Scoped Subwatershed Study, Part B: Detailed Studies and Impact Assessment (Preliminary Draft)

Settlement Area Boundary Expansion
Region of Peel
Project # 198127

Prepared for:

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

11/24/2020

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1.0 Introduction

The Regional Municipality of Peel (Peel Region) has initiated an Environmental Screening and Scoped Subwatershed Study (Environmental 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 SABE study and Regional Official Plan Amendment (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. The Environmental Study, which is comprised of the Phase 1: Environmental Screening (ES) Study and the Phase 2: Scoped Subwatershed Study (Scoped SWS is one of several technical studies that are informing the SABE, the results of which will be used to develop the Regional Official Plan Amendment for the settlement area boundary expansion. This approach will ensure that water resources and natural heritage features and functions are protected, restored or improved, through the land development process and will set the basis for future local municipal official plan amendment(s) (LOPA), led by the Town of Caledon. The LOPA(s) are proposed to be supported by detailed subwatershed study(s) to be completed at a time appropriate to the anticipated timing of the corresponding LOPA(s).

The terminology used to define the various areas under study is important for context and clarity. The **Initial Study Area** for this study is defined as the Agricultural and Rural lands in the Town of Caledon (Caledon) excluding lands within the Greenbelt Plan Area. Within this area, a **Focus Study Area (FSA)** has been established over the course of the study, which is described as "a broad area in the southern part of Caledon that serves as the basis for the SABE technical studies", within which the Settlement Area Boundary Expansion (SABE) will be identified. The **Settlement Area Boundary Expansion Study** is the overall study being undertaken by Peel Region to identify expansions to settlement areas (defined in the Growth Plan) to accommodate population and employment growth to 2051 after accounting for intensification in the Region's 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, including the Scoped SWS.

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."

Phase 1 of the Environmental Study constituted the Environmental Screening Study which was completed in mid-2020 with a draft report being submitted to Peel Region to provide input to defining the limits and constraints associated with 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, and the hydrogeologic and surface water systems. The environmental features and systems identified through this screening exercise have been integrated with the findings from the parallel study process led by the Hemson Consulting Team working on behalf of Peel Region, involving additional technical studies including municipal servicing, transportation, agricultural, cultural heritage, and climate change etc., to identify further constraints, needs, and opportunities, to define a Focus Study Area (FSA). The 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 thereby enable one or more settlement area expansions.

Phase 2 of the Environmental Study entails the Scoped Subwatershed Study (Scoped SWS) to define and support the selection of the SABE and establish preliminary management strategies and future study guidance. The following summarizes the primary components (parts) of the Scoped SWS:

Part A: Existing Conditions and Characterization

Part B: Detailed Studies and Impact Assessment (this report)

Part C: Implementation Plan

The Part A: Existing Conditions and Charcterization Report (Draft) has been completed and submitted to Peel Region and the Technical Advisory Committee (TAC) in October 2020. The Draft Part A Report has built upon the findings from Phase 1 of the Environmental Study, and further characterizes the environmental and water resources features, areas and systems within, and bounding the FSA, identifies limitations and constraints to development potential by location within the FSA, and thereby further informs refinement of the FSA to establish the SABE.

The Draft Part B: Detailed Studies and Impact Assessment report provides an overview of the anticipated impacts associated with future development within the FSA, and provides general guidance for management opportunities and requirements for future environmental studies to support subsequent stages of land use planning. This Draft Part B report has initially been completed for the entirety of the FSA to further inform refining the Region's SABE. Subsequent iterations of this Part B report will be refined to provide a more focused discussion and assessment of anticipated impacts associated with future development within the SABE specifically, which will include further details on the various land uses and also the primary servicing infrastructure associated with roads and municipal water and wastewater. Furthermore, the report also provides detailed discussion of future study requirements expected to be conducted at the local scale specific to support Caledon's LOPA.

2.0 Part B: Detailed Studies and Impact Assessment

The impact assessment has been completed across disciplines, to assess the impact of the future development within the FSA, in the absence of management and mitigation. For the purpose of this report, this assessment has been completed premised on general impacts associated with urbanization within the FSA without specific consideration to the specific form and location of development (i.e. residential versus employment land use conditions; receiving watercourses/systems, etc.). The findings of this impact assessment represent the basis from which specific management strategies and design criteria are developed. The results of the impact assessment and associated management strategies will be further refined based upon the land use plan for the SABE, once received. The following sections initially summarize the key findings from the Part A Characterization, in order to provide context for the work which follows, as well as the details associated with the impact assessment for the respective study disciplines.

2.1 Summary of Characterization Outcomes

The SABE Team (Hemson led) has been responsible for the initial identification and selection of the Focused 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 led) has been working in parallel and close consultation to ensure that technical inputs to the FSA, and ultimately the SABE study, are provided accordingly. The initial input to this process was outlined in the Environmental Screening report (May, 2020).

The Draft Scoped SWS Part A: Characterization report (Spetember, 2020) provides a detailed discussion of the background information provided for use in the Scoped SWS, discipline-specific findings of the characterization, and integrated mapping of the features, areas and systems within the FSA related to the natural heritage system (NHS), and Water Resource System (WRS). The latter constitutes key hydrologic areas, and key hydrologic features, as defined by current Provincial and Regional policy, as well as initial constraint assessments of the watercourses and headwater drainage features within the FSA. The following sections provide a high-level overview of key findings from the Draft Part A report (September, 2020).

2.1.1 Surface Water Quantity and Groundwater Resources

2.1.1.1 Surface Water Characterization

Baseline Characterization

Drainage Patterns:

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 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 limits of the respective subwatersheds and drain towards watercourse features directly outside of the FSA. 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:

The soils within an area directly influence the infiltration potential under pre-development and post-development land use conditions, as well as the requirements for mitigating impacts to flooding and erosion following development. Higher permeability material, such as sand and gravel, have lower pre-development runoff potential, hence are generally more sensitive to increases in impervious coverage and associated increases in storm runoff volumes and peak flow rates. As such, development areas with higher permeability soils tend to have relatively higher storage volume requirements for flood and erosion protection; where groundwater levels are deeper, these soils also afford greater opportunities for infiltrating storm runoff. By contrast, lower permeability material, such as clay, generally has a higher pre-development runoff potential, hence a relatively lower sensitivity to increases in impervious coverage and associated increases in storm runoff volumes and peak flow rates. As such, development areas with lower permeability soils tend to have relatively lower storage volume requirements for flood and erosion control compared to areas with higher permeability soils, as well as relatively lower capture volume requirements for maintaining water budget and groundwater recharge. Higher groundwater levels in areas with lower permeability soils generally present a constraint to servicing, and may require additional management requirements to mitigate groundwater interaction (i.e. use of synthetic liners, importing fill material to raise finished grade).

The surficial soils mapping for the FSA indicates that surficial soils consist primarily of Clay Loam, Sandy Loam and Clay. This blend of soils is noted to also be 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 surficial geology mapping for the FSA indicates that the surficial geology consists primarily of diamicton, which is a poorly sorted sediment containing a range of particle sizes. There are local occurrences of 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. A summary of the soils by subwatershed is provided in Table 2.1.1.1.

Table 2.1.1.1: Summary of Soil Composition by Subwatershed (%)

Subwatershed	Soil Type					
	Clay Loam	Sandy Loam	Clay	Loam	Muck	Bottom Land
Main Humber	85.5	0.8	-	9.7	-	4.1
West Humber	70.1	4.1	15.3	0.2	-	10.3
Upper Etobicoke	86.3	1.2	-	-	0.2	12.3
Fletcher's	100	-	-	-	-	-
Huttonville	100	-	-	-	-	-
Main Credit	89.5	-	-	-	-	10.5
Spring Creek	100	-	-	-	-	-

Topography:

The topography of a development area influences the grading requirements for a development to implement storm infrastructure. Areas with shallow grades (i.e. 2% or less) which drain to poorly defined streams (i.e. headwater drainage features, unconfined watercourses) generally require relatively large volumes of imported fill material to achieve the grades necessary for storm drainage. By contrast, areas with steeper grades (i.e. 2% or greater) which drain toward confined watercourses tend to offer better opportunities for balancing cut and fill within the site and constructing storm infrastructure below existing grade without requiring significant volumes of imported fill.

The ground slopes at the surface within the FSA have been characterized based upon the 5 m 2012 DEM for the Etobicoke Creek provided by TRCA and the 1 m 2017 Digital Elevation Model for the Humber River provided by Peel Region 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. A summary of the proportion of ground slope class by subwatershed is presented in Table 2.1.1.2, and is shown graphically on Drawing WR1 (see Appendix G).

Table 2.1.1.2: Summary of Topographic Composition by Subwatershed (%)

Subwatershed	Ground Slope		
	0% – 2%	2% – 5%	>5%
Main Humber	36	33	31
West Humber	58	30	12
Upper Etobicoke	65	21	14
Fletcher's	79	19	2
Huttonville	73	19	8
Main Credit	97	2	1
Spring Creek	47	39	12

Existing Land Use:

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 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 to the FSA lie toward the south, within the Fletcher's Creek Subwatershed, as well as the Etobicoke Creek Watershed and the West Humber Subwatershed. The existing development within the Fletcher's Creek Subwatershed and the West Humber subwatershed also include stormwater management facilities which provide local 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.

Detailed Characterization and Assessment

The surface water system has been characterized for surface water quality, as well as quantity specific to hydrologic response (flows) and hydraulic performance (open watercourse systems).

Hydrology:

The previously completed hydrologic studies for the Etobicoke Creek and Humber River watersheds were both prepared on behalf of TRCA, using the modelling software Visual OTTHYMO (VO). 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. Neither study characterized existing conditions land use or assessed the impact of future land development on the regional-scale water balance or erosion potential of downstream receivers.

The hydrologic analyses for the Fletcher's Creek and Huttonville Creek Subwatersheds applied the Hydrologic Simulation Program-Fortran (HSP-F) hydrologic model. HSP-F is both an event based and continuous hydrologic model, although it is more commonly used for continuous modelling. In addition to the differences in model platform and methodologies, several discrepancies between the boundaries of the Credit River, Etobicoke Creek, and Humber River watersheds were noted based upon a review of the subcatchment boundary information for each hydrologic model. A number of areas were identified as either overlapping or unaccounted for as part of the separate studies.

Flood Vulnerable Areas:

As part of the current study, TRCA has provided a GIS mapping shapefile indicating the limits of existing flood vulnerable areas (FVAs), as defined through hydraulic modelling and floodline mapping. This information has indicated that four (4) FVAs are located downstream of the FSA along the Upper Etobicoke Creek in Downtown Brampton, Main Humber in Bolton and further downstream in Vaughan, as well as the confluence of the West Humber and Lower Main Humber branches in northern Etobicoke (ref. Drawing WR5, Appendix G). Supplemental assessments completed for this Scoped SWS (ref. Part A Report, Section 2.3.2.3) have indicated that flood damages at the Downtown Brampton FVA along the Etobicoke Creek would occur for events more severe than the 50 year return period, and flood damages at the FVA along the Humber River would occur for events above the 100 year return period.

Flood Hazards:

Regulatory flood hazard mapping has been established for various reaches of regulated watercourses within the FSA. In several instances, the flood hazard mapping has been "estimated" along some reaches (primarily along the unconfined watercourses), hence has not been developed based upon field verified hydraulic structures and current topographic mapping. Furthermore, flood hazard mapping has not been delineated along certain reaches which would typically attract TRCA regulation (i.e. generally watercourses with contributing drainage areas greater than 50 ha), hence the extent of floodline mapping will need to be extended along various reaches through the FSA to establish that floodline mapping, as part of future studies for all regulated watercourses within the area. Where flood hazard mapping is currently available, the results indicate that the Regulatory flood hazard is largely contained within the well-defined riverine systems and does not extend onto the tableland adjacent to the confined systems.

Key Hydrologic Features and Key Hydrologic Areas:

Consolidated mapping of key hydrologic features and key hydrologic areas 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 key hydrologic features mapping depicts the permanent and intermittent streams, lakes, seepage areas and springs, and wetlands within the FSA. The key hydrologic areas mapping depicts the Ecologically Significant Groundwater Recharge Areas, areas of shallow depth to water table, and contributing drainage areas to flood vulnerable areas. The key hydrologic features and key hydrologic areas mapping are included in Appendix G.

2.1.1.2 Groundwater Characterization

The FSA is situated almost completely within the South Slope physiographic region which is characterized by till plains. 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.

Within the FSA, the ground surface generally slopes from 285 meters above sea level (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.

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. Regionally, the bedrock dips to the southwest. Numerous bedrock valleys exist within and adjacent to the FSA and are infilled with thicker sequences of overburden sediments.

The surficial geology in the FSA consists primarily of fine-grained sediments characterized by the sandy silt to silty clay sediments associated with the Halton Till and Wildfield Till (ref. Drawing GW-4, Appendix G). 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.

There is an interpreted sequence of six unconsolidated Quaternary deposits overlying the bedrock within the FSA. 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. North of the FSA, overburden thickens to over 200 m along parts of a bedrock valley. The thicknesses and continuity of the units varies across the FSA. The six stratigraphic units include the following:

- *Halton Till* – 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 to thicknesses exceeding 30 m and approaching 50 m in areas of inferred bedrock valleys.
- *Oak Ridges Moraine Deposits* –The Oak Ridges Moraine deposits are found beneath the Halton till and are predominantly comprised of fine sands and silts but coarser sands and gravels can dominant local areas. 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 the bedrock valleys. The deposits thin downslope towards the southeast where they are inferred to become discontinuous approaching Mayfield Rd.
- *Newmarket Till* – The Newmarket Till is a dense silty sand till found below the Oak Ridges Moraine deposits and the Halton Till where the Oak Ridges Moraine is absent. This till is interpreted to be discontinuous across the FSA, with thickest accumulations, up to 30 m, occurring within bedrock valleys.
- *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. This formation is discontinuous across the FSA and occurs primarily in the bedrock valleys.
- *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.
- *The Scarborough Formation* – The sediments consist of organic sands overlying silts and clays. 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.

Aquifer and aquitard units are defined on the basis of the estimated ability of the unit to yield water and correlates with hydraulic conductivity so that stratigraphic units are considered aquifers where the hydraulic conductivity is relatively high and aquitards where the hydraulic conductivity is relatively low. 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.

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 (ref. Drawing GW-7, Appendix G). 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, with some wells reporting flowing conditions indicating water levels at or above ground surface (ref. Drawing GW-7, Drawing GW-8a, Appendix G). Groundwater in deeper aquifer systems also generally flows from the Niagara Escarpment eastward and from the Oak Ridges Moraine southeastward within the FSA. The bedrock valleys may act as preferential flow pathways with groundwater moving toward and along them. It is expected that the majority of flow within the aquifer units underlying the FSA is derived from regional recharge within the Oak Ridges Moraine that is upgradient of the FSA.

Long-term trend data in groundwater levels within the aquifers directly underlying the FSA are limited but available data indicate seasonal variations of approximately 1 m with highs in the spring. The water table within the Halton Till is generally within the upper 3 m of ground surface and varies 1-2 m seasonally based on the geotechnical studies reviewed for this study as well as 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.

The Halton Till 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. Groundwater flow within the discontinuous sand lenses that potentially occur within the Halton Till may also be significant on a local scale where these sand lenses intercept surface water features.

The Oak Ridges Moraine Groundwater Program (ORMGP) staff has prepared draft mapping of potential groundwater "Areas of Concern" (AOC) for the area surrounding the FSA (Drawing GW-8a, Appendix G) as part of an overall goal to identify areas where elevated groundwater levels may pose an issue for subsurface construction or maintenance beyond what would be considered typical with respect to dewatering volumes, both short term and long term, and the potential impacts related to disposal of the water or the impact on groundwater levels. A significant reduction in groundwater levels may lead to an impact on water levels in surface water features, groundwater discharge and available water in water supply wells, particularly when dewatering a confined hydrostratigraphic unit.

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 (ref. Drawings GW-4 and GW-9, Appendix G).

Significant Groundwater Recharge Areas (SGRAs), which represent areas of relatively higher groundwater recharge rates that are important for providing groundwater recharge to an aquifer and Ecologically Significant Groundwater Recharge Areas (ESGRAs) which represent areas of land where groundwater recharge occurs that may directly support groundwater-dependent features such as coldwater streams, wetlands and their ecological functions, are presented on Drawing GW-9. Within the FSA, SGRAs are interpreted in small, localized areas that coincide with small pockets of sands and gravels mapped at ground surface (ref. Drawing GW-4, Appendix G). ESGRAs were delineated across the FSA through modelling, the details of which were presented in the 'Scoped Subwatershed Study Part A – Existing Conditions and Characterization (Draft)' (Wood, October 2020). The ESGRAs were predominant in the southwestern portion of the FSA and in some areas of the north part of the northeastern portion of the FSA.

Potential groundwater discharge for the FSA has been presented through two modelling methods. 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. The model predicts that groundwater is likely to discharge along the majority of the higher order watercourses found in the FSA. A second method presents groundwater discharge areas where the interpolated water table elevation is greater than ground surface elevations. The distribution of these discharge areas 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. Results from both methods are shown on Drawing GW-10 (Appendix

G). 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 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 (Appendix G) may indicate a more relevant groundwater function compared with overland flow to the feature.

The baseline water balance is presented within the groundwater impact assessment (Section 2.3.1.2).

The majority of the domestic wells in the FSA are completed within the overburden as opposed to bedrock. The Thorncliffe and Scarborough Aquifers can provide large capacity wells, although these aquifers may be more limited in extent within the FSA. 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).

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. There are no WHPAs within the FSA although there are WHPAs adjacent to the FSA (ref. Drawing GW-12, Appendix G)

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 distribution of HVAs in the FSA is shown on Drawing GW-12 (Appendix G). Regionally, HVAs are predominant north of the FSA; however, some patches of HVAs are present throughout the FSA.

2.1.2 Aquatic Resources and Water Quality

Most of the watercourses in the FSA are small or intermediate warmwater streams (ref. Map F1 – Appendix G).

Within the FSA, small coldwater streams are present in the western headwaters of Etobicoke Creek, Campbells Cross Creek in the West Humber watershed, and several small watercourses in the Main Humber watershed in the north-eastern portion of the FSA (ref. Map F1 – Appendix G).

Brook Trout (*Salvelinus fontinalis*) are not present in the coldwater streams in the Etobicoke Creek watershed (TRCA, 2006) but do occur in coldwater streams in the Humber River watershed.

Redside Dace (*Clinostomus elongatus*), an endangered fish species both provincially and federally, is the only aquatic species at risk known to occur within, or in the immediate vicinity of, the FSA. Reaches of the four largest tributaries in the West Humber subwatershed are Redside Dace habitat within the FSA and Redside Dace habitat is present downstream from the FSA in the Main Humber, Huttonville Creek and Fletchers Creek subwatersheds (ref. Map F2 – Appendix G).

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 of high quality, compared to current Provincial Water Quality Objectives (PWQO) standards and surface water chemistry reported in literature. The water quality varies amongst the sampled parameters and across the available sites, with local exceedances shown with regards to metals, nutrients, microorganisms and Total Suspended Solids (TSS). However, as noted in the Draft, Part A report, October , 2020, the available background information was limited to the broader systems, with varying periods of record, and limited details regarding the conditions at the time of sampling (i.e. wet weather or dry weather). Consequently, further sampling and analysis as part of future studies to distinguish the conditions at the time of monitoring (i.e. wet weather vs. dry weather), as well as conducting multi-year / seasonal samples and direct sampling within the FSA, would be required to more accurately characterize the surface water quality within the FSA and associated effectiveness of any planned management strategies.

2.1.3 Stream Morphology, Erosion Hazards and Assessment

The primary purpose of the fluvial geomorphology assessment 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. Within the scoped level of the current study, the geomorphic assessment has followed a desktop approach with limited fieldwork.

Clear definitions of surface water feature types are essential when identifying and characterizing features, as the type of analyses, impacts upon these features, and opportunities for management differ. Definitions, as established in the Phase 2 Part A Characterization report, are as follows:

Watercourses

Watercourses are defined as permanently to intermittent 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 typically regulated features by the Conservation Authority (CA), and fish are also typically found within these features.

Headwater Drainage Features (HDFs)

Non-permanently flowing drainage features that may not have defined bed or banks have been 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 currently not identified as regulated features, and fish may or may not be found within the features.

Previous work in other jurisdictions has utilized a threshold contributing area to surface water features to help scope HDFs and Watercourses, prior to 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.

The characterization (ref. Phase 2 Part A, October, 2020 (Draft)) focused on available mapping, aerial imagery, and previous reporting. Through the desktop assessment for the characterization, surface water features within and downstream of the FSA were divided into segments (reaches), and identified at a preliminary level as watercourses and HDFs (ref. Appendix G, Map SM-1). Reach nomenclature from Mayfield West (AMEC, 2012) was maintained in the current study where there is overlap. However, the reach delineation was updated based on current observations and the scoped level of study. Limited fieldwork was completed as windshield assessments to attempt to confirm feature type and presence on the landscape from a nearby vantage (road or watercourse crossing). In total, 418 reaches were delineated for this study, of those 182 are classified as watercourse, and the remaining 236 are considered HDFs. Due to the limited fieldwork, feature type and reach breaks should finalized through future detailed geomorphic studies which will be carried out in subsequent planning studies.

It was also noted that 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.

Based on mapping and the findings of the windshield assessment, erosion hazard limits (meander belt and stable top of slope hazards) were delineated accordingly for confined (stable top of slope) and unconfined (meander belt width) settings (ref. Appendix G Map SM-2). This was completed at a high-level for the purpose of characterizing the larger study area and developing an initial characterization of area hazards. Development will need to avoid erosion hazards and incorporate applicable setbacks for watercourse reaches. These erosion hazards are subject to confirmation and/or refinement, and finalization through future planning stages.

Rapid Geomorphic Assessments were not completed under the current study as per the TOR. 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) to develop management recommendations.

An assessment of erosion sensitivity was completed primarily through air photo interpretation, windshield assessments and review of background data. A map was compiled of sites considered to be undergoing excessive erosion, based on the windshield assessment. Additional work to characterize erosion sensitivity at the desktop level is ongoing and will be completed following the identification of the SABE.

An erosion threshold assessment was not completed as part of the current study as per the TOR. Rather, background studies within and adjacent to the study area were reviewed.

Erosion thresholds were determined for the Mayfield West, Phase 2 Secondary Plan Comprehensive Environmental Impact Study and Management Plan, Part A - Existing Conditions and Characterization (2014). Erosion thresholds were determined for sites MEC-R1, MEC-R2, MEC-R5, MEC-R8, MEC-R25 and MFC-R3. The results are presented in Table 2.1.3.1. 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 2.1.3.1: 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

Erosion thresholds were also determined as part of the North West Brampton Urban Development Area Phase 1 – Subwatershed Characterization and Integration (2010) fluvial geomorphology study. Following 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 2.1.3.2 presents the critical discharge rates and velocities that were used in the durational assessment to inform stormwater management criteria.

Table 2.1.3.2: Summary of Northwest Brampton Erosion Threshold Results

Reach Name, Mayfield West SWS	Critical Discharge (m^3/s)	Critical Velocity (m/s)
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

2.1.4 Natural Systems

2.1.4.1 Terrestrial Features and Wildlife

Characterization findings for the FSA have been structured based on general feature/habitat types that are present based on available information. General feature/habitat types have been summarized for wetlands, woodlands, and open/early successional habitat.

Wetlands

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 203.3 ha (2.5%) of the FSA and adjacent 120m area. Among the seven subwatersheds (SWS) 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 no wetland features identified in the Huttonville Creek or Spring Creek subwatersheds within the FSA. Table 2.1.4.1 summarizes the number of wetland and aquatic features and associated area coverage within the FSA, as well as general descriptions of where these communities tend to be located. 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).

Table 2.1.4.1: Summary of wetland and aquatic features by type present in the FSA

Wetland Type	Number of Features in FSA	Area Coverage within FSA (ha)	Location within the FSA
Wetlands			
Shallow Marsh (MAS)	91	20	Shallow marsh 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)	142	114	These features combined total 114 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.
Thicket Swamp (SWT)	25	16	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)	54	48.5	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)	105	23	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.
Shallow Aquatic (SA)	3	0.1	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)	4	0.4	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)	9	2	Submerged shallow aquatic communities across the FSA, with a few features in each section of the area (western, central and eastern). 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)	7	0.74	Floating-leaved shallow aquatic communities occur across the FSA as small features within natural woodlots or forests. These areas are often dominated by Duckweed.

Woodlands

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 417.6 ha (5.2%) 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 2.1.4.2).

Table 2.1.4.2 summarizes the number of woodland features and area coverage within the FSA, as well as general descriptions of where these communities tend to be located.

Table 2.1.4.2: Summary of woodland features by type present in the FSA

Woodland Type	Number of Features in FSA	Area Coverage within FSA (ha)	Location within FSA
Cultural Woodland (CUW)	48	52	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. A
Cultural Savannah (CUS)	37	45	Predominantly location in western and central portions of FSA; typically along edges of forests or agricultural fields.
Cultural Plantation (CUP)	65	51	Throughout FSA, resulting from anthropogenic-based disturbances which may or may not be maintained.
Deciduous Forest (FOD)	139	199	Throughout FSA but slightly more abundant in the western and central sections of the FSA, often associated with larger natural areas located along riparian corridors.
Mixed Forest (FOM)	18	20	These communities are mostly found in the western portion of the FSA, although they are evenly distributed within that section.
Coniferous Forest (FOC)	1	0.66	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.
Deciduous Swamp (SWD)	54	48.55	Throughout FSA; similar to other wetland types in the FSA, larger deciduous swamps occur along riparian corridors, with smaller pockets within woodlots adjacent to agricultural fields.

Open/Early Successional Features

Based on the available ELC data, there were 510 open/early successional features identified within the FSA and adjacent 120m. Polygons were represented by all five ELC community series types including:

- Cultural Plantation (CUP)
- Cultural Meadow (CUM)
- Cultural Thicket (CUT)
- Cultural Woodland (CUW)
- Cultural Savannah (CUS)

In total, cultural communities accounted for 729 ha of the FSA and surrounding 120m. Table 2.1.4.3 summarizes the number of cultural features and area coverage within the FSA, as well as general descriptions of where these communities tend to be located.

Table 2.1.4.3: Summary of Open/Early Successional features by type present in the FSA

Cultural Community Type	Number of Features in FSA	Area Coverage within FSA (ha)	Location within FSA
Cultural Meadow (CUM)	293	511	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 by non-native plant species, with mineral soil types that are dry to moist.
Cultural Plantation (CUP)	65	51	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 Thicket (CUT)	67	70	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 Savannah (CUS)	37	45	Cultural savannahs are mostly found in the western and central sections of the FSA, 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 Woodland (CUW)	48	52	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.

Flora

In total 125 unique plant species records occurred within the FSA based on available secondary source data; this compares to 760 unique records associated with the broader seven Subwatershed areas within the

Region of Peel. Within the Subwatershed 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).

The flora species records available within the FSA are reflective of the inventories being undertaken relatively in high-quality natural areas. Species occurrence data were 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 are not considered 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.

Fauna

Overall, records of 76 fauna species were identified through secondary sources in the FSA. This included seven amphibian species, 58 bird species, five mammal species, two invertebrate species and four reptile species.

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 watercourses. As with flora records, this may reflect the location of monitoring site selection and/or availability of suitable habitat.

2.1.5 Natural Heritage System and Water Resource System

2.1.5.1 Natural Heritage System

Approach

Through the Characterization Report (Part A) of the Scoped SWS, a review of existing natural systems mapping for the FSA (Part A, Section 2.4.1) was conducted. Specifically, it considered the Provincial Natural Heritage System (NHS), the Peel Greenlands System, and the Conservation Authority NHS (individually and as a consolidated CA NHS). This review compared and contrasted the methods used and overall approach to each type of system mapping.

As a Regional project, the Greenlands System Policies in the ROP provide important policy direction for establishing an NHS for the FSA. Provincial policies for the Greenbelt Plan NHS apply within those areas mapped as Greenbelt NHS which traverse the FSA. The CA NHS provides important information and perspective for areas considered important natural cover to meet the objectives set forth through those studies. In the context of the current study, the CA NHS has been used to provide guidance in establishing targets for the FSA NHS and as a vetting tool against which to compare the proposed FSA NHS.

The Core Area, Natural Areas and Corridors (NAC) and Potential Natural Areas and Corridors (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, Local Area Municipality Official Plans, Natural Heritage Study, etc.) in order to reflect the specific character of the area for which land use planning is being advanced. Additionally, the structure of the Greenlands System 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 at a regional scale. It is recognized that the current Scoped SWS is based primarily on available information and desktop analysis and that detailed SWSs will follow to confirm or refine the approach set out for the Preliminary NHS for the FSA. The Characterization Report (Part A) considered existing conditions. As such, the report focused on the identification of *existing features* that are recommended to comprise the NHS using available datasets and analyses. Through Part A, the following NHS feature classes were identified and mapped:

- **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 do not meet Key Feature criteria, are too small to retain their ecological function as isolated features, are too far to functionally connect to the system, or are areas that require further assessment to confirm their status within the NHS for the FSA. They are recognized for their supportive functions on the pre-development (i.e. existing) landscape.

The following areas were also identified as required to form a robust and connected system, but were not identified through the Characterization Report:

- **Corridors / Linkages** are used to build upon NHS features to create a connected and integrated system.
- **Enhancement Areas** are used to improve the form and/or function of the NHS by infilling, extending or adding to the features and areas that comprise the NHS (i.e. Key Features, Supporting Features). Consideration will be given to direction provided by the underlying studies to the CA NHS.

Identification of these areas is informed by the Characterization Report (Part A), including targets set out in that report, and the Impact Assessment (Part B- this report) to ensure a robust and connected system is identified and direction provided for implementation at future planning stages. Criteria for and mapping of these areas is provided in Section 2.4.2.2 of this report.

Criteria for identification of Key Features and Supporting Features were detailed in the Characterization Report, including analyses to support the proposed criteria (ref. Section 2.5.2.3).

Preliminary NHS Features

Key Features of the NHS were identified using criteria set out in the Characterization Report (ref. Section 2.5.2.3; Table 2.5.2.12) and include the following:

- Key Feature:
  - Woodlands
  - Wetlands
  - Valleylands
  - Environmentally Sensitive / Significant Areas
  - Significant Wildlife Habitat
  - Fish Habitat
  - Provincially significant Life Science and Earth Science Areas of Natural and Scientific Interest (ANSI)
  - Regionally significant Life Science ANSIs
  - Habitat for Endangered and Threatened Species confirmed in consultation with the MECP
  - Headwater drainage features identified as Protection or Conservation[1]
  - Key Natural Heritage Features as defined in the Greenbelt Plan and the Growth Plan within applicable areas of the FSA
  - Key Hydrologic Features as defined in the Greenbelt Plan and the Growth Plan within applicable areas of the FSA
  - Sand Barrens, Savannahs, and Grasslands (as defined through the Provincial Plans and per associated ELC classification)
- Supporting Features:
  - Woodlands
  - Wetlands
  - Valleylands
  - Regionally significant Earth Science ANSIs
  - Headwater drainage features identified as Mitigation[1]
  - Ecologically Significant Groundwater Recharge Areas (ESGRAs)[1]
  - Other natural features (per the Greenbelt Plan and the Growth Plan, within applicable areas of the FSA)

The application of the criteria, set out in Table 2.5.2.12 of the Characterization Report (Table 2.5.2.12, Appendix G) using available feature data for the FSA, is shown on Figure DA2-6 (Appendix G).

2.1.6 Geotechnical and Slope Stability

A desktop study was performed to identify areas of potential watercourse and valley slope instabilities within the 'Focused Study Area'. Slope stability is dependent on a number of factors; slope inclination, soil stratigraphy, groundwater table, slope vegetation, table land drainage features, proximity to watercourse, and previous landslide history.

Some factors can be determined and others inferred based on a desktop study alone, others require a visual inspection of the physical slope, and others a subsurface investigation. As the scope for the Scoped SWS was limited to a desktop study, these factors were either determined based on available resources or assumed, to determine the slope stability risk rating and associated level of investigation. The methodology and rating system of the "Technical Guide – River and Stream Systems: Erosion Hazard Limit", prepared by

[1] Pending identification or confirmation based on further assessment through future stages of study (e.g., detailed subwatershed studies, site-specific studies)

the Ontario Ministry of Natural Resources (2002) was used. This categorizes slopes as either 'low', 'slight' or 'moderate'. The level of investigation to determine the long term stable top of slope increases when the risk of instability increases, with a visual inspection required for 'low' risk, a visual inspection, subsurface investigation or conservative analysis for a 'slight' risk, and a subsurface investigation for 'moderate risk'.

Resources used to assess the slope factors were: topographic mapping provided by Peel Region for geometry (height, inclination, and proximity to watercourse), soil data and mapping from the Ontario Geological Survey for soils, and aerial images for signs of active/historical failures and slope vegetation. Due to the resolution of images only large and unobscured failures were visible.

For planning/development purposes, the identification of the long-term stable top of slope (LTSTOS) is important, as this is the point from which no development is allowed by the applicable conservation authority between the LTSTOS and the watercourse. In addition, an emergency access allowance of 10 m (in addition to the LTSTOS, away from the watercourse) is required by the CVC and TRCA to provide a buffer for any future repairs or access to the slope.

Credit River Watershed: no permanent watercourses or accessible slopes were noted in the FSA project limits

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

Humber Watershed: All watercourses within the Humber River watershed were classified as low or slight instability risk with the exception of two areas which were moderate risk;

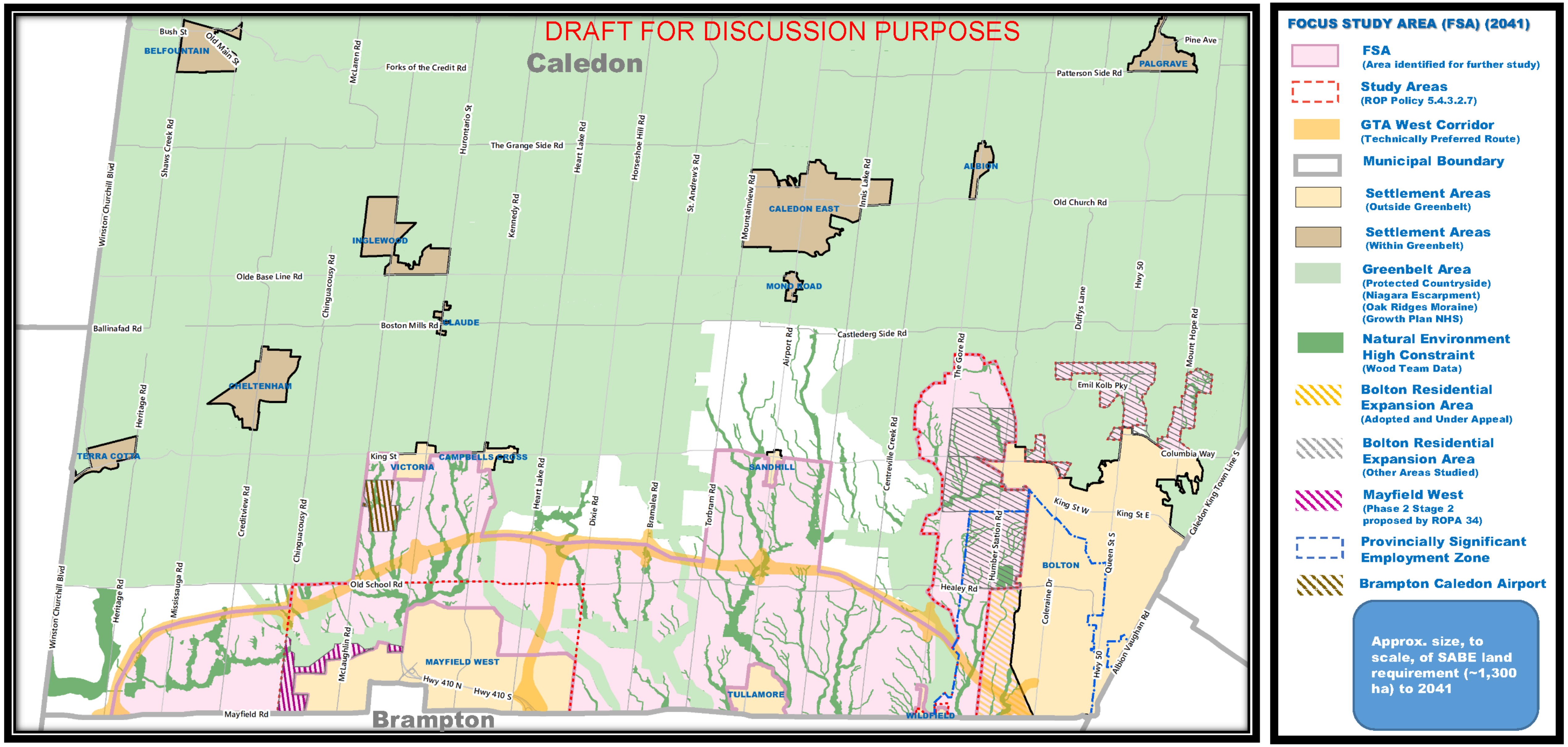
- a slope failure noted immediately east of The Gore Road ~1.1km south of King Street (West Humber subwatershed)
- an area ~700 m east of the intersection between Emil Kolb Parkway and King Street (Main Humber River subwatershed)

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 future site inspections and some areas will require subsurface investigations and slope analyses. It is expected that some areas may have localized toe erosion and sloughing of the toe, but this does not always mean an instability of the overall slope.

Irrespective of the preliminary slope stability ratings, any proposed municipal service watercourse crossings (water, wastewater, stormwater and transportation) will have to undertake a 'moderate instability potential' level investigation consisting of site inspection, boreholes, piezometers, lab tests, surveying and report.

2.2 Land Use

Hemson, working on behalf of the Region of Peel, developed an initial FSA map based on input provided during the screening phases discussed earlier. The derivation of the FSA map has considered the high constraint features, as well as the currently planned orientation/alignment of the proposed GTA West Highway, as well as the existing communities of Bolton, Mayfield, Tullamore and other smaller hamlets. The FSA limits have been intentionally established to encompass a geography beyond the specific growth needs for residential and employment lands for Peel to 2051, in order to allow for refinement and adjustments based on various constraints and opportunities related to environmental management and other technical study input. Figure 2.2.1.1 depicts the location of the FSA, currently without any distinction for future land use type (i.e. residential, employment, mixed), nor any specific detail on supporting infrastructure associated with new roads (arterial and collectors) or any major servicing corridors. The foregoing detail is expected to be provided following the initial preparation of this report (i.e. November 2020), at which time the SABE limits, including preliminary preferred locations for community (residential and mixed uses) and employment land needs, and supporting infrastructure will be available. At that time (post November 2020), the Wood Team will supplement the current reporting with more detailed assessment of the impacts and management strategies associated with the SABE.



Disclaimer: This map has been developed for the Settlement Area Boundary Expansion (SABE) Study and represents an area to be studied for the purpose of identifying a SABE.
For additional information, please refer to the *Settlement Area Boundary Expansion Study Phase A: Focus Study Area* report.

Note:

(1) There may be opportunities to expand rural settlements outside the FSA as part of the SABE Study.
(2) Other natural environmental constraints not identified on this map, including features not captured through existing mapping and potential buffers, will be identified through further analysis and may further limit development.
(3) ROP Policy 5.4.3.2.7 as it relates to the area surrounding Bolton is under appeal.
(4) The ~1,300 ha SABE is based on a draft land needs assessment which is under review.

1 cm = 1 km

Figure 2.2.1.1: Focus Study Area (FSA)

In summary, the determination of a 2051 SABE boundary for Peel, has to the date of writing, not been established and rather for the purpose of this initial assessment the entire FSA has been considered, as the overall preliminary draft SABE remains pending.. The limits of the SABE within the FSA are currently in the process of being refined, based upon input from detailed companion studies, including the Scoped SWS, as well as to comply with recent updates to Provincial planning direction and criteria which require a review of land use planning across Peel Region, based upon opportunities for infill and redevelopment, as well as greenfield development. For the purpose of this Draft Part B Report, the impact assessment has beeen completed for the entire FSA, and has been premised on a uniform blend of community (i.e. residential) and employment land needs, with a representative impervious coverage of 51% for all candidate future development areas. The source of the coverage (imperviousness) estimate is based on work conducted by TRCA with Peel Region to assess off site flood risk. This value of imperviousness coverage is intended to represent a blend of all land uses rather than any one type explicitly for sensitivity testing purposes. The ,recommended SABE boundary and land use mix will be identified in the next stage of study as part of the more detailed SABE delineation by the Hemson Team. Therefore as noted, the findings presented herein will be updated as part of subsequent stages of reporting for the Scoped SWS, to refine the impact assessment and managemet plans specific to the SABE, once established.

2.3 Detailed Studies

The first stage of the impact assessments has been completed, to assess the impact of the future development within the FSA, in the absence of management and mitigation. Recognizing the scale of the current land use planning for the FSA, this assessment has been completed based upon the insights gained from previous studies within the respective subwatersheds encompassing the SABE, as well as guidance from studies elsewhere within the GTA for similar physiographic and environmental conditions. The following sections present the findings of the impact assessment for the respective study disciplines. Once the SABE is delineated, this report will conduct a second stage of impact assessment specifically focused on the SABE and associated infrastructure.

2.3.1 Surface Water Quantity and Groundwater Resources

2.3.1.1 Surface Water Impact Assessment

As noted in the Draft Part A report, 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. On the west side, , the FSA lands fall within the 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 G). The approximate contributing drainage areas of the FSA within each subwatershed are summarized in Table 2.3.1.1.

Table 2.3.1.1. 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 %

In addition to the above, it is recognized that minor portions of the FSA may extend into the headwaters of the Spring Creek Subwatershed of the Etobicoke Creek Watershed, based upon a review of available mapping. The size of the areas potentially within the Spring Creek Subwatershed is quite small (i.e. <5 ha total), hence it is anticipated that any development of these areas would be graded such that stormwater management requirements for these lands would be addressed by the stormwater management plan for the balance of the development within the adjacent subwatershed (i.e. Upper Etobicoke Creek Subwatershed and West Humber River Subwatershed).

The conversion of rural lands to urban land use, without stormwater management, is recognized to reduce the amount of rainfall which infiltrates into the ground, increasing the volume of surface runoff generated from storm and snowmelt events, as well as the rate at which runoff is conveyed toward receiving systems. In addition, runoff from urban land uses is recognized to generally increase the concentration and mass loadings of heavy metals and certain phosphorus-based chemicals, as well as certain anions, particularly chlorides from road salts during winter maintenance, and increased temperature in surface runoff. These impacts, if unmitigated, are generally recognized to result in an increased risk of flooding and erosion along watercourses and drainage systems proximate to the new urban area, as well as a deterioration to the water quality and associated ecology within the receiving systems. These changes to runoff volume, rate, and water quality resulting from urban development, may likewise translate to an increased risk of flooding and erosion at a broader subwatershed or watershed scale within the receiving system, and similar deterioration to the surface water quality. The risk of flooding and erosion, as well as the impacts to surface water quality, are also recognized to depend upon the proportion and location of new development relative to the total contributing drainage area to the location of interest within the subject drainage area/subwatershed. The following section summarizes the anticipated impacts of future development within the FSA to the receiving systems within the respective subwatersheds which constitute the FSA.

Flooding: Off-Site Impact Assessment

Methodology

As part of the impact assessment for the FSA lands, an off-site hydraulic impact assessment has been completed for the Etobicoke Creek and Humber River, Flood Vulnerable Areas (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 has been completed using the as-approved HEC-RAS hydraulic 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 based on the results of the hydrologic impact assessment completed by TRCA (ref. Hydrologic Assessment Memo, TRCA, November 2019), which identified the potential changes in peak flow rates associated with a "50% Whitebelt build-out" and "100% Whitebelt build-out" scenarios for the Humber River Watershed. The coverage assumption for the built-out areas, based on input from Peel Region, was based on an impervious level of 51% representing an average of all land uses considered for this area.; this coverage is considered sufficiently representative for the current preliminary assessment to provide an indication of potential impacts from future development at a regional planning scale. Furthermore, 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 has been 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 has been summarized in the subsequent section.

The change in flood risk within the FVAs has been 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 damages (costs) within the affected FVAs. The flood damage costs have been 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 have 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 Storm) with the as-approved steady state flows in order to represent the baseline condition, and executed with the future Whitebelt development flows, in order to quantify potential impacts. However, only the 100-year and Regional Storm events are included in the 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. It should be noted that the mapping capabilities of RAS-Mapper are limited, by which the flood extents can only be plotted to the extent of the bounding cross-sections. A detailed floodplain delineation / clean-up is out of scope to the current study (i.e. spills analysis) and has thus not been completed for this assessment, as it is assumed that the characterization of changes to flood risks can be sufficiently determined through the hydraulic results (WSE, wetted width) and the estimated extents, in order to assess the impacts associated with headwater development.

The resulting maps provide estimated flood inundation limits and have been used to extract the resulting maximum WSE surrounding the flood vulnerable buildings; given that 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 extracted WSE has then been 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 was then 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 was not available 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 2.3.1.2.

Table 2.3.1.2: 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**

As demonstrated in Table 2.3.1.2, 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 located within a less dense urban community, with primarily residential properties located within the floodplain.

Baseline Conditions

As outlined in the methodology section, the hydraulic models for both the Etobicoke Creek and Humber River FVAs have been executed using the as-approved steady state flows to generate baseline conditions for hydraulic results, floodplain limits and associated flood damage estimates. The 100-year and Regional Storm 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 (ref. Appendix A).

The resulting flood damage curves for the baseline (as-approved model) conditions for each FVA has been summarized in Table 2.3.1.3.

Table 2.3.1.3: 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 predicted 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 have been used as the baseline condition for comparison to the future Whitebelt land use conditions, in order to estimate the potential impacts and change in flood risk, as well as associated potential damages.

Future Land Use Conditions (Whitebelt)

<u>Etobicoke Creek</u>

As mentioned previously, the Etobicoke Creek watershed was not included in the Whitebelt Modelling scenario completed by TRCA (ref. Hydrologic Assessment Memo, TRCA, November 2019); as per TRCA's recommendation, the future development flows, including the 2- through 100-year peak flow results (with existing SWM) and the Regional Storm event (without SWM), from the Etobicoke Hydrology Study have been employed in the current assessment (ref. Etobicoke Creek Hydrology Update, MMM Group, April 2013). In addition to the hydrologic modelling and analyses undertaken by TRCA, the Downtown Brampton Flood Protection Class Environmental Assessment (AECOM, June 2020) provided a preferred alternative, which is estimated to remove 19 ha of currently flood-prone lands from the Regulatory floodplain. The recommendations advanced in the June 2020 Class EA were based upon 2D MIKE FLOOD modelling of the FVA and flow rates generated from the April 2013 Hydrology Update. The application of the 2D MIKE FLOOD modelling for the Downtown Brampton FVA is recognized to be beyond the scope of the current study, hence the findings presented herein are considered to represent a conservative estimation of the anticipated flooding impacts within the Downtown Brampton FVA.

In order to replicate the potential for development within the headwater drainage area (per the FSA), the "Ultimate" land use condition evaluated in the Etobicoke Hydrology Study has been selected as the hydrologic input for the HEC-RAS steady state flow table generation. This future land use condition is described as "areas beyond the Official Plan (OP) within the headwaters are developed, while Environmental Protection Area (EPA) and Greenbelt area remain in their existing condition." While this condition is not specific to the FSA lands alone, it is assumed to provide a sufficient representation of headwater development, in order to characterize the potential flood impacts downstream.

It should be noted that the HEC-RAS model used in this assessment has applied an energy balance approach in order to establish the equivalent flow split between the by-pass channel and the spill to the SPA/Flood Damage Centre (FDC) for the Regional Storm event; the by-pass channel has sufficient capacity for all events up to and including the 350 year (ref. Downtown Brampton Flood Protection Feasibility Study, Amec Foster Wheeler, 2016), therefore a flow split is only required for the Regional Storm event. As noted previously, the analyses presented herein have not applied the 2D MIKE FLOOD modelling developed for the recently completed Downtown Brampton Flood Protection Class Environmental Assessment. Moreover, the preferred alternative advanced in the Class Environmental Assessment consists of expanding the valley corridor within the upstream limits of the FVA, thereby removing an estimated 19 ha of currently flood prone land from the Regulatory floodplain. The preferred alternative advanced in the Class EA has not been explicitly incorporated into the impact assessment, although the influence of this recommendation has been considered in the interpretation of the results.

This energy balance has been updated for the future development flows, by which the input flows to both the by-pass channel and spill into the SPA/FDC have been determined through an iterative process to ensure the hydraulic grade lines (HGLs) for both systems are equivalent at the upstream confluence point. The baseline flow split (2014) and future flows updated flow split are summarized in Table 2.3.1.4.

Table 2.3.1.4: Flow Proportion Update for Etobicoke Creek Spill into Downtown Brampton FVA – Regional Storm

Creek System	Baseline Conditions (2014)		Future Land Use Conditions	
	Regional Flow (m^3/s)	Flow Split (%)	Regional Flow (m^3/s)	Flow Split (%)
Total	306	-	344.7	-
By-pass	143.3	46.8 %	156.5	45.4 %
SPA / FDC	162.7	53.2 %	188.2	54.6 %

As demonstrated in Table 2.3.1.4, the flow proportion between the two hydraulic systems remains generally similar to the split under baseline conditions, with both systems experiencing a higher flow, and the FDC system accommodating an additional 1.5 % (+/-) of the total flow entering the system at the confluence point.

The future conditions peak flows for the reaches within and bounding the FVA have been sourced from the "Ultimate" land use conditions hydrologic assessment as part of the Etobicoke Hydrology Study. The storm events selected for this analysis include the Regional Storm and 2- through to 100-year design storm events; it should be noted that the 350-year has not been included in the current assessment, as it is not an input for potential flood damage calculations in the QPT.

The future conditions steady flow table utilized in the hydraulic assessment and the comparison to baseline conditions flows are presented in Table 2.3.1.5 and Table 2.3.1.6.

Table 2.3.1.5: HEC-RAS Steady Flow Table - Future Land Use (Ultimate) Conditions – Etobicoke Creek

Reach	River Station	Hydrologic Flow Node	Regional	100-yr	50-yr	25-yr	10-yr	5-yr	2-yr
Sections 26to28	26.82	2.13	345.80	95.84	83.11	70.95	55.40	45.42	32.10
Sections 26to28	26.81	2.14	342.12	95.80	83.11	70.94	55.31	45.41	32.12
Sections 26to28	26.76	2.15	344.71	96.39	83.60	71.33	55.58	45.61	32.29
Sections 26to28	26.73	2.15	344.71	96.39	83.60	71.33	55.58	45.61	32.29
FDC[1]	26.57	-	188.21	0.10	0.10	0.10	0.10	0.10	0.10
Brampton bypass	26.71	-	156.50	96.39	83.60	71.33	55.58	45.61	32.29
Sections15&25&26	26.34	2.16	344.98	96.13	83.54	71.19	55.41	45.52	32.32

Note: [1] The by-pass channel has sufficient capacity for up to the 350 year event (baseline conditions = 128.9 m^3/s) – therefore a placeholder of 0.10 m^3/s was maintained in the model for all design storm events (HEC-RAS requires a flow value > 0).

Table 2.3.1.6: Peak Flow Comparisons – Future Land Use (Ultimate) – Etobicoke Creek

Reach	River Station	Hydrologic Flow Node	Regional	100-yr	50-yr	25-yr	10-yr	5-yr	2-yr
Sections 26to28	26.82	2.13	18%	27%	24%	21%	17%	17%	19%
Sections 26to28	26.81	2.14	18%	25%	23%	20%	15%	16%	18%
Sections 26to28	26.76	2.15	13%	16%	14%	11%	7%	8%	10%
Sections 26to28	26.73	2.15	13%	16%	14%	11%	7%	8%	10%
FDC	26.57	-	16%	0%	0%	0%	0%	0%	0%
Brampton bypass	26.71	-	9%	16%	14%	11%	7%	8%	10%
Sections15&25&26	26.34	2.16	15%	12%	10%	8%	3%	3%	6%

The future Whitebelt (ultimate) development land use condition is demonstrated to produce a Regional Storm peak flow of approximately 18% higher than baseline conditions; the relative increase across the design storms is shown to be higher, at a maximum increase of 27% during the 100-year within the most upstream reach (Sections 26 to 28), and less of an increase (maximum of 12%) in the reach downstream of the FVA. These flows have been incorporated into the approved HEC-RAS model (2014) and simulated for all the noted storm events.

The results of the future land use conditions hydraulic assessment have been summarized in terms of the change in water surface elevation (WSE), wetted top width (i.e. simulated floodplain width), and approximate mapping of the flood extents. The results for the simulated WSE changes and wetted width throughout the impacted reaches are summarized in Table 2.3.1.7 and Table 2.3.1.8. The future conditions flood extents for both the 100 year and Regional events are presented on Drawing WR1a and Drawing WR1b (ref. Appendix A).

Table 2.3.1.7: Summary Changes of HEC-RAS Computed WSE for Future Whitebelt Conditions – Etobicoke Creek FVA

Storm Event	HEC-RAS Reach	Average Change in Flow (%)	Average Diff in WSE (m)	Max Diff in WSE (m)	Min Diff in WSE (m)
100 YR	Sections 26to28	21%	0.20	0.45	-0.02
	FDC	0%	0.01	0.15	0
	Brampton bypass	16%	0.15	0.2	0
	Sections15&25&26	12%	0.11	0.14	0
	Total Summary	***10%***	***0.10***	***0.45***	***-0.02***
Regional	Sections 26to28	16%	0.14	0.27	0
	FDC	16%	0.17	0.26	0
	Brampton bypass	9%	0.20	0.52	0
	Sections15&25&26	15%	0.13	0.28	0
	Total Summary	***14%***	***0.16***	***0.52***	***0***

Table 2.3.1.8: Summary Changes of HEC-RAS Wetted Width for Future Whitebelt Conditions – Etobicoke Creek FVA

Storm Event	HEC-RAS River/ Reach	Average Change in Flow (%)	Average Diff in Top Width (m)	Max Diff in Top Width (m)	Min Diff in Top Width (m)
100 YR	Sections 26to28	21%	14.21	41.04	-0.32
	FDC	0%	0.41	7.93	0
	Brampton bypass	16%	0.61	0.79	0
	Sections15&25&26	12%	2.85	11.28	0
	Total Summary	***10%***	***3.70***	***41.04***	***-0.32***
Regional	Sections 26to28	16%	8.41	33.15	0
	FDC	16%	3.28	13.91	0
	Brampton bypass	9%	7.66	104.01	0
	Sections15&25&26	15%	8.61	39.08	0
	Total Summary	***14%***	***6.29***	***104.01***	***0***

The results in Table 2.3.1.7 demonstrate that under the Whitebelt land use conditions, the WSE will increase by an average of approximately 0.10 m during the 100-year, with the maximum increase shown as 0.45 m occurring within the most upstream reach. Similar trends are seen during the Regional Storm event, with an average increase of approximately 0.16 m and a maximum increase of 0.52 m occurring within the by-pass channel.

These increases in simulated WSE result in an expansion of the floodplain, demonstrated in Table 2.3.1.8 and on Drawing WR1a and Drawing WR1b (ref. Appendix A). The results indicate an average increased wetted top width of 3.7 m and 6.3 m during the 100-year and Regional Storm events, respectively. There are local occurrences of larger floodplain expansions, including maximum increases of 41 m within the upstream reach during the 100-year, and over 100 m in the by-pass channel during the Regional Storm event.

The flood damage costs associated with the future land use conditions have been estimated at each of the flood vulnerable buildings within the expanded floodplain. The results are considered to be conservative in nature, as they are based upon 1D HEC-RAS modelling rather than the 2D modelling completed for the June 2020 Class EA, and have not explicitly accounted for implementing the preferred alternative from the Class EA which would remove approximately 19 ha of currently flood prone land from the Regulatory floodplain. Nevertheless, the results of this assessment are considered sufficient to allow for a comparison to baseline conditions and characterization of the associated downstream flood risk related to uncontrolled Whitebelt development, particularly recognizing the scale of the current level of study. The results of this analysis are summarized in Table 2.3.1.9.

Table 2.3.1.9: Direct Flood Damage Estimations for Future Whitebelt Conditions – Etobicoke Creek FVA

Land Use Condition	2-yr to 25-yr	50-yr	100-yr	Regional	Average Annual
Baseline	-	-	$ 9,044	$ 125,938,520	$ 576,481
Future Whitebelt	-	$ 9,408	$ 166,583	$ 140,146,562	$ 643,524
Difference to Baseline (%)	-	- %	1742%	11%	12%

Under the future Whitebelt land use conditions, minor damages are shown to occur during the 50-year storm event which are roughly equivalent to the damage estimates of the 100-year baseline conditions. This is a significant result as it demonstrates an increased flood risk to vulnerable buildings under the higher frequency events. The damage estimates are shown to increase significantly under the 100-year event, at a magnitude of over 15 times the baseline conditions estimate.

The flood damage estimates for the Regional Storm event demonstrate a smaller magnitude of change (11%), however, a larger dollar amount of approximately $14M; this is considered to be a conservative estimate of the anticipated damages, due to the estimated frequency of the Regional Storm event (i.e. 0.4%) which has been applied in the analysis. This increase is primarily due to the increased flood depths occurring at each of the flood vulnerable buildings, as well as two (2) additional flood vulnerable buildings not previously impacted under baseline conditions, which are now estimated to incur flood damages within the expanded floodplain. The Regional Storm event remains as the primary source for average annual damages, generating an increase of approximately 12% in direct flood damages on an average annual basis. It should be noted that the absolute flood damage costs generated as part of this assessment represent simplified estimations, therefore the reported dollar amounts should be interpreted accordingly. The foregoing assessment has also not accounted for the benefits which would be associated with the implementation of the recommendations advanced in the Downtown Brampton Flood Protection Environmental Assessment (AECOM, June 2020), which is estimated to remove 19 ha of currently flood-prone lands from the Regulatory floodplain. The important finding from this assessment is the proportion of the noted changes and the resulting increases to flood risk in downstream systems as a result of the higher peak flows occurring from uncontrolled development within the headwaters.

For potential Whitebelt development within the upper Etobicoke Creek Watershed, it can be seen that higher flood depths and wider flood extents are expected within the Downtown Brampton FVA, which results in significantly higher damages within the primarily urban/commercial downtown core. These damages are demonstrated to occur during the major storm events and begin to occur earlier under higher frequency events, than shown under baseline conditions (50-year and above). This demonstrates the relative sensitivity of the Etobicoke Creek system, and the downstream effects within the dense urbanized area of the Downtown Brampton SPA.

Humber River

As outlined previously, the primary input for the Humber River off-site hydraulic assessment is the results of the hydrologic impact assessment completed by TRCA (ref. Hydrologic Assessment Memo, TRCA, November 2019), which assumed a 51% impervious coverage. This assessment 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. For the purpose of this assessment, only the 100% Whitebelt build-out scenario has been carried forward to characterize the potential flood risk associated with uncontrolled development in the headwaters.

This assessment was completed by TRCA using the “Future OP no SWM” Visual OTTHYMO (VO) model developed as part of the Humber River Hydrology Update as a base model; TRCA completed necessary model updates in the headwater drainage areas to represent the potential Whitebelt development and urbanized land use conditions. This was completed by adjusting a variety of subcatchment parameters and applying an assumed 51% imperviousness for future urban development; further details related to the model updates can be found in the Memo prepared by TRCA (ref. Hydrologic Assessment Memo, TRCA, November 2019).

In accordance with industry standard floodplain mapping methodologies, the 2- through 100-year design storm events are simulated using the hydrologic flow results of the existing land use conditions with SWM practices in place, and the Regional Storm event flows are sourced from the future land use conditions without SWM to provide the most conservative estimate of floodplain limits. Given that the Whitebelt hydrologic impact assessment completed by TRCA utilized a base model which did not contain SWM, further data mining has been completed in order to more accurately represent the impacts or changes to the flood risks under the design storm events (2- through 100-year), so that an appropriate comparison could be completed against the baseline conditions which would receive the benefit of peak flow control from existing SWM.

In order to develop representative flow results for the design storm events which could be incorporated into the hydraulic modelling, the peak flows from the “Future OP + 100% Whitebelt (no SWM)” have been compared against the “Future OP (no SWM)” at select nodes to determine the change (or delta) in peak flow which can be attributed to the uncontrolled Whitebelt development. This delta peak flow has then been added to the “Existing with SWM” peak flows as per baseline conditions (approved model), to demonstrate the increase in peak flow associated with the uncontrolled Whitebelt development. This approach has been applied for each of the design storms (2- through 100-year), in absence of a Whitebelt development model which contains existing SWM. The Regional Storm event peak flows have been sourced directly from the Future OP + 100% Whitebelt (no SWM) scenario, as this methodology is consistent with the baseline conditions and does not require future data processing.

An example of this peak flow approach is presented in Table 2.3.1.10 for the 100-year event at one of the flow change locations in the HEC-RAS model.

Table 2.3.1.10: Whitebelt Development Peak Flow Example – 100-year

Node ID	River (Reach)	100-year Peak Flow (m^3/s)				
		EX HEC-RAS (Existing w SWM)	Future OP (no SWM)	Future OP + 100% Whitebelt (no SWM)	Delta	Whitebelt Flow
45	West Humber Creek (Reach1)	222.03	312.40	575.43	263.02	485.05

The resulting future land use (Whitebelt) conditions peak flows for the design storms and the Regional Storm event have been applied in the Humber River HEC-RAS model (Humber in Toronto, Wood, 2017) at a total of five (5) flow change locations. These locations have been selected to focus on reaches within the FVA and select reaches downstream to ensure appropriate tailwater conditions for HEC-RAS computations.

The future conditions steady state flow table and the comparison to baseline conditions flows are presented in Table 2.3.1.11 and Table 2.3.1.12.

Table 2.3.1.11: HEC-RAS Steady Flow Table - Future Land Use (Whitebelt) Conditions – Humber River

River (Reach)	River Station	Hydrologic Flow Node	Regional	100-yr	50-yr	25-yr	10-yr	5-yr	2-yr
West Humber Crk (Reach 1)	2569.364	45	1251.96	485.05	413.51	339.45	246.24	127.65	75.69
Lower Humber (Reach 5)	3220.292	49.9	1745.41	603.89	509.85	422.09	313.64	152.59	87.37
Lower Humber (Reach 4)	5219.595	0.155	1705.31	593.80	500.18	415.96	310.83	152.92	86.33
Lower Humber (Reach 3)	3047.155	49.5	1706.59	593.80	500.18	415.96	310.83	152.92	86.36
Lower Humber (Reach 2)	2359.812	49.3	1720.16	584.02	495.42	413.29	305.54	153.99	88.55

Table 2.3.1.12: Peak Flow Comparisons – Future Land Use (Whitebelt) – Humber River

Reach	River Station	Hydrologic Flow Node	Regional	100-yr	50-yr	25-yr	10-yr	5-yr	2-yr
West Humber Crk (Reach 1)	2569.364	45	41%	118%	117%	115%	108%	119%	94%
Lower Humber (Reach 5)	3220.292	49.9	21%	64%	64%	60%	55%	62%	46%
Lower Humber (Reach 4)	5219.595	0.155	21%	62%	62%	59%	54%	62%	45%
Lower Humber (Reach 3)	3047.155	49.5	21%	62%	62%	59%	54%	62%	45%
Lower Humber (Reach 2)	2359.812	49.3	21%	60%	61%	59%	53%	60%	40%

The future Whitebelt development land use conditions result in a Regional Storm peak flow of approximately 41% higher than baseline conditions at the downstream point of the West Humber Creek, as this system contains contributions from the vast majority of the Whitebelt development lands. Downstream of the confluence point of the West Humber and Main Humber River, an approximate 21% increase in the Regional Storm peak flow is shown throughout the Lower Humber River. The relative increase across the design storms is seen to be higher, with increases ranging from 94-118% within the West Humber Creek and increases of 40-64% within the Lower Humber River. These flows have been incorporated into the approved HEC-RAS model (2017) and simulated for all the noted storm events.

The results of the future land use conditions hydraulic assessment have been summarized in terms of the change in water surface elevation (WSE), wetted top width (i.e. simulated floodplain width), and mapping of the flood extents. The results for the simulated WSE changes and wetted width throughout the impacted reaches, both within the FVA and local connecting tributaries, are summarized in Table 2.3.1.13 and Table 2.3.1.14. The future conditions flood extents for both the 100 year and Regional Storm events are presented on Drawing WR2a and Drawing WR2b (ref. Appendix A).

Table 2.3.1.13: Summary Changes of HEC-RAS Computed WSE for Future Whitebelt Conditions – Humber River FVA

Storm Event	HEC-RAS		Average Change in Flow (%)	Average Diff in WSE (m)	Max Diff in WSE (m)	Min Diff in WSE (m)
	River	Reach				
100 YR	Berry Creek	Reach 1	0%	0.92	0.95	0.88
	Lower Humber	Reach 4	62%	1.01	1.02	1.01
		Reach 5	64%	1.23	1.34	0.89
		Reach 6	0%	0.93	1.08	0.74
	West Humber Creek	Reach 1	118%	1.16	1.75	0.78
	Total Summary		***64%***	***1.10***	***1.75***	***0.74***
Regional	Berry Creek	Reach 1	0%	0.92	0.95	0.88
	Lower Humber	Reach 4	21%	0.91	0.92	0.91
		Reach 5	21%	0.42	1.23	0.31
		Reach 6	0%	0.40	0.42	0.37
	West Humber Creek	Reach 1	41%	0.56	1.36	0.41
	Total Summary		***22%***	***0.59***	***1.36***	***0.31***

Table 2.3.1.14: Summary Changes of HEC-RAS Wetted Width for Future Whitebelt Conditions – Humber River FVA

Storm Event	HEC-RAS		Average Change in Flow (%)	Average Diff in Top Width (m)	Max Diff in Top Width (m)	Min Diff in Top Width (m)
	River	Reach				
100 YR	Berry Creek	Reach 1	0%	14.58	62.13	3.04
	Lower Humber	Reach 4	62%	5.14	6.02	4.58
		Reach 5	64%	30.22	91.94	4.1
		Reach 6	0%	7.43	17.23	2.32
	West Humber Creek	Reach 1	118%	119.31	518.32	2.15
	Total Summary		***64%***	***53.35***	***518.32***	***2.15***
Regional	Berry Creek	Reach 1	0%	14.58	62.13	3.04
	Lower Humber	Reach 4	21%	39.84	74.47	8.44
		Reach 5	21%	54.01	279.38	0.43
		Reach 6	0%	9.81	26.32	0.86
	West Humber Creek	Reach 1	41%	12.56	41.23	1.51
	Total Summary		***22%***	***27.16***	***279.38***	***0.43***

The results in Table 2.3.1.13 demonstrate that under the Whitebelt land use conditions, the simulated WSE would increase by an average of approximately 1.10 m during the 100-year event, with a maximum increase of 1.75 m occurring within the West Humber Creek, and a minimum increase of 0.74 m, which demonstrates flood depth increases within all reported / connecting systems. Similar trends are seen under the Regional Storm event, with an average WSE increase of approximately 0.59 m, a maximum increase of 1.36 m occurring within the West Humber Creek and a minimum increase of 0.31 m across all reported / connecting systems.

There are two (2) connecting tributaries which do not experience changes in peak flow as a result of Whitebelt development; these include the Lower Humber Reach 6, which is located upstream of the confluence with the West Humber, and the Berry Creek tributary which contributes to the Lower Humber River directly downstream of Albion Road. Both of these systems demonstrate WSE increases under the 100-year and Regional Storm events, which can be attributed to the tailwater influences with the FVA alone, as these systems would not experience direct changes to peak flow and hydrologic relationships as a result of Whitebelt development.

These simulated increases in WSE result in an expansion of the floodplain, demonstrated in Table 2.3.1.14 and on Drawing WR2a and Drawing WR2b (ref. Appendix A). The results indicate an average increased wetted top width of 53.35 m and 27.16 m during the 100-year and Regional Storm events, respectively. There are local occurrences of larger floodplain expansions, including a maximum increase of over 500 m during the 100-year event within the West Humber Creek just upstream of the Albion Road crossing, and over 270 m in the Lower Humber River during the Regional Storm event. It should be noted that these large occurrences of top width expansion are primarily in locations where artificial levees or high points contained the flow within the main channel under baseline conditions and are now being exceeded within the floodplain.

The flood damage costs associated with the future land use conditions have been estimated at each of the flood vulnerable buildings within the expanded floodplain. This allows for a comparison to baseline conditions and characterization of the associated downstream flood risk related to uncontrolled Whitebelt development. The results of this analysis are summarized in Table 2.3.1.15.

Table 2.3.1.15: Direct Flood Damage Estimations for Future Whitebelt Conditions – Humber River FVA

Land Use Condition	2-yr to 50-yr	100-yr	Regional	Average Annual
Baseline	-	-	$ 18,359,764	$ 84,026
Future Whitebelt	-	$ 355,397	$ 32,163,356	$ 151,267
Difference to Baseline (%)	-	- %	75%	80%

Under the future Whitebelt land use conditions, minor damages are shown to occur beginning during the 100-year storm event, which under baseline conditions did not incur any damage estimates as a result of riverine flooding. This is significant as it demonstrates the flood risk increasing in frequency and is no longer only limited to the Regional Storm event.

The flood damage estimates for the Regional Storm event demonstrate a 75% increase, which equates to an estimated dollar amount of approximately $14M. This increase is primarily due to the increased flood depths occurring at each of the flood vulnerable buildings, as well as twenty-three (23) additional flood vulnerable buildings incurring flood damages as a result of the expanded floodplain. The Regional Storm event remains as the primary source for average annual damages, generating an increase of approximately 80% in direct flood damages on an average annual basis.

It should be noted that the absolute flood damage costs generated as part of this assessment represent simplified estimations, therefore the reported dollar amounts should be interpreted accordingly. The important finding from this assessment is rather the proportion of the noted changes and the resulting increases to flood risk in downstream systems as a result of the higher peak flows occurring from uncontrolled development within the headwaters.

For development within the upper Humber River Watershed, it can be seen that higher flood depths and wider flood extents are expected within the Humber River FVA, as well as within the hydraulically connected systems upstream and connecting tributaries, as a result of the tailwater influences. These hydraulic impacts result in higher damages occurring during the major storms, and flood damages beginning to occur during the more frequent storm events (no longer limited to the Regional Storm). This demonstrates the sensitivity of the Humber River system, and the effects further downstream within the watershed.

Main Humber Subwatershed

Flood Risk (on-site/off-site):

Per Table 2.3.1.1, the portion of the FSA within the Main Humber Subwatershed is relatively small in size (i.e. 438 ha), and represents a small proportion of the total subwatershed area (i.e. 1.2 %). The portions of the FSA within the subwatershed drain toward the major confined watercourses via a series of headwater drainage features, hence there is currently no formal flood hazard delineated within the designated FSA lands within the main Humber Subwatershed. Although these portions of the FSA lie upstream of designated FVAs within the Humber River Watershed, it is anticipated that development of these lands would have a negligible impact to off-site/downstream flood risk due to the small proportion of these areas relative to the total contributing drainage areas to the FVAs. Moreover, as the lands drain directly toward the well-defined and regulated watercourse systems, it is anticipated that development of these lands would not represent a local flood risk, provided that the current discharge locations are retained and utilized post-development. As such, it is anticiapted that stormwater management for quantity controls, if required for these areas, would not require over-control of peak flows for flood protection of downstream properties (i.e. post-to-pre control anticipated to be sufficient). Furthermore, quantity controls for the Regional (Hurricane Hazel) Storm event may not be required for these areas, however this would be subject to confirmation as part of future detailed studies (local SWS) and a determination of the recommended SABE boundary.

Erosion Risk:

The erosion assessment completed for the Part A report indicated that no erosion sensitive sites are currently located proximate to the FSA in the Main Humber Subwatershed. While it is anticipated that development of the FSA within the Main Humber Subwatershed would increase erosion potential along the receiving watercourses, it is anticipated that any potential erosion impacts may be mitigated through conventional practices (i.e. extended-detention storage within end-of-pipe facilities with drawdown times less than 5 days, implementation of Low Impact Development (LID) infiltration-based Best Management Practices (BMPs).

Water Budget:

The key hydrologic features and key hydrologic areas within, and proximate to, the FSA within the Main Humber Subwatershed include several ecologically significant groundwater recharge areas (ESGRAs), and some areas with low depth to water table. As such, development of the FSA within the Main Humber Subwatershed would, without mitigation, be expected to reduce groundwater contributions to these areas. This is disussed in further detail in Section 2.3.1.2.

West Humber Subwatershed

Flood Risk (on-site/off-site):

The portion of the FSA within the West Humber Subwatershed is relatively large in size (i.e. 5335 ha), and represents a sizeable proportion of the total subwatershed area (i.e. 26.4 %). The portions of the FSA within the subwatershed drain toward the major confined watercourses, as well as various unconfined watercourses, hence some of the contributing areas have a regulated flood hazard associated with the drainage features through the site, as well as through downstream properties. Moreover, as portions of the lands drain directly toward the unconfined watercourses and drainage features offsite, it is anticipated that development of these lands, in the absence of stormwater management, would increase peak flows offsite, thus presenting a local flood risk to adjacent properties. As such, it is anticipated that stormwater management for quantity controls would be required to control post-development flows to pre-development levels for all events including the Regional Storm event, in order to mitigate both local and subwatershed-scale flood risks. As the FSA is located toward the headwaters, it is anticipated that a uniform application of post-to-pre control or a combination of strategic post-to-pre control and undercontrol would provide adequate flood protection, and over-control of peak flows for flood protection of downstream properties would not be required. The requirements for stormwater management are to be established as part of future studies (i.e. local SWSs).

Erosion:

The erosion assessment completed for the Part A report indicated that erosion sensitive sites are within and bounding the FSA in the West Humber Subwatershed. As such, it is anticipated that development of the FSA within the West Humber Subwatershed would increase erosion potential along the receiving watercourses. The erosion impacts may be mitigated through the provision of extended detention storage within end-of-pipe facilities, potentially in combination with LID infiltration BMPs to reduce the volume of surface runoff). The specific requirements for mitigating erosion impacts are to be determined as part of future studies.

Water Budget:

The key hydrologic features and key hydrologic areas within and proximate to the FSA within the West Humber Subwatershed include ecologically significant groundwater recharge areas (ESGRAs), areas with low depth to water table, and pockets of significant groundwater recharge areas. In addition, key hydrologic features in the form of seepage areas and wetlands are located within this portion of the FSA. As such, development of the FSA within the West Humber Subwatershed would be expected to reduce groundwater contributions to these areas, potentially impacting the water budget to sensitive ecological features. Measures to promote groundwater recharge through the application of LID infitration BMPs will be required to mitigate these impacts. The implementation of these measures will require infiltration of clean runoff (i.e. rootop runoff) and pre-treatment of surface runoff from other paved surfaces (i.e. roads, parking lots, driveways) to maintain the quality of infiltrated surface runoff. This is discussed further in Section 2.3.1.2.

Upper Etobicoke Creek Subwatershed

Flood Risk (on-site/off-site):

The portion of the FSA within the Upper Etobicoke Creek Subwatershed is relatively large in size (i.e. 2027 ha), and represents a sizeable proportion of the total subwatershed area (i.e. 20.3 %). The portions of the FSA within the subwatershed drain toward the major confined watercourses and various unconfined watercourses, hence some of the contributing areas have a regulated flood hazard associated with the drainage features through the site, as well as through downstream properties. Moreover, as portions of the lands drain directly toward the unconfined watercourses and drainage features offsite, it is anticipated that development of these lands, in the absence of stormwater management, would increase peak flows offsite, thus presenting a local flood risk to adjacent properties. As such, it is anticipated that stormwater management for quantity controls would be required to control post-development flows to pre-development levels for all events including the Regional Storm event, in order to mitigate both local and subwatershed-scale flood risks. As the FSA is located toward the headwaters, it is anticipated that a uniform application of post-to-pre control or a combination of strategic post-to-pre control and undercontrol would provide adequate flood protection, and over-control of peak flows for flood protection of downstream properties would not be required.

Erosion:

The erosion assessment completed for the Part A report indicated that erosion sensitive sites are within and bounding the FSA in the Upper Etobicoke Creek Subwatershed. Consequently, it is anticipated that development of the FSA within the Upper Etobicoke Creek Subwatershed would increase erosion potential along the receiving watercourses. The erosion impacts may be mitigated through the provision of extended detention storage within end-of-pipe facilities, potentially in combination with LID infiltration BMPs to reduce the volume of surface runoff).

Water Budget:

The key hydrologic features and key hydrologic areas within and proximate to the FSA within the Upper Etobicoke Creek Subwatershed include ecologically significant groundwater recharge areas (ESGRAs), areas with low depth to water table, and pockets of significant groundwater recharge areas. In addition, key hydrologic features in the form of seepage areas and wetlands are located within this portion of the FSA. As such, development of the FSA within the Upper Etobicoke Creek Subwatershed would reduce groundwater contributions to these areas, potentially impacting water budget to sensitive ecological features. This is discussed further in Section 2.3.1.2.

Fletcher's Creek Subwatershed

Flood Risk (on-site/off-site):

The portion of the FSA within the Fletcher's Creek Subwatershed is relatively small in size (i.e. 196 ha), and represents a small portion of the total subwatershed area (i.e. 4.5 %). The portions of the FSA within the subwatershed drain toward the headwater drainage features, which are not regulated based upon flood hazard definition. This segment of the FSA drains directly toward the unconfined watercourses and drainage features offsite, hence it is anticipated that development of these lands in the absence of stormwater management would increase peak flows offsite, thus presenting a local flood risk to adjacent properties. As such, it is anticipated that stormwater management for quantity controls would be required to control post-development flows to pre-development levels for all events including the Regional Storm event, in order to mitigate both local and subwatershed-scale flood risks. As the FSA is located within the headwaters of the subwatershed, it is anticipated that a uniform application of post-to-pre control or a combination of strategic post-to-pre control and undercontrol would provide adequate flood protection, and over-control of peak flows for flood protection of downstream properties would not be required. The requirements for stormwater management are to be established as part of future studies.

Erosion:

The erosion assessment completed for the Part A report indicated that erosion sensitive sites have been identified within areas of the Fletcher's Creek Subwatershed downstream of the FSA. As such, it is anticipated that development of the FSA within the Fletcher's Creek Subwatershed would increase erosion potential along the receiving watercourses. Based upon findings from previous studies, it is anticipated that the erosion impacts may be mitigated through the provision of extended detention storage within end-of-pipe facilities, and may potentially be combined with LID infiltration BMPs to reduce the volume of surface runoff.

Water Budget:

The key hydrologic features and key hydrologic areas within and proximate to the FSA within the Fletcher's Creek Subwatershed are limited to shallow depth to groundwater and the presence of headwater drainage features. Although development of the FSA within the Fletcher's Creek Subwatershed would be anticipated to reduce groundwater recharge, it is not anticipated to represent a significant impact to the groundwater system, key hydrologic features or areas. Nevertheless, measures to promote groundwater recharge through the application of LID infitration BMPs should be considered, in order to augment the stormwater management performance in the area. This is discussed further in Section 2.3.1.2.

Huttonville Creek Subwatershed

Flood Risk (on-site/off-site):

The portion of the FSA within the Huttonville Creek Subwatershed is small in size (i.e. 43 ha), and represents a small portion of the total subwatershed area (i.e. 2.8 %). The portions of the FSA within the subwatershed drain toward the headwater drainage features, which are not regulated based upon flood hazard definition. This segment of the FSA drains directly toward the unconfined watercourses and drainage features offsite, hence it is anticipated that development of these lands in the absence of stormwater management would increase peak flows offsite, thus presenting a local flood risk to adjacent properties. As such, it is anticipated that stormwater management for quantity controls would be required to control post-development flows to pre-development levels for all events including the Regional Storm event, in order to mitigate both local and subwatershed-scale flood risks. As the FSA is located within the headwaters of the subwatershed, it is anticipated that a uniform application of post-to-pre control or a combination of strategic post-to-pre control and undercontrol would provide adequate flood protection, and over-control of peak flows for flood protection of downstream properties would not be required.

Erosion:

The erosion assessment completed for the Part A report indicated that erosion sensitive sites have been identified within areas of the Huttonville Creek Subwatershed downstream of the FSA. As such, it is anticipated that development of the FSA within the Huttonville Creek Subwatershed would increase erosion potential along the receiving watercourses. Based upon findings from previous studies, it is anticipated that the erosion impacts may be mitigated through the provision of extended detention storage within end-of-pipe facilities, and may potentially be combined with LID infiltration BMPs to reduce the volume of surface runoff.

Water Budget:

No key hydrologic features or key hydrologic areas have been identified within or proximate to the FSA within the Huttonville Creek Subwatershed, hence while development of the FSA within the Huttonville Creek Subwatershed would be anticipated to reduce groundwater recharge, it is not anticipated to represent a significant impact to the groundwater system, key hydrologic features or areas. Nevertheless, measures to promote groundwater recharge through the application of LID infitration BMPs should be considered, in order to augment the stormwater management performance in the area. This is discussed further in Section 2.3.1.2.

Main Credit River (Glen Williams to Norval)

Flood Risk (on-site/off-site):

The portion of the FSA discharging toward the Main Branch of the Credit River is relatively small in size (i.e. 23 ha), and represents a small proportion of the local subwatershed area (i.e. 1.0 %). The portions of the FSA within the subwatershed drain toward the major confined watercourses via a series of headwater drainage features, hence there is currently no flood hazard delineated within the designated FSA lands. As the land drain directly toward the well-defined and regulated watercourse systems, it is anticipated that development of these lands would not represent a local flood risk, provided that the current discharge locations are retained and utilized post-development. As such, it is anticipated that stormwater management for quantity controls, if required for this area, would not require over-control of peak flows for flood protection of downstream properties (i.e. post-to-pre control anticipated to be sufficient). Furthermore, quantity controls for the Regional (Hurricane Hazel) Storm event may not be required for this area, however this would be subject to confirmation as part of detailed studies.

Erosion:

The erosion assessment completed for the Part A report indicated that no erosion sensitive sites are currently located proximate to the FSA discharging toward the Credit River Main Branch. While it is anticipated that development of the FSA within this area would increase erosion potential along the receiving watercourses, it is anticipated that the erosion impacts may be mitigated through conventional practices (i.e. extended-detention storage within end-of-pipe facilities with drawdown times less than 5 days, implementation of LID infiltration BMPs). The specific requirements for mitigating erosion impacts are to be determined as part of future studies.

Water Budget:

The key hydrologic areas within and proximate to the FSA discharging toward the Credit River include areas with low depth to water table, although it is recognized that additional key hydrologic areas and features may be located downstream along the Credit River Main Branch. While the size of the FSA within this area is of such small magnitude that development of this area is not anticipated to present an adverse impact to key hydrologic features or areas, measures to promote groundwater recharge through the application of LID infitration BMPs are nevertheless recommended in order to enhance the performance of the storwmater management system. This is discussed further in Section 2.3.1.2.

2.3.1.2 Groundwater Impact Assessment

The increase in impervious surfaces reduces the natural infiltration and when unmitigated leads to a subsequent decrease in groundwater recharge, related groundwater levels and a potential decrease to groundwater discharge to wetlands and stream reaches where this discharge currently exists. This reduction in infiltration may also lead to a potential decrease in recharge to the deeper water producing units particularly the upper aquifer consisting of the Oak Ridges Moraine deposits.

An existing conditions water balance was developed for each of the seven subwatersheds that occur within the FSA as part of the Existing Conditions and Characterization Part A report. The water balance parameters (i.e., evapotranspiration [ET], recharge, runoff and precipitation) were estimated from a model developed by the ORMGP and based on a 10-year climate record from 2004 to 2014, and are provided in Table 2.3.1.16 in units of mm/year and m^3/day. The existing water balance values were quite similar among the seven subwatersheds (i.e., within 25 to 40 mm of each other) 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). Additional details about the existing conditions water balance can be found within 'Scoped Subwatershed Study Part A – Existing Conditions and Characterization (Draft)' (Wood, October 2020).

Table 2.3.1.16 Existing Conditions Water Balance (Focus Study Area)

Authority	Watershed	Subwatershed	Total Area in FSA (m^2)	P	ET	RO	R	ΔS
				(mm/year)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	810	545	140	120	5
		Fletcher's Creek	1,910,000	810	535	150	120	5
		Huttonville Creek	430,000	810	515	175	115	5
TRCA	Humber River	Main Humber	4,310,000	785	520	150	105	10
		West Humber	53,390,000	790	530	135	120	5
	Etobicoke Creek	Spring Creek	70,000	790	520	155	105	10
		Upper Etobicoke	20,250,000	800	520	140	135	5
				(m^3/day)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	510	343	88	76	3
		Fletcher's Creek	1,910,000	4,239	2,800	785	628	26
		Huttonville Creek	430,000	954	607	206	135	6
TRCA	Humber River	Main Humber	4,310,000	9,269	6,140	1,771	1,240	118
		West Humber	53,390,000	115,556	77,525	19,747	17,553	731
	Etobicoke Creek	Spring Creek	70,000	152	100	30	20	2
		Upper Etobicoke	20,250,000	44,384	28,849	7,767	7,490	277

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

Future development and transition from rural agricultural land use to urban land use without mitigation has the potential to reduce ET and recharge and increase runoff. Among other impacts, 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 future stormwater management plans that seek to maintain the pre-development water balance at a subcatchment to subwatershed level, based on an understanding of the operative factors (e.g., variability in hydraulic conductivity, vegetation and imperviousness) 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.

A future conditions water balance with no mitigation was estimated for the seven subwatersheds in the FSA for the impact assessment. The overall impact assessment has assumed a representative impervious coverage of 51% for the FSA for this Draft Part B report (Section 2.2). Given this, water budget parameters for developable lands were estimated for the FSA subwatersheds using ORMGP model output from an existing medium density residential development on the Halton Till in the Brampton area located adjacent to the FSA (ORMGP 2018). A medium density residential development was considered representative for this exercise as this land use has been associated with a similar magnitude of total imperviousness (50% including developable and NHS areas) in areas already developed in Brampton and in other municipal studies in southern Ontario (e.g. Matrix and SSP&A 2014, Matrix 2020). The Halton Till was considered appropriate as the majority of the FSA is covered at surface by the Halton Till or Wildfield Till, which are considered relatively finer grained sediments (ref. Drawing GW-4, Appendix G). ORMGP modelled average water budget parameters (i.e., ET, runoff, and recharge) were used for this representative development available from the ORMGP (2018; Table 2.3.1.17) and then scaled to the area of developable lands in each subwatershed (Table 2.3.1.18a and 2.3.1.18b). Where lands within each subwatershed were considered undevelopable (i.e., NHS lands as per the Peel Official Plan), water budget parameters were carried forward from the existing conditions assessment (Table 2.3.1.16) and then scaled to the area of undevelopable lands (Table 2.3.1.18a and 2.3.1.18b).

The change in water balance between existing conditions and estimated post development conditions, is presented as a deficit or surplus in Tables 2.3.1.18a (in units of mm/year) and 2.3.1.18b (in units of m^3/day) for each subwatershed. The surplus or deficit indicates that a generalized assessment assuming average imperviousness similar to medium density residential development on Halton Till has the potential to reduce recharge by 66 to 87 mm/year (13 to 10,678 m^3/day) or 76 mm/year (2,409 m^3/day) on average. This development also has the potential to increase runoff by 319 to 354 mm/year (65 to 47,327 m^3/day) or 335 mm/year (10,238 m^3/day) on average.

Given the similarity in surficial geology throughout the FSA, the level of infiltration or runoff mitigation due to increased imperviousness and reduction in vegetation needed to maintain existing conditions will be expected to be similar between subwatersheds in the FSA. Low Impact Development Best Management Practices are recommended to mitigate recharge reductions and the increase in runoff. Areas of sand mapped at surface may offer opportunities for additional infiltration; however, these occurrences are localized, and small in extent, and infrequent in the FSA. The areas of groundwater concern mapping show that the depth to groundwater and upward gradients are present in many areas underlying FSA and may restrict centralized infiltration (e.g., subsurface infiltration tanks galleries).

Under future development ET may reduce by 230 to 279 mm/year (49 to 34,803 m^3/day) or 253 mm/year (7,501 m^3/day) on average across the FSA from increased impervious surfaces (Table 2.3.1.18a and 2.3.1.18b). Strategies that have the potential to mitigate reduced ET include those that promote and enhance vegetation in developed areas.

Table 2.3.1.17 Representative Water Balance for a Medium Density Residential Development on Halton Till

Authority	Watershed	Subwatershed	Total Area in FSA (m^2)	P	ET	RO	R	ΔS
				(mm/year)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	810	266	494	39	11
		Fletcher's Creek	1,910,000	810	266	494	39	11
		Huttonville Creek	430,000	810	266	494	39	11
TRCA	Humber River	Main Humber	4,310,000	785	266	494	39	(14)
		West Humber	53,390,000	790	266	494	39	(9)
	Etobicoke Creek	Spring Creek	70,000	790	266	494	39	(9)
		Upper Etobicoke	20,250,000	800	266	494	39	1
				(m^3/day)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	510	168	311	25	7
		Fletcher's Creek	1,910,000	4,239	1,392	2,585	204	58
		Huttonville Creek	430,000	954	313	582	46	13
TRCA	Humber River	Main Humber	4,310,000	9,269	3,141	5,833	461	(165)
		West Humber	53,390,000	115,556	38,909	72,259	5,705	(1,316)
	Etobicoke Creek	Spring Creek	70,000	152	51	95	7	(2)
		Upper Etobicoke	20,250,000	44,384	14,758	27,407	2,164	55

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

Table 2.3.1.18a Future Conditions Water Balance for a Medium Density Residential Development on Till in the Focus Study Area (mm/year)

Authority	Watershed	Subwatershed	Total Area in FSA (m^2)	Undevelopable / Developable Area in FSA (m^2)		P	ET	RO	R	ΔS
						(mm/year)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	Undevelopable	0	0	0	0	0	0
				Developable	230,000	810	266	494	39	11
				Deficit/Surplus vs Existing		**0**	**(279)**	**354**	**(81)**	**6**
		Fletcher's Creek	1,910,000	Undevelopable	0	0	0	0	0	0
				Developable	1,910,000	810	266	494	39	11
				Deficit/Surplus vs Existing		**0**	**(269)**	**344**	**(81)**	**6**
		Huttonville Creek	430,000	Undevelopable	0	0	0	0	0	0
				Developable	430,000	810	266	494	39	11
				Deficit/Surplus vs Existing		**0**	**(249)**	**319**	**(76)**	**6**
TRCA	Humber River	Main Humber	4,310,000	Undevelopable	0	0	0	0	0	0
				Developable	4,310,000	785	266	494	39	(14)
				Deficit/Surplus vs Existing		**0**	**(254)**	**344**	**(66)**	**(24)**
		West Humber	53,390,000	Undevelopable	5,271,577	78	52	13	12	0
				Developable	48,118,423	712	240	445	35	(8)
				Deficit/Surplus vs Existing		**0**	**(238)**	**324**	**(73)**	**(13)**
	Etobicoke Creek	Spring Creek	70,000	Undevelopable	0	0	0	0	0	0
				Developable	70,000	790	266	494	39	(9)
				Deficit/Surplus vs Existing		**0**	**(254)**	**339**	**(66)**	**(19)**
		Upper Etobicoke	20,250,000	Undevelopable	1,882,296	74	48	13	13	0
				Developable	18,367,704	726	241	448	35	1
				Deficit/Surplus vs Existing		**0**	**(230)**	**321**	**(87)**	**(4)**
Average Subwatershed Deficit/Surplus vs Existing Condition						**-**	**(253)**	**335**	**(76)**	**(6)**

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

Table 2.3.1.18b Future Conditions Water Balance for a Medium Density Residential Development on Till in the Focus Study Area (m^3/day)

Authority	Watershed	Subwatershed	Total Area in FSA (m^2)	Undevelopable / Developable Area in FSA (m^2)		P	ET	RO	R	ΔS
						(m^3/day)				
CVC	Credit River	Credit River - Glen Williams to Norval	230,000	Undevelopable	0	0	0	0	0	0
				Developable	230,000	510	168	311	25	6
				Deficit/Surplus vs Existing		**0**	**(176)**	**223**	**(51)**	**3**
		Fletcher's Creek	1,910,000	Undevelopable	0	0	0	0	0	0
				Developable	1,910,000	4,239	1,392	2,585	204	47
				Deficit/Surplus vs Existing		**0**	**(1,408)**	**1,800**	**(424)**	**21**
		Huttonville Creek	430,000	Undevelopable	0	0	0	0	0	0
				Developable	430,000	954	313	582	46	11
				Deficit/Surplus vs Existing		**0**	**(293)**	**376**	**(90)**	**5**
TRCA	Humber River	Main Humber	4,310,000	Undevelopable	0	0	0	0	0	0
				Developable	4,310,000	9,269	3,141	5,833	461	106
				Deficit/Surplus vs Existing		**0**	**(2,999)**	**4,062**	**(779)**	**(12)**
		West Humber	53,390,000	Undevelopable	5,271,577	11,410	7,655	1,950	1,733	72
				Developable	48,118,423	104,147	35,067	65,125	5,141	1,186
				Deficit/Surplus vs Existing		**0**	**(34,803)**	**47,327**	**(10,678)**	**527**
	Etobicoke Creek	Spring Creek	70,000	Undevelopable	0	0	0	0	0	0
				Developable	70,000	152	51	95	7	2
				Deficit/Surplus vs Existing		**0**	**(49)**	**65**	**(13)**	**(0)**
		Upper Etobicoke	20,250,000	Undevelopable	1,882,296	4,126	2,682	722	696	26
				Developable	18,367,704	40,258	13,386	24,859	1,963	453
				Deficit/Surplus vs Existing		**0**	**(12,782)**	**17,814**	**(4,831)**	**201**
Average Subwatershed Deficit/Surplus vs Existing Condition						**-**	**(7,501)**	**10,238**	**(2,409)**	**(327)**

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

In addition to the change in the water balance described in the foregoing, a more qualitative impact assessment is presented given the relatively consistent nature of surficial geology and subsequent potential recharge across the undeveloped lands within the FSA (ref. Drawings GW-4, GW-9, Appendix G) and the current application of a general land use across the FSA. The prevalence of the fine grained surficial till is expected to generally limit the groundwater connection to surface water features with exceptions, as discussed in detail in 'Scoped Subwatershed Study Part A – Existing Conditions and Characterization (Draft)' (Wood, October 2020) and summarized in Section 2.1.1.2 of this report, in particular where the till unit is thinner (Drawing GW-5a, Appendix G) and groundwater from the upper aquifer has the potential to discharge to surface, and local groundwater flow through the shallow fractured till may contribute to surface water features. It is generally expected that the overall unmitigated reduction in recharge to the underlying aquifers within the FSA may be a relatively smaller portion of regional recharge contributing to those aquifers.

As previously noted, various types of subsurface infrastructure and the related construction have the potential to impact the groundwater flow system by reducing water levels, intercepting groundwater flow and subsequently affecting groundwater discharge or groundwater recharge to deeper systems.

These impacts can occur as a result of the following:

- Short term dewatering during construction and potential longer-term dewatering where infrastructure is constructed below the water table.
- Foundations constructed below the water table which require sump pumps or Foundation Drain Collector (FDC) systems to reduce groundwater levels.
- Interception of groundwater and subsequent flow along potential permeable pathways associated with permeable backfill within servicing and utility trenches.

The extent of the infrastructure (i.e. spatial size and depth) and location within the groundwater flow system, will determine the extent of the potential impact and the extent and type of groundwater management technique. The potential groundwater impacts described above would be greater and more prevalent in soils that have a greater hydraulic conductivity. This would occur in the more permeable sand or silty sand units at surface, and within deeper discrete sand lenses and within the Oak Ridges Moraine upper aquifer or fractured bedrock, where the infrastructure goes to that depth.

The existence of a shallow groundwater table and the potential for strong upward gradients, reflected in flowing wells (Drawing GW-8a, Appendix G), if intercepted, can lead to geotechnical issues, extensive dewatering and related decrease in groundwater levels which may impact existing wells and potential groundwater discharge.

Dewatering activities may intercept the shallow groundwater flow that would normally flow into the local watercourses or wetlands. To minimize any disruption to the flow conditions or water levels within the affected surface water features, the intercepted groundwater flows should be returned to the feature. In the case of wetlands, the groundwater pumped during construction may actually exceed the natural groundwater discharge and care should be taken not to disrupt the temporal hydroperiod. Dewatering activities must take into account the seasonal reliance on groundwater for ecological needs. The volumes of groundwater pumped during construction, spatial area being affected (i.e. extent water level drawdown), proximity to the ecological feature and the timing should be considered within the overall construction planning.

Utilizing a dedicated (third pipe) system [i.e. Foundation Drain Collector (FDC) systems] provides an option to direct higher quality water, particularly to address temperature impacts, to surface water features. The design of these systems relates to outlet location and potential volumes of water, may possibly be optimized to provide the maximum benefit to baseflow and various wetlands.

Similar to dewatering activities, the proximity of a subsurface structure adjacent to groundwater discharge areas in surface water courses or wetlands may redirect groundwater flow within the shallow system, around the actual discharge point. The ecological significance related to the specific locations for groundwater discharge can be very important when considering the redirection of groundwater flow. Infrastructure design or mitigative techniques should allow for groundwater flow to the natural area where it is functionally significant (i.e. direct fish habitat or support of localized hydroperiod).

Although the redirection of groundwater flow along the permeable backfill of utility trenches may eventually discharge to local surface water bodies, the overall impact may not be beneficial. As such, the redirection of groundwater flow may be managed with anti-seepage collars or clay plugs.

Agricultural tile drains are used to reduce high water tables. The removal of these agricultural drainage tiles is expected to increase water table levels and as such, higher water levels may have to be addressed where infrastructure is constructed below the water table or where siting storm water management facilities.

The potential impacts to groundwater quality within the underlying aquifers are reduced as a result of the nature of the surficial till unit. Where the till is thinner there is an increased potential for impact but the till is greater than 3 m throughout the majority of the FSA (ref. Drawing GW5a, Appendix G). Existing domestic wells within the development area can provide a direct conduit from ground surface to the open portion of the well for contaminants to enter the groundwater flow system. Additionally, monitoring wells can provide the same short-circuiting pathway if they are not maintained. Water quality management for storm water is discussed in Section 2.4.2. The Region of Peel and Town of Caledon have referred to Salt Management Plans on their respective websites and these plans are expected to provide additional guidance aimed at minimizing potential loadings (NOTE: Specific plans need to be confirmed). In addition, the following should be considered to minimize potential water quality impacts:

- Hydrogeological sensitivity for locating underground storage tanks (i.e. surficial sand unit, proximity to water course or wetland). Require associated groundwater monitoring for storage tanks.
- Spills management plans.
- Minimize application of fertilizer, pesticides and herbicides.
- Maintain a contaminant threats inventory.

To prevent potential contaminants from entering the groundwater flow system through abandoned private domestic wells or unused monitoring wells, it will be necessary that they be properly decommissioned as per MOECC Ontario Regulation 903.

Based on the discussion above, the following outlines the subwatershed specific potential for groundwater impacts within the FSA. Where the impacts relate more to a reduction in recharge the related deficit can be addressed through stormwater management and the implementation of Low Impact Development (LID) infiltration-based Best Management Practices (BMPs). This is discussed in detail in Sections 2.3.1.1 and 2.4.2. In addition, the importation of lake-based water, applications and leakage of domestic water will offset in part the potential recharge reduction related to impervious surfaces.

The extent of the potential groundwater impacts to the various receptors (eg, aquifers, streams and wetlands) within the subwatersheds are based on the following:

- The permeable nature of the surfical sediments (Drawing GW-4),
- The thickness of the Halton Till (Drawing GW-5a),
- Areas of shallow ground water and areas of flowing wells (Drawing GW-8a),
- Areas of groundwater discharge and seeps and springs (Drawing GW-10),
- ESGRAs and SGRAs (Drawing GW-9) and
- HVAs (Drawing GW-12).

Main Humber Subwatershed

Thickness of surficial till of less than 3 m is more predominant adjacent to the FSA along various reaches correlating with the groundwater discharge and only one minor reach within the FSA.

There is one minor HVA and a number of ESGRAs.

West Humber Subwatershed

Thickness of surficial till is less than 3 m along various reaches correlating with the groundwater discharge mainly south of Healey Road. Groundwater discharge and seeps and springs occur along most of the higher order reaches. The sources of the discharge are more likely regional but local recharge should be considered for mitigation in the absence of more detailed studies.

A shallow water table exists within the central and north-eastern portion and flowing well conditions are predominant in these same areas north of Healey Road closer to King street. These areas give rise to the potential for extensive dewatering and associated impacts on the local flow system and potential groundwater discharge. These areas may also restrict the implementation of various stormwater practices.

There are two minor SGRAs related to the surficial sand and gravel. ESGRAs are more predominant in the eastern portion and HVAs in the central portion.

Upper Etobicoke Creek Subwatershed

Thickness of surficial till is less than 3 m in the southwestern portion north of Mayfield Road correlating with the groundwater discharge. Additional groundwater discharge and seeps and springs occur throughout this portion of the FSA but mainly to the west of Mclaughlin Road. Discharge and seeps and springs occur along most of the higher order reaches. The sources of the discharge are more likely regional but local recharge should be considered for mitigation in the absence of more detailed studies.

A shallow water table exists mainly within the western portion and along with instances of flowing well conditions. These areas give rise to the potential for extensive dewatering and associated impacts on the local flow system and potential groundwater discharge. These areas may also restrict the implementation of various stormwater practices.

There is a minor SGRA related to the surficial sand and gravel on the eastern boundary. ESGRAs are more common throughout and HVAs are more predominant in the western portion.

Fletcher's Creek Subwatershed

A shallow water table exists within the eastern limit of the FSA within the Fletcher's Creek Subwatershed. This area can give rise to the potential for extensive dewatering and associated impacts on the local flow system and potential groundwater discharge. These areas may also restrict the implementation of various stormwater practices.

An HVA is noted in the eastern portion of the FSA within this subwatershed.

Huttonville Creek Subwatershed, Main Credit Glen Williams to Norval SubwatershedThickness of surficial till is less than 3 m and a flowing well exist at the surface water divide increasing the potential for greater dewatering quantities.

2.3.2 Water Quality

Urbanization of the FSA would be anticipated to impact the quality of surface water primarily through increased concentrations and mass loadings of heavy metals and certain phosphorus containing chemicals associated with urban land forms. Stormwater quality controls will therefore be required, in order to mitigate these impacts. In addition, three of the main watercourses in the West Humber Subwatershed support Redside Dace habitat, hence are required to address enhanced stormwater quality requirements per Ministry of Natural Resources and Forestry.

In addition, given the small size of the FSA within the Huttonville Creek Subwatershed and the portion of the FSA discharging toward the Credit River Main Branch, the development area discharging toward the stormwater management facilities may in some instances be too small to sustain wet-of-pipe facilities, thus requiring source controls for stormwater quality, quantity, and erosion control.

2.3.3 Geotechnical and Slope Stability

As discussed in Section 2.1.1, watercourse valley slopes within the FSA and select watercourse valley slopes which may impact lands within the FSA were assessed via desktop study for instability risk. The methodology from the "Technical Guide – River and Stream Systems: Erosion Hazard Limit", prepared by the Ontario Ministry of Natural Resources (2002) was used.

During the permitting process with the appropriate conservation authority, a number of slope setbacks are applied to determine the erosion hazard limit for slopes and in turn the limits of development. For slopes, the erosion hazard limit is comprised of:

'erosion hazard limit' = 'toe erosion allowance' + 'allowance for stable slope' + 'erosion access allowance'

Toe Erosion Allowance

If the watercourse is >15 m from the toe of the slope a toe erosion allowance is not required. If the watercourse is <15 m from the toe of the slope a toe erosion allowance is required. The toe erosion allowance can be estimated using the soil type, field observations, and bankfull width, or determined by a fluvial geomorphologist.

Allowance for Stable Slope

The allowance for stable slope is the focus of the geotechnical components and relies on using the slope geometry, soil properties, and groundwater table to determine location of the stable top of slope.

Erosion Access Allowance

The erosion access allowance is set by the relevant permitting authority. In the case of this FSA, both the CVC and TRCA use an erosion access allowance of 10 m. 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.

Where the watercourse is defined as an unconfined system, the erosion hazard limit is comprised of an allowance for a flooding hazard limit or meander belt allowance plus and erosion access allowance, however, has no slope stability component.

In the Part A Characterization, the watercourse valley slopes were defined as either 'low', 'slight', or 'moderate' in terms of risk of instability. Refer to Appendix D for a figure showing an overview of the full FSA ratings, and Appendix G for more detailed figures. All ratings were based on a desktop study only and that rating would need to be confirmed with a visual assessment during subsequent development planning approval stages. Current guidance is offered as follows:

Risks for 'Low' Instability Potential Slopes

It is likely the physical top of slope is the stable top of slope. No additional setback beyond the toe erosion allowance (if any) and the erosion access allowance would be required.

Risks for 'Slight' Instability Potential Slopes

The physical top of slope may not be the stable top of slope. Any additional surcharges or works near the crest of the slope should be assessed. For development, the stable top of slope should be within the slope height distance from the physical top of slope. Toe erosion allowance (if any) and the erosion access allowance would be in addition.

Risks for 'Moderate' Instability Potential Slopes

The physical top of slope is likely not the stable top of slope. Any additional surcharges or works near the crest of the slope should be assessed. For development, the stable top of slope may be more than the slope height distance from the physical top of slope. Toe erosion allowance (if any) and the erosion access allowance would be in addition to other setback allowances.

If there is insufficient space to allow for the additional setback required for a stable top of slope (such as bridge crossings or other infrastructure), there are options available to stabilize the slope such as:

- Installing retaining walls at the toe of the slope several options are available:
    - Gabion baskets
    - Armour stone
    - Concrete gravity wall
- Rebuild and reinforce the slope with geotextile and/or geogrid
- Reinforce the slope with soil anchors

Credit River Watershed
No permanent watercourses or accessible slopes were noted in the FSA. No slope stability concerns are anticipated**Etobicoke Creek Watershed**

All watercourse slopes were identified as 'low' risk of instability, and therefore the physical top of slope is likely the stable top of slope with the exception of the following which were identified as 'slight' risk:

- 1500 m long section from 100 m west of McLaughlin Road to Hurontario Street, ~1700 m north of Mayfield Road
- 100 m long section location ~700 m north of Old School Road and ~700 m east of Hurontario Street.

Humber River Watershed – West Humber Subwatershed

All watercourse slopes were identified as 'low' or 'slight' risk of instability except for the following which was identified as 'moderate' risk:

- a slope failure noted immediately east of The Gore Road ~1.1km south of King Street

For the 'low' risk areas, the physical top of slope is likely the stable top of slope. The 'slight' risk areas may require and additional setback from the physical top of slope of up to the slope height to obtain the stable top of slope. As a slope failure was visible in the moderate risk, further deterioration of the slope would be expected and the stable top of slope is likely greater than the slope height in distance from the physical top of slope.

Humber River Watershed – Main Humber Subwatershed

All watercourse slopes were identified as 'low' or 'slight' risk of instability except for the following which was identified as 'moderate' risk:

- an area ~700 m east of the intersection between Emil Kolb Parkway and King Street (Main Humber River subwatershed)

For the 'low' risk areas, the physical top of slope is likely the stable top of slope. The 'slight' risk areas may require and additional setback from the physical top of slope of up to the slope height to obtain the stable top of slope. As a slope failure was visible in the moderate risk, further deterioration of the slope would be expected and the stable top of slope is likely greater than the slope height in distance from the physical top of slope.

2.3.4 Stream Morphology, Erosion Hazards and Assessment

2.3.4.1 Stream Morphology Impact Assessment

The Stream Morphology Impact Assessment focuses on the potential impacts to form and process of watercourses and HDFs based on the proposed changes to impervious cover. A detailed SABE-based land use plan has not been developed for the FSA as of the time of writing. Thus, the impact assessment for watercourses has been completed based on the understanding that the FSA will have a future average impervious area of 51%, in lieu of a detailed land use plan, at this time.

The primary impacts to watercourses from urbanization are changes to the hydrologic regime, as a result of increased impervious cover. Increased surface runoff is typically mitigated through integrated stormwater management. Other impacts include changes to the sediment regime (decreased input) with increased impervious cover, and feature realignment, relocation, or removal (watercourses and HDFs). The following summarizes impacts to geomorphic character and function, and mitigation to maintain or enhance the functions that should be considered in the impact assessment:

i. Channel erosion is a necessary natural process; however anthropogenic pressures, such as uncontrolled stormwater runoff, may accelerate and exacerbate natural erosional processes, resulting in loss of property, threats to infrastructure and environmental degradation [e.g. smothering of fish nests (redds) through excessive deposition].
Erosion thresholds can be applied to provide insight regarding the capacity of each watercourse system to accommodate an altered land use or flow regime. Application of appropriate thresholds as stormwater best management practice targets should limit rates of erosion to pre-development conditions. This extends to areas downstream of the Focused Study Area (FSA). To be completed in future studies. Within the current study, better understanding towards areas more sensitive to erosion may be determined upon refinements to the landuse plan and delineation of the SABE. At present, the number of erosion sites, where observed in each subwatershed, may increase in number without SWM.

ii. Land use changes such as the removal of headwater drainage features or vegetation and increases in imperviousness, will increase flow discharges and diminish the development of resisting forces.
Maintaining appropriate hydrologic and sediment regimes will be necessary to preserve the function of the headwater channels and their role in maintaining stream health in downstream areas. The main branches of watercourses within the study area are largely protected by the Preliminary NHS, Provincial NHS, Conservation Authority NHS (natural features only) and the Peel Greenland's System Core; it will be necessary to ensure that tributaries and headwater drainage features are appropriately managed to maintain or enhance the natural functions within the overall system. At present, HDFs have only been identified at a high-level and field confirmation is required through the application of the TRCA/CVC (2014) guidelines for evaluating headwater features in future studies.

iii. Maintenance of existing riparian vegetation within the stream corridor acts to stabilize the banks, reduce flow velocities and also provides inputs of organic material and debris to streams which aid in creating a diverse morphology and habitat.
Riparian corridor protection/enhancement through the development of the Natural Heritage System along streams is a key element of a management strategy to manage and provide enhancement of form and function within a subwatershed. The main branches of watercourses within the study area are largely protected by the Preliminary NHS, Provincial NHS, Conservation Authority NHS (natural features only) and the Peel Greenland's System Core.

iv. The delineation of natural hazard limits associated with river and valley systems allows for the lateral and downstream migration of 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 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. Incorporation of these corridors and setbacks into the NHS will ensure that channels may continue to provide habitat function, linkages, and floodplain storage. Several reaches within each subwatershed have portions of the erosion hazard corridor not currently enveloped by the NHS.

Erosion Hazard Corridors

The method for delineating hazard corridors within the study area differed between confined and unconfined reaches. A stable top of slope setback was defined for confined reaches whereby the valley toe was estimated from site topography, and a stable 3:1 slope setback was determined based on the average elevation difference from the floodplain to the table land. The PPS requires that a toe erosion setback be applied where a watercourse is within 15m of the valley toe (MNR, 2002) in addition to the stable slope allowance. To be conservative, this study 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 8m where there is evidence of active erosion. This was informed by previous work completed as part of the geotechnical assessment for Mayfield West (AMEC, 2014). For unconfined reaches, meander belts were defined based on the central tendency of the channel planform, an additional 20% was applied to the total meander belt width as a factor of safety in-lieu of determining the 100-year erosion rate. An additional erosion access allowance of 6m per side has also been applied to the erosion hazard delineation as per the PPS for both confined and unconfined reaches.

These erosion hazard corridors are intended to contain all of the natural meander and migration tendencies, and slope stability of a channel/valley based on historic alignment and potential future alignment. This permits geomorphic adjustment to occur without risking damage to surrounding infrastructure and property. Implementation and respect for the hazard corridor can reduce and control negative impacts to watercourse systems which may occur as a result of urbanization. A secondary benefit of the hazard corridor width is to protect surrounding riparian vegetation and other ecological habitats and functions. Development within a hazard corridor is strictly limited to specific low impact and localized uses, such as trail or road crossings, and therefore disturbance to the riparian habitat is minimized. Maintaining riparian vegetation ensures resiliency of the fluvial system as proper vegetative support reduces bank erosion and widening. Hazard mapping provided in the Phase 2 Part A report is available in Appendix G. Refinements to erosion hazard mapping are expected as more detailed fieldwork may be completed through future studies.

An additional consideration is the Redside Dace (RSD) habitat classification of reaches within the study area. Under Ontario Regulation 242/08 of the Endangered Species Act (2007), for Redside Dace occupied reaches, Redside Dace habitat includes the stream, its meander belt, and 30 m wide riparian zone on each side of the meander belt. The erosion hazard mapping presented in Appendix G represents erosion hazard setbacks, however, in future stages of integration, the 30 m setback should be applied to the preliminary meander belt limits and incorporated into the NHS for Redside Dace occupied reaches.

Table 2.3.4.1 lists the reaches in each subwatershed with erosion hazard corridors that lie partially or entirely outside of all NHS limits, including the Preliminary NHS, Provincial NHS, Conservation Authority NHS (Natural areas) or Peel's Core Greenlands. Table 2.3.4.2 presents the area of erosion hazard corridors within and outside of NHS limits for each subwatershed.

The Fletcher's Creek Subwatershed has the highest proportion of erosion hazard area outside of any NHS limits. This is largely since the FSA encompasses only a small number of watercourse reaches, and these are unconfined headwater tributaries that are located in an agricultural setting with limited riparian cover. Similarly, many reaches of the Main Humber subwatershed within the FSA are HDFs or headwater tributaries and a moderate proportion of their erosion hazards are not encompassed by the NHS. Within the Etobicoke Creek and West Humber Subwatersheds, reaches that are entirely or partially outside of the NHS are generally tributaries rather than main stem reaches. On main stem reaches, typically only small portions of the erosion hazard limit lie outside of the NHS. One exception to this trend is the western branch of Etobicoke Creek, that has hazard lands that lie mainly outside of the NHS.

Table 2.3.4.1: Hazard Corridors and/or Regulatory Limits not Enveloped by NHS Features (Preliminary NHS, Provincial NHS, Conservation Authority NHS or Peel Greenland's System Core)

Subwatershed	Reach ID
Etobicoke Creek	MEC-R7*, MEC-R7(1)*, MEC-R7(2)*, MEC-R6, MEC-R6(1), MEC-R6(2), MEC-R5*, MEC-R5(2)*, MEC-R4(7)*, MEC-R4(8a)*, MEC-R4(3)*, MEC-R3(1)*, **MEC-R2(2)*, MEC-R2(3)*, MEC-R2(4-3)*, MEC-R2(4-4)*, MEC-R2(4-4a)*,** MEC-R2(4-4b)*, **MEC-R2(3-1)*,** MEC-R2(3-2)1b*, MEC-R2(3-2)1a*, MEC-R2(3-2)3, MEC-R2(3-5)*, MEC-R2(3-6)*, MEC-R2(3-6a)*
Fletcher's Creek	FC(4)*, FC(3), FC(1)
Main Humber River	HRT(2)2-1, TCC(1)*, TCC(2), TCC(11)*, TCC(13)
West Humber River	**CCC(3)*, CCC(5)*, CCC(6)*, SC(2)*,** SC(2)1-1*, **SC(3)*,** SC(3)2-1*, SC(3)2-2, **SC(4)*,** SC(4)1-1, SC(4)2-1, SC(4)2-2, SC(5)*, SC(5)1-1*, WHT1(3)*, WHT1(4)*, WHT1(5)*, WHT1(6)*, WHT1(6)1-1*, WHT1(6)3-1, WHT1(6)4-1, WHT2(1)2-1, WHT2(1)1-1*, WHT2(2)1-1a*, WHT2(5)7-1*, **WHT2(6)*,** WHT2(7)1-1c*, WHT2(1)1-1*, WHT2(7)*, WHT3(2)*, WHT3(3), WHT3(3)2-1, WHT3(3)3-1, WHT3(4), WHT3(5)2-1a, **WHT3(8)*,** WHT3(7)*, WHT3(7)1-1*, WHT(A)*, WHT4(1)2-1*, WHT4(1)3-1*, WHT4(1)6-1*, WHT4(2-1)*, WHT4(3)3-1a*, WHT4(3)6-1*, WHT4(3)7-1*, WHT4(3)8-1*

*Partially enveloped
Bold: Only the 6m erosion allowance is outside the NHS

Table 2.3.4.2: Erosion Hazard Area (ha) outside and inside of NHS Features (Preliminary NHS, Provincial NHS, Conservation Authority NHS or Peel Greenland's System Core)

Subwatershed	Erosion Hazard Area Outside NHS (all) (ha)	Erosion Hazard Area Inside NHS (all) (ha)	% Erosion Hazard Area Outside of NHS (all)
Etobicoke Creek	45.94	299.19	13%
Fletcher's Creek	5.62	0.75	88%
Main Humber River	4.12	10.64	28%
West Humber River	170.08	754.18	18%
TOTAL	**225.75**	**1064.83**	**17%**

Stream Length and Realignment

As the hazard corridor assessment indicates, many area watercourses which flow through these corridors are partially or wholly protected by the current NHS plan. Changes in land use may result in the need for realignments or relocation of existing watercourses and conservation HDFs, and/or the removal of limited function headwater drainage features (HDFs) to increase/optimize the developable area. This is particularly common in areas with several low-order streams which could be combined to reduce fragmentation of the land parcels, and which may enhance the existing natural heritage system. These types of changes are more common in areas which are already partially or fully developed, and land use changes are less significant. Realignment of watercourses in most cases is not supported, but it may be acceptable if the existing channel is degraded or has already been heavily modified as part of the existing land use, or if it can be demonstrated to enhance the NHS. In cases of degradation or channelization, the channel presents a restoration opportunity and realignment would be supported, subject to additional study. Should realignments be proposed, stream lengths should be maintained, however, slight reductions in sinuosity may be permitted, provided it can be justified, based on an overall net gain. Any realignment is subject to local constraints and additional elements proposed during the detailed design phase. Significant loss of stream length reduces aquatic habitat and reduces the fluvial system's ability to effectively convey water and sediment that maintains a state of quasi-equilibrium. Depending on the conditions, loss of stream length may increase channel slope increasing available potential energy which could lead to increased adverse erosion.

The existing dominant land uses in the FSA are agricultural, recreational (e.g. golf course), suburban areas, valleylands and transportation (e.g. Regional Roads). These land use types, with the exception of suburban areas, are relatively low-impact compared to an urbanized landscape. Further field assessment would be required to determine on site if any watercourses within the study area are severely degraded. However, the Phase 2 Part A assessment did find that many watercourse reaches had been modified (often straightened) and some have poor riparian corridors (ref Part A, Appendix E, Table 1. As the land use plan has not yet been developed, no watercourse removals or realignments have been proposed. However, there are several opportunities for rehabilitation to enhance/restore banks or short segments within protected stream reaches (refer to Section 2.4.2.2 for a discussion on surface water feature constraints and management). High constraint watercourses can undergo minor realignment or repair in order to facilitate infrastructure development, or to mitigate an immediate risk. Medium constraint streams may be identified for potential relocation; these are primarily unconfined reaches. NHS development may identify potential zones for relocation that reduce fragmentation of the NHS. High-constraint streams (refer to Section 2.4.2.2) within well-defined, confined and semi-confined settings should be protected as they currently exist to ensure natural function is maintained. General riparian enhancements, farm crossing removals (fords and culverts), and in-channel habitat features (e.g. wood debris) are encouraged and would enhance the form and function of area streams, and those receiving reaches downstream.

Headwater Drainage Features

HDFs have been identified through desktop assessment and the windshield assessment. In future studies, HDFs should be evaluated following the TRCA / CVC (2014) protocol through which they may be assigned management recommendations. As per the TRCA / CVC (2014) protocol, management recommendations for HDFs range from 'no management' to 'protection'. Section 2.3.4.4 discusses each type of management recommendation. In future studies when the HDF assessments are completed, it is recommended that the initial management recommendations as per the TRCA/CVC protocols be reviewed in consultation with Technical Advisory Committee (of the respective study) to develop a consensus regarding how to determine if the HDF management recommendations are appropriate, or if there are site-specific modifiers that should alter the management recommendation from that of the TRCA/CVC guidelines (final management recommendation). The HDF protocol and final consensus on the management recommendation determines the strategy and opportunities for each feature and is important in terms of potential influence on complementary land uses.

Road Crossings and Alignments

Road crossings are an integral part of urbanization and an important consideration in terms of impacts to watercourses. Crossing locations associated with the FSA and SABE are not yet known, and therefore impacts cannot be assessed at this time. However, the following discussion presents considerations when siting and sizing crossings and road alignments.

A poorly sited road crossing can result in negative impacts to the channel and higher risk to the structure itself. There are a number of factors which should be considered when identifying the most appropriate location for a road crossing. For a large development area, it is important to minimize the number of times the proposed road network crosses the watercourse valley. This will reduce impacts to the watercourse as well as the surrounding natural heritage features. Road crossings should not be located within close succession to each other. Providing an adequate distance between crossings allows for an area of potential adjustment, if there are negative impacts to the watercourse as a result of the subject crossing structure. This minimizes the risk of compromising any additional structures located downstream. Analysis of the configuration of proposed watercourse crossings should be completed when a Land Use Plan has been developed.

On a local, site-specific scale there are several risk factors which need to be considered for the individual crossings with respect to geomorphic function. These risk factors would be used to assess both crossing locations and determine appropriate structure spans and alignment; these may be considered recommendations and Section 2.3.4.4 may refer to them:

- **Channel Size**: The potential for lateral channel movement and erosion tends to increase with stream size. HDFs tend to exhibit low rates of lateral migration due to the stabilizing influence of vegetation on the channel bed and banks. Erosive forces in active watercourses tend to exceed the stabilizing properties of vegetation and result in higher migration rates.

- **Valley Setting**: Watercourses with wide, flat floodplains and low valley and channel slopes tend to migrate laterally across the floodplain over time. Watercourses that are confined in narrow, well drained valleys are less likely to erode laterally but are more susceptible to down-cutting and channel widening, particularly where there are changes in upstream land use. Typically, the classification of the valley will fall into one of three categories: confined, partially confined, and unconfined.

- **Meander Belt Width**: The meander belt width represents the maximum expression of the meander pattern within a channel reach. Therefore, this width/corridor covers the lateral area that the channel could potentially occupy over time. This value has been used by regulatory agencies for corridor delineation associated with natural hazards and the meander belt width is typically of a similar dimension to the Regulatory floodplain. The use of the meander belt width of structure sizing has been established as a criterion by some regulatory agencies and represents a very conservative approach.

- **Meander Amplitude**: The meander amplitude and wavelength are important parameters to ensure that channel processes and functions can be maintained within the crossing. For the purposes of this protocol, the meander amplitude of the watercourse would be measured in the vicinity of the crossing and used as a guide to determine the relative risk to the structure. The number of meander wavelengths to be considered is both dependent on the scale of the watercourse and the degree of valley confinement.

- **Rapid Geomorphic Assessment (RGA) Score:** An RGA score is essentially a measure of the stability of the channel. Channels that are unstable tend to be actively adjusting and thus are sensitive to the possible effects of the proposed crossing. Accordingly, there is more risk associated with unstable channels. The RGA score reveals three levels of stability: 0-0.20 is stable; 0.21-0.40 is moderately stable; >0.40 is unstable. This parameter may be incorporated into the assessment of road crossings when RGAs have been completed in future studies.

- **100-year Migration Rates:** Using historical aerial photographs, migration rates may be quantified (where possible) for each crossing location. A higher migration rate indicates a more unstable system and higher geomorphic risk. Ideally, watercourse crossing structures should be aligned perpendicular to and centered on a straight section of channel, or at an appropriate skew that would not affect channel processes. In terms of sizing, the structure would ideally span the meander belt width in order to accommodate the downstream migration of meander features. In many cases, however, the costs prohibit such structure sizes. From a geomorphic perspective, larger structures are favored to minimize the long-term risk and maintenance associated with natural channel adjustment.

Stormwater Management and Erosion

Channel erosion is a necessary natural process; however, anthropogenic pressures, such as uncontrolled stormwater runoff, may accelerate and exacerbate natural erosional processes, resulting in loss of property, threats to infrastructure and environmental degradation (e.g. smothering of fish nests (redds) through excessive deposition).

Erosion thresholds can be applied to provide insight regarding the capacity of each watercourse system to accommodate an altered land use or flow regime. Application of appropriate thresholds as stormwater best management practice targets should limit rates of erosion to pre-development conditions. This extends to areas downstream of the FSA. Erosion exceedance analysis is not within the current scope, but a high-level understanding of the impacts of impervious areas and unmanaged runoff on the receiving natural systems within and downstream of the FSA, has been completed.

Discussion of previously completed erosion thresholds assessments that was completed for the North West Brampton Urban Development Area Phase 1 – Subwatershed Characterization and Integration (2010) and the Mayfield West, Phase 2 Secondary Plan Comprehensive Environmental Impact Study and Management Plan (2014) is provided in Section 2.1.3. The following describes the outcome of these analyses:

Mayfield West:

- Critical discharge rates were determined at six sites (Refer to Figure 2.3.4.1.1). Five of these sites correspond to reaches within the current FSA (Refer to Table 2.1.3.1); these include MEC-R1, MEC-R2, MEC-R3, MEC-R4(2) and MEC-R2.
- Critical discharge rates ranged from 0.06 m^3/s (MEC-R2) to 2.15 m^3/s (MEC-R1). Critical velocities ranged from 0.41 m/s (MEC-R3) to 1.13m/s (MEC-R4(2)). Note reach names listed here are FSA reach names. Refer to Table 2.1.3.1 for corresponding Mayfield West study reach names.
- These critical discharge rates and velocities may be used as a general reference point to inform the future determination of SWM targets for development areas within the Upper Etobicoke Creek subwatershed in future studies. Additionally, detailed geomorphological studies should be completed to determine critical thresholds on sensitive and/or representative watercourses within and downstream of the FSA. Selection of appropriate sites for this work should be completed in consultation with the appropriate conservation authority.

North West Brampton:

- Critical discharge rates were determined at two sites located downstream of the current FSA (Refer to Figure 2.3.4.1.2).
- Site SW4 was located on Fletcher's Creek west of McLaughlin Road at Regional Road 10. At this site, critical discharge rates of 0.39 m^3/s and 0.91 m^3/s were determined for the channel banks and bed, respectively. The critical discharge rates corresponded to critical velocities of 0.55 m/s on the channel banks and 0.54 m/s on the bed. Site SW4 is downstream of the Fletcher's Creek reaches within the FSA.
- Site EM10 was located on Huttonville Creek east of Mississauga Road and south of Highway 7. The critical discharge rate and velocities at this site were 0.59 m^3/s and 0.65 m/s, respectively. Site EM10 is downstream of the FSA lands within the Huttonville Creek subwatershed.
- These critical discharge rates and velocities may be used as a general reference point to inform the future determination of SWM targets for development areas within the Fletcher's Creek and Huttonville Creek subwatersheds in future studies. Additionally, detailed geomorphological studies should be completed to determine critical thresholds on sensitive and/or representative watercourses within and downstream of the FSA. Selection of appropriate sites for this work should be completed in consultation with the appropriate conservation authority.

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

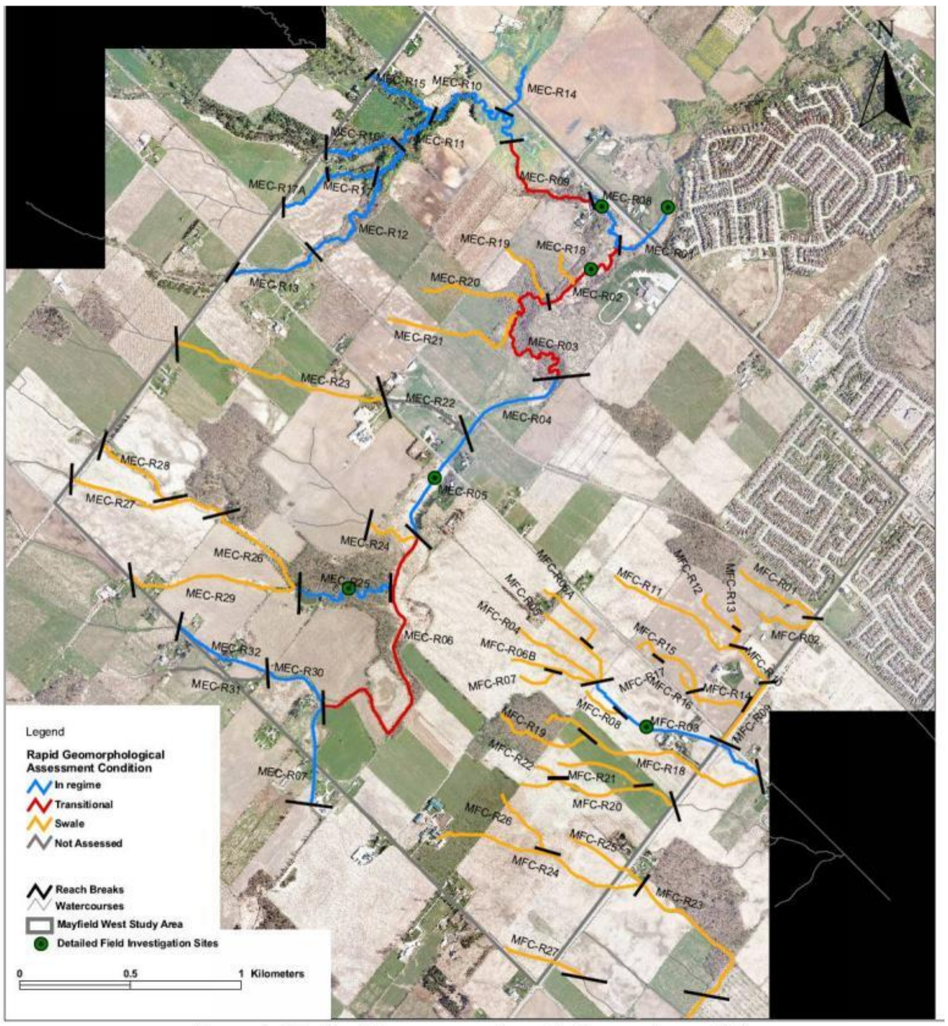


Figure 4.4.2: Rapid assessment results for reaches within the Mayfield West Study Area

Detailed Field Investigation

The results of the field assessment indicate that the landscape of the Mayfield West Phase 2 Study Area is dominated by two distinct geomorphic zones: the Etobicoke Creek valley lands and the headwaters of Etobicoke Creek and Fletchers Creek. The main branches of Etobicoke

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Figure 2.3.4.1.1 – Erosion Threshold Site Locations, Mayfield West Secondary Plan, 2014.

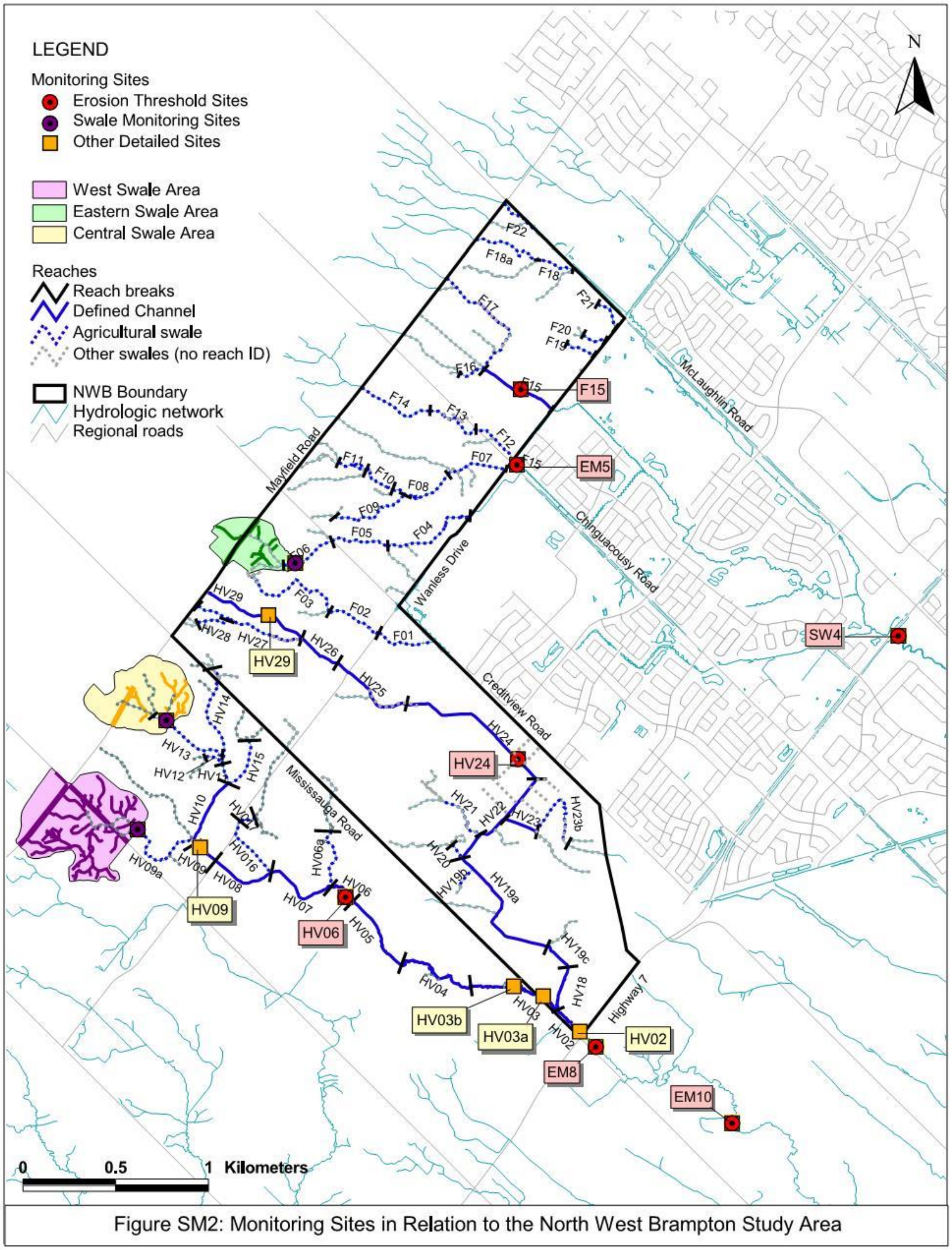

Figure 2.3.4.1.2 – Erosion Threshold Site Locations, **North West Brampton Urban Development Area, 2010.**

2.3.4.2 Etobicoke Creek Subwatershed

Figures 2.3.4.2.1 and 2.3.4.2.2 present the watercourse and HDF mapping and erosion hazard corridors outside of the NHS limits for the Etobicoke Creek subwatershed, respectively. HDF and management recommendations for the subwatershed will need to be determined in future studies. Additional field assessments will need to be completed in future studies to evaluate potential impacts at the reach scale.

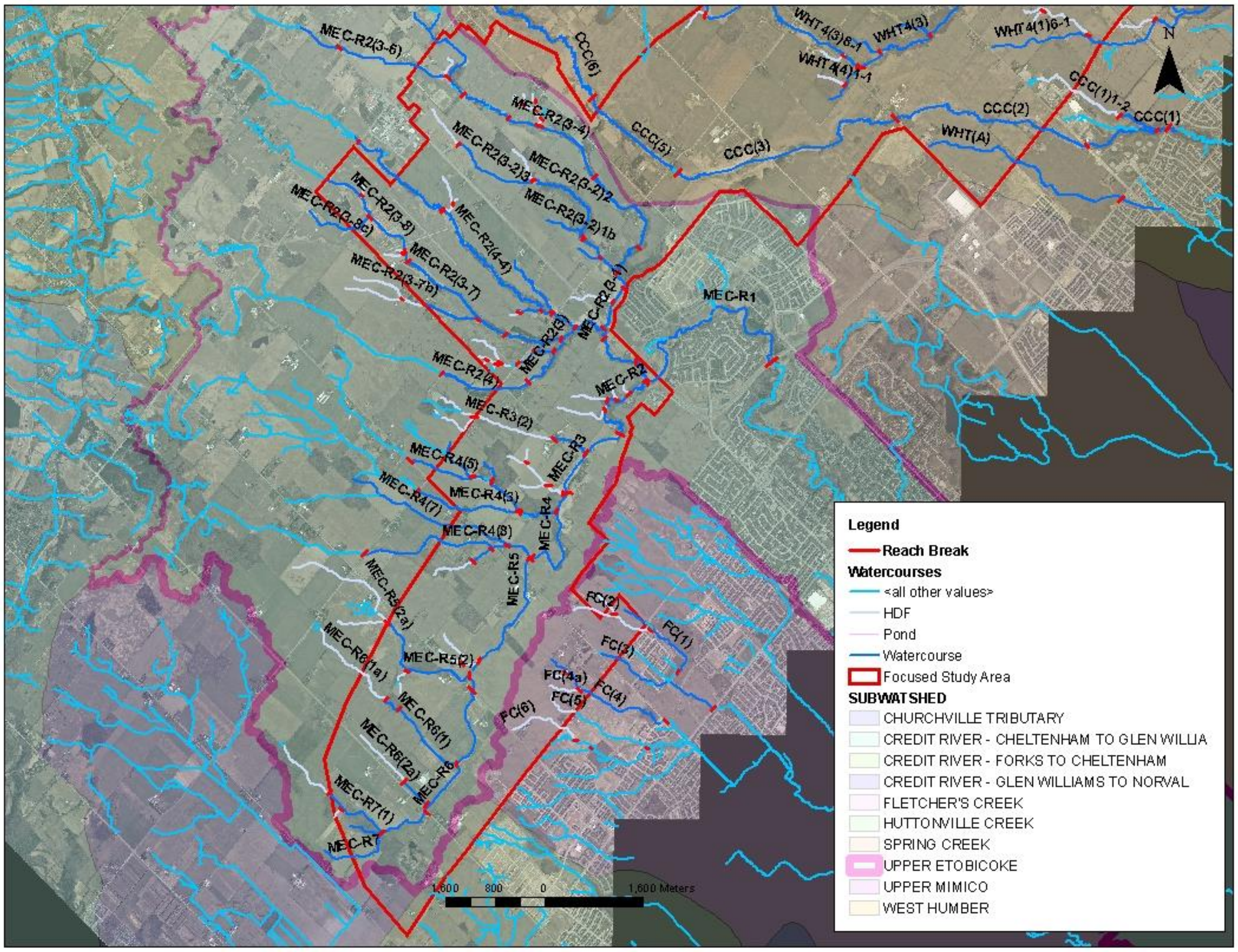

Figure 2.3.4.2.1 Watercourse and HDF Reaches, Etobicoke Creek Subwatershed

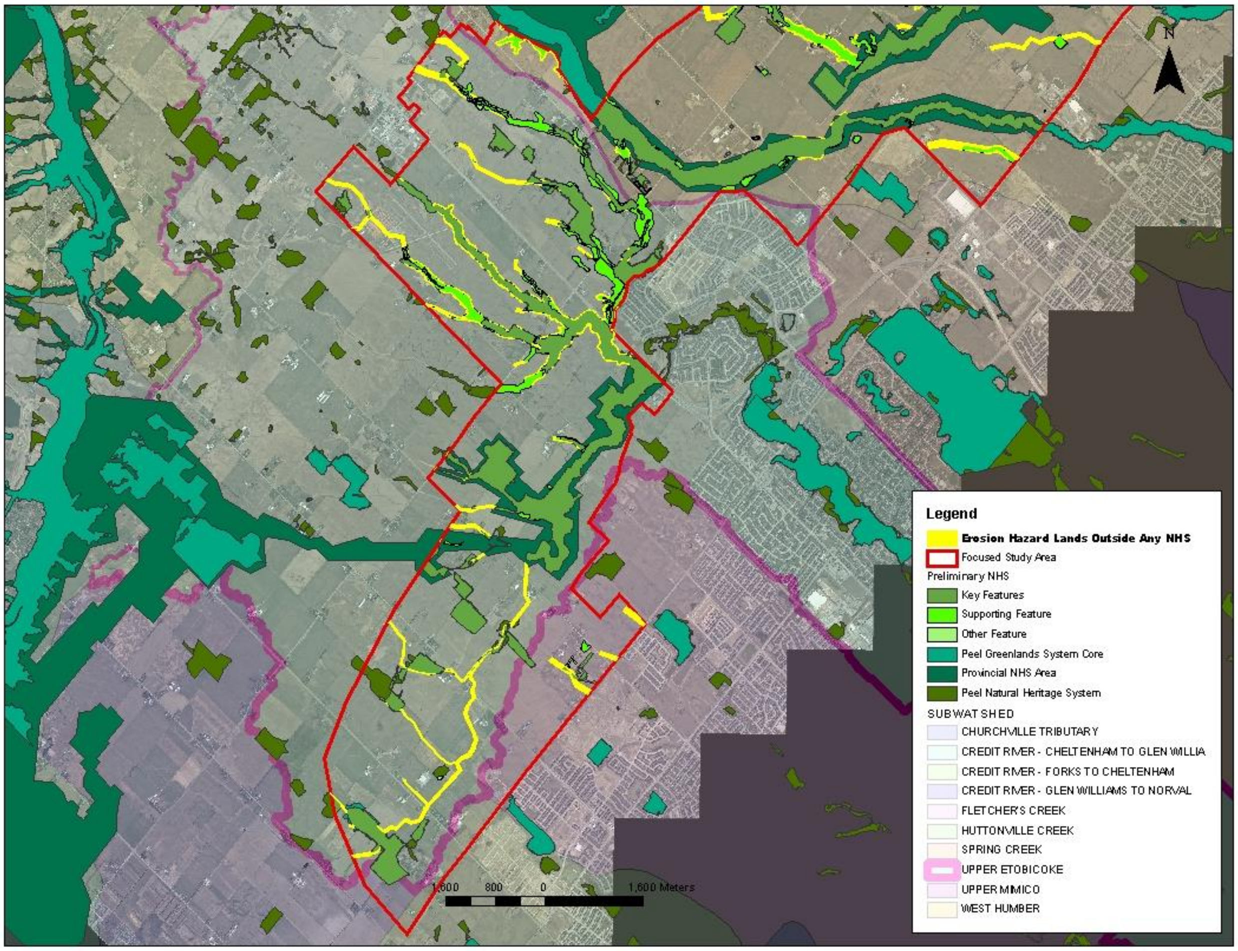

Figure 2.3.4.2.2 Erosion Hazard Limits Outside of NHS, Etobicoke Creek Subwatershed

Erosion Assessment

Map SM3 in Appendix G 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, SM3 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.

Four erosion sites were mapped within the portion of the Etobicoke Creek Subwatershed within the FSA. Field observations included bank erosion at a culvert, incision downstream of a culvert, bank erosion on one bank within a straightened reach, and severe erosion upstream of a bridge (Reach MEC-R3). The four erosion sites were dispersed across the western portion of the subwatershed.

Under the proposed scenario (51% average impervious land use), the number of erosion sites is likely to increase without management of stormwater runoff. SWM is required to prevent channel response to urbanization, which can include continued or increased rates of bank erosion, channel degradation, channel enlargement, and degraded water quality and stream habitat. Unmanaged erosion issues at culverts in particular can lead to the development of fish barriers in cases of channel incision.

Erosion Thresholds and SWM

Utilize previously determined erosion thresholds determined as part of the Mayfield West Secondary Plan (2014) to inform initial SWM planning at a general level. As plans develop, and SWM locations are proposed, erosion thresholds should be determined for sensitive and/or representative areas downstream of potential outfalls. These values should be compared to existing thresholds and those for sensitive locations to determine the most representative. Erosion threshold evaluation for SWM is to be evaluated through future studies.

Watercourse/HDF Management

Feature constraints and management recommendations will be completed through the integration of study disciplines. At this stage, further characterization and impact assessment can be made based on terrestrial or aquatic input for specific features (e.g. ponds, ELC mapping), and will be completed as land use plans are developed for the SABE. Field work to confirm/update watercourse and HDF mapping, and to complete the HDF assessment following TRCA/CVC (2014) guidelines are required through future studies to refine and finalize reach-specific constraints and management recommendations.

Erosion Hazard Delineation

A number of erosion hazards and associated setbacks are not enveloped by the Preliminary NHS, particularly along upper tributary reaches and along the western branch of Etobicoke Creek within the FSA, and should be incorporated into the system. For watercourses with rehabilitation or realignment opportunities, NHS development can potentially locate preferred zones for realignment that benefit the NHS and potential land use change. Management options contained within the Classification and Management Table (Table 2.3.4.4.1) should be applied. In future studies when the TRCA/CVC (2014) HDF guidelines are applied, attempts should be made to include protection and conservation HDF features within the NHS, as these features provide temporary habitat, sediment and flow contributions, and ecological linkage.

Mapping provided herein has only applied this setback to the erosion limit (i.e. meander belt or stable top of slope) and 6m erosion access allowance per the Provincial Policy Statement. Other setbacks per the respective conservation authority need to be applied to finalize the hazard delineation and refinement of the NHS.

2.3.4.3 Fletcher's Creek Subwatershed

Figures 2.3.4.3.1 and 2.3.4.3.2 present the watercourse and HDF mapping and erosion hazard corridors outside of the NHS limits for the Fletcher's Creek subwatershed, respectively. HDF and management recommendations for the subwatershed will be determined in future studies. Additional field assessments will need to be completed in future studies to evaluate potential impacts at the reach scale.

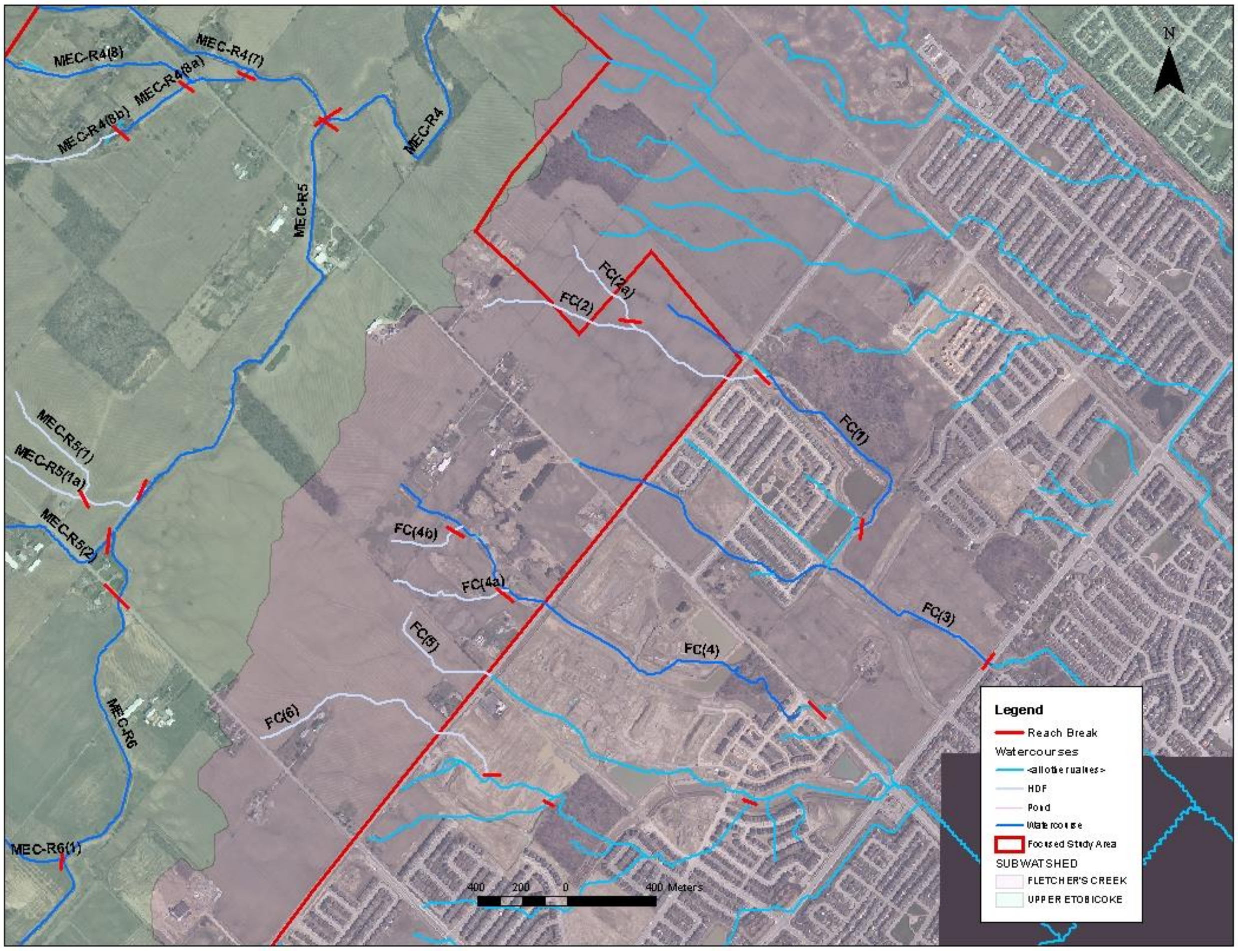

Figure 2.3.4.3.1 Watercourse and HDF Reaches, Fletcher's Creek Subwatershed

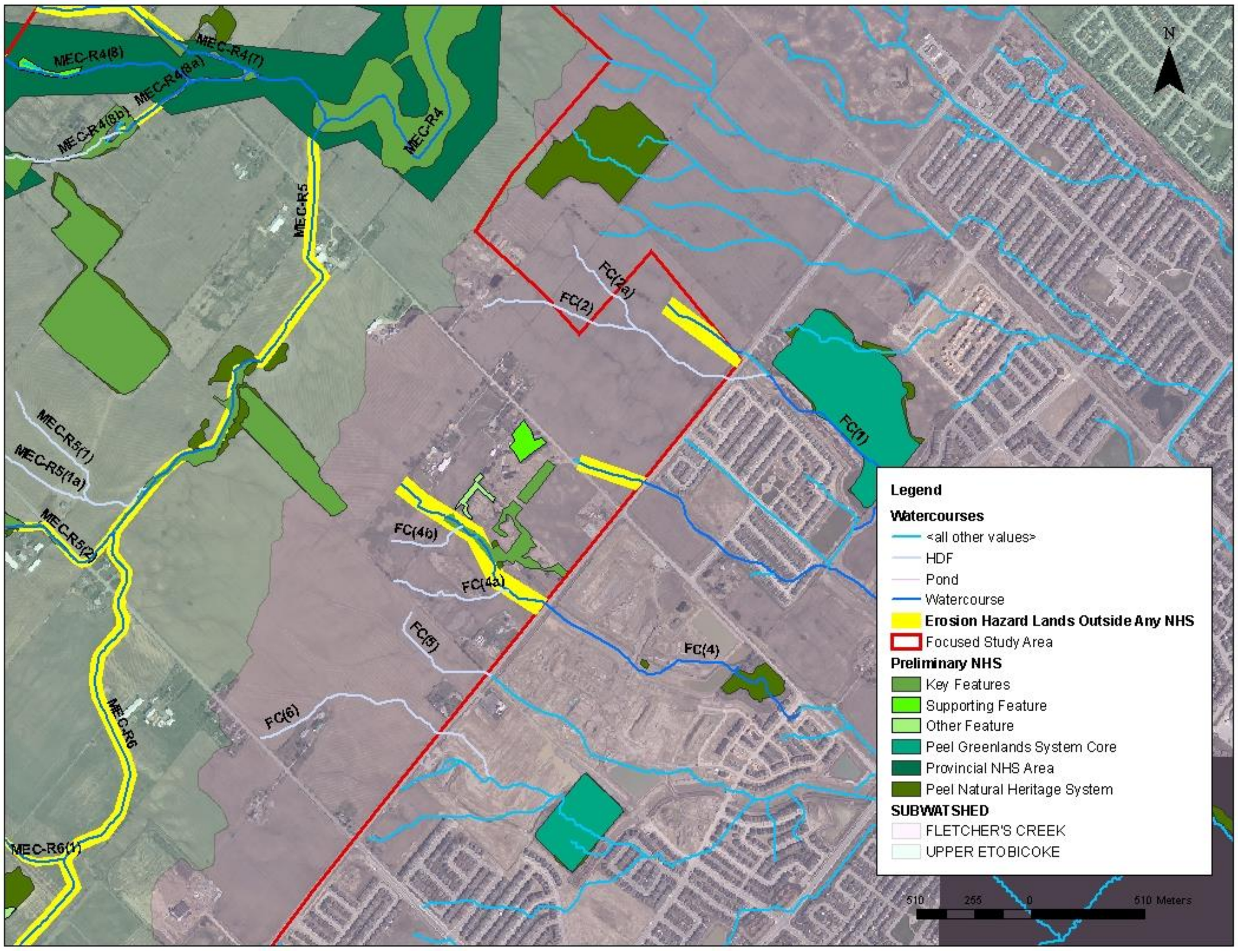

Figure 2.3.4.3.2 Erosion Hazard Limits Outside of NHS, Fletcher's Creek Subwatershed

Erosion Assessment

Map SM3 in Appendix G 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, SM3 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.

No erosion sites were mapped within the portion of the Fletcher's Creek subwatershed within the FSA. Nevertheless, under the proposed scenario (51% average impervious land use), erosion sites could increase without management of stormwater runoff. SWM is required to prevent channel response to urbanization, which can include continued or increased rates of bank erosion, channel degradation, channel enlargement, and degraded water quality and stream habitat. Unmanaged erosion issues at culverts in particular can lead to the development of fish barriers in cases of channel incision.

Erosion Thresholds and SWM

Utilize previously determined erosion thresholds for Site SW4 – Fletchers Creek (Northwest Brampton SWS, 2010) to inform initial SWM planning at a general level. As plans develop, and SWM locations are proposed, erosion thresholds should be determined for sensitive and/or representative areas downstream of potential outfalls. These values should be compared to existing thresholds and those for sensitive locations to determine the most representative. Erosion threshold evaluation for SWM is to be evaluated through future studies.

Watercourse/HDF Management

Feature constraints and management recommendations will be completed through the integration of study disciplines. At this stage, further characterization and impact assessment can be made based on terrestrial or aquatic input for specific features (e.g. ponds, ELC mapping), and will be completed as land use plans are developed for the SABE. Field work to confirm/update watercourse and HDF mapping, and to complete the HDF assessment following TRCA/CVC (2014) guidelines are required through future studies to refine and finalize reach-specific constraints and management recommendations.

Erosion Hazard Delineation

Several hazards and associated setbacks are not enveloped by the Preliminary NHS and should be incorporated into the system. For watercourses with rehabilitation or realignment opportunities, NHS development can potentially locate preferred zones for realignment that benefit the NHS and potential land use change. Management options contained within the Classification and Management Table (Table 2.3.4.4.1) should be applied. In future studies when the TRCA/CVC (2014) HDF guidelines are applied, attempts should be made to include protection and conservation HDF features within the NHS, as these features provide temporary habitat, sediment and flow contributions, and ecological linkage.

Mapping provided here has only applied this setback to the erosion limit (i.e. meander belt or stable top of slope) and 6m erosion access allowance per the Provincial Policy Statement. Other setbacks per the respective conservation authority need to be applied to finalize the hazard delineation and refinement of the NHS.

2.3.4.4 Main Humber River Subwatershed

Figures 2.3.4.4.1 and 2.3.4.4.2 present the watercourse and HDF mapping and erosion hazard corridors outside of the NHS limits for the Main Humber River subwatershed, respectively. HDF and management recommendations for the subwatershed will be determined in future studies. Additional field assessments will need to be completed in future studies to evaluate potential impacts at the reach scale.

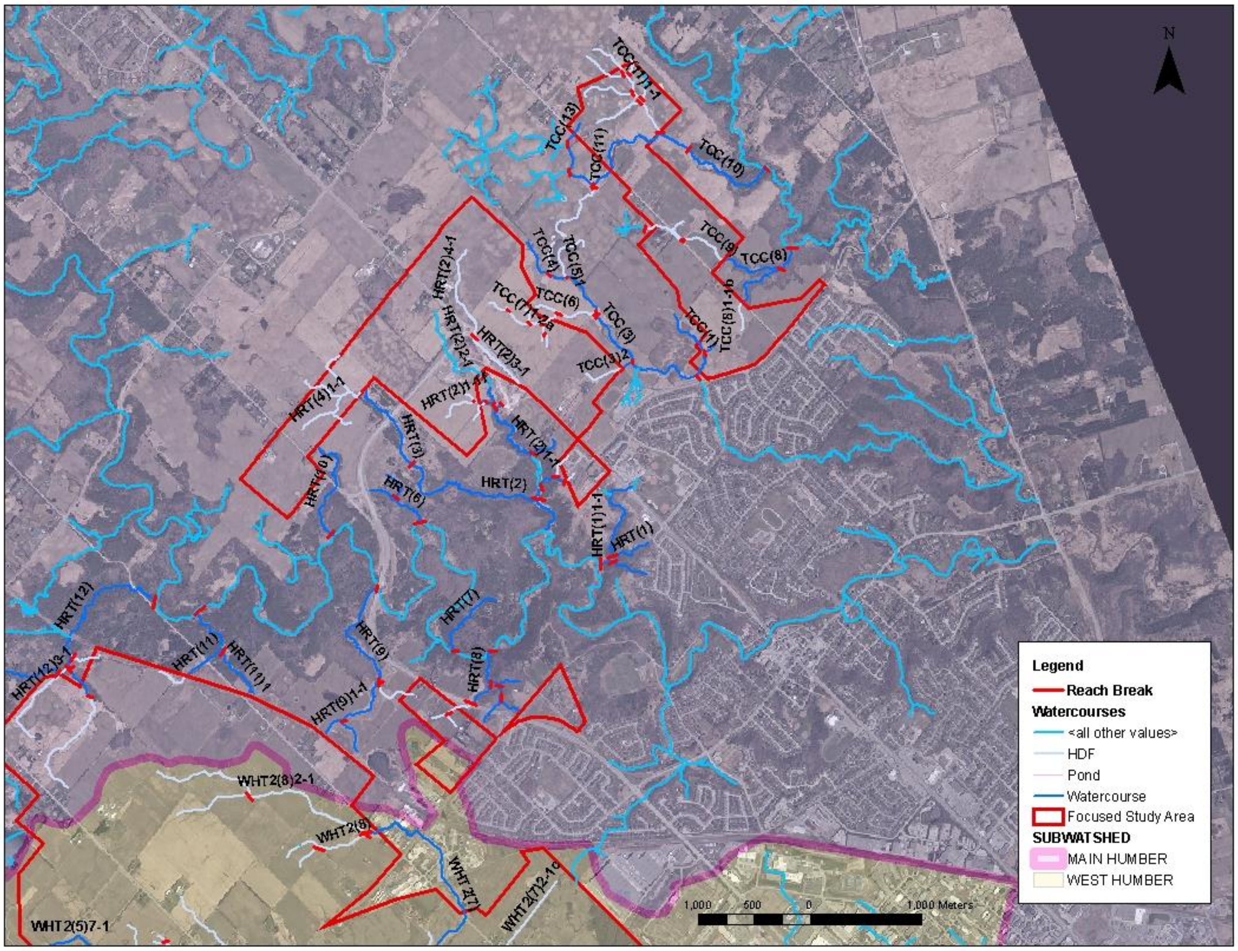

Figure 2.3.4.4.1 Watercourse and HDF Reaches, Main Humber Subwatershed

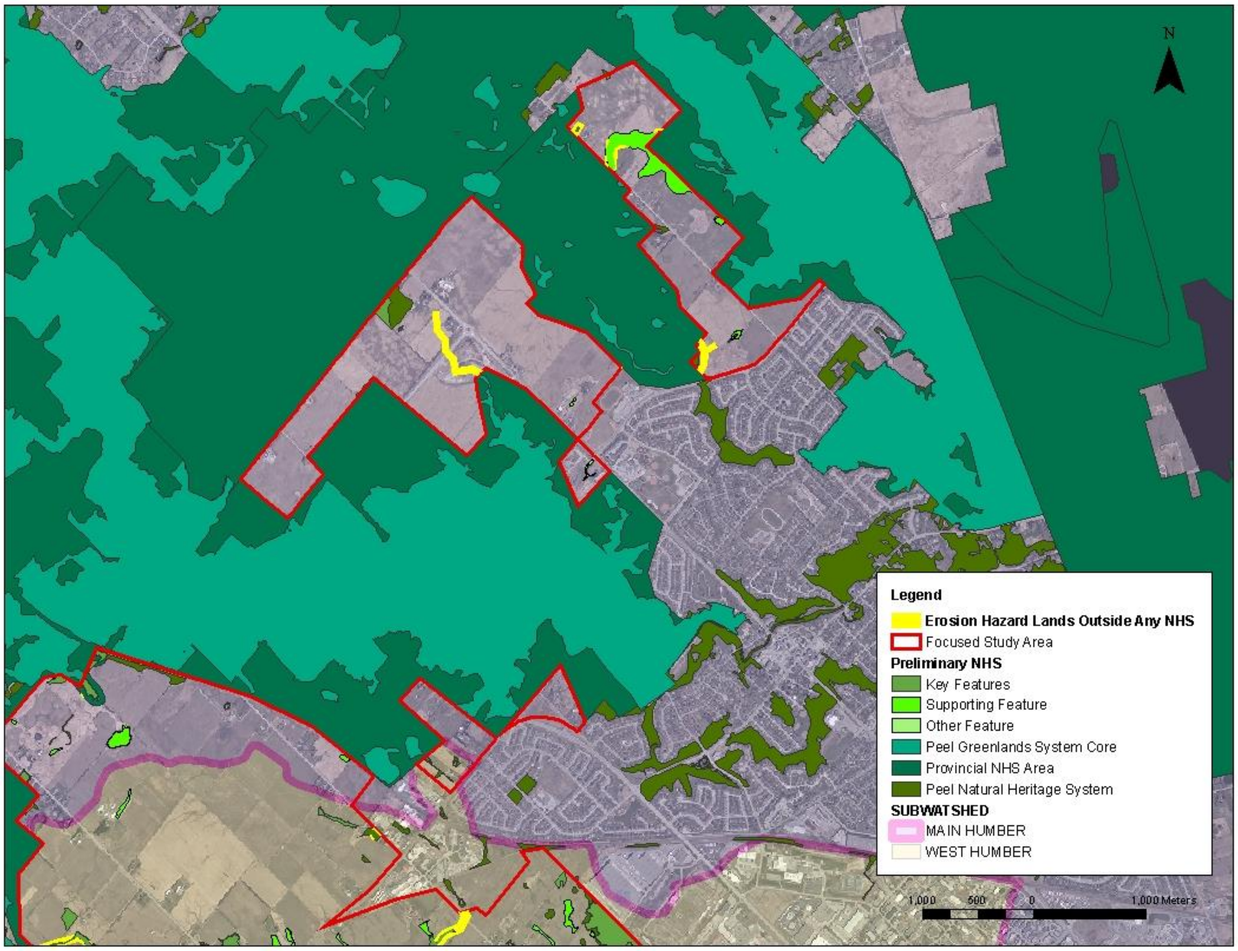

Figure 2.3.4.4.2 Erosion Hazard Limits Outside of NHS, Main Humber River Subwatershed

Erosion Assessment

Map SM3 in Appendix G 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, SM3 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.

Two erosion sites were mapped within the Main Humber Subwatershed. These sites were located at the inlet and outlet of the same culvert crossing of a headwater tributary. Field observations included erosion and incision near the culvert. The culvert marks the transition of the tributary from an HDF to a watercourse.

Under the proposed scenario (51% average impervious land use), the number of erosion sites is likely to increase without management of stormwater runoff. SWM is required to prevent channel response to urbanization, which can include continued or increased rates of bank erosion, channel degradation, channel enlargement, and degraded water quality and stream habitat. Unmanaged erosion issues at culverts in particular can lead to the development of fish barriers in cases of channel incision.

Erosion Thresholds and SWM

Erosion thresholds should be determined for receiving watercourses in future studies to inform initial SWM planning. As plans develop, and SWM locations are proposed, erosion thresholds should be assessed for sensitive and/or representative areas downstream of potential outfalls. These values should be compared to existing thresholds and those for sensitive locations to determine the most representative. Erosion threshold evaluation for SWM is to be evaluated through future studies.

Watercourse/HDF Management

Feature constraints and management recommendations for watercourses and HDFs will be completed through the integration of study disciplines. At this stage, further characterization and impact assessment can be made based on terrestrial or aquatic input for specific features (e.g. ponds, ELC mapping), and will be completed as land use plans are developed for the SABE. Field work to confirm/update watercourse and HDF mapping, and to complete the HDF assessment following TRCA/CVC (2014) guidelines are required through future studies to refine and finalize reach-specific constraints and management recommendations.

Erosion Hazard Delineation

Several hazards and associated setbacks are not enveloped by the Preliminary NHS and should be incorporated into the system. For watercourses with rehabilitation or realignment opportunities, NHS development can potentially locate preferred zones for realignment that benefit the NHS and potential land use change. Management options contained within the Classification and Management Table (Table 2.3.4.4.1) should be applied. In future studies when the TRCA/CVC (2014) HDF guidelines are applied, attempts should be made to include protection and conservation HDF features within the NHS, as these features provide temporary habitat, sediment and flow contributions, and ecological linkage.

Mapping provided here has only applied this setback to the erosion limit (i.e. meander belt or stable top of slope) and 6m erosion access allowance per the Provincial Policy Statement. Other setbacks per the respective conservation authority need to be applied to finalize the hazard delineation and refinement of the NHS.

2.3.4.5 West Humber River Subwatershed

Figures 2.3.4.5.1 and 2.3.4.5.2 present the watercourse and HDF mapping and erosion hazard corridors outside of the NHS limits for the West Humber subwatershed, respectively. HDF and management recommendations for the subwatershed will be determined in future studies. Additional field assessments will need to be completed in future studies to evaluate potential impacts at the reach scale.

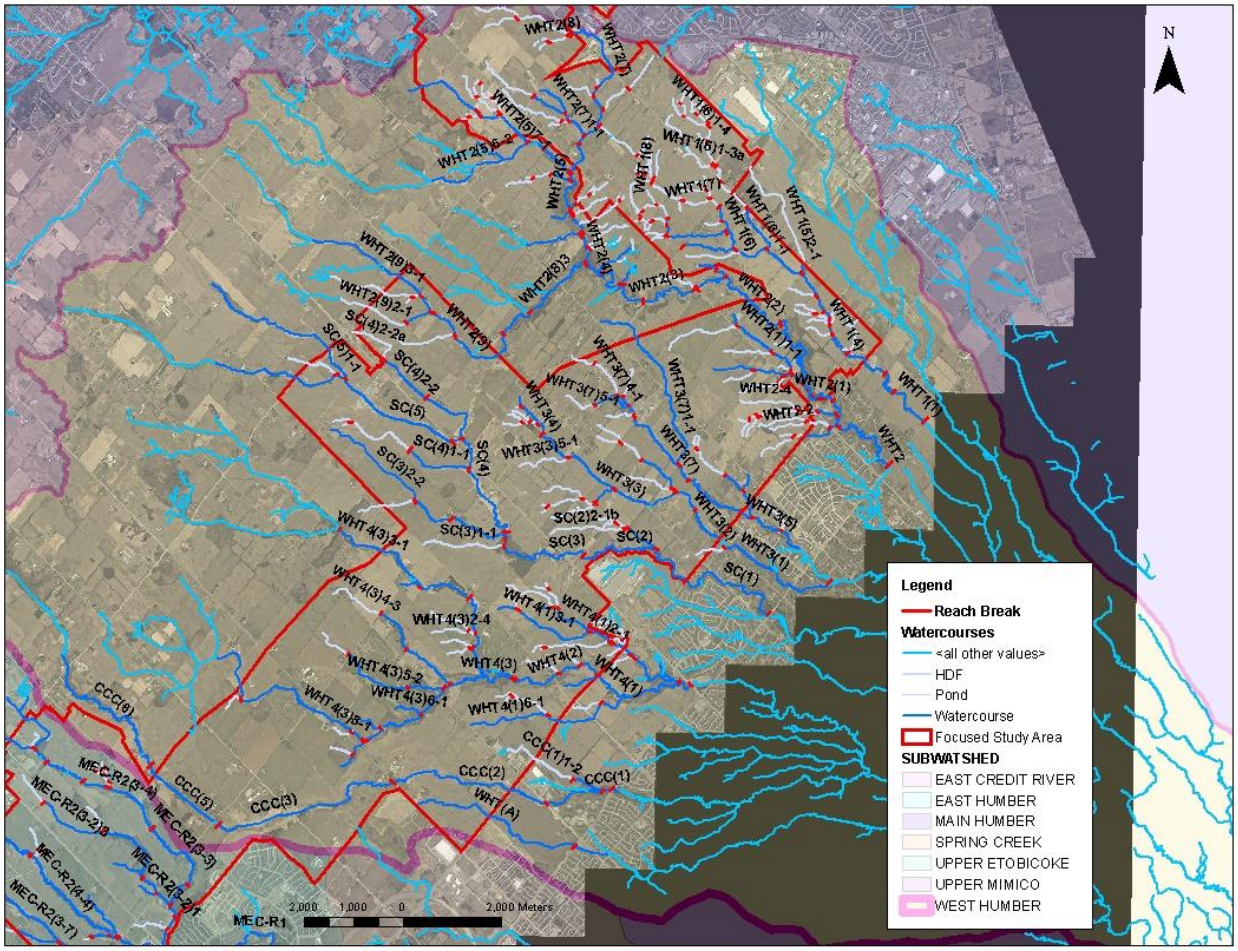

Figure 2.3.4.5.1 Watercourse and HDF Reaches, West Humber Subwatershed

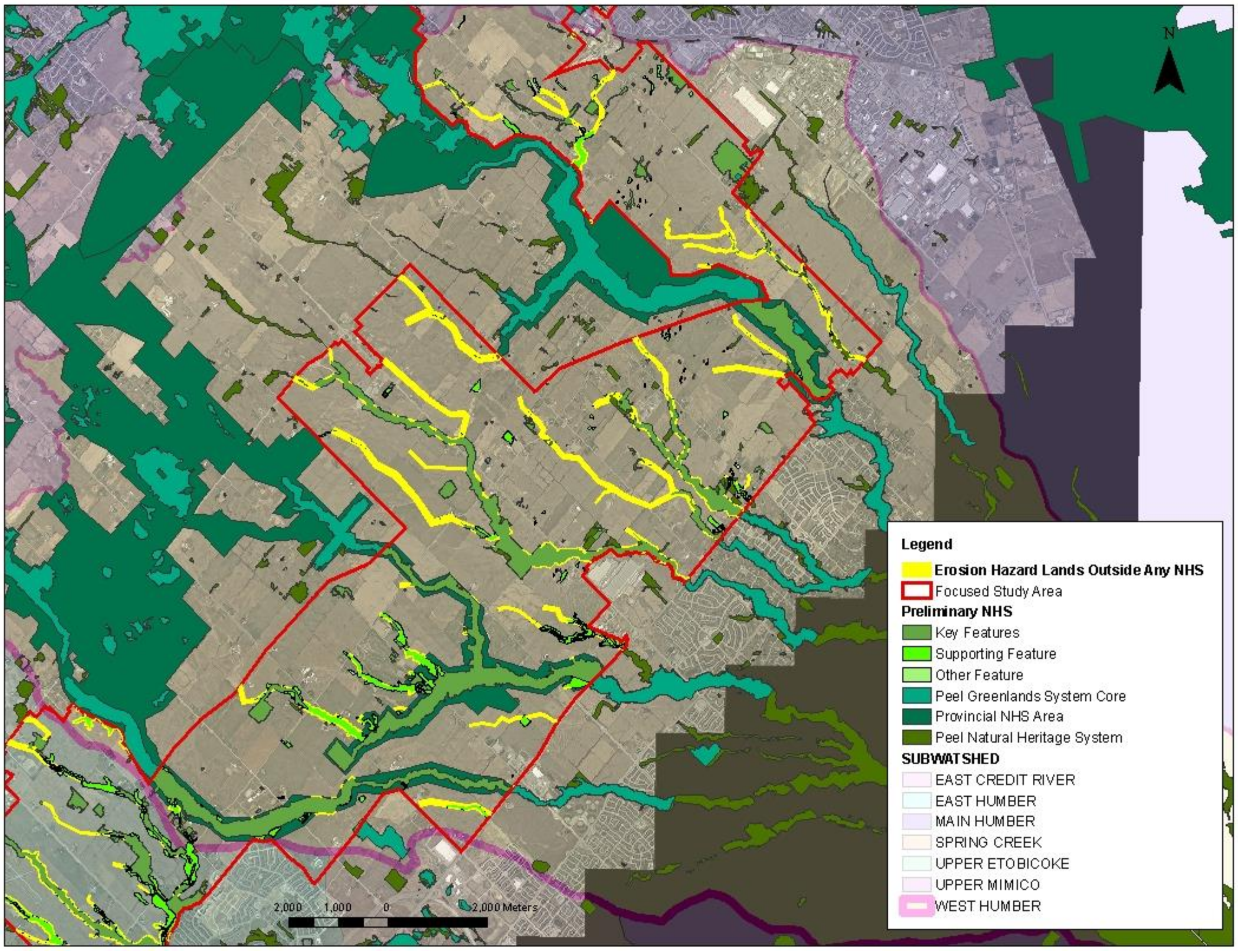

Figure 2.3.4.5.2 Erosion Hazard Limits Outside of NHS, West Humber River Subwatershed

Erosion Assessment

Map SM3 in Appendix G 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, SM3 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.

Eighteen erosion sites were mapped within the West Humber Subwatershed. These sites were located both on main stem reaches and headwater tributary reaches. Many of the erosion sites were noted at existing road crossings in the form of local channel widening, bank erosion near the culvert, bed incision, culvert damage and an exposed CSP bottom. At other sites, field observations included steep banks, ditch incision and bank undercutting.

Under the proposed scenario (51% average impervious land use), the number of erosion sites is likely to increase without management of stormwater runoff. SWM is required to prevent channel response to urbanization, which can include continued or increased rates of bank erosion, channel degradation, channel enlargement, and degraded water quality and stream habitat. Unmanaged erosion issues at culverts in particular can lead to the development of fish barriers in cases of channel incision.

Erosion Thresholds and SWM

Erosion thresholds should be determined for receiving watercourses in future studies to inform initial SWM planning. As plans develop, and SWM locations are proposed, erosion thresholds should be assessed for sensitive and/or representative areas downstream of potential outfalls. These values should be compared to existing thresholds and those for sensitive locations to determine the most representative. Erosion threshold evaluation for SWM is to be evaluated through future studies.

Watercourse/HDF Management

Management recommendations for watercourses and HDFs will be completed through the integration of study disciplines. At this stage, further characterization and impact assessment can be made based on terrestrial or aquatic input for specific features (e.g. ponds, ELC mapping), and will be completed as land use plans are developed for the SABE. Field work to confirm/update watercourse and HDF mapping, and to complete the HDF assessment following TRCA/CVC (2014) guidelines are required through future studies to refine and finalize reach-specific constraints and management recommendations.

Erosion Hazard Delineation

Many erosion hazard corridors and associated setbacks are not enveloped by the Preliminary NHS, particularly within upper tributary reaches with disturbed riparian corridors, and should be incorporated into the system. For watercourses with rehabilitation or realignment opportunities, NHS development can potentially locate preferred zones for realignment that benefit the NHS and potential land use change. Management options contained within the Classification and Management Table (Table 2.3.4.4.1) should be applied. In future studies when the TRCA/CVC (2014) HDF guidelines are applied, attempts should be made to include protection and conservation HDF features within the NHS, as these features provide temporary habitat, sediment and flow contributions, and ecological linkage.

Mapping provided here has only applied this setback to the erosion limit (i.e. meander belt or stable top of slope) and 6m erosion access allowance per the Provincial Policy Statement. Other setbacks per the respective conservation authority need to be applied to finalize the hazard delineation and refinement of the NHS.

2.3.5 Natural Heritage System and Water Resource System

2.3.5.1 Water Resource System

The impacts of future development on the water resource system can occur locally within the study area and downstream within the receiving system. Unmitigated, the future development of the FSA would reduce groundwater recharge, potentially affecting local seeps and springs within the area and baseflow within receiving aquatic systems. Based upon the soils within the study area, it is anticipated that the key hydrologic features within the study area (particularly wetlands) would be largely dependent upon surface water; as such, depending upon the specific type of vegetation within the receiving feature, the impacts of the land use change to the hydroperiod may result in an overabundance of runoff during critical seasons and periods for the vegetation, thereby adversely affecting the receiving feature.

In addition, portions of the FSA are recognized to lie upstream of designated flood vulnerable areas (FVAs) within the Etobicoke Creek Watershed and the Humber River Watershed. These areas are currently at risk of flooding during formative storm events, and analyses completed for this study have indicated that more frequent flooding of these areas may be anticipated following development within the SABE. Locally, portions of the FSA within the headwaters of receiving drainage systems would be anticipated to increase the rate of runoff, resulting in increased flood risk locally within the FSA and within receiving downstream systems proximate to the FSA.

The key hydrologic features and key hydrologic areas mapping, developed as part of the Part A Draft Characterization Report have been reviewed in conjunction with the findings of the impact assessment to determine the potential impacts (without mitigation) to each of the key hydrologic features and areas identified within the respective subwatersheds encompassing the FSA. The results of this assessment are summarized in Table 2.3.5.1.

Table 2.3.5.1: Summary of anticipated impacts to key hydrologic features and key hydrologic areas by subwatershed.

Subwatershed	Key Hydrologic Feature/Key Hydrologic Area	Anticipated Impact
Main Humber Subwatershed	Watercourses and HDFs	Increased erosion potential and consequential degradation to riparian and aquatic habitat Reduced water quality
	Seepage Areas and Springs	Reduced groundwater recharge locally Potential reduction to groundwater discharge within receiving watercourses
	Wetlands	Reduced water quality to wetlands Alteration to hydroperiod, potentially affecting wetland vegetation
	Waterbodies	N/A
	Significant Groundwater Recharge Areas	N/A
	Ecologically Significant Groundwater Recharge Areas	Reduced quantity of groundwater recharged within these areas Potential reduction in groundwater discharge to associated wetlands or stream reaches
	Downstream Flood Vulnerable Areas	No significant impacts anticipated
	Shallow Depth to Groundwater	N/A
West Humber Subwatershed	Watercourses and HDFs	Increased erosion potential and consequential degradation to riparian and aquatic habitat Reduced water quality

		Reduced water quality to Redside Dace habitat Increased flooding potentially locally and offsite
	Seepage Areas and Springs	Reduced groundwater recharge locally Potential reduction to groundwater discharge within receiving watercourses Potential reduction to baseflow within Redside Dace habitat
	Wetlands	Reduced water quality to wetlands Alteration to hydroperiod, potentially affecting wetland vegetation
	Waterbodies	Increased runoff exceeding capacity of waterbody
	Significant Groundwater Recharge Areas	Reduced groundwater recharge to two minor sand and gravel deposits. Potential reduction to groundwater discharge to local watercourse or wetland
	Ecologically Significant Groundwater Recharge Areas	Reduced quantity of groundwater recharged within these areas Potential reduction in groundwater discharge to associated wetlands or stream reaches
	Downstream Flood Vulnerable Areas (FVA)	Increased flood risk and damages within FVA at confluence of West Humber and Main Humber Rivers.
	Shallow Depth to Groundwater	Potential for dewatering and subsequent potential reduction to groundwater discharge to local water courses or wetlands

Upper Etobicoke Creek Subwatershed	Watercourses and HDFs	Increased erosion potential and consequential degradation to riparian and aquatic habitat Reduced water quality Reduced water quality to downstream Redside Dace habitat Increased flooding potentially locally and offsite
	Seepage Areas and Springs	Reduced groundwater recharge locally Potential reduction to groundwater discharge within receiving watercourses Potential reduction to baseflow within downstream Redside Dace habitat
	Wetlands	Reduced water quality to wetlands Alteration to hydroperiod, potentially affecting wetland vegetation
	Waterbodies	Increased runoff exceeding capacity of waterbody
	Significant Groundwater Recharge Areas	Reduced groundwater recharge to a minor sand and gravel deposit Potential reduction to groundwater discharge to local watercourse or wetland
	Ecologically Significant Groundwater Recharge Areas	Reduced quantity of groundwater recharged within these areas Potential reduction in groundwater discharge to associated wetlands or stream reaches
	Downstream Flood Vulnerable Areas (FVA)	Increased flood risk and damages within Downtown Brampton FVA

	Shallow Depth to Groundwater	Potential for dewatering and subsequent potential reduction to groundwater discharge to local water courses or wetlands
Fletcher's Creek Subwatershed	Watercourses and HDFs	Increased erosion potential Reduced water quality locally Nominally reduced water quality to downstream Redside Dace habitat Increased flood potentially locally and offsite
	Seepage Areas and Springs	Potential nominal reduction to baseflow within downstream Redside Dace habitat
	Wetlands	N/A
	Waterbodies	N/A
	Significant Groundwater Recharge Areas	N/A
	Ecologically Significant Groundwater Recharge Areas	N/A
	Downstream Flood Vulnerable Areas (FVA)	N/A
	Shallow Depth to Groundwater	N/A
Huttonville Creek Subwatershed	Watercourses and HDFs	Increased erosion potential Reduced water quality locally Nominally reduced water quality to downstream Redside Dace habitat Increased flood potentially locally and offsite
	Seepage Areas and Springs	Nominal reduction to baseflow within downstream Redside Dace habitat
	Wetlands	N/A
	Waterbodies	N/A
	Significant Groundwater Recharge Areas	N/A

	Ecologically Significant Groundwater Recharge Areas	N/A
	Downstream Flood Vulnerable Areas (FVA)	N/A
	Shallow Depth to Groundwater	N/A
Main Credit River	Watercourses and HDFs	Increased erosion potential and consequential degradation to riparian and aquatic habitat Reduced water quality Increased flood potentially locally and offsite
	Seepage Areas and Springs	N/A
	Wetlands	Reduced water quality to wetlands Alteration to hydroperiod, potentially affecting wetland vegetation
	Waterbodies	Increased runoff exceeding capacity of waterbody
	Significant Groundwater Recharge Areas	N/A
	Ecologically Significant Groundwater Recharge Areas	N/A
	Downstream Flood Vulnerable Areas (FVA)	N/A
	Shallow Depth to Groundwater	N/A

The general findings presented in Table 2.3.5.1 will be refined as appropriate to summarize the anticipated impacts from the SABE land use plan once received.

2.3.5.2 Natural Heritage System

Aquatic System and Fisheries

The impacts of land use and land use change on aquatic communities usually occur due to effects on habitat rather than direct impacts on the biotic communities. Direct alteration of aquatic habitats, for example stream channelization, clearly has the potential to negatively affect aquatic habitat but changes at the landscape scale, particularly those that affect how water moves through the system, are equally important. Changes to hydrogeology and hydrology can bring about changes in flow, channel form and stability, and water quality and temperature. Stormwater directed to watercourses can affect water quality and water temperature. Changes to riparian vegetation can affect bank stability, water temperature and food supply. The planning focus is on predicting the effects of land use change on aquatic habitats and then managing the change in order to prevent harmful effects. The overall intent is to ensure that, following development, aquatic habitats continue to support healthy aquatic communities of native species that are appropriate to the habitats' natural potential. In southern Ontario, where Redside Dace habitat is present, it is typically the focus of aquatic habitat protection and management due to the species' endangered status. It is often assumed that the protection of Redside Dace habitat will inherently address, or take precedence over, the requirements of the other aquatic species that are present. A notable exception to this is coldwater streams which support species such as Brook Trout that require colder summer water temperatures than Redside Dace.

The lack of understanding of the specific habitat requirements and mechanistic linkages between habitat requirements and Redside Dace survival or abundance, limits the ability to predict the impacts of habitat changes on Redside Dace. Where Redside Dace habitat exists, the management approach is usually to assume that a best case scenario involves maintaining the existing conditions for key attributes where the impacts of change have unpredictable (and therefore potentially undesirable) consequences (e.g. a change in groundwater discharge), and moving in a positive direction for attributes where no negative and potential positive consequences are predicted (e.g. conversion of riparian buffers from row crop agriculture to natural cover). In practical terms, this management approach is equally valid, regardless of the aquatic habitat and species under considerations.

Groundwater discharge is an important factor influencing aquatic habitats in southern Ontario. Not only does it provide flow, but the cooling effects of groundwater on summer stream temperature are considered essential for maintaining the thermal conditions suitable for Redside Dace and other coolwater fish species, and for coldwater species such as Brook Trout and Mottled Sculpin. As is the case with flow, the influence of groundwater on water temperature extends downstream from the point of discharge. Therefore, groundwater discharge is not necessarily occurring within reaches occupied by coolwater species; it may be occurring upstream. Local groundwater discharge is necessary to maintain a thermal regime suitable for coldwater species, such as Brook Trout and Mottled Sculpin. Furthermore, Brook Trout spawn exclusively in locations where groundwater is percolating through the substrate, so specific discharge locations can be critically important in stream reaches where they occur.

Table 2.3.5.2 summarizes the occurrence of coldwater streams and Brook Trout within and Redside Dace within and proximate to the FSA. Each of these is considered sensitive to habitat changes that can occur as a result of urban development and specific mitigation measures are, as a result of policy in the case of Redside Dace, or may be required in order to mitigate the impacts of development, depending on the susceptibility of the specific watercourses.

Table 2.3.5.2: Occurrence of coldwater streams and fish species that are sensitive to habitat change by subwatershed.

Watershed	Sub-watershed	Coldwater streams present in FSA	Brook trout present in FSA	Redside Dace present in FSA	Redside Dace present downstream in proximity to FSA
Credit River	Credit River - Glen Williams to Norval	No	No	No	No
	Fletcher's Creek	No	No	No	Yes
	Huttonville Creek	No	No	No	Yes
Humber River	Main Humber	Yes	Yes	No	No
	West Humber	No	No	Yes	Yes
Etobicoke Creek	Upper Etobicoke Creek	Yes	No	No	No
	Spring Creek	No	No	No	No

Terrestrial Features

To evaluate potential impacts on terrestrial resources, it was assumed that Whitebelt areas within the FSA would be transitioned from a predominantly agricultural matrix, to an urban matrix, with an average impervious cover of 51%. Areas assumed to be excluded from development included lands within the Greenbelt and areas identified as Natural Environment High Constraint in the land-use (Figure 2.2.1.1).

Natural Cover

Total natural cover within the FSA that is composed of either wetland, woodland, and/or early successional meadow or shrub-dominated features includes approximately 1157 ha of the land base (~14.4 %) (Table 2.3.5.3). Based on the proposed FSA land use plan (Figure 2.2.1.1), approximately 817.0 ha of natural cover will be maintained, and 340.0 ha will be removed.

The majority of the natural cover that will be removed is represented by Open/Early Successional vegetation types (~ 246.3 ha); removal of wetland features represents 24.4 ha, and woodland areas 69.3 ha.

Table 2.3.5.3: Terrestrial natural features and area coverage (ha) within the FSA

Feature Type	Maintained (ha)	Removed (ha)	Current FSA Total
Open/Early Successional	384.4	246.3	630.7
Wetland	178.3	24.4	202.7
Woodland	254.3	69.3	323.5
Natural Cover Total	817.0	340.0	1157.0

Natural system quality and function based on surrounding land-use matrix

To evaluate the potential for impacts to habitat patches[2] within the FSA, methodologies to identify patches that are likely to be most affected by a transition from agriculturally dominated to urban dominated was undertaken. Characteristics such as patch size, patch shape, and matrix influence[3] were used to calculate the anticipated patch sensitivity resulting in potential impacts. Patches were scored using the TRCA's landscape analysis method, resulting in patch L-scores that are a proxy for patch quality (L1 Excellent to L5 Very Poor). The series of figures presented in DA2-2 a-g (Appendix E) show the resulting patch L-scores for wetland, woodland, and meadow habitat types with the FSA.

In general, a transition from a predominantly agricultural matrix to urban matrix is expected to have a minimal effect on the patch quality scores for woodlands and wetlands, as these features are maintained within high-constraint areas and/or the Greenbelt lands within the FSA, thus the size and shape parameter of calculated patch score will not be affected. The score for matrix influence however will increase for most of the wetland and woodland patches (i.e. the amount of urbanization within 2 km will increase). The largest change in this component of patch score will be for wetland and woodland patches that are currently greater than 2 km from existing urban areas in Brampton and Bolton, as patches that are currently close to these urban lands will have already factored in adjacent urban areas into their matrix influence scores.

Impacts to meadow patches is expected as there is an anticipated 25% reduction in ELC communities identified as Open/Early Successional habitat (Table 2.3.5.4). Where these patches are maintained, similar to woodland and wetland patches, impacts to overall patch quality will be largely influenced by changes to matrix influence.

Table 2.3.5.4: Terrestrial patch conditions for features within the FSA

Patch Condition	Woodlands		Wetlands		Meadows		Beaches and Bluffs	
	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
L3 - Fair	16	433.5	18	84.0	6.0	68.3		
L4 - Poor	117	827.1	253	206.9	165.0	834.4	4	1.1
L5 - Very Poor	6	19.1	20	12.4	15.0	59.0		

Impacts associates with the proposed land-use transition based on selection of the final SABE boundary and proposed land-uses will evaluate the change in patch scores based on existing conditions presented in Table 2.3.5.4.

Habitat Connectivity / Linkage Assessment

Habitat connectivity across the landscape was evaluated using Circuitscape (McRae et al. 2008; McRae and Shah, 2009); based on existing conditions, the results of the Circuitscape analysis is shown in Figure DA2-3. The method borrows algorithms from electronic circuit theory to predict connectivity in heterogeneous

[2] A habitat patch is any discrete area with a definite shape and habitat configuration used by a species for breeding or obtaining other resources. They may be comprised of a single or multiple habitat types (e.g., woodland, wetland, open habitats).

[3] Matrix influence refers to the effect of adjacent and intervening landscape between features or patches has on a given habitat patch or feature. This may include factors such as adjacent habitat quality, opportunities for wildlife movement (landscape permeability) and habitat type.

landscapes. It provides a simplified model of potential ways to connect features on the landscape, based on the degree to which land cover is ecologically permeability (i.e. how well animals can move across the landscape) as assigned by the user in the model; this is modeled using a parameter called resistance. As a simplified proxy for wildlife movement, it can be used as one of several tools or considerations to evaluate the potential importance of corridors to support ecological linkage. Circuitscape has been used to model habitat connectivity of many natural systems, including the Great Lakes Basin in Ontario (Bowman and Cordes, 2015), the CVC watershed, and as part of the Peel Climate Change Vulnerability study. Model parameters to weight the resistance of landscape features and areas in the FSA. The same model parameters used in these Circuitscape models was applied to weight the resistance of landscape features and areas in the FSA. This included weighting areas where the landscape is unnatural and assumed to be impermeable to movement as high resistance (e.g. roads and urbanized areas as resistance weight 1000); areas where landscape is unnatural but permeable to movement as medium resistance (e.g. agricultural areas as resistance weight 100); and area with natural cover were assumed to provide unimpeded movement (e.g. areas with vegetation cover as resistance weight 10).

Under current conditions, connectivity of the landscape is highest where wetland, woodland, open/early successional habitats are present and predominantly occurring along watercourses and within existing valleylands (Figure DA2-3). The predominantly agricultural matrix results in connectivity being relatively diffuse as the landscape matrix is generally permeable, with areas of high concentration being present in only a few locations across the FSA. With the FSA landscape matrix transitioning from predominately agricultural to urban over time, the relative importance of existing features along watercourses and within existing valleylands, and those that connect tableland features, will increase in importance. Although assumptions regarding land-use change have not been incorporated for the FSA in the existing conditions analysis, examples of the increase in relative connectivity importance of these areas can been seen in areas south of the FSA where the land-use matrix is largely urban (Figure DA2-3).

Native terrestrial community types and species

Impacts to particular vegetation community types within the FSA includes open/early successional, wetland, and woodland vegetation types (Table 2.3.5.5).

Woodland vegetation features that would end up being removed based on the current FSA land-use plan included Cultural Plantation, Cultural Woodland, Coniferous Forest, Deciduous Forest, and Mixed Forest. The location of woodland features that were not captured within the Greenbelt and high constraint environmental areas are shown on Figures DA2-2a to DA2-2c (Appendix E).

Wetland vegetation features that would end up being removed based on the current FSA land-use plan included Meadow Marsh, Shallow Marsh, Shallow Aquatic, Submerged Shallow Aquatic, Mixed Shallow Aquatic, Floating-leaved Shallow Aquatic, Deciduous Swamp, and Thicket Swamp. The location of wetland features that were not captured within the Greenbelt and high constraint environmental areas are shown on Figure DA2-2d to DA2-2f (Appendix E).

Open/Early Successional vegetation features that would end up being removed based on the current FSA land-use plan included Cultural Meadow, Cultural Savanah, Cultural Thicket, and hedgerows. The location of the meadow features that represent open/early successional features that were not captured within the Greenbelt and high constraint environmental areas are shown on Figure DA2-2g.

As a number of these features represent important ecological areas both functionally (composition, habitat, and connectivity), their removal would have a detrimental impact on the broader natural system. Therefore, where these features provide important habitat values, potential for connectivity, and/or opportunities for enhancement, they may be included within the Region’s Natural Heritage System.

As part of the SABE impact assessment, a similar impact assessment will be undertaken to ensure features that are significant are protected, and identify opportunities for protection and/or enhancement where features provide important supporting habitat and/or functions.

Table 2.3.5.5: Vegetation communities (ELC community series) maintained and removed based on the conceptual FSA land-use plan

Vegetation Type Group	ELC Community Series	Maintained (ha)	Removed (ha)	Current FSA Total (ha)
Open/Early Successional	BLO	<0.1		<0.4
	BLS	<0.1		<0.1
	CBO	0.1		0.1
	CUM	295.4	215.6	511.0
	CUS	34.7	10.8	45.5
	CUT	53.5	16.8	70.3
	HR	0.6	3.1	3.7
Wetland	MAM	103.4	10.0	113.4
	MAS	15.5	5.1	20.6
	SA	0.0	0.1	0.1
	SAF	0.6	0.1	0.7
	SAM	0.1	0.3	0.4
	SAS	1.2	1.1	2.3
	SWD	42.4	6.2	48.6
	SWT	15.0	1.7	16.6
Woodland	CUP	38.1	13.5	51.6
	CUW	45.7	6.3	52.0
	FOC	0.2	0.4	0.7
	FOD	159.9	39.1	199.0
	FOM	10.4	10.0	20.3

The TRCA's approach to identifying vegetation communities that include characteristics and functions that are the most sensitive to the transition from an agricultural matrix to an urban matrix are shown in Figure 2-4. The majority of vegetation communities do not have L-Rankings at this time (i.e. approximately 774.7 ha are not currently ranked, representing 65.6% of all vegetated areas within the FSA). These areas are primarily represented by open/early succession habitat types.

Vegetation communities that are anticipated to the most sensitive to land-use change in the FSA are those that are ranked as L1 to L3 communities and represent only a small portion of vegetation communities (2.1 % of all vegetated areas; 6.1% of vegetated areas with known ranking). Using existing information regarding vegetation-type sensitivity, 45 vegetation communities covering approximately 24.8 ha are identified as being particularly sensitive to the proposed land-use change (red areas on Figure DA2-4; Appendix E). The majority of vegetation communities present within the FSA are those that are likely resilient to an urban matrix and are ranked as L4, L5, or L+ (32.3% of vegetated areas; 93.8% of vegetated areas with known rankings).

Vegetation communities that are most sensitive to an urban matrix (i.e. having TRCA L-Ranks of L1 to L3) occur within the Greenbelt and/or high constraint areas within the FSA (Figure DA2-4). Some that are outside of these areas include wetland and woodland features in the west sections of the Etobicoke Creek Subwatershed, and isolated features in the main Humber River Subwatershed (Figure DA2-4).

Vegetation communities that are expected to be less sensitive to a future urban matrix are also predominantly within the Greenbelt and/or high constraint areas within the FSA (Figure DA2-4). Larger features in this category tend to be associated with the Etobicoke Creek subwatershed and the West Humber River Subwatershed. Smaller and/or more isolated features tend to be associated with the Main Humber Creek watershed in the east areas of the FSA.

Table 2.3.5.6: Sensitivity ranking summary for vegetation communities present within the FSA

Vegetation Community L-Rank	Number of Features	Area of Features (ha)
L2	4	2.0
L3	41	22.8
L4	146	98.7
L5	180	167.4
L+	140	115.1
No Rank - Further Study Required	614	774.7

Flora and Fauna Species Sensitive to Urban Environments

The transition from an agricultural to urban matrix can result in changes to the diversity of flora and fauna that are present in natural features. Generally, species that are less tolerant of urbanized areas will either decrease in abundance and/or become locally extirpated, whereas species that are tolerant/resilient, will tend to be maintained and/or increase in abundance. The majority of species occurrences for flora and fauna that are sensitive to urbanization, occur within the Greenbelt and/or high constraint environmental areas (Figures DA2-5a and DA2-5b; Appendix E). Some records however, occur in features that are not currently identified as high constraint and therefore would be directly impacted.

Flora species that are documented in the FSA that may be the most sensitive to the transition to an urban (based on TRCA L-ranks 1 to 3) are presented in Table 2.3.5.7. Locations of flora based on species L-rank are shown in Figure DA2-5b (Appendix E).

Table 2.3.5.7: Flora present in the FSA that are expected to be the most sensitive to urbanization

Sensitivity to Urbanization (TRCA L-Rank)	Scientific name	Common name	Number of records within the FSA
L1	*Pinus resinosa*	red pine	6
L2	*Carex viridula ssp. viridula*	greenish sedge	1
	Carex lasiocarpa	slender woolly sedge	1
L3	*Carex utriculata*	beaked sedge	2
	Salix nigra	black willow	2
	Iris versicolor	blue flag	11
	Claytonia caroliniana	broad-leaved spring beauty	21
	Najas flexilis	bushy naiad	1
	Prunus nigra	Canada plum	4
	Viola canadensis	Canada violet	6
	Taxus canadensis	Canada yew	6
	Dryopteris clintoniana	Clinton's wood fern	2
	Cardamine concatenata	cut-leaved toothwort	18
	Dicentra cucullaria	Dutchman's breeches	7
	Carex leptonervia	few-nerved wood sedge	1
	Potamogeton zosteriformis	flat-stemmed pondweed	1
	Potamogeton natans	floating pondweed	7
	Carex alopecoidea	foxtail wood sedge	6
	Carex crinita	fringed sedge	21
	Carex grayi	Gray's sedge	2
	Sparganium eurycarpum	great bur-reed	10
	Sparganium emersum	green-fruited bur-reed	1
	Luzula acuminata	hairy wood rush	1
	Uvularia grandiflora	large-flowered bellwort	9
	Viola rostrata	long-spurred violet	1
	Cystopteris tenuis	Mackay's fragile fern	6
	Claytonia virginica	narrow-leaved spring beauty	8
	Epilobium leptophyllum	narrow-leaved willow-herb	1

	Glyceria borealis	northern manna grass	2
	Gymnocarpium dryopteris	oak fern	1
	Carex pallescens	pale sedge	1
	Mitchella repens	partridgeberry	2
	Hypopitys monotropa	pinesap	8
	Antennaria parlinii ssp. fallax	plantain-leaved pussytoes	1
	Crataegus coccinea var. pringlei	Pringle's hawthorn	3
	Cardamine douglassii	purple cress	3
	Carex woodii	purple-tinged sedge	2
	Streptopus lanceolatus var. lanceolatus	rose twisted-stalk	5
	Euonymus obovatus	running strawberry-bush	49
	Carya ovata	shagbark hickory	20
	Hepatica acutiloba	sharp-lobed hepatica	14
	Salix lucida	shining willow	1
	Alnus incana ssp. rugosa	speckled alder	1
	Carex laxiculmis var. laxiculmis	spreading wood sedge	2
	Dicentra canadensis	squirrel-corn	17
	Lemna trisulca	star duckweed	2
	Larix laricina	tamarack	2
	Vallisneria americana	tape-grass	1
	Carex molesta	troublesome sedge	1
	Nymphaea odorata ssp. tuberosa	tuberous water-lily	1
	Carex tuckermanii	Tuckerman's sedge	14
	Chelone glabra	turtlehead	5
	Equisetum fluviatile	water horsetail	2
	Ludwigia palustris	water purslane	3
	Picea glauca	white spruce	26
	Phlox divaricata	wild blue phlox	1
	Ilex verticillata	winterberry	5
	Anemone quinquefolia var. quinquefolia	wood-anemone	8
	Equisetum sylvaticum	woodland horsetail	4

Fauna species that are documented in the FSA that may be the most sensitive to the transition to an urban (based on TRCA L-ranks 1 to 3) are presented in Table 2.3.5.8. Location of wildlife species based on L-rank are shown on Figure DA2-5b (Appendix E).

Table 2.3.5.8: Fauna present in the FSA that are expected to be the most sensitive to urbanization

Sensitivity to Urbanization (TRCA L-Rank)	Species Group	Scientific Name	Common Name	Number of records within the FSA
L2	AMPHIBIANS	*Hyla versicolor*	Gray Treefrog	2
		Lithobates catesbeianus	American Bullfrog	1
		Lithobates sylvaticus	Wood Frog	15
		Pseudacris crucifer	Spring Peeper	8
	BIRDS	*Ammodramus savannarum*	Grasshopper Sparrow	2
		Circus hudsonius	Northern Harrier	3
		Mniotilta varia	Black-and-white Warbler	1
		Seiurus aurocapilla	Ovenbird	4
	CRUSTACEANS	*Fallicambarus fodiens*	Chimney Crayfish/ Digger Crayfish	20
L3	AMPHIBIANS	*Lithobates pipiens*	Northern Leopard Frog	5
	BIRDS	*Accipiter striatus*	Sharp-shinned Hawk	2
		Chordeiles minor	Common Nighthawk	1
		Cistothorus platensis	Sedge Wren	2
		Coccyzus americanus	Yellow-billed Cuckoo	1
		Coccyzus erythropthalmus	Black-billed Cuckoo	5
		Dolichonyx oryzivorus	Bobolink	1
		Empidonax alnorum	Alder Flycatcher	1
		Eremophila alpestris	Horned Lark	14

		Geothlypis philadelphia	Mourning Warbler	15
		Hylocichla mustelina	Wood Thrush	34
		Meleagris gallopavo	Wild Turkey	1
		Pipilo erythrophthalmus	Eastern Towhee	1
		Piranga olivacea	Scarlet Tanager	3
		Pooecetes gramineus	Vesper Sparrow	17
		Porzana carolina	Sora	1
		Scolopax minor	American Woodcock	10
		Setophaga virens	Black-throated Green Warbler	1
		Sphyrapicus varius	Yellow-bellied Sapsucker	1
		Toxostoma rufum	Brown Thrasher	19
	MAMMALS	*Zapus hudsonius*	Meadow Jumping Mouse	1
	REPTILES	*Chrysemys picta marginata*	Midland Painted Turtle	1
		Storeria o. occipitomaculata	Northern Red-bellied Snake	2

Species and Habitats with Policy Implications

Species with policy implications that may be impacted in areas if suitable habitat is not protected, are shown in Table 2.3.5.9. The list only includes wildlife species, as documented in the Part A Characterization report (draft), only one species of flora conservation concern was documented within the FSA (Honey Locust, *Gleditsia triacanthos*). Species that are either Endangered or Threatened Federally and/or Provincially (locations shown in Figure DA2-5c), species that are of Specific Concern Provincially, species that are rare in Ontario (S-rank is S1, S2, or S3), and/or species that are indicators of Significant Wildlife Habitat in Ecoregion 6E are identified (locations shown on Figure DA2-5d).

Additionally, areas that have potential to support Significant Wildlife Habitat (SWH) are largely captured within the Greenbelt and high environmental constraint areas (Figure DA2-5e). Areas where SWH is located outside of these areas will require additional consideration through the SABE impact assessment. It is anticipated that where SWH is associated with key features and other areas that are protected, impacts can be avoided. Where they are not associated with key features and other areas that are protected, consideration may be given to determine if they habitat types and functions can be incorporated into ecological enhancements areas (for example, where features are represented by early successional habitat types).

Table 2.3.5.9: Fauna present in the FSA that have one or more policy implications

Species Group	Species Name	Common Name	SARA	ESA	Provincial Special Concern	Provincially Rare	SWH Indicator
AMPHIBIANS	*Lithobates catesbeianus*	American Bullfrog					1
	Anaxyrus americanus	American Toad					1
	Hyla versicolor	Gray Treefrog					1
	Lithobates clamitans	Green Frog					1
	Lithobates pipiens	Northern Leopard Frog					1
	Pseudacris crucifer	Spring Peeper					1
	Lithobates sylvaticus	Wood Frog					1
BIRDS	*Empidonax alnorum*	Alder Flycatcher					1
	Setophaga ruticilla	American Redstart					1
	Mniotilta varia	Black-and-white Warbler					1
	Coccyzus erythropthalmus	Black-billed Cuckoo					1
	Setophaga virens	Black-throated Green Warbler					1
	Polioptila caerulea	Blue-gray Gnatcatcher					1
	Dolichonyx oryzivorus	Bobolink	1	1			1
	Toxostoma rufum	Brown Thrasher					1
	Petrochelidon pyrrhonota	Cliff Swallow					1
	Chordeiles minor	Common Nighthawk	1		1		1
	Geothlypis trichas	Common Yellowthroat					1
	Tyrannus tyrannus	Eastern Kingbird					1
	Sayornis phoebe	Eastern Phoebe					1
	Pipilo erythrophthalmus	Eastern Towhee					1
	Contopus virens	Eastern Wood-Pewee			1		
	Spizella pusilla	Field Sparrow					1
	Ammodramus savannarum	Grasshopper Sparrow			1		1
	Dumetella carolinensis	Gray Catbird					1
	Myiarchus crinitus	Great Crested Flycatcher					1
	Butorides virescens	Green Heron					1
	Picoides villosus	Hairy Woodpecker					1
	Eremophila alpestris	Horned Lark					1
	Passerina cyanea	Indigo Bunting					1
	Empidonax minimus	Least Flycatcher					1
	Geothlypis philadelphia	Mourning Warbler					1

	Colaptes auratus	Northern Flicker					1
	Circus hudsonius	Northern Harrier					1
	Stelgidopteryx serripennis	Northern Rough-winged Swallow					1
	Icterus spurius	Orchard Oriole					1
	Seiurus aurocapilla	Ovenbird					1
	Melanerpes carolinus	Red-bellied Woodpecker					1
	Sitta canadensis	Red-breasted Nuthatch					1
	Vireo olivaceus	Red-eyed Vireo					1
	Agelaius phoeniceus	Red-winged Blackbird					1
	Pheucticus ludovicianus	Rose-breasted Grosbeak					1
	Archilochus colubris	Ruby-throated Hummingbird					1
	Passerculus sandwichensis	Savannah Sparrow					1
	Piranga olivacea	Scarlet Tanager					1
	Accipiter striatus	Sharp-shinned Hawk					1
	Melospiza melodia	Song Sparrow					1
	Porzana carolina	Sora					1
	Melospiza georgiana	Swamp Sparrow					1
	Pooecetes gramineus	Vesper Sparrow					1
	Meleagris gallopavo	Wild Turkey					1
	Empidonax traillii	Willow Flycatcher					1
	Aix sponsa	Wood Duck					1
	Hylocichla mustelina	Wood Thrush	1		1		
	Sphyrapicus varius	Yellow-bellied Sapsucker					1
	Coccyzus americanus	Yellow-billed Cuckoo					1
CRUSTACEANS	*Fallicambarus fodiens*	Chimney Crayfish/ Digger Crayfish					1
MAMMALS	*Odocoileus virginianus*	White-tailed Deer					1
REPTILES	*Storeria dekayi*	DeKay's Brownsnake					1
	Thamnophis sirtalis sirtalis	Eastern Gartersnake					1
	Chrysemys picta marginata	Midland Painted Turtle					1
	Storeria o. occipitomaculata	Northern Red-bellied Snake					1

Climate Vulnerability

In recent years, many southern Ontario urban centres have been impacted by extreme storm events (north Toronto 2005, Hamilton 2009, West Toronto 2013, Burlington 2014, and many more), leading to considerable flood and erosion damage. These events have been speculated by many to be a result of climate change, and have prompted Federal and Provincial Ministries, Regional and Municipal governments to enact policies and programs in response to this crisis.

In 2017, Peel Region Council unanimously endorsed a Climate Change Statement of Commitment, which directed the Region of Peel to develop a climate change master plan. The climate change master plan (ref. The Climate Change Master Plan, Region of Peel, 2019), provides a framework for reducing greenhouse gas emissions and building resiliency throughout Peel Region. As part of these efforts, stormwater management infrastructure has been recommended to incorporate elements of green infrastructure and low impact development best management practices, as well as the need for planning and design of stormwater quantity controls for formative storm events above the 100 year return period.

Climate vulnerability has not yet been assessed as part of this report.

Overlay methods will be used based on the Region of Peel and TRCA's climate change vulnerability study to identify areas that have been identified has having high vulnerability.

Once the SABE boundary has been provided, the assessment will include an evaluation of high vulnerability areas that are included in the SWS conceptual NHS, areas outside of the SWS NHS that may provide opportunities for enhancement and/or design considerations that complement management strategies identified for the protection and enhancement of natural features and functions of the NHS.

2.4 Land Use Evaluation and Impact Assessment/Management

2.4.1 Integrated Impact Assessment

The foregoing investigations and discussions of the existing natural systems have proceeded on a discipline-specific basis, working toward an integrated characterization and assessment of the features, functions and form related to the existing systems. This integration has allowed for a fuller understanding of the fundamental environmental components and systems within the study area. An integrated characterization and assessment of each study discipline generally occurs on two levels, namely: i) integrated characterization to validate or confirm the findings of respective disciplines, and ii) an integrated characterization of key environmental features and systems to define the functions, attributes, and interdependencies, and to thereby provide guidance for establishing management opportunities and requirements based on future land uses.

Primary environmental elements stemming from the discipline-specific characterization work described in the previous report sections included:

- Natural Heritage (including wetland/woodlot features/areas)
- Surface water features (watercourses and HDFs)
- Recharge and Discharge Areas

Each of these elements to varying degrees has required an integrated assessment in order to establish the significance and associated sensitivity of the features, particularly in the context of the proposed urbanizing setting; the following provides some associated guidance in this regard:

i. Natural Heritage Units
    - diversity and significance of species (flora and fauna)
    - potential for corridor linkage and benefits to key biota
    - presence/absence of fluvial unit
    - local catchment area (size and land use)

- groundwater influence to sustainability of habitats and functions
- feature size, plant community diversity, and proximity to other features

ii. Watercourses and Headwater Drainage Features
- presence/absence of form/stability
- baseflow /intermittent/permanent
- groundwater discharge (reach specific)
- presence/absence of riparian corridor vegetation
- bankfull/riparian/flood flows
- floodplain
- erosion sensitivity
- fish habitat (direct/indirect)
- benthic invertebrates
- temperature/water quality

iii. Recharge and Discharge Areas
- rate of infiltration/recharge
- location of functional recharge areas
- functional relationship to watercourses, wetlands or terrestrial features
- quantity of groundwater flux

The foregoing factors/considerations (and others) have been summarized as they relate to the respective environmental units, features and systems. The following sections provide insight regarding these units, features and systems, which have been used in subsequent study stages to inform the preliminary and future land use planning process.

2.4.2 Preliminary Management Strategy

The results of the foregoing impact assessment have been used to establish a preliminary management strategy for the NHS, watercourses, and water resources systems for the FSA. Where available, recommendations from previous studies have been used to determine specific quanta and metrics, and are referenced as appropriate in the following sections.

2.4.2.1 Water System (Surface and Ground)

The results of the impact assessment have demonstrated that, in the absence of stormwater management, future development within the FSA would be anticipated to increase the risk of flooding and erosion along receiving drainage features within the FSA and downstream, as well as degrading the quality of surface runoff to aquatic habitat and terrestrial features and the supply of surface water and potentially groundwater to sensitive features. Previous studies within the respective subwatersheds encompassing the FSA include recommendations for stormwater management, which serve as an indication of the stormwater management requirements for the FSA, subject to further assessment as part of subsequent studies. The following provides an overview of stormwater management criteria for flood control, erosion control, water quality control, and water budget management for similar developments within the subwatersheds and in other municipalities through the GTA.

Flood Control:

The end-of-pipe storage volume requirements for flood control, above extended detention storage volume requirements, vary according to soil type, surface slopes, and land use conditions. No stormwater management facility sizing criteria has been provided for development within the Main Humber River or West Humber River Subwatershed; in the absence of this information, a literature review has been completed for subwatershed studies in various municipalities across the GTA (i.e. Mississauga, Brampton, Markham, and Milton) to determine the potential range of unitary storage volume required for quantity control for the 100 year and Regional Storm events. The range of incremental detention storage volumes within end-of-pipe facilities for 100 year and Reigional Storm control based upon a literature review of subwatershed study recommendations through the GTA, is summarized in Table 2.4.2.1. The specific requirements for mitigating flooding impacts will need to be determined as part of future studies. It is also important as part of future studies to not only assess the impacts locally but also on a subwatershed basis to ensure that hydrograph timing effects are considered when establishing the levels of control warranted by the proposed development. Furthermore, as noted previously, the sizing of flood control facilities should consider the influence of climate change, and should therefore assess stormwater management facility performance for climate adjusted storm events.

Table 2.4.2.1: Range of Detention Storage Requirements for 100 Year and Regional Storm Event Flood Controls Across GTA (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume[1. 2.]
100 Year	400 - 1250
Regional Storm Event	0 - 1200

NOTES: 1. Unitary 100 year storage volumes are exclusive of extended detention storage requirements for erosion and/or stormwater quality control.

2. Unitary Regional Storm event storage volumes are in addition to 100 year storage volumes and extended detention storage volume requirements.

Erosion Control:

Similar to flood control volume requirements within end-of-pipe facilities, the extended detention storage volume requirements for erosion control vary according to soil type, surface slopes, and land use conditions. In addition, analyses completed for the Fletcher's Creek and Huttonville Creek Subwatershed Study (Amec et. al., June 2011) indicate that extended detention storage requirements may be reduced through the implementation of LID infiltration BMPs as part of the formal stormwater management plan for the development area. No stormwater management facility sizing criteria has been provided for development within the Main Humber River or West Humber River Subwatershed; in the absence of this information, a literature review has been completed for subwatershed studies in various municipalities across the GTA (i.e. Mississauga, Brampton, Markham, and Milton) to determine the potential range of unitary extended detention storage volume required for erosion control. The range of incremental extended detention storage volumes within end-of-pipe facilities for erosion control based upon a literature review of subwatershed study recommendations through the GTA, is summarized in Table 2.4.2.2. The specific requirements for mitigating erosion impacts will need to be determined as part of future studies

Table 2.4.2.2: Range of Extended Detention Storage Requirements for Erosion Control Across GTA (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume.
Extended Detention/Erosion	150 - 500

Water Budget:

For water budget, measures to promote groundwater recharge through the application of LID infitration BMPs will be required to mitigate these impacts. The implementation of these measures will require infiltration of clean runoff (i.e. rootop runoff) and pre-treatment of surface runoff from other paved surfaces (i.e. roads, parking lots, driveways) to maintain the quality of infiltrated surface runoff. Studies completed for other municipalities within the GTA have demonstrated that a relatively modest capture rate (i.e. 1 mm/impervious ha – 6 mm/impervious ha) would be sufficient in may low permeability environments to maintain groundwater recharge for relatively impermeable soils, whereas larger capture volumes (i.e. 10 mm/impervious ha – 15 mm/impervious ha or more) may be required for more permeable soils. The sizing of LID infiltration BMPs should also consider requirements to sustain or augment baseflow within receiving watercourses, hence should include a holistic assessment of the existing groundwater and aquatic systems, potentially requiring a spatially varied sizing criteria for LID infiltration BMPs.

Water Quality:

For stormwater quality control and thermal mitigation, the stormwater quality controls should provide stormwater quality control to anEnhanced standard of treatment per current Provincial guidelines (ref. MOE, 2003), and should also incorporate measures to mitigate thermal enrichment of runoff to receiving systems. In addition to satisfying requirements to provide stormwater quality treatment to an Enhanced Standard, as per current MECP criteria, stormwater quality management for three of the main watercourses in the West Humber Subwatershed are Redside Dace habitat, hence are required to address the requirements outlined in the Guidance for Development Activities in Redside Dace Protected Habitat Version 1.2 (Ministry of Natural Resources and Forestry, March 2016), specifically providing discharge temperatures below 24°C for stormwater Whitebelt management facilities connected to Redside Dace streams and have dissolved oxygen concentrations of at least seven milligrams per litre, and TSS levels less than 25 mg/L above background conditions.

Regulatory Controls:

The results of the offsite impact assessment for the West Humber River have demonstrated that future development within the, Whitebelt upstream of the designated flood vulnerable area (FVA) would increase the risk and frequency of flooding within the FVA compared to existing conditions. Consequently, future development of the FSA within the West Humber Subwatershed would be required to incorporate measures to mitigate the increased risk of flooding through the FVA for all events, including the Regional Storm event. A review of the hydraulic structures through and downstream of the FSA, as documented in the Part A report indicates that the hydraulic structures consist of single or multi-span bridges, hence hydraulic structure upgrades are anticipated to be less feasible as the size of opening has, in most instances, been optimized for hydraulic conveyance. As such, it is anticipated that Regional Stom controls for the FSA, to mitigate increased flood risk to the downstream known FVAs, would be required. Where feasible this could consist of additional detention storage within end-of-pipe facilities. Where detention storage within end-of-pipe facilities is infeasible or less practical, alternative measures (i.e. strategic online storage, use of NHS buffers, distributed system storage etc. per the Guidance in TRCA, 2016) may be investigated, however would be required to consider environmental conditions and constraints in establishing these alternatives.

Upper Etobicoke Creek:

Flooding:

The end-of-pipe storage volume requirements for flood control for the Upper Etobicoke Creek Subwatershed have been previously provided within the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan (Amec et. al., December 2014). The volume requirements are presented in Table 2.4.2.3, per the recommendations of that study.

Table 2.4.2.3: Detention Storage Requirements for 100 Year and Regional Storm Event Quantity Control for Upper Etobicoke Creek per Amec et. al., December 2014 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume[1, 2]
100 Year	575
Regional Storm	0

NOTES: 1. Unitary 100 year storage volumes are exclusive of extended detention storage requirements for erosion and/or stormwater quality control.

2. Unitary Regional Storm event storage volumes are in addition to 100 year storage volumes and extended detention storage volume requirements.

As noted previously, stormwater management sizing criteria for quantity control are dependent upon the type and extent of development within a given study area, hence it is anticipated that the stormwater management requirements for the FSA within the Upper Etobicoke Creek Subwatershed would differ from those determined for the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan. In that regard, it is anticipated that the storage volumes required for 100 year and Regional Storm control would be comparable to the range provided in Table 2.4.2.1, rather than the values outlined in Table 2.4.2.3. Nevertheless the storage volume requirements are to be determined as part of future studies. In addition, as discussed earlier, off-site impact management needs to be assessed both locally and regionally at a subwatershed scale, to ensure that hydrograph timing effects will be considered. This will be particularly important for the Etobicoke Creek through Downtown Brampton where works are planned as part of the Riverwalk project to protect the City's downtown core from major flooding., as advanced in the Downtown Brampton Flood Protection Environmental Assessment (AECOM, June 2020).

Erosion:

The end-of-pipe extended detention storage volume requirements for erosion control for development within the Upper Etobicoke Creek Subwatershed have been previously provided within the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan (Amec et. al., December 2014). The volume requirements are presented in Table 2.4.2.4, per the recommendations of that study.

Table 2.4.2.4: Extended Detention Storage Requirements for Erosion Control for Upper Etobicoke Creek per Amec et. al., December 2014 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume
Extended Detention/Erosion	325

As noted previously, stormwater management sizing criteria for erosion control are dependent upon the type and extent of development within a given study area. As such, it is anticipated that the stormwater management requirements for the FSA within the Upper Etobicoke Creek Subwatershed would differ from those determined for the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan. and are to be determined as part of future studies.

Fletcher's Creek:

Flooding:

The end-of-pipe storage volume requirements for flood control within the Fletcher's Creek Subwatershed have been previously provided within the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan (Amec et. al., December 2014), as well as the Fletcher's Creek and Huttonville Creek Subwatershed Study for Northwest Brampton (Amec et. al., June 2011). The range of volume requirements are presented in Table 2.4.2.5, per the recommendations of those studies.

Table 2.4.2.5: Detention Storage Requirements for 100 Year and Regional Storm Event Quantity Control for Fletcher's Creek per Amec et. al., December 2014 and Amec et. al., June 2011 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume[1, 2]
100 Year	600 - 1250
Regional Storm	0 - 1225

NOTES: 1. Unitary 100 year storage volumes are exclusive of extended detention storage requirements for erosion and/or stormwater quality control.

2. Unitary Regional Storm event storage volumes are in addition to 100 year storage volumes and extended detention storage volume requirements.

The information in Table 2.4.2.5 indicates that the detention storage volume requirements for the Fletcher's Creek Subwatershed, as determined by previous Subwatershed Studies, varies by location. Nevertheless, given that the portion of the FSA within the Fletcher's Creek Subwatershed is proximate to the locations and extent of development assessed as part of previous studies, it is anticipated that the detention storage volume requirements for quantity control would be in the range established as part of the previous studies. The specific storage volume requirements will be determined as part of future studies. In addition, as discussed earlier, off-site impact management needs to be assessed both locally and regionally at a subwatershed scale, to ensure that hydrograph timing effects will be considered. Furthermore, as noted previously, the sizing of flood control facilities should consider the influence of climate change, and should therefore assess stormwater management facility performance for climate adjusted storm.

Erosion:

The end-of-pipe extended detention storage volume requirements for erosion control within the Fletcher's Creek Subwatershed have been previously provided within the Mayfield West Phase 2 Comprehensive Environmental Impact Study and Management Plan (Amec et. al., December 2014) as well as the Fletcher's Creek and Huttonville Creek Subwatershed Study for Northwest Brampton (Amec et. al., June 2011). The volume requirements are presented in Table 2.4.2.6, per the recommendations of those studies.

Table 2.4.2.6: Extended Detention Storage Requirements for Erosion Control per Amec et. al., December 2014 and Amec et. al., June 2011 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume
Extended Detention/Erosion	250

As noted previously, stormwater management sizing criteria for erosion control are dependent upon the type and extent of development within a given study area. While the stormwater management sizing criteria for the FSA to provide erosion control within the Fletcher's Creek Subwatershed may differ from those determined for the December 2014 and June 2011 Subwatershed Studies, it is anticipated that the unitary sizing criteria would be comparable to those determined from the previous studies for similar land use conditions (i.e. residential). Furthermore, the results of the June 2011 Subwatershed Study indicate that extended detention storage requirements may be reduced through the implementation of LID infiltration BMPs, as part of the formal stormwater management plan for the development area. End-of-pipe extended detention storage requirements for erosion control will be determined as part of future studies.

Huttonville Creek:

Flooding:

The end-of-pipe storage volume requirements for flood control, above extended detention storage volume requirements, have been previously provided for development within the Huttonville Creek Subwatershed within the Fletcher's Creek and Huttonville Creek Subwatershed Study for Northwest Brampton (Amec et. al., June 2011). The range of volume requirements are presented in Table 2.4.2.7, per the recommendations of those studies.

Table 2.4.2.7: Detention Storage Requirements for 100 Year and Regional Storm Event Quantity Control for Huttonville Creek per Amec et. al., June 2011 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume[1, 2]
100 Year	550 - 1150
Regional Storm	975 - 1200

NOTES: 1. Unitary 100 year storage volumes are exclusive of extended detention storage requirements for erosion and/or stormwater quality control.

2. Unitary Regional Storm event storage volumes are in addition to 100 year storage volumes and extended detention storage volume requirements.

The information in Table 2.4.2.7 indicates that the detention storage volume requirements for the Huttonvilile Creek Subwatershed, as determined by previous Subwatershed Studies, varies by location. Nevertheless, given that the portion of the FSA within the Huttonville Creek Subwatershed is proximate to the locations and extent of development assessed as part of previous studies, it is anticipated that the detention storage volume requirements for quantity control would be in the range established as part of the previous studies. The specific storage volume requirements will be determined as part of future studies. In addition, as discussed earlier, off-site impact management needs to be assessed both locally and regionally at a subwatershed scale, to ensure that hydrograph timing effects will be considered. Furthermore, as noted previously, the sizing of flood control facilities should consider the influence of climate change, and should therefore assess stormwater management facility performance for climate adjusted storm events.

Erosion:

The end-of-pipe extended detention storage volume requirements for erosion control within the Huttonville Creek Subwatershed have been previously provided within the Fletcher's Creek and Huttonville Creek Subwatershed Study for Northwest Brampton (Amec et. al., June 2011). The range of volume requirements are presented in Table 2.4.2.8, per the recommendations of those studies.

Table 2.4.2.8: Extended Detention Storage Requirements for Erosion Control per Amec et. al., June 2011 (m^3/impervious hectare)

Operating Condition	Unitary Storage Volume
Extended Detention/Erosion	200 - 325

As noted previously, stormwater management sizing criteria for erosion control are dependent upon the type and extent of development within a given study area. While the stormwater management sizing criteria for the FSA to provide erosion control within the Huttonville Creek Subwatershed may differ from those determined for June 2011 Subwatershed Study, it is anticipated that the unitary sizing criteria would be comparable to those determined from the previous study for similar land use conditions (i.e. residential). Furthermore, the results of the June 2011 Subwatershed Study indicate that extended detention storage requirements may be reduced through the implementation of LID infiltration BMPs as part of the formal stormwater management plan for the development area. End-of-pipe extended detention storage requirements for erosion control will be determined as part of future studies.

General SWM Practices:

Recognizing the above requirements, the following technologies and practices are available to address the anticipated stormwater management criteria for flood and erosion control, stormwater quality and thermal contol, and maintaining water budget:

Stormwater quantity controls for flooding and/or erosion:

- End-of-pipe facilities (i.e. wetlands, wet ponds, hybrid facilities, dry ponds).
- Source controls (i.e. underground tanks, pipe storage, surface storage in parking lots, rooftop storage).
- LID infiltration BMPs.

Water Budget/Infiltration

- Bioswales/biofilters.
- Infiltration trenches.
- Rain gardens.
- Bumpouts.
- Rain barrels.
- Increased topsoil thickness.
- Perforated pipes/exfiltration systems.
- Exfiltration tanks.

TSS removal as per current (2003) MOE criteria:

- Wet end-of-pipe facilities (i.e. wetlands, wet ponds, hybrid facilities).
- Vegetated technologies (i.e. grassed swales, buffer strips, etc.).
- Oil/grit separators.

- Bioswales/biofilters.
- Infiltration trenches.

Thermal control:

- LID infiltration BMPs
- Urban terrestrial canopy (also NHS)
- Facility shading (includes orientation and length/width ratio)
- Facility cooling trenches
- Facility bottom draws
- Stormwater management facility orientation
- Concrete Sewer System
- Underground Storage Facilities
- Green & White roofs
- Floating Islands
- Other measures

The specific measures applied will need to be established as part of future detailed studies (local SWS), based upon the land use condition of the contributing drainage area, and subject to approval by the respective municipality and Conservation Authority, and Provincial ministries including MECP. In addition, given the small size of the FSA discharging toward the Credit River Main Branch and the Huttonville Creek Subwatershed, the development area discharging toward those stormwater management facilities may be too small to sustain wet-of-pipe facilities, thus requiring source controls for stormwater quality, quantity, and erosion control.

As indicated in the foregoing, it is anticipated that LID BMPs will form a component of the stormwater management plan specifically to maintain groundwater recharge and manage water budget, and potentially to augment erosion protection for the receiving watercourses. This may also include source controls to provide stormwater quantity control for development areas which are too small to support wet end-of-pipe facilities. Several technologies and techniques are available for incorporating into the stormwater management plan for future development areas, however it is recognized that each LID BMP provides different functional benefits. A summary of the function for common LID BMPs and source controls is provided in Table 2.4.2.9.

Table 2.4.2.9: Stormwater Management Function Provided by Selected LID Stormwater BMP's and Stormwater Source Control Practices

Practice	Flood Control	Erosion Control	Quality Control	Runoff Volume Reduction	Groundwater Recharge
Rooftop Storage	X				
Parking Lot Storage	X				
Amended Topsoil		X	X	X	X
Green Roofs		X	X	X	
Oil/Grit Separators			X		
Rainwater Harvesting		X		X	
Pervious Pipes		X	X	X	X
Oversized Pipes	X				
Permeable Pavement		X	X	X	X
Soakaway Pits		X	X	X	X
Infiltration Trenches		X	X	X	X
Bumpouts		X	X	X	X
Grassed Swales			X		
Biofilters/Bioswales		X	X	X	X

In addition to the foregoing practices, the stormwater management system should be established with consideration for the influence of climate change. In this regard, the stormwater management facility performance should be assessed for climate adjusted storm events. The planning of quantity controls for these events should account for the influence of any proposed Regional Storm control facilities, applying an appropriate methodology .

Site Grading Considerations:

The portion of the FSA within the Main Humber Subwatershed, as well as portions within the West Humber Subwatershed and Upper Etobicoke Creek Subwatershed are located adjacent to confined and well defined watercourse features. The overburden thickness mapping in these areas suggests deeper groundwater levels within the tableland in these locations, hence it is anticipated that requirements for imported fill in these locations would be limited, and cut and fill may be balanced at the site to achieve the grades required for storm servicing.

Other portions of the FSA within the West Humber Subwatershed and the Upper Etobicoke Creek Subwatershed discharge toward unconfined but regulated watercourses. In these areas it is anticipated that imported fill may be required to achieve the grades required for storm servicing, although the quantity of imported fill would be anticipated to be relatively minor.

For the balance of the FSA which extends through the headwaters of Fletcher's and Huttonville Subwatersheds, as well as within the subwatershed discharging to the Main Credit River and within the headwaters of the West Humber and Upper Etobicoke Creek Subwatershed, the areas are drained by and toward headwater drainage features and watercourses with limited definition. In these areas, it is anticipated that imported fill would be required in order to achieve the grades required for storm servicing. The volume required may be offset by grading portions of these sites to drain toward deeper valley systems within the Upper Etobicoke Creek Subwatershed and the Humber Watershed, however this would be subject to further assessment as part of future studies and approval by the municipality and the Conservation Authority.

All site grading will be required to comply with Town of Caledon development design standards, and should include evaluations of major and minor system conveyance capacity. Evaluating major system conveyance capacity for events greater than the 100 year return period should be considered, to account for the potential influence of climate change in the design of the municipal pluvial system.

2.4.2.2 Drainage Features – Watercourses and HDFs

Feature Classification and Management Strategies

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.

Stream management is to be approached on a reach or feature basis as these units display relative homogeneity with respect to form, function, and habitat. Key management practices, in terms of stream morphology, are recommended according to the geomorphic constraint rating, or HDF management recommendation. Management strategies may include several options, or specific guidance. Note that HDF assessments are required through future study, and only then may management recommendations be determined.

Generally, watercourse features are protected and regulated by the Conservation Authority, while HDFs are not generally regulated. Both Watercourses and HDFs may provide some important functions 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 rationale 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 is ongoing and will be completed following further development of the land use plan and delineation of the SABE. Constraint rankings and management recommendations for watercourses will be reported in a subsequent iteration of the impact assessment. In the current scoped study, this can only be completed based on existing data with some minor field confirmation, and recommendations for further analysis. As a result, constraint rankings determined in this study may be considered preliminary, as field observations are required to characterize surface water feature function. HDF assessments cannot be completed in any capacity under the current desktop scope of work, as they require seasonally-based field investigations to evaluate form and function on a feature-by-feature basis.

Watercourse Feature Constraints – Classification & Management

An integration of key characteristics and functions, for each discipline will be applied in the development of a constraint ranking for watercourses within the SABE. 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 for the SABE 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 (mapped as solid red lines)

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. These watercourses have an associated erosion hazard (meander belt or stable top of slope). .

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.

High-constraint watercourses and their corridors are to be protected in current form and location, with appropriate regulatory setbacks and ecological buffers. Minor modification through rehabilitation/enhancement may be acceptable at select locations where it provides an enhancement to the system, given sufficient rationale.

Medium Constraint Watercourses (mapped as solid blue lines)

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,

Medium Constraint watercourses are to remain open and protected with applicable hazard corridors, regulatory setbacks, and ecological buffers. Channel/corridor realignment (horizontal and vertical) may occur where restoration and enhancement is included in design options.

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.

If constraint analysis does not designate a watercourse as having high or medium constraint, it will be classified as a low constraint. For the purpose of mapping at the Scoped Subwatershed Study scale, these features will be designated as headwater drainage features. However, their feature type and presence cannot be confirmed at the desktop scale, 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.

Headwater Drainage Features

Headwater Drainage Features are not being mapped or evaluated in detail in the current study, and future work through subsequent planning stages is required to confirm these features and evaluate them following the CVC/TRCA (2014) guidelines (Table 2.4.2.10) will allow for management recommendations to be mapped similarly to the constraint rankings presented here for watercourses. In the current study, 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, constraints and management will be addressed through the lens of the appropriate policy framework. Integration with other study components will capture such "red-flags" for each feature, where possible through the scoped level of study. This integration and identification of constraints around HDFs at a desktop level will be completed for features within the SABE.

Table 2.4.2.10: Recommended HDF Management Classifications (TRCA/CVC 2014)

HDF Classification	Description/Management
Protection	Important Functions: e.g. swamps with amphibian breeding habitat; perennial headwater drainage features; seeps and springs; SAR habitat; permanent fish habitat with woody riparian cover • Protect and/or enhance the existing feature and its riparian zone corridor, and groundwater discharge or wetland in-situ; • Maintain hydroperiod; • Incorporate shallow groundwater and base flow protection techniques such as infiltration treatment; • Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted; • Design and locate the stormwater management system (e.g. extended detention outfalls) are to be designed and located to avoid impacts (i.e. sediment, temperature) to the feature.
Conservation	Valued Functions: e.g. seasonal fish habitat with woody riparian cover; marshes with amphibian breeding habitat; or general amphibian habitat with woody riparian cover. • Maintain, relocate, and/or enhance drainage feature and its riparian zone corridor; • If catchment drainage has been previously removed or will be removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible; • Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary; • Maintain or replace external flows, • Use natural channel design techniques to maintain or enhance overall productivity of the reach; • Drainage feature must connect to downstream.

Mitigation	Contributing Functions: e.g. contributing fish habitat with meadow vegetation or limited cover • Replicate or enhance functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream; • Replicate on-site flow and outlet flows at the top end of system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage); • Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater practices (refer to Conservation Authority Water Management Guidelines for details);
Recharge Protection (the current study recommends that recharge protection is incorporated into the 'mitigation' classification)	Recharge Functions: e.g. features with no flow with sandy or gravelly soils • Maintain overall water balance by providing mitigation measures to infiltrate clean stormwater, unless the area qualifies as an Area of High Aquifer Vulnerability under the Oak Ridges Moraine Conservation Plan (ORMCP) or Significant Recharge Areas under the Source Water Protection Act. These areas will be subject to specific policies under their respective legislation. • Terrestrial features may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with them.
Maintain or Replicate Terrestrial Linkage (the current study recommends that terrestrial linkages are incorporated into the 'Conservation' classification)	Terrestrial Functions: e.g. features with no flow with woody riparian vegetation and connects two other natural features identified for protection • Maintain the corridor between the other features through in-situ protection or if the other features require protection, replicate and enhance the corridor elsewhere • If the feature is wider than 20 m, it may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with it.
No Management Required	Limited Functions: e.g. features with no or minimal flow; cropped land or no riparian vegetation; no fish or fish habitat; and no amphibian habitat. • The feature that was identified during desktop pre-screening has been field verified to confirm that no feature and/or functions associated with headwater drainage features are present on the ground and/or there is no connection downstream. These features are generally characterized by lack of flow, evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation. No management recommendations required.

Erosion Hazard Corridors

Watercourse features and associated hazard limits (i.e. meander belts for unconfined systems, and stable top of slopes for confined systems) should be incorporated into the development of the NHS in order to protect the feature and habitat, as well as to mitigate risks associated with the hazard. Following designation of geomorphic constraint rankings to each watercourse reach, should a medium constraint watercourse be realigned or relocated, a design meander belt and appropriate setbacks should be developed and then incorporated into the NHS. Realignment recommendations and opportunities (locations) are not explicitly identified in a subwatershed study, however, features that may be recommended for realignment based on the current characterization or function (e.g. degraded, channelized) are provided at a preliminary level. Where necessary, natural channel design may be utilized for high-constraint (red) watercourses to address an immediate issue or permit the construction of essential infrastructure.

Corridor Enhancements and Rehabilitation

Enhancements of watercourse corridors should include the removal of barriers to the movement of water and sediment in the downstream direction, and fish in the upstream direction (e.g. severe debris jams/dams, weirs), provided they do not serve a necessary function (e.g. grade control). In the case of grade control weirs, opportunities to replace the structure with natural channel design features (e.g. a series of riffles) should be explored.

Rehabilitation options to improve the geomorphic function of watercourses, primarily those of medium constraint classification that been previously channelized or modified by agricultural practices may include:

- Re-establish a functioning floodplain: Creating a bankfull channel with better connectivity to a wider floodplain, or terrace, allows flows and fine sediment to overtop the banks during periods of high water levels. This excess water would then travel across the floodplain, dissipating energy across a much larger surface area. Vegetation would also decrease velocity, thus reducing erosion issues downstream

- Provide a low-flow channel: Creating a low-flow channel will provide storage and refugia for aquatic organisms during drought conditions as well as reducing the potential for sedimentation within the channel.

- Re-establish a 'natural' meander planform: Using reference reaches as an indication of channel planform prior to agricultural influences; it is obvious that historical ditching and straightening has removed the natural meander planform of many reaches within the study area. This channelization effectively increases stream gradient and, consequently, the stream energy available to erode bed and banks. The restoration of a more 'natural' meandering planform can help to re-establish more natural geomorphological processes and increase geomorphological diversity.

- Re-establish riparian vegetation: Re-establishing a healthy riparian vegetation community can help increase bank stability in addition to creating shading and improving fish and wildlife habitat. The provision of bank vegetation also provides a source of woody debris and organic matter for the stream, as well as providing a natural buffer to reduce fine sediment input from tilled agricultural fields.

Maintenance of Channel Length and Sediment Supply

Stream length and sinuosity should be maintained at a minimum, unless rationale is provided where a balance cannot be maintained between pre- and post- construction. Drainage density targets have historically been applied to maintain stream length and function but have not been specifically evaluated in the Phase 2 impact assessment. . Previous work, applied the more historical SWS practice of developing drainage density targets. For reference these include, the Huttonville Creek, Springbrook Creek and Churchville Tribtuary SWS (2004) identified drainage densities of 4.17 km/km^2 and 4.23 km/km^2 for Huttonville Creek and Springbrook Creek respectively, and provided drainage density targets ranging from 1.21 – 4.21 km/km^2.

Although there have been drainage density targets developed for existing areas within and downstream of the FSA, the trend towards a feature by feature evaluation of headwaters through the application of TRCA/CVC (2014) guidelines provides a more comprehensive and detailed approach to managing drainage features than a drainage density target has historically. It is recommended to apply the constraint ranking methodology for watercourses and HDF evaluations to determine appropriate strategies to manage surface water features that maintains or enhances the function of each feature.

The HDF management recommendations that will be determined for each feature will essentially act to maintain the functional role of each feature to supply water and sediment in the downstream direction. It is also noted that sediment supply / transport under existing conditions is influenced by human activities, including agricultural land management and potential inputs from road surface drainage, and therefore does not represent "natural" conditions. Conservation and Mitigation management recommendations maintain connectivity, and the supply role of each feature. Some features may be replicated with LID BMPs or swales to maintain the primary function(s).

Channel design and subsequent channel management practices will be required to encourage the delivery of natural sediment supply. Streams in corridors should be designed such that natural erosion may occur in keeping with the nature of the channel, thereby replicating the natural potential to generate sediment for transport downstream. Naturalization of swales in urban areas should be encouraged where possible to facilitate natural sediment generation.

It is however noted, that it is not necessarily desirable to replicate current sediment supply conditions in the headwaters since these are heavily impacted by agricultural practices, resulting in potential higher volumes of fine sediment conveyance of poor quality than would occur under more "natural" conditions.

Road Crossings

Road crossings should be oriented and sized appropriately using geomorphic risk factors (e.g. bankfull width, channel stability, erosion rates, meander amplitude), ref. "Road Crossings and Alignments" in Section 2.3.4.2.

Erosion Thresholds and SWM

Critical discharges should be applied as SWM targets to mitigate adverse erosion downstream following development and major alteration to site hydrology. Future studies should identify potential SWM discharge locations and erosion thresholds should be determined for receiving watercourses, and then compared to values adjacent and downstream for representativeness and sensitivity.

2.4.2.3 Natural Heritage System

Management of the Natural Heritage System will focus on the following primary objectives:

- **Protect** features of the NHS, including through the application of appropriate **buffers**
- *Where appropriate*, consider **replication** of existing features in a location that better supports its form and function in the context of the NHS as a whole.
- Connect the system through **linkages** at multiple scales to ensure the continued flow and movement of species and materials across the landscape
- **Enhance** the NHS through habitat creation or restoration

These management objectives support the protection and long-term sustainability of the NHS and consider its connectivity and value to areas beyond its limits. Mapping and analyses presented below represents an NHS for the FSA, however it is important to note that ultimately, the NHS will be defined for the SABE and as such, refinements to the analyses and information presented here will be updated as the SABE is confirmed. Similarly, management strategies and implementation will apply to the refined area of the SABE. Each of the management objectives listed above is briefly outlined below.

Protecting Features of the NHS

The Characterization Report (Part A) prepared preliminary NHS criteria in consideration of an analysis of existing conditions (scoped to available information) and applicable policies (e.g., PPS, Greenbelt Plan, Growth Plan, ROP). As ELC mapping was used to identify the sSWS preliminary key features, it is expected that there will be discrepancies with mapping based historical data (e.g. MNRF locations and boundaries of wetlands).

Application of the criteria developed through the Characterization Report generated a map showing the preliminary features of the FSA NHS (Figure DA6a, Appendix G). Table 2.4.2..11 provides a summary of the features of the FSA NHS identified as Key Features and Supporting Features.

Table 2.4.2.11: Composition of Preliminary FSA NHS Features

Feature Type[a]	Key Feature			Supporting Feature		
	ha	% of NHS	% of FSA	ha	% of NHS	% of FSA
Wetland	181.6	18%	2%	19.4	2%	<1%
Woodland	387.2	39%	5%	25.7	3%	<1%
Valleyland	479.3	48%	6%	224.5	23%	3%
Savannah, Sand Barren	18.1	2%	<1%	n/a	n/a	n/a
Totals[bc]	**814.2**	**82%**	**10%**	**178.9**	**18%**	**2%**

[a] No ESAs, Provincially or Regionally Significant ANSIs occur within the FSA.
[b] Feature types overlap within the NHS. As such, totals and a sum of individual feature types do not align. Totals account for overlap and represent the total land area occupied.
[c] 3.0 ha of 'other woodland' were also identified. These are not considered part of the NHS. They are represented in the totals

Combined, Key Features and Supporting Features represent 12% of the FSA; of this 10% of the FSA (~814ha) is Key Features and 2% is Supporting Features. Under existing conditions, approximately 15% of the FSA is comprised of natural cover (i.e. vegetation communities).

As noted, natural features and areas across the FSA are largely linear and focused along existing watercourses and valley systems. This distribution is reflected in the composition of the NHS with Valleylands comprising 48% of the Key features and 23% of the Supporting Features identified. It is acknowledged that limits of valleylands will be assessed and confirmed through subsequent levels of study, as additional and more detailed site-level information becomes available.

When considering the preliminary FSA NHS to other systems identified within the FSA, the FSA NHS captures:

- 82% of the CA NHS (excluding enhancement areas)
    - The CA NHS considers all natural cover. The preliminary FSA NHS does not capture open successional habitats such as cultural savannahs, thickets and meadows with the exception of those as may be identified as meeting Significant Wildlife Habitat criteria through subsequent levels of study. This represents a key difference in these two systems.
    - Where these natural vegetation communities occur within proposed restoration areas or linkages, they are recommended to be retained. Recommendations for enhancement

opportunities also considers the target to maintain or enhance these habitats on the local landscape. This is discussed in the Implementation Report (Part C).

- 55% of the Province's NHS
    - The Province's NHS was developed at a very coarse scale. It includes features, linkages and adjacent landscape areas which may be suitable for enhancement. These differences in delineation are evident in the comparison.
    - With the introduction of enhancement areas through , better alignment between these systems is expected.
    - As part of the more detailed SABE Impact Assessment, policy boundaries for the Greenbelt Plan NHS and the Growth Plan NHS will be integrated with the sSWS NHS mapping to show areas of overlap/differences.
- 99% of the Greenlands Core Areas
    - Policies of the ROP were a major policy driver for identification of Key Features for the FSA NHS. As such, alignment between the mapped Greenlands Core Areas and the FSA NHS were expected.
    - Per Table 2.1.5.6, Valleylands represent the predominant feature type of the NHS. Mapping for this feature class is a mapped component of the Greenland Core Areas and was used to inform and delineate the Preliminary FSA NHS.
    - Although all Greenlands Core Areas should be captured as key features,minor discrepancies exist where Core Areas have either been developed, converted to agricultural lands, or classified as a different feature type based on current data (e.g. historically identified as a woodland or wetland and identified as a lower constraint feature type based on ELC data).

Buffers

Buffers are implemented to protect an NHS feature and its ecological functions by mitigating impacts of a proposed development, change in adjacent land use, or site alteration. The extent of buffers, and activities that may be permitted within, should be based on the sensitivity and significance of the natural heritage feature and its contribution to the long-term ecological functions of the FSA NHS. Guidance for buffer widths is typically achieved through a detailed local subwatershed study or similar study which provides landscape context but is informed by site-specific information. Due to the scoped nature of the current Scoped SWS, only preliminary guidance is provided in the Implementation Plan (Part C).

Within the Greenbelt Plan NHS, buffers are called Vegetation Protection Zones (VPZ) and are prescribed specific widths within its policies. VPZs shall apply within the applicable areas of the Plan.

Buffers are typically vegetated (and in the case of VPZs shall be vegetated), whether through planting or natural regeneration; as such, they become 'natural' and provide habitat for wildlife. The vegetation within buffers or VPZs enhance the function of the buffer to mitigate impacts to the feature. While naturally vegetated buffers will provide habitat for wildlife and potentially enhance the functions of the feature, they should not (according to their intended purpose) be identified or managed as part of the feature; rather, they should be treated and managed for the function they were intended to fulfil, which is to provide protection from impacts resulting from changes in adjacent land use.

Buffers are considered a Supporting Feature in the NHS.

Buffer widths are generally as determined through a site-specific studies (e.g., Subwatershed Study, Environmental Impact Study, or other similar study) that examines a sufficiently large area at a sufficient level of detail to determine the significance and sensitivity of features. Through the current scoped subwatershed study, preliminary buffer recommendations are made; these are to be confirmed or revised through a detailed subwatershed study or comparable study, at the local scale, as additional information becomes available.

Recognizing that protection zones in the form buffers will be applied to key features, a preliminary 30 m buffer has been applied to areas identified as key features in the NHS (Figures DA2-6, DA2-7, and DA2-8).

Feature Replication

Key Features are to be retained in-situ and wherever possible, Supporting Features are to be retained in situ. There may be occurrences where retaining a feature in-situ in an urbanizing landscape matrix will result in an impact to its form or function that cannot be reasonably mitigated. In these instances, consideration may be given to replication of the feature (like for like or net benefit) in a location in close proximity to its original location that will ensure its form and function and sustained for the long term and that provides a benefit to the NHS.

Not all feature types are appropriate to consider for replication. Preliminary guidance is provided below.

- Potentially suitable features:
  - Low hydrologic interactions and/or complexity (groundwater infiltration, contributions)
  - Low species diversity
  - Low wildlife habitat function(s)
  - Simple structure(s) (substrate, vegetation)
  - Short establishment period to replace function being replicated (<2 years)
- Poor suitability features:
  - Complex hydrologic interactions and/or complexity
  - Receive or are dependent on groundwater for their composition or function
  - Moderate to high species diversity
  - Moderate to high wildlife habitat functions
  - Complex structures (substrate, vegetation)
  - Longer establishment period to replace function being replicated (>5 years)
  - Support specialized habitat or habitat for *significant* species

Feature replication is to be used only in cases where retention in-situ will result in impacts that cannot be reasonably mitigated. Replication is not to be used to clear an area of features for the purposes of development. All reasonable mitigation options must be considered in advance of proposing replication. Feature replication is to be like-for-like (e.g. a tableland wetland must be replicated as a tableland wetland) and provide a net benefit to the NHS. Interactions between the feature and other elements of the NHS and WRS must be taken into consideration in determining whether replication is appropriate.

Linkages

Under existing conditions, the landscape of the FSA is relatively permeable to wildlife (i.e. wildlife is able to move across the landscape without significant barriers) (Figure DA2-3). As the landscape matrix urbanizes, landscape permeability will decline. Identification and implementation of linkages forms a critical component of the NHS to maintain connectivity within the system and to areas outside of the FSA. Identifying linkages for the FSA. The following objectives has guided the approach and development of criteria for linkages for the FSA NHS:

- Ensure a connected NHS that can support existing functions under a developed land use scenario.

- Maintain and where possible enhance movement and connectivity to features and areas within and external to the FSA.
- Explore opportunities for softened interfaces between the natural and built environment that support the NHS and WRS.

To achieve these objectives the following general approach has been used:

- Use available literature, NHS features and supplementary analyses (e.g., habitat connectivity) to inform identification of landscape linkage locations and establish recommended linkage parameters (widths, design, etc.)
- Identify and enhance connections along existing pathways / corridors where possible and across the landscape where necessary.
- Identify linkages to replace landscape permeability that will be lost through land development north-south and east-west.
- Use linkages at multiple landscape scales to meet connectivity objectives.
- Create local-scale connections to maintain feature interactions, including connecting isolated Key Features wherever possible.

In consideration of the above objectives and the general approach advocated for FSA NHS linkages, three linkage categories have been identified:

- **Major Landscape Linkage** | These are large, landscape connections which connect major corridors / areas south of the FSA to those north of the FSA. They are generally aligned with and/or are in the same areas as the province's NHS where linkages are interpreted as a key function. Major Landscape Linkages are comprised of a Minimum Vegetated Width and a Permeable Landscape Zone.

- **Local Landscape Linkage** | These are smaller scale (width) linkages which provide landscape-level connectivity within or to areas external to the FSA. They often provide important redundancy in landscape connectivity, link and connect blocks of features. Local Landscape Linkages are comprised of a Minimum Vegetated Width and a Permeable Landscape Zone.

- **Feature (or Site)-Scale Linkage** | These represent small, localized linkages intended to connect over short distances. Feature-Scale Linkages are comprised of a Minimum Vegetated Width.

The **Minimum Vegetation Width** (MVW) of a corridor represents the <u>minimum</u> width of natural, self-sustaining vegetation to be established within the linkage. MVWs have been developed based on:

- Literature with respect to species requirements
- Existing NHS Key Feature widths through the proposed linkages

Within a given corridor, no areas are to have less than the minimum width of natural self-sustaining vegetation identified for the linkage. All existing natural features and areas within the MVW are to be retained and/or enhanced (Key Features, Supporting Features, other natural vegetation communities). Areas not currently supporting natural, self-sustaining vegetation are to be established as such in accordance with enhancement targets *[enhancement targets have not yet been set. Being considered for a future submission*]. Naturalized widths may be greater than the minimum based on the limits of Key Features, Enhancement Areas, and/or retention of Supporting Features and other natural vegetation. In no way is the MVW intended to indicate or support the removal of features beyond its limit; features are to be considered in the context of the NHS (i.e. as Key Features, Supporting Features, etc.) and applicable protections and policies afforded them, and addressed accordingly.

The **Permeable Landscape Zone** (PLZ) is a blended transition between natural and built form, allowing for some permeable land uses with supportive or complementary functions to occur within this designated portion of a comprehensive linkage (i.e. MVW+PLZ). This zone may be comprised of any combination of the following:

- Key Features
- Supporting Features
- Other natural vegetation communities
- Enhancement Areas
- Non-vegetated areas suitable for linkage-compatible uses

In no way is the PLZ intended to indicate or support the removal of features within or beyond its limit; features are to be considered in the context of the NHS (i.e. as Key Features, Supporting Features, etc.) and applicable protections and policies afforded them, and addressed accordingly. Existing natural vegetation communities are to be retained wherever possible to increase habitat diversity and support total natural cover. Enhancement Areas may also be identified within this zone and are to be addressed in accordance with guidance provided in this Scoped SWS.

[*Additional guidance for permitted uses within the PLZ to be considered in subsequent submission*]

Table 2.4.2.12 provides a summary of Minimum Vegetation Width and Permeable Landscape Zone for each linkage type identified for the FSA.

Table 2.4.2.12: FSA Linkage Types

Linkage Type	Minimum Vegetated Width	Permeable Landscape Zone (total width)	TOTAL
Major Landscape Linkage	100+ m	60+ m	160+ m
Minor Landscape Linkage	60+ m	30+ m	90+ m
Feature (or Site) Scale	30+ m	n/a	30+ m

The values presented in Table 2.4.2.12 represent minimum widths. Where appropriate, corridor widths are to exceed the minimums presented to support connectivity and habitat of the FSA NHS. Implemented widths may be greater than those in the table based on feature limits.

Major Landscape Linkages and Local Landscape Linkages have been mapped for the Scoped SWS and are shown on the "*Preliminary NHS and Landscape Linkages*" Figure (Appendix E); they are briefly considered below.

A total of four Major Landscape Linkages were identified within the FSA. These generally correspond with where the Greenbelt NHS traverses the FSA. They represent major linkages that connect to systems external to the FSA. They provide major movement corridors and are to be of sufficient width to permit large animal movement, provide habitat to support residency and movement of slow animals. The Major Landscape Linkages were mapped using an approximated corridor centerline along Key Features. Linkage widths were based on minimum widths targets and an approximated average width of the NHS Key Features through the corridor where minimum widths were exceeded.

Six Local Landscape Linkages were identified and mapped within the FSA. The Local Landscape Linkages connect the Major Landscape Linkages and provide north-south, east-west movement opportunities. As with the Major Landscape Linkages, these linkages were mapped using an approximated corridor centerline.

Feature (or site) scale linkages have not been mapped at this time; this will be re-visited at the time of the release of the SABE.

Composition of the mapped linkages (Major and Local Landscape Linkages) is provided in Table 2.4.2.13. Wherever possible, linkages followed existing feature pathways; where not available, effort was made to identify minimum distance opportunities for connecting.

Table 2.4.2.13: FSA Linkage Land Cover Summary

	Key Features	Supporting Features	Outside of NHS	Total Area
Major Landscape linkage				591.5 ha
Minimum Vegetation Width	225.7 ha (66%)	3.0 ha (1%)	115.8 ha (34%)	344.6 ha
Permeable Landscape Zone	50.1 ha (20%)	6.6 ha (3%)	189.9 ha (77%)	246.8 ha
Local Landscape Linkage				
Minimum Vegetation Width	118.6 ha (46%)	13.9 ha (5%)	123.5 ha (48%)	256.0 ha
Permeable Landscape Zone	37.7 ha (31%)	4.0 ha (3%)	81.8 ha (66%)	123.48 ha

Enhancement Areas

Enhancements provide opportunities to increase the total natural cover within the NHS. Per the targets set out in the Characterization Report, a minimum recommended target of 11-14% of the FSA developable area is to be identified as enhancement area. For example, if the total land area is 1,000 ha and 300 ha of this is not developable (e.g., is within floodplain, the NHS, etc.), the minimum enhancement area target would be 77 ha (11%) – 98 ha (14%).

Enhancements are considered through two mechanisms:

- Targeted enhancement areas which meet specific criteria and/or objectives to support the system.
    - Specific areas are delineated for enhancement.
    - Targeted enhancement has been used in many SWS to identify areas for restoration with specific objectives for the NHS.
- Area-based enhancements which provide flexible opportunities to support a systems-based approach to enhancement.
    - This area-based enhancement is used in the Province's NHS for the Greater Golden Horseshoe.

Additional consideration for enhancement area opportunities can also be incorporated into the NHS upon completion of the SABE analysis and management recommendations.

Using this combination provides some flexibility during future land use planning processes to inform enhancement opportunities through site-specific study and/or to accommodate best practices for land use planning and design.

Table 2.4.2.14: FSA Preliminary Enhancement Recommendations

Enhancement Type	Feature Types Applicable To	Criteria
Defined Enhancement Areas		
Improved shape, size, contiguity *Small, site-level infill efforts.*	All terrestrial Key Features of the NHS	- Fill gaps, 'holes' or inlets <120 wide within, along the perimeter of, or between Key Features - Fill bays and inlets <1ha within existing Key Feature blocks
Connecting Valleylands and Tablelands *Identify areas / opportunities for upland habitat adjacent to and supporting significant valleylands.*	Significant Valleylands	- Key Features occurring within 60m of a significant valleylands – infill intervening lands.
Floodplain[1] *Opportunities for enhancements presented within floodplains where development is generally restricted.*	Floodplain	- Preliminary identification of floodplain areas as *potential* enhancement areas.
Linkage - MVW *Enhancements associated with the establishment of natural, self-sustaining vegetation to facilitate habitat connectivity for the FSA NHS linkages.*	Minimum Vegetated Width(s) – Major and Local Landscape Linkages, Feature (or Site) Scale Linkages Areas '*Outside the NHS*'	- Portions of the Minimum Vegetated Widths not currently under natural cover are to be restored / enhanced to a natural, self-sustaining vegetation condition.
Un-Defined Enhancement Areas		
Linkage – LPZ *Enhancements associated with the establishment of natural, self-sustaining vegetation to facilitate habitat connectivity for the FSA NHS linkages.*	Landscape Permeability Zone(s) – Major and Local Landscape Linkages Areas '*Outside the NHS*'	- A set % of the LPZ is to be returned to natural, self-sustaining vegetation. - *To be further explored through a subsequent draft.*
Greenbelt Plan NHS *Enhancements within the Greenbelt Plan NHS as directed by the plan*	Land within the Greenbelt Plan NHS and outside of features.	- In accordance with policies of the plan. - Policy 3.2.2.3(e) requires that 30% of the total developable area will remain or be returned to natural self-sustaining vegetation.
Green Infrastructure *Opportunities these provide for wildlife.*	Regional storm management areas / flood mitigation or	- Consider identification of a % restoration objective within these areas as part of a broader /

	attenuation for downstream flood risk areas.	comprehensive approach to considering these within the SSWS. - *To be explored through a subsequent draft.*
Habitat Creation / NHS Expansion *Habitat diversity (heterogeneity), size, shape*	TBD	- % land area restoration in defined areas where habitat creation will provide net benefit to the NHS. - Target % is provided on an area-specific basis. - *Specific habitat opportunities will be identified through subsequent draft(s).*
Climate Change Resilience	TBD	- *To be explored through a subsequent draft.*

[1] It is anticipated that floodplain mapping will be refined through future planning stages. As such areas available for enhancement within floodplains will be refined through future planning stages. Additional refinement of areas identified as this preliminary stage may also be identified through subsequent iterations upon further review and discipline integration.

Defined enhancement areas are shown in Appendix E and are summarized in the table below. Enhancements associated with corridor areas are not mapped in this submission.

Table 2.4.2.15: Defined NHS Enhancement Summary

Defined Enhancement Type	Key Features	% of FSA
Shape, Size, Connectivity	110.3 ha	1.4 %
Connecting Valleys and Tablelands	0.48 ha	0.01 %
Floodplain	361.0 ha	4.5 %
Linkage – Minimum Vegetation Width(s)	239.3 ha	3.0%
Total*	**711.1 ha**	**8.9%**

*Some enhancement areas overlap. As such, please refer to the total line for total land cover occupied.

As mapped, floodplain enhancement opportunities comprise the largest potential enhancement opportunities within the FSA. It is important to note that floodplain limits may be refined through more detailed planning stages as additional information becomes available. Restoration areas should be updated accordingly.

Areas *Outside of the NHS* within the Minimum Vegetation Widths of the Major and Local Landscape Linkages represent the next most significant enhancement opportunities. Like floodplain enhancements, alignment of the linkages may change slightly as more detailed studies are completed; as such, the values represented a preliminary estimate.

Upon completion of the SABE impact assessment and management plan, enhancement areas recommendations will be reconciled against Regional and CA targets of 11%-14%.

2.5 Detailed Scope for Local Subwatershed Study(s)

The general management recommendations outlined in this Scoped Subwatershed Study are to be assessed in detail and refined as part of future Local Subwatershed Studies. The Local Subwatershed Studies are to be completed in support of subsequent Secondary Plans, and prior to consideration of Draft Plan Approvals. The local Subwatershed Studies should include multi-year field work supporting detailed technical analyses including hydrology, hydraulics, hydrogeology, geotechnical investigations, and fluvial geomorphology, as well as an integrated evaluation of aquatic habitat, terrestrial features, watercourse systems, key hydrologic areas and key hydrologic features.

Of particular importance, the Local Subwatershed Studies are required to establish targets for developing the environmental and stormwater management strategy for the respective Secondary Plan Area. In this respect, monitoring programs are to be implemented as part of Local Subwatershed Studies, to provide a more detailed characterization and assessment of the aquatic and terrestrial ecology and water resources systems and the interdependent linkages within these systems, to develop a refined constraint assessment of the natural features and systems within the respective Secondary Plan Area, and calibrate/validate the numerical models used for the hydrologic and hydraulic analyses and groundwater assessment. General Terms of Reference building from this Scoped SWS for Local Subwatershed Studies are included in Appendix F.

3.0 Next Steps

The following summarizes the next steps in completing the Scoped Subwatershed Study:

1. Receive feedback from Peel's SABE Team on Preliminary FSA assessment
2. Workshop with TAC
3. Update Impact Assessment based on SABE details
4. Address TAC comments on Part A
5. Prepare Part B and C reporting

Appendix A

Appendix B

Ground Water

Surface Water

Appendix C

Stream Systems

Appendix D

Geotechnical

Appendix E

Natural Heritage Systems