Premier Gateway

Scoped Subwatershed Study

Phase 2: Impact Assessment and Management Strategy (Draft)

Prepared for:

Town of Halton Hills

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Submitted to:

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1.0 INTRODUCTION

The Premier Gateway Lands in the Town of Halton Hills are generally bounded by Sixth Line to the west, Eighth Line to the east, Steeles Avenue to the south, and lie south of 5 Sideroad. In 2015, the Town initiated the Premier Gateway Phase 1B Employment Area Integrated Planning Project to prepare a detailed Secondary Plan Study which includes appropriate land use designations and policies for the Phase 1B Employment Area and identify up to 75 ha of additional 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 2021 planning horizon in the Town. As part of this process, a Scoped Subwatershed Study has been initiated in order to define and establish the constraints and opportunities within the Premier Gateway Lands related to the terrestrial and aquatic ecology, stream systems, and surface water and groundwater resources (quantity/quality).

The Scoped Subwatershed Study is being completed in the following phases:

Phase 1: Study Area Characterization
Phase 2: Impact Assessment and Management Strategy

The Phase 1 report has been completed in February 2016 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.

This report summarizes the methodologies and results of the Phase 2: Impact Assessment and Management Strategy component of the overall Scoped Subwatershed Study. Additional information is also provided regarding the supplemental investigations completed subsequent to the submission of the Phase 1 report, to inform the overall characterization of the study area

2.0 SUMMARY OF PHASE 1 SUBWATERSHED STUDY CHARACTERIZATION

The following summarizes the key findings and additional investigations and characterization work completed, subsequent to the submission of the February 2016 Phase 1 Report.

2.1 Surface Water

2.1.1 Hydrology

The study area is situated within Subwatershed 4 of the Sixteen Mile Creek Watershed. The existing land use conditions within the Premier Gateway Lands are generally agricultural, golf course, and open space, with some isolated residential and commercial land use fronting Steeles Avenue. The study area drains from the north to the south, and conveys runoff from lands to the north through the study area via open watercourses. Lands south of Premier Gateway Lands form part of the Highway 401 Corridor which either have been developed recently, or are approved for future development. The soils within the study area consist of Chinguacousy clay loam, Jeddo clay loam and Oneida clay loam, which are classified as SCS Type 'C' soils, exhibiting relatively low rates of infiltration and comparatively higher rates of runoff. Surface slopes within the Premier Gateway Lands are typically low, ranging from approximately 0.2% to 3.5%.

Hydrologic analyses have been completed using the HSP-F hydrologic model for the existing land use conditions within the study area. The hydrologic model has been calibrated using local flow and rainfall data collected as part of the field monitoring program for the Scoped Subwatershed Study. Peak frequency flows have been established for the study area using continuous simulation and frequency analysis, and peak Regional Storm peak flows has been established by executing the Regional (Hurricane Hazel) Storm event as a discrete storm event. The subcatchments boundary plan for existing land use conditions is provided in Drawing WR-1.

Subsequent to the completion of the Phase 1 report, and following extensive consultation with Conservation Halton staff, the hydrologic analyses have been revised to apply the calibrated model parameters for the continuous simulation, and the uncalibrated model parameters for the Regional Storm event. Correspondence regarding the revised approach is provided in Appendix 'B' for reference. The updated peak frequency flows and Regional Storm event peak flows corresponding to the approved modelling are provided in Table 2.1.1.

Table 2.1.1 Simulated Peak Frequency Flows and Regional Storm Event Flows for Existing Land Use Conditions (m^3/s)									
Reference Node	Location	Frequency (Years)							
		1.25	2	5	10	20	50	100	Regional
1.548	Downstream of Sixth Line	2.2	4.9	11	16.9	24	35.7	46.5	82.1
1.560/1.516	Downstream End of Subcatchment 241	0.1	0.2	0.3	0.4	0.5	0.6	0.8	2.21
1.526	West Branch North of Steeles Ave	2.3	5.1	11.1	16.6	23.3	33.9	43.5	83.8
1.527	Middle 16 Mile Creek at Steeles Ave	4.4	9.1	19	28	38.8	56.2	72	116
1.535	Hornby Tributary Upstream of site	1	2.3	5	7.4	10.1	14.3	17.9	48.4
1.542/1.506	Hornby Tributary at Trafalgar Road	0.5	0.7	0.9	1.1	1.3	1.5	1.7	6.51
1.545	Hornby Tributary at Steeles Avenue	1.9	3.5	6.3	8.6	11.2	15	18.2	59
1.529	Middle 16 Mile Creek at Highway 401	6.6	13	25.7	36.9	49.9	70.2	88.4	188
1.530	Subwatershed 4 of Middle 16 Mile Creek Outlet	6.8	13.1	25.7	36.6	49.1	68.5	85.6	180

The results of the continuous simulation have been used to assess the existing erosion potential along selected watercourses within the study area, based upon duration of time (in hours and percent to total time) during which the flows would be above the critical erosive flows. The results of this assessment are presented in Table 2.1.2.

Table 2.1.2 Erosion Assessment for Existing Land Use Conditions			
Reach	Location	Duration of Erosive Flows	
		Hours	Percent of Total Time
E-T1-2	Middle 16 MC-East Branch-North of Steeles Ave.	5711	1.55
T-1	Middle 16 MC at Hwy 401	5932	1.61
HT-1	Hornby Trib. At Hwy 401	21263	5.78

2.1.2 Hydraulics

The Regional Storm peak flows presented in Table 2.1.1 have been used to develop floodline mapping through the Premier Gateway Lands. The HEC-RAS hydraulic model, which was developed for the Phase 1 Report and applied for the initial hydraulic analyses, has been applied for this assessment. The updated Regulatory (Regional) Floodline Mapping through the Premier Gateway lands is provided on Drawing WR-2. Similar to the findings presented in the Phase 1

Report, the updated floodline mapping for the Premier Gateway lands is noted to be e comparable to the current floodline mapping developed as part of the 1986 Flood Damage Reduction Program (FDRP) for the Sixteen Mile Creek Watershed.

2.2 Groundwater

A summary of the significant hydrogeologic findings for the preliminary 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 silt layers and sand pockets exist.
- These sediments tend to reduce recharge, lateral and vertical groundwater flow and associated groundwater discharge.
- If sufficient groundwater gradients exist and more permeable discrete pathways exist within the Halton till and silt sands, groundwater discharge may occur.
- The overburden is underlain by the Queenston shale. The upper portions of the Queenston shale can be extensively fractured.
- A buried bedrock valley is known to exist within and south of the study area.
- The overburden thickness ranges from 10 m to 30 m with the thickest sections correlating with the buried valley.
- A more extensive silty-sand to sand and gravel basal unit is present directly overlying the bedrock and appears to be thicker within the bedrock valley.
- Groundwater recharge values have been reported to be in the range of 80 mm/yr to 110 mm/yr.
- Groundwater supplies are obtained from both the over burden and the bedrock. Lager diameter dug or bored wells and drilled wells in the basal sand and gravel provide water in the overburden wells. The upper fracture shale provides water for the drilled bedrock wells. Wells generally provide sufficient quantities of quality water.
- Flowing wells in the basal sand and gravel and upper bedrock exist in the southern portion of the study area indicating significant upward gradients.
- Hydraulic connection of this lower unit to local wells, both overburden and bedrock, appears to have been demonstrated during a construction dewatering along Steeles Avenue east of Sixth Line.
- There is currently no site specific hydrostratigraphic data indicating direct linkages to the stream reaches.
- It is expected that the more regional groundwater system may provide for significant discharge potential within the study area to add to the potential lateral shallow component provided by the local recharge.
- Groundwater discharge appears to occur in various stream reaches based on stream flow and water temperature measurements and observations of Watercress (*Nasturtium officinale*).

2.3 Stream Morphology

The stream morphology component of the Phase 1 Characterization Assessment established existing and historic form and function for study area watercourses, all of which were associated with Middle Sixteen Mile Creek. This included an assessment of sediment movement within the

system, channel planform evolution, and geometric characteristics relating to channel stability and function. Central to this study was the need to gain both a qualitative and quantitative understanding of channel processes within the area such that guidance can be given to proposed land use changes, thereby ensuring continued stable channel dynamics, as well as ensuring that any potential impacts to downstream channels is avoided and/or minimized. To achieve this objective, the following tasks were completed:

- Background review – available pertinent reporting, historic and current aerial photography, surficial geology and physiography, and available spatial data (e.g. Conservation Halton watercourse shapefiles).
- Reach delineation and preliminary identification of headwater drainage features using available aerial photography and mapping (e.g. topographic, land use).
- Delineated the meander belt on a reach basis for watercourses in the vicinity of the study area
- Completed field reconnaissance to characterize existing geomorphic conditions and stability, document evidence of active erosion and confirm desktop results (i.e. reach delineation, meander belt, and headwater drainage features).
- Initiated and completed the Headwater Drainage Feature (HDF) assessments
- Developed erosion thresholds for sensitive or representative reaches.

The following sub-sections quickly summarize the methods applied and highlight key results of the stream morphology characterization and assessment. Additionally, subsequent results and updates to the HDF and watercourse assessments stemming from discussions and a site visit with Conservation Halton and Halton Region staff has been included.

2.3.1 Desktop Assessment

2.3.1.1 Reach Delineation

Following a review of aerial photography, previous reporting (Dillon, 2000), mapping (topography, watercourse, surficial geology) of watercourses and drainage features for the study area, and downstream were divided into “reaches”. These reaches are lengths of channel that exhibit similar influences with respect to land cover, vegetation, valley setting, and hydrology. Channel characteristics such as pattern, geometry (mainly width), and gradient reflect these influencing factors, and are also used to help delineate reaches. Aerial photography was used to identify less defined and minor drainage features that could be potential HDFs. This exercise overall enables a grouping and comparison of channel characteristics throughout, and helps to guide field investigations. Refinements to the reach/HDF delineation were made in the field. A total of 13 stream reaches and 11 HDFs were identified during the reach delineation (see Figure 2.4.1).

2.3.1.2 Historic Assessment

Land development through the study area mostly occurred between 1954 and 1978 including: Trafalgar Road extension, Hornby Glen Golf Course construction, Hornby Park construction, and several small residential properties along Sixth Line and Steeles Avenue. Channel straightening was evident in the earliest photos as some reaches and HDFs were relocated to the boundaries of crop fields. Minor realignments accompanied road work, or development at the golf course. The golf course further impacted drainage through the creation of ponds, and intermittent piping along a drainage feature. Planform changes were noted throughout, mainly for reaches through

agricultural zones with minimal riparian buffers. Migration rates could not be accurately determined as a result of photo quality and georeferencing issues.

2.3.1.3 Meander Belt Width Delineation

In order to identify the hazard associated with channel erosion, a meander belt width delineation was completed for watercourse reaches within and downstream of the study area, and appropriate setbacks were applied to create a final hazard corridor. A process-based methodology was applied to determine the meander belt by utilizing a combination of background data, aerial photography (current and historic), and contour information. Meander belts were delineated for each reach, and because of the limited ability to quantify migration rates, an overall factor of safety of 20% (10% to either side of the meander belt) was added to the preliminary belt width to create the final hazard corridor (Appendix D-1).

Following the Phase 1 report, HDF HT-2b-2 (S3) was upgraded to watercourse. A meander belt was delineated accordingly, with a final width of 6.48m.

2.4 Field Reconnaissance

Fieldwork began in 2015 and consisted of three components: a headwater drainage feature (HDF) assessment, rapid geomorphic and stream assessments (by reach), and detailed surveys at selected sensitive and/or representative reaches.

2.4.1 HDF Assessment

Through a review of aerial photography and mapping, several smaller drainage features were identified for a HDF assessment. Furthermore, features that were identified as watercourse yet were imperceivable the aerial imagery, were flagged as potential HDFs then assessed using the HDF protocols to confirm the feature type.

Following the guidance of the TRCA/CVC (2014) protocol, the HDFs were visited on two separate occasions (no feature required three visits). As outlined in the Phase 1 report, the timing of the visits was based on the three visit recommendation set out in the TRCA/CVC protocol. Subsequent to the Phase 1 report, a technical memorandum was released to provide an update on the classification and recommendations for HDFs after completing the full TRCA/CVC protocol (Appendix D-2). Details outlining the protocol and methodology can be found in the Phase 1 report and also the HDF technical memo. Figure 2.4.1 shows the distribution of headwater drainage features and watercourses through the study area, and the final management recommendation to inform site development. Site visits, reporting and the timing of comments from CH and the Region occurred as outlined below:

i. May 28, 2015 - initial visits were conducted during the Site Visit #2 timing window in 2015. All features were visited during this visit with the exception of HDF-1, HT-2b-4 (a and b), and W-T1-2b.
ii. July 3, 2015 - visit conducted during the Site Visit #3 timing window in 2015. Only HDF-1 and W-T1-2b were visited on this date, based on conditions during the assessment it was determined that a Site Visit #2 would be superfluous for these features and was not needed in 2016.
iii. March 8, 2016 - all features were visited on this date to serve as Site Visit #1. Due to unseasonably warm winter conditions, this is somewhat earlier than the normal freshet visit (late March-April). A melt event occurred on this date as a result of snowfall accumulation occurred over the previous week followed by warming temperatures (high

of 11.6° Celsius on March 8, 2016). Typically, Site Visit #1 is conducted a few days after the freshet to allow for melt of the snow pack and runoff. To compensate for a smaller snowpack in 2016, the Site Visit #1 was conducted closer to the melt event. However, this may have resulted in somewhat higher flows than would normally be anticipated for a typical Site Visit #1.

iv. May 25, 2016 - this served as the Site Visit #2 for HT-2b-4 (a and b) because access was not available in 2015 during the proper timing window.
v. June 3, 2016 – Parish Aquatic Services, a division of Matrix Solutions Inc. supplied a technical memorandum: *Results of Headwater Drainage Feature Assessment for Premier Gateway Scoped Subwatershed Study* (Appendix D-2).
vi. August 5th and August 23rd, 2016 - comment letters in response to the HDF technical memo were provided by Conservation Halton and Halton Region, respectively. One of the comments recommended a meeting to occur with representatives of the Region, Conservation Halton, and the study team to help ensure agreement on the required revisions from these comments, and those for the Phase 1 report (supplied separately). Similarly Conservation Halton recommended a site visit to further assess watercourses which had been assessed as HDFs, and the appropriateness of the assessment.
vii. October 26th, 2016 – A meeting was held to review a comment matrix developed by the study team. Several items were addressed, and a memo from the Region on December 6th, 2016 highlighted outstanding issues within the matrix, following this meeting. A recurring comment was the recommendation for a site visit to clarify classifications and recommendations.
viii. January 19, 2017 - Site visit accompanied by staff from Conservation Halton and Halton Region to review four HDFs: HT-2b-4, HT-2b-3, HDF-2, and HDF-1. The Agencies provided summary comments/concerns in a memo dated March 9th, 2017. These comments were considered when updating and finalizing the HDF assessment and recommendations.

The goal of the TRCA/CVC protocol is to objectively classify those features on the landscape which are not considered permanent watercourses but appear to serve some hydrologic, terrestrial, riparian, or aquatic function. Due to the subjective, ill-defined nature of these features, the protocol at times does not appear to adequately capture their function and importance. It is understood that a protocol can never address or anticipate all possible scenarios that may arise in the field. Therefore, to address this, two management recommendations have been provided for the features: one based on strict adherence to the TRCA/CVC protocol (protocol management recommendation), and a second based on the protocol results and interpretation of overall function and importance of the feature to the system (final management recommendation). This helps to address features that are particularly complex or difficult to interpret. Both recommendations have been shown in the updated summary table (Appendix D-3), along with specific notes and rationale. The summary table and mapping (Figure 2.4.1) have been updated following the January 2017 site visit, and subsequent comments and internal discussions. Management recommendations range from No-Management to Protection.

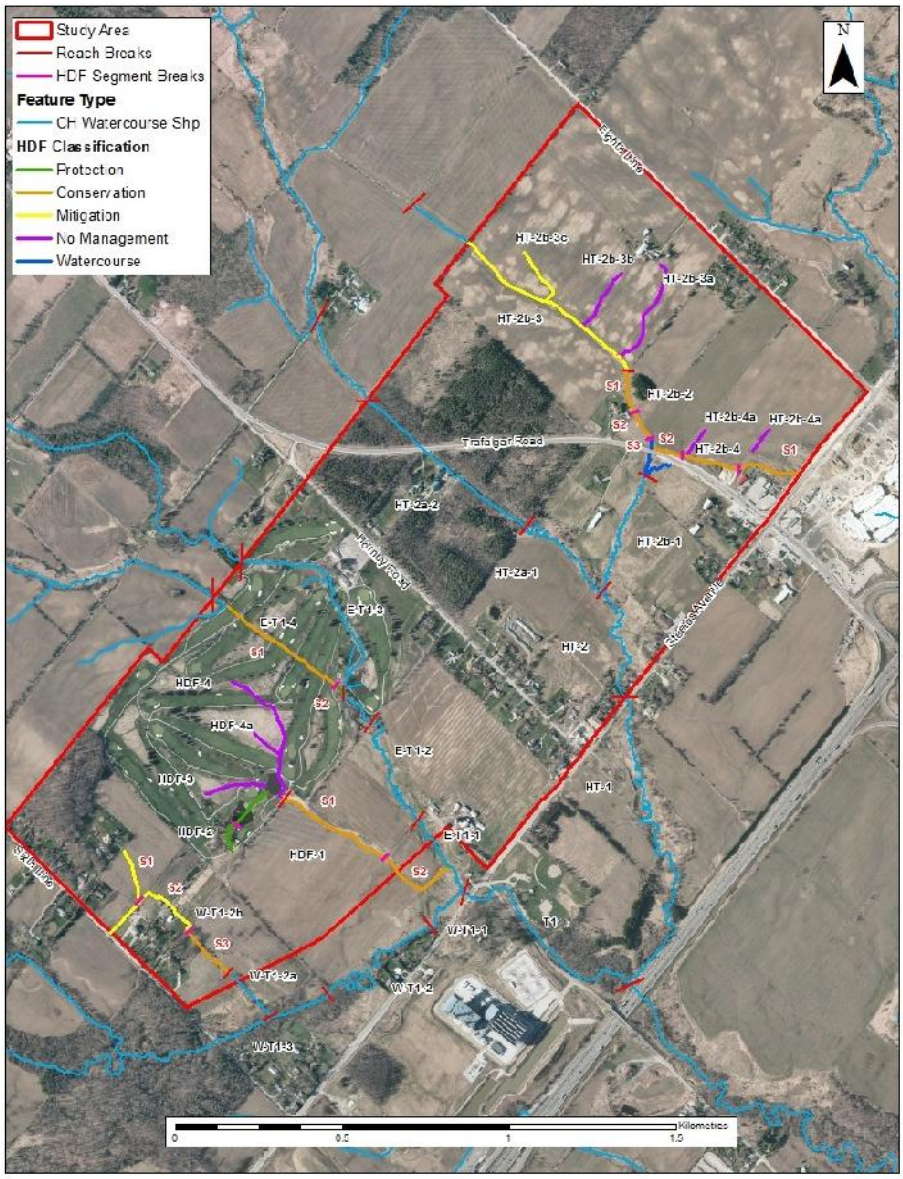

Figure 2.4.1: HDF Identification and Management Classification.

Through the comment/response exercise, TAC meetings, and the site visit in January of 2017, the adjustments and updates were made to the HDF assessment and management table (Appendix D-3). Table 2.4.1 summarizes conflicting classifications between Conservation Halton and the HDF assessment. Each of these segments were identified through the Phase 1 study as potential HDFs based on aerial photography, then assessed during field investigations to fulfill Site Visit #2 and Site Visit #1. As stated, field visits were completed in a reverse order due to project timing relative to the hydroperiod.

Table 2.4.1	Headwater Drainage Feature (HDF) Classification Summary and Rationale for Conflicting Classifications			
Drainage Feature Segment	**Conservation Halton Classification**	**Preliminary Study Classification**	**Final Study Classification**	**Notes/Rationale**
E-T1-4	Regulated Watercourse	HDF	HDF	Site Visit #2 - May, 2015 , channel was difficult to assess due to frequent piping through the golf course. Where open, it was poorly defined and heavily encroached by vegetation. Some small erosion areas were noted from high flows. The lower segment was a well-defined trapezoidal channel. Dry throughout. Based on the amount of flow observed during (up to 0.34m depth and 2m wetted width) Site Visit #1 (March 2016), historic aerial photos, and conditions upstream of the study area, management recommendations were adjusted to a higher rating, though still maintained as a HDF. It is noted that upstream of the golf course the feature appears to be a defined watercourse based on a review of aerial photography. Modification by the golf course has made this feature difficult to assess fully. It is thought that with removal of the golf course this could potentially be a more significant feature than it currently appears to be, based on upstream conditions.
HT-2b-2	Regulated Watercourse	HDF	HDF, with lower segment (S3) reclassified as watercourse	Standing water at downstream end (S3) of segment (Site Visit #2), defined bed/banks through length of segment, and gravel substrates on the bed suggest that this is a permanent feature of higher importance. Segment 3 was reclassified as a 'watercourse' consistent with segment downstream of Trafalgar Road. The upper segments (S1 and S2) within this reach were classified as HDFs due to a lack of definition and being dry during Site Visit #2. Additionally, the depression was found to be filled with dense grass. Site Visit #1 noted a sufficient amount of flow, and as such management recommendations were increased, while classification remained as HDF due to lack of channel definition.
HT-2b-3	Regulated Watercourse	HDF	HDF	Larger feature. Although dry, the presence of healthy vegetation observed during Site Visit #2 indicative of wetter conditions later into the dry season. Still lacks definition and has been maintained as HDF.

2.4.1.1 Rapid Assessments

Watercourse reaches were characterized using rapid geomorphic and stream assessment techniques to assess channel form and stability, and stream health, respectively. The Rapid Geomorphic Assessment (RGA) is a qualitative method for documenting channel instability based on the presence or absence of indicators which reveal trends of widening, degradation, aggradation, and planform adjustment. Scores are tallied and an index value is determined to indicate whether the channel is in-regime (stable), transitional, or in-adjustment (unstable). The Rapid Stream Assessment Technique (RSAT) also provides a qualitative, broad assessment of the overall health and function of a reach. This system integrates visual estimates of channel

conditions and numerical scoring of stream parameters using six categories: channel stability, erosion and deposition, physical in-stream habitat, water quality, riparian conditions, and biological indicators. Based on the total numerical score, a reach is assigned a category of low, moderate, or high stream quality.

Overall, RGA scores characterized reaches as being either in-regime (stable), or in transition. Transitional scores were either low, or closer to the middle of the range between 'in-regime' or 'in-adjustment'. In general, area channels were widening and aggrading, with few having indication of degradation and planform adjustment. RSAT scores were moderate for all but two reaches which exhibited low stream quality. Limiting factors for low RSAT scores were poor riparian condition, in-stream habitat, and biological indicators.

2.4.1.2 Detailed Surveys

The purpose of the detailed characterization was to confirm the characterization completed through the rapid assessments and obtain site-specific information that will aid in identification of constraints and opportunities for subwatershed planning. The detailed characterization also provides additional information for subsequent analyses to inform management recommendations, such as determination of erosion thresholds and stormwater management plans for erosion control. The detailed surveys included measurements of bankfull channel cross-section, and the long profile to provide a measurement of stream gradient and to characterize bedforms. Substrates and bank composition were characterized at each cross-section.

Rapid assessment results were used to select the most sensitive reaches downstream of the study area for detailed surveys. Downstream reaches were selected as they were less altered (more representative), and they are more likely to be impacted by land use changes or potentially receive additional flow from stormwater management outlets.

For the Premier Gateway Scoped Subwatershed Study, two detailed sites were completed as part of the 2015 assessment reaches W-T1-2 and HT-1, and a third in 2016 within reach E-T1-2. These reaches had minimal channel alteration, were considered 'transitional' and were located near the downstream end of the study area (HT-1 is downstream of the study area). Bankfull characteristics for the Hornby Tributary section averaged 3.14m in width, and 0.5m in depth, with dominating bed materials ranging from pebbles to medium gravel. East and West Tributaries to Middle Sixteen Mile Creek had average widths of 4.33m and 4.79m, and mean depths of 0.37, and 0.32m, respectively. Substrates were dominated by coarse gravels in both tributaries.

2.4.2 Erosion Thresholds

Data from the detailed field assessment has been used to complete the erosion threshold analysis. This analysis determines the hydraulics (discharge, channel depth, average channel velocity) at which the channel produces sufficient shear stress to initiate mobilization of a given particle size (D_{crit}), i.e., the 'threshold' condition at which sediment will start to mobilize. It is then assumed that if this 'threshold' flow is sustained erosion will eventually occur, therefore the flow is referred to as the 'erosion threshold'.

Depending on the boundary materials in each reach, different methods (calculations) were applied in the determination of an appropriate erosion threshold. For example, an equation more suited to gravels was used in for Reach HT-1, while this and an additional equation to account for cohesive glacial till beneath the gravel veneer was applied to Reach W-T1-2. To minimize

changes and maintain the gravel deposit, and to provide a more representative value for reaches with fewer or no till exposure, the gravel threshold was selected and considered for the cumulative effective work analysis as a part of the impact assessment.

Critical discharges provided for the impact assessment were: **1.49 m^3/s** (W-T1-2), **0.38 m^3/s** (HT-1), and **0.42 m^3/s** (W-T2-1).

2.5 Natural Environment

2.5.1 Fisheries/Aquatics

Habitat assessments were conducted on watercourses in 2015 (May and November) to establish existing aquatic conditions and to identify and quantify key habitat areas within the study area. The habitat assessment included an inventory of barriers to fish migration, existing on-line ponds, sources of stream baseflow and groundwater discharge, temperature measurements, and notation of aquatic vegetation. Additional habitat characterizations included basic channel morphology, channel substrates, bank stability, dissolved oxygen, instream habitat and cover, and general comments about the reaches.

Electrofishing was conducted by aquatic biologists in September 2015 to determine the fish community within aquatic habitats in the study area. A spawning survey for Brook Trout (*Salvelinus fontinalis*) was conducted by aquatic biologists in November 2015 to determine whether this species was spawning in a cold-water section of creek that flows through the Hornby Glen Golf Course. Sampling for the benthic invertebrates was conducted in May 2015 using the Ontario Benthos Biomonitoring Network (OBBN) protocol and indices were used to assess the benthic invertebrate community.

Watercourses identified through stream morphology work were classified as permanent, intermittent, or ephemeral based on field observations, and are shown on Drawing E1. They have also been assigned a cold, cold-cool, cool, cool-warm, or warm water designation, based on surveys and background information, as shown on Drawing E5. Headwater drainage features (HDF) are identified as such, and were assessed by Matrix Solutions. With the exception of the cold water designation for Golf001 and Golf003 (ref. Drawing E2), which are the upstream and downstream portions of the same channel segment, all other channel segments where water was present have been designated as cool water. All ephemeral channel segments have been designated as warm water. The East Branch of the Middle Sixteen Mile Creek tributary showed some of the best habitat within the study area, with the observation of American Brook Lamprey (*Lampetra appendix*) and Brook Trout (*Salvelinus fontinalis*), as well as abundant Watercress.

Benthic sampling indicated all the watercourses within the study area are impaired, with Steeles005, located along East Sixteen Mile Creek, being slightly less impaired than others. The greatest fish species diversity was observed within Steeles003, located along the West Branch of the Middle Sixteen Mile Creek tributary. All monitoring locations are shown on Drawing E2.

The Collectors Permit required for fish surveys was applied for on April 7, 2015 from the MNRF, however the permit was not received until August 14, 2015 (despite several requests in the

interim). At that time NRSI had to add additional staff to the permit and we received it back August 25, 2015. As such, the fish community assessment could only be conducted after this date.

Although spring sampling ensures that there is sufficient water flow to sample all available habitats, it may erroneously characterize ephemeral watercourses as providing high quality fish habitat. Summer or fall fish sampling is often preferred as it falls within low flow conditions and allows for the characterization of permanent fish populations. Given this and the project's timeline, the sampling dates in September were deemed appropriate by NRSI aquatic biologists. Conservation Halton expressed concern that watercourses providing fish habitat only on a seasonal basis were not sampled and their function may not have been fully characterized. As such, a conservative approach has been applied in assessing the watercourses in accordance with Conservation Halton direction.

Marginal habitat was not sampled within the fish sampling as minimal marginal habitat exists within the study area. The only site that could have been electrofished in May and June would have been Sixth001. This habitat has limited potential fish habitat, restricted to the lower portion of the reach (as observed in mid-November). The only other habitats that could be marginal were observed as dry on of May 28, 2015 (Golf004, Golf002, Steeles001, and Trafalger001) when aquatic habitat assessments were conducted. Photos of the watercourses that were assessed are included in Appendix E.

Sampling stations for fish were located within the study area, as well as south of the study area, and were chosen in consultation with Samantha Mason, Senior Aquatic Ecologist with Conservation Halton (see Mason pers. comm. 2015, correspondence in Appendix E). Several sites were located downstream of the study area due to limited access, as well as due to dry conditions. Electrofishing was conducted downstream of confluences where possible to determine the communities of fish located in the area.

2.5.2 Terrestrial Ecology/Systems

Terrestrial field surveys were undertaken in 2015 within the subject area, where property access was granted, in order to characterize natural features and identify significant and sensitive natural heritage features and species. Vegetation community delineation was completed according to the standard Ecological Land Classification (ELC) System for southern Ontario (Lee et al. 1998), along with a three-season detailed botanical survey. In 2017, a woodland edge analysis took place surrounding the Sixth Line Woodlot and the Coulson Tract. Other terrestrial surveys completed in 2015 included:

- Breeding bird surveys
- Owl survey
- Stick nest surveys
- Snake surveys
- Turtle surveys
- Anuran call count surveys

- Butterfly and odonate surveys

All surveys were completed in accordance with provincial and local guidance documents.

Wetland pockets within the subject area are very small and are not considered provincially significant. The wetland boundary to the northeast of Steeles and Trafalgar intersection was surveyed October 26, 2016 to determine its size, as it may be proposed to be removed and compensated for elsewhere. This was completed as per a request from Conservation Halton made at the Technical Advisory Committee meeting on October 24, 2016. The core areas of the marsh are dominated by Cattails (*Typha* species) and contain shallow, sporadic pooled water and some degree of organic soils. Fringe areas transition to sparse Cattails mixed with Lance-leaved Aster (*Symphyotrichum lanceolatum*) and occasional Rushes (*Scirpus* species). For a large portion of the eastern boundary, the edge of the agricultural field is more or less the boundary of the wetland. There is an overgrown grassed access to the field leading in from Trafalgar Road. This creates a separation of the 2 large wetland units by approximately 5m. A culvert was not observed because of the dense Cattails, at the time of the survey, but it was noted on the site visit with the Region of Halton and Conservation Halton in January 2017 (McCabe and Howatt pers. comm. 2017).

Overall, the marsh is comprised of Cattails, Phragmites (*Phragmites australis*), Lance-leaved Aster, and Reed Canary Grass (*Phalaris arundinacea*), with a couple of Willow (*Salix* species) shrubs present, but otherwise no other trees or shrubs. There are a few other wetland indicators present, but fairly low diversity overall. The fringe and upland is Canada Goldenrod (*Solidago canadensis*), Smooth Brome (*Bromus inermis ssp. inermis*), Canada Thistle (*Cirsium arvense*), and Common Burdock (*Arctium minus ssp. minus*). The auto shop adjacent to the wetland appears to have encroached into the wetland historically, and there are a few areas of overgrown topsoil piles to the north of the auto shop, as well as a berm-like feature to the far east.

The far eastern wetland pocket is dominated by Reed Canary Grass and exists because of human disturbance. Topographically it is separated from the actual cattail marsh by an area which is fresh-moist meadow and contains no wetland species. The hydrology of the Reed Canary Grass area is also likely further influenced by the ditch on the north side of Steeles Avenue which would direct some amount of water into this lower area during high rainfall events, thus probably facilitating the wetter vegetation which would not naturally occur in the absence of the berm and the ditch. In total, the wetland areas surveyed are 1.26ha. Correspondence on the wetland, including a map, is attached in Appendix E.

Woodlands within the subject area are considered significant. The Town of Halton Hills retained NRSI in the summer of 2017 to undertake a woodland edge analysis to help determine the delineation of the Natural Heritage System and buffers. This work was detailed in a separate report (NRSI, August 2017), attached in Appendix E.

Several Significant Wildlife Habitats were confirmed within the subject area, or considered as 'candidate':

- Bat Maternity Colonies (candidate)
- Amphibian Breeding Habitat (Woodland)
- Habitat for Species of Conservation Concern - Eastern Wood-Pewee

The following Species at Risk were observed within the subject area:

- Barn Swallow
- Bobolink
- Eastern Meadowlark

Habitats within the subject area for Bobolink and Eastern Meadowlark are not considered optimal for either species due to the small, fragmented nature of the open fields, and all large fields are planted in soy and corn, unsuitable for these species. Butternut trees were also observed, but all were dead.

Based on the field surveys completed, as well as the Regional Natural Heritage System, a revised natural heritage system has been proposed, referred to as the Premier Gateway Natural Heritage System (PG NHS).

3.0 LAND USE PLAN

The Premier Gateway Phase 1B Secondary Plan Study is intended to establish a planning framework for the Phase 1B 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. Through proposed modifications to Official Plan Amendment No. 10[1], Premier Gateway Phase 1 Employment Area to the 2021 planning horizon is proposed to be divided into two separate areas based on the phasing of development. The new Phase 1B Employment Area will be the focus for initial development and will identify the location of up to 75 hectares of additional 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 2021 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 is being undertaken in 5 phases with the following work program:

- Phase 1 – Project Initiation;
- Phase 2A - Existing Conditions;
- Phase 2B - Scoped Subwatershed and Natural Heritage System Planning;
- Phase 3 - Detailed Planning Study;
- Phase 4A - Recommended Land Use Option;
- Phase 4B - Preferred Land Use Plan;
- Phase 5A – Draft Secondary Plan, Official Plan & Zoning By-law Amendments; and,
- Phase 5B - Final Secondary Plan, Official Plan & Zoning By-law Amendments.

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

- Steering Committee Meetings;
- Technical Advisory Committee Meetings;
- Public Open Houses and Workshops;
- Statutory Open House;
- Statutory Public Meeting; and
- Reports to Council.

Two Public workshops have been held to date. The first one was held on November 27, 2015 and the purposes was the introduce the study. The meeting included an open house, an exercise to identify priorities for the study area, a presentation on the existing study process and policy framework and a question and answer session.

[1] Official Plan Amendment 10 is designed to bring the Town's Official Plan into conformity with Regional Official Plan Amendment 38 which implements the Growth Plan for the Greater Golden Horseshoe, the Greenbelt Plan and the Provincial Policy Statement in the Halton context.

The second workshop was held on June 22, 2016 and included an open houses as well as a presentation on the background analysis undertaken to date. It was followed by a working group session where participants were asked to complete a series of exercises regarding two land use concept options and addressing the location of commercial development, the proposed road pattern, existing residential and other comments.

Subsequent to the public review, a preferred land use concept was created and was endorsed by Council which identifies the location for 75 hectares of 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.

Drawing LU1 reflects the Preferred Land Use Concept. The Concept would result in approximately 2700 jobs in the south half of the study area by 2031. For the 75 ha of land being added in the north half, assuming a density of 24.74 jobs per hectare (which is average for the total Premier Gateway Employment Lands), there would be approximately 1850 jobs in the north half for a total employment of approximately 4500 jobs in the Phase 1B Secondary Plan area.

The revised Preferred Land Use Concept has been evaluated with respect to transportation and servicing (water / wastewater). No significant changes have been identified arising from those technical evaluations.

The Preferred Land Use Concept will form the basis for the draft Secondary Plan and the Regional and Town Official Plan Amendments.

4.0 IMPACT ASSESSMENT

Analyses and assessments have been completed to determine the potential impacts of the proposed land use change within the Premier Gateway Lands on the area's 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 section presents the findings of the impact assessment related to the specific study disciplines.

4.1 Surface Water/Groundwater/Water Quality

4.1.1 Future Uncontrolled Land Use Conditions

Surface Water

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 used for this assessment. The hydrologic model has been revised to represent the future land use condition as per land use plan provided. 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 diversions and retaining pre-development drainage patterns, while optimizing contributing drainage areas to support wet end-of-pipe facilities. The impervious coverage for each land use is summarized in Table 4.1.1. The subcatchment parameters for key parameters of interest are summarized in Table 4.1.2, and the corresponding subcatchment boundary plan is presented in Drawings WR-3.

Table 4.1.1 Imperviousness / Coverage Values Based on Land Use

Land Use	Imperviousness (%)
Greenlands	5
Business Employment/Convenience/Commercial/Motor Vehicle Commercial/Utility	90
Residential Low Density I	65
Residential Low Density II	70
Medium Density	75
Mixed use	68
Public Open Space	35
Online SWM Ponds	50

Table 4.1.2 Subcatchment Parameters for Future Land Use Conditions

Subcatchment ID	Area (ha)	Imperviousness (%)	Pervious								Impervious	
			INFILT (mm/hr)	UZSN (mm)	LZSN (mm)	INTFW (day ^{1})	IRC (day ^{1})	GWRC (day ^{1})	SLOPE (m/m)	LSUR (m)	SLOPE (m/m)	LSUR (m)
203	2148.37	1%	5.55	12	100	4	0.5	0.97	0.0109	445.9	0.0109	222.9
204	283.54	1%	7.8	12	100	4	0.5	0.97	0.0087	327.9	0.0087	164.0
240	468.57	1%	7.8	12	100	4	0.5	0.97	0.0087	327.9	0.0087	164.0
241	2.59	8%	0.5	7.5	75	15	0.05	0.97	0.0998	31.9	0.0036	69.0
242	1.29	3%	0.5	7.5	75	15	0.05	0.97	0.0446	19.0	0.0010	40.0
243	1.93	5%	0.5	7.5	75	15	0.05	0.97	0.0200	16.2	0.0200	40.0
244	5.35	5%	0.5	7.5	75	15	0.05	0.97	0.0259	49.4	0.0200	40.0
245	1.41	3%	0.5	7.5	75	15	0.05	0.97	0.0137	32.8	0.0591	55.0
246	22.59	71%	0.5	7.5	75	15	0.05	0.97	0.0200	235.6	0.0200	40.0
247	1.17	3%	0.5	7.5	75	15	0.05	0.97	0.0043	117.0	0.0722	45.0
248	19.94	9%	0.5	7.5	75	15	0.05	0.97	0.0159	879.0	0.0071	35.0
250	873.3	1%	4.0	12	100	4	0.5	0.97	0.0085	401.8	0.0085	200.9
251	58.51	4%	0.5	7.5	75	15	0.05	0.97	0.0200	680.0	0.0200	40.0
252	14.79	4%	0.5	7.5	75	15	0.05	0.97	0.0200	233.0	0.0200	40.0
253	3.04	5%	0.5	7.5	75	15	0.05	0.97	0.0200	21.9	0.0200	40.0
254	3.31	5%	0.5	7.5	75	15	0.05	0.97	0.0217	87.3	0.0200	40.0
255	3.45	5%	0.5	7.5	75	15	0.05	0.97	0.0200	117.8	0.0200	40.0
260	4.73	12%	0.5	7.5	75	15	0.05	0.97	0.0031	225.2	0.0200	40.0
261	37.9	80%	0.5	7.5	75	15	0.05	0.97	0.0075	530.0	0.0309	89.0
262	24.42	70%	0.5	7.5	75	15	0.05	0.97	0.0071	423.0	0.0200	40.0
263	15.14	56%	0.5	7.5	75	15	0.05	0.97	0.0100	80.0	0.0050	318.0
264	39.76	72%	0.5	7.5	75	15	0.05	0.97	0.0100	80.0	0.0050	493.0
265	75.04	1%	0.5	7.5	75	15	0.05	0.97	0.0102	1228.0	0.0200	40.0
266	12.79	1%	0.5	7.5	75	15	0.05	0.97	0.0036	281.0	0.0200	40.0
267	11.14	1%	0.5	7.5	75	15	0.05	0.97	0.0365	130.0	0.0200	40.0
268	5.84	82%	0.5	7.5	75	15	0.05	0.97	0.0998	72.0	0.0050	40.0
269	5.59	5%	0.5	7.5	75	15	0.05	0.97	0.0998	68.9	0.0050	40.0
270	5.13	5%	0.5	7.5	75	15	0.05	0.97	0.0998	63.3	0.0050	40.0
271	3.05	90%	0.5	7.5	75	15	0.05	0.97	0.0998	37.6	0.0050	40.0
272	14.05	90%	0.5	7.5	75	15	0.05	0.97	0.0200	384.7	0.0071	40.0
273	6.60	5%	0.5	7.5	75	15	0.05	0.97	0.0446	97.1	0.0050	40.0
274	2.43	5%	0.5	7.5	75	15	0.05	0.97	0.0446	35.8	0.0050	40.0
275	4.20	90%	0.5	7.5	75	15	0.05	0.97	0.0200	97.8	0.0591	40.0
276	34.39	77%	0.5	7.5	75	15	0.05	0.97	0.0446	506.1	0.0050	40.0
277	4.47	90%	0.5	7.5	75	15	0.05	0.97	0.0200	37.4	0.0200	40.0
278	26.93	40%	0.5	7.5	75	15	0.05	0.97	0.0200	225.6	0.0200	40.0
279	18.23	65%	0.5	7.5	75	15	0.05	0.97	0.0200	622.5	0.0200	40.0
280	6.44	90%	0.5	7.5	75	15	0.05	0.97	0.0217	169.9	0.0200	40.0
281	13.63	92%	0.5	7.5	75	15	0.05	0.97	0.0217	359.6	0.0200	40.0
282	34.44	87%	0.5	7.5	75	15	0.05	0.97	0.0200	542.6	0.0200	40.0
283	31.91	90%	0.5	7.5	75	15	0.05	0.97	0.0200	502.7	0.0200	40.0

The HSP-F hydrologic model for the future land use conditions has been used to determine the peak frequency flow rates up to the 100 year frequency flow condition, as well as for the Regional Storm event at key locations within, and downstream of, the Premier Gateway Lands, in the absence of stormwater management controls. The simulated peak flow rates for future uncontrolled land use conditions are summarized in Table 4.1.3, and the percent difference compared to existing land use conditions are presented in Table 4.1.4.

Table 4.1.3 Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Uncontrolled Land Use Conditions (m^3/s)

Reference Node	Location	Frequency (Years)							
		1.25	2	5	10	20	50	100	Regional
1.548	Downstream of Sixth Line	2.2	4.9	11	16.9	24	35.6	46.4	82.1
1.560/1.516	Downstream End of Subcatchment 241	0.3	0.5	0.7	0.8	1	1.2	1.4	2.91
1.526	West Branch North of Steeles Ave	2.4	5.1	11	16.5	23.1	33.8	43.7	83.2
1.527	Middle 16 Mile Creek at Steeles Ave	5.6	9.3	16.5	22.6	29.7	41	51.2	117
1.535	Hornby Tributary Upstream of site	1	2.3	5	7.4	10.1	14.3	17.9	48.4
1.542/1.506	Hornby Tributary at Trafalgar Road	1.3	1.8	2.4	2.8	3.1	3.5	3.8	7.15
1.545	Hornby Tributary at Steeles Avenue	4.3	6.2	8.7	10.3	11.8	13.6	15	62.9
1.529	Middle 16 Mile Creek at Highway 401	9.6	15.1	24.7	32.4	40.9	53.5	64.4	192
1.530	Subwatershed 4 of Middle 16 Mile Creek Outlet	8.5	13.8	23.4	31.4	40.5	54.3	66.4	185

Table 4.1.4 Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions (%)									
Reference Node	Location	Frequency (Years)							
		1.25	2	5	10	20	50	100	Regional
1.548	Downstream of Sixth Line	0	0	0	0	0	-0.3	-0.2	0
1.560/1.516	Downstream End of Subcatchment 241	200.0	150.0	133.3	100.0	100.0	100.0	75.0	31.7
1.526	West Branch North of Steeles Ave	4.3	0	-0.9	-0.6	-0.9	-0.3	0.5	-0.7
1.527	Middle 16 Mile Creek at Steeles Ave	27.3	2.2	-13.2	-19.3	-23.5	-27.0	-28.9	0.9
1.535	Hornby Tributary Upstream of site	0	0	0	0	0	0	0	0
1.542/1.506	Hornby Tributary at Trafalgar Road	160.0	157.1	166.7	154.5	138.5	133.3	123.5	9.8
1.545	Hornby Tributary at Steeles Avenue	126.3	77.1	38.1	19.8	5.4	-9.3	-17.6	6.6
1.529	Middle 16 Mile Creek at Highway 401	45.5	16.2	-3.9	-12.2	-18.0	-23.8	-27.1	2.1
1.530	Subwatershed 4 of Middle 16 Mile Creek Outlet	25.0	5.3	-8.9	-14.2	-17.5	-20.7	-22.4	2.8

The results in Table 4.1.4 indicate that the proposed development of the Premier Gateway lands would be anticipated to increase peak flows locally and downstream during the more frequent storm events (i.e. 2 year and lower). The results further indicate that peak flows during the less frequent events (i.e. 10 year through 100 year) would increase locally as a result of the proposed development, although reductions may occur further downstream within the subwatershed due to shifts in the timing of peak flows. Furthermore, the results indicate that Regional Storm peak flows would be anticipated to increase locally and downstream, although the increase in Regional Storm peak flows online the receiving watercourses downstream would be anticipated to be relatively minor.

Additional analyses have been completed to determine the increased erosion potential which would result from the proposed development of the Premier Gateway Lands. These analyses have assessed the duration of flow above the critical flow rate at the key locations identified in the fluvial geomorphologic assessment. The results of this assessment are presented in Table 4.1.5 based upon hours exceedance and Table 4.1.6 based upon percentage of total duration.

Table 4.1.5 Erosion Assessment for Future Uncontrolled Land Use Conditions (hours exceedance)			
Erosion Site ID	**Existing Land Use Conditions**	**Future Uncontrolled Land Use Conditions**	**Difference (%)**
E-T1-2	5711	5992	4.9
T-1	5932	4278	-27.9
HT-1	21263	24983	17.5

Table 4.1.6 Erosion Assessment for Future Uncontrolled Land Use Conditions (percent total duration)			
Erosion Site ID	**Existing Land Use Conditions**	**Future Uncontrolled Land Use Conditions**	**Difference**
E-T1-2	1.55	1.63	0.1
T-1	1.61	1.16	-0.5
HT-1	5.78	6.79	1.0

The results in Tables 4.1.5 and 4.1.6 indicate that the future development of the Premier Gateway Lands would marginally increase the erosion potential at sites E-T1-2 and HT-1, however would decrease the erosion potential at site T-1 along the Sixteen Mile Creek at Highway 401. The information in Table 4.1.6 indicates that sites E-T1-2 and T-1 exhibit a relatively low erosion potential, as demonstrated by the relatively lower duration of erosive flows, however site HT-1 exhibits a higher erosion potential as demonstrated by the higher duration of erosive flows. Despite the higher erosion potential at site HT-1, the proposed development of the Premier Gateway lands would marginally increase the erosive flows relative to the total duration of flow at this location (i.e. 1% increase); this is considered attributable to the influence of the runoff from the lands external to the Premier Gateway Lands.

Surface Water Quality

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, stormwater quality control to an *Enhanced* standard of treatment is required for all new development.

4.1.2 Stormwater Management Systems Sizing (Quantity and Quality)

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 has 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 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 jurisdiction. The resulting unitary storage and discharge criteria under this stormwater management scenario (end-of-pipe only) are summarized in Table 4.1.7.

Table 4.1.7 Stormwater Management Facility Sizing Criteria for Future Land Use With Stormwater Management Scenario

Quantity Component	Cumulative Unitary Volume (m^3/impervious ha)	Unitary Discharge (m^3/s/ha)
West Branch (Subcatchment 241) & Hornby Tributary (Subcatchment 255)		
Erosion	250	0.0007
25 Year	600	0.012
100 Year	1000	0.028
Regional Storm	2000	0.101
West Branch Tributary (Subcatchment 242)		
Erosion	250	0.0007
25 Year	600	0.012
100 Year	1600	0.014
Regional Storm	3200	0.4545
East Branch Tributary (Subcatchment 245)		
Erosion	250	0.0007
25 Year	400	0.012

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 42 year continuous simulation. Frequency analyses have been completed using the simulated instantaneous annual maximum flow rates to determine the 2 year through 100 year frequency flows. The Regional Storm event has been simulated as a discrete storm event, and the simulated peak flows have been extracted from the model results. The simulated peak frequency and Regional Storm event flows are presented in Table 4.1.8, and the percent difference compared to existing land use conditions is presented in Table 4.1.9.

Table 4.1.8 Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended Stormwater Management (m^3/s)

Reference Node	Location	Frequency (Years)							
		1.25	2	5	10	20	50	100	Regional
1.548	Downstream of Sixth Line	2.2	4.9	11	16.9	24	35.6	46.4	82.1
1.560/1.516	Downstream End of Subcatchment 241	0.1	0.2	0.3	0.4	0.5	0.6	0.7	2.11
1.526	West Branch North of Steeles Ave	2.2	5	11	16.6	23.2	33.8	43.5	82.9
1.527	Middle 16 Mile Creek at Steeles Ave	3.4	7.3	15.4	22.7	31.3	44.7	56.7	115
1.535	Hornby Tributary Upstream of site	1	2.3	5	7.4	10.1	14.3	17.9	48.4
1.542/1.506	Hornby Tributary at Trafalgar Road	0.2	0.3	0.6	0.7	0.9	1.2	1.4	4.07
1.545	Hornby Tributary at Steeles Avenue	1.7	3.3	6.1	8.4	10.9	14.6	17.7	58.7
1.529	Middle 16 Mile Creek at Highway 401	5.5	10.9	21.8	31.2	42	58.7	73.3	186
1.530	Subwatershed 4 of Middle 16 Mile Creek Outlet	5.7	11.1	21.8	31	41.4	57.4	71.3	179

Table 4.1.9 Percent Change in Simulated Peak Frequency Flows and Regional Storm Event Flows for Future Land Use Conditions with Recommended Stormwater Management Compared to Existing Land Use Conditions (%)									
Reference Node	Location	Frequency (Years)							
		1.25	2	5	10	20	50	100	Regional
1.548	Downstream of Sixth Line	0	0	0	0	0	-0.3	-0.2	0
1.560/1.516	Downstream End of Subcatchment 241	0	0	0	0	0	0	-12.5	-4.5
1.526	West Branch North of Steeles Ave	-4.3	-2.0	-0.9	0	-0.4	-0.3	0.0	-1.1
1.527	Middle 16 Mile Creek at Steeles Ave	-22.7	-19.8	-18.9	-18.9	-19.3	-20.5	-21.3	-0.9
1.535	Hornby Tributary Upstream of site	0	0	0	0	0	0	0	0
1.542/1.506	Hornby Tributary at Trafalgar Road	-60.0	-57.1	-33.3	-36.4	-30.8	-20.0	-17.6	-37.5
1.545	Hornby Tributary at Steeles Avenue	-10.5	-5.7	-3.2	-2.3	-2.7	-2.7	-2.7	-0.5
1.529	Middle 16 Mile Creek at Highway 401	-16.7	-16.2	-15.2	-15.4	-15.8	-16.4	-17.1	-1.1
1.530	Subwatershed 4 of Middle 16 Mile Creek Outlet	-16.2	-15.3	-15.2	-15.3	-15.7	-16.2	-16.7	-0.6

The results in Tables 4.1.8 and 4.1.9 indicate that the recommended stormwater management sizing criteria for the Premier Gateway Lands would control post-development flows to pre-development levels at all locations.

Additional analyses have been completed to determine the duration of flow above critical erosive flows under future land use conditions with recommended stormwater management. The results of this assessment are presented in Table 4.1.10 based upon the duration of erosive flows in hours, and Table 4.1.11 based upon the percent of total duration of flow.

Table 4.1.10 Erosion Assessment for Future Land Use Conditions with Recommended Stormwater Management (hours exceedance)			
Erosion Site ID	Hours Exceedance		Difference (%)
	Existing Land Use Conditions	Future Controlled Land Use Conditions	
E-T1-2	5711	5545	-2.9
T-1	5932	3893	-34.4
HT-1	21263	21704	2.1

Table 4.1.11 Erosion Assessment for Future Land Use Conditions with Recommended Stormwater Management (percent total duration)

Erosion Site ID	Percent Total Duration Exceedance		Difference (%)
	Existing Land Use Conditions	Future Controlled Land Use Conditions	
E-T1-2	1.55	1.51	-0.04
T-1	1.61	1.06	-0.55
HT-1	5.78	5.9	0.12

The results in Tables 4.1.10 and 4.1.11 indicate that the recommended stormwater management criteria would mitigate the increased erosion potential along the receiving watercourses to within acceptable levels. Furthermore, additional analyses have indicated that the drawdown times within the respective end-of-pipe facilities would be less than 72 hours (i.e. 3 days), hence providing a drawdown time acceptable to the Municipality.

4.1.3 Water Budget and Runoff Volume Reduction

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.

Hydrologic analyses have been completed to determine the change to the water budget resulting from the development of the Premier Gateway Lands. The assessment has evaluated both the local and subwatershed-scale impacts of the proposed development. The HSP-F hydrologic model has been revised to determine the groundwater recharge, surface runoff volume, and evapotranspiration under each land use condition. The results of this assessment are presented in Table 4.1.12.

Table 4.1.12 Water Budget Summary (mm/year)

Location	Surface Runoff	Groundwater Recharge	Evapotranspiration
Existing Land Use Conditions			
Secondary Plan Area	388	99	318
Subwatershed (at Hwy. 401)	350	243	213
Future Uncontrolled Land Use Conditions			
Secondary Plan Area	527	6	272
Subwatershed (at Hwy. 401)	360	235	211
Difference			
Secondary Plan Area	139	-93	-46
Subwatershed (at Hwy. 401)	10	-8	-2

The results in Table 4.1.12 indicate that under uncontrolled conditions, the future development of the Premier Gateway Lands would increase surface runoff volume, and reduce groundwater recharge and evapotranspiration at both the local and subwatershed scale. The results further indicate that the change in water budget would be most pronounced at the local scale, however at the subwatershed scale the effects would be less significant due to the size of the development area relative to the total size of the subwatershed.

4.1.4 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 MOECC 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:

i. 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).
ii. 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 BMP's, oil/grit separators, vegetated technologies, etc.) are to be applied.
iii. LID BMP's are to be applied throughout the development area.
iv. Regional Storm controls are to be incorporated into the design of wet end-of-pipe facilities.

4.2 Stream Morphology

The Phase 2 assessment focuses on the potential impacts to watercourses based on the proposed land use plan. The primary impact to watercourses from urbanization is changes to the hydrologic regime as a result of increased impervious cover. Increased surface runoff can be largely mitigated through integrated stormwater management. 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, five indicators were reviewed. The indicators and corresponding targets are outlined in Table 4.2.1.

Table 4.2.1 Indicator Employed in Phase 2 and Corresponding Targets	
Indicator	**Target**
Meander belt width corridors	Stream corridors are protected from interference
	Natural cover maintained in stream corridors
	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
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
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

4.2.1 Meander Belt Widths

A watercourse's meander belt width is a designated corridor that is intended to contain all of the natural meander and migration tendencies of a channel based on historic alignment and potential future alignment. This permits channel adjustment to occur without risking damage to surrounding infrastructure and property. Implementation and respect for the meander belt width corridor can reduce and control negative impacts which may occur as a result of urbanization. A secondary benefit of the meander belt width is to protect surrounding riparian vegetation. Development within the meander belt width is strictly limited to specific low impact and localized uses, such as trail or road crossings, and therefore disturbance to vegetation is minimized. Maintaining riparian vegetation ensures resiliency of the fluvial system as proper vegetative support reduces bank erosion and widening. Meander belt mapping, updated following the Phase 1 report is available in Appendix D. The update includes linework for HT-2b-2 (S3) which was upgraded from HDF to watercourse in 2017.

An additional erosion allowance and ecological buffers have been considered for the Premier Gateway Subwatershed Area as setbacks to the meander belt corridor. Final corridor widths for each reach will provide a continuous natural corridor, forming the Natural Heritage System (ref. Table 4.2.2).

All watercourses identified in this study are protected within the proposed Premier Gateway Natural Heritage System (NHS). However, there are areas where the *final corridor width* is not encompassed by the preliminary NHS. In general the NHS sufficiently contains the final corridors as depicted in Figure 4.2.1. However there are localized zones where the final corridor extends

outside of the preliminary NHS. Most discrepancies occur in E-T1-3 where the final corridor limit falls outside of the NHS by approximately 13m at the most, which is considered relatively minor.

Table 4.2.2 Summary Meander belt and Final Corridor Widths

Reach	Meander Belt Width (MBW) incl. 20% factor of safety (m)	MBW +Slope Allowance: 5m each side (m)	Final Corridor Width (m) MBW + Slope Allowance + Regulation allowance: 15m each side (m)
HT-2b-1	21.6	31.6	61.6
HT-2a-2	21.6	31.6	61.6
HT-2a-1	43.2	53.2	83.2
HT-2	36.0	46.0	76.0
HT-2b-2 (S3)	6.48	16.48	46.48
E-T1-3	40.8	50.8	80.8
E-T1-2	43.2	53.2	83.2
E-T1-1	52.8	62.8	92.8
W-T1-3	36.0	46.0	76.0
W-T1-2a	16.8	26.8	56.8
W-T1-2	96.0	96.0	136.0
W-T1-1	33.6	43.6	73.6

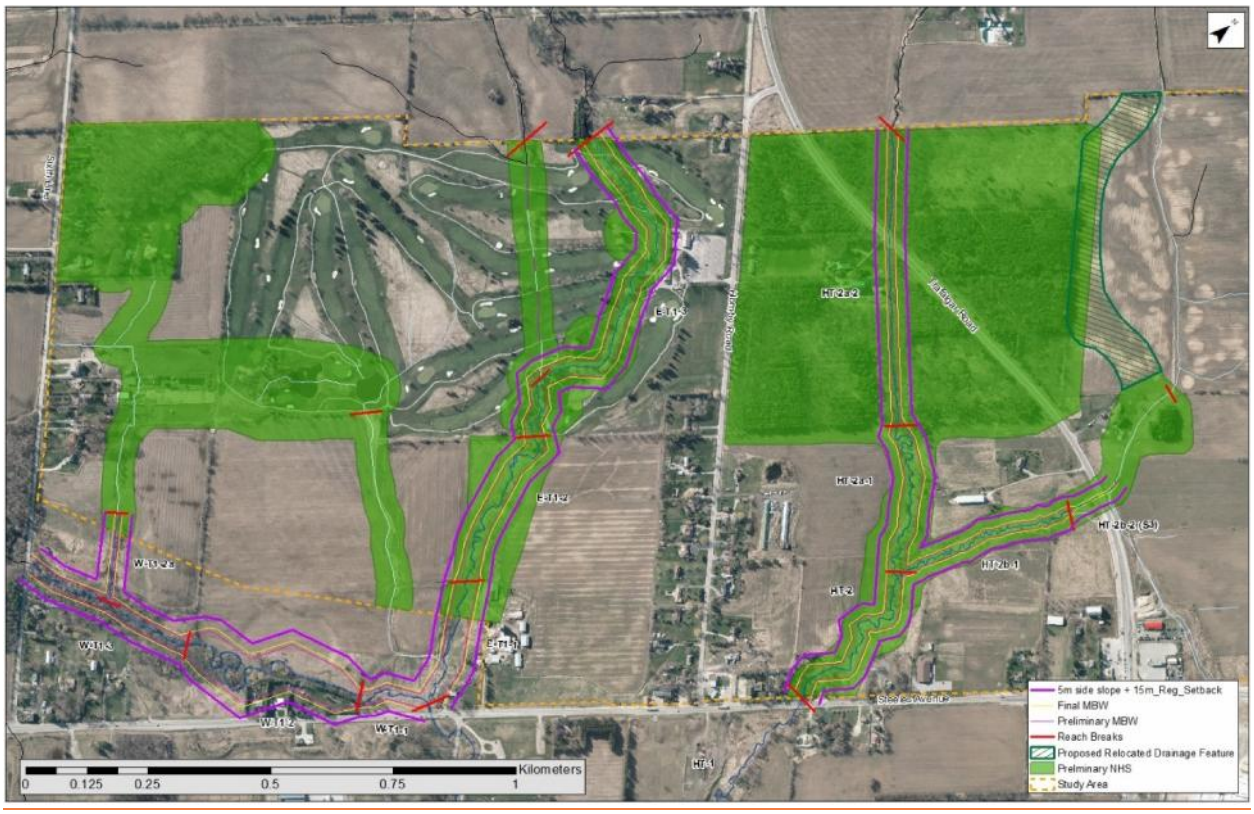

Figure 4.2.1 Meander belt and final corridors overlain onto the preliminary NHS

4.2.2 Stream Length and Realignment

Changes in land use may result in realignments of existing watercourses, and/or the removal of headwater drainage features (HDFs) to increase 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. Modifications may be large-scale realignments or small-scale removal of a bend or reduction of sinuosity. These types of changes are more common in areas which are already partially or fully developed and land use changes are less significant. Realignment of watercourses in most cases is not supported, but it may be acceptable if the existing channel is degraded or has already been heavily modified as part of the existing land use. In these cases, the channel presents a restoration opportunity and realignment would be supported. Should realignments be proposed, it is critical to ensure that stream lengths are maintained at a minimum, which is subject to local constraints and additional elements proposed during the detailed design phase. Loss of stream length reduces aquatic habitat and reduces the fluvial system's ability to effectively convey water and sediment. Depending on the conditions, loss of stream length may increase channel slope increasing available potential energy which could lead to increased erosion.

The existing dominant land uses in the Premier Gateway Area are agricultural and recreational (golf course). These land use types are relatively low-impact compared to an urbanized landscape. The Phase 1 assessment did not find that any of the watercourse reaches were severely degraded as a result of the current land uses. There were no reaches where restoration

through realignment and natural channel design would be recommended. The main branches and tributaries should be protected as they currently exist to ensure natural function is maintained. In accordance with the results of the Phase 1 assessment, the proposed land use plan has not proposed any watercourse removals or realignments. With that said, there are several opportunities for *rehabilitation* to enhance/restore banks or short segments within these protected stream reaches. Riparian enhancements, farm and golf course crossing removals (fords and culverts), and in-channel habitat features (e.g. wood debris) would benefit the form and function of area streams, and those receiving reaches downstream, and should be explored for the reaches within the study area, with the exception of HT-2a-2 which is located within the Halton Regional Forest (Coulson Tract).

Some minor, and very localized channel realignments or bank treatments may be required at existing road crossings should they be enhanced, and any proposed road crossings. These potential impacts are discussed in the section on road crossings below.

Headwater Drainage Features

Although area watercourses are protected in place within the natural heritage corridor, HDFs have management recommendations ranging from 'no management' to 'protection'. Section 5.2 discusses each type of management recommendation, and the HDF technical memo describes protocols and rationale used to determine each recommendation (Appendix D-2). The headwater drainage feature summary table in Appendix D-3 provides an overall review of feature evaluation, recommendations, and rationale.

Seven HDFs with 'no management' recommendations will be removed as they present no value in terms of form or function, hydrologically or ecologically. The remaining HDFs will be protected within the Premier Gateway Natural Heritage System, with the exception of HT-2b-4 which has been recommended for 'conservation'. This feature must be maintained to an extent whereby function, riparian corridor, and downstream watercourse connection remain or are enhanced. HDF-2 is the only feature recommended for protection in-situ, but some enhancements may be implemented.

In some cases, potential relocation has been proposed in the land use plan for degraded or highly impacted HDFs. Three HDFs that have potential relocation/realignment with classifications of 'conservation' (E-T1-4 and HDF-1), and 'mitigation' (HT-2b-3 and HT-2b-3c). These were created or heavily impacted by each land use (e.g. tilling, grazing, piping, and tile drains). As such, the relocation presents the opportunity to restore and enhance these features, including relocation towards other NHS features, reducing segmentation by developed land parcels.

It should be noted that HDFs E-T1-4 and HT-2b-3 are classified by CH as watercourses, although the Town's Consulting Team has classified these features as HDFs. Regardless of their classification, these are highly impacted streams of poor form and function. The management recommendation for relocation and the accompanying enhancements (i.e. natural corridor design) remains the same under either classification.

4.2.3 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 a number of factors which should be

considered when identifying the most appropriate location for a road crossing. For a large development area, it is important to minimize the number of times the proposed road network crosses the watercourse valley. This will reduce impacts to the watercourse as well as the surrounding natural heritage features. Road crossings should not be located within close succession to each other. Providing an adequate distance between crossings allows for an area of potential adjustment, if there are negative impacts to the watercourse as a result of the 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. These risk factors are used to evaluate both crossing locations and determine appropriate structure spans and alignment:

- **Channel Size:** The potential for lateral channel movement and erosion tends to increase with stream size. HDFs tend to exhibit low rates of lateral migration due to the stabilizing influence of vegetation on the channel bed and banks. Erosive forces in active watercourses tend to exceed the stabilizing properties of vegetation and result in higher migration rates.
- **Valley Setting:** Watercourses with wide, flat floodplains and low valley and channel slopes tend to migrate laterally across the floodplain over time. Watercourses that are confined in narrow, well drained valleys are less likely to erode laterally but are more susceptible to down-cutting and channel widening, particularly where there are changes in upstream land use. Typically the classification of the valley will fall into one of three categories: confined, partially confined, and unconfined.
- **Meander Belt Width:** The meander belt width represents the maximum expression of the meander pattern within a channel reach. Therefore, this width/corridor covers the lateral area that the channel could potentially occupy over time. This value has been used by regulatory agencies for corridor delineation associated with natural hazards and the meander belt width is typically of a similar dimension to the Regulatory floodplain. The use of the meander belt width of structure sizing has been established as a criterion by some regulatory agencies and represents a very conservative approach
- **Meander Amplitude:** The meander amplitude and wavelength are important parameters to ensure that channel processes and functions can be maintained within the crossing. For the purposes of this protocol, the meander amplitude of the watercourse would be measured in the vicinity of the crossing and used as a guide to determine the relative risk to the structure. The number of meander wavelengths to be considered is both dependent on the scale of the watercourse and the degree of valley confinement.
- **Rapid Geomorphic Assessment (RGA) Score:** An RGA score is essentially a measure of the stability of the channel. Channels that are unstable tend to be actively adjusting and thus are sensitive to the possible effects of the proposed crossing. Accordingly, there is more risk associated with unstable channels. While the actual RGA score will be reported, there are 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 in order to accommodate the downstream migration of meander features. In many cases, however, the costs

prohibit such structure sizes. From a geomorphic perspective, larger structures are favored to minimize the long-term risk and maintenance associated with natural channel adjustment.

The Phase 2 assessment reviewed the proposed road crossing locations qualitatively in the context of these risk factors. Structure sizing is generally determined in subsequent planning phases through detailed site-specific assessments. The proposed land use plan includes three (3) new road crossings, two (2) existing crossings, and three (3) potential crossings. Those which cross watercourses are at risk to erosion through natural migration, as are road segments proposed adjacent to the preliminary NHS. Considering the preliminary status of the road alignments, only existing crossings are reviewed here for their impact on morphological process. Management recommendations are provided in Section 5.2 at a high level, based on the risk factors considered above. Crossings are proposed for Reaches/HDFs HT-2b-1, HT-2b-3, ET-1-3, and HDF-1 (S1), and should be sized according to the guidelines above.

See Section 4.3.5 with regards to road crossing considerations and natural heritage features and functions.

Table 4.2.3 Existing Road Crossing Impacts (Adapted from Phase 1 report Table 5.1)					
Crossing No.	**Location**	**Reach**	**Crossing Type**	**Span (m)**	**Impact**
5	Trafalgar Road 415 m North of Steeles Avenue	HT-2b-2 (S3)	Concrete Box	3.09	Bankfull width observed was ~1.5m. This structure is slightly narrower than the minimum recommendation of 3x bankfull width. It is at risk to upstream erosion, however, a low flow channel has developed within the culvert, and there is not any major evidence of erosion at present.
6	Trafalgar Road 1.1 km North of Steeles Avenue	HT-2a-2	Twin Concrete Box	2.74	Bankfull width observed from 5.5m to 7.5m. The combined span of this twinned box culvert is geomorphically undersized, nor does the twinned design allow for channel migration. As this reach appears to be historically straightened, this crossing is at risk to erosion as the channel regains sinuosity. A scour pool has developed upstream, suggesting that there may be some issues regarding flow conveyance and recirculation.

4.2.4 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 Premier Gateway Subwatershed Study Area.

Discussion of the erosion assessment is provided in Sections 4.1.1 and 4.1.2.

4.3 Natural Environment

Wetland at Steeles and Trafalgar

The Premier Gateway NHS was developed based on the Regional NHS. It was refined based on site specific study. All natural heritage features identified through the characterization process of the project have been included within the PG NHS, with the exception of the cattail marsh to the northeast of the Steeles/Trafalgar intersection. This wetland was characterized in more detail and its boundary surveyed in October 2016, as it may be proposed for removal and compensation elsewhere. If it is to be compensated for, it should be replaced at an area ratio of at least 1:1. It

should also be replaced as a Cattail marsh, preferably within the subject area, contiguous with the PG NHS. See Section 2.5.2 for more information on this wetland, as well as Appendix E. If it is to be retained in situ, the wetland is to be protected with 15m buffers. The water balance of the wetland must be retained from pre to post construction. The final HDF classification has identified the HDF in this vicinity (HT-2b-4) as 'conservation'. As such, the management of the wetland and the HDF should be established based upon the integrated function of both features.

Watercourses

All watercourses and some HDFs will be protected within the PG NHS. A total of 4 headwater drainage features, which are included in the Regional NHS, have been identified for potential relocation. The HDF in the northeast of the subject area (HT-2b-3) has been shown relocated further to the west, adjacent to the Coulson Tract. This will provide enhancement to the Coulson Tract, as well as increased benefit to the relocated HDF, as it will be contiguous with other habitats. The watercourses and HDFs are located within a minimum 60m wide corridor, where a 30m buffer has been provided on either side of the water feature. Where the meander belt assessment has identified a greater corridor (ref. Section 4.2.1), the PG NHS should be widened as required as part of future studies to incorporate the full meander belt, factor of safety, and erosion allowance. This will ensure protection of the feature, as well as fish communities. Where water feature based corridors are proposed for relocation, they should be moved to an area contiguous with other natural features, to provide overall benefit to the natural heritage feature and the wildlife that use and inhabit them.

Significant Wildlife Habitat

Where Significant Wildlife Habitat was identified, it was included in the Premier Gateway NHS, which meant that some areas were expanded from the Regional NHS.

Premier Gateway NHS

Overall, the proposed Premier Gateway NHS includes additional lands beyond identified natural heritage features and their buffers, that provide additional enhancement to the system. These enhancements provide for increased ecological services such as wildlife habitat and movement opportunities, increased buffering to natural heritage features, and restoration opportunities such as additional vegetation plantings.

Buffers from natural heritage features have been included within the development of the Premier Gateway NHS, so additional buffers are not required. The exception to this is permitting requirements for any Endangered or Threatened species that may be applicable at the time of development.

Road Crossings

Hornby Road and Trafalgar Road currently bisect the study area. The Preferred Land Use Concept shows 3 additional roads within the study area. The proposed roads have been aligned to avoid the Premier Gateway NHS, but will cross it in several locations, mostly across

watercourses. To minimize impact, the road crossings have been aligned to be perpendicular to the watercourse. The crossing opening will be sized at a later stage, but should consider wildlife movement. The crossings should be wide enough to allow some terrestrial movement of small to medium sized mammals, such as Raccoon and Fox. This will also allow for the movement of amphibians and reptiles.

The north-south road proposed to connect Hornby Road from the proposed roundabout to Sixth Line south of Steeles Avenue will be located slightly within the Greenbelt. The new road will be a minimum of 30m from the watercourse. The Greenbelt Plan (Government of Ontario 2017) allows for the development of infrastructure within the Greenbelt, however impacts should be minimized. This proposed road will be subject to an Environmental Assessment. The current landuse within the Greenbelt where the road is proposed is a private residence and farm, beside pasture land for horses; no natural heritage feature will be directly impacted within the Greenbelt with the alignment of the proposed road.

Stormwater Management

As per Section 4.1.2, the recommended stormwater management sizing criteria for the Premier Gateway Lands will control post-development flows to pre-development levels at all locations. As well, the recommended stormwater management criteria will mitigate the increased erosion potential along the receiving watercourses to within acceptable levels, and will provide stormwater quality control to an Enhanced standard of treatment.

Mitigation Measures

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

The Endangered Species Act protects Endangered and Threatened species. Where Barn Swallow nests or foraging habitat is to be removed, the permitting process must be started with the MNRF. Nests are to be replaced through a new nesting structure. 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.

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.

During construction activities such as clearing and grubbing, dust 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 subject 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 put in place and maintained in good repair. Areas of bare soil should be seeded to reduce erosion.

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

It is recommended that a trail system be established to allow people access and use of the Premier Gateway NHS. The trail system should be constructed at the start of development, to give people immediate access, and discourage the establishment of footpaths. Fencing should also be considered at the edge of the Premier Gateway NHS to keep people and pets 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. If possible, a plan for invasive species control should be prepared and implemented.

Areas within the Premier Gateway NHS that are currently not natural (e.g. agricultural areas, golf course) should be naturalized and planted with native, non-invasive species. 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.

Construction and Design Related Mitigation Recommendations

The following recommendations are general in nature but are 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 Premier Gateway NHS.
- Sediment and erosion control measures must be installed prior to, and maintained during construction. Areas of bare soil should be re-vegetated as soon as feasible to prevent erosion of soils (within 30 days of inactivity).

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

Monitoring Recommendations

(1) Prior to Construction

On-site inspections of the sediment and erosion control measures, as well as tree protection measures prior to construction.

(2) During Construction

- Regular monitoring of sediment and erosion control measures, as well as tree protection fencing to ensure maintenance and effectiveness.
- Pruning of any limbs or roots (of trees to be retained) disrupted during construction.
- Maintenance of Premier Gateway NHS.
- Monitoring of groundwater levels and baseflow during dewatering activities.
- Ensure other mitigation measures are adhered to, such as fuelling of machinery at designated locations away from woodlands, wetlands, and watercourses; storage of machinery and material, fill, etc. in designated areas; and equipment movement through natural areas and setbacks to be controlled.

(3) Subsequent to Construction

Buffer, restoration, and compensation plantings should be monitored after installation. Following planting, it is recommended that the plantings be inspected to ensure that the correct species and number of plants were planted in accordance with the approved planting plan. Two years after planting, the plantings should be inspected again to ensure a good survival rate. Any specimens not healthy in vigorous growing condition should be replaced at that time. To increase survival, it is recommended that new plantings be maintained through watering during the first two years after installation. Tree staking is to be removed two years after installation.

5.0 RECOMMENDED ENVIRONMENTAL AND STORMWATER MANAGEMENT PLAN

5.1 Stormwater Management

The recommended stormwater management plan has been developed based upon the principles provided in Section 4.1.4, and the sizing criteria presented in Section 4.1.2. The recommended stormwater management plan is presented in Drawing WR-4, and the preliminary sizing of the stormwater management facilities for erosion and flood control is presented in Table 5.1.1.

Table 5.1.1 Summary of Stormwater Quantity Management Peak Flow and Storage Requirements

Facility Reference #	Drainage Area (ha)	Extended Detention		Flood Control[2]					
				25 Year[1]		100 Year		Regional	
		Storage (m^3)	Discharge (m^3/s)	Storage (m^3)	Discharge (m^3/s)	Storage (m^3)	Discharge (m^3/s)	Storage (m^3)	Discharge (m^3/s)
West Branch (Subcatchment 241)									
668	5.84	1,197	0.004	2,873	0.07	4,789	0.17	9,578	0.59
671	3.05	686	0.002	1,647	0.04	2,745	0.09	5,490	0.31
West Branch Tributary (Subcatchment 242)									
672	14.05	3,161	0.009	7,587	0.17	20,232	0.20	40,464	6.39
676	34.39	6,620	0.023	15,888	0.41	42,368	0.49	84,737	15.63
East Branch Tributary (Subcatchment 245)[3]									
646	22.59	4,010	0.015	6,416	0.27	n/a	n/a	n/a	n/a
675	4.20	945	0.003	1,512	0.05	n/a	n/a	n/a	n/a
678	26.93	2,693	0.018	4,309	0.32	n/a	n/a	n/a	n/a
677	4.47	1,006	0.003	1,609	0.05	n/a	n/a	n/a	n/a
Hornby Tributary (Subcatchment 255)									
679	18.23	2,962	0.012	7,110	0.22	11,850	0.52	23,699	1.84
681	13.63	3,135	0.009	7,524	0.16	12,540	0.39	25,079	1.38
680	6.44	1,449	0.004	3,478	0.08	5,796	0.18	11,592	0.65
682	34.44	7,491	0.023	17,978	0.41	29,963	0.98	59,926	3.48
683	31.91	7,180	0.022	17,231	0.38	28,719	0.91	57,438	3.22

Notes: 1. Corresponds only approximately to return period flow rates/storage.
2. Emergency overflow to be provided above maximum required storage condition.
3. No quantity control required for 100 year and Regional Storm events.

Key components of the recommended stormwater management plan are as follows:

- Wet ponds are recommended to address requirements for water quality, erosion control, and flood control.
- The locations of stormwater management facilities are to be provided as shown, in order to maintain the supply of runoff to receiving systems, and to minimize requirements for operation and maintenance by the Town.
- Low Impact Development Best Management Practices (LID BMP's) are recommended throughout the future development in order to manage water budget and maintain groundwater recharge. The type and location of LID BMP's are to be established as part of future studies in consultation with Town staff.

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 the MOECC

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 any 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 through water well records the majority of the shallow overburden typically consists of silty clay. The site specific characteristics will need to be confirmed through additional drilling, test pits and infiltration tests.

Employing various the BMP's will aid in promoting infiltration, maintaining recharge and reducing runoff, as well as maintaining groundwater levels and related groundwater discharge.

Permanent groundwater control relating to buildings commonly utilizes perimeter drains and underdrains which may then be directed to a dedicated foundation drain collection (FDC) system and discharged to local watercourses. The amount of water collected and the extent of groundwater drawdown varies with depth and the size of the collection system and the local hydrostratigraphy.

Management of the post development groundwater system includes practices which attempt to maintain groundwater levels and practices which are employed to reduce local groundwater levels. Additionally, water and waste water infrastructure can potentially leak or infiltrate groundwater depending on the conditions. It is important to note the potential interconnection of the 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.

5.2 Watercourses and HDFs

Watercourse features and the associated hazard limits (i.e. final meander belt) are protected in-place within the preliminary NHS. From a channel morphology perspective, management considerations are based on the location of development with respect to the final meander belt limit, and for road crossings to be sized appropriately using risk factors outlined in Section 4.2.3. Final corridor setbacks which extend beyond the geomorphic limits (i.e. meander belt) are, in general, sufficiently encompassed by the preliminary NHS, however there are zones of minor discrepancy where the final corridor limit falls beyond the preliminary NHS (ref. Section 4.2.1). The proposed preliminary NHS should be re-evaluated based on hazard delineation refinement as part of future studies.

Despite the watercourse and meander belt being essentially protected from development activities, there are several opportunities for remediation that should be explored during subsequent planning phases. As mentioned in Section 4.2.2, there are some opportunities for remediation that should be explored in subsequent stages of site planning (Table 5.2.1).

Table 5.2.1 Watercourse Management Summary

Reach	Impact Summary	Recommendations
HT-2b-1	► Proposed crossing at downstream end. ► Channel and meander belt protected within preliminary NHS	► Design crossing appropriately based on risk factors. Minimum 3x bankfull width. Note the confluence immediately downstream. ► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings)
HT-2a-2	► Channel and meander belt protected within preliminary NHS ► Existing road crossing is undersized and limits natural channel processes.	► Upgrade and design crossing appropriately based on risk factors. Minimum 3x bankfull width, or meander amplitude: whichever is more conservative.
HT-2a-1	► Proposed road alignment along eastern portion of NHS. ► Channel and meander belt protected within preliminary NHS	► Avoid road grading within meander belt. ► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings)
HT-2	► Channel and meander belt protected within preliminary NHS	► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings)
HT-2b-2 (S3)	► Channel and meander belt protected within preliminary NHS ► Existing crossing slightly undersized.	► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings). ► Monitor existing crossing for erosion issues and address with natural channel design features if possible.
E-T1-3	► Channel and meander belt protected within preliminary NHS ► Proposed road alignment along eastern portion of NHS. ► Proposed road crossing at downstream end of reach. ► Currently located within the golf course.	► Avoid road grading within meander belt. ► Enhance riparian zone and any channel issues associated with existing land use (e.g. golf course structures and crossings) ► Design crossing appropriately based on risk factors. Minimum 3x bankfull width, or meander amplitude: whichever is more conservative.

E-T1-2	► Channel and meander belt protected within preliminary NHS ► Proposed road alignment along eastern portion of NHS.	► Avoid road grading within meander belt. ► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings, livestock activity)
E-T1-1	► Channel and meander belt protected within preliminary NHS	► Avoid road grading within meander belt. ► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings, livestock activity
W-T1-3	► Located outside of study area. No direct impacts.	► No management recommendation
W-T1-2a	► Channel and meander belt protected within preliminary NHS	► Enhance riparian zone and any channel issues associated with existing land use (e.g. farm crossings, livestock activity)
W-T1-2	► Located outside of the study area. No direct impacts.	► Can benefit from enhancement of the riparian zone and any channel issues associated with existing land use (e.g. farm crossings, livestock activity)
W-T1-1	► Located outside of the study area. No direct impacts.	► Can benefit from enhancement of the riparian zone and any channel issues associated with existing land use (e.g. farm crossings, livestock activity)

Section 4.2.2.1 briefly discusses the management recommendations for area HDFs with respect to channel length and realignment. The table found in Appendix D-3 summarizes the HDF assessment and final management recommendations. The TRCA/CVC protocol is designed to determine appropriate management recommendations based the results of the assessment, but site specific issues may lend the assessor to determine a more appropriate recommendation based on the interpretation of overall function and importance of the feature to the drainage system.

Of the eight (8) management recommendations from the protocol, the HDF assessment for the study area resulted in the application of four (4) recommendation designations. A description of each of these four recommendations, directly from the protocol are presented below:

Protection *- Important Functions: e.g. swamps with amphibian breeding habitat; perennial HDFs; seeps and springs; Species at Risk habitat; permanent fish habitat with woody riparian cover*

- *Protect and/or enhance the existing feature and its riparian zone corridor, and groundwater discharge or wetland in-situ.*
- *Maintain hydroperiod.*
- *Incorporate shallow groundwater and baseflow protection techniques such as infiltration treatment.*
- *Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted.*
- *Design and locate the stormwater management system (e.g. Extended detention outfalls) are to be designed and located to avoid impacts (i.e. Sediment, temperature) to the feature.*

Conservation *- Valued Functions: e.g. seasonal fish habitat with woody riparian cover; marshes with amphibian breeding habitat; or general amphibian habitat with woody riparian cover.*

- *Maintain, relocate, and/or enhance drainage feature and its riparian zone corridor.*

- *If catchment drainage has been previously removed or will be removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. Restore original catchment using clean roof drainage), as feasible.*
- *Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary.*
- *Maintain or replace external flows.*
- *Use natural channel design techniques to maintain or enhance overall productivity of the reach.*
- *Drainage feature must connect to downstream.*

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

- *Replicate or enhance functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream.*
- *Replicate on-site flow and outlet flows at the top end of system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage).*
- *Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development stormwater options (refer to Conservation Authority Water Management Guidelines for details).*

***No Management Required** - Limited Functions: e.g. features with no or minimal flow; cropped land or no riparian vegetation; no fish or fish habitat; and no amphibian habitat.*

- *The feature that was identified during desktop pre-screening has been field verified to confirm that no feature and/or functions associated with HDFs are present on the ground and/or there is no connection downstream. These features are generally characterized by lack of flow, evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation. No management recommendations required.*

Table 5.2.1 summarizes final recommendations, and rationale. Please see section 4.2.2 and Appendices D-2, D-3, and D-4 for further detail. Table 2.4.1 presents conflicting designations of HDFs between CH and those concluded during this study. Management recommendations to realign and apply natural channel design principles – where appropriate – remain regardless of the designation. Should future studies reclassify these features as watercourse, then the meander belt corridor will need to be delineated as necessary (see section 6.1.1).

5.2.1 Road Crossings and Alignment

Road crossings, and road alignments proposed adjacent to the Natural Heritage System should be located beyond the erosion hazard (final meander belt width), and preferably outside of the final natural heritage corridor. The hazard based approach to geomorphically assessing and designing crossings (Section 4.2.3) should be applied to all new crossings, and any crossing upgrades. Where a risk-based approach is not suitable, the crossing span should be a minimum of 3x the bankfull width. Crossings should be open bottom or embedded to provide a natural bottom comprised of typical substrates in consideration of aquatic habitat and passage. Coarser materials for scour protection should be located beneath a veneer of naturally occurring substrates. In addition, hydraulic structures spanning regulated watercourses should be sized to

satisfy current requirements for freeboard and clearance, as well as conveyance of the Regional Storm event peak flow rate and allow for wildlife movement.

5.2.2 Erosion Thresholds

Critical discharges determined through the erosion threshold analysis should be applied as SWM targets to mitigate excess erosion downstream of the study area following development and major alteration to site hydrology.

5.3 Natural Heritage

The Premier Gateway Natural Heritage System (Premier Gateway NHS) is a refinement of the Regional Natural Heritage System (RNHS). The RNHS was identified through "Sustainable Halton," a project undertaken by the Region of Halton that included the identification of a Natural Heritage System, which is intended to achieve long term protection of natural heritage features and functions (NSEI 2009). The RNHS developed through this project and identified in the Region's Official Plan (2014) and ROPA 38 (2015) is approximate, and it is recognized that additional studies will refine the boundaries through field verification (see Section 116.1 in ROPA 38).

The areas included in the RNHS include woodlands, wetlands, and watercourses, along with appropriate buffers, linkages, and enhancement areas identified by NSEI (2009) and shown on Map 1G of the Official Plan. Section 115.3 of ROPA 38 (Halton Region 2015a) lists the components of the RNHS as the following:

- key features, including:
  - significant habitat of Endangered and Threatened species
  - significant wetlands
  - significant coastal wetlands
  - significant woodlands
  - significant valleylands
  - significant wildlife habitat
  - significant Areas of Natural and Scientific Interest
  - fish habitat enhancements to key features, including Centres for Biodiversity
- linkages
- buffers
- watercourses
- wetlands

Sustainable Halton (NSEI 2009) established 30m buffers from all features, which is consistent with Greenbelt buffers and what some other municipalities are promoting.

The Premier Gateway NHS was developed based on the RNHS. It was refined based on site specific study. All natural heritage features identified through the characterization process of the project have been included within the Premier Gateway NHS, with the exception of the cattail marsh to the northeast of the Steeles/Trafalgar intersection. A total of 4 headwater drainage

features, which are included in the RNHS, have been identified for potential relocation. Significant Wildlife Habitat has been included in the Premier Gateway NHS, thereby increasing the overall size of the system.

The Premier Gateway NHS connects to the Greenbelt. The revised Greenbelt Plan (2017) added Urban River Valley Corridors to the Greenbelt as 120+m wide corridors, centered on a watercourse (60m from each side of the water's edge). An Urban River Valley Corridor has been identified immediately south of the study area, centered on Middle Sixteen Mile Creek, connecting 2 Greenbelt areas. The existing Sixth Line runs directly through this corridor.

6.0 REQUIREMENTS FOR FUTURE STUDIES

6.1 Subwatershed Impact Studies

Subwatershed Impact Studies represent an intermediate level of study, which is required in areas where multiple land ownership within the subwatershed occurs. This level of study would focus on integrating the servicing, stormwater, and environmental management of adjacent development to a greater level of detail than is normally achieved through the Secondary Plan and Scoped Subwatershed Study; the detailed site specific work may identify additional features/functions which were not captured as part of the Scoped Subwatershed Study, which should be evaluated using the same criteria as established in the Scoped Subwatershed Study. The objectives of this level of study are to:

- Update the characterization of features that are recommended to be integrated in the NHS.
- Refine the natural heritage and natural hazard limits reflecting the NHS objectives and other intentions of the subwatershed study (i.e. final staking of Natural Heritage System features and buffers, calculation of riparian storage volumes, etc.)
- Confirm watercourse constraint ranking and HDF classification
- Determine preferred servicing plan
- Determine road layout
- Develop and define integration of stormwater management facilities
- Define phasing in areas of multiple ownership
- Define cost sharing for monitoring programs
- Refine meander belt width delineation, hazard setbacks and regulatory setbacks
- Redefine limits of NHS with respect to updated watercourse corridor widths
- Develop further characterization of groundwater resources associated protection measures, and mitigation techniques
- Verify that the water budget would be appropriately managed through the proposed development and stormwater management plan
- Determine detailed road alignment and configuration of watercourse and valley crossings
- Identification and field staking of significant NHS features in consultation with Town and Conservation Halton
- Prescribe site specific standards and preliminary design for landscaping, implementation and management of corridors, wetland creation areas, buffers, and restoration areas
- Develop strategies to enable construction phasing while allowing rescue of biota from small isolated habitats, and maintenance of the NHS resources and functioning through the construction period.
- Develop use of LID measures.
- Preliminary analysis of stream corridor dimensions required to maintain pre-development riparian strategy.

Pre-consultation with the Town and Conservation Halton is recommended to develop Terms of Reference for Subwatershed Impact Studies.

6.2 Functional Servicing Studies

Functional Servicing Reports are typically prepared as part of the detailed site design process, in order to identify the manner in which water, sanitary, and storm servicing is to be provided for the site. The information provided within these documents generally includes, but is not limited to:

- Location and preliminary sizing of sanitary sewers.
- Location and preliminary sizing of storm sewers.
- Location and preliminary sizing of watermains.
- Preliminary site grading plan.
- Location and preliminary sizing of stormwater management facilities.
- Location and preliminary sizing of hydraulic structures (i.e. bridges and culverts).
- Preliminary channel grading plans and supporting analyses.
- Assessment of riparian storage for existing channel and preliminary channel designs.

Current practice by Conservation Halton also requires that these studies include an assessment of the impacts of the proposed servicing for the site, specifically related to potential impacts to groundwater systems and recommended mitigation strategies.

6.3 Stormwater Management Plans

Requirements for Stormwater Management Plans are outlined within the Stormwater Management Best Management Practices Guidelines (MOE, March 2003). Stormwater Management Plans are prepared in support of individual development applications. The stormwater management plans complement the planning process associated with Draft Plans of Subdivision or individual Site Plans. Stormwater management reporting associated with this planning stage would be the “Functional Design” plan. Subsequently, in support of final subdivision design, a “Detailed Design” plan is prepared.

6.3.1 Functional Design

This level of design typically involves demonstrating the feasibility of providing stormwater management for a particular development. In areas where no Subwatershed Plan has been completed, the Stormwater Management Plan will be required to address additional issues such as environmental baseline conditions and screening of various stormwater management strategies and techniques. For the Premier Gateway Lands, the intent of the Functional Design Stormwater Management Plan would focus on demonstrating compatibility and compliance with principles and requirements prescribed in the Scoped Subwatershed Study, as well as the specifics emanating from the Subwatershed Impact Study. This includes identifying specific stormwater management infrastructure which is to be implemented for the proposed development (i.e. type of LID BMP’s, end-of-pipe facilities, thermal mitigation techniques such as cooling trenches and bottom draws, etc.).

6.3.2 Detailed Design

The detailed design submission is required to demonstrate how the required information, outlined in the Functional Design report, has been integrated, providing further details on the proposed stormwater management system (i.e. details related to minor system design details, landscaping,

safety, and maintenance aspects of Stormwater Management Facility design), as well as outlining subsequent specific monitoring requirements.

6.4 Natural Channel Design Briefs

Natural Channel Design Briefs are prepared in support of any proposed realignment, alteration, or enhancement to a regulated open watercourse. These reports would provide the following information, specifically related to the detailed design of any proposed realignment, alteration, or enhancement to regulated watercourses.

- Details related to the natural channel design principles applied to the detailed design of the watercourse.
- Fluvial geomorphological analysis of the proposed watercourse design.
- Rationale for selection of plantings within the riparian zone and floodplain.
- Details regarding any enhancements proposed within the adjacent watercourse.
- Detailed hydrologic and hydraulic analyses of proposed watercourse and hydraulic structures to demonstrate impacts to floodplains, and freeboard under proposed conditions, maintenance of riparian storage post-development.
- Detailed assessment of impacts of proposed watercourse to aquatic habitat and fish species.
- Detailed design drainage for proposed watercourse and corridor.

6.5 Monitoring and Adaptive Management Plans

Monitoring and Adaptive Management Plans are generally developed as part of Subwatershed Impact Studies. The information collected as part of these plans is intended to verify the performance of the environmental and stormwater management system advanced in the Subwatershed Impact Study, as well as to provide guidance for potential modifications to the management plan to satisfy the objectives of the Scoped Subwatershed Study. Additional details regarding various components of the monitoring and adaptive management plan are provided below.

6.5.1 Surface Water Quantity

Surface water monitoring should include collection of local stream flow and rainfall data. The selection of the appropriate gauge site should be completed in consultation with Conservation Halton and Town of Halton Hills staff.

Each stormwater management facility identified in the Subwatershed Impact Study should be monitored for inflow and outflow and temperature. Given that the inlet and outlet control structures are generally well documented with well defined hydraulic rating curves, continuous level recording devices would be considered appropriate.

Regular inspection of the inlets and outlets should be completed to ensure that they are free of debris and sediment, hence functioning in accordance with theory. As a minimum, inspections should be completed every 2 weeks and following major storms for the first two years of operation. Any problems should be rectified by the consultant or reported to the Town for rectification, if

special equipment is required. The gauges should be installed from April 1 to November 30 and be capable of providing data in a minimum of 5 minute increments. All data should be collected in digital format and processed into a tabular inlet/outlet hydrograph form.

Depending on the results of the first year of monitoring, consideration should be given to monitoring the performance of the facilities year round (i.e. inclusive of the December 1 to March 31 period).

6.5.2 Surface Water Quality and Temperature

Surface Water Chemistry

Chemical sampling using grab sampling should be completed to characterize and verify the stormwater quality management system. Instream monitoring to establish pre-development (i.e. baseline) conditions should be completed for two years prior to development; the location of instream water quality monitoring should be determined in consultation with Conservation Halton and Town staff.

Water chemistry monitoring of post-developed conditions should be completed for a minimum of three years post development, and should include monitoring of the inlet and outlet of each stormwater management facility after construction as well as online the receiving watercourse at the same location identified for pre-development monitoring.

Grab sampling is recommended for collecting water quality samples from each site for the monitoring program. Each site should have 3 events sampled per year, typically representative of an average spring, summer and fall event (rainfall event volumes of over 15 mm depth are preferable).

The following parameters are recommended for monitoring surface water chemistry and water quality:

The parameters to sample for includes:

- Oil and Grease
- Total Phosphorus
- Anions (Nitrate, Nitrite, Phosphate, Chloride)
- Ammonia
- Total Kjeldahl Nitrogen (TKN)
- Conductivity
- Total Solids (TS)
- Total Suspended Solids (TSS)
- BOD5
- Dissolved Oxygen
- pH/alkalinity
- Salinity
- Total Coliforms

- Faecal Coliforms
- PAH
- Metals (Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, W, U, V, Zn, Zr).

Surface Water Temperature

Continuous temperature gauges should be installed from June 1 to September 30 at the outlet from all facilities and both upstream and downstream of the facility outlets, to monitor the effectiveness of measures to cool the effluent and the impact on stream temperature. Locations for online monitoring of water temperature should be determined in consultation with Conservation Halton and Town staff.

6.5.3 Groundwater

A select number of future monitoring wells should be maintained and monitored for seasonal groundwater levels to assess the overall trend of the study area development on the local groundwater levels and correlated with precipitation records. It would be expected that the groundwater level data be collected for a period of 5 years beyond build out and then assessed to determine if static trends have been realized. Spot baseflow measurements at select locations, as recommended through the more detailed studies, should be carried out as well for a time period consistent with the groundwater level monitoring.

6.5.4 Stream Morphology

The collection of field data from similar sites over an extended period of time can provide great insight on channel processes and function. This monitoring can also yield information regarding the response of channel to changes in upstream land use. Typically, a land use change will result in some alteration in the hydrologic regime (increased flow volumes) and sediment regime (initially more sediment being supplied to the channel followed by an overall decrease in loadings). These alterations can result in changes in the channel planform, bank erosion, cross-sectional area and substrate composition which, in turn, may locally affect aquatic habitat and water quality.

From a geomorphic perspective, while geomorphic monitoring stations were established during Phase 1, additional monitoring control points and pre-construction baseline surveys should be established within 2-3 years prior to land alteration. Preferably these should be installed within the relevant or sensitive reaches prior to stormwater being released within the system. Monitoring would subsequently take place annually during- and post-construction to fulfill performance evaluation requirements. The post-construction monitoring period should extend for 5-years following completed build-out. Specifically, the following steps should be taken to monitor for development impacts:

Control Cross-sections – Are to be monitored twice annually. Once following the spring freshet, and again in the fall. An additional site visit should be conducted at each site following a peak storm in excess of the 5-year storm event for the system.

Substrate Composition – A modified Wolman pebble count should be conducted at each control cross-section on an annual basis, the results of which will be tabulated in a particle size distribution chart. An additional site visit will be conducted at each site following a peak storm in excess of the 5-year storm event for the system. Due to the dynamic nature of substrate composition, no action will be taken until Year 5 unless the adjustment is identified as a potential risk to the function of the channel by a qualified geomorphologist.

Lateral Migration – A series of erosion pins installed in areas of active bank migration as well as areas of anticipated migration should be measured during each monitoring visit to determine rates of bank adjustment. An additional site visit will be conducted at each site following a peak storm in excess of the 5-year storm event for the system.

Photographic Record – Photographs from a known vantage point should be used to document general geomorphic site conditions on an annual basis. An additional site visit will be conducted at each site following a peak storm in excess of the 5-year storm event for the system. These photographs will be used as supplemental information to inform decisions regarding the need for mitigation.

Analysis of ongoing monitoring may be used for adaptive management of the study area, however, mitigation should only be applied following an investigation into the causes. The exception being major adjustment requiring immediate works where risk to property, human safety, or infrastructure is imminent. Mitigation measures would be recommended based on the extent and source of the issue. Table 6.5.1 summarizes monitoring parameters and indicator thresholds for investigation.

Table 6.5.1 Summary of Fluvial Geomorphology Monitoring Targets

Monitoring Parameter	Indicator Monitoring Threshold*
Bankfull cross-sectional area (m^2)	Maintain bankfull cross-sectional area within 30% of existing conditions
Mean bankfull channel depth	Maintain bankfull depth within 30% of existing conditions
Bank migration rates (cm/yr)	Normal migration rates ~ 2% of bankfull width per year where migration is expected (i.e., cutbanks). As rates may vary due to extreme flood events; evaluate migration over the longer term (e.g., 3-5 years).
Substrate distribution, D_{50} and D_{90}	Maintain D50 and D90 particle sizes within plus or minus one order of magnitude of existing conditions. As sizes may vary due to extreme flood events; evaluate substrate trends over the longer term (e.g., 3-5 years).

Note: * Threshold exceedances, if documented, will require an interpretation of site conditions and trends by a qualified Professional Geomorphologist to explore if any adaptive management or remediation recommendations are appropriate.

This monitoring could be undertaken by a variety of parties including the Town of Halton Hills, Halton Region, and Conservation Halton. However, a fluvial geomorphologist should be used to

interpret the findings and assess whether substantial change has occurred. The geomorphologist should also be able to link any change with the causative factors and processes.

Appendix A

Correspondence

Appendix B

Hydrology and Hydraulics

Appendix C

Groundwater

Appendix D

Fluvial Geomorphology

Appendix E

Aquatic and Terrestrial Ecology