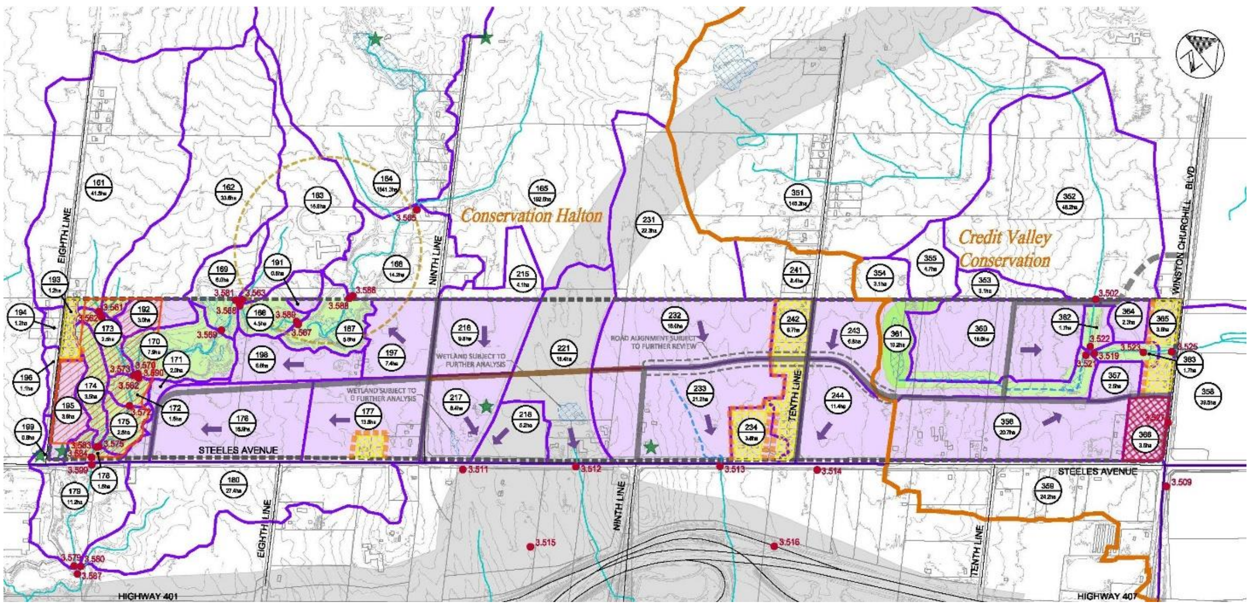
Town of Halton Hills

# Premier Gateway Phase 2B Scoped Subwatershed Study

## Phase 2: Impact Assessment and Management Strategy

November 15, 2023

Final



# Premier Gateway Phase 2B Scoped Subwatershed Study

## Phase 2: Impact Assessment and Management Strategy

Town of Halton Hills

Final

Project No.: WW20101004
Date: November 15, 2023

WSP E&I Canada Limited
3450 Harvester Road
Burlington, ON
Canada  L7N 3W5

wsp.com

# Revision History

**FIRST ISSUE**

| | | |
|---|---|---|
| May 27, 2022 | Draft release of Phase 2 report (as Wood) | |
| Prepared by | Reviewed by | Approved by |
| Aaron Farrell (Wood) | Ron Scheckenberger (Wood) | Aaron Farrell (Wood) |

**DRAFT FINAL**

| | | |
|---|---|---|
| Sept. 18, 2023 | Updated based on agency comments (as WSP) | |
| Prepared by | Reviewed by | Approved by |
| Abhijeet Patel (WSP)<br>Aaron Farrell (HDR) | Matt Senior (WSP) | Matt Senior (WSP) |

**FINAL**

| | | |
|---|---|---|
| November 15, 2023 | Updated based on agency comments (as WSP) | |
| Prepared by | Reviewed by | Approved by |
| Abhijeet Patel (WSP)<br>Aaron Farrell (HDR) | Matt Senior (WSP) | Matt Senior (WSP) |

# Signatures

Approved[1] by (must be reviewed for technical accuracy prior to approval)

November 15, 2023

Per: Matt Senior, M.A.Sc., P.Eng.
Associate, Senior Water Resources Engineer
WSP E&I Canada Limited

Date:

WSP E&I Canada Ltd. (WSP) prepared this report solely for the use of the intended recipient, Town of Halton Hills, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

The original of this digital file will be conserved by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

# Contributors

## Client

| | |
|---|---|
| Project Manager (Town of Halton Hills) | Melissa Ricci |
| Project Manager (Macaulay Shiomi Howson) | Lorelei Jones |

## WSP

| | |
|---|---|
| Project Manager | Matt Senior |
| Hydrology / Hydraulics & Water Quality | Allison Zhang (legacy Wood) |
| Hydrology / Hydraulics & Water Quality | Abhijeet Patel |
| Proof (non-technical) / Format | Melinda Nowak |

## Subconsultants

| | |
|---|---|
| HDR (legacy WSP) Project Manager / Water Resources Lead | Aaron Farrell |
| Natural Resources Solutions Inc., Terrestrial and Aquatic Ecology | Katharina Richter |
| Natural Resources Solutions Inc, Terrestrial and Aquatic Ecology | Nathan Miller |
| Blackport and Associates, Groundwater | Bill Blackport |
| Matrix Solutions Inc., Groundwater | Jeff Melchin |
| Matrix Solutions Inc., Fluvial Geomorphology | John McDonald |
| Matric Solutions Inc., Fluvial Geomorphology | Natasha Cyples |

# TABLE OF CONTENTS

## *Tables*

## *Figures*



## *Appendices*

# 1 INTRODUCTION

The Premier Gateway Phase 2B Lands lie at the southern limit of the Town of Halton Hills and are generally bounded by Steeles Avenue to the south and agricultural lands to the north, between Winston Churchill Boulevard to the east and Eighth Line to the west. The study area straddles the boundary between the Sixteen Mile Creek Watershed in Conservation Halton (CH) jurisdiction, and the Mullet Creek Subwatershed of the Credit River Watershed in Credit Valley Conservation (CVC) jurisdiction. In 2020, the Town of Halton Hills initiated the Premier Gateway Phase 2B Employment Area Integrated Planning Project. This Project represents an integrated planning project that involves both secondary planning and the completion of a Scoped Subwatershed Study.

The Scoped SWS has been established as a three-phase process, as follows:

Phase 1: Study Area Characterization

Phase 2: Impact Assessment and Management Strategy

Phase 3: Implementation and Monitoring

The Draft Phase 1 Report has been completed in June 2021 and presented to the Technical Steering Committee for review and comments. Comments received from the representatives of the Steering Committee and associated responses and actions provided by the Town's Consulting Team are provided in **Appendix A**. The Draft Phase 1 Report has been updated on the basis of these comments during final reporting.

This report summarizes the methodologies and results of the Phase 2: Impact Assessment and Management Strategy component of the overall Scoped Subwatershed Study. For context, relevant information is provided regarding the key findings from the Phase 1: Study Area Characterization, related to the overall characterization of the study area, which has informed the development of the management and implementation plan accordingly. Comments received from the representatives of the Steering Committee, and associated responses and actions provided by the Town's Consulting Team, regarding the Phase 2 report, are provided in **Appendix A**.

# 2 OVERVIEW OF BASELINE ASSESSMENT AND CHARACTERIZATION

## 2.1 Introduction

The following summarizes the key findings and characterization information from the Phase 1: Study Area Characterization.

## 2.2 Surface Water

### 2.2.1 Hydrology

#### 2.2.1.1 Summary of Phase 1 Characterization

The study area is located between Eighth Line and Winston Churchill Boulevard. The study area crosses two jurisdictions – CH and CVC (ref. Drawing WR2). The total size of the study area is 253.74 ha of which185.6 ha is within Sixteen Mile Creek Watershed in CH jurisdiction, with the remaining 68.14 ha lying within the Mullet Creek Subwatershed in CVC jurisdiction. The following provides an overview of the study area characteristics within the respective watersheds / subwatersheds and corresponding jurisdictions.

Within the Conservation Halton jurisdiction, East Branch of Sixteen Mile Creek enters the study area between Eighth Line and Ninth Line and exits the study area at Steeles Avenue. Several non-regulated drainage features were characterized along the East Branch of Sixteen Mile Creek. The external drainage area to Sixteen Mile Creek East Branch is approximately 1940 ha. The total drainage area to Sixteen Mile Creek East Branch at the downstream boundary of the study area (i.e., Steeles Avenue) is approximately 2068.06 ha. The Sixteen Mile Creek East Branch, East Lisgar Branch drains north to south within the study area between Ninth Line and Tenth Line, with a total contributing area of approximately 143 ha at Steeles Avenue. Soils within the study area have been characterized based upon a review of the surficial geology mapping information (Ontario Ministry of Energy, Northern Development and Mines, 2020), Soil Survey Complex (Ontario GeoHub, 2019) and the physiography mapping provided by the Town for use in this study. The study area is characterized by bevelled till plains based on the physiography mapping. The surficial geology for the study area is noted to consist predominately of Halton Till, which is characterized as diamicton with primary material of clayey silt to silt. There is a Modern Alluvium area concentrated along the Sixteen Mile Creek East Branch. Glaciolacustrine deposits with primary material of clay and silt are found in proximity to drainage features contributing to Sixteen Mile Creek. Overall, the soils are with low permeability and low infiltration potential. The surface slopes within the urban expansion area and the existing urban area tend to be moderate between 1.5 and 2.5%. There are slightly steeper areas along watercourses (between 3 and 5% +/-). The existing land use conditions are primarily agricultural lands and open space. Rural development and rural residential areas are noted along the major roads.

Within the CVC jurisdiction, Mullet Creek enters the study area from the north. A tributary of Mullet Creek within the study area drains from west to east and confluences with the Mullet Creek west of Winston Churchill Boulevard. At the confluence, Mullet Creek continues to flow east between two private properties and exits the study area at Winston Churchill Boulevard. The external drainage area to the study area is approximately 193 ha. The total contributing drainage area at the downstream boundary of the study area (i.e., Winston Churchill Boulevard) is approximately 267.92 ha. The wetland within the study area, between Tenth Line and Winston Churchill Boulevard., is characterized as an internally draining subcatchment during smaller rainfall events. The soils within the CVC jurisdiction are largely similar to the soils within the Conservation Halton jurisdiction. The soils have been characterized by bevelled till plains based on the physiography mapping. The surficial geology for the study area is noted to consist predominately of Halton Till, which is characterized as dimincton with primary material of clayey silt to silt. Glaciolacustrine deposits with primary material of clay and silt are found in proximity to drainage features contributing to Mullet Creek. Overall, the soils are with low permeability and low infiltration potential. The surface slopes within the urban expansion area and the existing urban area tend to be moderate between 1 and 2%. The existing land use conditions are primarily agricultural lands and open space. Rural development areas are noted along the Steeles Avenue and Winston Churchill Boulevard.

A HSP-F hydrologic model and a Visual OTTHYMO hydrologic model have been developed based on the current available models provided for this study. The purpose of developing the hydrologic model in different platforms is to maintain consistency with the current hydrologic modelling approach within CH and CVC jurisdictions. The HSP-F methodology has been applied as the key hydrologic model to establish stormwater management criteria. The Visual OTTHYMO methodology has been applied as a verification of the HSP-F modelling results. The subcatchment boundary plans for the existing land use conditions hydrologic models are presented in **Drawings WR-1** and **WR-2**.

The HSP-F hydrologic model has been executed for a 56-year continuous simulation. The peak frequency flows as well as Regional Storm event have been determined for the existing land use conditions. In addition, erosion analyses have been completed for the existing land use conditions. The Visual OTTHYMO hydrologic model has been executed to determine the design storm 2-to-100-year return period peak flows as well as Regional Storm peak flows for the existing land use conditions.

Differences in simulated flows were noted between the two modelling platforms and when comparing to the parent models, potentially due to refined parameters as well as different algorithms and methodologies applied within the platforms. However, in general, both the HSP-F hydrologic model and a Visual OTTHYMO hydrologic model are comparable to the parent hydrologic models and are considered representative of the existing land use condition.

### 2.2.2 Hydraulics

#### 2.2.2.1 Summary of Phase 1 Characterization

HEC-RAS hydraulic models have been developed to delineate the Regulatory Flood Hazard for the reaches of the Sixteen Mile Creek East Branch and the Mullet Creek which extend through the study area. The HEC-RAS hydraulic model cross-sections have been established using the LiDAR mapping provided for use in this study, as well as the hydraulic structure inventory completed for the roads bounding the study area. The flows for the hydraulic modelling have been obtained from the hydrologic modelling (HSP-F) completed for this study. The flood hazard mapping for the respective reaches has been delineated based upon the simulated water surface elevations from the hydraulic modelling and the topographic mapping provided for use in this study.

## 2.3 Groundwater

A summary of the significant hydrogeologic findings for the Phase 1 characterization include the following:

- The study area is within the Peel Plain physiographic region.
- The surficial overburden consists primarily of the clay silt, silty sand Halton till and glaciolacustrine silt and clay. Within the Halton till discrete sandy layers exist.
- The overburden is underlain by the Queenston shale. The upper portions of the Queenston shale can be extensively fractured.
- A thicker, channelized basal sand / gravel deposit is interpreted along 10$^{th}$ Line. within the Study Area.

- The overburden thickness ranges from 3 m (underlying East Sixteen Mile Creek) to 20 m, with the majority of the Study Area underlain by 15 to 20 m of overburden.
- Groundwater recharge values are reported to be less than 100 mm/year in the area due to the fine-grained surficial sediments; however, greater recharge may occur locally in areas where pockets of sand / gravel are mapped at surface (e.g., area of Steeles Avenue and southern extent of 9$^{th}$ Line). Recharge values on similar surficial geologic units have been noted to range from 49 - 170 mm/year.
- Groundwater supplies are obtained from both the overburden (i.e., sand lenses and basal sands / gravels) and the upper portion of the bedrock where the bedrock is weathered and fractured. Wells generally provide sufficient quantities of quality water.
- Groundwater flow characteristics include the following:
  - lateral flow in the shallow overburden and bedrock, from a relative high in the northwest and declining toward the east (Mullet Creek subwatershed), as well as the southeast and southwest (East Sixteen Mile Creek subwatershed). Shallow overburden groundwater is interpreted to flow towards East Sixteen Mile Creek.
  - lateral flow through the upper 2 to 3 m of till where the till can be significantly fractured.
  - lateral connection within the upper fractured till can be relatively significant, compared to the massive till, but is generally localized (e.g., 10's of metres).
  - horizontal flow patterns in the upper fractured till will be controlled by local depressional topography and restricted by underlying, more massive, and less permeable till where it exists.
  - vertical groundwater flux below the upper fractured till, within the more massive till, is generally low unless more permeable, interconnected lenses exist.
  - The direction of groundwater flow is largely vertically downward through the fine-grained Halton Till, until intercepting a sand lens or basal sand / upper fractured bedrock where it would then migrate laterally. Flowing wells were not observed within the Study Area. The closest flowing wells identified in the Ontario Ministry of the Environment, Conservation and Parks (MECP) Water Well Information System database are located approximately 550 to 740 m south or southwest of the Study Area near Highway 407 and Highway 401. Flowing wells are interpreted to exist to the southwest of the Study Area as described as part of the Premier Gateway Phase 1B project (AFW 2016), as well as near a bedrock valley where a larger, more regional groundwater flow system is interpreted to source the flowing wells. However, some upward gradients between the bedrock

and overburden were interpreted in the current study area based on the WWIS data and is possible in other areas where there is sufficient regional flow supporting thicker and more continuous units of sand / gravels that lie on top of bedrock.

- Groundwater discharge is interpreted to occur along various portions of East Sixteen Mile Creek and its tributaries based on the following main observations:
  - observed baseflow during three monitoring events on East Sixteen Mile Creek at Steeles Avenue at the southern part of the Gilbach (formerly Hodero) property (southwestern portion of the Study Area).
  - seasonal upward gradients and potential groundwater discharge observed during concurrent surface water level and groundwater level monitoring on East Sixteen Mile Creek and its tributaries on the Gilbach property as part of JLA et al. (2020).
  - observation of open water on East Sixteen Mile Creek during a winter stream survey, approximately 350 m upstream of the Gilbach property, and interpreted cool water thermal regime classification of the creek based on water temperature and present fish communities.

## 2.4 Surface Water Quality

### 2.4.1 Summary of Phase 1 Characterization

The water quality monitoring samples indicate that the existing surface water quality is of relatively high quality. Concentrations of organics, nutrients, and TSS are lower than have been reported in other areas of the watershed for Sixteen Mile Creek for largely agricultural land use conditions, and concentrations of various metals are below values reported elsewhere in the Watershed as well as PWQO's. The lower concentrations are considered potentially attributable to the influence of stormwater management practices within urbanized areas of the watershed. PWQO exceedances are noted for silver, with some exceedances occurring for cadmium, cobalt, copper, and iron. Although concentrations of lead were noted to be higher compared to other locations in the watershed, PWQO exceedances were noted to be highly infrequent. Grab Sampling indicates higher concentration for copper, cobalt, iron, zinc, BOD5, total phosphorus, and TSS. Compared with the long-term statistical results and previous studies, the findings from the grab sampling are considered consistent with the surface water quality within the Sixteen Mile Creek Watershed.

# 2.5 Stream Morphology

## 2.5.1 Summary of Phase 1 Characterization

The Phase 1 Characterization Report included a background review of previous and ongoing studies, a desktop evaluation of erosion hazard limits, characterization of headwater drainage features (HDFs) and watercourses, as well as field investigations to confirm and update the results of the desktop analyses. Desktop exercises included a historical assessment of channel adjustment and changes in land use as well as identified the presence of HDFs and watercourses within the Study Area. Reach walks were completed on three separate occasions to evaluate HDFs using protocols outlined in the TRCA / CVC guidelines (2014) as well as to conduct rapid geomorphic assessments on watercourse reaches to evaluate their stability. Detailed channel surveys and geomorphic monitoring were then completed on watercourse reaches downstream of the Study Area to evaluate downstream sensitivity and to develop erosion threshold values for particle entrainment. Results of the Phase 1 analyses are summarized below.

### 2.5.1.1 Historic Assessment

The historical assessment indicated that natural lateral channel adjustment or migration has been fairly limited since 1954 along Mullet Creek, but there has been lengthening and meander development along East Sixteen Mile Creek – Reach ESMC1 – as it continues to regain sinuosity. Prior to 1954, it is assumed that some direct modification occurred within ESMC1 based on the straighter channel planform and assumed clearing of trees relative to the forested corridor downstream of the Study Area. Land use has remained fairly consistent and between 1954 and 2019 photography, agricultural impacts to watercourse and HDFs persist. This is most notable along impacted reaches of Mullet Creek which appear to have remained in the same position within cropped lands, and a narrow riparian zone. East Sixteen Mile Creek meanders within a well-developed floodplain situated within a defined valley, and agricultural practice seems to be limited to tablelands in recent years. Local alterations to watercourses occurred within the last 5 - 10 years where crossings were upgraded (replaced) or lengthened.

### 2.5.1.2 Erosion Hazard Assessment

The study area contains unconfined (meander migration is not restricted by valley slopes), and partially confined (valley slopes restrict migration in some parts of the reach) to confined reaches (valley slope restricts migration throughout the reach). Unconfined reaches are limited to Mullet Creek, while East Sixteen Mile Creek is characterized by a meandering channel in a well-developed floodplain, set within a defined valley with some valley wall contacts (partially confined to confined). Meander belt widths were delineated for Mullet Creek reaches – MC(4)1 and MC(4)2. Due to limitations with the available photo record, 20% of the bankfull width was added as a factor of safety in lieu of a projected 100-year migration limit based off photo measurements. A 6 m erosion access allowance was added to the meander belt widths of Mullet Creek in accordance with Provincial Policy (OMNR, 2002).

East Sixteen Mile Creek may exhibit some partial confinement; however, it has a floodplain to tableland differential along the well-defined slopes that exceeds 2 m and must be treated as a confined system (CH, 2016), therefore, a long-term stable top of slope was delineated for ESMC1 following guidelines from Provincial Policy (OMNR, 2002). A toe erosion allowance of either 2 m or 8 m (**Drawing FG-1**) was included in the long-term stable top of slope delineation where the creek was within 15 m of the valley toe, based on the slope material composition of stiff cohesive soil (clays, clay-silt) (OMNR 2002) as per the Provincial Policy Statement 3.1.1. An additional 15 m regulatory setback was applied to East Sixteen Mile Creek long-term stable top of slope (CH, 2016). **Table 2.5.1** and **Table 2.5.2** detail the results of the erosion hazard assessment for confined (long term stable top of slope) and unconfined (meander belt) systems respectively. Erosion hazard limits are subject to further refinements as part of future staking exercises as supervised by CH and/or subsequent planning studies respectively.

**Table 2.5.1: Meander Belt Widths for Unconfined Reaches**

| Reach | Meander Belt Width (m) | 20% Factor of Safety (10% Either Side of Channel) | Meander Belt Width + FOS (m) | Preliminary Meander Belt Width (m) (including 6 m erosion access allowance)* |
|---|---|---|---|---|
| **Mullet Creek** | | | | |
| MC(4)1 | 38 | 7.6 | 45.6 | 58 |
| MC(4)2 | 33 | 6.6 | 39.6 | 52 |

*rounded up to nearest whole number

**Table 2.5.2: Hazard Corridor Delineations for Confined Reaches**

| Reach | Valley Floor Width (m) | Average Slope Height (m) | 3:1 Stable Top of Slope Setback (m) | Conservation Halton 15 m Regulatory Setback for Major Systems (m)* | Toe Erosion Allowance (m) | Total Hazard Corridor (m) |
|---|---|---|---|---|---|---|
| **East Sixteen Mile Creek** | | | | | | |
| ESMC1 | 50 – 175 | 3 – 5 | 9 - 15 | 15 | 2 – 8 | 79 – 227 |

*15 m regulatory setback was applied on either side of erosion hazard.

#### 2.5.1.3 Headwater Drainage Feature Assessment

HDFs were found predominantly in agricultural settings within the Study Area. Previously unmapped HDFs were identified on most properties that were visited. An agency site walk occurred on October 23, 2020, to confirm the feature type, and location of HDFs and watercourses. Due to project scheduling, a modification to the HDFA protocols (TRCA / CVC, 2014) was proposed and accepted whereby the third visit was completed in September of 2020, then followed by first and second visits in March and June of 2021. Updates, where necessary, were made to the feature type and extent following the agency site walk.

HDF assessments were completed following the protocols outlined in TRCA / CVC (2014), to develop an “HDFA Classification” for the purpose of the Phase 1 Characterization. Due to limited or contributing hydrology scores, several HDFs were given ‘no-management required’, or ‘mitigation’ HDFA classifications based on the guidelines. As site-specific nuances may require a modification to the management classification from the protocol, the study team may propose a revised “Final Management” recommendation with supporting rationale for the impact assessment (Phase 2, this report), and the management and implementation plan (Phase 3).

The TRCA / CVC (2014) guidelines suggest that higher constraint classification be extended into downstream reaches regardless of the feature results (e.g., a protection classification extending downstream into conservation and/or mitigation reaches). In general, the approach applied here does not agree with that recommendation. That is, if a conservation or mitigation reach is located downstream of a protection reach, it may not be upgraded to protection as those lesser constraint features may often benefit from rehabilitation and enhancement, especially given that HDFs in the study area are almost entirely modified by agricultural practices. However, where a lesser constraint feature acts as a linkage, through the HDFA classification, it has been designated as conservation (at a minimum). One example exists within the study area where a linkage resulted in a conservation status on a ‘mitigation’ feature, as the linkage can be considered a characteristic of the feature. HDFs MC(6) provides an example where the feature classification of 'conservation' was determined to maintain a surface linkage to an upstream wetland. HDF management recommendations are subject to approval by the Technical Advisory Committee (TAC) and are anticipated to be a collaborative effort to finalize management recommendations and opportunities through Phases 2 and 3.

#### 2.5.1.4 Rapid Assessments

The Rapid Assessment of watercourses within the Study Area characterized dominant geomorphic processes and evidence of instability. East Sixteen Mile Creek reaches were mostly well defined, where reaches ESMC1 and ESMC(2) were permanently flowing, with active geomorphic processes occurring. Each reach contained widening as the dominant geomorphic process. The occurrence of vertical banks, slumping, and undercutting, with occasional debris jams in ESMC(2) has resulted in the creek system being more unstable or 'transitional' in the RGA scoring when compared to ESMC1 upstream of Steeles Avenue, which is considered more stable and was scored as 'in regime' in the rapid assessment. Reaches TESMC(1) and TESMC(2) were inaccessible, but noted to be poorly defined and not suitable for the completion of Rapid Assessments made from the road ROW.

Mullet Creek reaches were noted to be highly impacted by current and historical land-use (agricultural), with a narrow riparian zone and poor channel definition upstream of Winston Churchill Boulevard. Manicured lawns were present up to the poorly defined channel banks on either side upon approach to Winston Churchill Boulevard. All watercourse reaches upstream of Winston Churchill were found to be in-regime and vegetatively controlled. Downstream of Winston Churchill within Reach MC(4), a well-defined, intermittent channel extended for approximately 500 m, within a narrow riparian corridor with deciduous trees along either side. Aggradation and widening towards the right bank were noted to be the dominant geomorphic processes for this relatively unstable reach ('transitional'). Vertical and undercut banks were noted throughout as bank vegetation was minimal.

#### 2.5.1.5 Erosion Threshold Analysis

Detailed geomorphic surveys were completed on more sensitive, downstream reaches of ESMC(2) and MC(4) within each subwatershed. Critical discharge, velocity, and shear stress values were determined for each site using the Komar (1987) equation for gravel substrates. Median particle sizes of 17 mm and 19 mm were evaluated for ESMC(2) and MC(4), respectively. A critical discharge of 0.70 $m^3/s$ was determined for each ESMC(2), and 0.79 $m^3/s$ for MC(4).The recommended critical threshold values were provided to inform the exceedance analysis for the purposes of developing a stormwater management plan that does not increase erosion in receiving watercourses.

For potential receiving channels along Steeles Avenue – TESMC(1) and TESMC(2) – a unitary rate was of 0.7 l/s/ha was derived from erosion threshold analyses completed in the Ninth Line Scoped Subwatershed Study (Wood, 2020) and is considered appropriate at the Scoped SWS level of study.

The Gilbach Scoped SWS also completed an erosion threshold analysis for ESMC(2), and determined a value of 0.44 $m^3/s$. This is lower than that determined in the current study, which is primarily due to differences in the median particle diameter: 11.1 mm (Gilbach study) compared to 17 mm (current study). Other inputs also varied including slope and roughness, but the primary difference was the median particle diameter. At the scoped level of study, either value can be appropriate for preliminary assessment of SWM, however, these results may be confirmed through subsequent stages of planning and design (i.e., SIS).

# 2.6 Natural Environment

## 2.6.1 Summary of Phase 1 Characterization

### 2.6.1.1 Terrestrial Ecology

The study area and adjacent lands consists of rural residential areas along the major roads, industrial and commercial lands, agricultural fields, and natural heritage features. The study area includes the East Sixteen Mile Creek corridor and associated wetlands, woodlands, and other natural features. In addition, lands to the east within the study area include other small woodlands, a wetland, watercourses, HDFs, and meadow communities.

Wetlands within the study area fall within three catchment areas: East Sixteen Mile to the west, Mullet Creek to the east, and an unnamed catchment area located within the centre of the study area. Most wetlands are comprised of a Forb Mineral Meadow Marsh community (MAS2-10), with additional tableland wetlands dominated by varying amounts by Cattail (*Typha sp.)*, Reed Canary Grass (*Phalaris arundinacea*), European Reed (*Phragmites australis ssp. australis*), or Willows (*Salix sp.*).

Woodland and forest cover within the study area and adjacent lands is sparse. Woodlands (CUW and FOD7-4) within the East Sixteen Mile Creek corridor are considered significant. The woodland (FOD4) east of 10th Line is not considered significant.

The following Significant Wildlife Habitat (SWH) was identified within the study area, which falls in Ecoregion 7E:

- Turtle Wintering Area (Candidate)
- Reptile Hibernacula (Candidate)
- Rare Vegetation Community (Confirmed): Fresh-Moist Black Walnut Lowland Deciduous Forest (FOD7-4)
- Turtle Nesting (Candidate)
- Habitat for Species of Conservation Concern: Terrestrial Crayfish (Confirmed), Eastern Wood-pewee (Confirmed)

Wildlife movement was observed predominantly along the East Sixteen Mile Creek corridor, in a north-south direction, including crossing below the bridge at Steeles Avenue. Wildlife movement throughout the rest of the study area was found to be relatively diffuse, including within the location of Mullet Creek, although wildlife in the area used the box culvert underneath Winston Churchill Boulevard to move through the area. Coyote (*Canis latrans*) was found to be the most common mammal species utilizing these linkages between higher quality habitats, with good numbers of American Mink (*Neovison vison*) and Ermine (*Mustela erminea*), as well as a variety of small mammals. A few White-tailed Deer (*Odocoileus virginianus*) were observed in the study area.

Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), Eastern Small-footed Myotis (*Myotis leibii*), and Little Brown Myotis (*Myotis lucifugus*) are regulated Species at Risk (SAR) that were identified within the study area in the Phase 1 report.

#### 2.6.1.2 Aquatic Ecology

East Sixteen Mile Creek was identified as having a coolwater thermal regime and providing Type 1 Fish Habitat. The benthic communities within East Sixteen Mile Creek are considered ‘fair to fairly poor’. East Sixteen Mile Creek provides a high constraint to development. The Mullet Creek tributary was classified as warmwater Type 3 Fish Habitat, providing a medium constraint to development.

Fish were observed in East Sixteen Mile Creek, but not Mullet Creek. Brook Stickleback (*Culea inconstans*) was observed in both the pond and the pool associated with the HDF located east of 9$^{th}$ Line North (TESMC(1)5-1 and TESMC(1)) (Drawing FG-3).

East Sixteen Mile Creek within the study area does not provide Trout spawning.

#### 2.6.1.3 Preliminary Natural Heritage System

A preliminary Natural Heritage System (NHS) was identified on Maps 6A and 6B in the Phase 1 report, as a refinement of the Town's Greenlands system and the Region's Key Features and Regional Natural Heritage System (RNHS). The preliminary NHS is comprised of wetlands, watercourses, fish habitat, Significant Woodlands, and the floodplain adjacent to East Sixteen Mile Creek and Mullet Creek. The NHS also incorporates linkages that will assist in ensuring that important natural heritage features within the study area and adjacent lands remain connected to one another and the broader NHS.

# 3 LAND USE PLAN

The Premier Gateway Phase 2B Secondary Plan Study is intended to establish a planning framework for the Phase 2B lands, to guide their future growth and development. It is being carried out in accordance with the *Planning Act* and the *Environmental Assessment Act* through the Municipal Class Environmental Assessment process for any future required municipal infrastructure. The Phase 2B Employment Area will be the focus for initial development and will identify the location of land to be designated for employment and added to the Premier Gateway Employment Area to replace the shortfall of designated employment lands to the current 2051 planning horizon in the Town. To provide the framework for development, the Town has initiated a study process which includes the identification of the additional lands; appropriate related Regional and Local Official Plan amendments; a Secondary Plan for the expanded Employment Area, a Scoped Subwatershed Study, and an Implementation Plan.

The Study process includes an extensive community engagement program which is designed to ensure meaningful consultation with all participants. This includes:

— Steering Committee Meetings

— Technical Advisory Committee Meetings

— Public Open Houses and Workshops

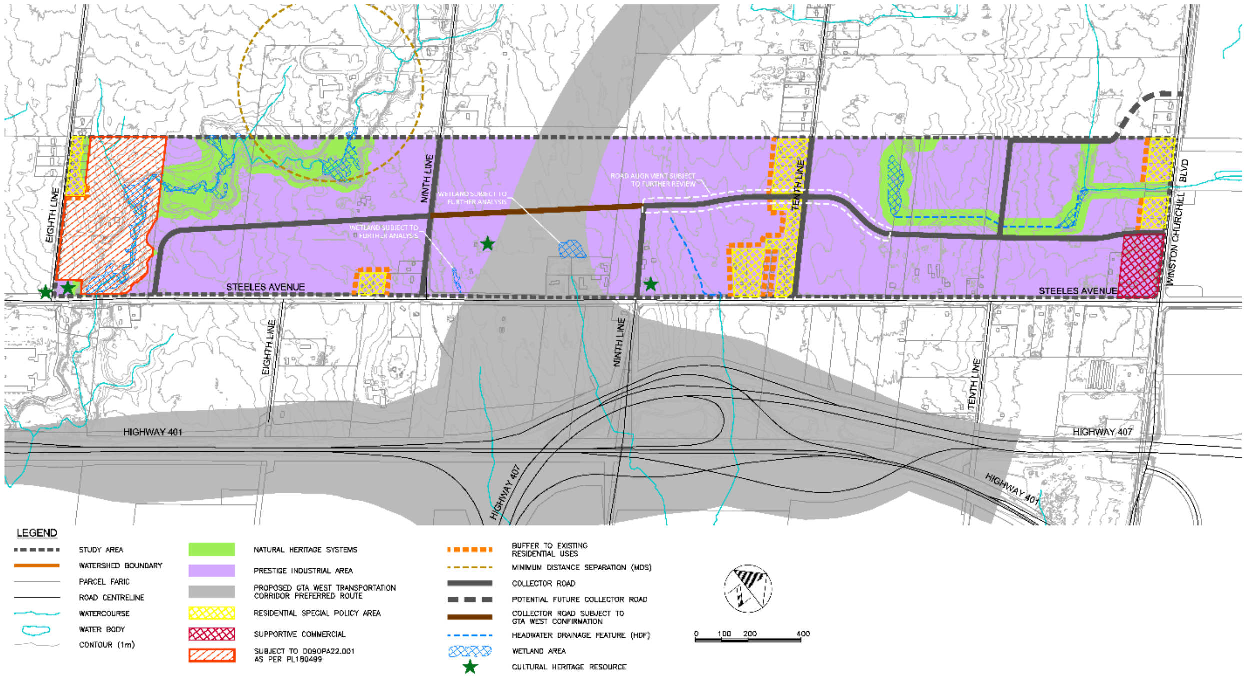
— Statutory Open House

— Statutory Public Meeting

— Reports to Council

Subsequent to the public review, a preferred land use concept was created and was endorsed by Council which identifies the location for new employment lands, a natural heritage system, various employment land uses, recognition of existing residential land uses, the transportation system, and areas subject to further analysis. In addition, the planning process was integrated with the Scoped Subwatershed Study for the Gilbach lands, which are located to the west limit of the Premier Gateway Phase 2B lands and which is being completed through a separate but parallel process. Following discussions with the Town, Halton Region, and Conservation Halton, these lands have been designated a Special Policy Area.

The preferred land use concept is presented in **Figure 3.1**Error! Reference source not found. and **Drawing LU-1**.




## Figure 3.1: Preferred Land Use Plan

# 4 IMPACT ASSESSMENT

## 4.1 Introduction

Analyses and assessments have been completed to determine the potential impacts of the proposed land use change within the Premier Gateway Phase 2B Lands on the area's natural resources, in the absence of contemporary management practices in-place. The purpose of the testing has been to specifically determine how the land use impact and management concept satisfies various objectives regarding the preservation and/or enhancement of natural features and system functionality. The following presents the findings of the impact assessment related to the specific study disciplines.

## 4.2 Surface Water and Groundwater

### 4.2.1 Future Uncontrolled Land Use Conditions

#### 4.2.1.1 Hydrologic Model Development

**Conservation Halton Jurisdiction**

Hydrologic analyses have been completed in order to assess the impacts of the proposed land use concept for the Premier Gateway Lands, in the absence of stormwater management controls for flood and erosion control. The HSP-F hydrologic model for the existing land use conditions has been revised to represent the future land use condition as per land use plan provided (ref. Figure 3.1). The model has been rediscretized within the limits of the Premier Gateway Lands in order to represent the future drainage areas and outlets, premised upon minimizing changes to drainage areas based on grading and retaining pre-development drainage patterns, while optimizing contributing drainage areas to support wet end-of-pipe facilities. The GTA West Corridor lies along the drainage boundary within the lands in the Lisgar District, hence it has been assumed that the limits of the GTA West Corridor would represent the drainage boundaries for the lands east and west of the corridor and the properties regraded accordingly. Further, it has been assumed that all stormwater management for the GTA West Corridor is to be provided within the Ministry's right-of-way, per current practice by the Ministry of Transportation Ontario (MTO), and would service the future roadway only (i.e., no reliance on stormwater management facilities within external lands). In the absence of any details regarding the planning for the future GTA West Corridor and the associated stormwater management, these lands have been assumed under existing (undeveloped) land use conditions. The assumed impervious coverage for each land use is summarized in **Table 4.2.1**, and the subcatchment parameters for key parameters of interest for the HSP-F hydrologic model are summarized in **Table 4.2.2**. The corresponding subcatchment boundary plan is presented in **Drawing WR-3** and the model schematic is presented in **Drawing WR-4**.

Consistent with the Approved Work Plan and the methodology applied for the Phase 1 report, the Visual OTTHYMO (VO) hydrologic model for the existing conditions within the Premier Gateway lands north of the Lisgar Community has been refined and updated to represent the proposed development in the absence of stormwater management. During the course of this update, it was determined that the increased number of subcatchments resulting from the model refinement generated significantly higher peak flow rates for external lands, which skewed subsequent analyses for sizing stormwater management facilities. Consequently, recognizing that the VO modelling is principally intended to verify and refine the sizing criteria for stormwater management facilities, the VO modelling has been developed to represent the future development areas to the respective outlets in one catchment, and the external areas in another catchment, and to thereby better maintain consistency with the discretization from the existing conditions hydrologic model. The model subcatchment parameters are summarized in **Table 4.2.3**.

**Table 4.2.1: Impervious Coverage by Land Use**

| Land Use | Imperviousness (%) |
|---|---|
| Prestige Industrial Area | 90 |
| GTA West [(a)] | 5 |
| Residential Special Policy Area [(a)] | 20 |
| Supportive Commercial | 85 |
| Wetland | 0 |
| NHS | 5 |
| ROW | 90 |
| SWM Ponds | 50 |

(a): Assumed to have same land use as existing condition

## Table 4.2.2: HSP-F Subcatchment Parameters for Future Land Use Conditions – Sixteen Mile Creek East Branch

| Subcatchment ID | Total Area (ha) | Imperviousness | Pervious | | | | | | | | Impervious | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | INFILT (mm/hr) | UZSN (mm) | LZSN (mm) | INTFW ($day^{-1}$) | IRC ($day^{-1}$) | AGWRC ($day^{-1}$) | SLOPE (m/m) | LSUR (m) | SLOPE (m/m) | LSUR (m) |
| 161 | 41.29 | 6.0% | 5.73 | 12 | 100 | 4 | 0.1 | 0.97 | 0.010 | 120 | 0.010 | 120 |
| 162 | 33.63 | 3.0% | 6 | 12 | 100 | 4 | 0.1 | 0.97 | 0.014 | 150 | 0.014 | 150 |
| 163 | 15.93 | 6.0% | 6.02 | 12 | 100 | 4 | 0.1 | 0.97 | 0.011 | 125 | 0.011 | 125 |
| 164 | 1641.31 | 6.0% | 6.07 | 12 | 100 | 4 | 0.1 | 0.97 | 0.006 | 700 | 0.005 | 700 |
| 165 | 192.55 | 3.0% | 6.07 | 12 | 100 | 4 | 0.1 | 0.97 | 0.006 | 700 | 0.005 | 450 |
| 166 | 14.21 | 3.0% | 6.76 | 12 | 100 | 4 | 0.1 | 0.97 | 0.008 | 110 | 0.008 | 110 |
| 167 | 5.78 | 4.4% | 6.74 | 12 | 100 | 4 | 0.1 | 0.97 | 0.018 | 120 | 0.018 | 120 |
| 168 | 4.48 | 3.2% | 7.02 | 12 | 100 | 4 | 0.1 | 0.97 | 0.017 | 85 | 0.017 | 85 |
| 169 | 6.00 | 3.6% | 6.45 | 12 | 100 | 4 | 0.1 | 0.97 | 0.024 | 120 | 0.024 | 120 |
| 170 | 7.93 | 5.0% | 6.87 | 12 | 100 | 4 | 0.1 | 0.97 | 0.002 | 85 | 0.002 | 85 |
| 171 | 1.96 | 90.0% | 5.6 | 12 | 100 | 4 | 0.1 | 0.97 | 0.014 | 80 | 0.014 | 80 |
| 172 | 1.62 | 5.0% | 7.47 | 12 | 100 | 4 | 0.1 | 0.97 | 0.021 | 60 | 0.021 | 60 |
| 173 | 2.51 | 5.0% | 6.63 | 12 | 100 | 4 | 0.1 | 0.97 | 0.016 | 100 | 0.016 | 100 |
| 174 | 3.46 | 5.0% | 6.08 | 12 | 100 | 4 | 0.1 | 0.97 | 0.023 | 90 | 0.023 | 90 |
| 175 | 2.76 | 5.0% | 7.42 | 12 | 100 | 4 | 0.1 | 0.97 | 0.010 | 80 | 0.010 | 80 |
| 176 | 16.85 | 90.0% | 5.85 | 12 | 100 | 4 | 0.1 | 0.97 | 0.013 | 130 | 0.013 | 130 |
| 177 | 13.82 | 84.1% | 5.97 | 12 | 100 | 4 | 0.1 | 0.97 | 0.005 | 200 | 0.005 | 200 |
| 178 | 1.55 | 3.9% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.025 | 110 | 0.025 | 110 |
| 179 | 11.16 | 21.0% | 7.07 | 12 | 100 | 4 | 0.1 | 0.97 | 0.008 | 90 | 0.008 | 90 |
| 180 | 27.35 | 9.0% | 5.81 | 12 | 100 | 4 | 0.1 | 0.97 | 0.007 | 140 | 0.007 | 140 |
| 191 | 0.47 | 90.0% | 7.02 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 192 | 3.03 | 90.0% | 6.87 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |

| Subcatchment ID | Total Area (ha) | Imperviousness | Pervious | | | | | | | | Impervious | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | INFILT (mm/hr) | UZSN (mm) | LZSN (mm) | INTFW ($day^{-1}$) | IRC ($day^{-1}$) | AGWRC ($day^{-1}$) | SLOPE (m/m) | LSUR (m) | SLOPE (m/m) | LSUR (m) |
| 193 | 1.18 | 20.0% | 6.43 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 194 | 1.16 | 43.0% | 6.63 | 12 | 100 | 4 | 0.1 | 0.97 | 0.016 | 100 | 0.016 | 100 |
| 195 | 3.55 | 90.0% | 6.08 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 196 | 1.07 | 27.1% | 6.08 | 12 | 100 | 4 | 0.1 | 0.97 | 0.023 | 90 | 0.023 | 90 |
| 197 | 7.43 | 90.0% | 6.74 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 198 | 6.62 | 90.0% | 5.85 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 199 | 0.76 | 55.4% | 5.85 | 12 | 100 | 4 | 0.1 | 0.97 | 0.013 | 130 | 0.013 | 110 |
| | | | | | | | | | | | | |
| 215 | 4.11 | 3.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.010 | 120 | 0.010 | 120 |
| 216 | 5.23 | 90.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 217 | 8.44 | 90.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 218 | 9.77 | 5.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.010 | 120 | 0.010 | 120 |
| 221 | 18.44 | 7.8% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.014 | 225 | 0.014 | 225 |
| 231 | 22.30 | 3.0% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.011 | 125 | 0.011 | 125 |
| 232 | 15.96 | 90.0% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 233 | 21.22 | 90.0% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 234 | 3.84 | 31.3% | 6.03 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 241 | 8.39 | 3.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.013 | 170 | 0.013 | 170 |
| 242 | 6.72 | 31.6% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 243 | 6.81 | 90.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |
| 244 | 11.41 | 90.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.020 | 40 | 0.020 | 30 |

**Table 4.2.3: Visual OTTHYMO Subcatchment Parameters for Future Land Use Conditions – East Lisgar Branch**

| | NHYD | Name | Area (ha) | S (%) | CN | CN III | IA (mm) | Tc (hr) | Tp (hr) |
|---|---|---|---|---|---|---|---|---|---|
| NasHyd | 9215 | S-215 | 4.11 | 0.30 | 83 | 92 | 5 | 0.73 | 0.49 |
| | 9218 | S-218 | 5.23 | 0.68 | 83 | 92 | 5 | 0.60 | 0.40 |
| | 9221 | S-221 | 18.44 | 0.49 | 82.1 | 91 | 5 | 1.00 | 0.67 |
| | 9231 | S-231 | 26.15 | 0.62 | 83.1 | 92 | 5 | 0.95 | 0.63 |
| | 9241 | S-241 | 15.11 | 0.46 | 85.8 | 93 | 5 | 0.74 | 0.50 |
| StandHyd | 9216 | S-216 | 18.20 | 0.87 | 79 | 90 | 2 | | |
| | 9232 | S-232 | 37.18 | 1.15 | 80 | 90 | 2 | | |
| | 9242 | S-242 | 18.22 | 0.55 | 80 | 90 | 2 | | |

### CVC Jurisdiction

The scoped HSP-F hydrologic model for the Premier Gateway Study Area within the Mullet Creek Subwatershed has been updated to represent the future development within the Premier Gateway Lands in the absence of stormwater management. The subcatchment parameters for the HSP-F model representing the headwaters of the Mullet Creek Subwatershed, under future land use conditions, are summarized in **Table** 4.2.4 for key parameters of interest.

Consistent with the Approved Work Plan and the methodology applied for the Phase 1 report, the Visual OTTHYMO (VO) hydrologic model for the existing conditions within the Premier Gateway lands within the Mullet Creek Subwatershed has been refined and updated to represent the proposed development in the absence of stormwater management. Similar to the approach applied for the VO model of the Lisgar District, the VO modelling has been developed to represent the future development areas to the respective outlets in one catchment, and the external areas in another catchment, and to thereby better maintain consistency with the discretization from the existing conditions hydrologic model. The model subcatchment parameters are summarized in **Table 4.2.5**.

## Table 4.2.4: HSP-F Subcatchment Parameters for Future Land Use Conditions – Mullet Creek

| Subcatchment ID | Total Area (ha) | Imperviousness | Pervious | | | | | | | | Impervious | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | INFILT (mm/hr) | UZSN (mm) | LZSN (mm) | INTFW ($day^{-1}$) | IRC ($day^{-1}$) | AGWRC ($day^{-1}$) | SLOPE (m/m) | LSUR (m) | SLOPE (m/m) | LSUR (m) |
| 351 | 145.33 | 3.0% | 5.86 | 12 | 100 | 4 | 0.1 | 0.97 | 0.001 | 150 | 0.001 | 150 |
| 352 | 48.19 | 3.0% | 5.83 | 12 | 100 | 4 | 0.1 | 0.97 | 0.007 | 130 | 0.007 | 130 |
| 353 | 3.11 | 4.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.007 | 85 | 0.007 | 85 |
| 354 | 3.12 | 3.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.024 | 90 | 0.024 | 90 |
| 355 | 4.65 | 3.0% | 6.00 | 12 | 100 | 4 | 0.1 | 0.97 | 0.023 | 75 | 0.023 | 75 |
| 356 | 20.65 | 90.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.011 | 180 | 0.011 | 180 |
| 357 | 2.53 | 90.0% | 5.98 | 12 | 100 | 4 | 0.1 | 0.97 | 0.021 | 160 | 0.021 | 160 |
| 358 | 39.50 | 16.1% | 5.56 | 12 | 100 | 4 | 0.1 | 0.97 | 0.016 | 250 | 0.016 | 250 |
| 359 | 24.15 | 23.9% | 5.56 | 12 | 100 | 4 | 0.1 | 0.97 | 0.016 | 250 | 0.016 | 250 |
| 360 | 18.86 | 90.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.011 | 180 | 0.011 | 30 |
| 361 | 10.15 | 6.3% | 5.90 | 12 | 100 | 4 | 0.1 | 0.97 | 0.024 | 135 | 0.024 | 30 |
| 362 | 1.72 | 5.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.007 | 85 | 0.007 | 30 |
| 363 | 1.72 | 5.0% | 5.98 | 12 | 100 | 4 | 0.1 | 0.97 | 0.021 | 160 | 0.021 | 30 |
| 364 | 2.25 | 90.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.007 | 85 | 0.007 | 30 |
| 365 | 3.80 | 23.3% | 5.98 | 12 | 100 | 4 | 0.1 | 0.97 | 0.021 | 160 | 0.021 | 30 |
| 366 | 3.59 | 85.0% | 5.80 | 12 | 100 | 4 | 0.1 | 0.97 | 0.003 | 140 | 0.003 | 145 |

**Table 4.2.5: Visual OTTHYMO Subcatchment Parameters for Future Land Use Conditions – Mullet Creek**

| | NHYD | Name | Area (ha) | S (%) | CN | CN III | IA (mm) | Tc (hr) | Tp (hr) |
|---|---|---|---|---|---|---|---|---|---|
| NasHyd | 351 | S-351 | 145.33 | 1.50 | 83.3 | 92 | 5 | 1.75 | 1.05 |
| | 352 | S-352 | 48.19 | 1.60 | 81.8 | 91 | 5 | 1.07 | 0.64 |
| | 353 | S-353 | 3.11 | 2.57 | 81.3 | 91 | 5 | 0.42 | 0.28 |
| | 354 | S-354 | 3.12 | 1.14 | 82.4 | 92 | 5 | 0.38 | 0.25 |
| | 355 | S-355 | 4.65 | 0.34 | 82.4 | 92 | 5 | 0.72 | 0.48 |
| | 358 | S-358 | 39.50 | 0.70 | 84 | 92 | 5 | 1.53 | 0.92 |
| | 359 | S-359 | 24.15 | 1.00 | 85.8 | 93 | 5 | 1.58 | 0.95 |
| | 361 | S-361 | 10.15 | 1.00 | 79 | 90 | 5 | 1.32 | 0.88 |
| | 362 | S-362 | 1.72 | 0.44 | 79 | 90 | 5 | 0.65 | 0.43 |
| | 363 | S-363 | 1.72 | 0.24 | 79 | 90 | 5 | 0.96 | 0.64 |
| StandHyd | 356 | S-356 | 20.65 | 1.60 | 79 | 90 | 2 | | |
| | 357 | S-357 | 2.53 | 0.60 | 79 | 90 | 2 | | |
| | 360 | S-360 | 18.86 | 1.80 | 79 | 90 | 2 | | |
| | 364 | S-364 | 2.25 | 1.60 | 79 | 90 | 2 | | |
| | 365 | S-365 | 3.80 | 1.70 | 79 | 90 | 2 | | |
| | 366 | S-366 | 3.59 | 1.00 | 79 | 90 | 2 | | |

### 4.2.1.2 Hydrologic Analysis for Flooding Impacts

**Conservation Halton Jurisdiction**

Consistent with the methodology applied for assessing existing land use conditions for the Phase 1 report, the HSP-F hydrologic model representing future land use conditions in the absence of stormwater management has been executed for a 56-year continuous simulation (1962 – 2017). Simulated instantaneous annual maximum peak flows have been extracted from the continuous simulation dataset, and frequency analyses have been completed using the Log Pearson Type III Distribution, which represents the applicable distribution for the watershed; the applicability of the Log Pearson Type III Distribution has been confirmed based upon the review of the coefficient of skew, as well as visual inspection of the correlation between the best fit trendline and the sample population. In addition, the Regional Storm event has been simulated as a discrete storm event, and the simulated peak flows have been obtained from the simulated results; the applicable areal reduction factors have been applied to the rainfall datasets for the Regional Storm event simulation, in accordance with current Provincial standards.

The simulated peak frequency flows and Regional Storm peak flows for the future uncontrolled land use conditions are summarized in **Table 4.2.6**, and the percent difference in peak flows compared to existing land use conditions (ref. Phase 1 Report Table 2.2.6) is presented in **Table** 4.2.7.

In addition, the VO hydrologic model for the Lisgar District has been used to generate simulated peak return period and Regional Storm event flows for the study area. Consistent with the approach applied for the Phase 1 Characterization, the 12-hour SCS distribution has been applied to generate the synthetic design storms for the return period storm events. The Hurricane Hazel Strom has been applied for the regional storm event. The simulated peak flows at the outlets of the study area and are presented in **Table 4.2.8**, and the percent difference compared to existing land use conditions are presented in **Table 4.2.9**.

## Table 4.2.6: Simulated Peak Frequency Flows and Regional Storm Event flows for Future Uncontrolled Land Use Conditions – Sixteen Mile Creek East ($m^3/s$)

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.565 | SMCE1 +/-2250 m U/S of Steeles Ave. (Inlet of Sub166) | 1833.85 | 3.2 | 5.13 | 8.54 | 11.3 | 14.5 | 19.2 | 23.3 | 68.6 |
| 3.566 | SMCE +/-1536 m U/S of Steeles Ave. (Outlet of Sub166) | 1848.18 | 3.09 | 5.01 | 8.41 | 11.2 | 14.3 | 19 | 23.1 | 69 |
| 3.567 | SMCE +/-1236 m U/S of Steeles Ave. (Outlet of Sub167) | 1860.61 | 3.03 | 4.94 | 8.33 | 11.1 | 14.2 | 18.9 | 22.9 | 68.5 |
| 3.568 | SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub168) | 1865.25 | 3.03 | 4.93 | 8.3 | 11.1 | 14.1 | 18.8 | 22.8 | 68 |
| 3.563 | HDF1 tributary to SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub163) | 15.93 | 0.043 | 0.06 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.836 |
| 3.581 | Confluence of HDF and SMCE +/-914 m U/S of Steeles Ave. (Confluence of sub 163 & 168) | 1881.18 | 3.05 | 4.96 | 8.36 | 11.1 | 14.2 | 18.8 | 22.9 | 68.6 |
| 3.569 | SMCE +/-761 m U/S of Steeles Ave. (Outlet of Sub169) | 1888.07 | 3.04 | 4.95 | 8.35 | 11.1 | 14.2 | 18.8 | 22.9 | 68.2 |
| 3.570 | SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub170) | 1899.01 | 2.99 | 4.87 | 8.22 | 11 | 14 | 18.6 | 22.6 | 66.2 |
| 3.561 | HDF tributary +/-110m east of 8th Line (Outlet of Sub 161) | 41.45 | 0.12 | 0.16 | 0.24 | 0.3 | 0.36 | 0.45 | 0.52 | 2.43 |
| 3.562 | HDF tributary +/-120m east of 8th Line (Inlet of Sub173) | 75.59 | 0.17 | 0.25 | 0.39 | 0.49 | 0.61 | 0.77 | 0.92 | 4.21 |
| 3.573 | HDF tributary to SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub173) | 79.78 | 0.25 | 0.38 | 0.52 | 0.59 | 0.64 | 0.69 | 0.72 | 3.99 |
| 3.582 | Confluence of HDF and SMCE +/-265 m U/S of Steeles Ave. | 1978.79 | 3.11 | 5.05 | 8.52 | 11.4 | 14.5 | 19.4 | 23.6 | 69 |

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| | (Confluence of sub 173 & 170) | | | | | | | | | |
| 3.572 | SMCE +/-323 m U/S of Steeles Ave. (Outlet of Sub172) | 1980.78 | 3.11 | 5.05 | 8.52 | 11.4 | 14.6 | 19.4 | 23.6 | 68.8 |
| 3.575 | SMCE +/-65 m U/S of Steeles Ave. (Outlet of Sub175) | 1987.5 | 3.11 | 5.05 | 8.52 | 11.4 | 14.5 | 19.3 | 23.5 | 68 |
| 3.584 | SMCE +/-59 m U/S of Steeles Ave. (Inlet at Sub 178) | 1995.11 | 3.13 | 5.08 | 8.56 | 11.4 | 14.6 | 19.4 | 23.6 | 68.2 |
| 3.578 | SMCE U/S of Steeles Ave. | 1999.07 | 3.09 | 5.04 | 8.53 | 11.4 | 14.6 | 19.4 | 23.6 | 66.4 |
| 3.586 | SMCE D/S of Steeles Ave. | 2029.58 | 3.42 | 5.36 | 8.79 | 11.6 | 14.7 | 19.4 | 23.4 | 67.8 |
| 3.579 | SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 179) | 2040.73 | 3.36 | 5.29 | 8.72 | 11.5 | 14.7 | 19.5 | 23.6 | 67.5 |
| 3.580 | Tributary to SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 180) | 27.35 | 0.14 | 0.22 | 0.28 | 0.31 | 0.33 | 0.34 | 0.35 | 1.49 |
| 3.587 | Confluence of tributary and SMCE +/- 457 m D/S of Steeles Ave. (Confluence of Sub 179 & 180) | 2068.09 | 3.39 | 5.35 | 8.82 | 11.7 | 14.9 | 19.7 | 23.9 | 68.2 |
| 3.511 | Lisgar Branch at Steeles Ave. +/- 130 m east of 9th Line (Outlet of Sub201) | 20.68 | 0.58 | 0.78 | 0.99 | 1.09 | 1.17 | 1.26 | 1.31 | 2.34 |
| 3.512 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub202) | 36.76 | 0.089 | 0.14 | 0.19 | 0.22 | 0.23 | 0.24 | 0.24 | 0.905 |
| 3.513 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub203) | 52.47 | 0.63 | 0.84 | 1.08 | 1.21 | 1.31 | 1.43 | 1.51 | 3.24 |
| 3.514 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub204) | 33.09 | 1.13 | 1.41 | 1.74 | 1.92 | 2.09 | 2.28 | 2.41 | 3.86 |

**Table 4.2.7: Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions – Sixteen Mile Creek East (%)**

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.565 | SMCE1 +/-2250 m U/S of Steeles Ave. (Inlet of Sub166) | 1833.85 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3.566 | SMCE +/-1536 m U/S of Steeles Ave. (Outlet of Sub166) | 1848.18 | 2.7 | 1.6 | 0.8 | 0.9 | 0.7 | 0.5 | 0.4 | 1.0 |
| 3.567 | SMCE +/-1236 m U/S of Steeles Ave. (Outlet of Sub167) | 1860.61 | 1.3 | 1.4 | 1.0 | 0.9 | 0.7 | 0.0 | -0.4 | 0.9 |
| 3.568 | SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub168) | 1865.25 | 2.0 | 1.6 | 0.9 | 0.9 | 0.0 | 0.0 | -0.4 | 0.7 |
| 3.563 | HDF1 tributary to SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub163) | 15.93 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.5 |
| 3.581 | Confluence of HDF and SMCE +/-914 m U/S of Steeles Ave. (Confluence of sub 163 & 168) | 1881.18 | 2.0 | 1.4 | 0.8 | 0.0 | 0.0 | -0.5 | 0.0 | 0.7 |
| 3.569 | SMCE +/-761 m U/S of Steeles Ave. (Outlet of Sub169) | 1888.07 | 2.0 | 1.4 | 0.8 | 0.0 | 0.0 | -0.5 | -0.4 | 0.7 |
| 3.570 | SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub170) | 1899.01 | 2.7 | 1.7 | 0.7 | 0.9 | 0.0 | -0.5 | -0.4 | 0.8 |
| 3.561 | HDF tributary +/-110 m east of 8th Line (Outlet of Sub 161) | 41.45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| 3.562 | HDF tributary +/-120 m east of 8th Line (Inlet of Sub173) | 75.59 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 3.573 | HDF tributary to SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub173) | 79.78 | 38.9 | 40.7 | 26.8 | 15.7 | 1.6 | -12.7 | -23.4 | 1.5 |
| 3.582 | Confluence of HDF and SMCE +/-265 m U/S of Steeles Ave. (Confluence of sub 173 & 170) | 1978.79 | 3.0 | 1.6 | 0.7 | 0.9 | 0.0 | 0.5 | 0.4 | 0.7 |

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.572 | SMCE +/-323 m U/S of Steeles Ave. (Outlet of Sub172) | 1980.78 | 3.3 | 1.6 | 0.7 | 0.9 | 0.7 | 0.0 | 0.0 | 0.6 |
| 3.575 | SMCE +/-65 m U/S of Steeles Ave. (Outlet of Sub175) | 1987.5 | 3.0 | 1.6 | 0.6 | 0.0 | -0.7 | -0.5 | -0.4 | 0.6 |
| 3.584 | SMCE +/-59 m U/S of Steeles Ave. (Inlet at Sub 178) | 1995.11 | 3.6 | 1.8 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| 3.578 | SMCE U/S of Steeles Ave. | 1999.07 | 4.0 | 1.6 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| 3.586 | SMCE D/S of Steeles Ave. | 2029.58 | 13.2 | 6.8 | 2.1 | 0.0 | -0.7 | -1.5 | -2.5 | 1.2 |
| 3.579 | SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 179) | 2040.73 | 12.4 | 6.0 | 1.6 | 0.0 | -0.7 | -1.0 | -1.3 | 0.7 |
| 3.580 | Tributary to SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 180) | 27.35 | 40.0 | 57.1 | 40.0 | 29.2 | 22.2 | 3.0 | -2.8 | 0.0 |
| 3.587 | Confluence of tributary and SMCE +/-457 m D/S of Steeles Ave. (Confluence of Sub 179 & 180) | 2068.09 | 12.3 | 5.5 | 1.3 | 0.0 | -0.7 | -1.0 | -0.8 | 0.7 |
| 3.511 | Lisgar Branch at Steeles Ave. +/- 130 m east of 9th Line (Outlet of Sub201) | 20.68 | 1387.2 | 1222.0 | 942.1 | 808.3 | 631.3 | 530.0 | 424.0 | 114.7 |
| 3.512 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub202) | 36.76 | 48.3 | 40.0 | 18.8 | 4.8 | -14.8 | -33.3 | -45.5 | -46.1 |
| 3.513 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub203) | 52.47 | 563.2 | 460.0 | 332.0 | 266.7 | 204.7 | 150.9 | 118.8 | 20.4 |
| 3.514 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub204) | 33.09 | 769.2 | 642.1 | 521.4 | 448.6 | 397.6 | 330.2 | 288.7 | 35.9 |

**Table 4.2.8: Simulated Peak Flow Rates for Return Period and Regional Storm Event under Future Uncontrolled Land Use Conditions fo the Study Area – East Lisgar Branch ($m^3/s$)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 3501 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub191) | 27.53 | 2.60 | 3.66 | 4.69 | 5.49 | 6.24 | 7.06 | 3.86 |
| 9221 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub192) | 18.45 | 0.36 | 0.62 | 0.87 | 1.08 | 1.28 | 1.51 | 2.16 |
| 3503 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub193) | 63.33 | 4.70 | 7.18 | 9.20 | 10.79 | 12.28 | 13.90 | 8.19 |
| 3504 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub194) | 33.33 | 2.37 | 3.69 | 4.72 | 5.54 | 6.38 | 7.23 | 4.48 |

**Table 4.2.9: Percent Change in Simulated Peak Flow Rates for Return Period and Regional Storm Event under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions – East Lisgar Branch (%)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 3501 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub191) | 33 | 688% | 565% | 508% | 472% | 452% | 431% | 73% |
| 9221 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub192) | -50 | -19% | -20% | -20% | -20% | -20% | -20% | -40% |
| 3503 | Lisgar Branch at Steeles Ave. +/- | 21 | 613% | 546% | 486% | 456% | 434% | 415% | 59% |

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| | 1473 m east of 9th Line (Outlet of Sub193) | | | | | | | | |
| 3504 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub194) | 1 | 315% | 289% | 257% | 242% | 234% | 226% | 26% |

The results in **Table 4.2.6** to **Table** 4.2.9 indicate that peak flows within the Lisgar District downstream of the proposed development would increase as a result of the proposed development for all events and frequency flow conditions. This is considered attributable to the increase in drainage area to the outlets anticipated as a result of the grading as noted previously, as well as the proposed urbanization of the area. The results indicate that the peak flows within the Lisgar District downstream of the GTA West Corridor (ref. VO NHYD 9221) would decrease; this is, however, attributable to the assumed grading noted previously, as well as the representation of the GTA West corridor as undeveloped for the purpose of this Scoped Subwatershed Study. This result is to be confirmed by the future studies in support of the GTA West Corridor, once initiated.

The results in **Table 4.2.6** to **Table** 4.2.9 indicate that the peak flows along the Sixteen Mile Creek East Branch would increase for the more frequent flow conditions (i.e., 2 year through 10 year frequency flows) as a result of the proposed development, however peak frequency flows for the less frequent flow conditions (i.e., 20 year through 100 year frequency) and for the Regional Storm event would marginally increase, or, in some locations, would be reduced compared to existing conditions. This is considered attributable to the change in the timing of peak flows from the future development area compared to the timing of flows from the upstream area along the Sixteen Mile Creek East Branch.

Based upon the foregoing, stormwater quantity controls are considered warranted for all future development within the Premier Gateway Phase 2B Area draining toward the Lisgar District, to control post-development flows to pre-development levels for all events and frequency flow conditions up to and including the Regional Storm event. Although the development of the Premier Gateway Phase 2B Area draining toward the Sixteen Mile Creek East Branch would not be anticipated to present an increased flood risk to downstream properties within the Sixteen Mile Creek Watershed, quantity controls are nevertheless considered potentially required in order to manage flood potentially locally, particularly for properties on the east side of the Sixteen Mile Creek East Branch.

### CVC Jurisdiction

Consistent with the Approved Work Plan and the methodology applied for the Sixteen Mile Creek East Branch, the scoped HSP-F model representing future uncontrolled land use conditions for the Mullet Creek has been executed for a 56-year continuous simulation using the current meteorological dataset developed for the watershed. Simulated instantaneous peak flows have been extracted from the continuous simulation dataset, and frequency analyses have been completed using the Log Pearson Type III Distribution, which represents the applicable distribution for the watershed; the applicability of the Log Pearson Type III Distribution has been confirmed based upon the review of the coefficient of skew, as well as visual inspection of the correlation between the best fit trendline and the sample population. In addition, the Regional Storm event has been simulated as a discrete storm event, and the simulated peak flows have been obtained from the simulated results. The simulated peak frequency flows and Regional Storm peak flows for the future uncontrolled land use conditions are summarized in Error! Reference source not found. and the percent d ifference compared to existing land use conditions is presented in **Table 4.2.11**.

In addition, the VO hydrologic model representing future uncontrolled land use conditions for the Premier Gateway lands within the Mullet Creek Subwatershed has been executed for the 2-to-100-year return periods using the 24 hour Chicago storm distribution as well as the Regional Storm event. Simulated peak flows at key locations within the study area are presented in **Table 4.2.12**, and the percent difference compared to existing conditions is presented in **Table 4.2.13**.

## Table 4.2.10: Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Uncontrolled Land Use Conditions – Mullet Creek ($m^3/s$)

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.502 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub302) | 193.53 | 0.29 | 0.51 | 0.81 | 0.99 | 1.15 | 1.34 | 1.48 | 6.25 |
| 3.503 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub303) | 205.61 | 0.29 | 0.51 | 0.82 | 1.01 | 1.18 | 1.38 | 1.51 | 6.2 |
| 3.506 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub306) | 53.33 | 1.25 | 1.62 | 2.16 | 2.54 | 2.91 | 3.43 | 3.84 | 6.27 |
| 3.519 | Confluence of headwater and Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Confluence of Sub 303 & 306) | 258.93 | 1.36 | 1.75 | 2.35 | 2.8 | 3.26 | 3.92 | 4.47 | 10.9 |
| 3.507 | Mullet Creek at Winston Churchill | 267.92 | 1.36 | 1.74 | 2.35 | 2.82 | 3.32 | 4.06 | 4.67 | 11.4 |
| 3.508 | Mullet Creek at Steeles Ave. | 308.96 | 1.32 | 1.67 | 2.25 | 2.7 | 3.2 | 3.94 | 4.58 | 13.6 |
| 3.509 | Mullet Creek at Winston Churchill South of Steeles Ave. | 24.15 | 0.2 | 0.28 | 0.38 | 0.45 | 0.5 | 0.57 | 0.61 | 1.67 |

**Table 4.2.11: Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions – Mullet Creek (%)**

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.502 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub302) | 193.53 | 20.8 | 21.4 | 11.0 | -1.0 | -10.9 | -23.0 | -30.5 | 0.0 |
| 3.503 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub303) | 205.61 | 16.0 | 15.9 | 5.1 | -4.7 | -13.9 | -25.4 | -32.9 | -4.6 |
| 3.506 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub306) | 53.33 | 1036.4 | 912.5 | 800.0 | 719.4 | 646.2 | 586.0 | 540.0 | 161.3 |
| 3.519 | Confluence of headwater and Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Confluence of Sub 303 & 306) | 258.93 | 300.0 | 207.0 | 137.4 | 110.5 | 89.5 | 70.4 | 59.1 | 24.9 |
| 3.507 | Mullet Creek at Winston Churchill Blvd. | 267.92 | 312.1 | 205.3 | 135.0 | 107.4 | 88.6 | 71.3 | 61.6 | 32.4 |
| 3.508 | Mullet Creek at Steeles Ave. | 308.96 | 187.0 | 131.9 | 89.1 | 73.1 | 61.6 | 51.0 | 44.9 | 37.8 |
| 3.509 | Mullet Creek at Winston Churchill South of Steeles Ave. | 24.15 | -4.8 | -3.4 | -7.3 | -4.3 | -7.4 | -6.6 | -9.0 | -9.7 |

**Table 4.2.12: Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Uncontrolled Land Use Conditions – Mullet Creek ($m^3/s$)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 12004 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub361) | 57.44 | 6.77 | 9.46 | 11.96 | 13.96 | 15.76 | 17.59 | 7.46 |
| 2001 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub352) | 196.63 | 2.66 | 4.44 | 6.17 | 7.74 | 9.14 | 10.69 | 19.90 |
| 2002 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub362) | 198.35 | 2.66 | 4.45 | 6.18 | 7.76 | 9.16 | 10.71 | 20.01 |
| 2004 | Mullet Creek at Winston Churchill Blvd. | 266.10 | 5.88 | 8.66 | 10.77 | 12.96 | 15.16 | 17.38 | 26.43 |
| 2006 | Mullet Creek at Steeles Ave. | 309.19 | 5.22 | 7.44 | 10.02 | 11.71 | 13.21 | 15.24 | 30.49 |

**Table 4.2.13: Percent Change in Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions – Mullet Creek (%)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 2008 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub356) | 8 | 689 | 545 | 471 | 431 | 404 | 378 | 26 |
| 2001 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub352) | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2002 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub353) | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 |
| 2004 | Mullet Creek at Winston Churchill Blvd. | 1 | 63 | 42 | 27 | 22 | 20 | 18 | -2 |
| 2006 | Mullet Creek at Steeles Ave. | 0 | 22 | 3 | 0 | -7 | -11 | -12 | -2 |

The results in Error! Reference source not found. to **Table** 4.2.13 indicate that peak flows along the Mullet Creek to the outlet from the Premier Gateway Phase 2B Area would increase as a result of the proposed development for all events and frequency flow conditions. This is considered primarily attributable to the proposed urbanization of the area. The results from the HSP-F modelling indicate that peak flows for the Regional Storm event at the outlet of the Mullet Creek to Winston Churchill Boulevard. would be anticipated to increase as a result of the proposed development, whereas the results from the VO modelling suggest that the Regional Storm peak flow rates would be reduced. This discrepancy in the model results is considered attributable to a difference in the timing of peak flows as indicated in the VO modelling, which is not represented in the HSP-F modelling. Nevertheless, based upon the foregoing results, quantity controls are considered warranted for the Premier Gateway Phase 2B Area within the Mullet Creek Subwatershed, in order to control post-development flows to pre-development levels for all events and frequency flow conditions up to the Regional Storm event.

#### 4.2.1.3 Hydrologic Analysis for Erosion Impacts

The results of the continuous simulation completed using the HSP-F models have also been used to assess the erosion potential of the existing watercourse systems under future uncontrolled land use conditions. Consistent with the methodology applied for the Phase 1 Characterization, duration analyses have been conducted at the stations used for fluvial geomorphologic monitoring, to determine the duration (in hours) of flows above the critical erosion flow rate at each monitoring location. In addition, analyses have been completed to determine the total volume of water which would be above the critical erosive flow at each location, based upon the results of the continuous simulation. The fluvial geomorphologic monitoring location for Sixteen Mile creek east branch was ~200 m downstream of Steeles Avenue (Node 3.586). The fluvial geomorphologic monitoring location for Mullet creek east branch was ~100 m downstream of Winston Churchill Boulevard. (Node 3.507). The critical flow values for the significant nodes within Lisgar District have been determined by area weighing the critical flow value for Mullet Creek (0.79 $m^3/s$ for total existing drainage area of 264.26 ha). The results of these analyses are presented in **Table 4.2.14** and **Table 4.2.15**, and the percent differences compared to existing conditions are presented in **Table 4.2.16 and Table 4.2.17.**

## Table 4.2.14: Duration Analysis for Erosion Assessment of Future Uncontrolled Land Use Conditions

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Total Hours Exceeded | Percent of Total Time Exceeded (%) |
|---|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/-200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 13244 | 2.70 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 695 | 0.14 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 6641 | 1.35 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | 62 | 0.01 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 5476 | 1.12 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 4279 | 0.87 |

## Table 4.2.15: Volume of Erosive Flow for Erosion Assessment of Future Uncontrolled Land Use Conditions

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Total Runoff Volume Exceeded ($Mm^3$) |
|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/-200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 45.53 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 1.06 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 1.63 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | 0.01 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 3.17 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 1.43 |

## Table 4.2.16: Change in Duration Analysis for Erosion Assessment of Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Percent Change in Total Hours Exceeded (%) | Change in Percent of Total Time Exceeded (%) |
|---|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/-200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 18.6 | 0.42 |
| MC(4) | Mullet Creek +/- 100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 139.7 | 0.08 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 2387.3 | 1.30 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | -76.8 | -0.04 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 1935.7 | 1.06 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 1496.6 | 0.82 |

**Table 4.2.17: Change in Volume of Erosive Flow for Erosion Assessment of Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions**

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Percent Change in Total Runoff Volume Exceeded (%) |
|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/-200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 13.4 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 113.0 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 4207.7 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | -83.5 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 3201.6 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 2248.8 |

The results in **Table 4.2.14** to **Table 4.2.17** indicate that the proposed development within the Premier Gateway Phase 2B Area would increase the duration and volume of erosive flows compared to existing conditions, beyond acceptable tolerances (i.e., greater than 5%). Consequently, erosion controls are considered required for the proposed development of the Premier Gateway Phase 2B Area.

#### 4.2.1.4 Surface Water Quality Impacts

Urban development is recognized to increase the concentration and total mass loadings of various water quality indices, specifically metals and oils / grease, compared to pre-developed land use conditions. If unmitigated, these changes in surface water chemistry could result in adverse impacts to downstream aquatic and terrestrial systems which rely on surface water for sustenance. For this reason, current Provincial Guidelines require stormwater quality controls be implemented for all new development. Within the Sixteen Mile Creek Watershed and the Credit River Watershed, stormwater quality control to an *Enhanced* standard of treatment is required for all new development.

### 4.2.2 Stormwater Management Systems Sizing (Quantity and Quality)

#### Conservation Halton Jurisdiction

Hydrologic analyses have been completed in order to determine the sizing criteria for stormwater management facilities which would be required to mitigate the hydrologic impacts of the future development, specifically related to increased off-site peak flows and erosion potential along the receiving watercourses. The HSP-F hydrologic model for the study area and VO hydrologic model for the Lisgar District have been modified in order to incorporate routing elements, at the outlets of the future development subcatchments, representing stormwater quantity and erosion control practices within the future land use.

The unitary storage and discharge criteria for erosion and flood control have been iteratively adjusted within the HSP-F hydrologic model until the requisite erosion and flood control has been achieved, premised upon providing peak flow reduction for all operating conditions (i.e., extended detention for erosion control and peak flow reduction for flood control up to the 100-year frequency flow condition), consistent with conventional practice. The unitary volumes have been adjusted by incremental multiples of 25 $m^3$/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary critical erosion flow and 100-year frequency flow at locations downstream of the Premier Gateway Lands. The analyses have also evaluated requirements to provide post-to-pre control for the Regional Storm event along the regulated watercourses, consistent with current practice in Conservation Halton's jurisdiction. The unitary criteria for the Lisgar District has been tested using the VO hydrologic model, and iteratively refined and tested using the HSP-F hydrologic model until a unitary criteria has been established which would satisfy requirements for flood control using both models. Consistent with current practice, the erosion control component has been discounted from the synthetic design storm modelling using the VO modelling. The resulting unitary storage and discharge criteria under this stormwater management scenario (end-of-pipe only) are summarized in **Table 4.2.18.**

.

### Table 4.2.18: Unitary Sizing Criteria for Stormwater Management – Sixteen Mile Creek

| Operating Condition | Unitary Storage ($m^3$/Impervious ha) | Unitary Discharge ($m^3$/s/ha) |
|---|---|---|
| Sixteen Mile Creek East Branch | | |
| Extended Detention | 400 | 0.00103 |
| 25 Year | 700 | 0.0043 |
| 100 Year | 1000 | 0.0118 |
| Regional | 1900 | 0.0330 |
| Lisgar District (Node 3.511) | | |
| Extended Detention | 275 | 0.0011 |
| 25 Year | 750 | 0.0033 |
| 100 Year | 1150 | 0.0144 |
| Regional | 1995 | 0.0380 |
| Lisgar District (Node 3.513) | | |
| Extended Detention | 275 | 0.0012 |
| 25 Year | 750 | 0.0042 |
| 100 Year | 1150 | 0.0178 |
| Regional | 1900 | 0.0448 |
| Lisgar District (Node 3.514) | | |
| Extended Detention | 275 | 0.0015 |
| 25 Year | 700 | 0.0075 |
| 100 Year | 1000 | 0.0129 |
| Regional 1 | 1300 | 0.0294 |
| Regional 2 | 1815 | 0.0540 |

It should be noted that for Lisgar District Node 3.514, Regional 1 refers to 100-year storage requirement for 100-year design storm per VO modelling. Whereas, Regional 2 refers to the regional storm controls required for both HSPF and VO, assuming the storage and discharge relationship prior to the regional stage for flood control has been applied (2-100 year). The HSP-F hydrologic model for the future land use conditions scenario has been revised to incorporate the storage-discharge relationships for the routing elements representing the various proposed stormwater management facilities within the study area, and the model executed for a 56-year continuous simulation using the current meteorological dataset developed for the watershed. Simulated instantaneous peak flows have been extracted from the continuous simulation dataset, and frequency analyses have been completed using the Log Pearson Type III Distribution, which represents the applicable distribution for the watershed; the applicability of the Log Pearson Type III Distribution has been confirmed based upon the review of the coefficient of skew, as well as visual inspection of the correlation between the best fit trendline and the sample population. In addition, the Regional

Storm event has been simulated as a discrete storm event, and the simulated peak flows have been obtained from the simulated results. The simulated peak frequency flows and Regional Storm peak flows for the future land use conditions with recommended stormwater management are summarized in **Table 4.2.19** and the percent difference compared to existing land use conditions is presented in **Table 4.2.20**.

In addition, the VO hydrologic model for the Lisgar District has been used to generate simulated peak return period and Regional Storm event flows for the study area under future land use conditions with recommended stormwater management. Consistent with the approach applied for the Phase 1 Characterization, the 12-hour SCS distribution has been applied to generate the synthetic design storms for the return period storm events. The Hurricane Hazel Strom has been applied for the Regional Storm event. The simulated peak flows at the outlets of the study area and are presented in **Table 4.2.21**, and the percent difference compared to existing land use conditions are presented in **Table 4.2.22.**

.

## Table 4.2.19: Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended SWM – Sixteen Mile Creek East ($m^3/s$)

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.565 | SMCE[1] +/-2250 m U/S of Steeles Ave. (Inlet of Sub166) | 1833.85 | 3.2 | 5.12 | 8.54 | 11.3 | 14.5 | 19.2 | 23.3 | 68.6 |
| 3.566 | SMCE +/-1536 m U/S of Steeles Ave. (Outlet of Sub166) | 1848.18 | 3.03 | 4.95 | 8.37 | 11.2 | 14.3 | 19 | 23.1 | 69.1 |
| 3.567 | SMCE +/-1236 m U/S of Steeles Ave. (Outlet of Sub167) | 1860.61 | 2.99 | 4.87 | 8.24 | 11 | 14.1 | 18.8 | 22.9 | 68.4 |
| 3.568 | SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub168) | 1865.25 | 2.97 | 4.85 | 8.22 | 11 | 14.1 | 18.8 | 22.8 | 67.9 |
| 3.563 | HDF[1] tributary to SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub163) | 15.93 | 0.043 | 0.06 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.836 |
| 3.581 | Confluence of HDF and SMCE +/-914 m U/S of Steeles Ave. (Confluence of sub 163 & 168) | 1881.18 | 2.99 | 4.89 | 8.29 | 11.1 | 14.2 | 18.9 | 23 | 68.5 |
| 3.569 | SMCE +/-761 m U/S of Steeles Ave. (Outlet of Sub169) | 1888.07 | 2.98 | 4.88 | 8.27 | 11.1 | 14.2 | 18.8 | 22.9 | 68 |
| 3.570 | SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub170) | 1899.01 | 2.92 | 4.79 | 8.15 | 10.9 | 14 | 18.6 | 22.7 | 66 |
| 3.561 | HDF tributary +/-110m east of 8th Line (Outlet of Sub 161) | 41.45 | 0.12 | 0.16 | 0.24 | 0.3 | 0.36 | 0.44 | 0.51 | 2.43 |
| 3.562 | HDF tributary +/-120m east of 8th Line (Inlet of Sub173) | 75.59 | 0.17 | 0.25 | 0.39 | 0.49 | 0.61 | 0.78 | 0.92 | 4.21 |
| 3.573 | HDF tributary to SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub173) | 79.78 | 0.2 | 0.28 | 0.42 | 0.53 | 0.65 | 0.81 | 0.95 | 3.99 |
| 3.582 | Confluence of HDF and SMCE +/-265 m U/S of Steeles Ave. | 1978.79 | 3.02 | 4.98 | 8.47 | 11.3 | 14.5 | 19.3 | 23.5 | 68.8 |

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| | (Confluence of sub 173 & 170) | | | | | | | | | |
| 3.572 | SMCE +/-323 m U/S of Steeles Ave. (Outlet of Sub172) | 1980.78 | 3.02 | 4.97 | 8.47 | 11.3 | 14.5 | 19.4 | 23.6 | 68.6 |
| 3.575 | SMCE +/-65 m U/S of Steeles Ave. (Outlet of Sub175) | 1987.5 | 3.02 | 4.97 | 8.46 | 11.3 | 14.5 | 19.3 | 23.5 | 67.7 |
| 3.584 | SMCE +/-59 m U/S of Steeles Ave. (Inlet at Sub 178) | 1995.11 | 3.02 | 4.98 | 8.49 | 11.4 | 14.6 | 19.4 | 23.6 | 68 |
| 3.578 | SMCE U/S of Steeles Ave. | 1999.07 | 2.97 | 4.95 | 8.48 | 11.4 | 14.6 | 19.4 | 23.5 | 66.2 |
| 3.586 | SMCE D/S of Steeles Ave. | 2029.58 | 3.02 | 5.02 | 8.58 | 11.5 | 14.7 | 19.6 | 23.8 | 67.5 |
| 3.579 | SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 179) | 2040.73 | 3 | 4.99 | 8.54 | 11.4 | 14.6 | 19.5 | 23.6 | 67.6 |
| 3.580 | Tributary to SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 180) | 27.35 | 0.1 | 0.14 | 0.2 | 0.24 | 0.27 | 0.33 | 0.36 | 1.49 |
| 3.587 | Confluence of tributary and SMCE +/-457 m D/S of Steeles Ave. (Confluence of Sub 179 & 180) | 2068.09 | 3.02 | 5.05 | 8.66 | 11.6 | 14.8 | 19.7 | 23.9 | 68.3 |
| 3.511 | Lisgar Branch at Steeles Ave. +/- 130 m east of 9th Line (Outlet of Sub201) | 20.68 | 0.039 | 0.06 | 0.09 | 0.11 | 0.14 | 0.18 | 0.22 | 1.1 |
| 3.512 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub202) | 36.76 | 0.059 | 0.08 | 0.12 | 0.14 | 0.17 | 0.2 | 0.23 | 0.905 |
| 3.513 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub203) | 52.47 | 0.13 | 0.18 | 0.26 | 0.32 | 0.38 | 0.46 | 0.53 | 2.83 |
| 3.514 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub204) | 33.09 | 0.12 | 0.17 | 0.23 | 0.27 | 0.31 | 0.36 | 0.4 | 1.76 |

## Table 4.2.20: Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions– Sixteen Mile Creek East (%)

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.565 | SMCE[1] +/-2250 m U/S of Steeles Ave. (Inlet of Sub166) | 1833.85 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 3.566 | SMCE +/-1536 m U/S of Steeles Ave. (Outlet of Sub166) | 1848.18 | 0.7% | 0.4% | 0.4% | 0.9% | 0.7% | 0.5% | 0.4% | 1.2% |
| 3.567 | SMCE +/-1236 m U/S of Steeles Ave. (Outlet of Sub167) | 1860.61 | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | -0.5% | -0.4% | 0.7% |
| 3.568 | SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub168) | 1865.25 | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.4% | 0.6% |
| 3.563 | HDF[1] tributary to SMCE +/-914 m U/S of Steeles Ave. (Outlet of Sub163) | 15.93 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.5% |
| 3.581 | Confluence of HDF and SMCE +/-914 m U/S of Steeles Ave. (Confluence of sub 163 & 168) | 1881.18 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.6% |
| 3.569 | SMCE +/-761 m U/S of Steeles Ave. (Outlet of Sub169) | 1888.07 | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | -0.5% | -0.4% | 0.4% |
| 3.570 | SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub170) | 1899.01 | 0.3% | 0.0% | -0.1% | 0.0% | 0.0% | -0.5% | 0.0% | 0.5% |
| 3.561 | HDF tributary +/-110m east of 8th Line (Outlet of Sub 161) | 41.45 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -2.2% | -1.9% | -0.4% |
| 3.562 | HDF tributary +/-120m east of 8th Line (Inlet of Sub173) | 75.59 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.3% | 0.0% | 0.2% |
| 3.573 | HDF tributary to SMCE +/-265 m U/S of Steeles Ave. (Outlet of Sub173) | 79.78 | 11.1% | 3.7% | 2.4% | 3.9% | 3.2% | 2.5% | 1.1% | 1.5% |

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.582 | Confluence of HDF and SMCE +/-265 m U/S of Steeles Ave. (Confluence of sub 173 & 170) | 1978.79 | 0.0% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% |
| 3.572 | SMCE +/-323 m U/S of Steeles Ave. (Outlet of Sub172) | 1980.78 | 0.3% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% |
| 3.575 | SMCE +/-65 m U/S of Steeles Ave. (Outlet of Sub175) | 1987.5 | 0.0% | 0.0% | -0.1% | -0.9% | -0.7% | -0.5% | -0.4% | 0.1% |
| 3.584 | SMCE +/-59 m U/S of Steeles Ave. (Inlet at Sub 178) | 1995.11 | 0.0% | -0.2% | -0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% |
| 3.578 | SMCE U/S of Steeles Ave. | 1999.07 | 0.0% | -0.2% | -0.2% | 0.0% | 0.0% | 0.0% | -0.4% | 0.2% |
| 3.586 | SMCE D/S of Steeles Ave. | 2029.58 | 0.0% | 0.0% | -0.3% | -0.9% | -0.7% | -0.5% | -0.8% | 0.7% |
| 3.579 | SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 179) | 2040.73 | 0.3% | 0.0% | -0.5% | -0.9% | -1.4% | -1.0% | -1.3% | 0.9% |
| 3.580 | Tributary to SMCE +/-457 m D/S of Steeles Ave. (Outlet of Sub 180) | 27.35 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 3.587 | Confluence of tributary and SMCE +/-457 m D/S of Steeles Ave. (Confluence of Sub 179 & 180) | 2068.09 | 0.0% | -0.4% | -0.6% | -0.9% | -1.3% | -1.0% | -0.8% | 0.9% |
| 3.511 | Lisgar Branch at Steeles Ave. +/- 130 m east of 9th Line (Outlet of Sub201) | 20.68 | 0.0% | -3.4% | -7.4% | -8.3% | -12.5% | -10.0% | -12.0% | 0.9% |
| 3.512 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub202) | 36.76 | -1.7% | -17.0% | -25.0% | -33.3% | -37.0% | -44.4% | -47.7% | -46.1% |
| 3.513 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub203) | 52.47 | 0.0% | -5.3% | -7.1% | -8.6% | -9.5% | -13.2% | -14.5% | -0.4% |
| 3.514 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub204) | 33.09 | 0.0% | 0.0% | -4.2% | -3.6% | -6.1% | -7.7% | -7.0% | -2.2% |

**Table 4.2.21: Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Land Use Conditions with Recommended SWM for the Study Area – East Lisgar Branch ($m^3/s$)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 3501 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub191) | 27.53 | 0.30 | 0.49 | 0.70 | 0.89 | 1.07 | 1.26 | 1.78 |
| 9221 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub192) | 18.45 | 0.36 | 0.62 | 0.87 | 1.08 | 1.28 | 1.51 | 2.16 |
| 3503 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub193) | 63.33 | 0.67 | 1.09 | 1.58 | 2.00 | 2.40 | 2.84 | 4.59 |
| 3504 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub194) | 33.33 | 0.53 | 0.86 | 1.17 | 1.42 | 1.66 | 1.94 | 2.75 |

**Table 4.2.22: Percent Change in Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions – East Lisgar Branch (%)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 3501 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub191) | 33% | -9% | -10% | -9% | -7% | -5% | -5% | -20% |
| 9221 | Lisgar Branch at Steeles Ave. +/- 1127 m east of 9th Line (Outlet of Sub192) | -50% | -19% | -20% | -20% | -20% | -20% | -20% | -40% |
| 3503 | Lisgar Branch at Steeles Ave. +/- 1473 m east of 9th Line (Outlet of Sub193) | 21% | 1% | -1% | 1% | 3% | 5% | 5% | -11% |
| 3504 | Lisgar Branch at Steeles Ave. +/- 568 m east of 9th Line (Outlet of Sub194) | 1% | -6% | -10% | -11% | -12% | -13% | -12% | -23% |

Compared with the results presented previously for the future uncontrolled land use condition, the results in **Table 4.2.19** to **Table 4.2.22** indicate that the stormwater management strategy would significantly reduce the post-development peak flows, effectively achieving post-to-pre control at the drainage outlets from the Premier Gateway Phase 2B study area for most locations. The results indicate that residual increases to peak flows would occur along the Sixteen Mile Creek East Branch for the Regional Storm event, despite the application of Regional Storm controls.

Supplemental analyses have been completed to determine the change in Regional Storm event peak flows compared to existing land use conditions, under both future uncontrolled conditions and future land use conditions with the recommended stormwater management including Regional Storm controls. These analyses have applied the currently approved HSP-F hydrologic model for the Sixteen Mile Creek Watershed and have incorporated the appropriate areal reduction factors per current Provincial guidelines. The simulated Regional Storm event peak flows at key downstream locations under the various land use conditions evaluated are presented in **Table 4.2.23**, and the percent change compared to existing land use conditions are presented in **Table 4.2.24**.

## Table 4.2.23: Simulated Regional Storm Event Peak Flows Along Sixteen Mile Creek Main Branch for Different Land Use Conditions ($m^3/s$)

| Reference Node | Location | Land Use Scenario for Premier Gateway Phase 2B | | |
|---|---|---|---|---|
| | | Existing | Future Uncontrolled | Future with Recommended SWM |
| 3.586 / 3.599 | 16MC East branch D/S of Steeles Ave. | 67 | 67.8 | 67.5 |
| 3.010 | 16MC East branch at Trafalgar Rd. (~350 m N of Britannia Rd.) | 82.1 | 83.9 | 82.3 |
| 7.060 | Confluence of 16MC EB with MB (with Centre Trib) at Britannia Rd. | 381.3 | 383.2 | 381.4 |
| 7.502 | Confluence of 16MC MB and Trib 10 (0.5 km E of 6th ln and 1.2 km S of Britannia Rd.) | 408.3 | 410.1 | 408.4 |
| 7.010 | Outlet of 16MC MB (outlet of East 2.UCI) | 513.2 | 518.5 | 516.7 |
| 4.011 | Confluence of 16MC MB and WB N of Hwy 407 | 828.5 | 833.2 | 832.0 |

## Table 4.2.24: Percent Change Simulated Regional Storm Event Peak Flows Along Sixteen Mile Creek Main Branch for Different Land Use Conditions Compared to Existing Land Use Conditions (%)

| Reference Node | Location | Land Use Scenario for Premier Gateway Phase 2B | |
|---|---|---|---|
| | | Future Uncontrolled | Future with Recommended SWM |
| 3.586 / 3.599 | 16MC East branch D/S of Steeles Ave. | 1.19 | 0.75 |
| 3.010 | 16MC East branch at Trafalgar Rd. (~350 m N of Britannia Rd. | 2.19 | 0.24 |
| 7.060 | Confluence of 16MC EB with MB (with Centre Trib) at Britannia Rd. | 0.50 | 0.03 |
| 7.502 | Confluence of 16MC MB and Trib 10 (0.5 km E of 6th ln and 1.2 km S of Britannia Rd.) | 0.44 | 0.02 |
| 7.010 | Outlet of 16MC MB outlet of East 2.UCI) | 1.03 | 0.68 |
| 4.011 | Confluence of 16MC MB and WB N of Hwy 407 | 0.57 | 0.42 |

The results in **Table 4.2.23** and **Table 4.2.24** indicated that residual increases to Regional Storm peak flows would be anticipated further downstream along the Sixteen Mile Creek under future land use conditions with stormwater management (i.e., between 0.02% and 0.74%), although would be less than the residual increases for future uncontrolled land use conditions (i.e., between 0.44% and 2.19%).

Note that as supplementary analysis was completed "Premier Gateway Scoped Subwatershed Study – Supplemental Information" (WSP, February 9, 2022) which concluded that Regional Storm Controls were not required for areas draining to the East Sixteen Mile Creek. Refer to a copy of the analysis in Appendix B. The analysis and associated recommendation were subsequently accepted by Conservation Halton.

**CVC Jurisdiction**

Hydrologic analyses have been completed in order to determine the sizing criteria for stormwater management facilities which would be required to mitigate the hydrologic impacts of the future development, specifically related to increased off-site peak flows and erosion potential along the receiving watercourses. The HSP-F hydrologic model for the study area and VO hydrologic models for the Mullet Creek Subwatershed have been modified in order to incorporate routing elements, at the outlets of the future development subcatchments, representing stormwater quantity and erosion control practices within the future land use.

The unitary storage and discharge criteria for erosion and flood control have been iteratively adjusted within the HSP-F hydrologic model until the requisite erosion and flood control has been achieved, premised upon providing peak flow reduction for all operating conditions (i.e., extended detention for erosion control and peak flow reduction for flood control up to the 100-year frequency flow condition), consistent with conventional practice. The unitary volumes have been adjusted by incremental multiples of 25 $m^3$/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary critical erosion flow and 100-year frequency flow at locations downstream of the Premier Gateway Lands. The analyses have also evaluated requirements to provide post-to-pre control for the Regional Storm event along the regulated watercourses, consistent with current practice in CVC jurisdiction. The unitary criteria has been tested using the VO hydrologic model, and iteratively refined and tested using the HSP-F hydrologic model until a unitary criteria has been established which would satisfy requirements for flood control using both models. Consistent with current practice, the erosion control component has been discounted from the synthetic design storm modelling using the VO modelling. The resulting unitary storage and discharge criteria under this stormwater management scenario (end-of-pipe only) are summarized in **Table 4.2.25**.

**Table 4.2.25: Unitary Sizing Criteria for Stormwater Management – Mullet Creek Subwatershed**

| Operating Condition | Unitary Storage ($m^3$/Impervious ha) | Unitary Discharge ($m^3$/s/ha) |
|---|---|---|
| Extended Detention | 250 | 0.0015 |
| 25 Year | 750 | 0.0031 |
| 100 Year | 900 | 0.0108 |
| Regional | 1950 | 0.0319 |

The HSP-F hydrologic model for the future land use conditions scenario has been revised to incorporate the storage-discharge relationships for the routing elements representing the various proposed stormwater management facilities within the study area, and the model executed for a 56-year continuous simulation using the current meteorological dataset developed for the watershed. Simulated instantaneous peak flows have been extracted from the continuous simulation dataset, and frequency analyses have been completed using the Log Pearson Type III Distribution, which represents the applicable distribution for the watershed; the applicability of the Log Pearson Type III Distribution has been confirmed based upon the review of the coefficient of skew, as well as visual inspection of the correlation between the best fit trendline and the sample population. In addition, the Regional Storm event has been simulated as a discrete storm event, and the simulated peak flows have been obtained from the simulated results. The simulated peak frequency flows and Regional Storm peak flows for the future land use conditions with recommended stormwater management are summarized in **Table 4.2.26** and the percent difference compared to existing land use conditions is presented in **Table 4.2.27**.

In addition, the VO hydrologic model for the Mullet Creek Subwatershed has been used to generate simulated peak return period and Regional Storm event flows for the study area under future land use conditions with recommended stormwater management. Consistent with the approach applied for the Phase 1 Characterization, the model has been executed for the 2-to-100-year return periods using the 24-hour Chicago storm distribution as well as the Regional Storm event. Simulated peak flows at key locations within the study area are presented in **Table 4.2.28**, and the percent difference compared to existing conditions is presented in **Table 4.2.29.**

.

**Table 4.2.26: Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended SWM – Mullet Creek ($m^3/s$)**

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.502 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub302) | 193.53 | 0.24 | 0.42 | 0.73 | 1 | 1.29 | 1.74 | 2.13 | 6.25 |
| 3.503 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub303) | 205.61 | 0.24 | 0.42 | 0.75 | 1.02 | 1.33 | 1.78 | 2.17 | 6.2 |
| 3.506 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub306) | 53.33 | 0.091 | 0.12 | 0.18 | 0.22 | 0.28 | 0.36 | 0.44 | 2.52 |
| 3.519 | Confluence of headwater and Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Confluence of Sub 303 & 306) | 258.93 | 0.32 | 0.54 | 0.92 | 1.23 | 1.56 | 2.07 | 2.5 | 8.72 |
| 3.507 | Mullet Creek at Winston Churchill Blvd. | 267.92 | 0.33 | 0.56 | 0.95 | 1.26 | 1.61 | 2.12 | 2.56 | 8.6 |
| 3.508 | Mullet Creek at Steeles Ave. | 308.96 | 0.44 | 0.69 | 1.11 | 1.44 | 1.8 | 2.33 | 2.79 | 9.71 |
| 3.509 | Mullet Creek at Winston Churchill South of Steeles Ave. | 24.15 | 0.2 | 0.28 | 0.38 | 0.45 | 0.5 | 0.57 | 0.61 | 1.67 |

**Table 4.2.27: Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions – Mullet Creek (%)**

| Node | Location | Contributing Drainage Area (ha) | Frequency (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.25 | 2 | 5 | 10 | 20 | 50 | 100 | |
| 3.502 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub302) | 193.53 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3.503 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub303) | 205.61 | -4.0 | -4.5 | -3.8 | -3.8 | -2.9 | -3.8 | -3.6 | -4.6 |
| 3.506 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub306) | 53.33 | -17.3 | -25.0 | -25.0 | -29.0 | -28.2 | -28.0 | -26.7 | 5.0 |
| 3.519 | Confluence of headwater and Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Confluence of Sub 303 & 306) | 258.93 | -5.9 | -5.3 | -7.1 | -7.5 | -9.3 | -10.0 | -11.0 | -0.1 |
| 3.507 | Mullet Creek at Winston Churchill Blvd. | 267.92 | 0.0 | -1.8 | -5.0 | -7.4 | -8.5 | -10.5 | -11.4 | -0.1 |
| 3.508 | Mullet Creek at Steeles Ave. | 308.96 | -4.3 | -4.2 | -6.7 | -7.7 | -9.1 | -10.7 | -11.7 | -1.6 |
| 3.509 | Mullet Creek at Winston Churchill South of Steeles Ave. | 24.15 | -4.8 | -3.4 | -7.3 | -4.3 | -7.4 | -6.6 | -9.0 | -9.7 |

**Table 4.2.28: Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Land Use Conditions with Recommended SWM – Mullet Creek ($m^3/s$)**

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 12004 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub361) | 57.44 | 0.36 | 0.60 | 0.97 | 1.31 | 1.54 | 1.79 | 3.26 |
| 2001 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub352) | 196.63 | 2.66 | 4.44 | 6.17 | 7.74 | 9.14 | 10.69 | 19.90 |
| 2002 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub362) | 198.35 | 2.66 | 4.45 | 6.18 | 7.76 | 9.16 | 10.71 | 20.01 |
| 2004 | Mullet Creek at Winston Churchill Blvd. | 266.10 | 3.03 | 5.04 | 7.17 | 9.06 | 10.68 | 12.47 | 23.69 |
| 2006 | Mullet Creek at Steeles Ave. | 309.19 | 3.57 | 5.97 | 8.46 | 10.66 | 12.55 | 14.64 | 27.69 |

## Table 4.2.29: Percent Change in Simulated Peak Flow Rates for Return Period and Regional Storm Event Under Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions – Mullet Creek (%)

| NHYD | Location | Contributing Drainage Area (ha) | Return Period (Years) | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 5 | 10 | 25 | 50 | 100 | |
| 12004 | Headwater tributary to Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub361) | 8 | -58 | -59 | -54 | -50 | -51 | -51 | -45 |
| 2001 | Mullet Creek +/-509 m U/S of Winston Churchill Blvd. (Outlet of Sub352) | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2002 | Mullet Creek +/-316 m U/S of Winston Churchill Blvd. (Outlet of Sub362) | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 |
| 2004 | Mullet Creek at Winston Churchill Blvd. | 1 | -16 | -17 | -16 | -15 | -15 | -16 | -12 |
| 2006 | Mullet Creek at Steeles Ave. | 0 | -16 | -17 | -16 | -15 | -15 | -16 | -11 |

Compared with the results presented previously for the future uncontrolled land use condition, the results in **Table 4.2.26** to **Table 4.2.29**.indicate that the stormwater management strategy would significantly reduce the post-development peak flows, effectively achieving post-to-pre control at the drainage outlets from the Premier Gateway Phase 2B study area, for all events up to and including the Regional Storm event.

### Erosion Assessment

The results of the continuous simulation completed using the HSP-F models have also been used to assess the erosion potential of the existing watercourse systems under future land use conditions with the recommended stormwater management. Consistent with the methodology applied for the Phase 1 Characterization, duration analyses have been conducted at the stations used for fluvial geomorphologic monitoring, to determine the duration (in hours) of flows above the critical erosion flow rate at each monitoring location. In addition, analyses have been completed to determine the total volume of water which would be above the critical erosive flow at each location, based upon the results of the continuous simulation. The fluvial geomorphologic monitoring location for Sixteen Mile creek east branch was ~200 m downstream of Steeles Ave. (Node 3.586). The fluvial geomorphologic monitoring location for Mullet creek east branch was ~100 m downstream of Winston Churchill Boulevard. (Node 3.507). The critical flow values for the significant nodes within Lisgar District have been determined by area weighing the critical flow value for Mullet Creek (0.79 $m^3/s$ for total existing drainage area of 264.26 ha). The results of these analyses are presented in **Table 4.2.30 a**nd **Table 4.2.31**, and the percent differences compared to existing conditions are presented in **Table 4.2.32** and **Table 4.2.33**.

## Table 4.2.30: Duration Analysis for Erosion Assessment of Future Land Use Conditions with Recommended SWM

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Total Hours Exceeded | Percent of Total Time Exceeded (%) |
|---|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/- 200 m D/S of Steeles Ave | 2029.58 | 0.70 | 11657 | 2.37 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 257 | 0.05 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 361 | 0.07 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | 62 | 0.01 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 205 | 0.04 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 338 | 0.07 |

## Table 4.2.31: Volume of Erosive Flow for Erosion Assessment of Future Land Use Conditions with Recommended SWM

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Total Runoff Volume Exceeded ($Mm^3$) |
|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/- 200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 40.6 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | 0.43 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 0.04 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | 0.01 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | 0.07 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 0.05 |

### Table 4.2.32: Change in Duration Analysis for Erosion Assessment of Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Percent Change in Total Hours Exceeded (%) | Change in Percent of Total Time Exceeded (%) |
|---|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/- 200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 4.4 | 0.10 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | -11.4 | -0.01 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 35.2 | 0.02 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | -76.8 | -0.04 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | -23.8 | -0.01 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | 26.1 | 0.01 |

### Table 4.2.33: Change in Volume of Erosive Flow for Erosion Assessment of Future Land Use Conditions with Recommended SWM Compared to Existing Land Use Conditions

| Erosion Site | Location | Contributing Drainage Area (ha) | $Q_{critical}$ ($m^3/s$) | Percent Change in Total Runoff Volume Exceeded (%) |
|---|---|---|---|---|
| ESMC(2) | East Sixteen Mile Creek +/- 200 m D/S of Steeles Ave. | 2029.58 | 0.70 | 1.2 |
| MC(4) | Mullet Creek +/-100 m D/S of Winston Churchill Blvd. | 267.92 | 0.79 | -13.9 |
| Node 3.511 | Outlet of Subcatchment 217 at Steeles Ave. | 27.53 | 0.062 | 0.0 |
| Node 3.512 | Outlet of Subcatchment 221 at Steeles Ave. | 18.44 | 0.110 | -83.5 |
| Node 3.513 | Outlet of Subcatchment 233 at Steeles Ave. | 63.33 | 0.157 | -30.2 |
| Node 3.514 | Outlet of Subcatchment 244 at Steeles Ave. | 33.33 | 0.099 | -10.4 |

The results in **Table 4.2.30** to **Table 4.2.33** indicate that the stormwater management strategy advanced for the Premier Gateway Phase 2B area would effectively control the duration and volume of erosive flows to within acceptable tolerances (i.e., within 5% of existing conditions). The results for Mullet Creek indicate an over-control of erosion, hence opportunities exist to refine the unitary criteria and optimize stormwater management performance.

#### Water Quality

To manage impacts of the future development on stormwater quality, it is recommended that stormwater quality facilities be designed to provide stormwater quality treatment to an Enhanced standard, per current Provincial criteria. The unitary sizing of stormwater quality facilities should be in accordance with current MECP (previously MOE) criteria. Where source controls may be proposed, facility sizing should be in accordance with manufacturer specifications.

### 4.2.3 Water Budget and Runoff Volume Reduction

#### Water Budget and Runoff Volume Management

The potential impacts to the groundwater flow system from the proposed development include the following:

- An increase in impervious surfaces and soil compaction reduces the natural infiltration of groundwater leading to a subsequent decrease in groundwater levels, potential decrease in groundwater discharge and a decrease in recharge of local aquifers.
- The installation of water and sewer infrastructure can lead to the interception of shallow groundwater flow along the backfilled material altering shallow groundwater flow paths and creating leakage into sanitary and storm sewers.
- Installation of infrastructure below the water table leads to the potential need for dewatering during construction and post construction and a decrease in groundwater levels.
- Infrastructure construction may encounter more extreme hydraulic conditions, as described in the characterization, which have the potential for significant upward gradients, for transmittal of large quantities of groundwater and the potential for significant groundwater level reductions during dewatering. The depth of this hydraulically confined system may vary across the site and depth and local hydraulic characteristics need to be confirmed.
  - The need to minimize runoff through enhanced infiltration.

– The removal of any existing tile drains which may lead to increased groundwater levels or remove direct discharge to the local tributaries.
– Potential reduction in groundwater levels and capacity in local water wells due to reduction in recharge and particularly dewatering for construction.

Hydrologic analyses have been completed as part of other studies (i.e., Northwest Brampton Subwatershed Study, Amec et. al., June 2011; Milton Phase 4 Subwatershed Study, Amec Foster Wheeler et. al., April, 2018) to establish unitary sizing criteria for LID infiltration BMPs to maintain pre development groundwater recharge. The results of the analyses have indicated that a relatively modest capture rates (i.e., 1 3 mm / impervious hectare) would be required to maintain pre-development groundwater recharge under urban land use conditions. This is to be confirmed as part of future studies (i.e., SISs), it is nevertheless anticipated that a similar rate of capture would be adequate to maintain pre-development groundwater recharge for the Premier Gateway Area.

A scoped water budget assessment has been completed for the wetland feature in the Mullet Creek Subwatershed, to confirm whether the water budget to the feature would be maintained post-development. Based upon the available information for the area, it is anticipated that the wetland is sustained by surface water runoff to the feature, hence this water budget assessment has been completed specifically to evaluate the change in surface runoff volume under existing and proposed conditions. Under proposed conditions, it is anticipated that the NHS would convey runoff from 4.65 ha of external land toward the wetland feature, as a result of the linkage along the north limit of the property. As such, this diversion would effectively maintain the total contributing drainage area to the wetland at pre-development conditions. The HSP-F hydrologic model has been used to verify that the surface runoff volume to the feature would be maintained on a monthly and average annual basis following the proposed development and drainage plan. The results of this assessment are presented in **Table 4.2.34.**

.

**Table 4.2.34: Water Budget Assessment for Existing Wetland in Mullet Creek Subwatershed**

| Month | Average Existing Runoff Volume ($m^3$) | Average Future Runoff Volume ($m^3$) | Difference (%) |
|---|---|---|---|
| January | 4401 | 4463 | 1 |
| February | 4528 | 4602 | 2 |
| March | 6508 | 6638 | 2 |
| April | 5166 | 5243 | 1 |
| May | 3278 | 3353 | 2 |
| June | 2048 | 2130 | 4 |
| July | 1748 | 1836 | 5 |
| August | 1616 | 1711 | 6 |
| September | 1571 | 1667 | 6 |
| October | 1775 | 1857 | 5 |
| November | 2880 | 2994 | 4 |
| December | 4096 | 4179 | 2 |
| Monthly Average | 3301 | 3389 | 3 |
| Annual Average | 39616 | 40672 | 3 |

The results in **Table 4.2.34** indicate that the water budget to the wetland feature, specifically the surface runoff volume, would be maintained at pre-development conditions with the drainage and stormwater management plan proposed for the area. The wetlands along the Sixteen Mile Creek East Branch are riparian wetlands which are sustained by the flows generated from the larger upstream lands, and thus are not reliant on local surface or groundwater from the Premier Gateway Phase 2B lands. Nevertheless, at detailed design, storm outfalls to the Sixteen Mile Creek East Branch are to be sited such that any adverse impacts to riparian wetlands are mitigated, particularly relating to loading of salt to features supporting amphibian habitat.

### 4.2.4 Recommended Stormwater Management Plan

The following technologies and practices are available to address the stormwater management criteria noted in the foregoing:

TSS removal as per MOE\MECP 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 as per MNRF Guidelines:

- 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

Erosion Control:

- End-of-pipe facilities (i.e., wetlands, wet ponds, hybrid facilities, dry ponds)
- LID infiltration-based BMPs (i.e., bioswales / biofilters with underdrains, infiltration trenches, rain gardens, perforated pipes, etc.)

Flood / Quantity Control:

- End-of-pipe facilities (i.e., wetlands, wet ponds, hybrid facilities, dry ponds)
- Underground Storage Facilities
- Surface storage (i.e., rooftop / parking lot storage)

The selection of the appropriate stormwater management practice is dependent upon the size and land use conditions within the development area. The following general principles have been applied in developing the recommended stormwater management plan:

**1** Wet end-of-pipe facilities are preferred, particularly for residential developments, due to their ability to address multiple stormwater management requirements (i.e., quantity, quality, thermal mitigation, and erosion control).

**2** Where drainage areas are insufficient to support an end-of-pipe facility (i.e., drainage areas less than 5 ha), source controls (i.e., underground storage, surface storage, LID BMPs, oil / grit separators, vegetated technologies, etc.) are to be applied.
**3** LID BMPs are to be applied throughout the development area.
**4** Regional Storm controls are to be incorporated into the design of wet end-of-pipe facilities.
**5** Stormwater management solutions are not to result in a negative impact on the Phase 2B Natural Heritage System.

It is noted that draft guidelines recently issued by MECP provide further direction for the implementation of LID BMPs, and the design of these systems accordingly. At the time that the guidelines are implemented into industry practice, they should be considered during the selection of SWM technologies.

### 4.2.5 Groundwater

The following subsections discuss potential impacts to groundwater quantity (Section 4.2.5.1) and quality (Section 4.2.5.2) due to land use change.

#### 4.2.5.1 Groundwater Quantity

The potential water quantity impacts to the groundwater flow system from the proposed development include the following:

- An increase in impervious surfaces and soil compaction increases surface runoff and reduces the natural infiltration of groundwater leading to a subsequent decrease in groundwater levels, potentially decreasing groundwater discharge and recharge of local aquifers. Additional discussions on changes in infiltration is provided in **Section 4.2.3**.
- The installation of water and sewer infrastructure can lead to the interception of shallow groundwater flow along the permeable backfilled material, altering shallow groundwater flow paths and long-term may result in leakage into sanitary and storm sewers or vice versa.
- Installation of infrastructure below the water table leads to the potential need for dewatering during construction and post construction and a decrease in groundwater levels.
- Foundations constructed below the water table may lead to the requirement of sump pumps or foundation drain collector (FDC) systems to reduce groundwater levels.

- Subsurface construction has the potential to encounter more extreme hydraulic conditions, such as significant upward gradients and flowing wells. As described in the groundwater characterization, flowing wells were not observed in the Study Area but have been observed less than 1 km to the south and southwest. If also encountered in the current Study Area, significant upward gradients could result in the transmittal of large quantities of groundwater to ground surface, geotechnical issues, and the potential for significant groundwater level reductions during dewatering, which may impact existing wells and potential groundwater discharge. Constructors should be aware of the potential for encountering these more extreme hydraulic conditions as observed in the greater area.
- The removal of existing tile drains (if present), which are used to reduce high water tables, may lead to increased groundwater levels or remove direct discharge to the local tributaries.

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 (e.g., such as on the surficial ice-contact gravel deposit located near the intersection of Steeles Avenue. and the southern extension of 9$^{th}$ Line as mapped by the OGS), within deeper discrete sand lenses, and within fractured bedrock, where the infrastructure goes to that depth.

Dewatering activities may be required where construction of infrastructure intercepts the water table. This dewatering may intercept the shallow groundwater flow that would normally flow into local watercourses or wetlands. 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. Potential erosional issues related to discharge quantities and discharge points need to be assessed.

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.

#### 4.2.5.2 Groundwater Quality

The potential impacts to groundwater quality within the underlying aquifers are reduced as a result of the low permeable nature and thickness of the surficial till unit. In the current Study Area, the thickness of the primarily fine-grained overburden is approximately 15 to 20 m, to a local minimum of approximately 3 m under a portion of East Sixteen Mile Creek. Where the till is thinner or where the occurrence of interconnected and thicker sand lenses is more prevalent, there is an increased potential for impact.

Groundwater quality protection should also be considered in relation to the location of Highly Vulnerable Aquifers (HVAs), such as the localized HVA present under the eastern extent of the area underlying Mullet Creek as mapped in the Credit Valley Source Protection Area Assessment Report (ref. Figure 4.2 of CTCSPC 2015). HVAs are aquifers that are highly susceptible to contamination from both human and natural sources and certain land uses may be restricted within these areas as presented in Official Plans.

Anthropogenic sources which may impact groundwater quality and may be more prevalent within an industrial land use base include accidental spills and leaking storage tanks.

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.

New roads or highways within the development area can present another potential impact to groundwater quality. This includes the winter application of road de-icers such as road salt, which is known to have an adverse effect on the environment and can result in increasing groundwater salt (e.g., chloride) concentrations. Elevated chloride concentrations that exceed or come close to the 250 mg/L Aesthetic Objective in the Ontario Drinking Water Quality Standard were observed at three wells as part of previous groundwater quality sampling in the Study Area as described in the Phase 1 report. These elevated concentrations may be related to road salt application.

#### 4.2.5.3 Groundwater Considerations for Gilbach Special Policy Area

It is understood that the Gilbach property located at the southwestern portion of the Study Area is considered a Special Policy Area as part of a separate and parallel planning process that is ongoing. As a result, potential impacts from a groundwater perspective from development both inside and outside this area should be considered. As summarized in **Section 2.3**, groundwater discharge is interpreted to occur along various portions of East Sixteen Mile Creek and its tributaries both within and near the Special Policy Area. An increase in impervious surfaces outside the Special Policy Area and inside the Study Area, for example, has the potential to decrease natural infiltration in the Study Area and potentially decrease groundwater discharge to East Sixteen Mile Creek within the Special Policy Area. Similarly, a reduction in infiltration within the Special Policy Area as a result of increased impervious area within the Special Policy Area could decrease groundwater discharge to East Sixteen Mile Creek within and outside the Special Policy Area. Potential impacts to the Special Policy Area from the Study Area and from the Special Policy Area to areas outside of the Special Policy Area should consider groundwater quantity and quality as summarized in **Sections 4.2.5.1** and **4.2.5.2**. Similarly, management of potential impacts between the two areas should consider the groundwater considerations in **Section 5.2.1**.

## 4.3 Stream Morphology

During the Phase 1 study, desktop evaluations were initially completed for all surface water features, followed by detailed field investigations where access to property was granted. This included the delineation of stream reaches, hazards (confined and unconfined), detailed surveys for erosion thresholds, and watercourse and HDF constraint ranking and classification as per the refined process as developed through prior work in the Town of Milton, and in collaboration with CH (**Table 4.2.31**). Additionally, a site walk with CH and CVC was undertaken on October 23, 2020, to confirm feature locations and types for the entire study area.

The Phase 2 assessment focuses on the potential impacts to watercourses based on the proposed based analysis. The primary impact to watercourses from urbanization is 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). However, it is difficult to fully mitigate the fundamental changes to the landscape and therefore the various targets outlined are employed to ensure key elements of the fluvial system are maintained and protected to help absorb any potential impacts which may arise. The targets acknowledge the risks associated with land use change and provide direction for best management practices. To assess if targets are properly met by the proposed land use plan, six indicators were reviewed. The indicators and corresponding targets are outlined in **Table 4.3.1.**

## Table 4.3.1: Indicator Employed in Phase 2 and Corresponding Targets

| Indicator | Target |
|---|---|
| Hazard corridors (confined and unconfined) | Stream corridors have minimal interference; however it is understood that changes may be approved for infrastructure construction / maintenance, stream rehabilitation and enhancement where necessary. |
| | Natural cover maintained in stream corridors for High-Constraint (Red) streams, and may be replicated / restored for realignments for Medium-Constraint (Blue) Streams |
| | Minimize or eliminate risk to public and private property from channel erosion and evolution |
| Stream length and realignment | Maintain natural channel structure* and rates of morphologic change[#] |
| | Complete HDF assessment to address drainage density function |
| Road crossings | Maintain natural channel structure* and rates of morphologic change[#] |
| | Minimize or eliminate risk to public and private property from channel erosion and evolution |
| | Minimize number of road crossings |
| | Ensure fish passage |
| | Minimize length of road crossings |
| Stormwater management ponds | Maintain natural channel structure* and rates of morphologic change[#] |
| | Maintain critical flow exceedance at critical locations[%] |
| Erosion thresholds | Work toward maintaining pre-development water budget |
| | Minimize or eliminate risk to public and private property from channel erosion and evolution |
| | Maintain natural channel structure* and rates of morphologic change[#] |
| | Maintain critical flow exceedance at critical locations[%] |
| Sediment Regime | Maintain or replicate sediment contributions, if required[$]. Quality of sediment produced from feature should be evaluated. E.g., fine silts and sands from agricultural fields are likely of poor quality and produce little in the way of downstream form and habitat function. Maintain or enhance downstream form and function in the context of sediment regime and channel evolution. |

*Maintaining natural structure refers to the ability for the plan to allow for the channel to evolve or be maintained naturally rather than requiring channelization or realignment, hardening, etc.

# Maintain existing rates of change where possible or allow for acceptable adjustment within a delineated hazard corridor.

% "Critical locations" refer to the governing locations for analyzing erosion impacts and controls; these are generally represented by the location with the lowest unitary critical flow rate ($m^3$/s per hectare drainage area).

$ Requires observations on natural sediment and sources (i.e., not from furrows or tilled land). Natural sediment sources can be replicated if the feature is relocated within an appropriate buffer (within an appropriate land use), or if a feature discharges to a designed sediment deposit that may become mobilized as designed.

### 4.3.1 Erosion Hazard Corridors

The method for delineating hazard corridors within the Study Area differed between confined and unconfined reaches. A long-term stable top of slope setback was defined for confined reaches whereby the valley toe was estimated from site topography (contours), and a stable 3:1 slope setback was determined based on the average elevation difference from the floodplain to the table land. The toe of slope was delineated in general and requires refinement through future study to better represent the natural topography. Based on observed toe materials and absence / presence of active erosion, an additional 2 m or 8 m was applied as the erosion limit in-lieu of a measurable 100-year erosion rate. 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.

These hazard corridors are intended to contain all 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 which may occur as a result of urbanization. A secondary benefit of the erosion hazard corridor width is to protect surrounding riparian vegetation. 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.

An additional erosion access allowance has been applied to the erosion hazard delineation of East Sixteen Mile Creek to represent CH's regulatory limit for major systems (15 m). This 15 m is to be applied to the greatest of all hazards between the erosion hazard limit and regional floodline. For Mullet Creek, a 6 m erosion access allowance was applied in accordance with the OMNR Technical Guide (2002). It should be noted that Mullet Creek reaches within the study area are of a medium constraint and are likely to undergo restoration enhancement and/or realignment, which will result in design modifications to the erosion hazard and flood extent. **Drawings FG-**1 and **FG-2** present an overlay of erosion hazards and the land use plan for East Sixteen Mile Creek, and Mullet Creek, respectively. The proposed NHS encapsulates the confined hazard limit for East Sixteen Mile Creek, and the additional 15 m Conservation Halton regulatory setback for major valley systems. Mullet Creek meander belts are captured within the NHS, and the 6 m erosion access allowance is generally included. However, as Mullet Creek reaches are currently impacted by agriculture and lawn maintenance, they have been evaluated as medium constraint features. They may benefit from rehabilitation enhancement and/or realignment. Hazard corridors are to be delineated based on the design corridor geometry, and/or empirical approaches to accommodate the erosion hazard. Which will require modifications to the NHS in subsequent studies.

### 4.3.2 Stream Length and Realignment

As the hazard corridor assessment indicates, all of the area watercourses which flow through these corridors are protected by the current NHS plan. Changes in land use may result in realignments or relocation of existing watercourses and conservation HDFs, and/or the removal of limited function headwater drainage features (HDFs) to increase 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 (high-constraint, red streams), but it may be acceptable locally if the existing channel is degraded or has already been heavily modified as part of the existing land use, if it can enhance the NHS, or to address a critical servicing or community design issue. The watercourse constraint evaluation (**Table 4.3.2**) determined those reaches which may be suitable for realignment / enhancement (blue constraint), which are associated with Mullet Creek – MC(4)1 and MC(4)2. In these cases, the channel presents a restoration opportunity and realignment would be supported. Should realignments be proposed, stream lengths should be maintained, however, slight reductions in sinuosity may be permitted, provided it can be justified. 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 erosion. The proposed realignment must also demonstrate how it meets the definition of essential watershed management, which is permitted in the Natural Heritage System as per policy 117.1 (15) of the ROP and demonstrate that there are no negative impacts to the key features and their ecological functions, as per policy 118(2) of the ROP. The realignments and enhancements advanced as part of this Scoped Subwatershed Study include incorporation of natural channel design elements, which would support fluvial and aquatic habitat functions for upstream and downstream systems, as well as providing safe conveyance of runoff, thus contributing to essential watershed management.

**Table 4.3.2: Integrated Watercourse Constraint Assessment**

| Watercourse Reach ID | Surface Water | Groundwater | Fluvial | Terrestrial | Fisheries | Net Constraint Ranking | Rationale / Comments |
|---|---|---|---|---|---|---|---|
| MC(4)1 | Medium | Low | Medium | Medium | Medium | **Medium** | Artificially constrained (has been historically straightened). Highly impacted by historical and current land uses, mostly dry. |
| MC(4)2 | Medium | Low | Medium | Medium | Medium | **Medium** | Artificially constrained (has been historically straightened). Highly impacted by historical and current land uses, mostly dry. |
| ESMC(1) | High | High | High | High | High | **High** | Permanently flowing, sinuous, within confined valley, fish present |

The existing dominant land uses within the Scoped SWS Study area are predominantly agricultural with occasional rural residential areas and small industrial / commercial properties along the major roads. These land use types are relatively low-impact compared to a fully urbanized landscape. The Phase 1 assessment did not find that any of the watercourse reaches of East Sixteen Mile Creek or Mullet Creek were severely degraded as a result of the current land uses, most were 'In Regime' (or stable), with one reach, ESMC(2), immediately downstream of the Study Area being 'Transitional'.

The preliminary land use plan has not proposed any watercourse removals or realignments. With that said, there are opportunities to enhance medium constraint watercourses, and 'conservation' HDFs associated with Mullet Creek. High-constraint watercourses (ESMC 1) and associated erosion hazards are to be maintained and protected in-situ, with appropriate erosion hazard and regulatory setbacks. The current land-use plan indicates that ESMC(1), the erosion hazard corridor, and agency setbacks are protected within the NHS.

Channel adjustments permitted at select locations given sufficient rationale (e.g., addressing an immediate high-risk erosion hazard, or instream barrier). A natural channel design approach is to be applied where modifications are proposed (local or reach scale). General riparian enhancements, farm crossing removals (e.g., fords and culverts), and in-channel habitat features (e.g., wood debris) are encouraged, which would enhance the form and function of area streams, and those receiving reaches downstream.

**Headwater Drainage Features (HDFs)**

HDFs have been evaluated and have management recommendations ranging from 'no management' to 'conservation', which imply different functions and requirements. This section provides a brief overview on the management implications for HDFs in the context of development impacts, while **Section 5.3** provides general management recommendations and opportunities for HDFs. **Table 4.3.3** presents an overall review of feature evaluation, recommendations, and rationale. The "Final Management" recommendation determines the strategy and opportunities that is proposed for each reach, based on site specific rationale (e.g., ecological linkages) or other considerations not captured by the TRCA / CVC guidelines. Therefore, the "final management" may differ from the HDFA Classification (feature characterization.) Modifications to the HDFA classification are described within **Table 4.3.3** as appropriate. **Table 1 in Appendix C** provides an integrated overview of watercourse and HDF definitions and management based on feature constraint and classification that has been applied in the current study. The following describes feature characterization and general management for area HDFs (note, 'protection' features were not determined within the study area):

**Conservation Feature** (mapped as solid yellow lines)

- 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 feature and its functions within an open corridor. May be protected in-situ, relocated, and/or enhanced (including riparian area). Linkages must be maintained whether feature remains in current alignment, or through relocation.

**Mitigation feature** (mapped as solid green lines)

- Contributing Functions: e.g., contributing fish habitat with meadow vegetation or limited cover.

— Maintain function to downstream features. These features are typically highly modified but provide some downstream function (e.g., supply of sediment and/or water, or seasonal fish habitat). Some complexities like the function of tile drains, where important, can be replicated through SWM, while fish habitat may be replicated within another nearby feature, or downstream in the floodplain (e.g., pond creation).

**No Management Required** (mapped as green-dashed lines)

— 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.

— Feature can be removed from the surface without any implication to the system.

**To Be Determined** (mapped as solid purple line)

— Features associated with non-provincially significant wetlands (Lisgar branch). Characterization upgraded to conservation based on wetland feature type or wetland linkage.

— "Final Management" recommendation to be determined through future study based on further wetland assessments:

  – Subwatershed Impact Studies and/or

  – GTA West (Highway 413) Environmental Studies

**Drawings FG-3** and **FG-4** present the HDFA management classification for each feature in the context of the proposed land use plan. 'Conservation' HDFs are captured within the proposed NHS, including linkages. 'Mitigation' and 'No Management Required' HDFs have not been incorporated into the NHS. There are no impacts from the potential removal of 'no management required' features, however, downstream function and contributions for 'mitigation' features should be maintained or replicated appropriately. Features that are 'subject to further analysis have not been included in the NHS, and should be re-evaluated for impacts pending more detailed, future wetland analysis and associated wetland management (e.g., protection in place or relocation).

## Table 4.3.3: Headwater Drainage Feature Evaluation and Management Recommendations

| HDF ID | CA Jurisdiction | Hydrology | Riparian | Fish Habitat | Terrestrial | HDF Type | HDFA Classification | Final Management Recommendation | Rationale / Comments |
|---|---|---|---|---|---|---|---|---|---|
| MC(5) | CVC | Contributing | Important | Contributing | Contributing | Channelized | Conservation | Conservation | "conservation" due to wetland riparian vegetation. |
| MC(5)3-2 | CVC | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | defined swale; standing water first visit and dry by second visit |
| MC(6) | CVC | Contributing | Limited | Contributing | Limited | Swale | Mitigation | Conservation | "conservation" based on connection to wetland upstream. |
| MC(6)1-1 | CVC | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | defined swale; standing water first visit and dry by second visit |
| TESMC(1)1-1 | CH | Limited | Limited | Contributing | Limited | No Defined Feature | No Management Required | No Management Required | poorly defined feature, no water observed. |
| TESMC(1)2-1 | CH | Limited | Limited | Contributing | Limited | No Defined Feature | No Management Required | No Management Required | poorly defined feature, no water observed. |
| TESMC(1)2-1a | CH | Contributing | Important | Contributing | Valued | Wetland | Conservation | TBD | "conservation" based on important riparian vegetation and contributing hydrology. Important riparian due to feature type and vegetation being wetland. Final Management TBD pending further wetland studies at subsequent planning stages. |
| TESMC(1)3-1 | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | poorly defined feature, no water observed. |
| TESMC(1)3-1a | CH | Contributing | Important | Contributing | Valued | Wetland | Conservation | TBD | "conservation" based on important riparian vegetation and contributing hydrology. Important riparian due to feature type and vegetation being wetland. |
| TESMC(1)4-1 | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | "no management required" as it is a swale with standing water 1st visit and dry by 2nd visit. |
| TESMC(1)5-1 | CH | Contributing | Contributing | Contributing | Limited | Channelized | Conservation | TBD | Feature would be "mitigation" based on contributing hydrology score, however connection to wetland upstream results in "conservation" to maintain linkage. Final Management TBD pending further wetland studies at subsequent planning stages. |
| TESMC(2)1-1 | CH | Contributing | Limited | Contributing | Limited | Channelized | Mitigation | Mitigation | "mitigation" based on contributing hydrology score and valued riparian score. Maintain contribution downstream. Contributing hydrology score due to feature type being channelized and contained standing water 1st and 2nd visit. Valued riparian score due to cultural meadow vegetation. |
| TESMC(2)2-1 | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | "no management required" as it is a swale with standing water 1st visit and dry by second visit |
| TESMC(2)2-1a | CH | Contributing | Valued | Contributing | Limited | Channelized | Mitigation | Mitigation | "mitigation" based on contributing hydrology score. Maintain contribution downstream. Contributing hydrology score due to feature type being channelized and contained flowing water first visit, standing water second visit. |
| TESMC(3)1 | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | poorly defined swale, no water observed. |
| TESMC(3)2 | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | poorly defined swale, no water observed. |
| TESMC(4) | CH | Limited | Limited | Contributing | Limited | Swale | No Management Required | No Management Required | swale with some definition, however standing water on 1st visit and dry by 2nd visit. |

| HDF ID | CA Jurisdiction | Hydrology | Riparian | Fish Habitat | Terrestrial | HDF Type | HDFA Classification | Final Management Recommendation | Rationale / Comments |
|---|---|---|---|---|---|---|---|---|---|
| TESMC1a | CH | Contributing | Important | Contributing | Valued | Wetland | Conservation | TBD | "conservation" based on important riparian vegetation and contributing hydrology. Important riparian due to feature type and vegetation being wetland. Final Management TBD pending further wetland studies at subsequent planning stages. |
| TESMC1b | CH | Limited | Limited | Contributing | Limited | No Defined Feature | No Management Required | No Management Required | poorly defined feature, no water observed. |

### 4.3.3 Road Crossings and Alignments

Road crossings are an integral part of urbanization and an important consideration in terms of impacts to watercourses. A poorly sited road crossing can result in negative impacts to the channel and higher risk to the structure itself. There are several 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 because of the crossing structure. This minimizes the risk of compromising any additional structures located downstream.

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, they are:

- **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 downcutting 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.

— **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 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.

— **Hydraulic Capacity:** Hydraulic design criteria for freeboard, clearance and conveyance for the Regional Storm event will be evaluated and ensuring no increased flood risk to upstream private properties.

In addition to the geomorphic and erosion risk considerations, from a natural heritage perspective, the crossing of roads and infrastructure through the NHS should be avoided where possible. Where necessary, the crossings should consider the following:

— aligned at the narrowest part of the NHS

— perpendicular to watercourse crossings

— minimize width of crossing without compromising public safety

— maximize span of crossing over watercourses and consider wildlife movement under crossing

— consider wildlife road mortality and wildlife crossings

- install directional fencing to direct wildlife to crossing locations
- in the case of infrastructure, consider naturalization of crossing area to the greatest extent possible and minimize maintenance requirements

The proposed land use plan includes several road crossings, with limited to no impacts anticipated based on the current scale of planning:

- Crossing spacing provides no concern based on the current road alignment
- Crossings proposed for 'no management required' HDFs result in no impact. Features include: H5S1a, H4S1, TESMC1b, TESMC(1)1-1, TESMC(1)4-1, TESMC(1)2-1, TESMC(1)3-1, and MC(5)3-2
- Proposed crossings over medium constraint watercourse MC(4)2, and at the reach break between 'conservation' HDFs MC(6) and MC(5) should consider enhancements to currently impacted features. This includes the removal / replacement of the existing farm crossing located at the reach break between HDFs MC(5) and MC(6)

It is recommended that the risk-based and ecological guidelines provided in this report section be applied in the evaluation and design of watercourse and HDF crossings. Additionally, crossing designs should consider channel enhancement locally, unless reach-scale enhancements and/or realignments are proposed for impacted features. Siting and sizing of watercourse crossings should follow the guidance provided in CVC's Technical Guideline for Watercourse Crossings, CVC's Fluvial Geomorphic Guideline, and TRCA's Crossings Guideline for Valley and Stream Corridors.

### 4.3.4 Stormwater Management and Erosion Thresholds

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 Study Area. Erosion threshold values were calculated for reaches ESMC(2) (East Sixteen Mile Creek) and MC(6) (Mullet Creek), with critical discharge values of 0.70 $m^3/s$ and 0.79 $m^3/s$ respectively.

The results in **Table 4.2.30** to **Table 4.2.33** indicate that the stormwater management strategy advanced for the Premier Gateway Phase 2B area would effectively control the duration and volume of erosive flows. The results for the Mullet Creek indicate an over-control of erosion, hence opportunities exist to refine the unitary criteria and optimize stormwater management performance. These analyses should be confirmed as part of future studies (i.e., at SIS stage).

Discussion of the erosion assessment is provided in **Sections 0**. The following describes the outcome of this analysis:

— Volume and Duration Analyses reflect effective SWM and limited concern with respect to channel erosion.

— Modelled duration and volume reductions for site MC(4) may result in aggradation. However, this reduction may reduce in-stream erosion of this currently impacted and widening reach.

— Future analysis should consider that this feature, and other Mullet Creek watercourse reaches – MC(4)1 and MC(4)2 - will undergo design enhancements as they are medium constraint and impacted features.

## 4.4 Natural Environment

### 4.4.1 Wetlands

Wetlands within the East Sixteen Mile Creek corridor and Mullet Creek area are protected within the proposed NHS with 30 m buffers. Within the East Sixteen Mile Creek corridor, many of the wetland units are located centrally to the proposed NHS, so are protected within the larger floodplain and NHS. The Lisgar Wetlands have been identified with a 15 m buffer. If subsequent studies (e.g., SIS) propose a reduction in the 30 m buffer width to the wetlands within the East Sixteen Mile Creek corridor and Mullet Creek area, an Ontario Wetland Evaluation would be required to support the refinement of the buffer width and must meet the policies of the Regional Official Plan and regulations from the Conservation Authorities.

The tableland wetlands within the Gilbach property are undergoing a separate review process, which includes the potential for wetland removal and compensation.

Where wetland boundaries dictate the outer edge of the NHS, the wetland boundaries are to be staked with the Conservation Authority at the SIS stage and surveyed by an OLS. This includes the Lisgar Wetlands, central to the study area, including more detailed analysis to confirm retention of these areas is required. A wetland water balance assessment should be undertaken at the detailed planning and design stage to ensure the water balance for each wetland unit is maintained post development to pre-development conditions.

### 4.4.2 Woodlands and Trees

All woodlands within the study area are protected within the proposed NHS. Significant woodlands are protected with 30 m buffers from the dripline. Cultural woodlands (CUW) and the small FOD4 community are protected with a recommended buffer of 10 m from the dripline. Driplines are to be surveyed at the SIS stage. Criteria for evaluating woodland significance within the study area was determined as per the guidelines of the Halton Region Official Plan (section 277). An analysis on woodland significance was provided to the Town through a memo, dated January 20, 2023, which is attached as Appendix H.8 of the Phase 1 report.

It is recommended that isolated trees and hedgerows be retained through the development process where possible in order to realize the many benefits trees provide including, but not limited to, beautification, cooling, mitigating climate change, improving stormwater management, and psychological benefits such as reducing stress and providing relaxation. Tree conservation is supported by both the Town of Halton Hills and the Region of Halton. Where tree removal is required, a tree inventory and preservation plan are to be prepared to support the development application. Tree compensation and a planting plan is to be included in the tree inventory and preservation plan report (refer to the Town's OP, Section C9).

Tree removal must consider the Migratory Birds Convention Act and the Endangered Species Act with regards to breeding birds and SAR bats.

### 4.4.3 Significant Valleylands

The East Sixteen Mile Creek valleyland is considered significant and is protected within the proposed NHS. The valleyland boundaries are defined by the long-term stable top of slope and natural heritage features that overlap with the top of slope boundary. The overlapping surveyed feature boundaries and appropriate buffers will dictate the Significant Valleyland boundary at the SIS stage.

### 4.4.4 Significant Wildlife Habitat

Confirmed SWH (FOD7-4, Terrestrial Crayfish, Eastern Wood-pewee) is incorporated and protected within the proposed NHS. Candidate habitat for Turtle Wintering and Nesting Areas is also protected within the proposed NHS. Reptile hibernacula were not identified through this study. These may be associated with old barn and building foundations, typically not included in the proposed NHS.

Where additional SWH may be identified in the future through more detailed, site specific assessments, these habitats could potentially be removed and compensated for elsewhere. In such cases it is recommended the compensation habitats be located adjacent to the proposed NHS to create an even more robust system and in order to provide habitat connectivity for the created wildlife habitat.

### 4.4.5 Habitat for Endangered and Threatened Species

Bobolink, Eastern Meadowlark, Eastern Small-footed Myotis, and Little Brown Myotis were reported through the SWS. These species are protected by the Endangered Species Act (ESA).

Breeding habitat for Bobolink and potentially Eastern Meadowlark was identified in the fields north of East Sixteen Mile Creek. Where this habitat is to be removed, a permit is required from the MECP under the ESA (Part IV of O. Reg. 830/21) or through application of the Species at Risk Conservation Fund, O. Reg. 829/21.

Fulsome bat surveys were not completed as part of the SWS, but Eastern Small-footed Myotis and Little Brown Myotis were reported from the Gilbach SWS. Where tree removal or buildings are proposed for removal, bat surveys may be necessary to determine implications under the ESA.

Habitat for Endangered and Threatened Species is predominately associated with the East Sixteen Mile Creek corridor and area. The NHS proposed in this area protects foraging habitat and the travel corridor for SAR bats. Where habitat for SAR is to be compensated for, it is recommended the compensation habitats be located adjacent to the proposed NHS to create an even more robust system and in order to provide habitat connectivity for the SAR.

### 4.4.6 Fish Habitat

Fish habitat has been protected within the proposed NHS as East Sixteen Mile Creek and Mullet Creek are protected within the NHS. Brook Stickleback were observed with a HDF (TESMC(1)) east of 9$^{th}$ Line South. Habitat for fish will remain south of Steeles Avenue.

### 4.4.7 Natural Heritage System

A preliminary NHS was identified through Phase 1 of the SWS, as outlined in Section 3.2.3 of that report. The NHS was refined through Phase 2 of the SWS. The proposed NHS includes the following:

- Wetlands (surveyed boundaries) within the East Sixteen Mile Creek and Mullet Creek catchment areas, as well as 30 m buffers.
- Significant Woodland (FOD7-4) community with a 30 m buffer.
- Other woodlands (FOD4, CUW) with a 10 m buffer.
- Confirmed SWH (FOD7-4, Terrestrial Crayfish, Eastern Wood-pewee) and candidate SWH (Turtle Wintering and Turtle Nesting Areas).
- Fish habitat (East Sixteen Mile Creek and Mullet Creek) with 30 m buffer.
- Stable top of slope with a 15 m access allowance.
- Linkage (60 m wide) between the Mullet Creek wetlands along the HDF identified with a management recommendation of Conservation (MC(5) and MC(6)).
- Linkage (60 m wide) between the thicket swamp (SWT2-2) and woodland (FOD4) in the eastern portion of the study area.

The proposed NHS is shown on Map 6, as well as the Land Use Plan (Figure 3.1). The various supporting layers are shown on Map A in **Appendix D**. The NHS protects the significant and sensitive natural heritage features within the study area and ensures connection to areas outside the study area. The proposed NHS is robust as it is comprised of the wetlands, woodlands, watercourses, Significant Wildlife Habitat, and the floodplain. Through the SIS or detailed design stage, it is recommended that non-developable areas, created through the irregular NHS boundary, be included in the NHS and naturalized to provide an enhancement to the proposed system. The lands adjacent to the proposed NHS are ideal for any compensation measures that are to be provided, as well as open space uses such as stormwater management and LID.

The regulatory and NHS boundaries identified through the SWS are considered approximate, preliminary, and subject to change / increase through the future SIS process once the wetlands are formally staked with the Conservation Authority and an Ontario Land Surveyor.

The Lisgar Wetlands central to the study area are not included in the proposed NHS as they are not connected to other natural heritage features or areas. They are shown on Map 6 with 15 m buffers. These vegetation communities are to undergo further assessment at the SIS stage. These areas, if they are wetland, could potentially be removed and compensated for elsewhere, preferably adjacent to other areas of the NHS. The proposed GTA West Transportation Corridor route traverses the study area in this location and will require a separate Environmental Assessment process to be completed by the Province.

As can be seen on Map 6, the proposed NHS is generally in line with the Town Greenlands system and Region's NHS (RNHS). The proposed NHS does not include a portion of the RNHS west of 10th Line. The RNHS was associated with a formerly mapped floodplain limit, however the drainage feature central to it was confirmed as a HDF through the SWS. The HDF (TESMC(2)1-1) was evaluated as requiring mitigation. There are no natural heritage features associated with this HDF and it was therefore not included in the proposed NHS. Similarly, HDF MC(6)1-1 east of 10th Line, was evaluated as requiring no management, which is in an area of tilled agricultural field. This area was also excluded from the proposed NHS.

The proposed NHS is robust and is anticipated to protect the significant and sensitive natural heritage features located within it from the impacts of development of the adjacent lands. Mitigation recommendations as listed below, such as fencing the NHS perimeter, will help protect this area. Crossings of the NHS should be avoided.

### 4.4.8 Mitigation Measures

The following provides a list of mitigation measures to avoid impact and should be implemented during the development of the study area.

The Endangered Species Act protects Endangered and Threatened species. Removal of barns, houses, or individual trees may need to be surveyed for SAR bats or bat maternity roosts. This should be done in consultation with the MNRF. Where tree removal is to occur, agencies must also be consulted with regards to the potential for bat maternity roost SWH.

The Migratory Birds Convention Act protects migratory birds, their eggs and nests from being harmed or destroyed. It is recommended that any tree removal and vegetation clearing (including grading) be undertaken prior to May 1 or following August 31. Should vegetation clearing have to occur within this time, a nest search must be completed by a qualified biologist within 48 hours of the clearing to assess whether or not any nests are located in the area. Clearing cannot be done if an active nest is present.

Potential indirect impacts to wildlife may arise from noise and dust associated with construction activities and unnatural lighting resulting from the development. Noise associated with construction will be temporary, therefore significant effects on wildlife from noise are not expected.

Wildlife-vehicle collisions are a risk across roads and must be minimized. Mitigation measures include strategically enabling (e.g., crossing structures) or discouraging (e.g., exclusion fencing) wildlife crossings along roads.

Bird-window collisions should be minimized and building design elements should be considered and implemented through the subsequent planning process to mitigate bird collisions.

During construction activities such as clearing and grubbing can create dust that can lead to changes in vegetation due to increased heat absorption and decreased transpiration; adverse effects in wildlife due to high levels of sedimentation and visual impacts. In order to suppress dust, areas of bare soil should be moistened with water during construction activities to ensure that the amount of dust within the study area is reduced. Topsoil stockpile locations should be in areas of lesser wind exposure and away from natural features. Erosion and sediment control measures should be installed correctly prior to site alteration and maintained in good repair throughout the construction process. Areas of bare soil should be seeded to reduce erosion. Best management practices should be followed with regards to topsoil storage in order to maintain the microbiota of the soil which will benefit plant growth once the topsoil is redistributed across the developed area.

Detailed lighting designs should include directional lighting for all areas of road and developments that are within 30 m of the natural features to eliminate lightwash. It is recommended that guidelines from the International Dark Sky Association be considered.

If trails are to be considered for this area, it is recommended they be established at the start of development to give people immediate access and discourage the establishment of footpaths. Proposed trail alignments should be developed in consultation with all agencies and the trail location should be staked in the field with all agencies present. Preference will be given for trail alignment outside of the Conservation Authorities' Regulation Limit. Proposed alignments within the Regulation Limit must conform with Conservation Authority policies and will require a permit from the Authority. Proposed trail siting in proximity to the NHS should be aligned closer to the development area and away from the core natural heritage features. Trail alignments proposed within the Phase 2B Natural Heritage System should adhere to the natural heritage policies of the Regional Official Plan.

Chainlink fencing should be installed along the edge of the NHS to keep blowing garbage outside of sensitive areas. Specific fencing locations should be determined at the detailed design stage. Existing disturbances within natural heritage features, such as debris piles, should be removed. A plan for invasive species control should be prepared and implemented.

Areas within the NHS that are currently not natural (e.g., agricultural areas) should be naturalized (i.e., enhanced / restored) and planted with native, non-invasive species. This includes Linkages. Milkweed species (*Asclepias sp.*) should be included in seeding mixes to provide habitat of Monarch. Other species beneficial to pollinators should be planted as well. It is recommended that planting and seeding plans be established at detailed design stages.

### 4.4.9 Construction and Design Related Mitigation Recommendations

The following recommendations are general in nature but are largely standard mitigation measures for development and construction. The following recommendations are provided to ensure that any potential impacts are minimized:

— Individual trees (e.g., hedgerows, surrounding residences) should be maintained and protected where possible. Where trees in fair to excellent condition have to be removed, these should be compensated for. Compensation plans are to be developed at the detailed design stage.

— No storage of equipment, materials or fill is to occur within the natural areas or their buffers.

— Maintenance of machinery during construction should occur at a designated location away from the proposed NHS.

— Sediment and erosion control measures must be installed correctly prior to site alternation and maintained in good working order throughout construction. Sediment and erosion control fencing should be removed following construction and any disturbed areas naturalized using native species.

— Any areas of bare soil that arise should be graded and re-vegetated as soon as possible to avoid gullying and erosion (within 30 days of inactivity). A suitable native seed mix is to be applied to all exposed areas of soil that are immediately adjacent to the natural areas.

— During the installation of the construction limit fencing, any hazard trees should be identified by a Certified Arborist or qualified other and removed or pruned as warranted. Cavity trees may have to be surveyed for SAR bats prior to any removal. This should be done in consultation with the MECP.

- Planting of native tree and shrub species on currently un-vegetated portions of the site is recommended to enhance site conditions. Natural succession and plantings can be used to create native vegetation zones around retained natural heritage features.
- Litter and debris should be removed from the construction areas on an ongoing basis.

# 5 RECOMMENDED ENVIRONMENTAL AND STORMWATER MANAGEMENT PLAN

## 5.1 Introduction

The following provides an overview of the recommended environmental and stormwater management plan for the Premier Gateway Phase 2B lands. Further details are provided in the Phase 3 report for the sizing and implementation of the recommendations.

## 5.2 Stormwater Management

The recommended stormwater management plan has been developed based upon the principles provided in **Section 4.2.4**, and the sizing criteria presented in **Section 0**. Key components of the recommended stormwater management plan are as follows:

- Wet ponds are recommended for the future urban development within all development areas in the Sixteen Mile Creek and Mullet Creek Subwatersheds.
- LID BMPs shall be applied throughout the future development lands to maintain water budget and further enhance stormwater quality and erosion control. The specific type of LID BMP shall be determined based upon the contributing land use and in consultation with the Town of Halton Hills.
- The stormwater management plan for the GTA West Corridor is to be determined through a separate process and shall be established with regard for the stormwater management criteria presented herein.

Clay plugs and anti-seepage collars could be utilized to prevent preferential flow along infrastructure backfilled material.

Dewatering to implement servicing may be necessary and the volume and length of time of the dewatering may vary. A dewatering water management plan may be necessary to address local lowering of the water table and appropriate discharge of water. For dewatering volumes greater than 50,000 l/day at Permit to Take Water will be required from MECP.

### 5.2.1 Groundwater Considerations

Groundwater management generally focuses on adjusting the deficiencies in the water balance resulting from increased impervious surfaces and soil compaction as discussed above. The extent of groundwater management is consequently dependent on the characteristics of the groundwater flow system including:

- The ability of the stratigraphic units to infiltrate and transmit water.
- The ecological connection of the stratigraphic units to local wetlands, watercourses or underlying aquifers.
- The need to meet stormwater management requirements.

The ability of the stratigraphic units to infiltrate or transmit water will be dependent on the sand, silt and clay content. As previously presented as part of the characterization work, the surficial overburden primarily consists of the clay silt, silty sand, Halton till and glaciolacustrine silt and clay. The site-specific subsurface characteristics, including the continuity and thickness of sandy layers and potential for strong upward gradients and flowing well conditions will need to be confirmed through additional drilling, test pits, and infiltration tests.

Employing various Best Management Practices will aid in promoting infiltration, maintaining recharge and reducing runoff, as well as maintaining groundwater levels and related groundwater discharge as presented within the stormwater management plan (**Section 4.2.4** and/or Section 5.2 Additional management strategies for groundwater quantity issues include:

- Sump pumps, perimeter drains, underdrains, and foundation drain collection (FDC) systems - permanent groundwater control relating to buildings commonly utilizes perimeter drains and underdrains which may then be directed to a dedicated FDC system and discharged to local water courses. The amount of water collected and the extent of groundwater drawdown varies with depth, the size of the collection system, and the local hydrostratigraphy.
- Dewatering - groundwater takings for construction dewatering are regulated by the MECP. Where construction dewatering is greater than 50,000 L/day but less than 400,000 L/day registration on the Environmental Activity and Sector Registry will be required. For dewatering greater than 400,000 L/day a Permit To Take Water (PTTW) will be required as per Ontario Regulation 387/04. Additional PTTW information can be found at https://www.ontario.ca/page/permits-take-water.
- Dewatering activities must account for the quality of water being removed, and the discharge point or receiving body as it relates to potential water quality impacts.

Dewatering must also take into account the potential reduction in groundwater levels and associated potential impacts on groundwater receptors. Technical reports are a basic requirement for a PTTW.

- Anti-seepage collars or clay plugs – the redirection of shallow groundwater flow along permeable backfill associated with buried linear infrastructure may be managed with anti-seepage collars or clay plugs.
- Infrastructure design – as subsurface structures may redirect shallow groundwater flow around the original discharge point, this can be important where that discharge is ecologically significant. Infrastructure design or mitigative techniques should allow for groundwater flow to the natural area where it is functionally significant (e.g., direct fish habitat or support of localized hydroperiod).

It is important to note the potential interconnection of various water management practices. Practices which are promoting local infiltration to maintain recharge or reduce overland flow may be increasing groundwater levels and groundwater flow which may potentially be intercepted by FDC systems, sump pumps, and dewatering systems, for example.

There are also management strategies for mitigating groundwater quality issues. The Region of Halton and Town of Halton Hills, for example, have a Salt Management Plan for managing and minimizing potential loadings of road salt during the winter months (Halton et al. 2003). In addition, the following should be considered to minimize potential groundwater 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; employment lands may possess a higher potential risk to groundwater quality depending on the specific industries.
- Require contaminant management plans as a condition of development in industrial / employment areas for employment uses / types that are considered to be a high risk to groundwater contamination.

Additional groundwater quality management recommendations are presented in the Source Protection Plans for Halton Region Source Protection Area (HHSPC 2019) and CTC Source Protection Region (CTCSPC 2019a) and the supporting Assessment

Reports for Halton Region Source Protection Area (HHSPC 2017) and Credit Valley Source Protection Area (CTCSPC 2019b).

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 MECP Ontario Regulation 903.

## 5.3 Watercourses and Headwater Drainage Features

General watercourse and HDF definitions and management strategies are presented **Table 1 of Appendix C** Watercourse and Headwater Drainage Feature Classification. In addition to the guidance provided in **Appendix C**, management recommendations for watercourses include:

High Constraint Watercourses (Red streams)

— Apply management strategies / opportunities for High Constraint (Appendix C)

— Incorporate erosion hazard into NHS

Medium Constraint Watercourses (Blue streams)

— Apply management strategies / opportunities for Medium Constraint (Appendix C)

— Incorporate existing or designed feature and setbacks into NHS. Design setbacks can be developed in the case this is realigned

— Enhance riparian zone along agricultural fields

— For realignments, all management recommendations, riparian corridors (appropriate buffer, regulated setbacks) to be established in future studies. Natural channel design principles to be implemented for any realignments

**Drawings FG-1** and **FG-2** present the erosion hazard corridors in relation to the land use plan. **FG-3** and **FG-4** present the watercourse constraints in relation to the land use plan.

Potential watercourse crossing locations have not been identified in the current land use plan.

For HDFs, a modified classification and evaluation methodology to characterize and provide management recommendations for individual HDFs was used as described in the Phase 1 report. The approach first applies the guidelines set by TRCA / CVC (2014) to determine a feature classification ("**HDFA Management**"), which may then be carried forward to "**Final Management**" or altered based on site opportunities, or other constraints that the protocol may not capture (e.g., feature protection based on location within a significant valley or terrestrial feature). The following briefly summarizes management strategies for HDFs, while **Table 1 in Appendix C** provides an overview of feature definitions and management:

- **Protection feature** (red-dashed features) – Protect in place and maintain contributions to and from feature, to be incorporated into the NHS. Channel adjustments may be permitted at select locations given sufficient rationale, and as approved by Regulatory Agencies.
- **Conservation feature** (yellow features) – Realignment permitted provided important ecological functions are maintained, including linkage functions if the existing feature provides a linkage function. Conservation features providing important linkage functions may be incorporated into the NHS.
- **Mitigation feature** (green features) – maintain function to downstream features. These features are typically highly modified but provide some downstream function (e.g., supply of sediment and/or water, or seasonal fish habitat). Some complexities like the function of tile drains, where important, can be replicated through LID practices, swales, or other SWM, while fish habitat may be replicated within another nearby feature, or downstream in the floodplain (e.g., pond or wetland creation).
- **No management required** (green-dashed features) – feature can be removed from the surface without any implication to the system.
- **To be determined** (pink features) – final management to be determined based on future wetland analysis through additional study.

**Drawing FG-3** and **FG-4** identify the final HDF management recommendations in relation to the land use plan. Reach specific management recommendations for watercourses and HDFs are to be provided through Phase 3 of the Scoped SWS, where required.

### 5.3.1 Road Crossings and Alignment

Road crossings should be oriented and sized appropriately using geomorphic risk factors (e.g., bankfull width, channel stability, erosion rates, meander amplitude), and ecological considerations (ref. "Road Crossings and Alignments" in Section 4.3.3).

### 5.3.2 Erosion Thresholds

Critical discharges determined through the erosion threshold analysis should be applied as SWM targets to mitigate adverse erosion downstream following development and major alteration to site hydrology. Analyses presented through the Scoped SWS should be refined through subsequent planning studies. Additionally, future studies should identify potential SWM discharge locations and erosion thresholds should be confirmed or determined for receiving watercourses (sensitive or representative), and downstream impacts evaluated.

# BIBLIOGRAPHY


- AMEC Foster Wheeler Environment & Infrastructure (AFW). 2020. Premier Gateway Scoped Subwatershed Study, Phase 1: Study Area Characterization (Draft), Town of Halton Hills.
- Amec Foster Wheeler. 2020. Premier Gateway Scoped Subwatershed Study Phase 2: Impact Assessment and Management Strategy Final Report. Prepared for the Town of Halton Hills.
- Conservation Halton. 2017. Conservation Halton's Guidelines for Ecological Studies. August 2017.
- CTC Source Protection Committee (CTCSPC). 2019a. Approved Source Protection Plan: CTC Source Protection Region. December 2019.
- CTC Source Protection Committee (CTCSPC). 2019b. Approved Updated Assessment Report: Credit Valley Source Protection Area. December 2019.
- Halton-Hamilton Source Protection Committee (HHSPC). 2019. Source Protection Plans for the Halton Region Source Protection Area and the Hamilton Region Source Protection Area, Version 3.3, October 12, 2017. In effect February 5, 2019.
- Halton-Hamilton Source Protection Committee (HHSPC). 2017. Assessment Report, Halton Region Source Protection Area. October, 2017.
- Jennifer Lawrence & Associates Inc., MGM Consulting, Savanta, Geo Morphix, DS Consultants, Minnow Environmental (JLA et al). 2020. Town of Halton Hills – Halton Region, Scoped Subwatershed Study, Northeast Corner of Steeles Avenue and 8th Line, Final Report. September 2020.
- Regional Municipality of Halton, City of Burlington, Town of Halton Hills, Town of Milton, and Town of Oakville (Halton et. al.). 2003. Salt Management Plan Summary. July 2003.