ludwigia palustris	water purslane	3
Abies balsamea	balsam fir	2
Carex utriculata	beaked sedge	2
Salix nigra	black willow	2
Carex bromoides	brome-like sedge	2
Dryopteris clintoniana	Clinton's wood fern	2
Sagittaria latifolia	common arrowhead	2
Dryopteris cristata	crested wood fern	2
Wolffia borealis	dotted water-meal	2
Rubus pubescens	dwarf raspberry	2
Carex grayi	Gray's sedge	2
Acer x freemanii	hybrid swamp maple	2
Carex sprengelii	long-beaked sedge	2
Carex laxiflora	loose-flowered sedge	2
Glyceria borealis	northern manna grass	2
Mitchella repens	partridgeberry	2
Prunus pensylvanica	pin cherry	2
Carex woodii	purple-tinged sedge	2
Pyrola elliptica	shinleaf	2
Schoenoplectus tabernaemontani	soft-stemmed bulrush	2
Carex laxiculmis var. laxiculmis	spreading wood sedge	2
Mimulus ringens	square-stemmed monkey-flower	2
Lemna trisulca	star duckweed	2
Ranunculus hispidus var. caricetorum	swamp buttercup	2
Bidens vulgata	tall beggar's-ticks	2

Scientific Name	Common Name	Number of Occurrence Records within FSA
Larix laricina	tamarack	2
Equisetum fluviatile	water horsetail	2
Carya cordiformis	bitternut hickory	1
Carex intumescens	bladder sedge	1
Typha latifolia	broad-leaved cattail	1
Cicuta bulbifera	bulblet-bearing water-hemlock	1
Diervilla lonicera	bush honeysuckle	1
Najas flexilis	bushy naiad	1
Calamagrostis canadensis	Canada blue joint	1
Elodea canadensis	common water-weed	1
Rudbeckia laciniata	cut-leaved coneflower	1
Crataegus submollis	Emerson's hawthorn	1
Carex leptonervia	few-nerved wood sedge	1
Potamogeton zosteriformis	flat-stemmed pondweed	1
Carex aurea	golden-fruited sedge	1
Sparganium emersum	green-fruited bur-reed	1
Carex viridula ssp. viridula	greenish sedge	1
Luzula acuminata	hairy wood rush	1
Gleditsia triacanthos	Honey-locust	1
Crataegus macracantha	long-spined hawthorn	1
Viola rostrata	long-spurred violet	1
Caltha palustris	marsh marigold	1
Epilobium leptophyllum	narrow-leaved willow-herb	1
Gymnocarpium dryopteris	oak fern	1
Carex pallescens	pale sedge	1
Salix amygdaloides	peach-leaved willow	1
Persicaria pensylvanica	Pennsylvania smartweed	1
Antennaria parlinii ssp. fallax	plantain-leaved pussytoes	1
Toxicodendron radicans var. radicans	poison ivy (vine form)	1
Carex hystericina	porcupine sedge	1
Carex pseudocyperus	pseudocyperus sedge	1
Carex retrorsa	retrorse sedge	1
Salix lucida	shining willow	1
Carex lasiocarpa	slender woolly sedge	1
Antennaria howellii ssp. neodioica	small pussytoes	1
Alnus incana ssp. rugosa	speckled alder	1
Glyceria grandis	tall manna grass	1
Vallisneria americana	tape-grass	1
Carex molesta	troublesome sedge	1
Nymphaea odorata ssp. tuberosa	tuberous water-lily	1

Scientific Name	Common Name	Number of Occurrence Records within FSA
Lysimachia thyrsiflora	tufted loosestrife	1
Equisetum variegatum ssp. variegatum	variegated scouring-rush	1
Veronica anagallis-aquatica	water speedwell	1
Alisma triviale	water-plantain	1
Oryzopsis asperifolia	white-fruited mountain-rice	1
Phlox divaricata	wild blue phlox	1
Betula alleghaniensis	yellow birch	1

Fauna

The location of fauna records are presented in Map DA2. A detailed summary of fauna records is presented in Appendix F.

Overall, records of 76 fauna species were identified through secondary sources in the FSA compared to 207 species within the associated subwatersheds in Peel Region. This included records for amphibians (7 FSA, 14 SWS), birds (58 FSA, 153 SWS), mammals (5 FSA, 28 SWS), invertebrates (butterflies, dragonflies, and crustaceans; 2 FSA, 6 SWS), and reptiles (4 FSA, 6 SWS).

Species occurrence with each group tended to be higher for the FSA areas within the Upper Etobicoke and West Humber Subwatershed. In part, this reflects the larger area of the FSA occupied by these subwatersheds, and potentially more site investigations that have been undertaken in these areas. Conversely, the lower number of species occurrences in the other FSA Subwatershed areas may reflect a combination of lack of site-specific sampling within the FSA, SWS areas within the FSA having limited extent (e.g. Credit River, Fletcher's Creek, and Spring Creek, and Main Humber), and that existing suitable habitat may be relatively limited within these areas (e.g. Credit River, Spring Creek).

Records within the FSA tended to be associated with existing woodland and wetland features (particularly in the west and central FSA areas), with very few records associated with agricultural lands and/or along water courses. As with flora records, this may reflect the location of monitoring site selection and/or availability of suitable habitat.

Amphibians

Amphibian species documented within the FSA are under-represented when compared to the broader Subwatershed area (Tables 2.3.4.6 and 2.3.4.7). Species that have been confirmed within the FSA represent those that are typically detected when conducting nocturnal amphibian call surveys; notably, salamander species are not represented.

The distribution and abundance of the amphibian species that have been documented within the FSA are important indicators of ecological integrity and function of wetland and/or woodland habitats. The diversity and abundance of calling amphibian species and/or the occurrence of salamander species in breeding ponds is used to determine the significance of wildlife habitat and potential for terrestrial linkages, primarily using criteria established for Significant Wildlife Habitat (SWH).

Table 2.3.4.6. Amphibian Species Occurrence in the FSA

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Lithobates sylvaticus	Wood Frog	15
Lithobates clamitans	Green Frog	11
Pseudacris crucifer	Spring Peeper	8
Lithobates pipiens	Northern Leopard Frog	5
Anaxyrus americanus	American Toad	4
Hyla versicolor	Gray Treefrog	3
Lithobates catesbeianus	American Bullfrog	1

Table 2.3.4.7. Amphibian Species Occurrences within the FSA and Associated Subwatershed areas within Peel Region

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	0	6
Fletcher's Creek	1	11
Huttonville Creek	0	7
Main Humber	3	11
Spring Creek	0	7
Upper Etobicoke	4	6
West Humber	7	9
Total Unique Species Records	**7**	**14**

Birds

Bird species documented within the FSA are under-represented when compared to the broader Subwatershed areas (Tables 2.3.4.8 and 2.3.4.9). The 58 species recorded within the FSA represent only 38% of the species from the broader subwatershed areas. Bird species that have been documented represent a range of habitat guild types including, but not limited to forests/woodlands, wetlands, open/early successional habitat, and agricultural habitats. The distribution, diversity, and abundance of the various bird species documented within the FSA have important implications for evaluating the significance of habitats type using various criteria for wetland significances, Significant Wildlife Habitat (e.g. area sensitive species, species of conservation concern) and habitat for Endangered or Threatened species.

Table 2.3.4.8. Bird Species Occurrence within the FSA

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Contopus virens	Eastern Wood-Pewee	47
Hylocichla mustelina	Wood Thrush	34
Geothlypis trichas	Common Yellowthroat	20
Toxostoma rufum	Brown Thrasher	19
Dumetella carolinensis	Gray Catbird	17
Pooecetes gramineus	Vesper Sparrow	17
Passerculus sandwichensis	Savannah Sparrow	16
Geothlypis philadelphia	Mourning Warbler	15
Eremophila alpestris	Horned Lark	14
Tyrannus tyrannus	Eastern Kingbird	13
Scolopax minor	American Woodcock	10
Setophaga ruticilla	American Redstart	7
Colaptes auratus	Northern Flicker	7
Empidonax traillii	Willow Flycatcher	7
Agelaius phoeniceus	Red-winged Blackbird	6
Pheucticus ludovicianus	Rose-breasted Grosbeak	6
Coccyzus erythropthalmus	Black-billed Cuckoo	5
Melospiza georgiana	Swamp Sparrow	5
Butorides virescens	Green Heron	4
Passerina cyanea	Indigo Bunting	4
Seiurus aurocapilla	Ovenbird	4
Vireo olivaceus	Red-eyed Vireo	4
Tachycineta bicolor	Tree Swallow	4
Corvus corax	Common Raven	3
Megascops asio	Eastern Screech-Owl	3
Spizella pusilla	Field Sparrow	3
Myiarchus crinitus	Great Crested Flycatcher	3
Picoides villosus	Hairy Woodpecker	3
Empidonax minimus	Least Flycatcher	3
Circus hudsonius	Northern Harrier	3
Sitta canadensis	Red-breasted Nuthatch	3
Piranga olivacea	Scarlet Tanager	3
Sitta carolinensis	White-breasted Nuthatch	3
Sayornis phoebe	Eastern Phoebe	2
Ammodramus savannarum	Grasshopper Sparrow	2
Stelgidopteryx serripennis	Northern Rough-winged Swallow	2
Melanerpes carolinus	Red-bellied Woodpecker	2
Cistothorus platensis	Sedge Wren	2
Accipiter striatus	Sharp-shinned Hawk	2
Melospiza melodia	Song Sparrow	2
Aix sponsa	Wood Duck	2
Empidonax alnorum	Alder Flycatcher	1

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Megaceryle alcyon	Belted Kingfisher	1
Mniotilta varia	Black-and-White Warbler	1
Setophaga virens	Black-throated Green Warbler	1
Polioptila caerulea	Blue-gray Gnatcatcher	1
Dolichonyx oryzivorus	Bobolink	1
Petrochelidon pyrrhonota	Cliff Swallow	1
Chordeiles minor	Common Nighthawk	1
Pipilo erythrophthalmus	Eastern Towhee	1
Cardinalis cardinalis	Northern Cardinal	1
Mimus polyglottos	Northern Mockingbird	1
Icterus spurius	Orchard Oriole	1
Archilochus colubris	Rub-throated Hummingbird	1
Porzana carolina	Sora	1
Meleagris gallopavo	Wild Turkey	1
Sphyrapicus varius	Yellow-bellied Sapsucker	1
Coccyzus americanus	Yellow-billed Cuckoo	1

Table 2.3.4.9. Birds Species Occurrences with the FSA and Associated Subwatershed areas within Peel Region

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	1	24
Fletcher's Creek	6	82
Huttonville Creek	0	71
Main Humber	4	126
Spring Creek	0	86
Upper Etobicoke	37	92
West Humber	44	106
Total Unique Records	**58**	**153**

Invertebrates

The occurrence and distribution of invertebrate species is lacking within the FSA and within the broader subwaterhsed areas (Tables 2.3.4.10 and 2.3.4.11). Of the two species documented, Chimney Crayfish has important implications for determining the presence of Significant Wildlife Habitat. It is expected that the occurrence of other invertebrate species, particularly butterflies and dragonflies, will have important implications for determining the presence of wetland significance, Significant Wildlife Habitat, and habitat for Endangered or Threatened Species.

Table 2.3.4.10. Invertebrate (Butterflies, Dragonflies, Crustaceans) Species Occurrence in the FSA

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Fallicambarus fodiens	Chimney Crayfish / Digger Crayfish	20
Polygonia comma	Eastern Comma	1

Table 2.3.4.11. Invertebrates (Butterflies, Dragonflies, Crustaceans) Species Occurrences within the FSA and Associated Subwatershed areas within Peel Region

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	0	0
Fletcher's Creek	1	6
Huttonville Creek	0	2
Main Humber	0	1
Spring Creek	0	1
Upper Etobicoke	1	1
West Humber	1	1
Total Unique Records	**2**	**6**

Mammals

The five mammal species documented within the FSA represent 18% of those documented in the associated Subwatershed study areas (Tables 2.3.4.12 and 2.3.4.13). Although the diversity and abundance of mammals can be important indicators of habitat integrity and function, the occurrence of individual species is not typically required to determine the presence of environmental constraints, unless they are Endangered or Threatened Species at Risk, or are species of conservation concern and their habitat requirements trigger SWH criteria.

Table 2.3.4.12. Mammal Species Occurrences in the FSA

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Ondatra zibethicus	Muskrat	3
Tamias striatus	Eastern Chipmunk	2
Sylvilagus floridanus	Eastern Cottontail	2
Odocoileus virginianus	White-tailed Deer	2
Zapus hudsonius	Meadow Jumping Mouse	1

Table 2.3.4.13. Mammals Species Occurrences within the FSA and Associated Subwatersheds within Peel Region

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	0	1
Fletcher's Creek	0	7
Huttonville Creek	0	8
Main Humber	0	23
Spring Creek	0	14
Upper Etobicoke	4	15
West Humber	4	19
Total Unique Records	**5**	**28**

Reptiles

The four reptile species documented in the FSA represented 67% of the reptiles documented within the broader Subwatershed areas (Tables 2.3.4.14 and 2.3.4.15). Notably, Snapping Turtle and Eastern Milksnake, species documented in the broader Subwatershed areas but not within the FSA are almost certainly present. The diversity and abundance of the reptile species documented within the FSA and those that are likely present have important implications for determining the significance of wetlands and whether habitat areas support Significant Wildlife Habitat.

Table 2.3.4.14. Reptile Species Occurrences within the FSA

Scientific Name	Common Name	Number of Occurrence Records within the FSA
Storeria o. occipitomaculata	Northern Red-bellied Snake	2
Storeria dekayi	DeKay's Brownsnake	1
Thamnophis sirtalis sirtalis	Eastern Gartersnake	1
Chrysemys picta marginata	Midland Painted Turtle	1

Table 2.3.4.15. Reptiles Species Occurrences within the FSA and Associated Subwatersheds within Peel Region

Subwatershed	# species recorded in FSA	# species recorded in associated SWS within Peel Region
Credit River	0	2
Fletcher's Creek	0	4
Huttonville Creek	0	2
Main Humber	0	5
Spring Creek	0	6
Upper Etobicoke	3	5
West Humber	1	4
Total Unique Records	**4**	**6**

Significant Wildlife Habitat

In total, 23 SWH types were determined to have potential to be present within the FSA study area based on candidate SWH criteria for Ecoregion 6E. Of these, 4 types were not mapped as they required site specific/seasonal information regarding conditions present and/or represented site specific habitat characteristics of species of conservation concern (identified below in Table 2.3.4.16). Of the 19 SWH types that were mapped, a grid approach (grids 250 m x 250 m) was used to identify whether or not candidate SWH criteria triggers were present within the grid area. In total 1767 grid squares were required to cover the FSA study area; of these, 929 (53%) had at least one candidate SWH criteria present. The remaining grid squares had between 1 and 15 SWH criteria present. Higher occurrence grid cells (i.e. those with 10 to 15 criteria) are distributed throughout the FSA study area, and generally associated with areas that have occurrences of large and/or diverse vegetation community types (Map DA5i).

A brief summary of the coverage and general distribution of Significant Wildlife Habitat types that have been determined to be present within the FSA study area based on criteria for Ecoregion 6E are presented below.

Table 2.3.4.16. Summary of SWH types with candidate significant habitat present within the FSA

SWH Type	Coverage within FSA (Number of grid squares and percent)	Map reference and FSA Distribution Description	General habitat description/association
Seasonal Concentration Areas of Animals			
Amphibian breeding habitat (woodland)	347 (19.6%)	Map DA5ii: Distributed throughout the FSA, with a slightly higher concentration in the west terrestrial zone.	Generally associated with wetlands located in or adjacent to treed areas.
Amphibian breeding habitat (wetland)	675 (38.2%)	Map DA5iii: Distributed evenly across the FSA.	Generally associated with wetlands that lack tree cover.
Bat maternity colonies Map DA5iv	395 (22.4%)	Map DA5iv: Distributed across the FSA with a higher concentration in the west terrestrial zone.	Generally associated with forest and swamp plant communities.
Colonially-nesting bird breeding habitat (tree/shrub) Map DA	119 (6.7%)	Map DA5v: Distributed across the FSA, with a higher concentration in the west terrestrial zone.	Generally associated with treed habitats and occurrence of various heron and egret species.
Raptor wintering areas	136 (7.7%)	Map DA5vi: Localized patches distributed across the FSA study area.	Associated with patches that include treed areas adjacent to larger meadow plant communities (> 15 ha).
Shorebird migratory stopover areas	359 (20.3%)	Map DA5vii: Distributed relatively evenly throughout the FSA.	Primary associated with meadow marsh habitats in the FSA .

SWH Type	Coverage within FSA (Number of grid squares and percent)	Map reference and FSA Distribution Description	General habitat description/association
Turtle wintering areas	643 (36.4%)	Map DA5viii: Distributed across the FSA with slightly higher concentrations located in the west and east FSA terrestrial zones.	Associated with any swamp, meadow marsh, open aquatic or shallow aquatic ELC types within the FSA.
Waterfowl stopover and staging areas (aquatic)	151 (8.5%)	Map DA5ix: Localized occurrences distributed across the FSA.	Associated with a variety of shallow marsh, shallow aquatic, and swamp community types.
Waterfowl stopover and staging areas (terrestrial)	Not mapped	Potential to be distributed across the FSA.	Requires confirmation of flooding in cultural meadow plant community types and fields during the spring (mid-March to May)
Reptile hibernaculum	Not mapped	Potential to be distributed across the FSA, but would be localized where suitable habitat exists.	Habitat can be present in any ecosite type and require site-specific surveys to determine presence.
Rare Vegetation Communities			
Other rare vegetation communities	84 (4.8%)	Map DA5x: Sparse distribution throughout the FSA.	Associated with plant communities that are considered rare in Ontario
Savannah	38 (2.2%)	Map DA5xi: Localized occurrences within each FSA terrestrial zone.	Associated with cultural savannah plant communities within the FSA
Old growth forest	Not mapped	Requires site specific surveys to be undertaken to confirm appropriate forest structure.	Potential to be associated with older (>140 year), larger (>30 ha)forest and swamp community types
Specialized Habitat for Wildlife			
Bald Eagle and Osprey nesting, foraging, and perching habitat	314 (17.8%)	Map DA5xii: Distributed across the FSA, with a higher concentration in the west terrestrial zone.	Generally associated with swamp habitats adjacent to wooded areas directly adjacent to riparian areas, rivers, lands, ponds, and wetlands
Seeps and springs	270 (15.3%)	Map DA5xiii: Distributed across the FSA.	Associated with forested habitats within headwater areas of watercourses

SWH Type	Coverage within FSA (Number of grid squares and percent)	Map reference and FSA Distribution Description	General habitat description/association
Turtle nesting areas	204 (11.5%)	Map DA5xiv: Distributed across the FSA.	Associated with appropriate nesting substrates adjacent to a variety of shallow marsh and aquatic habitats
Waterfowl nesting areas	395 (22.4%)	Map DAxv: Distributed across the FSA, with slightly higher concentration in the west FSA terrestrial zone.	Associated with upland habitats located adjacent to a variety of wetland community types
Habitat for Species of Conservation Concern			
Marsh breeding bird habitat	407 (23%)	Map DA5xvi: Distributed evenly throughout the FSA.	Generally associated with various wetland types
Open country bird breeding habitat	33 (1.9%)	Map DA5xvii: Located in two discrete areas: one in the middle terrestrial zone (north and east of the intersection at Old School Road and Airport Road), and the second in the east terrestrial zone, east of Mount Hope Road.	Associated with large grassland areas (> 30 ha)
Shrub/early successional bird breeding habitat	47 (2.7%)	Map DA5xviii: Located in localized patches within the central and east FSA terrestrial zones.	Associated with a variety of early successional woody and shrub cultural habitat types
Terrestrial crayfish	541 (30.6%)	Map DA5xix: Distributed across the FSA.	Associated with a variety of wetland plant community types
Special concern and rare wildlife species	Not mapped	Habitat specific requirements determine whether or not candidate habitat is present based on occurrence of species identified as Special Concern (ESA) or those that are provincially rare (S1-S3, SH).	Species with occurrence in the available data that meet these criteria occur across the FSA and are summarized in Table 2.4.4.17.
Amphibian movement corridors	637 (36%)	Distributed evenly across the FSA.	Associated with areas to connect candidate SWH for amphibian breeding habitat (wetland and woodland types).

Table 2.3.4.17. Species of Conservation Concern with occurrences in the FSA that may trigger SWH

Common Name	SARA END or THR, and not ESA END or THR	ESA Special Concern	SRank S1 to S3
Western Chorus Frog (Great Lakes/St. Lawrence – Canadian Shield Pop.)	X		X
Common Nighthawk	X	X	
Golden-winged Warbler	X	X	
Red-headed Woodpecker	X	X	
Wood Thrush	X	X	
Eastern Wood-Pewee		X	
Grasshopper Sparrow		X	
Monarch		X	
Snapping Turtle		X	X

Significant Wildlife Habitat types that were not identified within the FSA study area based on the Ecoregion 6E criteria schedules included:

- Bat hibernacula
- Colonially-nesting bird breeding habitat (bank and cliff)
- Colonially-nesting bird breeding habitat (ground)
- Migratory butterfly stopover habitat areas
- Landbird migratory stopover areas
- Deer wintering congregation areas
- Cliffs and talus slopes
- Sand barren
- Alvar
- Tallgrass prairie
- Woodland raptor nesting habitat
- Woodland area-sensitive bird breeding habitat
- Bat migratory stopover habitat

Terrestrial Species at Risk

The Natural Heritage Information Centre (NHIC) was queried for species at risk (SAR) and restricted species data available for the area within and directly adjacent to the FSA. Nine (9) species were found to be present in NHIC data squares either fully or partially overlapping the FSA, which cover an area of 1 km^2 (Table SAR NHIC records) (Table 2.3.4.18). This does not include records which are now considered historical (prior to 1970), have not yet been reviewed by NHIC staff, do not inform an element occurrence (e.g. a SAR bird seen flying overhead), or that result in a negative search result. Information about restricted species that are not displayed openly on the NHIC site was also requested for the area. Of the 9 current species there are six species of birds, one vegetation species, one fish species, and one reptile species. Species results are provided in the table below. Species at Risk in Ontario (SARO) ranks two of these species as endangered, four as threatened, and three as special concern.

Table 2.3.4.18. SAR NHIC Records

Species Type	Common Name	Scientific Name	SRank	SARO Status	COSEWIC Status
Bird	Bank Swallow	*Riparia riparia*	S4B	THR	THR
Bird	Barn Swallow	*Hirundo rustica*	S4B	THR	THR
Bird	Bobolink	*Dolichonyx oryzivorus*	S4B	THR	THR
Bird	Eastern Meadowlark	*Sturnella magna*	S4B	THR	THR
Bird	Eastern Wood-pewee	*Contopus virens*	S4B	SC	SC
Bird	Wood Thrush	*Hylocichla mustelina*	S4B	SC	THR
Plant	Butternut	*Juglans cinerea*	S2?	END	END
Fish	Redside Dace	*Clinostomus elongatus*	S2	END	END
Reptile	Snapping Turtle	*Chelydra serpentina*	S3	SC	SC

Based on species records provided by TRCA and CVC, five Species at Risk were documented within the FSA and adjacent 120m. This included:

Bobolink (Threatened)

- Single occurrence in southern half of western FSA
- Occurred within agricultural field surrounded by cultural meadow and woodland
- Historically lived in tallgrass prairie and other open fields. Now often found in hayfields where they nest on the ground.

Common Nighthawk (Special Concern)

- 1 occurrence in central FSA
- Within a cultural woodland surrounded by other natural/cultural forested or meadow areas
- General habitat is open areas with little to no ground vegetation. Also nests in cultivated fields, orchards, and urban sites including parks or gravel roads but most often in natural areas.

Wood Thrush (Special Concern)

- 34 occurrences across FSA
- Mostly occurs in western and central portions of FSA
- Mainly associated with larger, natural forested area interior
- General habitat requirements are larger mature deciduous and mixed forests with well developed undergrowth as well as tall trees for perching. Larger forests are preferred but will also use smaller stands of trees.

Eastern Wood-Pewee (Special Concern)

- 47 occurrences across FSA
- Mostly clustered in the western section of FSA
- Mainly associated with larger, natural forested areas and edges
- General habitat requirements are intermediate age stands of deciduous and mixed forests with clearings and edges

Grasshopper Sparrow (Special Concern)

- 2 occurrences in FSA
- 1 in meadow marsh and 1 in cultural meadow habitat in western section FSA
- Habitat is open, grassland areas including hayfields and pastures. Prefers sparsely vegetated areas.

2.3.5 Geotechnical and Slope Stability Assessment

A desktop study was performed to identify areas of potential watercourse and valley slope instabilities within the 'Focus Study Area'. Topographic mapping provided by Peel Region was used as the main tool to categorize the slopes as low, slight, or moderate risk of instability. Publicly available aerial images were also reviewed for obvious signs of failures.

2.3.5.1 Geological Setting

Based on mapping from the Ontario Geological Survey (Surficial Geology of Southern Ontario, 2010, MRD 128), surficial soils predominantly consist of clay to silt textured till, with pockets of fine textured (clay and silt, minor sand and gravel) glacioulacustrine deposits west of Hurontario Street, and with localized alluvial deposits within the stream valley.

Based on drift mapping from the Ontario Department of Mines (Map 2179 – Brampton Area, 1969), along with the aforementioned surficial mapping, and a cursory review of the Ministry of Environment, Conservation, and Parks, bedrock depth varies but is not expected to be present at surface (or exposed by any creeks within the study area).

2.3.5.2 Erosion Hazard Limit

Both the Credit Valley Conservation and Toronto Region Conservation Authorities require the erosion hazard limit to be assessed using the same methodology as provided in the "Technical Guide – River and Stream Systems: Erosion Hazard Limit", prepared by the Ontario Ministry of Natural Resources (2002). This guide provides procedures for determining the erosion hazard limit, which in turn relates to development limits.

The erosion hazard limit is defined differently in confined systems (watercourse in a defined valley) and unconfined systems (flat meandering watercourse).

For confined systems, the erosion hazard limit is made up of three parts; toe erosion allowance (where the watercourse is within 15 m of the toe of slope), stable slope allowance, and erosion access allowance.

For unconfined systems, the erosion hazard limit is related to the bank full width, flooding hazard limit or meander belt allowance, and erosion access allowance.

Stability of existing slopes (and internal stable slope allowance) is discussed in the following section.

2.3.5.3 Slope Stability Risk Rating

As part of the Provincial technical guide there is a slope rating system to determine the level of investigation required to assess slope stability. This rating system is based on seven factors;

1. Slope inclination
2. Soil Stratigraphy
3. Seepage from Slope Face
4. Slope Height
5. Vegetation Cover on Slope Face
6. Table Land Drainage and Gullies
7. Previous Landslide History

An additional consideration for toe erosion is also proximity to watercourse. These factors would be determined based on a site visit. Each factor is assigned a numerical value depending on condition and the overall score used to define the slope as 'low', 'slight', or 'moderate potential for instability. Based on these ratings, the requirement for investigation is determined.

As this project is scoped/limited to a preliminary assessment (and given the quantity of watercourse slopes), a complete site review of all river and creek banks was not included in the scope. The risk rating has thus been limited to factors which could be determined by desk top study, therefore the assessment is considered modified, and tailored to the Scoped SWS. Discussion on the approach used for each factor is below:

1. Slope inclination
   a. Estimated based on the digital elevation model provided by Peel Region for West Humber River and Etobicoke Creek
2. Soil Stratigraphy
   a. Taken as the predominant soil type - clay to silt textured till
3. Seepage from Slope Face
   a. Assumed as none. Seepage is not visible from aerial images and can only be properly assessed from a site inspection
4. Slope Height
   a. Estimated based on the digital elevation model provided by Peel Region for West Humber River and Etobicoke Creek
5. Vegetation Cover on Slope Face
   a. Estimated based on the general cover visible in aerial imagery
6. Table Land Drainage and Gullies
   a. Assumed as minor drainage over the slope with no active erosion as rills and gullies are only visible during site inspection.
7. Proximity of Watercourse to Slope Toe
   a. Estimated based on the digital elevation model provided by Peel Region for West Humber River and Etobicoke Creek
8. Previous Landslide History
   a. Generally assumed to be none as only very large failures readily visible in historical aerial imagery. Site inspections may also give indications of previous landslides.

As noted, this study is limited to a desk top exercise; future studies would require a slope inspection to confirm rating and requirements for investigation.

Low instability risk slopes are considered stable slopes which would only require a site inspection and letter to confirm the slope is stable.

Slight instability risk slopes are typically stable slopes which require a site inspection and conservative slope stability analysis to verify if the existing slope is stable.

Moderate instability risk slopes may or may not be stable in their current form. A geotechnical subsurface investigation is required to assess. The stable top of slope may not be the current top of slope.

Watercourses within the study area were reviewed based on the above criteria and assigned to the appropriate instability risk category. Figures in Appendix G are provided with a general discussion for each watershed as follows.

Humber Watershed

All watercourses within the Humber River watershed were classified as *low* or *slight* instability risk except the following, all shown on Figure G-B3:

- Immediately east of The Gore Road
  - Slope failure noted due to toe erosion
- Between Emil Kolb Parkway and Queen Street N, north of King Street
  - While the watercourse is not within the study area the erosion hazard limit may impact a portion of the study area

Etobicoke Watershed

All watercourses within the Etobicoke Creek watershed were classified as *low* or *slight* instability risk. Watercourses to the west of Chinguacousy Road are likely classified as unconfined systems, with watercourses to the east of Chinguacousy Road predominantly confined systems.

2.3.5.4 Stable Slope Allowance

Based on the classification from the desk top study, a majority of slopes are classified as having a low or slight instability risk. It is anticipated that a large majority of these slopes would be found to be stable slopes in their current configuration, or any stable slope allowance to be minor.

A few sections within the Humber Watershed were classified as moderate instability risk as shown on Figure G-B3. These sections may be found to require an additional setback to provide a slope with the required factor of safety against instability.

2.3.5.5 Toe Erosion Allowance

Where the watercourse is within 15 m of the toe of slope an additional allowance will be required for a toe erosion allowance. This may be up to 15 m from the watercourse depending on a number of factors.

2.3.5.6 Erosion Access Allowance

Both the CVC and TRCA require a 10 m erosion access allowance. This is in addition to the long-term stable top of slope (stable top of slope plus any toe erosion allowance).

This requirement is found in the CVC Watershed Planning and Regulations Policy (2010), Section 6.2.1 (b) and TRCA Planning and Development Procedure Manual (2008), Section 2.1.2.

This erosion access allowance is required for both confined and unconfined systems.

2.3.5.7 Summary

For confined watercourses, all areas will be required to incorporate a toe erosion allowance (where the watercourse is within 15 m of the toe of slope) along with the erosion access allowance. Large additional setbacks to obtain a stable top of slope are not anticipated with the possible exception of a few 'moderate instability risk' areas. Classification will ultimately need to be confirmed by site inspections and localized sections of slope instability where toe erosion is occurring can be expected however, the stable top of slope may still be the physical top of slope (as the toe erosion may be creating a localized instability and not an overall slope instability).

2.4 Natural Heritage and Water Resource Systems: Review

2.4.1 Natural Heritage System Review

2.4.1.1 Governing Policies, Definitions and Guidance Documents

Provincial Direction

The PPS provides direction for the protection of natural features and areas and directs municipalities to identify a Natural Heritage System (NHS) in accordance with the following policies:

> *2.1.1 Natural features and areas shall be protected for the long term.*
>
> *2.1.2 The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.*
>
> *2.1.3 Natural heritage systems shall be identified in Ecoregions 6E & 7E, recognizing that natural heritage systems will vary in size and form in settlement areas, rural areas, and prime agricultural areas.*

These policies set the direction and requirement for identification and protection of a Natural Heritage System and natural heritage external to the system, in accordance with the policies of applicable provincial plans.

Under the PPS, a NHS is defined as a system of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include:

- Natural heritage features and areas
- Federal and Provincial Parks and Conservation Reserves
- Lands that have been restored or have the potential to be restored to a natural state
- Areas that support hydrologic functions
- Working landscapes that enable ecological functions to continue
- Significant Wetlands
- Significant Coastal Wetlands
- Significant Woodlands
- Significant Valleylands
- Significant Wildlife Habitat
- Significant Areas of Natural and Scientific Interest (ANSI)
- Other Coastal Wetlands

Although not expressly stated, the inclusion of 'areas that support hydrologic functions' makes clear that interactions with the WRS are also expected to be considered to support their relationship and inter-related functions.

The definition of the NHS provides flexibility to municipalities to go beyond the minimum requirements to protect features identified as *significant* under the PPS through the broad inclusion of 'natural heritage features and areas' and 'working landscapes that enable ecological functions to continue'. Restoration and enhancement of NHS' is captured through the inclusion of 'lands that have been restored or have the potential to be restored to a natural state' as a means of encouraging the improvement of existing features and functions.

Through the consolidated review of provincial plans undertaken by the provincial government, the province aligned its natural heritage policies and planning and undertook mapping of a consolidated Natural Heritage System across the Growth Plan for the Greater Golden Horseshoe area, the Greenbelt Plan area, and the Niagara Escarpment. Applicable to the FSA, is direction provided by the Growth Plan for the Greater Golden Horseshoe (the Growth Plan; MMA Office Consolidation 2020) and the Greenbelt Plan (MMA 2017). These plans provide further direction and in some cases criteria for the identification of features that comprise the natural heritage system within their plan boundaries, and provide policies for the protection, connection, and enhancement of the system. The Plans require the identification and protection of Key Natural Heritage Features (KNHFs) and are defined consistently between these two plans as:

- Habitat of endangered species and threatened species
- Fish habitat
- Wetlands
- Life science areas of natural and scientific interest (ANSIs)
- Significant valleylands
- Significant woodlands
- Significant wildlife habitat (including habitat for special concern species)
- Sand barrens, savannahs, and tallgrass prairies, and
- Alvars

The plans also require the identification of Key Hydrologic Features (KHFs) and Key Hydrologic Areas (KHAs) in accordance with the guidance of the plan(s), as appropriate. These are defined and addressed through the Water Resource System for the FSA (**Section 2.4.4**).

Municipal Direction

The Region of Peel's Regional Official Plan (ROP) is the long-term policy framework for land use planning decision making within the Region, including policies and direction for protection of the environment through the Peel Greenlands System (Section 2.3). The Greenlands System is intended to support and express the Region's vision for the protection of the natural environment.

Functionally, the Greenlands System is comprised of Core Features, Natural Areas and Corridors and Potential Natural Areas and Corridors which collectively identify known and potential features and areas of significance to the protection of and long-term vision for a sustainable and resilient natural environment within the Region. The policies for the Greenlands System provide direction for identification of natural features and areas within the Region.

As part of the Peel 2051 Regional Official Plan Review process a review of the Greenlands System and its associated policies was undertaken to consider them in the context of work that has occurred since their preparation (e.g., provincial, local municipal, etc.) and is presented in a discussion paper (Region of Peel, 2020). Consideration is also given to the findings of this review developing a preliminary NHS for the FSA.

Guidance Documents and Other Studies

In addition to policy direction provided to Provincial and Regional Plan documents, numerous guidance documents and studies have been prepared at the federal, provincial and local level which inform and support the identification of a preliminary NHS for the FSA:

- **How Much Habitat is Enough? 3rd Edition (2013)** | Provides high-level guidance on natural feature cover relative to potential risks to biodiversity, maintaining viable wildlife populations, and selected ecosystem functions and attributes. Used as a benchmark to assess cover within a watershed.

- **Natural Heritage Reference Manual. 2nd Edition. (2010)** | Provides technical guidance for implementing the natural heritage policies of the PPS. Prepared for the 2005 PPS, it remains a relevant and commonly used document to guide identification of features for an NHS.
- **Significant Wildlife Habitat Technical Guide (2000)** | Provides technical guidance for the identification of Significant Wildlife Habitat. Largely replace in function by the Significant Wildlife Habitat Ecoregion Criteria Schedules, this document is the basis upon which the criterion schedules were developed and remains an important guidance document.
- **Significant Wildlife Habitat Ecoregion Criteria Schedule. Ecoregion 6E. (2015)** | Provides detailed criteria defining candidate habitats and confirmed Significant Wildlife Habitat.
- **Regional Natural Heritage System (NHS) Integration Project: Conservation Authority Natural Heritage System in the Town of Caledon and Region of Peel (2019)** | A comparison and assessment of natural heritage systems prepared by Conservation Authorities with jurisdictions within the Region of Peel. Provides recommendations for implementation of the integrated Conservation Authority NHS at the Regional scale.

These guidance documents and reports were reviewed and used to inform preparation of a preliminary NHS for the FSA.

2.4.1.2 Natural Systems Comparative Review

Natural heritage systems (NHSs) within the Region of Peel have been developed independently at three different jurisdictional levels: provincial, watershed (i.e., Conservation Authority) and municipal. The result of this is that four separate NHSs have been mapped within the FSA, each developed with a different purpose and approach. As a result, while there is some overlap between these systems, they differ in the features they identify and in their overall influence on the SABE planning process. The planning history and purpose of the different NHSs which exist within the FSA are reviewed below, as well as a discussion on their applicability to the SABE and influence on the planning process.

Province's Natural Heritage System

The Province's NHS (as mapped) is intended to identify a broad landscape-scale system applicable across the Growth Plan Area. It does not, and was not intended to, identify all natural heritage features and areas that may be *significant* at a provincial, watershed or municipal level. As such, it does not identify all features which may protected under the PPS and/or local plans and policies. It is expected that NHSs mapped at the watershed or municipal level will incorporate the Province's NHS, but also reflect a more detailed assessment of features at a local scale. The province has identified a NHS which consists of the following components:

- Regional NHS for the Greater Golden Horseshoe
- Greenbelt Plan NHS
- Oak Ridges Moraine Natural Core Areas and Natural Linkage Areas
- Niagara Escarpment Plan Escarpment Natural Areas and Escarpment Protection Areas

All of the provincial NHS features mapped in the FSA fall into the Greenbelt Plan area, specifically within the Protected Countryside designation, and are therefore subject to the policies in the Greenbelt Plan.[3] Although the entire FSA is situated within the Growth Plan area, the majority of the Province's NHS within the FSA is comprised of Greenbelt Plan NHS and only three small areas of the GGH Regional NHS features

[3] Note that the Protected Countryside designation applies not only to natural heritage features but also to agriculture, recreation and natural resources.

are mapped within the FSA. The FSA is located just outside of the Oak Ridges Moraine Plan area and well outside of the Niagara Escarpment Plan area, so the policies of those plans do not apply to provincial NHS features in the FSA.

Influence on the FSA NHS

Under s. 3.2.2.4 of the Greenbelt Plan, the Greenbelt NHS, including the policies pertaining to *Key Natural Heritage Features*, shall apply to areas being considered for expansion of settlement areas. As such, the following Greenbelt Plan policies will influence the development of a NHS within the FSA:

- Section 3.2.2.3 speaks to new development or site alteration within the NHS:
  - Development and site alteration shall have no negative impact to *Key Natural Heritage Features* (KNHFs) or *Key Hydrologic Features* (KHFs) or their function(s) as defined in the Plan
  - Connectivity within the NHS and between KNHFs or KHFs located within 240 m of each other will be maintained or, where possible, enhanced for the movement of native plants and animals across the landscape
  - At least 30% of the *total developable area* will remain or be returned to natural self-sustaining vegetation[4]
- Section 3.2.2.5: The boundaries of the NHS may be refined, with greater precision as official plans are brought into conformity with the Plan, in a manner that is consistent with the Plan and the system as mapped in the Plan (Schedule 4).

These policies apply to lands occurring within the Greenbelt NHS and will be considered in the development of the FSA NHS in those areas. Specifically, these policies may influence the identification of NHS features, restoration and/or enhancement areas and linkages.

Additional Greenbelt Plan policies provide further direction with respect to development (e.g., area of disturbance, impervious area) which will not influence the identification of the FSA NHS but are relevant to development planning.

Conservation Authority Natural Heritage Systems

The FSA falls within the jurisdiction of two Conservation Authorities: the Toronto and Region Conservation Authority (TRCA) and Credit Valley Conservation (CVC). Both TRCA and CVC have developed NHSs within their watersheds, as described below. In the Region of Peel, TRCA and CVC have collaborated to create an integrated Conservation Authority NHS. Hereinafter, "Conservation Authority NHS" (CA NHS) refers to the integrated Region of Peel Conservation Authority NHS.

Toronto and Region Conservation Authority Target Terrestrial NHS

The Target Terrestrial NHS (TTNHS) was developed by the Toronto and Region Conservation Authority (TRCA) through the preparation of the Terrestrial NHS Strategy (TNHSS), which was approved in principle in 2007. The TNHSS was prepared to support biodiversity conservation efforts in response to substantial declines observed in natural features (community types) and species across TRCA's jurisdiction.

The TNHSS used a modeled approach using a multi-criteria analysis to identify quality, quantity and distribution scores to assess the existing natural cover and consider the impacts of continued land use activities consistent with those being observed. The model identified that further declines in natural heritage and biodiversity could be expected as a result of continued land use change. Associated with these declines,

[4] Specific policies apply to non-renewable resources.

impacts to other "ecosystem services" rendered by natural heritage features and areas (e.g., water quality, flooding, etc.) could be expected.

To support efforts to conserve biodiversity and maintain ecosystem services, a second model was developed to identify a TTNHS which represents an expanded and improved NHS compared to existing conditions. Targets were set for natural cover within different land use planning areas (e.g., Greenbelt, Rural, Urban) with an overall target of 30% natural cover within TRCA's jurisdiction. It should be noted that while the TTNHS recognizes the importance of connectivity and considers existing connectivity as a criterion, it does not identify or map linkages to connect the terrestrial system across the landscape.

Most of the FSA is within TRCA's jurisdiction and, contains various features and areas identified as components of the TTNHS. It is important to note that the TTNHS does not only map the boundaries of existing features on the landscape but also of *potential* feature boundaries where ecological restoration and/or enhancement could be implemented to expand and improve natural system.

Credit River Watershed NHS (Credit Valley Conservation)

Credit Valley Conservation (CVC) mapped the Credit River Watershed NHS (CRWNHS) using criteria developed through the Natural Heritage System Strategy (NHSS). The CRWNHS consists of Natural Heritage Features, Buffers to protect Natural Heritage Features from the effects of land use change, and Natural Heritage Areas, which represent clusters of the most significant Natural Heritage Features. It is important to note that the criteria in the NHSS were developed prior to the release of several key provincial criteria and guidance documents. Natural Heritage Features in the CRWNHS may therefore include features which qualify as *significant* under the PPS, but these may change if current provincial criteria and guidelines were applied. It should be noted that because the CRWNHS includes Buffers, the boundaries of the CRWNHS do not necessarily correspond to the boundaries of features as they appear on the landscape.

Only a small portion of the FSA falls within the Credit River watershed and therefore only a few features in the CRWNHS fall within the FSA.

CVC and TRCA Integrated Regional NHS for the Town of Caledon and Region of Peel

In 2018, at the request of the Region of Peel, CVC and TRCA undertook an exercise to integrate their NHSs into a single Conservation Authority NHS for the Region. The watersheds of Conservation Halton, the Lake Simcoe Region Conservation Authority and the Nottawasaga Valley Conservation Authority were also included in the exercise. The result is an integrated regional Conservation Authority NHS which includes Natural Features, Potential Enhancement Areas, watercourses and waterbodies. There is good alignment between the integrated Conservation Authority NHS and features in the provincial NHS and Peel Greenlands System.

The integrated Conservation Authority NHS is described as a "landscape level tool" rather than a regulatory tool and identifies policies and resources which may inform regional NHS policies. The integrated Conservation Authority NHS also recognizes that some small features fall outside of the NHS and should be considered for inclusion based on certain criteria (e.g., through site-specific study).

The entire FSA falls within the Region of Peel's integrated Conservation Authority NHS and includes features identified for both protection and potential enhancement.

Influence on the FSA NHS

Through the report, the CA NHS is described as a landscape level tool rather than a regulatory tool. It uses a science-based, modelled approach to identifying a target NHS; while relationship to policy is considered, the system has not been built from a policy basis for an NHS. Based on this, it is not recommended that the CA NHS be adopted directly. However, it does serve as an excellent resource for comparing, contrasting and validating the FSA NHS.

Several key items from the Conservation Authority NHS which can be used to assess or validate the FSA NHS are:

- 'Good' quality patches (based on TRCA's TNHSS criteria) are the most likely to support the broadest range of species, including those more sensitive to human disturbance and/or with increased conservatism (i.e., more restrictive habitat requirements). Therefore, a key principle of a NHS should be to maximize retention or creation of 'good' quality habitat patches. TRCA maintains a ranking system for TTNHS features which could be used to validate the FSA NHS.
- Distribution of Natural Areas, (particularly those of 'good' quality as described in TRCA's TTNHS) should be considered in the context of a system to provide habitat opportunities across the landscape.
- The Conservation Authority NHS recommends a minimum of 48% natural cover in the Town of Caledon. This includes lands beyond the FSA where existing natural cover is substantially higher. Consideration may be given to how lands within the FSA support this recommendation.
- Review and consideration of enhancement opportunities, and identification of multiple benefits to site selection for enhancements.

Peel Greenlands System

The Region of Peel's Greenlands System is described in Section 2.3 of the ROP, which provides the rationale for the system and the context for the preparation and delineation of an interconnected system. It should be noted that the criteria used to identify the Greenlands System were determined prior to the release of several key provincial plans and guidance documents (e.g., Peel created a regional guideline for identifying significant wildlife habitat prior to the release of MNRF's Significant Wildlife Habitat Criteria Schedules). As a result, features which were mapped using the criteria in the ROP may change if assessed using current provincial criteria and guidance documents.

Peel's Greenlands System is comprised of three categories: Core Areas, Natural Areas and Corridors (NACs) and Potential Natural Areas and Corridors (PNACs). Core Areas are mapped on Schedule A of the ROP and are intended to represent provincially and regionally significant features and generally include those features and areas that are considered *significant* under the PPS. NACs include features with important ecological features, forms and/or functions which are critical to supporting the integrity of the Core Areas. PNACs include features which warrant further assessment to determine their form and function on the local landscape and their importance for supporting Core Areas and NACs. NACs and PNACs may be important or significant at local municipal scales as determined through planning support studies (e.g., a subwatershed study).

Influence on the FSA NHS

Peel's Greenlands System and its supporting policies in the ROP will be the primary natural system used to develop the FSA NHS. Natural features in the FSA will be assessed using the criteria in the ROP, but consideration will be given to provincial criteria and guidelines which have been released since the ROP criteria.

2.4.1.3 Comparative Review of NHS Features in the FSA

Distribution of NHS Features in the FSA

Provincial NHS

Since most of the FSA is designated as a settlement area in the Growth Plan, the provincial NHS generally occurs immediately outside the FSA boundary. Provincial NHS features within the FSA occur along the corridors of major watercourses (e.g., Etobicoke Creek, the West Humber River and their tributaries). As discussed previously, the boundaries of the provincial NHS along these corridors do not necessarily reflect the boundaries of natural features on the landscape. While the provincial NHS within the study area encompasses natural heritage features which qualify as *significant* under the PPS (e.g., *significant valleylands* of Etobicoke Creek, the West Humber River and their tributaries), the intention of the provincial NHS is that feature boundaries within the NHS will be refined using provincial criteria. Thus, the provincial NHS within the study area encompasses not just natural features but also agricultural land, roads and other infrastructure.

Conservation Authority NHS

The Conservation Authority NHS identifies natural heritage features at a much finer scale than both the provincial NHS and the Peel Greenlands System. It is the only NHS which identifies features outside of the major watercourse corridors in the FSA, but the largest Conservation Authority NHS features are valleylands associated with Etobicoke Creek, the West Humber River and other watercourses in the FSA. Smaller features identified in the Conservation Authority NHS include wetlands and woodlands. Although the largest Conservation Authority NHS features are roughly contiguous with provincial NHS features and Core Areas of the Peel Greenlands System, the Conservation Authority NHS document recommends that smaller features be considered for inclusion in the NHS based on certain criteria. Overall, Conservation Authority NHS features have a relatively even distribution across the FSA. Notable areas which lack TTNHS features include: the area between Airport Road, Goreway Drive, King Street and and Old School Road; the area between McVean Drive and The Gore Road; and the area north of King Street between The Gore Road and Clarkway Drive.

Peel Greenlands System

Core Areas of Peel's Greenlands System are mainly located along major watercourses in the FSA (e.g., Etobicoke Creek, the West Humber River and their tributaries). The only Core Areas not associated with watercourses are the Etobicoke Creek Headwaters II Wetland Complex (located between Heritage Road and Mississauga Road) and a large woodland located northwest of Healey Road and Clarkway Drive.

Areas of Overlap and Discrepancies between Systems

Major Watercourses

All three of the major NHSs in the FSA (i.e., provincial NHS, Conservation Authority NHS and Peel Greenlands System) overlap along four major watercourse corridors: Etobicoke Creek, the West Humber River and two tributaries of the West Humber River. This makes sense since watercourses and their associated floodplains and valleylands have generally avoided conversion to agriculture and other land use changes and therefore represent the most intact natural features on the landscape. They also function as logical corridors and connections between other natural features. Within these corridors, however, the boundaries of the systems differ considerably. The provincial NHS encompasses a much wider area than both the Conservation Authority NHS and the Peel Greenlands System because those systems have taken a more refined approach to mapping natural heritage features.

The Conservation Authority NHS and Peel Greenlands System also differ in which features have been mapped along major watercourses in the FSA. Along Etobicoke Creek, for example, the Conservation Authority NHS maps the boundaries of wetlands and woodlands associated with the creek, while the Peel Greenlands System maps the boundaries of the floodplain and valleyland as a Core Area. This is particularly evident along Etobicoke Creek between Chinguacousy Road and McLaughlin Road.

Minor Watercourses

The Conservation Authority NHS and the Peel Greenlands System overlap along four minor watercourses in the FSA, two of which are tributaries of Etobicoke Creek (between McLaughlin Road and Kennedy Road North) and three of which are tributaries of the West Humber River (between Torbram Road and McVean Drive), including Salt Creek. These watercourses and their associated terrestrial corridors are not included in the provincial NHS. The Conservation Authority NHS and Peel Greenlands System differ in how features along these corridors are mapped. Along Salt Creek, for example, the Conservation Authority NHS maps the boundaries of woodlands and wetlands as NHS features while the Peel Greenlands System maps the floodplain and valleyland of Salt Creek as Core Areas.

Other Areas of Overlap

The Etobicoke Creek Headwaters II Wetland Complex, located between Heritage Road and Mississauga Road at the western end of the FSA, is mapped as a feature of the Conservation Authority NHS and a Core Area of the Greenlands System. The boundaries of the Conservation Authority NHS and the Greenlands System are mostly contiguous here, but the TTNHS is slightly more expansive since it includes potential enhancement areas in addition to the existing feature.

A large woodland in the eastern portion of the FSA, located northeast of Healey Road and Clarkway Drive, is also mapped as both a feature of the Conservation Authority NHS and Core Area of the Greenlands System. This is one of the few locations where the Greenlands System is more expansive than the Conservation Authority NHS, since the Core Area includes a sliver of open country habitat which is excluded from the Conservation Authority NHS.

Discrepancies

Within the FSA, the largest area of the provincial NHS which does not overlap with Conservation Authority NHS features or Greenlands Core Areas is the area bisected by Chinguacousy Road.

Interestingly, while most of the Salt Creek floodplain is mapped as a Core Area of the Greenlands System, relatively few features along Salt Creek are mapped in the Conservation Authority NHS. One reason for this may be that the Salt Creek floodplain contains relatively few wetlands and woodlands which would have been captured in the Conservation Authority NHS.

The Conservation Authority NHS includes a substantial number of features which do not overlap with either the provincial NHS or the Greenlands System. Some of the most apparent examples are located along various minor watercourses in the FSA (e.g., several tributaries of Etobicoke Creek between McLaughlin Road and Kennedy Road North; a tributary of the West Humber River south of Healey Road and west of Clarkway Drive). Other large features which are only included in the Conservation Authority NHS include: large wetlands between Mississauga Road and Chinguacousy Road (i.e., Etobicoke Creek Headwaters I Wetland Complex); a woodland located north of Old School Road between Heart Lake Road and Dixie Road; and a large woodland located north of Mayfield Road and west of Centreville Creek Road.

Recommendations

Upland Linkages

NHS features in the FSA are closely associated with watercourses (although the Conservation Authority NHS maps some upland features which are not closely associated with watercourses). However, connections and corridors between upland features, and between upland features and watercourse corridors, are equally important for promoting ecological integrity at a landscape scale. The FSA NHS should therefore consider upland corridors and identify opportunities for restoring or enhancing upland corridors, where possible.

Underrepresented Areas

Potential FSA NHS features should be looked for within the provincial NHS to the east and west of Chinguacousy Road. This area represents a linkage from Little Etobicoke Creek to Greenbelt NHS features outside of the FSA.

Salt Creek is an example of how NHS features should not be limited to wetlands and woodlands which are visible on aerial imagery. FSA NHS features along Salt Creek should include an uninterrupted valleyland from the headwaters to mouth of the creek.

The area bisected by Old School Road between the two provincial NHS corridors should be explored for potential FSA NHS features. Other underrepresented areas include: the Central Zone between Airport Road and Goreway Drive; the Central Zone between McVean Drive and the Gore Road; and all of the Eastern Zone north of Healey Road.

2.4.2 Water Resources Systems Review

The components of the water resource system are defined by Provincial Policy, specifically the 2020 Growth Plan for the Greater Golden Horseshoe and the 2017 Greenbelt Plan. The following sections summarize the governing policies and components of the water resource system, as well as the component information available to compile the mapping. The integrated compilation of this information to generate the water resource system mapping is discussed in Section 2.5.1.

2.4.2.1 Governing Policies and Definitions

The requirement for a Water Resource System (WRS) is set out by the PPS and includes the identification of features and functions which are necessary for the ecological and hydrological integrity of a watershed and include:

- Groundwater features
- Hydrological functions
- Natural heritage features and areas
- Surface water features including shoreline areas

Although not identified as part of the WRS explicitly, the PPS also directs planning authorities to maintain linkages and related functions among components of the WRS. With the basic direction set out in the PPS, interactions and relationships between a NHS and WRS are identified through the inclusion of natural heritage features and areas.

Section 4.2.1 of the Growth Plan for the Greater Golden Horseshoe provides the following requirements for defining the water resource system:

1. "Upper- and single-tier municipalities, partnering with lower-tier municipalities and conservation authorities as appropriate, will ensure that *watershed planning* is undertaken to support a

comprehensive, integrated, and long-term approach to the protection, enhancement, or restoration of the *quality and quantity* of water within a *watershed*.

2. *Water resource systems* will be identified to provide for the long-term protection of *key hydrologic features*, *key hydrologic areas*, and their functions.

3. *Watershed planning* or equivalent will inform:
   a. the identification of *water resource systems;*
   b. the protection, enhancement, or restoration of the *quality and quantity* of water;
   c. decisions on allocation of growth; and
   d. planning for water, wastewater, and stormwater *infrastructure*.

4. Planning for large-scale *development* in *designated greenfield areas*, including *secondary plans*, will be informed by a *subwatershed plan* or equivalent.

5. Municipalities will consider the Great Lakes Strategy, the targets and goals of the Great Lakes Protection Act, 2015, and any applicable Great Lakes agreements as part of *watershed planning* and coastal or waterfront planning initiatives."

Further, the Growth Plan for the Greater Golden Horseshoe provides the following definitions for Key hydrologic features and key hydrologic areas:

Key hydrologic features: "Permanent streams, *intermittent streams*, inland lakes and their littoral zones, *seepage areas and springs*, and *wetlands*."

Key hydrologic areas: "*Significant groundwater recharge areas*, *highly vulnerable aquifers,* and *significant surface water contribution areas* that are necessary for the ecological and hydrologic integrity of a *watershed*."

The above policies and definitions are noted to be consistent with the requirements and definitions in Section 3.2.3 of the Greenbelt Plan for water resource systems.

2.4.2.2 Key Hydrologic Features

Consolidated mapping of key hydrologic features within the FSA has been prepared, based upon the background information provided for the Scoped Subwatershed Study, for the various components per Section 4.2.1 of the Growth Plan for the Greater Golden Horseshoe and Section 3.2.5 of the Greenbelt Plan. The following provides an overview of the component pieces for mapping the key hydrologic features.

Permanent and Intermittent Streams

Mapping of the drainage features and watercourses within the FSA has been provided by Peel Region, TRCA and CVC. Although the information does not distinguish between stream types (i.e. permanent and intermittent), it illustrates the drainage patterns and associated features on the landscape. The watercourse mapping has further been overlain with the floodline mapping provide by CVC and TRCA to identify those features which are currently regulated based upon the respective Authority's flood hazard criteria, encompassing permanent and intermittent watercourses. Those features which are not currently regulated based upon flood hazard may, potentially, be regulated subject to further study and review. The unregulated features have currently been assumed to constitute headwater drainage features (HDFs), which would be classified as part of future studies to establish corresponding management requirements, for these features post-development. Notwithstanding as part of the Scoped SWS further initial characterization work has been conducted of the various reaches to support future studies.

Lakes

Mapping of the surface drainage features within the FSA, as provided by TRCA and CVC, includes lakes and ponds. Although various ponds have been identified within the FSA, no lakes are located within the FSA. Furthermore, the ponds within the FSA are noted to consist primarily of dug agricultural ponds and some stormwater management facilities; no natural ponds are currently known to exist within the FSA.

Seepage Areas and Springs

Seepage Areas and Springs have been identified within the FSA based on potential groundwater discharge locations identified from the TRCA Expanded Groundwater Flow Model. The specific location and the quantity of discharge associated with this mapping will need to be field verified. It is also expected that areas not included on the current map will be field verified to confirm whether seeps and springs exist.

Wetlands

Mapping of wetland features has been provided by the Region of Peel, and is also included within the ecological land classification mapping provided by TRCA and CVC. The mapping information contains Provincially Significant Wetlands (PSWs), unevaluated wetlands, and Evaluated-Other (i.e. non-PSW). The dataset has been used to be separated these features based on wetland significance classification type for categorization.

2.4.2.3 Key Hydrologic Areas

Key hydrologic areas per Provincial guidance primarily represent areas of significant and/or sensitive groundwater recharge, and areas of surface water contributions. Significant and sensitive groundwater recharge areas have been identified based upon Significant Groundwater Recharge Areas (SGRAs) mapping developed through the Source Water Protection, which represent areas of relatively higher groundwater recharge rates that are important for providing groundwater recharge to an aquifer. Ecologically Significant Groundwater Recharge Areas (ESGRAs) represent areas of land where groundwater recharge may directly support groundwater-dependent features such as coldwater streams, wetlands and their ecological functions (TRCA 2019), and have been delineated by carrying out reverse particle tracking within the regional-scale groundwater flow modelling using the TRCA Expanded Groundwater Flow model (ORMGP 2018b). The quantity of recharge water associated with the ESGRAs has not been quantified and it is recognized that these areas are predominantly on low permeability till. In addition, the endpoints will need to be field verified to determine groundwater discharge exists.

Areas of significant surface water contributions represent those areas which contribute surface runoff toward surface water dependent features such as streams and wetlands. Surface water dependent features located within the limits of regulated watercourses and/or the defined NHS would be sustained through the minimizing of drainage area modifications from grading post-development. Smaller surface water dependent features located on the tableland would be identified as part of subsequent studies, and management strategies developed accordingly to provide a supply of clean runoff to the features to mimic the pre-development hydroperiod.

2.5 Natural Heritage and Water Resource System: Application

2.5.1 Water Resource Systems

Integrated mapping of the water resources systems has been compiled based upon the information and governing policies outlined in Section 2.4.2.

2.5.1.1 Key Hydrologic Features Mapping

As noted previously, the permanently flowing and intermittent watercourses encompass those drainage features which are regulated by Conservation Authorities based upon hazard definition and/or protected environmental features, as well as headwater drainage features which are not regulated but provide a drainage and/or ecological function. In general, the "high" constraint watercourses within the FSA represent permanently flowing drainage features, and the "medium" and "low" constraint watercourses represent intermittent watercourses and headwater drainage features. However, there are cases where permanently flowing streams may be designated as a medium constraint, or intermittent that may be of a high-constraint due to factors beyond streamflow hydrology.

Seepage areas and springs have been inferred from the TRCA Expanded Groundwater Flow Model, in locations that represent where groundwater discharge equals or exceeds the median discharge rate. These areas are localized to the watercourses within the FSA, many of which are not currently regulated based upon flood hazard definition.

As described previously, 335 wetland polygons represented by eight plant community types are present within the FSA and surrounding 120 m, from the West Humber River, Upper Etobicoke Creek, Main Humber, Fletchers Creek, and the Credit River subwatersheds. Given the presence of clay till throughout the FSA, most of the wetlands tend to be supported by surface runoff while there may also be groundwater dependent wetlands in incised valleys, or where there is shallow groundwater linked to the broader groundwater system. Specifically, 18 wetland units totalling 27.2 ha within the FSA + 120 m intersect with significant groundwater recharge areas (SGRA; per Region of Peel mapping, 2020) and 59 wetlands totalling 27.7 ha intersect with ecologically significant groundwater recharge areas (ESGRA; per TRCA mapping, 2020). Further, a total of 139 (234.7 ha) are associated with (i.e. within 30 m of) watercourses and 71 (88.9 ha) are associated with HDFs in the FSA + 120 m. In terms of groundwater-dependency, 152 polygons have low (<4 m) mean depth to groundwater and 90 wetlands (144 ha) are present within valleylands. Of the wetlands that are within valleylands, 67 contain a low (<4 m) depth to groundwater comprising 121.3 ha.

Mapping of key hydrologic features has been compiled based upon the foregoing components. The resulting mapping is provided in Drawing WR11 in Appendix D.

2.5.1.2 Watercourses

There are three major items of integration between the watercourse systems and the surface water, groundwater, and ecological systems. The integration ensures that watercourse systems and their associated erosion hazards are isolated from development, and that reach-scale management can be determined for watercourses and HDFs to reduce impacts to the natural environment, protect features and their functions, and mitigate risks from environmental hazards associated with watercourses.

Erosion Hazard Delineation

The delineation of natural erosion hazard limits associated with river and valley systems allows for the natural processes of lateral and downstream channel migration for unconfined features though the floodplain, and the estimated stable top of slope for confined valleys. Planning around such hazards allows for natural stream form and function to continue, while avoiding erosion risk to property or infrastructure.

The meander belt width and stable top of slope, plus associated setbacks represent a constraint to development and land use planning, and are integrated in the development of the Natural Heritage System (NHS).

In-Stream Erosion

Channel erosion and sediment transport are natural processes necessary to maintain overall stream health. However, development pressures and stormwater runoff, may accelerate erosion processes, which leads to increased risk to property, infrastructure, and human populations, and environmental degradation. As a practical approach to assess in-stream erosion risks, erosion thresholds and critical discharges are typically evaluated based on preliminary SWM plans and times of exceedance between pre- and post- development scenarios.

In order to calculate an erosion threshold, or critical hydraulics for particle entrainment, fieldwork is required to characterize reach form, function, and stability, and to evaluate the overall sensitivity and representativeness of receiving features within and downstream of the FSA. Using those field observations, sites may be selected for detailed survey of channel profile, cross-section, and composition (bed and banks). The current assignment is scoped and therefore will not have any new erosion thresholds calculated based on desktop and field observations. However, during the impact assessment, relative sensitivity to erosion will be evaluated using stream power or channel-slope mapping, to highlight reaches that may require careful consideration for the area SWM design. Additionally, results from the previous work in North-West Brampton (AMEC, 2010) and Mayfield West (AMEC, 2011) to determine area-rated erosion thresholds will be evaluated for comparison to reaches within the current study area to, at a preliminary level, observe any similarities in stream sensitivity and function that may lead to a preliminary erosion threshold analysis.

Detailed field studies are required during future local subwatershed studies to evaluate erosion sensitivity and provide management guidance for stormwater management.

Drainage Feature Integrated Characterization and Management – Watercourses and HDFs

Watercourses and HDFs form an intricate surface water network that primarily conveys water and sediment, but also provides functional processes which drive the ecological health of riparian and aquatic systems including direct and indirect habitat, linkages, thermal regime and water quality. Management of these drainage features requires integration between each discipline to determine current function, and future requirements for protection, mitigation, and/or enhancement at the reach and site-specific scales.

Generally, watercourse features are protected and regulated by the Conservation Authority, while HDFs are not regulated. Both Watercourses and HDFs may provide some important function that should be considered when evaluating impacts from development and identifying management opportunities. Regulation of watercourses does not preclude them from modification through development, but substantial rational would be required to complete channel design works and realignments, to the satisfaction of applicable review agencies. Therefore, it is prudent to determine appropriate management opportunities and constraints for area drainage features that seek to maintain, mitigate, or enhance the form and function required for each feature. The management constraints/recommendations will also impact the delineation of the NHS as some features may require protection which are not regulated (i.e. HDFs), or other regulated or non-regulated features may have realignment opportunities.

An integration of key characteristics and functions for each discipline can be applied through the development of a watercourse constraint ranking, and through the application of a Headwater Drainage Feature Assessment (e.g. CVC/TRCA, 2014). The former will be completed through the impact assessment phase of the current study at the scoped level based on existing data with some minor field confirmation, with recommendations for future study, while the latter cannot be completed in any capacity under the current desktop scope of work. HDF assessments require seasonally-based field investigations to evaluate form and function on a feature-by-feature basis.

Watercourse Feature Constraints

An integration of key characteristics and functions, for each discipline will be applied in the development of a constraint ranking for watercourses within the FSA. Each watercourse will be assessed a ranking of high, medium or low, on a reach-by-reach basis, based upon various environmental factors and considerations, with individual rankings per discipline. A constraint ranking will then be established, conservatively, by utilizing the most limiting constraint observed for the feature, which may be suggested by all, few, or even one discipline. The findings of the assessment will ultimately provide guidance regarding the management opportunities and requirements for each watercourse feature within the study area. This process will be completed through the impact assessment to determine management recommendations for each feature.

The following sections summarize, in general, the definitions/ criteria to be applied by discipline, in developing the individual constraint rankings for the area watercourses at a scoped, desktop level of study.

High Constraint Watercourses

High constraint watercourses are features that have attributes (e.g. floodplains, unstable banks) that attract Conservation Authority regulations, and have usually been deemed high-quality systems that should not be re-located and replicated in a post-development scenario. They must remain open and protected in their present condition and locations, with the exception of select localized sites where rehabilitation may be of benefit to the system.

Surface Water (Hydrology)
These corridors contain a well-defined channel within a well-defined and established valley system, with large contributing drainage areas (i.e. generally 200 ha or more).

Geomorphology
These corridors contain a defined active channel with well-developed channel morphology (i.e., riffle-pool), material sorting, floodplain development, and/or a well-defined valley. They have an associated erosion hazard (meander belt or stable top of slope) and have been identified as Significant Valleylands.

Aquatic (Fisheries)
Permanently wetted (flowing or standing water over most of watercourse length) that is generally associated with continuous or seasonal groundwater discharge, or with wetland storage and/or pond flows. Fish community (or the potential for) is present and natural habitat is usually fully developed. Either habitat and/or flow source characteristics may be difficult to replicate or maintain.

-and/or-

Habitat occupied by species at risk.

Hydrogeology (Groundwater)
High-constraint rankings based upon groundwater inputs are assigned based upon the presence/absence of baseflow and the manner in which groundwater contributions support local or downstream aquatic habitat. The groundwater constraint rankings are established in conjunction with the aquatic constraint ranking.

Terrestrial/Riparian
The watercourse segments that are within terrestrial features that are of high ecological quality; are determined to be provincially, regionally, and/or locally significant; and/or are determined to provide critical habitat functions for wildlife (e.g. consistent with criteria for Significant Wildlife Habitat). These include

significant woodlands, significant life-science ANSIs, ESAs, the Provincial NHS, PSWs, and other valleylands that may provide a linkage function across the landscape.

Medium Constraint Watercourses

Medium constraint watercourses have attributes (e.g. floodplains, unstable banks) that attract Conservation Authority regulation, but are typically highly impacted and therefore may be realigned using natural channel design and other principles of environmental design.

Surface Water (Hydrology)
These reaches have relatively smaller contributing drainage areas (i.e. generally between 50 ha and 200 ha), and typically are not located within defined valley corridors.

Geomorphology
These reaches may have well-defined morphology (defined bed and banks, evidence of erosion/sedimentation, and sorted substrate). These reaches maintain geomorphic function and have potential for rehabilitation. In many cases, these reaches are presently exhibiting evidence of geomorphic instability or environmental degradation due to historic modifications and land use practices.

Aquatic (Fisheries)
Seasonally wetted (flowing or standing water) that is generally associated with seasonally high groundwater discharge or seasonally extended contributions from wetlands/ponds (no perennial flow). May provide an extended seasonal migration route for fish. Fish community (or the potential for) is present for an extended seasonal period. Potential permanent refuge fish habitat may be provided by naturally occurring storage features such as channel pools, wetlands, and other water bodies.

Hydrogeology (Groundwater)
Medium constraint rankings are established in conjunction with the aquatic constraint ranking, and as having potential groundwater discharge from the TRCA Expanded Groundwater model.

Terrestrial/Riparian
Watercourse segment that is within terrestrial features that are determined to be of low or moderate ecological quality; are determined to be not provincially, regionally, and/or locally significant; and/or are determined to not provide critical habitat functions for wildlife (e.g. consistent with criteria for Significant Wildlife Habitat). These include unevaluated wetlands,

Low Constraint Watercourses

These features are ephemeral in nature and are typically poorly defined, lacking function or quality as defined by each discipline for High and Medium constraint features when completing a desktop assessment. These features resemble headwater drainage features; however, their type and presence cannot be confirmed at the desktop scale, nor through windshield assessments. At the present time, these are to be considered watercourses, and as such will have what should be considered preliminary regulatory setbacks. In future studies, further analysis and field confirmation is required to confirm feature presence and type, and then undertake the appropriate assessments to determine the feature constraint and management opportunities. As such, characterization mapping and setbacks may change compared to what is presented in the current study.

Headwater Drainage Features

Future work through subsequent planning stages to confirm these features and evaluate them following the CVC/TRCA (2014) guidelines will allow for management recommendations to be mapped similarly to the constraint rankings presented here for watercourses. At the scoped level, headwater drainage features are only being identified as HDFs, and are not subject to detailed site investigations or study integration, however, if there are critical issues around HDFs (e.g. terrestrial features and/or corridors) that may be identified, constraint ranking and management will be addressed through the lens of the appropriate policy framework. The fulsome integration will capture such "red-flags" for each feature, where possible through the scoped level of study.

Application of Constraint Rankings

The development of constraint rankings and management strategies will be developed and applied through the impact assessment phase of this study. Based on the constraint ranking, general management strategies exist, that may be modified on a reach-by-reach basis through TAC engagement. This process is often iterative and may be finalized following detailed analysis through subsequent planning stages. The scoped level of assessment may only provide few specific management recommendations, and this is an ongoing process to be presented in subsequent reports. Management strategies are only presented for high and medium constraint features as low constraint are subject to confirmation of feature presence and type, and appropriate assessments.

2.5.1.3 Key Hydrologic Areas Mapping

Significant Groundwater Recharge Areas within the FSA correlate with the more permeable sediments and as such are very limited given the predominance of the low permeability soils. Additional mapping from TRCA has identified various Ecologically Significant Groundwater Recharge Areas, which may represent key hydrologic areas within the FSA and which will require further assessment as part of future studies to verify function and extent of these areas. As previously noted the ESGRAs do not consider the quantity of recharge or the verification of the endpoint groundwater discharge. It should be noted that local scale groundwater flow may provide a groundwater/surface water function but not be represented on the scale that these maps were created.

The background information has also identified Groundwater Areas of Concern within the FSA, which, in part, represent areas of shallow depth to water table (i.e. depth to water table less than 4 m). Although not specifically defined in the Provincial Policies as a component of the key hydrologic areas, the groundwater areas of concern are nevertheless considered to represent key hydrologic areas within the FSA as the shallow depth to water table may represent a functional connection for potential groundwater discharge and general groundwater availability for wetlands and woodlands.

Due to the limited infiltration within the FSA, it is anticipated that several terrestrial features may be sustained by direct surface runoff. In this respect, the contributing drainage areas to these features are considered to represent key hydrologic areas local to the study area. The contributing drainage area to each of the currently identified features has been delineated based upon the available contour data. In addition, the portions of the FSA within the Etobicoke Creek Watershed and the West Humber Subwatershed are recognized to lie upstream of designated flood vulnerable areas (FVAs) within each watershed. Although contributing drainage areas to FVAs are not defined as key hydrologic areas under current Provincial Policy, the FVAs are nevertheless considered to represent areas sensitive to specific changes to the area hydrology (i.e. increases in peak flow rates) and have thus been considered in developing the key hydrologic area mapping.

The key hydrologic areas mapping is provided on Drawing WR12 in Appendix D.

2.5.2 Natural Heritage System

2.5.2.1 Goals for the FSA NHS

Goals for the NHS provide high-level guidance for the identification of the NHS for the FSA and should guide future studies and land use planning for its management. Goals for the FSA build upon those identified in systems applicable to the area and specifically draw from and align closely with the goals and principles identified in the Conservation Authority natural heritage systems within Peel (CA NHS) as presented in the Conservation Authority Natural Heritage System for the Region of Peel (CVC 2019). Goals include:

- Develop a system (NHS) that balances policy direction, emerging science and natural heritage planning best practices.
- Establish a robust, connected and ecologically resilient system (NHS) for the long-term benefit of environmental and public health, well-being and safety.
- Provide opportunities and direction for the enhancement of the NHS to establish a sustainable system in a changing landscape matrix and that supports climate change resilience.

An additional goal of the CA NHS, while not specifically addressed through this study, is relevant to long-term management of the NHS by local area municipalities and opportunities to align land use planning (e.g., open space, parks, trails) with system-level planning:

- To provide outdoor appreciation and recreational opportunities and to promote healthy communities (CA NHS).

While primarily outside the scope of the current study, it is important that all levels of land use planning process consider the interface between the built and natural environments and recognize the intrinsic benefits provided through access to nature for the mental and physical well-being of future residents. It is important that consideration be given to this so that the system and future land use planning is structured in a way that can support this goal while also continuing to support resilient ecological functions. Where appropriate, discussion and guidance provided here highlights some potential opportunities in this area.

The scoped nature of the current subwatershed study must be taken into consideration and it be recognized that system refinements will occur through future stages of work (e.g., detailed subwatershed studies and other future studies identified in the Scoped SWS Part C Implementation Report) to confirm and refine direction provided here. To this end, the following guiding principles have been set and are specific to the current stage of work:

- Develop clear and well-documented guidance for the identification and confirmation of the system to ensure consistency through future stages of study.
- Identify a broad range of enhancement opportunities to provide flexibility for system refinement through future studies while still ensuring that system target(s) can be met.
- Provide direction for implementation that will support future stages of land use planning and decision-making in achieving net benefit outcomes for the NHS.

2.5.2.2 Structure of the Preliminary NHS for the FSA

The Core Area, NAC and PNAC categories within the ROP provide guidance for identification of their composite features across the Region. Refinement of areas, criteria, etc. is appropriate at refined scales through appropriate planning studies (e.g., SWS, AMOP, Natural Heritage Study, etc.) in order to reflect the specific character of the area for which land use planning is being moved forward. Additionally, the structure of the Greenlands Network is such that it relies on further studies to make determinations as to the significance (Provincial, Regional, Municipal) of features in order to confirm how features and areas are to be addressed at finer planning scales (i.e. to inform development)

The current Scoped Subwatershed Study provides the platform through which this refinement should occur. It is recognized that the current Scoped SWS is based primarily on available information and desktop analysis and that a detailed SWS will follow to confirm or refine the approach set out for the Preliminary NHS for the FSA.

The NHS for the FSA will include Core, NAC and PNAC features of the Peel Greenlands; Key Natural Heritage Features and Key Hydrologic Features identified through policies of the Growth Plan and the Greenbelt Plan; and features contained within the CA NHS. To provide a consistent terminology and clarity for the preparation of the impact assessment (Part B) and Implementation (Part C) reports, the following terminology and categorization has been used:

- **Key Features** include those features and areas that are recommended to be protected as part of a connected NHS through this scoped study. Key features are comprised of all *Core Areas* as defined in the ROP and a sub-set of *NAC* and *PNAC* features which meet specific criteria set out based on analyses conducted for the FSA. Many Key Natural Heritage Features and some Key Hydrologic Features will be captured as Key Features of the FSA NHS.
- **Supporting Features** include those features and areas that are not, based on available information identified as Key Features but meet criteria as Supporting Features. For some features in this category, further assessment is required to determine if they meet Key Feature criteria; others require further assessment to evaluate their functions, interactions and contributions to the NHS in order to determine how they are managed (e.g., protect / retain in-situ, replicate, compensate, no management required).
- **Other Features** include those features and areas that are not Key or Supporting features but meet criteria as 'Other Features'. This category may include small and/or isolated features, features or areas requiring further assessment to determine their status (e.g., if they are / include Key Features).
- **Linkages** provide connectivity within and across the system and to features and areas external to the FSA to support a connected and resilient system structure. These will be defined through Part B (Impact Assessment). Criteria will be developed for the identification and mapping of linkages / corridors (location, width, etc.) and will be used to build upon NHS features presented in this report to create a connected and integrated system. All Key Features of the NHS are to be connected by linkages through implementation. Under constraints assessment terminology, Linkages are considered Moderate Constraint.
- **Enhancements** are opportunities to strengthen the system in supporting the goal of establishing a robust and resilient NHS and support net benefit targets. Thesewill de defined through Part B (Impact Assessment). Enhancement areas will be identified using a set of guiding criteria and will be informed by targets for the NHS. Consideration will be given to areas identified as potential enhancement areas through the CA NHS to build upon and / or refine direction provided by the underlying studies to the CA NHS. Under constraints assessment terminology, Enhancement Areas are considered Moderate Constraint.

2.5.2.3 Setting Targets for the FSA NHS

While policy determines the requirement to identify an NHS, targets should be used to inform the identification and planning of a comprehensive NHS. Targets should be set that are achievable and that provide an appropriate amount of flexibility to facilitate good land use and natural heritage planning to occur at both broad-scale and site-specific planning levels.

Environment Canada's publication How Much Habitat is Enough? (Environment Canada 2013) provides a strategic framework and set of guidelines for protecting and enhancing wetland, riparian, forest and grassland habitats. It is intended to serve as a starting point for the development of NHS' with a focus in areas where natural heritage features and areas are more fragmented. The report does not set targets; however, some of the guidance provided can be used to inform the preparation of targets. For the purposes of setting targets for the FSA, guidance provided on cover or broader objectives (e.g., 'no net loss') were used:

- **Wetland Habitat** | Ensure 'no net loss' of wetland area and focus on maintaining and restoring wetland functions at a watershed and subwatershed scale based on historic reference conditions. At a minimum, the greater of (a) 10% of each major watershed and 6% of each subwatershed or (b) 40% of the historic watershed wetland coverage, should be protected and restored.
- **Riparian Habitat** | 75% of stream length should be naturally vegetated.
- **Forest Habitat** | 30% forest cover is the minimum forest cover threshold for a high-risk approach with anticipated substantial reductions in biodiversity and aquatic system health. 40% forest cover and 50% forest cover represent moderate and low risk approaches which are expected to support substantially increasing species diversity and habitat functions, and aquatic system health.
- **Grassland Habitat** | Maintain, restore and create native grassland patches to their historic extent and type at a county, municipal and/or watershed scale considering past and present conditions.

Additional guidance provided through the report (e.g., proximity, habitat complexity, etc.) were considered through the preparation of criteria for feature identification.

The Conservation Authority Natural Heritage System for the Region of Peel (CVC 2019) provides a comparison and integrated consideration of recommended or target natural heritage systems for the Region and Caledon. Existing natural cover and potential enhancement areas identified through the preparation of the CA NHS' can be used to inform targets for the FSA as a subset of these areas. Percent cover as a proportion of the total land area of the municipal area (Town or Region) are presented in Table 2.5.2.1.

Table 2.5.2.1. Summary of CA NHS % Cover

Cover Type	Caledon CA NHS	Peel CA NHS
Natural Cover	**34%**	**23%**
Woodland (forest, cultural woodland, plantations)	23%	n/a
Wetland	7%	n/a
Successional	7%	n/a
Aquatic	1%	n/a
Other Natural	<1%	n/a
Potential Enhancement Areas	**14%**	**11%**
Total CA NHS Cover	**48%**	**34%**

n/a = details not available

Existing natural cover increases as you move northward through the Region from densely urban landscapes to more rural areas. This is reflected in the total CA NHS Cover for Caledon vs. the Region as a whole.

Existing natural cover within the FSA is an important consideration in identifying targets for the area-specific NHS. A summary of existing natural cover in the FSA is provided in Table 2.5.2.2.

Table 2.5.2.2. Summary of Existing Natural Cover in the FSA

Cover Type	Existing Cover in the FSA
Natural Cover	**15%**
Woodland (forest, cultural woodland, plantations)	6%*
Wetland	3%*
Successional	7%
Aquatic	<1%
Other Natural	<1%

* Forested wetlands (Deciduous Swamp) is captured under both woodland and wetland.

While the FSA is located within the Town of Caledon, it retains substantially lower natural cover than the overall numbers for Caledon or the Region. Much of the natural cover remaining on the landscape in the FSA is associated with watercourses and valley systems; tableland features are under-represented in the existing natural cover.

Based on existing natural cover and its composition on the landscape targets for the FSA focus on retaining and enhancing natural cover through the identification of a comprehensive NHS. To support a net gain outcome, biodiversity (existing in the face of increased pressures from development and support gains) and to support system resilience and adaptation to climate change, a substantial enhancement target has been included as a key recommendation for the FSA NHS. Recommended targets for the FSA NHS are presented in Table 2.5.2.3 below.

Table 2.5.2.3. Targets for the FSA NHS

Feature Type	Target for the FSA NHS
Natural Cover*	• No net loss of natural cover.
Woodland	• No net loss of existing woodland cover. • Increase total woodland cover through NHS enhancement with a focus on creation of table land features.
Wetland	• No net loss of wetland cover. • Increase total wetland cover through NHS enhancements.
Valley and Stream Corridors	• No net loss of ecological and hydrologic functions provided by valleylands. • Increase natural cover within valley and stream corridors through NHS enhancement.
Successional / Open Habitats	• Maintain important existing successional / open habitats contiguous to other features and areas of the NHS. • Increase representation and quality of open country habitats across the landscape through NHS enhancement opportunities; strive to create at least one habitat area with a minimum size threshold of 5ha.

Feature Type	Target for the FSA NHS
Aquatic	• Achieve 75% naturally vegetated watercourse length through protection of existing, enhancement or restoration[5].
Sand Barrens, Savannahs, Grasslands	• Protection of all Sand Barrens, Savannahs and Grasslands where they occur.
NHS Enhancement	• Identify distributed enhancement opportunities across the NHS to support the development of a robust and sustainable system. • Increase natural cover* by 30%

2.5.2.4 Feature Analyses: Informing the Preliminary NHS and Developing Criteria

Characterizations presented in Section 2.3, spatial analyses (geographic information systems [GIS]) on existing features and areas, and targets identified in Section 2.4.1.3 were used to assess features of the FSA and establish criteria for identifying Key Features and Supporting Features of the FSA. These are presented by NHS component in the sections below and the composite outcome is shown on Figure DA6a.

Woodlands

To reflect current policies and guidance documents and to consider the relative representation of woodlands within the FSA, two analyses were undertaken to assess woodlands within the FSA:

- Identification of Core, NAC and PNAC Woodlands of the Peel Greenlands System using guidance provided in Section 2.3.2.2 and Table 1 of the Peel ROP.
- Identification of *Significant Woodlands* using criteria and guidance provided in the Natural Heritage Reference Manual (2010) and informed by an analysis of woodland cover within the FSA.

Core Woodlands of the Peel Greenlands System

Woodland criteria in the ROP include size and function-based elements. In undertaking this assessment, not all criteria could be assessed or comprehensively assessed as field work is required to confirm or inform the assessment for some criteria (old growth forest, significant species or vegetation communities). A preliminary assessment of the presence Significant Species could be conducted using data made available for the current study, where such data was available. Table 2.5.2.4 presents the criteria assessed through this analysis.

Table 2.5.2.4. Core Woodlands Criteria Assessment for the FSA

Characteristic	Criteria	Outcome
Woodland Size	*Urban system size thresholds were applied.* ***Core**: ≥4ha* ***NAC**: ≥2ha and <4ha* ***PNAC**: CUW and CUS ≥2ha; all other woodlands >0.5ha*	48 woodlands meet the Core size criteria 21 woodlands meet the NAC size criteria 43 woodlands meet the PNAC size criteria 27 woodlands are <0.5 ha and do not the size thresholds for the Greenlands System.

[5] 75% naturalized stream length is to be based on the total stream length of protected watercourses and HDFs (Protection, Conservation) as determined through a detailed subwatershed study.

Characteristic	Criteria	Outcome
Surface Water Quality	**Core**: n/a **NAC**: ≥0.5ha and within 30m of a watercourse, surface water feature or wetland. **PNAC**: no additional criteria	87 woodlands meet the NAC criteria
Significant Species or Communities	**Core**: n/a – urban size criteria captures woodlands that would be captured through this criterion. **NAC**: ≥0.5ha and <4ha that supports G1-G3 or S1-S3 species or communities; contains SAR habitat or contains any of the forest communities listed in Table 1 of the ROP. **PNAC**: no additional criteria	36 woodlands have records of significant species and are ≥0.5 ha

Note: criteria are assessed independently. As such a woodland may meet a criteria for identification as a NAC and as a Core woodland. Where a woodland meets different thresholds, the higher category applies (i.e., in order of precedence: Core, NAC, PNAC).

The Age criteria identified in Table 1 of the ROP cannot be assessed through the SSWS as additional detailed site information is required; this criterion should be assessed through a detailed Subwatershed Study.

Table 2.5.2.5 presents a summary of woodland classification in accordance with the criteria from Table 1 applied (per Table 2.3.4.4). Count refers to the proportion of woodlands within the FSA that are captured under each category. Area refers to the woodland area and % of total woodland area within the FSA that is captured under each category.

Table 2.5.2.5. Summary of Woodland Classification – Peel Greenlands

Greenlands Category	Count	Area
Core	48 (34%)	~1165 ha (91%)
NAC	47 (34%)	~88 ha (7%)
PNAC	17 (12%)	~19 ha (1%)
Other Woodlands	27 (19%)	~7 ha (<1%)
ALL WOODLANDS	**139**	**~1280**[6]

Through this analysis, 71 woodlands had categories changed compared to the Significant Woodland Mapping provided by the Region. Of these, 57 received a category 'increase' (e.g., from NAC to Core, PNAC to NAC, no category to PNAC, etc.) and 14 received a category 'decrease' (e.g., from Core to NAC, etc.).

The application of the 4 ha Urban System size threshold had the largest impact on woodland categorization for the Peel Greenlands System. Application of this threshold is considered appropriate due to the low amounts of natural cover within the FSA and in consideration of the purpose of assessing the FSA to inform a settlement boundary expansion (i.e., bringing lands into the 'Urban System' under the ROP). Additionally, it supports the NHS target for 'no net loss' of woodland cover.

[6] Woodland area is calculated based on woodlands in their entirety that are wholly or partially contained within the FSA. As such, this woodland area does not correspond to % woodland cover in the FSA.

Natural Heritage Reference Manual Significance Assessment

As a comparative analysis and to validate the Peel Greenlands woodland analysis, woodland cover within the FSA was considered using guidance set out in the Natural Heritage Reference Manual to identify woodlands that should be considered *significant* under the PPS, the Growth Plan and the Greenbelt Plan.

Three criteria were assessed for the purposes of this SSWS and based on available data. These are presented in Table 2.5.2.6 below.

Table 2.5.2.6. Natural Heritage Reference Manual *Significant Woodland* Criteria Applied to the FSA

Characteristic	Criteria	Rationale	Outcome
Woodland Size	Woodlands ≥4ha are *significant* Woodlands ≥2ha *and* meeting at least one additional criterion are *significant*	While woodland cover for the Region and Subwatersheds of the FSA is 16% and 17%, respectively, woodland cover in the FSA is low (6%). A size threshold has been set based on woodland cover for the FSA to support the 'no net loss' target for woodlands. At 6% cover, this correlates to a size threshold of ≥4ha in the NHRM. A secondary, composite size criterion (i.e. size plus at least one additional criterion) has been applied to reflect the following: While much of the woodland cover by area is captured in a few large woodlands, the median woodland size (i.e. @ 50^{th} percentile) in the FSA is 1.9 ha and the 75^{th} percentile is 5.3 ha. This means that half of the woodlands in the FSA are <1.9 ha and only 25% are greater than 5.3 ha. 6% woodland cover is on the bottom of the % cover range for a 4 ha size threshold. Consideration should be given to use of a smaller threshold to support the 'no net loss' target for woodlands in the FSA NHS.	48 woodlands are *significant* based on size ≥4ha 18 woodlands are *significant* based on the composite criteria: ≥2ha and meeting one additional criteria (below). 3 woodlands are identified as candidate significant based on the composite criteria. These woodlands occur within 30m of an Ecological Significant Groundwater Recharge Area. Field verification of hydrologic significance is required to confirm *significance* (i.e., woodlands are or are not significant)
Woodland Interior	Woodlands with interior habitat of any size are *significant*	Per the NHRM, where woodland cover is <15% all interior habitat, measured as >100m from woodland edge, should be considered significant.	23 woodlands have interior habitat and are therefore considered *significant*

Characteristic	Criteria	Rationale	Outcome
Proximity to other Significant Features	Woodlands ≥2ha and within 30m of a Watercourse or Provincially Significant Wetland are *significant*. Woodlands ≥2ha and within 30m of an ESGRA is considered candidate *significant*	Proximity is used to identify woodlands which may support or contribute to the function of a proximal feature (hydrologic, habitat complexity, etc.). Ecologically Significant Groundwater Recharge Areas (ESGRAs) are modelled areas of potential significance. Due to uncertainty these areas are used to trigger further assessment at future stages and not to confirm *significance*.	95 woodlands are within 30m of a watercourse. Of these, 58 are ≥2ha and considered *significant*. 28 woodlands are within 30m of a PSW. Of these, 24 are ≥2ha and considered *significant*. 69 woodlands are within 30m of an ESGRA. Of these, 40 are ≥2ha and considered *significant*.

Note: criteria are assessed independently. As such a woodland may meet a criterion for identification as a significant until multiple characteristics.

Additional criteria will be assessed to refine this assessment through Part B (Impact Assessment) (e.g., linkage).

Table 2.5.2.7 presents a summary of the NHRM woodland significance assessment (per Table 2.3.4.6). Count refers to the proportion of woodlands within the FSA that are captured under each category. Area refers to the woodland area and % of total woodland area within the FSA that is captured under each category.

Table 2.5.2.7. Summary of Woodland Significance – NHRM

Significance	Count	Area
Significant	66 (47%)	~1216 ha (95%)
Candidate	3 (2%)	~9.6 ha (<1%)
Not Significant	70 (50%)	~54 ha (4%)
ALL WOODLANDS	**139**	**~1280**[7]

Woodland Analysis Comparison

Woodlands identified as Core under the Greenlands Network are comparable to those identified as *significant* under the NHRM. Outcomes of these analyses are relatively consistent with a difference of approximately 4% woodland cover between these two approaches.

- 48 woodlands are identified as both *significant* and Core
    - All woodlands identified as Core are also identified as *significant*
- 18 woodlands are identified as *significant* but not Core (NACs)
- All three candidate *significant* woodlands are identified as NACs

Recommendation: Woodlands for the FSA NHS

It is recommended that woodlands that meet the threshold for *significance* in accordance with the NHRM policies within the FSA, as presented here, be identified as Key Features for the FSA NHS. All NAC and PNAC woodlands not identified as *significant* under the assessment presented here are to be identified as

[7] Woodland area is calculated based on woodlands in their entirety that are wholly or partially contained within the FSA. As such, this woodland area does not correspond to % woodland cover in the FSA.

Supporting Features. Table 2.5.2.8 summarizes the recommended Key Feature and Supporting Features criteria for the FSA NHS; outcomes are shown on Figure DA6b.

Table 2.5.2.8. Criteria for Identifying Woodlands of the FSA NHS

	Criteria

Key Feature	All Core Woodlands
	
	NHRM *Significant* woodlands:
	• Woodlands ≥4ha
	• Woodlands with interior habitat of any size
	• Woodlands ≥2ha and within 30m of a Watercourse or Provincially Significant Wetland.
	• *Woodlands ≥0.5ha and:*
	  o *Occurring within 30m of a permanent or intermittent stream, or a Key Feature*
	  o *Containing ≥0.5ha >100yrs of age and having late successional characteristics (excludes plantations)*
	  o *Supporting rare species or vegetation communities (per Table 1 of the ROP)*

Supporting Feature	All other NAC and PNAC woodlands using the Urban System Threshold(s)
Pending Further Assessment	Woodlands ≥2ha and within 30m of an ESGRA is considered candidate *significant*. Further assessment is required to determine their classification within the FSA NHS.

Wetlands

A total of 291 wetland polygons with a total area of 303 ha wholly are partially occur within the FSA. Wetlands in their entirety are used for assessments of analyses to ensure assessed are not skewed. When considered within the FSA boundary only, wetlands represent 7% of FSA by area.

ECCC's How Much Habitat is Enough recommends 6% of subwatersheds as a minimum threshold for wetland coverage. Based on current representation of wetlands within the FSA, this supports the 'no net loss' target for wetlands within the FSA. Wetlands are also identified as a Key Hydrologic Feature as part of the Water Resource System and are considered through that system as well (Section 2.4.2).

A brief analysis of wetlands within the FSA is presented below to inform NHS criteria for the FSA.

Provincially Significant Wetlands

A total of 59 wetland polygons comprising ~95ha is identified as PSW. This represents ~20% of wetland polygons by count and 31% of polygons by area. PSWs are identified as Core features under the Peel Greenlands System.

PSWs are to be considered Key Features in the FSA NHS.

Evaluated-Other and Unevaluated Wetlands

Evaluated-Other wetlands and Unevaluated wetlands are identified as NACs and PNACs respectively under the Peel Greenlands Systems. This classification approach provides general direction for assessment of wetlands in land use planning. The SSWS provides an opportunity to provide further guidance for their consideration in the land use planning process.

In order to determine which NAC and PNAC wetlands should be integrated into the FSA NHS as Key Features beyond PSWs and which may be considered Supporting Features, an analysis was conducted to consider wetland size and potential capture thresholds of wetlands within the FSA. PSWs are excluded from the analysis as they are automatically captured as Key Features.

Excluding PSWs, a total of 232 wetlands are wholly or partially contained within the FSA. These represent a total area of ~208 ha, 69% of wetlands by area within the FSA. Within this subset, wetlands are generally very small in size. The median wetland size is 0.24ha and the 75th percentile is only 0.7ha. This means that half of the wetlands in the FSA are 0.24 ha or less and only 25% of wetlands within the FSA are larger than 0.7ha, however the relative area captured changes substantially.

To support 'no net loss' of wetlands, it is recommended that additional 'other' wetlands (i.e., unevaluated, evaluated – non-PSW) be included with PSWs as Key Features using size thresholds (primary and secondary) with consideration for additional functional criteria (e.g. proximity to other Key Features). An assessment of potential thresholds and their relative influence on wetland capture is presented in Table 2.5.2.9 below.

Table 2.5.2.9. Assessment of Size Thresholds for Key Feature Wetlands in the FSA NHS

Potential Size Thresholds	Count	Area	Wetland Capture (by Area)
≥2 ha	23	128	62%
≥1 ha	47	162	78%
≥0.7 ha (75th Percentile)	58	172	83%
≥0.5 ha	76	182	78%
≥0.24 (50th Percentile)	116	197	95%

It is recognized that very small wetlands that occur isolated on the landscape are may not be suitable for retention in situ. As such, consideration should also be given to the inherent or intrinsic form and function, and its position and relationship to other features and areas on the landscape in addition to size. This approach is consistent with that used for woodlands.

Recommendation: Wetlands for the FSA NHS

In consideration of the assessment presented above, criteria have been developed for identification of Key Feature and Supporting Feature wetlands within the FSA (Table 2.5.2.10); outcomes are shown on Figure DA6c.

Table 2.5.2.10. Recommended Criteria for Identifying Key Feature Wetlands for the FSA NHS

	Criteria
Key Features	Core Area Wetlands (i.e. Provincially Significant Wetlands) NAC and PNAC Wetlands ≥2ha NAC and PNAC wetlands ≥0.5ha that are contiguous to or occur within 30m of a permanent or intermittent watercourse. NAC and PNAC wetlands ≥0.5ha that hydrologically contribute to a headwater identified as Protection or Conservation. NAC and PNAC wetlands contiguous to a significant woodland.
Supporting Features	All other NAC and PNAC wetlands (i.e. all other wetlands)

Significant Wildlife Habitat

Significant Wildlife Habitat is protected under the PPS, Growth Plan and Greenbelt Plan (as a Key Natural Heritage Feature). Section 2.3.4.2 provides an overview of candidate SWH within the FSA in accordance with applicable guidance documents. Due to the scoped nature of the SSWS, SWH cannot be confirmed. Further assessment to determine if SWH occurs within the FSA is to be undertaken through future, more detailed studies (e.g., detailed Subwatershed Study) through which field data will be collected.

Candidate SWH presented through this SSWS is intended to provide direction for screening purposes and to inform potential for SWH and a Terms of Reference for a detailed Subwatershed Study, Site-Specific Studies, etc.

Recommendation: Significant Wildlife Habitat

All confirmed SWH is to be considered a Key Feature in the FSA NHS. There are no Supporting Features associated with SWH. Candidate habitat areas are shown on Figure DA5.

Fish Habitat

Fish Habitat is defined in the Federal Fisheries Act. This definition applies to the FSA. Fish Habitat is identified as a NAC in the ROP. Under the PPS, Growth Plan and Greenbelt Plan, fish habitat is a Key Natural Heritage Feature.

Recommendation: Fish Habitat for the FSA NHS

Direct (Permanent and Seasonal) fish habitat is considered a Key Features of the NHS. Indirect habitat is considered a Supporting Feature.

Due to limitations in available information for the SSWS, fish habitat could not be confirmed. As such, watercourses (excludes HDFs) are used as a proxy for Fish Habitat. This feature type will be refined through subsequent levels of study through which detailed information is collected. Watercourses are shown on Figure DA6f.

Species at Risk

Due to limitations in available data to inform this SSWS, only habitat for Redside Dace is mapped (refer to Section 2.3.4). Further areas of SAR habitat will be integrated as such data becomes available through detailed studies (i.e., with field work). This is shown on Figure DA6f.

Recommendation: Habitat for Species at Risk Habitat in the FSA NHS

All SAR habitat, identified in accordance with general habitat descriptions, regulations or mapped in consultation with MECP is considered a Key Feature. There are no Supporting Features for this feature type.

Valleylands

Valleylands within the FSA NHS are defined in accordance with the Peel Greenlands policies. Core Valley and Stream Corridor Components are considered Key Features in the FSA NHS. NAC Valley and Stream Corridors are considered Supporting Features. The criteria for valleylands in the ROP are provided below in Table 2.5.2.11; outcomes are shown on Figure DA6d.

Table 2.5.2.11. Valleyland Criteria for the FSA NHS

CA NHS	Core Valley and Stream Corridor Component	Mapping Criteria
Key Feature	• Main branches, major tributaries, other tributaries and identified watercourses draining directly to Lake Ontario. • Valley and stream corridors are the natural resources associated with the river systems characterized by their landform, features and functions, and include associated ravines.	• Main branches, major tributaries and watercourses having direct drainage to Lake Ontario are to be mapped from their outlet to the furthest upstream extent of their defined valley landform (i.e., mapped to limit of crest of slope). • Other tributaries are to be included and mapped to the limit of their defined valley portion if they meet the following criteria: ▪ Contains habitat for aquatic SAR (END or THR) ▪ Watercourse crosses municipal boundaries and provides linkage to other Core Areas of the Greenlands System. • Excludes ill-defined HDFs including created headwater valley / stream corridors, discontinuous defined valley features and other non-valley landforms.
	• Ill-defined sections of major valleys	• Ill-defined sections are to be illustrated using regulatory floodplain and meander belt hazards whichever is greater unless site specific assessment has determined valley width in accordance with the text of this Plan. • Shown schematically and subject to site specific evaluation to confirm width of Core valley and stream corridor.
	• Associated Ravines	Associated ravines within the Urban System are to be included if meeting one or more of the following criteria: • Important ecological functions related to the valley landform, • Habitat for END / THR species • Linkage to other natural features of the Greenlands System • Flood and erosion hazards; or • Restoration potential Associated ravines within the Rural System are not considered Regional Core valley and stream corridors. • Significance is determined in accordance with the Town of Caledon Official Plan policies.
Supporting Features	• Any other valley or stream corridor not defined as part of the *Core* Areas	n/a

Environmentally Significant or Sensitive Areas

ESAs are no longer used by the Conservation Authorities. They have been superseded by a systems-based natural heritage protection approach (e.g., the TNHSS in TRCA jurisdiction).

ESAs defined by the Region and / or the Local Area Municipality are incorporated as Key Features. There are no supplementary features associated with this feature type. ESAs are shown on **Figure DA6e**.

Areas of Natural and Scientific Interest

There are no Provincial Life Science or Earth Science ANSIs within the FSA. There are no Regionally significant Life Science or Earth Science ANSIs within the FSA.

Sand Barrens, Savannahs and Grasslands

Sand Barrens, Savannahs and Grasslands are identified as Key Natural Heritage Features under the Growth Plan and Greenbelt Plan. Where they occur, these features are considered Key Features of the FSA NHS. These features are shown on **Figure DA6e**.

Open Country and Shrub Successional Habitats

Open country and shrub successional habitats are some of the fastest disappearing habitats on the Ontario landscape; particularly in areas where land is converting from agricultural and rural to urban. Some of these habitat areas are protected as Significant Wildlife Habitat, however these are often under-represented on the landscape overall as they receive little direct protection through policy. The PPS provides the opportunity for municipalities to include 'other natural heritage features and areas' within an NHS and through this, consideration has been given to representation and inclusion of these habitat types into the preliminary FSA NHS and to maintaining or protecting these habitats and their functions on the landscape in the long-term.

Open country and shrub successional habitats have been included in a preliminary manner through this scoped subwatershed study. Detailed assessment is required (e.g., through a local subwatershed study) to inform the form and function of these habitats in the context of the NHS and make final recommendations on their status in the NHS. Criteria have been prepared based on:

- Size – candidacy as Significant Wildlife Habitat, minimum size threshold for general consideration
- Proximity – potential functional interactions between these features and other components of the NHS (e.g., Key Feature Woodland or Wetland, etc.)

To recognize the need for further assessment, open country and shrub successional habitats (meadows, thickets, cultural savannahs) have been included as Supporting Features to the NHS for the current study. Through future study, the categorization of these features may be revised (e.g., become Key Features). Confirmation or refinement of these features is to be undertaken in consideration of the system targets.

Hydrologic Features

Hydrologic features and areas are addressed through the Water Resource System and discussion of interactions and intersections between these systems is discussion in Section 2.5.1. Further refinement and integration between these systems will be assessed through subsequent phases of the SSWS study.

At a minimum, it is anticipated that Headwater Drainage Features (HDFs) identified as Protection and Conservation will be integrated within the NHS as Key Features and HDFs identified as Conservation will be Supporting Features. Due to data limitations (field data), determinations on HDF classifications will not be completed as part of the SSWS; this assessment and integration of the outcomes of the assessment should be completed through subsequent studies through which this level of information is available (i.e., detailed subwatershed study).

Linkages

Linkages will be addressed through Part B (Impact Assessment). Preliminary guidance is provided here. Two primary levels of linkages may be used to support the establishment of a connected and functional system:

- **Landscape Scale** – large, broad connections; several categories may be identified to support landscape-level connectivity within the system. Minimum widths are assigned to guide their implementation. They are intended to form the key connections across the NHS to link / connect larger blocks or areas of key features in order to protect and maintain the system and provide some residence habitat within them to support extended durations for species moving through or within them. At their broadest scale, consideration should be given to supporting complete life cycles for some species (e.g., those with low mobility or as a way to support broader system biodiversity). It is recommended that Landscape Scale linkages be identified and mapped through the current Scoped Subwatershed Study.
- **Local Scale** – smaller, localized connections between features and are often assigned a minimum width (e.g., 30m), but may have a range of widths defined based on the distance between features, etc. It is recommended that guidance for local-scale linkages be developed, but that mapping of these small-scale linkages be informed by site-specific study and generally completed through future studies (e.g., a local subwatershed study).

Generally, linkages should follow, where possible, existing natural connections. Where existing features along which to establish linkages, consideration should be given to factors such as:

- Shortest path between features / areas
- Functional habitat connections to support target species requirements
- Topography & physiography
- Potential fragmentation impacts (e.g., road crossings – existing and future) to select areas that can support the least fragmented / interrupted alignment(s).
- East-west and north-south system connections
- System linkage redundancy to support a resilient system.

Review and consideration will specifically be given to the Province's NHS and the CA NHS in the preparation of linkages.

Enhancement Areas

Enhancement Areas will be addressed through Part B (Impact Assessment). Preliminary guidance is provided here.

The PPS provides direction for land use planning to protect and, where possible, improve ecological function and biodiversity of natural heritage systems. Identification of Enhancement Areas through this scoped Subwatershed study supports this direction and the identified system goals of establishing a robust and connected system. An enhancement target to increase natural cover by 30% (based on existing natural cover in the FSA) through enhancements to the NHS was set. This target was informed by the CA NHS enhancement targets for Peel and Caledon and specifically, the relative composition of enhancements within the CA NHS.

As a scoped subwatershed study, detailed site-specific information is not available to confirm enhancements areas for implementation. The objectives of this scoped study will be to:

- Identify an approach to identify enhancements that can be mapped or otherwise defined through the current study.
- Provide guidance on how enhancements will be confirmed, refined, and/or new enhancement areas identified that uphold the goals and targets of the NHS.
- Demonstrate through the identification of enhancement areas that the 30% natural cover enhancement target is achievable and appropriate.

To reflect the scoped nature of the current study, enhancements will generally include:

- **Defined Enhancements**. This group of enhancements will include discrete areas within which 100% of the land is considered a potential enhancement. Examples will include improvements to shape, size and/or contiguity of features within the NHS, infill of non-vegetated areas within components of the NHS (e.g., non-vegetated portions of valleylands, within linkages), and floodplains.
- **Un-defined Enhancements**. These include areas within which a portion of the lands are considered a potential enhancement opportunity and as-yet un-mapped / unidentified enhancement opportunities as may be identified through site-specific study. Examples include lands within the Greenbelt NHS but outside of features, species-specific opportunities as identified through detailed study (e.g., enhancement to support Species at Risk).

Enhancement Areas will be determined through spatial analysis, manual review, and professional opinion and informed by targets for the FSA NHS.

Criteria Summary

Table 2.5.2.12 presents a summary of recommended criteria for the Preliminary FSA NHS. As noted above, Linkages and Enhancements will be further explored through Part B with criteria and guidance provided through that next stage of work

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Table 2.5.2.12. Summary of Recommended Criteria for Identification of Key Features and Supporting Features for the Preliminary FSA NHS

Feature Type	PPS / Provincial Plan Feature	Peel Greenlands Designation	SSWS NHS Recommendation
Wetlands	**Significant Wetland** *As defined and delineated by the Province (MNRF)* **Significant Coastal Wetlands** *As defined and delineated by the Province (MNRF)* ***Wetlands*** *Key Natural Heritage Feature and Key Hydrologic Feature under the Growth Plan and Greenbelt Plan*	**Core Area** • *Significant wetlands and coastal wetlands as defined and delineated by the Province (MNRF)* **NAC** • *Evaluated non-provincially Significant wetlands* **PNAC** • *Unevaluated* wetlands	**Key Features** • *Core Area wetlands (i.e., PSWs)* • *NAC and PNAC Wetlands ≥2ha.* • *NAC and PNAC wetlands ≥0.5ha that are contiguous to or occur within 30m of a permanent or intermittent watercourse.* • *NAC and PNAC wetlands ≥0.5ha that hydrologically contribute to a headwater identified as Protection or Conservation.* • *NAC and PNAC wetlands contiguous to a significant woodland.* **Supporting Features** • All other NAC and PNAC wetlands Note: there are no coastal wetlands within the FSA.

Woodlands	**Significant Woodlands**
	As determined in accordance with provincial guidance documents.
	The Natural Heritage Resource Manual (NHRM 3rd Edition) is applicable to the project area
	Key Natural Heritage Feature under the Growth Plan and Greenbelt Plan..
		Core Area
		• *Woodlands in Rural System ≥16ha*
		• *Woodlands in Urban System ≥4ha*
		• *Woodlands ≥4ha containing ≥0.5ha >100yrs of age and having late successional characteristics (excludes plantations)*
		• *Woodlands ≥4ha and supporting rare species or vegetation communities (per Table 1 of the ROP)*
		NAC
		• *Woodlands in Rural System ≥4ha <16ha*
		• *Woodlands in Urban System ≥2ha <4ha*
		• *Woodlands ≥0.5ha containing ≥0.5ha >100yrs of age and having late successional characteristics (excludes plantations)*
		• *Woodlands ≥0.5ha supporting a significant linkage function, as determined through a natural heritage study*
		• *Woodlands ≥0.5ha within 100m of another significant feature supporting a significant ecological relationship between the features*
		• *Woodlands ≥0.5ha within 30m of a watercourse, surface water feature or any wetland that is or can be identified as a wetland in accordance with OWES.*
		• *Woodlands ≥0.5ha and supporting rare species or vegetation communities (per Table 1 of the ROP)*
		PNAC
		• *Cultural woodlands and cultural savannahs ≥4ha in the Rural System and ≥2ha in the Urban System and Rural Service Centres*
		• *All other woodlands ≥0.5ha*
			Key Features
			• *Core Woodlands*
			• *NHRM Significant woodlands:*
			  o *Woodlands ≥4ha*
			  o *Woodlands with interior habitat of any size*
			  o *Woodlands ≥2ha and within 30m of a Watercourse or Provincially Significant Wetland.*
			  o *Woodlands ≥0.5ha and occurring within 30m of a permanent or intermittent stream, or a Key Feature*
			  o *Containing ≥0.5ha >100yrs of age and having late successional characteristics (excludes plantations)*
			  o *supporting rare species or vegetation communities (per Table 1 of the ROP)*
			• *Woodlands ≥0.5ha and contiguous to or occurring within 30m of a headwater feature or wetland supporting a headwater feature.*
			Supporting Features
			All NAC and PNAC woodlands using the Urban System Threshold (where applicable).

Valleylands	**Significant Valleylands** *As determined in accordance with provincial guidance documents.* *The Natural Heritage Resource Manual (NHRM 3rd Edition) is applicable to the project area.*	**Core Area** • *Core valley and stream corridors as defined in Policy 2.3.2.2 and Table 2* *Core Valley Component:* • Main branches, major tributaries, other tributaries and identified watercourses draining directly to Lake Ontario.	**Key Features** • *Core* Valley and Stream Corridor Component **Supporting Features** • NAC Valley and Stream Corridors

Feature Type	PPS / Provincial Plan Feature	Peel Greenlands Designation	SSWS NHS Recommendation

		• Valley and stream corridors are the natural resources associated with the river systems characterized by their landform, features and functions, and include associated ravines.
		
		Mapping Criteria:
		• Main branches, major tributaries and watercourses having direct drainage to Lake Ontario are to be mapped from their outlet to the furthest upstream extent of their defined valley landform (i.e., mapped to limit of crest of slope).
		• Other tributaries are to be included and mapped to the limit of their defined valley portion if they meet the following criteria:
		  o Contains habitat for aquatic SAR (END or THR)
		  o Watercourse crosses municipal boundaries and provides linkage to other Core Areas of the Greenlands System.
		• Excludes ill-defined HDFs including created headwater valley / stream corridors, discontinuous defined valley features and other non-valley landforms.
		
		Core Valley Component:
		• Ill-defined sections of major valleys
		
		Mapping Criteria:
		• Ill-defined sections are to be illustrated using regulatory floodplain and meander belt hazards whichever is greater unless site specific assessment has determined valley width in accordance with the text of this Plan.
		• Shown schematically and subject to site specific evaluation to confirm width of Core valley and stream corridor.
		
		Core Valley Component:
		• Associated Ravines
		
		Mapping Criteria:
		• Associated ravines within the Urban System are to be included if meeting one or more of the following criteria:
		  o Important ecological functions related to the valley landform,
		  o Habitat for END / THR species
		  o Linkage to other natural features of the Greenlands System
		  o Flood and erosion hazards; or
		  o Restoration potential
		• Associated ravines within the Rural System are not considered Regional Core valley and stream corridors.
		  o Significance is determined in accordance with the Town of Caledon Official Plan policies.
		
		NAC
		• Any other valley or stream corridor not defined as part of the *Core* Areas	

Feature Type	PPS / Provincial Plan Feature	Peel Greenlands Designation	SSWS NHS Recommendation
Open County Habitats and Shrub Successional Habitats	"Other Natural Heritage Features and Areas"	n/a Some Open County Habitats are captured as Significant Wildlife Habitat.	**Key Features** • *Confirmed Open County and Shrub Thicket habitat is addressed through the Significant Wildlife Habitat Category.* **Supporting Features** • An open county or shrub thicket unit or complex which supports indicator species and meets one or more of the following: ○ *Overlaps with one of more of the following:* ▪ *MLL or LLL* ▪ *Key Feature* ▪ *ESGRA* ▪ *SGRA* ▪ *Greenbelt Plan NHS* ○ *Is contiguous to / overlaps with Redside Dace habitat (confirmed or contributing)* ○ *Occurs between two Key Features that are <240m apart (as a 'stepping stone' feature)*
Environmentally Sensitive or Significant Areas	n/a	**Core Area** • Environmentally Sensitive or Significant Areas	**Key Features** • ESA's as defined by the Region[8]. **Supporting Features** n/a
Significant Wildlife Habitat (SWH)	**Significant Wildlife Habitat**	**Core Area** *n/a* **NAC** • *Per Figure 5 of the Peel ROP and as defined by the Peel-Caledon Significant Woodland and Significant Wildlife Habitat* Study *(June 2009).* **PNAC** n/a	**Key Features** • *Confirmed SWH* ***Supporting Features*** *n/a*
Significant Areas of Natural and Scientific Interest	**Significant Areas of Natural and Scientific Interest** *As identified by the Province.*	**Core Area** • *Provincial Life Science ANSIs* **NAC** • *Regionally significant Life Science ANSIs* • *Provincially significant Earth Science ANSIs* **PNAC** • *Regionally significant Earth Science ANSIs*	**Key Features** • *Provincial and Regional Life Science ANSIs* • *Provincially Significant Earth Science ANSIs* **Supporting Features** • *Regionally Significant Earth Science ANSIs*
Fish Habitat	**Fish Habitat** *In accordance with the definitions provided under the Federal Fisheries Act.*	**Core Area** *n/a* **NAC** • *Fish habitat* **PNAC** *n/a*	**Key Features** • *Direct (Permanent or Seasonal) Fish Habitat* **Supporting Features** • *Indirect (Contributing) Fish Habitat*

8 Conservation Authority ESAs are no longer in use; they have been replaced by other policy protections and are not maintained.

Feature Type	PPS / Provincial Plan Feature	Peel Greenlands Designation	SSWS NHS Recommendation
Habitat for Threatened or Endangered Species	**Habitat for Endangered or Threatened Species** *As identified in consultation with the MECP.*	**Core Areas** • *Significant habitats of threatened and endangered species* **NAC** n/a **PNAC** n/a	**Key Features** • *Habitat of threatened and endangered species confirmed in consultation with the MECP.* **Supporting Features** n/a
Hydrologic Features	n/a	**Core Areas** n/a **NAC** • *Headwater* source or discharge areas **PNAC** • *Sensitive* groundwater recharge areas	**Key Features** • Headwater Drainage Features identified as Protection and Conservation[9]. **Supporting Features** • Headwater Drainage Features identified as Mitigation. • [to be confirmed] Ecologically sensitive groundwater recharge areas.
Provincially Designated Land Uses / Areas	n/a	**Core Areas** • *Escarpment Natural Areas of the Niagara Escarpment Plan* **NAC** • *Escarpment Protection Areas of the Niagara Escarpment Plan*	The FSA does not include any lands within the NEP area. The GBP and GP NHS are coincident within the FSA. For both plans, features are protected, corridors are to be maintained, and policies apply within the area of the Plan. **Key Features** • Key Natural Heritage Features as defined in the Greenbelt Plan and the Growth Plan. • Key Hydrologic Features as defined in the Greenbelt Plan and the Growth Plan. **Supporting Features** - Other natural features (per the Plans)
Other	*Guidance in the PPS for the identification of NHS' includes the option of including other natural heritage features and areas.* Under the Growth Plan and Greenbelt Plan Sand Barrens, Savannahs and Grasslands are identified as Key Natural Heritage Features.	**Core Areas** n/a **NAC** • *Any other natural features and functional areas interpreted as part of the Greenlands System NAC by the individual area municipalities, in consultation with the conservation authorities and the Ministry of Natural Resources and Forestry, including, as appropriate, elements of the Potential Natural Areas and Corridors (PNAC).* **PNAC** • *Potential ESA's identified as such by the conservation authorities.* • *Any other natural features and functional areas interpreted as part of the Greenlands System PNAC by the individual area municipalities, in consultation with the conservation authorities.*	**Key Features** Sand Barrens, Savannahs, and Grasslands (as defined through the Provincial Plans and per associated ELC classification) are considered Key Features. Additional features may be considered pending further review.
Linkages	To be determined through Part B General guidance: • Linkages are be implemented at multiple scales to capture both landscape-level and site-level connectivity (e.g., broad scale movement of plants and animals, site-scale habitat connectivity to support species life-cycle requirements) • Linkages should address both north-south and east-west connectivity		

9 In accordance with assessment guidelines for Headwater Drainage Features

Feature Type	PPS / Provincial Plan Feature	Peel Greenlands Designation	SSWS NHS Recommendation
	• To the extent possible, redundancy in linkages should be included to support system resilience. • Guidance for linkages should provide clear direction on minimum widths, implementation, and refinement through future study, etc.		
Enhancement Areas	To be determined through Part B General guidance: • Identify an approach to identify enhancements that can be mapped or otherwise defined through the current study. • Provide guidance on how enhancements will be confirmed, refined, and/or new enhancement areas identified that uphold the goals and targets of the NHS. • Demonstrate through the identification of enhancement areas that the 30% natural cover enhancement target is achievable and appropriate.		

2.6 Climate Change

The characterization presented in the preceding sections has built upon and summarized information provided from previous studies and analyses within the study area and portions of the GTA exhibiting similar physiography. In particular, the constraints presented above have been, inherently, based upon historic meteorological indicators and trends which have established and sustained key water resources and natural features within the landscape. However, as we move into the Anthropocene (i.e., the era in which human activity has been the dominant influence on climate and the environment), indications are that the future will no longer resemble the past, as manifested by the various impacts of Climate Change.

In 2014, the Intergovernmental Panel on Climate Change (IPCC) stated that "warming of the climate system is unequivocal" (IPCC, 2014). Evidence of Climate Change has amassed since that time, in the form of observed increases in temperature, rising sea levels, loss of snow and ice, and shifting precipitation patterns at the global scale. Recently, the Government of Canada issued a National Issues Report specifically related to the impacts and adaptation issues. Observed evidence of Climate Change impacts to Canada's water cycle include: melting ice, thawing permafrost, shorter duration of snow cover; increasing precipitation and a transition from snow to rain; changes in the timing of water availability; and changes in the nature of extreme events. It is projected that these impacts will impact Canada's water cycle, resulting in reduced water availability in southern basins, particularly in the summer, increasing the frequency and intensity of water-related extremes, and reducing water quality and more harmful algae blooms. Some specific impacts of anticipated changes to Canada's water cycle as a result of Climate Change are:

- Increased nutrients in water systems and incidences of harmful algae blooms.
- Increased risk that less water would be available during hotter months for energy and food production.
- Disruption to operating seasons, farming and industrial operations, and natural patterns for ecosystems.
- Increased flood events.
- Damaged infrastructure and increases operating costs.
- Increased property and casualty insurance payments.

It is widely accepted that, as warming increases, climate-related risks and impacts also increase. Higher rates and amounts of warming make it more difficult for adaptation actions to offer sufficient protection against these impacts. Consequently, significant impacts would remain despite the implementation of adaptation measures, thus limiting the effectiveness and potential of achieving adaptation. The limitations to adaptation are reached when there are no longer any practical or feasible adaptation options available, requiring that otherwise unacceptable risks must be accepted, adaptation objectives must be abandoned and/or transformation and "last resort" measures, such as relocation or retreat, must take place.

There are important linkages between actions that reduce greenhouse gas (GHG) emissions (climate change mitigation) and actions that build resilience to deal with climate change impacts (adaptation).

Co-benefits and synergies between adaptation and mitigation decisions - referred to as sustainable "win-win" approaches - can be obtained for actions that have both adaptation and mitigation objectives. These co-benefits and synergies include the use of nature-based approaches to adaptation in cities to create urban environments that are more resilient to heat waves (reducing associated health impacts) and to intense rainfall (reducing associated flooding), while also sequestering carbon and reducing energy demand. As well, it is recognized that risk trade-offs can emerge from particular actions that are designed to meet only one objective (adaptation or mitigation), but that can adversely affect the other objective, such as certain adaptation decisions which can result in an increase in GHG emissions (e.g., the increased use of air conditioners during heat events) as well as certain mitigation choices which would increase local vulnerability or risk (e.g., the increased exposure of the electricity grid to water supply shortages, which could result from expanded use of hydro-electricity). As a general practice and preference, priority should be given to minimizing or avoiding these negative consequences when planning actions to respond to climate change. These adaptation measures are discussed further in the Part B and Part C reports for this Scoped Subwatershed Study.

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Appendix A

Focus Study Area Constraint Summary

Appendix B

Data/Information Tracking

Appendix C

Groundwater

Appendix D

Surface Water

Appendix E

Stream Systems

Appendix F

Terrestrial and Natural Heritage Systems

Appendix G

Geotechnical