# Southwest Georgetown Subwatershed Study Addendum - VISION GEORGETOWN

Prepared for:
Town of Halton Hills
Project # TPB188066

Prepared for:

**Town of Halton Hills**
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Prepared by:
**Wood Environment & Infrastructure Solutions**

In association with:
**Palmer**

9/16/2020

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**Prepared for:**

Town of Halton Hills

**Prepared by:**

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**9/16/2020**

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# 1.0 Introduction

The Vision Georgetown lands within the Town of Halton Hills are generally bounded by Trafalgar Road to the south, Eighth Line to the north, No. 10 Sideroad to the east, and No. 15 Sideroad to the west. The majority of the lands, lie within the Sixteen Mile Creek Watershed, although the west portion of the site is within the Silver Creek Subwatershed of the Credit River Watershed.

The Town of Halton Hills retained AECOM to complete a Subwatershed Study in support of the Secondary Plan for the study area. The Subwatershed Study outlines a strategy to manage the stormwater runoff and watercourses and environmental systems within the study area. Furthermore, the Natural Heritage System was established through the Subwatershed Study Process for the Secondary Plan. The Subwatershed Study was provided to the Town in May 2017. Although the Subwatershed Study and Secondary Plan received approval from Town Council, Conservation Halton (Authority) and Halton Region (Region) noted that various comments provided by both parties during the course of the Subwatershed Study remained outstanding, and from their perspective needed to be addressed in order for the Authority and the Region to approve the Subwatershed Study and the Secondary Plan.

The Town of Halton Hills subsequently retained Wood Environment & Infrastructure Solutions (Wood) to review the SWS and conduct a scoped supplemental assessment to support the finalization of the Secondary Plan, and address comments arising from Conservation Halton and Halton Region. The analyses were completed specifically to establish the size and geometry of the watercourse corridor for Tributary A through the Vision Georgetown Area for inclusion in the Secondary Plan, as well as to verify the stormwater management sizing criteria advanced in the May 2017 Subwatershed Study for stormwater quantity (flood) control and refine the criteria as appropriate. The Secondary Plan and conceptual stormwater management plan for the Vision Georgetown area were subsequently updated by the Town based upon the results of these assessments, to maintain consistency. Moreover, this Addendum provides guidance for completing future studies, to address specific comments provided by the Authority and the Region which have not been directly addressed by this Addendum.

In addition, and in response to a request from a resident and local landowner within the Vision Georgetown area, the classification and management recommendations advanced in the May 2017 Subwatershed Study for Tributary C have also been reviewed, to confirm the findings of the May 2017 Subwatershed Study. The foregoing assessments have been informed by supplemental investigations completed by Palmer (formerly Palmer Environmental Consultants Inc.), related to the fluvial geomorphologic and terrestrial functions of the watercourses and terrestrial features on the landscape. The findings of these analyses have been compiled into this Addendum to the May 2017 Subwatershed Study, to specifically address the outstanding comments from Conservation Halton and Halton Region.

# 2.0 Tributary A Management Approach

The May 2017 Subwatershed Study, identified Tributary A (which extends through the east portion of the Vision Georgetown lands within the Sixteen Mile Creek Watershed), as requiring further study to establish more accurate corridor dimensions based upon standard criteria for flood protection and riparian storage, to inform the development of the Secondary Plan. As part of the Subwatershed Study, a Technical Memorandum was prepared by AECOM (April, 2016) which established Performance Specifications to guide the process for sizing the watercourse corridor as part of future studies. The Technical Memorandum and corresponding Performance Specifications are included in Appendix V of the May 2017 Subwatershed Study (ref. Appendix B-1).

The Performance Specifications were understood to have been established by AECOM in consultation with Conservation Halton and the Town of Halton Hills. As part of this Addendum, an assessment of the guidance from the Subwatershed Study has been completed, specifically to determine the dimension and configuration of Tributary A under the proposed future land use condition within the study area. This section has been prepared to summarize the findings of the supplemental analyses. These analyses have been informed by dialogue with Conservation Halton and Town staff, along with further information prepared by Palmer Environmental Consulting Group Inc., to establish the meander belt widths for the specific watercourses (ref. Hrytsak/McParland/McKillop-Grace, March 29, 2018). Supporting documentation is noted in the sections below, and also provided in Appendix B-2. The information presented in the following sections was previously submitted to Conservation Halton and Halton Region June 13, 2018 as an Addendum to the May 2017 Subwatershed Study, specifically pertaining to the Tributary A management, riparian storage assessment and watercourse corridor planning. The information presented in the June 13, 2018 Addendum is presented below in its entirety, for completeness of documentation.

## 2.1 Hydrology

Peak flow rates have been determined, using the PCSWMM hydrologic model developed for the Vision Georgetown Subwatershed Study (AECOM, May 2017) for input to the hydraulic analyses. During the course of conducting the supplemental scope to support this Addendum, Conservation Halton has been consulted to confirm the approach to be used in establishing the peak flows for the hydraulic analyses of the existing and proposed watercourse system comprising Tributary A. Correspondence with Conservation Halton is provided in Appendix B-2 for reference, and the approach consultatively established with Conservation Halton for establishing peak flows is summarized as follows:

- Hydrographs have been extracted from the PCSWMM hydrologic model for each storm event (i.e. 1.5 year, 2 year, 5 year, 10 year, 25 year, 50 year, 100 year, Regional Storm event) at the following key locations: Watercourse A5-1, Watercourse AM6, Watercourse A2-1, Watercourse A3-1, Watercourse A4-1, Subcatchment A-3a, Subcatchment A-3b (ref. Figure 4.8.2).
- The hydrographs have been added at each incremental timestep to generate the resulting hydrograph at key confluences along Tributary A (i.e. Confluence of A5-1 and AM6, Confluence of AM6 with Subcatchment A-3a, Confluence of AM5 with A3-1 and A2-1, Confluence of AM5 with Subcatchment A-3b, Confluence of A4-1 with AM-4) (ref. Figure 4.6.1).
- The peak flow rates resulting from the summation of the hydrographs have been determined for each storm event and applied for the riparian storage assessment.

The Excel™ spreadsheet developed to establish peak flow rates in accordance with the above approach and methodology is provided in Appendix B-3.

## 2.2 Meander Belt Width

The meander belt widths for the various watercourses within the Vision Georgetown Secondary Planning area have been established as part of the May 2017 Subwatershed Study. Supplemental analyses have been completed by Palmer Environmental Consulting Group Inc., as requested by Conservation Halton, to establish the meander belt width for select watercourses within the Vision Georgetown study area (ref. Hrytsak/McParland/McKillop-Grace, March 29, 2018). A copy of the correspondence is included in Appendix B-4. The meander belt widths for the area watercourses are summarized in Table 2.2.1.

**Table 2.2.1. Meander Belt Widths for Area Watercourses (m)**

| Reach ID | Meander Belt Width |
|---|---|
| AM-7 | 29[1.] |
| AM-6 | 42[1.] |
| AM-5 | 60[1.] |
| AM-4 | 65[1.] |
| AM-2 | 76[1.] |
| AM-1 | 71[1.] |
| A5-1 | 44[2.] |
| A4-2 | 23[1.] |
| A4-1 | 36[1.] |
| A2-2 | 36[2.] |
| A2-1 | 38[2.] |

NOTES:
1. Meander Belt Width Defined As Per AECOM, May 2017 Subwatershed Study
2. Meander Belt Width Defined As Per Palmer Environmental Consulting Group Inc., March 29, 2018.

## 2.3 Riparian Storage Assessment – Existing Conditions

Supplemental hydraulic analyses have been completed to determine the riparian storage along Tributary A under existing conditions. The hydraulic analyses have been based on the currently approved HEC-RAS hydraulic model developed for the May 2017 Subwatershed Study, and refined as per the requirements provided by Conservation Halton (ref. e-mail correspondence Howatt-Farrell, January 11, 2018; e-mail correspondence Howatt-Farrell, January 24, 2018) to include two (2) additional cross-sections proximate to the downstream limit of the proposed watercourse modifications, as well as to incorporate a flow change at HEC-RAS Station 1764.95, coincident with the confluence of AM-6 with the outlet of Subcatchment A-3a. The simulated storage along the various watercourses, as well as the total storage within the watercourse system, have been determined for each of the return period storms, as well as the Regional Storm event using the flow data generated from the methodology described in Section 2.1. The results of this assessment are presented in Table 2.3.1; a digital copy of the HEC-RAS hydraulic model is included in Appendix B-5.

**Table 2.3.1. Riparian Storage Assessment – Existing Conditions ($m^3$)**

| Return Period Storm | Return Period Storm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A5-1 | AM6[1.] | AM5 | AM4 | AM3 | A2-1 | A4-3 | A4-2 | A4-1 | Total |
| 1.5 Year | 928 | 560 | 839 | 2011 | 1796 | 921 | 846 | 156 | 77 | 8134 |
| 2 Year | 1214 | 696 | 969 | 2959 | 2920 | 1091 | 2555 | 573 | 199 | 13176 |
| 5 Year | 6730 | 6973 | 3414 | 9774 | 4977 | 4428 | 2555 | 573 | 286 | 39710 |
| 10 Year | 14939 | 16653 | 7738 | 16000 | 7706 | 7416 | 3676 | 863 | 520 | 75511 |
| 25 Year | 21610 | 22345 | 17496 | 25695 | 12151 | 11389 | 4947 | 1228 | 788 | 117649 |
| 50 Year | 25129 | 25833 | 22541 | 28254 | 16329 | 15130 | 6057 | 1525 | 1036 | 141834 |
| 100 Year | 29962 | 30706 | 28344 | 33318 | 20604 | 18684 | 7114 | 1815 | 1279 | 171826 |
| Regional | 40248 | 39999 | 39873 | 43884 | 27166 | 29811 | 9412 | 2413 | 1742 | 234548 |

NOTE: [1.] Reach AM6 in the HEC-RAS model encompasses Reach AM7, as well as the Reach of AM6 upstream of the confluence with Reach A5-1.

## 2.4 Riparian Storage Assessment – Proposed Conditions

The HEC-RAS hydraulic model representing the Existing Conditions along Tributary A has been modified to represent the proposed regrading of the watercourse corridor, including the realignment of Watercourse A2-1, as well as the removal of Reach A4-3 per the Subwatershed Study recommendations. The following three (3) alternatives for the proposed watercourse corridor have been assessed for Riparian storage:

**Alternative 1:**

- Longitudinal grade of 0.3% for constructed watercourse corridor.
- Manning's Roughness coefficient of 0.08 for floodplains and 0.035 for channel.
- Watercourse corridors constructed to the following geometry:
  - 3:1 side slopes to valley corridor from floodplain to constructed top-of-bank.
  - 2% side slopes (cross fall) across floodplain from toe of valley slope to bank of channel.
  - Total floodplain bottom width as per meander belt width for respective watercourses (ref. Table 2.2.1).
  - Low flow channel an average of existing geometry.

**Alternative 2:**

- Longitudinal grade of 0.2% for constructed watercourse corridor.
- Manning's Roughness coefficient of 0.10 for floodplains and 0.035 for channel.
- Watercourse corridors constructed to the following geometry:
  - 3:1 side slopes to valley corridor from floodplain to constructed top-of-bank.
  - 2% side slopes across floodplain from toe of valley slope to bank of channel.
  - Total floodplain bottom width increased for respective watercourses as follows:
    Realigned A2-1 – 84 m
    A5-1 – 84 m
    AM6 – 79 m
    AM5 – 95 m
    AM4 – 100 m
  - Low flow channel an average of existing geometry.

**Alternative 3:**

- Longitudinal grade of 0.2% for constructed watercourse corridor.
- Manning's Roughness coefficient of 0.10 for floodplains and 0.035 for channel.
- Watercourse corridors constructed to the following geometry:
  - 3:1 side slopes to valley corridor from floodplain to constructed top-of-bank.
  - 0% side slopes (cross fall) across floodplain from toe of valley slope to bank of channel (i.e. flat floodplains potential for constructed wetland features).
  - Total floodplain bottom width increased for respective watercourses as follows:
    Realigned A2-1 – 84 m
    A5-1 – 84 m
    AM6 – 79 m
    AM5 – 95 m
    AM4 – 100 m
  - Low flow channel an average of existing geometry.

Digital copies of the HEC-RAS hydraulic models corresponding to each of the above three (3) scenarios are included in Appendix B-5. The results of the analyses are presented in Tables 2.4.1 ,2.4.2, and 2.4.3, and the percent changes in Riparian Storage compared to existing conditions are summarized in Tables 2.4.4, 2.4.5, and 2.4.6 respectively.

**Table 2.4.1. Riparian Storage Assessment – Proposed Conditions Alternative 1 ($m^3$)**

| Return Period Storm | HEC-RAS Reach ID | | | | | | |
|---|---|---|---|---|---|---|---|
| | A5-1 | AM6 | AM5 + AM4 | AM3 | A2-1 | A4-2 + A4-1 | Total |
| 1.5 Year | 305 | 317 | 3352 | 1796 | 1128 | 311 | 7209 |
| 2 Year | 359 | 368 | 5003 | 2920 | 1348 | 1159 | 11157 |
| 5 Year | 1031 | 881 | 15434 | 4977 | 4290 | 1246 | 27859 |
| 10 Year | 1754 | 1382 | 24333 | 7706 | 7641 | 1789 | 44605 |
| 25 Year | 2722 | 2184 | 34688 | 12151 | 11958 | 2559 | 66262 |
| 50 Year | 3498 | 2923 | 42837 | 16329 | 15228 | 3223 | 84038 |
| 100 Year | 4159 | 3650 | 50167 | 20604 | 18238 | 3875 | 100693 |
| Regional | 5335 | 5015 | 63369 | 27166 | 27226 | 5241 | 133352 |

**Table 2.4.2. Riparian Storage Assessment – Proposed Conditions Alternative 2 ($m^3$)**

| Return Period Storm | HEC-RAS Reach ID | | | | | | |
|---|---|---|---|---|---|---|---|
| | A5-1 | AM6 | AM5 + AM4 | AM3 | A2-1 | A4-2 + A4-1 | Total |
| 1.5 Year | 359 | 388 | 4270 | 1796 | 1301 | 311 | 8425 |
| 2 Year | 423 | 454 | 6522 | 2920 | 1557 | 1159 | 13035 |
| 5 Year | 1383 | 1224 | 20696 | 4977 | 5480 | 1246 | 35006 |
| 10 Year | 2379 | 2081 | 33481 | 7706 | 9854 | 1789 | 57290 |
| 25 Year | 3760 | 3497 | 50160 | 12151 | 15785 | 2559 | 87912 |
| 50 Year | 4980 | 4841 | 63187 | 16329 | 20980 | 3223 | 113540 |
| 100 Year | 6147 | 6208 | 75073 | 20604 | 26129 | 3875 | 138036 |
| Regional | 8410 | 8986 | 96736 | 27166 | 42747 | 5241 | 189286 |

**Table 2.4.3. Riparian Storage Assessment – Proposed Conditions Alternative 3 ($m^3$)**

| Return Period Storm | HEC-RAS Reach ID | | | | | | |
|---|---|---|---|---|---|---|---|
| | **A5-1** | **AM6** | **AM5 + AM·** | **AM3** | **A2-1** | **A4-2 + A4-1** | **Total** |
| 1.5 Year | 386 | 413 | 10070 | 1796 | 1301 | 311 | 14277 |
| 2 Year | 524 | 507 | 15065 | 2920 | 1601 | 1159 | 21776 |
| 5 Year | 2943 | 1615 | 37238 | 4977 | 11635 | 1246 | 59654 |
| 10 Year | 4291 | 3467 | 52619 | 7706 | 17818 | 1789 | 87690 |
| 25 Year | 5841 | 5447 | 70682 | 12151 | 24716 | 2559 | 121396 |
| 50 Year | 7022 | 6967 | 84957 | 16329 | 30132 | 3223 | 148630 |
| 100 Year | 8097 | 8350 | 98099 | 20604 | 35159 | 3875 | 174184 |
| Regional | 10047 | 10952 | 121872 | 27166 | 50101 | 5241 | 225379 |

**Table 2.4.4. Percent Change in Riparian Storage Compared to Existing Conditions – Proposed Conditions Alternative 1 (%)**

| **Return Period Storm** | **HEC-RAS Reach ID** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **A5-1** | **AM6** | **AM5 + AM4** | **AM3** | **A2-1** | **A4-2 + A4-1** | **Total** |
| 1.5 Year | -67.1 | -43.4 | 17.6 | 0.0 | 22.5 | -71.2 | -11.4 |
| 2 Year | -70.4 | -47.1 | 27.4 | 0.0 | 23.6 | -65.2 | -15.3 |
| 5 Year | -84.7 | -87.4 | 17.0 | 0.0 | -3.1 | -63.5 | -29.8 |
| 10 Year | -88.3 | -91.7 | 2.5 | 0.0 | 3.0 | -64.6 | -40.9 |
| 25 Year | -87.4 | -90.2 | -19.7 | 0.0 | 5.0 | -63.2 | -43.7 |
| 50 Year | -86.1 | -88.7 | -15.7 | 0.0 | 0.6 | -62.6 | -40.7 |
| 100 Year | -86.1 | -88.1 | -18.6 | 0.0 | -2.4 | -62.0 | -41.4 |
| Regional | -86.7 | -87.5 | -24.3 | 0.0 | -8.7 | -61.4 | -43.1 |

**Table 2.4.5. Percent Change in Riparian Storage Compared to Existing Conditions – Proposed Conditions Alternative 2 (%)**

| Return Period Storm | HEC-RAS Reach ID | | | | | | |
|---|---|---|---|---|---|---|---|
| | A5-1 | AM6 | AM5 + AM4 | AM3 | A2-1 | A4-2 + A4-1 | Total |
| 1.5 Year | -61.3 | -30.7 | 49.8 | 0.0 | 41.3 | -71.2 | 3.6 |
| 2 Year | -65.2 | -34.8 | 66.0 | 0.0 | 42.7 | -65.2 | -1.1 |
| 5 Year | -79.5 | -82.4 | 56.9 | 0.0 | 23.8 | -63.5 | -11.8 |
| 10 Year | -84.1 | -87.5 | 41.0 | 0.0 | 32.9 | -64.6 | -24.1 |
| 25 Year | -82.6 | -84.3 | 16.1 | 0.0 | 38.6 | -63.2 | -25.3 |
| 50 Year | -80.2 | -81.3 | 24.4 | 0.0 | 38.7 | -62.6 | -19.9 |
| 100 Year | -79.5 | -79.8 | 21.7 | 0.0 | 39.8 | -62.0 | -19.7 |
| Regional | -79.1 | -77.5 | 15.5 | 0.0 | 43.4 | -61.4 | -19.3 |

**Table 2.4.6. Percent Change in Riparian Storage Compared to Existing Conditions – Proposed Conditions Alternative 3 (%)**

| Return Period Storm | HEC-RAS Reach ID | | | | | | |
|---|---|---|---|---|---|---|---|
| | A5-1 | AM6 | AM5 + AM4 | AM3 | A2-1 | A4-2 + A4-1 | Total |
| 1.5 Year | -58.4 | -26.3 | 253.3 | 0.0 | 41.3 | -71.2 | 75.5 |
| 2 Year | -56.8 | -27.2 | 283.5 | 0.0 | 46.7 | -65.2 | 65.3 |
| 5 Year | -56.3 | -76.8 | 182.4 | 0.0 | 162.8 | -63.5 | 50.2 |
| 10 Year | -71.3 | -79.2 | 121.7 | 0.0 | 140.3 | -64.6 | 16.1 |
| 25 Year | -73.0 | -75.6 | 63.6 | 0.0 | 117.0 | -63.2 | 3.2 |
| 50 Year | -72.1 | -73.0 | 67.3 | 0.0 | 99.2 | -62.6 | 4.8 |
| 100 Year | -73.0 | -72.8 | 59.1 | 0.0 | 88.2 | -62.0 | 1.4 |
| Regional | -75.0 | -72.6 | 45.5 | 0.0 | 68.1 | -61.4 | -3.9 |

The foregoing results indicate the following:

- Constructing the proposed watercourse corridors per the Alternative 1 concept (i.e. bottom widths per meander belt width, standard floodplain roughness coefficients, and maintaining longitudinal grades approximately per existing conditions) would generally reduce the riparian storage along the reconstructed corridors, as well as overall within the system compared to existing conditions, particularly for the Regional Storm event (Regional Storm would be 43% less).
- Constructing the proposed watercourse corridors per the Alternative 2 concept (i.e. increased bottom widths to between 79 m and 100 m, increased floodplain roughness coefficients, and reduced longitudinal grades) would increase the riparian storage compared to the Alternative 1 concept, however reductions would still be anticipated along the tributaries and overall within the system compared to existing conditions, particularly for the Regional Storm event (Regional Storm would be 19% less).
- Constructing the proposed watercourse corridors per the Alternative 3 concept [i.e. increased bottom widths to between 79 m and 100 m, increased floodplain roughness coefficients, reduced longitudinal grades, and provide flatter floodplain overbank (to potentially accommodate wetlands throughout the system)] would increase the riparian storage compared to Alternatives 1 and 2, and would generally maintain or increase system-wide riparian storage as compared to existing conditions up to and including the 100 year return period, with only minor reductions in the system-wide riparian storage for the Regional Storm event (Regional Storm would be 3.9% less).

## 2.5 Conclusion

Based upon the foregoing, Alternative 3 has been advanced as the preliminary preferred alternative for the reconstructed Tributary A to maintain riparian storage and meet the Performance Specifications as generally laid out in Appendix B-1. A further review of the hydraulic model results has confirmed that the simulated water surface elevations at the upstream limits of the reconstructed watercourses would be at, or below, existing conditions, hence the reconstructed watercourse per Alternative 3 would not result in adverse hydraulic impacts (i.e. flooding) to upstream properties. A concept plan depicting the alignment and approximate extents of the reconstructed watercourse per Alternative 3 is provided in Appendix B-6.

The foregoing assessment was submitted to Conservation Halton under a Technical Memorandum (ref. Farrell/Scheckenberger-Howatt/Mayes, April 19, 2018) for review and comment. The comments subsequently issued by the Authority (ref. Howatt-Grace, May 4, 2018) noted that the Authority also concurred with the recommendation to advance Alternative 3 as the preferred alternative, and further noted that the meander belt width analyses for Tributary C (i.e. C-1, C-2, C-3, and c-4), Tributary A2 (i.e. A2-1 and A2-2), and Tributary A5-1 were supported by the Authority. Nevertheless, the comments provided by the Authority noted that additional investigations would be required as part of future Environmental Impact Reports to demonstrate that the proposed watercourse corridor would be sufficient to address other targets identified in the Subwatershed Study, and that the proposed floodplain alteration can be permitted subject to Ontario Regulation 162/06. Further, the Authority noted that the watercourse corridor designs will need to mitigate potential offsite impacts, encompass natural channel design principles, and include Regulatory setbacks in addition to other stormwater management criteria and Conservation Halton regulatory requirements. A copy of the correspondence is included in Appendix B-2.

# 3.0 Stormwater Management

## 3.1 Introduction

Following the completion of the supplemental assessment for Tributary A, as presented in Section 2 of this Addendum, Meridian Planning (Consultant retained by the Town of Halton Hills for Secondary Plan) updated the Vision Georgetown land use plan to incorporate the revisions to the watercourse and Natural Heritage System for the future land use condition. As part of this Addendum, a functional stormwater management plan has been developed for the Secondary Plan land use concept, based upon anticipated grading and drainage patterns under future land use conditions. Hydrologic analyses have been completed to assess the performance of the stormwater management infrastructure in accordance with the targets and criteria established in the Subwatershed Study (ref. AECOM, May 2017), and to refine the sizing criteria as required in order to achieve requisite stormwater quantity control. In addition, a desktop review and comparison of the sizing criteria provided in the May 2017 Subwatershed Study has been completed in order to verify that the erosion control criteria advanced in the Subwatershed Study is comparable with the recommendations advanced in similar settings, particularly within other areas of the Sixteen Mile Creek Watershed. The following summarizes the results of this analysis.

## 3.2 Stormwater Management Planning

The Secondary Plan land use concept for the Vision Georgetown Area has been provided by the Town of Halton Hills. (ref. Appendix C-1, Drawing 1).

A preliminary siting of stormwater management facilities and associated drainage areas has been completed based upon a review of the conceptual land use plan, including input from Town staff. The following criteria and approach has been applied for siting stormwater management infrastructure:

- Stormwater management facilities to be located at outlets of existing low constraint watercourses to maintain existing flow contributions to receiving watercourses.
- Drainage areas to stormwater management facilities to mimic existing drainage boundaries to the extent possible.
- Drainage boundaries to coincide with proposed roads where modifications to existing drainage boundaries are required.
- Drainage areas to stormwater management facilities to measure 5 ha as a minimum, per current Provincial standards for supporting wet end-of-pipe facilities for stormwater quality control.
- Approximate grades for watercourse corridors, established per supplementary technical analysis (ref. Section 2.0), used to guide preliminary site elevations.

The preliminary stormwater management plan, including facility locations and drainage areas, is presented in Appendix C-1 (ref. Drawing 2).

## 3.3 Hydrologic Modelling

### 3.3.1 Hydrologic Model Parameterization

The hydrologic analyses prepared by AECOM for the May 2017 Subwatershed Study adopted the PCSWMM methodology. The subject PCSWMM hydrologic model has been modified to reflect the proposed development, land uses, amended watercourse corridors, and stormwater management, per the Secondary Plan land use concept and stormwater management facility orientation developed as part of this Addendum. The drainage area and impervious coverage for the land uses in each subcatchment have been updated to reflect the proposed future condition. The soil parameterization has been retained from the parent subcatchments within the PCSWMM hydrologic model. The impervious coverage for each land use, reflecting consultation and input with Municipal staff, is presented in Table 3.3.1, and the subcatchment parameters are presented in Table 3.3.2.

**Table 3.3.1. Imperviousness Values for Future Land Use Conditions (%)**

| Land Use | Imperviousness |
|---|---|
| Cemetery | 15 |
| Community Park | 15 |
| Core Commercial Area | 90 |
| Greenlands / NHS | 5 |
| High Density Residential / Mixed Use Area | 87 |
| High Density Residential Area | 80 |
| Library / Community Centre | 75 |
| Local Commercial Area | 90 |
| Low Density Residential Area | 60 |
| Major Commercial Area | 90 |
| Major Institutional Area | 75 |
| Medium Density Residential Area | 73 |
| Mixed Use Gateway | 83 |
| Park | 15 |
| School | 75 |
| Special Study Area | 6 |
| Town Square Park | 15 |

**Table 3.3.2. Summary of Subcatchment Parameterization for Future Land Use Conditions**

| Name | Area (ha) | Width (m) | Flow Length (m) | Slope (%) | Imperv. (%) | N Imperv | N Perv | Suction Head (mm) | Conductivity (mm/hr) | Initial Deficit (frac.) |
|---|---|---|---|---|---|---|---|---|---|---|
| A-1_SWMA1 | 17.57 | 585.7 | 300.0 | 2.0 | 60.51 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| A-2_RES | 29.78 | 992.7 | 300.0 | 2.0 | 7.74 | 0.03 | 0.31 | 193.2 | 3.5 | 0.15 |
| A-2_SWMA2 | 13.39 | 743.9 | 180.0 | 2.0 | 60.08 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| A-4_SWMA4 | 35.35 | 1178.3 | 300.0 | 2.0 | 58.39 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| A-4a | 154.53 | 5151.0 | 300.0 | 2.0 | 6.15 | 0.018 | 0.2 | 175.1 | 6.5 | 0.17 |
| A-4b_SWM6 | 36.15 | 1205.0 | 300.0 | 2.0 | 66.85 | 0.018 | 0.2 | 193.2 | 3.5 | 0.15 |
| A-5_RES1 | 75.55 | 2518.3 | 300.0 | 2.0 | 15.72 | 0.03 | 0.31 | 191.3 | 4 | 0.16 |
| A-5_RES2 | 25.36 | 845.3 | 300.0 | 2.0 | 9.75 | 0.03 | 0.31 | 191.3 | 4 | 0.16 |
| A-5_SWMA5A | 29.31 | 1172.4 | 250.0 | 2.0 | 61.08 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| A-5_SWMA5B | 22.61 | 904.4 | 250.0 | 2.0 | 62.99 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| A-6_RES | 29.07 | 969.0 | 300.0 | 2.0 | 7.48 | 0.03 | 0.31 | 208.8 | 2 | 0.15 |
| A-7_SWMA7 | 10.79 | 431.6 | 250.0 | 2.0 | 71.77 | 0.018 | 0.2 | 191.3 | 4 | 0.16 |
| B-1_SWMB1 | 12.43 | 828.7 | 150.0 | 2.0 | 55.71 | 0.018 | 0.2 | 95.4 | 15.8 | 0.21 |
| B-1_Unc1 | 5.51 | 367.3 | 150.0 | 2.0 | 5.60 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| B-2_SWMB2 | 41.71 | 1390.3 | 300.0 | 2.0 | 63.44 | 0.018 | 0.2 | 104.2 | 11.9 | 0.19 |
| B-3_SWMB3 | 5.65 | 188.3 | 300.0 | 2.0 | 60.84 | 0.018 | 0.2 | 95.4 | 15.8 | 0.21 |
| C-1_SWMC1 | 12.77 | 851.3 | 150.0 | 2.0 | 50.03 | 0.018 | 0.2 | 175.4 | 8.7 | 0.18 |
| C-2_SWMC2 | 45.44 | 1514.7 | 300.0 | 2.0 | 58.18 | 0.018 | 0.2 | 175.4 | 8.7 | 0.18 |
| C-3_SWMX | 5.24 | 262.0 | 200.0 | 2.0 | 60.00 | 0.018 | 0.2 | 175.4 | 8.7 | 0.18 |
| D-1_SWMD1 | 18.27 | 730.8 | 250.0 | 2.0 | 61.63 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| E-1_SWME1 | 21.18 | 1412.0 | 150.0 | 2.0 | 73.49 | 0.018 | 0.2 | 208.8 | 2 | 0.15 |
| TribC-NHS | 9.29 | 309.7 | 300.0 | 3.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_2 | 11.23 | 1123.1 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_4 | 4.26 | 425.5 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_1 | 8.10 | 809.8 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_3 | 2.98 | 298.4 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_5 | 2.99 | 299.2 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_6 | 3.20 | 319.7 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_7 | 3.29 | 329.0 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_8 | 2.68 | 267.8 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribA-NHS_9 | 3.73 | 373.4 | 100.0 | 1.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribB-NHS_1 | 22.49 | 749.8 | 300.0 | 5.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |
| TribB-NHS_2 | 9.17 | 305.6 | 300.0 | 5.0 | 5.00 | 0.03 | 0.31 | 95.4 | 15.8 | 0.21 |

### 3.3.2 Assessment of Subwatershed Study Quantity Control Sizing Criteria

Hydrologic analyses have been completed to verify the performance of the stormwater management criteria in accordance with the targets established in the Subwatershed Study (ref. AECOM, May 2017) for stormwater quantity control. The stormwater management criteria for peak flow control, as advanced in the May 2017 Subwatershed Study, was established such that the post-development peak flow rates along the receiving watercourses would not exceed pre-development rates for the 2-year through Regional Storm design storm events. The hydrologic analyses applied the 24 hour Chicago synthetic design storm distribution, and corresponding hyetographs were developed based on the Town of Halton Hills Intensity-Duration-Frequency (IDF) standards. In addition, the Regional Storm (Hurricane Hazel) event was simulated as a discrete storm event for evaluating the impacts of the proposed future development. The unitary storage and discharge criteria for sizing stormwater management facilities, per the recommendations of the May 2017 Subwatershed Study, are summarized in Tables 3.3.3 and 3.3.4 respectively.

**Table 3.3.3. Unitary Storage Volume ($m^3$/ha) (ref. AECOM, May 2017)**

| Tributary/outlet | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr | Regional |
|---|---|---|---|---|---|---|---|
| A | 146 | 263 | 360 | 493 | 593 | 697 | 1693 |
| B | 159 | 238 | 318 | 427 | 514 | 600 | 1226 |
| C | 198 | 317 | 415 | 549 | 651 | 752 | 1676 |
| D | 373 | 538 | 665 | 836 | 956 | 1079 | 2507 |
| E | 360 | 525 | 652 | 820 | 946 | 1072 | 2498 |

**Table 3.3.4. Unitary Flow Targets ($m^3$/s/ha) (ref. AECOM, May 2017)**

| Tributary/outlet | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr | Regional |
|---|---|---|---|---|---|---|---|
| A | 0.0024 | 0.012 | 0.023 | 0.042 | 0.049 | 0.05 | 0.053 |
| B | 0.0016 | 0.0017 | 0.013 | 0.023 | 0.023 | 0.024 | 0.027 |
| C | 0.0017 | 0.004 | 0.013 | 0.03 | 0.036 | 0.037 | 0.041 |
| D | 0.0066 | 0.02 | 0.037 | 0.038 | 0.039 | 0.04 | 0.043 |
| E | 0.0035 | 0.009 | 0.009 | 0.01 | 0.01 | 0.01 | 0.011 |

The updated PCSWMM hydrologic model, representing the future development per the Secondary Plan land use concept and stormwater management plan developed as part of this Addendum, has been used to assess the performance of the stormwater management criteria advanced in the May 2017 Subwatershed Study. Consistent with the methodology applied for the Subwatershed Study, the PCSWMM model has been used to generate instantaneous 1.5 through 100 year return period peak flow rates based on synthetic design storms, as well as generating instantaneous peak flows for the Regional Storm (i.e. Hurricane Hazel) event. The simulated peak flows for existing and future controlled land use conditions are summarized in Table 3.3.5, and the percent change from existing conditions is summarized in Table 3.3.6.

**Table 3.3.5. Simulated Peak Flows for Existing and Future Controlled Land Use Conditions ($m^3/s$)**

| Reference Node | Location | Return Period (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 2 | 5 | 10 | 25 | 50 | 100 | |
| Existing Land Use Conditions | | | | | | | | | |
| 1 | | 0.27 | 0.36 | 1.64 | 2.83 | 4.50 | 6.03 | 7.56 | 12.98 |
| 2 | | 0.62 | 0.74 | 2.20 | 3.45 | 5.20 | 6.78 | 8.43 | 11.29 |
| 3 | | 0.24 | 0.29 | 0.74 | 1.14 | 1.69 | 2.20 | 2.70 | 3.67 |
| 4 | | 0.75 | 0.91 | 2.04 | 2.88 | 4.02 | 5.04 | 6.08 | 14.06 |
| 5 | | 0.93 | 1.11 | 2.44 | 3.42 | 4.79 | 6.01 | 7.27 | 16.63 |
| 6 | | 1.67 | 2.01 | 5.07 | 7.46 | 10.72 | 13.72 | 16.54 | 34.55 |
| 7 | | 1.84 | 2.20 | 5.51 | 8.05 | 11.55 | 14.72 | 17.79 | 36.58 |
| 8 | Tributary AM-4 and A4-1 Confluence | 2.25 | 2.75 | 6.99 | 10.25 | 14.66 | 18.71 | 22.63 | 45.67 |
| 9 | Tributary A Outlet | 2.30 | 2.84 | 7.16 | 10.49 | 15.02 | 19.08 | 23.17 | 46.44 |
| 10 | 10 Side Road Outlet | 0.13 | 0.15 | 0.38 | 0.57 | 0.84 | 1.08 | 1.33 | 1.51 |
| 11 | Tributary A11-1 Outlet | 0.31 | 0.37 | 0.92 | 1.39 | 2.05 | 2.64 | 3.23 | 3.43 |
| 12 | Tributary C Outlet | 0.09 | 0.11 | 0.80 | 1.50 | 2.51 | 3.44 | 4.34 | 6.58 |
| 13 | Tributary B Outlet | 0.08 | 0.09 | 0.61 | 1.44 | 2.66 | 3.82 | 4.95 | 5.90 |
| Future Land Use Conditions | | | | | | | | | |
| 1 | | 0.70 | 0.94 | 3.42 | 5.56 | 8.50 | 11.19 | 13.82 | 15.96 |
| 2 | | 1.13 | 1.33 | 3.50 | 5.79 | 9.04 | 12.03 | 14.99 | 25.03 |
| 3 | | 0.28 | 0.33 | 0.79 | 1.18 | 1.73 | 2.20 | 2.68 | 3.15 |
| 4 | | 1.40 | 1.65 | 4.13 | 6.70 | 10.35 | 13.63 | 16.88 | 28.78 |
| 5 | | 1.25 | 1.74 | 4.11 | 6.68 | 10.30 | 13.56 | 16.80 | 28.83 |
| 6 | | 1.48 | 2.04 | 4.87 | 7.75 | 11.81 | 15.45 | 18.96 | 31.49 |
| 7 | | 1.70 | 2.25 | 5.36 | 8.46 | 12.84 | 16.74 | 20.48 | 33.36 |
| 8 | Tributary AM-4 and A4-1 Confluence | 1.95 | 2.47 | 5.97 | 9.13 | 13.76 | 17.82 | 21.78 | 37.63 |
| 9 | Tributary A Outlet | 2.11 | 2.67 | 6.72 | 9.69 | 14.57 | 18.84 | 23.05 | 38.83 |
| 10 | 10 Side Road Outlet | 0.06 | 0.06 | 0.11 | 0.17 | 0.19 | 0.20 | 0.21 | 0.23 |
| 11 | Tributary A11-1 Outlet | 0.07 | 0.08 | 0.12 | 0.21 | 0.33 | 0.46 | 0.60 | 0.74 |
| 12 | Tributary C Outlet | 0.09 | 0.10 | 0.22 | 0.50 | 1.06 | 1.67 | 2.25 | 3.46 |
| 13 | Tributary B Outlet | 0.09 | 0.10 | 0.37 | 0.89 | 1.62 | 2.24 | 2.78 | 3.22 |

**Table 3.3.6. Percent Change in Simulated Peak Flows for Future Controlled Land Use Conditions Compared to Existing Land Use Conditions (%)**

| Reference Node | | Return Period (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 2 | 5 | 10 | 25 | 50 | 100 | |
| 1 | | 164.2 | 164.5 | 109.0 | 96.6 | 88.9 | 85.5 | 82.9 | 23.0 |
| 2 | | 82.6 | 80.1 | 59.2 | 67.8 | 73.7 | 77.4 | 77.8 | 121.7 |
| 3 | | 18.2 | 15.4 | 6.7 | 3.6 | 2.1 | 0.3 | -0.9 | -14.2 |
| 4 | | 86.3 | 82.0 | 102.0 | 132.5 | 157.6 | 170.7 | 177.8 | 104.7 |
| 5 | | 34.4 | 56.8 | 68.7 | 95.2 | 114.9 | 125.5 | 131.2 | 73.4 |
| 6 | | -11.5 | 1.6 | -4.0 | 3.9 | 10.2 | 12.6 | 14.6 | -8.9 |
| 7 | | -8.0 | 1.9 | -2.6 | 5.1 | 11.2 | 13.7 | 15.1 | -8.8 |
| 8 | Tributary AM-4 and A4-1 Confluence | -13.6 | -9.9 | -14.6 | -11.0 | -6.1 | -4.8 | -3.8 | -17.6 |
| 9 | Tributary A Outlet | -8.2 | -5.9 | -6.1 | -7.6 | -3.0 | -1.3 | -0.5 | -16.4 |
| 10 | 10 Side Road Outlet | -56.4 | -60.6 | -69.8 | -70.3 | -77.2 | -81.5 | -84.1 | -85.0 |
| 11 | Tributary A11-1 Outlet | -76.5 | -78.6 | -87.1 | -84.7 | -83.8 | -82.5 | -81.4 | -78.5 |
| 12 | Tributary C Outlet | -3.5 | -10.0 | -72.5 | -66.8 | -57.7 | -51.4 | -48.0 | -47.4 |
| 13 | Tributary B Outlet | 22.0 | 9.2 | -38.6 | -38.0 | -39.1 | -41.5 | -43.8 | -45.3 |

The results in Tables 3.3.5 and 3.3.6 indicate that increased peak flows would be anticipated at various locations within the Vision Georgetown area (ref. Nodes, 1, 2, 3, 4, 5, 6 and 7) under proposed controlled land use conditions with the stormwater management facilities sized per the criteria outlined in the May 2017 Subwatershed Study. The increases are noted to all lie along the reconstructed Tributary A, and are considered attributable to the changes in hydrology due to the relocation of Watercourse A2-1 and A2-2 along Trafalgar Road, as well as the location of stormwater management outfalls and proposed modifications to drainage boundaries. Nevertheless, given that these increases would be entirely within the Vision Georgetown lands, it is anticipated that the final grading adjacent to the reconstructed Tributary could be established so as to fully mitigate any potential flood risk to the adjacent future development associated with any increased water surface elevations resulting from these higher flows. Notably, there will be no off-site increases in peak flows.

The foregoing results further indicate that the peak flows at the outlets from the Vision Georgetown lands to external properties (ref. Nodes 9, 10, 11, 12, and 13) would be significantly reduced (i.e. over-controlled) under proposed land use conditions with stormwater management facilities sized per the criteria advanced in the May 2017 Subwatershed Study. This over-control is considered attributable, in part, to the methodology established in the Subwatershed Study, which applies the unitary storage criteria per hectare of development, as opposed to the more conventional approach of establishing and applying the unitary storage volume per impervious hectare. Although the results indicate that minor increases would be anticipated at Node 13 for the 1.5 year and 2 year events, it is anticipated that these increases could be mitigated through minor adjustments to the sizing criteria and associated discharge relationships.

### 3.3.3 Optimized Stormwater Management Facility Sizing Criteria

Supplemental hydrologic analyses have been completed for this Addendum to optimize the unitary storage and discharge criteria for sizing the stormwater management facilities within the Vision Georgetown Secondary Plan Area. The supplemental hydrologic analyses to establish updated unitary storage and discharge criteria have applied the PCSWMM modelling from the previous hydrologic analysis. Consistent with the previous methodology, the hydrologic analyses have applied the hyetographs for the 1.5 year through 100 year 24 hour Chicago design storms, as well as the Regional Storm (Hurricane Hazel) event. Further, minor modifications have been made to the PCSWMM models developed for the Subwatershed Study, to maintain consistency with current practices for hydrologic modelling; further details are provided below.

**UPDATED EXISTING CONDITIONS FLOWS**

The PCSWMM hydrologic model for the existing conditions has been updated to remove the hydraulic structures (i.e. culverts) at roadway crossings, consistent with conventional practice. The updated existing conditions model has been used to generate peak flows at key locations within, and proximate to, the Vision Georgetown Secondary Plan Area (ref. Drawing 2, Appendix C-1). The updated peak flows for existing land use conditions, at key locations, are presented in Table 3.3.7.

**Table 3.3.7. Simulated Peak Flows for Updated Existing Land Use Conditions ($m^3/s$)**

| Reference Node | Location | Return Period (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 2 | 5 | 10 | 25 | 50 | 100 | |
| Existing Land Use Conditions | | | | | | | | | |
| 1 | | 0.28 | 0.36 | 1.64 | 2.83 | 4.50 | 6.03 | 7.57 | 12.99 |
| 2 | | 0.63 | 0.74 | 2.20 | 3.45 | 5.20 | 6.78 | 8.43 | 11.3 |
| 3 | | 0.24 | 0.29 | 0.74 | 1.14 | 1.69 | 2.20 | 2.70 | 3.666 |
| 4 | | 0.75 | 0.91 | 2.04 | 2.87 | 4.01 | 5.02 | 6.06 | 14.05 |
| 5 | | 0.93 | 1.11 | 2.43 | 3.41 | 4.78 | 5.99 | 7.23 | 16.68 |
| 6 | | 1.64 | 1.97 | 5.03 | 7.39 | 10.64 | 13.64 | 16.51 | 34.7 |
| 7 | | 1.81 | 2.16 | 5.45 | 7.99 | 11.51 | 14.67 | 17.79 | 36.74 |
| 8 | Tributary AM-4 and A4-1 Confluence | 2.23 | 2.68 | 6.94 | 10.25 | 14.78 | 18.83 | 22.91 | 45.79 |
| 9 | Tributary A Outlet | 2.31 | 2.77 | 7.10 | 10.48 | 15.11 | 19.29 | 23.39 | 46.54 |
| 10 | 10 Side Road Outlet | 0.13 | 0.15 | 0.38 | 0.57 | 0.84 | 1.08 | 1.33 | 1.513 |
| 11 | Tributary A11-1 Outlet | 0.31 | 0.37 | 0.92 | 1.39 | 2.05 | 2.64 | 3.23 | 3.427 |
| 12 | Tributary C Outlet | 0.11 | 0.13 | 0.81 | 1.52 | 2.50 | 3.44 | 4.38 | 6.586 |
| 13 | Tributary B Outlet | 0.08 | 0.09 | 0.61 | 1.44 | 2.66 | 3.83 | 4.96 | 5.897 |

Compared with the results presented in the May 2017 Subwatershed Study for existing conditions, the results in Table 3.3.7 indicate that the updated existing conditions model, with hydraulic structures removed, produces the most significant changes in peak flows at certain locations for events smaller than 2-year return period (+19.2% to -2.6%). For the events above 2-year, the changes in peak flows at key outlets are very minor (+1.4% to -0.3%) from those report in the Subwatershed Study.

## UPDATED FUTURE CONDITIONS MODELLING AND STORMWATER MANAGEMENT CRITERIA

The PCSWMM hydrologic model representing proposed future land use conditions within the Vision Georgetown Area has been generated from the updated existing conditions model. The revisions noted in Section 3.2 (i.e. subcatchment discretization and parameterization, channel routing elements), have been incorporated into the hydrologic model. In addition, storage elements representing the stormwater management facilities within the Vision Georgetown Area (ref. Appendix C-1, Drawing 2) have been incorporated into the PCSWMM hydrologic model for future land use conditions.

The updated future conditions model has been used to establish optimized unitary storage and discharge criteria for sizing the stormwater management facilities within the Vision Georgetown Area. The unitary target flows have been established based on the results of updated existing conditions PCSWMM hydrologic model, and the proposed size of contributing drainage area to each outlet from the study area. The unitary storage criteria has been established by iteratively adjusting the sizing criteria in increments of 25 $m^3$/impervious ha until post-to-pre control has been achieved at the key outlets from the Vision Georgetown Area. (i.e. outlets for Tributary A,B,C and SWM D,E). It should be noted that the updated unitary storage criteria under this assessment have been calculated based upon the more conventional approach of providing a specified volume per impervious hectare (versus the sizing criteria of volume per development hectare as provided in the May 2017 Subwatershed Study). The updated unitary storage and discharge criteria are summarized in Tables 3.3.8 and 3.3.9, and the resulting storage-discharge relationships for the stormwater management facilities are provided in Appendix C-2.

**Table 3.3.8. Updated Unitary Storage Criteria for Vision Georgetown Area Stormwater Management Facilities ($m^3$/Impervious ha)[1.]**

| Receiving Tributary | Facility Operating Level/Condition | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr | Regional |
| A | 275 | 325 | 400 | 575 | 700 | 925 | 1300 |
| B | 300 | 400 | 475 | 575 | 650 | 675 | 1100 |
| C | 325 | 425 | 475 | 600 | 675 | 800 | 1200 |
| D | 250 | 325 | 375 | 425 | 475 | 500 | 550 |
| E | 350 | 475 | 550 | 675 | 750 | 800 | 1400 |

NOTE: [1.] Values represent cumulative storage volumes for flood control, exclusive of extended detention storage for erosion and/or stormwater quality control.

**Table 3.3.9. Updated Unitary Discharge Criteria for Vision Georgetown Area Stormwater Management Facilities ($m^3$/s/ha)[1.]**

| Receiving Tributary | Facility Operating Level/Condition | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr | Regional |
| A | 0.0053 | 0.014 | 0.020 | 0.029 | 0.037 | 0.045 | 0.089 |
| B | 0.0011 | 0.007 | 0.016 | 0.035 | 0.050 | 0.056 | 0.067 |
| C | 0.0016 | 0.010 | 0.019 | 0.031 | 0.042 | 0.053 | 0.080 |
| D | 0.0201 | 0.050 | 0.076 | 0.112 | 0.144 | 0.177 | Uncontrolled |
| E | 0.0073 | 0.018 | 0.027 | 0.040 | 0.051 | 0.063 | 0.071 |

The information in Tables 3.3.8 and 3.3.9 indicates that the stormwater management facility at Outlet D would require a significantly lower unitary storage volume compared to the balance of the stormwater management facilities within the Vision Georgetown Area. This is considered attributable to the proposed reduction in drainage area to Outlet D under the proposed storm servicing concept evaluated (i.e. 29.55 ha existing versus 18.27 ha future).

The PCSWMM hydrologic model representing future land use conditions has been updated to incorporate storage-discharge relationships for the stormwater management facilities based upon the unitary storage and discharge criteria presented in Tables 3.3.8 and 3.3.9. Consistent with the methodology applied for the Subwatershed Study, the PCSWMM model has been used to generate instantaneous 1.5 through 100 year return period peak flow rates based on the 24 hour Chicago storm distribution, , as well as for the Regional Storm (Hurricane Hazel) event. The simulated peak flows for the future controlled land use conditions with the recommended revised sizing criteria are summarized in Table 3.3.10, and the percent change from existing conditions are summarized in Table 3.3.11.

**Table 3.3.10. Simulated Peak Flows for Future Land Use Conditions with Recommended Revised Stormwater Management Sizing Criteria ($m^3/s$)**

| Reference Node | Location | Return Period (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 2 | 5 | 10 | 25 | 50 | 100 | |
| 1 | | 0.70 | 0.94 | 3.42 | 5.56 | 8.50 | 11.19 | 13.82 | 15.96 |
| 2 | | 1.13 | 1.33 | 3.50 | 5.78 | 9.04 | 12.02 | 14.99 | 25.02 |
| 3 | | 0.28 | 0.33 | 0.79 | 1.18 | 1.73 | 2.20 | 2.68 | 3.15 |
| 4 | | 1.39 | 1.66 | 4.16 | 6.71 | 10.31 | 13.57 | 16.81 | 29.09 |
| 5 | | 1.24 | 1.74 | 4.14 | 6.68 | 10.26 | 13.50 | 16.72 | 29.13 |
| 6 | | 1.60 | 2.11 | 5.12 | 7.83 | 11.86 | 15.37 | 18.77 | 33.67 |
| 7 | | 1.90 | 2.36 | 5.79 | 8.79 | 12.99 | 16.70 | 20.26 | 36.83 |
| 8 | Tributary AM-4 and A4-1 Confluence | 2.12 | 2.60 | 6.45 | 9.55 | 13.96 | 17.81 | 21.43 | 42.20 |
| 9 | Tributary A Outlet | 2.29 | 2.78 | 6.94 | 10.23 | 14.86 | 18.91 | 22.68 | 44.24 |
| 10 | 10 Side Road Outlet | 0.14 | 0.15 | 0.35 | 0.56 | 0.78 | 1.01 | 1.31 | 1.46 |
| 11 | Tributary A11-1 Outlet | 0.32 | 0.34 | 0.87 | 1.32 | 1.99 | 2.47 | 3.12 | 2.46 |
| 12 | Tributary C Outlet | 0.09 | 0.10 | 0.79 | 1.51 | 2.41 | 3.29 | 3.93 | 5.95 |
| 13 | Tributary B Outlet | 0.06 | 0.09 | 0.56 | 1.32 | 2.62 | 3.76 | 4.74 | 5.62 |

**Table 3.3.11. Percent Change in Simulated Peak Flows for Future Controlled Land Use Conditions Compared to Existing Land Use Conditions (%)**

| Reference Node | Location | Return Period (Years) | | | | | | | Regional |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 2 | 5 | 10 | 25 | 50 | 100 | |
| 1 | | 153.5 | 162.6 | 109.0 | 96.6 | 89.0 | 85.5 | 82.7 | 22.9 |
| 2 | | 79.9 | 80.0 | 59.1 | 67.7 | 73.8 | 77.3 | 77.9 | 121.4 |
| 3 | | 18.2 | 15.4 | 6.6 | 3.6 | 2.1 | 0.3 | -0.9 | -14.2 |
| 4 | | 85.8 | 83.0 | 103.8 | 133.5 | 157.2 | 170.2 | 177.5 | 107.0 |
| 5 | | 33.4 | 57.5 | 70.4 | 95.9 | 114.7 | 125.3 | 131.3 | 74.6 |
| 6 | | -2.7 | 7.2 | 1.8 | 6.0 | 11.5 | 12.7 | 13.7 | -3.0 |
| 7 | | 5.1 | 9.5 | 6.2 | 10.0 | 12.9 | 13.8 | 13.9 | 0.2 |
| 8 | Tributary AM-4 and A4-1 Confluence | -5.0 | -2.9 | -7.0 | -6.9 | -5.5 | -5.4 | -6.5 | -7.8 |
| 9 | Tributary A Outlet | -1.0 | 0.6 | -2.2 | -2.4 | -1.7 | -2.0 | -3.0 | -4.9 |
| 10 | 10 Side Road Outlet | 5.9 | -4.2 | -6.2 | -1.8 | -6.6 | -6.5 | -1.4 | -3.4 |
| 11 | Tributary A11-1 Outlet | 2.5 | -6.7 | -5.5 | -4.9 | -3.3 | -6.4 | -3.4 | -28.3 |
| 12 | Tributary C Outlet | -16.5 | -24.7 | -3.3 | -0.3 | -3.5 | -4.5 | -10.3 | -9.6 |
| 13 | Tributary B Outlet | -23.9 | -8.8 | -8.0 | -7.9 | -1.6 | -1.8 | -4.5 | -4.7 |

The results in Tables 3.3.10 and 3.3.11 indicate that the peak flows at the outlets from the Vision Georgetown lands to external properties (ref. Nodes 9, 10, 11, 12, and 13) (ref. Appendix C-1, Drawing 2) would be reduced to at, or below, pre-development levels under proposed land use conditions with stormwater management facilities sized per the revised (optimized) criteria. As such, the revised stormwater management sizing criteria would maintain post-development peak flows to pre-development levels, per the requirements of the May 2017 Subwatershed Study.

The results in Tables 3.3.10 and 3.3.11 also indicate that increased peak flows would be anticipated at various locations within the Vision Georgetown area (ref. Nodes, 1, 2, 3, 4, 5, 6 and 7) (ref. Appendix C-1, Drawing 2) under proposed controlled land use conditions with the stormwater management facilities sized per the revised criteria. As discussed earlier, the increases are all along the reconstructed Tributary A, and are considered attributable to the changes in hydrology due to the relocation of Watercourse A2-1 and A2-2 along Trafalgar Road, as well as the location of stormwater management outfalls and proposed modifications to drainage boundaries. Nevertheless, as cited earlier, given that these increases would be entirely within the Vision Georgetown lands, it is anticipated that the final grading adjacent to the reconstructed Tributary could be established so as to fully mitigate any potential flood risk to the adjacent future development within Vision Georgetown associated with any increased water surface elevations resulting from these higher flows.

### 3.3.4 Stormwater Management Facility Sizes

The revised unitary storage criteria, and the respective drainage area and imperviousness for each stormwater management facility, has been used to estimate the facility footprints. For these calculations, a maximum 2.5 m depth has been assumed for the facility to provide flood control storage for 100-year storm event, and a maximum 3.5 m depth has been assumed for the facility to provide flood control storage for the Regional Storm event. The resulting facility volumes and footprints are presented in Appendix C-3. The results indicate that the facility footprints would range from 0.39 ha to 2.46 ha for 100-year storm event and 0.47 ha to 2.49 ha for the Regional Storm event. The results also indicate that the estimated facility footprints represent between 3.6% to 10.1% of the contributing drainage area for 100-year storm event and 3.6% to 10.8% of the drainage area for the Regional Storm event. The facility footprints have assumed that 20% of the pond block would be required to accommodate maintenance access roads and a sediment decanting area.

The foregoing results have been compared with the footprints estimated for the facilities sized in accordance with the May 2017 Subwatershed Study criteria. The results of this assessment indicate that the optimized sizing criteria presented above would reduce the facility footprints by between 2.2% – and 58.8% for the 100-year storm event and would reduce the footprints by between 28.5% – and 75.2% for the Regional Storm event. Consequently, the optimized unitary storage and discharge criteria above would reduce the overall land requirements for stormwater management facilities to provide peak flow control, compared to facilities sized in accordance with the criteria advanced in the May 2017 Subwatershed Study.

### 3.3.5 Conclusion

Based upon the foregoing, it is concluded that the revised stormwater management criteria applied to the Secondary Plan conceptual land use development and stormwater management plan for the area, would provide requisite peak flow control, as the post-development peak flows would be less than pre-development peak flows at the outlets of the Vision Georgetown area for all the events up to, and including, the Regional Storm event. The revised sizing criteria would further reduce the footprints of the stormwater management facilities, compared to those required based upon the sizing criteria advanced in the May 2017 Subwatershed Study be up to 58.8 % for the 100 year event and 75.2 % for the Regional Storm event.

The foregoing assessment was submitted to Conservation Halton under a Technical Memorandum (ref. Patel/Farrell/Scheckenberger-Buonpensiero/Grace, September 6, 2018) for review and comment. The comments subsequently issued by the Authority (ref. Howatt-Grace, November 16, 2018) noted that the Authority generally concurs with the findings of the assessment, various items needed to be addressed in order for the Authority to support the updated sizing criteria, in some instances as part of future studies. Responses to the Authority's comments of November 16, 2018 were prepared December 21, 2018 and forwarded for distribution; responses were subsequently provided by Conservation Halton to the Town of Halton Hills, February 7, 2020. A copy of the November 16, 2018 correspondence from Conservation Halton and the responses are included in Appendix C-4 for reference, as well as the Authority's responses of February 7, 2020.

Based upon the responses provided by Conservation Halton (ref. February 7, 2020), it is understood that the Authority concurs that the remaining comments not addressed by this Addendum may be addressed as part of future studies. It should be noted that the Authority's response of February 7, 2020 states that the updated existing conditions peak flow rates documented as part of this Addendum are between 8% and 44% higher along Tributary A and at its outlet, as a result of the modelling updates completed for this Addendum. As indicated in Section 3.3.3, the integrated PCSWMM model developed as part of the May

2017 Subwatershed Study included hydraulic structures (i.e. bridges and culverts) in the model routing elements. As part of this Addendum, these structures have been removed from the existing conditions model, consistent with current industry practice for hydrologic modelling and analysis. The removal of these hydraulic structures has consequently removed the peak flow reduction which was accounted for in the modelling completed for the May 2017 Subwatershed Study, thus resulting in higher peak flow rates for the existing land use condition. It should also be noted that hydraulic structures were not included in the hydrologic analysis of future land use conditions completed for this Addendum.

## 3.4 Erosion Control Criteria

Erosion control criteria for stormwater management facility sizing are also provided within the May 2017 Subwatershed Study for each tributary outlet at Eighth Line (i.e. Tributary A, Tributary B, and Tributary C). The unitary sizing criteria for end-of-pipe facilities and release rates, per the May 2017 Subwatershed Study, are summarized in Table 3.4.1.

**Table 3.4.1. Recommended End-of-Pipe Erosion Control Criteria for Vision Georgetown Area (ref. AECOM, May 2017)**

| Tributary | Unitary Storage ($m^3$/ha) | Discharge |
|---|---|---|
| Tributary A | 300 | Determined to Provide 24 hour – 48 hour Drawdown |
| Tributary B | 40 | |
| Tributary C | 300 | |

The information in Table 3.4.1 indicates that the unitary storage criteria vary according to the receiving watercourse, consistent with conventional practice for establishing stormwater management criteria. The information presented in Table 3.4.1 further indicates that the unitary sizing criteria have been established in $m^3$/development hectare; as noted previously in Section 3.3.3, unitary sizing criteria are more conventionally established as a volume per impervious hectare in order reflect varying levels of impervious coverage. Furthermore, the release rates from the facilities are prescribed in the May 2017 Subwatershed Study as a drawdown time for the facility; the more conventional approach for providing release rates specifies a discharge rate per development hectare, which is based upon the critical flow rate at the erosion monitoring sites as determined from fluvial geomorphological investigations.

The erosion control criteria specified in the May 2017 Subwatershed Study have been used to determine corresponding unitary storage and discharge criteria for each receiving watercourse. The detention storage volumes within the end-of-pipe facilities have been determined based upon the unitary storage volumes prescribed in the May 2017 Subwatershed Study, and the size and impervious coverage of the contributing drainage areas per the future land use conditions PCSWMM model developed for this Addendum. Unitary discharge rates have been determined based upon the resulting extended detention storage volume, and the impervious area within the contributing drainage area per the future land use conditions PCSWMM model. Similarly, the release rates per the May 2017 Subwatershed Study criteria have been determined assuming an average drawdown time of 36 hours, and unitary discharge criteria have been determined based upon the resulting release rates and the contributing drainage area per the future land use conditions PCSWMM model. The corresponding unitary sizing criteria for storage and discharge, based upon the application of the sizing criteria advanced in the May 2017 Subwatershed Study, are presented in Table 3.4.2.

**Table 3.4.2. Unitary Storage and Discharge Criteria Corresponding to Erosion Control Criteria per AECOM, May 2017**

| Tributary | Unitary Storage ($m^3$/imp. ha) | | Discharge ($m^3$/s/ha) |
|---|---|---|---|
| | Range | Average | |
| Tributary A | 418 – 514 | 478 | 0.00463 |
| Tributary B | 63 – 72 | 67 | 0.00062 |
| Tributary C | 408 – 600 | 502 | 0.00463 |

The unitary sizing criteria presented in Table 3.4.2 have been compared with unitary erosion control criteria established for other Secondary Plan Areas within the Sixteen Mile Creek Watershed, specifically for the Premier Gateway Secondary Plan Area (ref. Amec Foster Wheeler, September 2017; Revised May 2018), the Boyne Survey Secondary Plan Area (ref. AMEC, November 2015), the Derry Green Secondary Plan Area (ref. Amec, November 2015), and the Bristol Survey Secondary Plan Area (ref. Philips Planning and Engineering Limited, January 2000). The unitary sizing criteria for erosion control within the Sixteen Mile Creek Watershed, as established per the other studies noted above, are summarized in Table 3.4.3. Recognizing that Tributary B lies within CVC jurisdiction, and is outside of the Sixteen Mile Creek Watershed, this assessment has focused on comparison of the results presented for Tributaries A and C which lie within the Sixteen Mile Creek Watershed.

**Table 3.4.3. Unitary Storage and Discharge Criteria for Erosion Control for Other Locations within Sixteen Mile Creek Watershed**

| Secondary Plan Area | Unitary Storage ($m^3$/imp. ha) | Discharge ($m^3$/s/ha) |
|---|---|---|
| Bristol Survey, Town of Milton | 430 | 0.0011 |
| Boyne Survey, Town of Milton | 375 – 430 | 0.0003 - 0.0011 |
| Derry Green, Town of Milton | 300 | 0.0011 |
| Premier Gateway, Town of Halton Hills | 250 | 0.0007 |

Compared with the information presented in Table 3.4.3, the information in Table 3.4.2 indicates that the sizing criteria presented in the May 2017 Subwatershed Study yields unitary storage volume requirements for Tributaries A and C which are comparable to those prescribed elsewhere within the Sixteen Mile Creek Watershed. The unitary sizing criteria are noted to be greater than those prescribed for the Derry Green and Premier Gateway Secondary Plan Areas, however this is considered attributable to the difference in land use conditions within the respective secondary plan areas (i.e. residential land use conditions for Vision Georgetown, versus employment land use conditions within Derry Green and Premier Gateway secondary plan areas).

The results also indicate that the unitary release rates prescribed in the May 2017 Subwatershed Study for Tributaries A and C are greater than those which have been established for other secondary plan areas within the Sixteen Mile Creek Watershed. This is considered primarily attributable to the methodologies and bases for establishing unitary discharge criteria for erosion control (i.e. drawdown time for Vision Georgetown, versus critical flow rate/fluvial geomorphologic criteria per other secondary plan areas), as well as the methodology applied to verify performance (i.e. critical velocity exceedance/erosion index

method per May 2017 Subwatershed Study versus duration critical flow exceedance/critical shear exceedance/volume exceedance of critical flow rate applied elsewhere).

Although the unitary release rates notably differ from those established as part of other studies in similar physiography, the comparable unitary sizing criteria is considered to be appropriate and suitable for developing the secondary plan. Nevertheless, recognizing the difference in unitary release rates compared to values established elsewhere within the Sixteen Mile Creek Watershed, further assessment is considered to be appropriate, as part of future studies post Secondary Plan, to verify the erosion criteria presented in the May 2017 Subwatershed Study, and refine the criteria as appropriate, as well as to assess the knickpoint regression along Tributary B as noted by Conservation Halton.

## 3.5 Requirements for Future Studies

As noted previously, comments provided by Conservation Halton for the supplemental assessment of the stormwater management sizing criteria (ref. Howatt-Grace, November 16, 2018) stated that additional analyses will be required in order for the Authority to support the sizing criteria advanced in the May 2017 Subwatershed Study, as well as the supplemental analyses for flood control. The following summarizes the additional requirements noted by the Authority:

- Assess how alternate rainfall distributions for the 1:2 year through 1:100 year storms would impact peak flows and storage targets, and provide justification for the rainfall distribution recommended for use.
- Provide additional analysis to determine the suitability of mitigating potential flood risk along Tributary A through adjacent grading, and confirm that upstream areas are not be impacted by increased water surface elevations along Tributary A; any changes to the channel geometry, in an effort to mitigate flood risk, are to be incorporated into the hydrologic model, and adjustments to the channel corridor width are to be established as required.
- Additional analysis to demonstrate that flood conveyance along watercourses and at hydraulic structures is achieved under future conditions.
- Extend PCSWMM hydrologic model to encompass lands downstream of Vision Georgetown study area (preferably to the confluence of Tributary E and Tributary A ) and assess downstream impacts to flood risk and flood hazard within SWM targets. [NOTE: The Town of Halton Hills has advised that this work is ongoing by David Schaeffer Engineering Ltd. on behalf of area landowners after meeting with Conservation Halton on July 5,2019 and CVC on July 9, 2019.]
- Confirm that the erosion targets and sizing criteria are sufficient to prevent increases to erosion along Tributary A where local peak flow increases are proposed.
- Provide additional details to support the planning of stormwater management facility footprints and include additional lands based on detailed design and grading requirements (i.e. freeboard, berming, maintenance, etc.).

The foregoing requirements are to be considered as part of future assessments being carried out post Secondary Plan process to support local development planning and design.

# 4.0 Watercourse Management for Tributary C

## 4.1 Background

During the course of the Addendum, the Town of Halton Hills was requested by a local resident to conduct a review of the constraint ranking and associated management requirements for Reaches 'C1' and 'C2' of Tributary 'C' as presented in the May 2017 Subwatershed Study. The subject watercourse reaches 'C1' and 'C2' are located toward the terminus of Tributary 'C', and immediately upstream of Eighth Line. Tributary 'C' is within the Sixteen Mile Creek watershed, conveying flows across Eighth Line. It confluences with Tributary 'A' approximately 500m downstream of Eighth Line and then crosses Side Road 10. As part of the May 2017 Subwatershed Study, Tributary 'C' was subdivided into six (6) stream reaches for the watercourse constraint ranking. The review as part of the Addendum has consisted of a multi-disciplinary assessment, consistent with the methodology applied in the May 2017 Subwatershed Study to establish the characterization and constraint rankings of the drainage features within the study area. The following summarizes the findings of these reviews, as well as the subsequent consultation and correspondence with Conservation Halton.

## 4.2 Supplemental Assessment

### 4.2.1 Water Resources

A review of the constraint ranking established in the Vision Georgetown Subwatershed Study (AECOM, May 2017) for Watercourse Reaches 'C1' and 'C2', located toward the terminus of Tributary 'C', has been completed specifically to confirm the "Low" constraint ranking for the Water Resources Criteria (i.e. "Flooding/Conveyance") of the feature. This has been conducted based upon the information provided in the May 2017 Subwatershed Study and prior experience on similar studies in Conservation Halton's jurisdiction. Technical correspondence summarizing the findings of this review is provided in Appendix D (ref. Patel/Farrell-Burke, January 10, 2019). Key findings are summarized below.

The information provided within the May 2017 Subwatershed Study indicates that the constraint rankings associated with the flooding and conveyance characteristics of the watercourse reaches have generally been based upon contributing drainage area to determine whether or not the feature would be regulated by Conservation Halton based upon the flooding hazard. This approach is noted to be consistent with conventional practice applied by Wood in other settings within Conservation Halton's jurisdiction. Drainage features with contributing drainage areas greater than 50 ha would generally be regulated by Conservation Halton based upon the flooding hazard and thus be classified as "Medium" or "High" ranking, and drainage features with contributing drainage areas less than 50 ha, would generally not be regulated by Conservation Halton and would thus be classified as a "Low" constraint.

The information provided within the May 2017 Subwatershed Study indicates that contributing drainage areas to watercourse reaches 'C1' and 'C2' would be at or near the 50 ha threshold generally applied by Conservation Halton to establish regulated features based upon flooding hazard. As such, based upon the criteria presented in the Subwatershed Study and conventional practice, the contributing drainage areas to the watercourse features would be sufficient to classify watercourse reaches 'C1' and 'C2' as "Medium" constraint for flooding and conveyance criteria.

However, recognizing that the features are located within a private residential lawn that is frequently maintained (ref. AECOM 2017, Appendix I), watercourse reaches 'C1' and 'C2' are considered to be subject to frequent disturbance as part of the routine lawn maintenance by the property owner. Furthermore, the 100m total reach length of watercourse reaches 'C1' and 'C2' is noted to be relatively small and further represents a small portion of Tributary 'C' which has been classified as a "Low" constraint watercourse,

hence is considered to provide limited benefit to the flooding and conveyance system of the Vision Georgetown Area and the contributing drainage areas to the reach.

Given the relatively small drainage area to the watercourse reaches, the frequent disruption of the feature due to lawn maintenance of the property, and the limited benefit derived from protecting the reach as an open feature for flooding and conveyance, Wood concurs with the "Low" constraint ranking for the surface water component of watercourse reaches 'C1' and 'C2', as advanced in the May 2017 Subwatershed Study for the Vision Georgetown Area.

### 4.2.2 Fluvial Geomorphology and Terrestrial

Palmer has completed a cursory fluvial geomorphological assessment of Tributary C to establish the feasibility of creating an intermittent channel to replace a segment of drainage feature classified as a headwater drainage feature (HDF). As HDFs generally have smaller catchments, their flows are of insufficient frequency, magnitude and duration to fluvially erode and deposit sediments in a way that would form a sinuous planform. A copy of the full Technical Memorandum regarding Palmer's assessment of Tributary C realignment alternatives (reaches C-1 to C-3) is provided in Appendix D. This includes descriptions of existing conditions, and realignment considerations.

Tributary C is a heavily fragmented HDF providing limited habitat connectivity upstream of 8$^{th}$ Line. The defined channels of reaches C1, C2 and C4 are separated by an undefined flow path, reach C3. The SWS classified reach C4 as "conservation". This classification of reach C4 indicates that reaches C1, C2 and C3 should also be managed as "conservation" to maintain function progressing downstream as an "open feature".

Several opportunities to enhance the fluvial geomorphological form and function of Reach C3 are worth considering.

**Reach C3**

- *New Channel Corridor (*Figure 4.1*)* – The construction of a defined environmental corridor would create a functional development setback and establish terrestrial and hydrological connectivity from C4 to C1. The length of open channel would increase from approximately 200 m to approximately 425 m. The new channel would be roughly centred along the 30 m-wide corridor. The proposed open channel corridor would establish a restoration and enhancement area of approximately 6,000 m$^2$ that would be part of the NHS.
- *Sinuous planform* – The construction of a defined channel along reach C3 would increase longitudinal habitat connectivity from C4 to C1. A more sinuous planform would increase the channel length (decrease channel gradient) and provide for improved aquatic and terrestrial habitat functions. The channel would be approximately centered along the environmental corridor, with a buffer of approximately 15 m on either side. Based on an investigation of surrogate reaches within the Sixteen Mile Creek watershed, meandering channels are not common within similarly sized headwater subwatersheds. The establishment of a 30 m environmental corridor would provide ample space for minor lateral adjustments to occur over the 100-year planning horizon.
- *Defined Channel* – Reach C3 has an identifiable general flow pattern within a cultivated agricultural field with no defined channel morphology. The construction of a low flow channel with a width:depth ration >10 and floodplain accessed during higher flow events would maintain a sustainable sediment transport regime within the new channel corridor, which would reduce

instability. As well, the minor erosive potential would be evenly distributed across a defined flood-prone area within the greater Vision Georgetown study area.

- *Enhanced Channel Habitat* – The use of Natural Channel Design (NCD) principles would reinstate natural form and function to the undefined channel, with subdued pool and riffle sequences and/or pocket wetlands to provide habitat diversity. Riparian planting would increase the shear strength of the channel banks and provide habitat benefits through increased shading, shelter and allocthonous food sources.
- *Restoration and Enhancement Plan* – A detailed plan would be developed providing for the planting of native trees, shrubs and herbaceous plants along reach C3 in place of the current agricultural field conditions. This would provide enhance terrestrial and aquatic habitat and wildlife connectivity.

**Reach C1, C2**

- *Realignment of reaches C1 and C2* – This realignment scenario is presented with an understanding of a pending Environmental Assessment along 8th Line. The relocation of reaches C1 and C2, and the culvert beneath 8th Line, would position Tributary C south of the 10512 8th Line private property, thereby creating one continuous reach from reach C4 to downstream of 8th Line. In addition, the relocation of reaches C1 and C2 would limit the continued vegetation management (mowed/maintained lawn under current conditions) along this section of the channel. This realignment scenario faces considerable constraints/challenges. For example, topography of the realignment area would require substantial cut and fill to achieve the desired channel grade. Further, vegetation removal from the coniferous woodlot along the eastern embankment of 8th Line would be required. Evaluating the feasibility of this option would require agency consultation.
- *Replacement of 8th Line Culvert* – Reach C1 currently pools at the inlet of the CSP culvert beneath 8th Line. A replacement culvert would restore connectivity by widening and constructing of a defined low flow channel along its bed to reconnect a fragmented HDF upstream of 8th Line, thereby improving hydrological connectivity and reducing backwater conditions. The replacement of the culvert would allow it to be sized to improve conveyance of flood flows beneath 8th Line, which are expected to be augmented by discharging stormwater management ponds. The feasibility of this approach should be further evaluated as part of the Class Environmental Assessment for 8th Line, currently underway for the Town.

The channel enhancement opportunities identified above would not only improve the fluvial geomorphological form and function of the lower reach of Tributary C but would also improve the ecological function of the channel corridor.

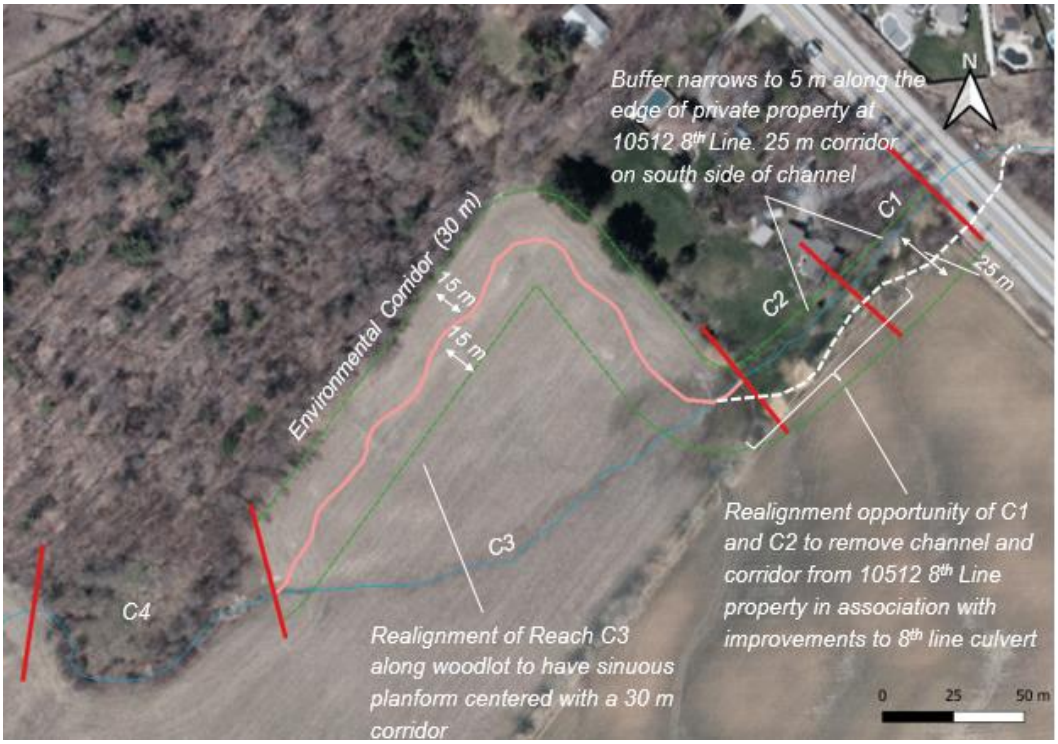


***Figure 4.1: Plan view of the proposed realignment of reach C3, centered along a 30 m-wide environmental corridor contiguous with an existing woodlot.***

## 4.3 Conclusion

The foregoing assessments were submitted to Conservation Halton as Technical Memoranda (ref. Patel/Farrell-Burke, January 10, 2019; Janas/Brierley-Burke, March 4, 2019) for review and comment, and a meeting was convened June 27, 2019 between the Town, Conservation Halton, Palmer, and Wood to discuss the findings further. The response subsequently provided by Conservation Halton (ref. Dearlove-Burke, July 23, 2019) noted that the Authority did not object to the realignment of Tributaries C-1, C-2, and C-3, however noted that the features are regulated by the Authority, hence further analysis and information is required as part of future studies to establish the required dimensions for the corridors (including buffers), as well as to determine potential impacts to flood conveyance, storage, and stream length upstream and downstream of Eighth Line. Subsequent correspondence provided by the Authority (ref. email correspondence Dearlove-Burke, September 19, 2019) elaborated that the basis for Authority's application of the regulated status to the subject features was due to several factors which contributed to the classification of the feature as a regulated watercourse. Consequently, future studies are required post Secondary Plan process, during the EIR/FSS stage, including consultation with Conservation Halton and Halton Region, regarding the management requirements of these features and design/location of the watercourse corridor, should any realignment and/or reclassification of the feature be considered as part of subsequent stages of planning and/or design.

# 5.0 Natural Heritage System

As part of the approval process for the Town's OPA 32 for the Southwest Georgetown Subwatershed Study & Vision Georgetown Secondary Plan, Halton Region has provided the Town with a number of outstanding matters to be resolved relating to the Natural Heritage System (NHS) prior to providing a Notice of Decision and approval of the Secondary Plan. In order to provide resolution to the matters raised by the Region, Palmer has provided further information and updates to the Southwest Georgetown Subwatershed Study (AECOM 2017) as part of this Addendum.

It has been agreed that many of the matters raised by the Region are to be further assessed at the EIR/FSS stage, which will provide the subsequent environmental studies required to implement the Environmental Management Strategy identified in the Subwatershed Study (SWS) and through the policies of the Secondary Plan.

In order for the outstanding matters to be appropriately addressed at the EIR/FSS stage, the following sections of the Addendum provide an itemized approach to provide clarity, confirmation and further information in order to complete an Addendum that is acceptable to the Region for completion of the Notice of Decision and approval of the Secondary Plan.

## 5.1 NHS Boundary Verification

Section 7.4.2.2 of the SWS provides direction on the NHS boundary verification where it is stated that at the EIR/FSS stage, some refinement of the Core Area and NHS delineation will be required. In many areas of the NHS it is anticipated that the refinement with respect to the limits of the key features will be minimal based on the extent of field verification and characterization completed as part of the subwatershed study; this also takes into account some feature staking that has been completed (e.g., some parts of Block D). However, it is recognized that through the concerns and matters raised by Halton Region, there are a number of specific areas and components of the NHS (e.g., buffer limits, enhancement area, local linkage) that will require further analysis and detailed information. This will include both the EIR/FSS and development plans that identify proposed land uses and residential densities. Figure 7.3.1 has therefore been revised to recognize that the proposed limits of the SWGNHS will be subject to final confirmation at the EIR/FSS stage. Further to what is stated in the SWS (and discussed in Section 5.2), additional refinements relating to the proposed Block D woodland management and enhancement plan will be required. The limits of any proposed Black Locust removal will be subject to a further detailed assessment and areas of reforestation will require confirmation in consultation with the agencies.

## 5.2 Black Locust Woodland

The Black Locust Woodland is part of the broader Block D significant woodland associated with the Silver Creek tributary. As discussed in the SWS including in Sections 5.7.1, 5.7.2 and 6.3.3.6, Black Locust is a highly invasive tree that once established can result in impacts to biological communities particularly where there is a level of existing disturbance. The lands on which the Black Locust woodland occurs are disturbed as a result of the former wayside aggregate pit use. With the past removal of topsoil (and loss of organic and nutrient rich upper horizon of soil), the nutrient poor conditions are favourable to the current dominance of Black Locust trees. In addition to the nutrient poor site conditions, the allelopathic effect of Black Locust likely contributes to preventing the regeneration of other tree species, including native species such as Sugar Maple. The expected ecological succession of a young woodland to a mid-age woodland with typical changes in tree species composition has been impeded in this area as is evident by the limited natural regeneration of native trees and shrubs. Based on this assessment, the SWS originally recommended the removal and management of Black Locust trees as part of a Block D Woodland Management and Enhancement Plan as detailed in Section 7.4.2.1 of the SWS.

In addition, the management of Black Locust within the Secondary Plan area is critical to prevent the spread and increased representation of this aggressively invasive species in the NHS including the buffers. At particular risk is the Block A proposed riparian flood storage area along Tributary A. It is anticipated that following the proposed reconstruction of this area, the site conditions will be ideal for Black Locust to become established and dominant. These considerations are based on ecosystem management practices found in the literature. The management of the Black Locust tree is recognized by the Ontario Invasive Plant Council and Environment and Climate Change Canada, which jointly published a comprehensive Best Management Practices (BMPs) for the effective control of this species and is a reference that informed the SWS for the management of the Black Locust in the Block D woodland (http://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/06/Black_Locust_BMP.pdf).

Section 5.7.2 of the SWS provided an evaluation of the Black Locust cultural woodland features and functions and includes comparison of features and functions of the native woodland area of Block D. A detailed analysis of the approach taken and rationale for the proposed removal and management of Black Locust trees is also provided in Section 5.7.2. This includes issues relating to the invasiveness of the tree, biological effects on other species (allelopathy) and effects on and threats to ecosystems and the Block D forest and buffers.

Section 7.4.2.1 of the SWS provided the objectives for the proposed removal of approximately 2.47 ha of Black Locust trees. This included the proposed future implementation of a comprehensive management and reforestation plan that will not result in long-term negative effects, impacts, or loss of the significant woodland features and functions of Block D. It is proposed that at the EIR/FSS stage, the following additional analysis and studies for Black Locust management will be required:

- Confirm the boundary limit of Black Locust tree removal along the west side of Unit 16a.
- Confirm the total restoration area and planting densities in the reforestation areas.
- Confirm the boundary limits of the proposed reforestation areas as shown on Figure 6.3.3.
- Develop a detailed reforestation plan in consultation with the agencies that includes the planned timing and schedule for Black Locust tree removal and reforestation planting.
- Develop an adaptive management and monitoring plan.

The invasiveness of a tree can be a consideration in delineating woodlands and excluding treed areas from woodlands and there are Provincial and Regional natural heritage planning policy examples. The Oak Ridge Moraine Conservation Plan (ORMCP) allows for the exclusion of European Buckthorn (*Rhamnus cathartica*) or Norway Maple (*Acer platanoides*) from woodlands where these species may threaten good forestry practice and environmental management (ORMCP Technical Paper #7). The York Region Official Plan (April 2019) recognizes circumstances where the ecological functions of a woodland are compromised due to prior land uses (a comparable example being the previous wayside pit that currently supports Black Locust in the Vision Georgetown Secondary Plan). In such cases it can be difficult to restore and manage invasive species dominated woodlands into native woodlands as described in Section 5.7.2 of SWS. The York Region OP gives consideration to the removal of woodlands based on compromised ecological function as demonstrated through an EIS that considers whether: the woodland is regenerating with a dominant proportion of invasive woody species; the area was not treed approximately 20 to 25 year ago; soils may be degraded (e.g., compacted, the top soil removed); and, there is limited ability to maintain or restore self-sustaining ecological function typical of native woodland. These are all comparable factors to the Black Locust woodland within the Secondary Plan area.

Section 277 of the Halton Region Official Plan sets out criteria for determining whether a woodland is significant[1]. The criteria are currently silent on invasive species. To that end, the Region has not approved the proposed removal of the Black Locust woodland and the related management and reforestation plan as set out in the SWS based on the Regional Official Plan policy framework. Given the foregoing, the Black Locust Woodland has been identified as a Special Study Area as part of the Regional modifications to the Vision Georgetown Secondary Plan. The Special Study Area stipulates that:

The policies of the NHS as they relate to woodlands in the Regional Official Plan shall apply to these lands until they are reassessed and re-designated pending:

a) The outcome of the Regional Official Plan review that will assess and update the policies and definitions for Woodland and Significant Woodland; and
b) The completion of an EIR that provides a detailed assessment of the Black Locust woodland ecological functions in accordance with relevant Provincial and Regional policies. Based on the detailed assessment the EIR shall delineate the portion of the Study Area that is to be included in the Natural Heritage System. Lands that are not integrated into the NHS may develop in accordance with the adjacent Low Density and Medium Density Residential Area designations.

The final determination of land use within the Special Study Area is to be completed in accordance with the above policies and through a Planning Act application without requiring a subsequent Regional Official Plan Amendment or Local Official Plan Amendment.

## 5.3 Block C-D Linkage

Palmer has utilized the Sustainable Halton Report 3.02 throughout the SWS report, including as part of the identification of the Enhancement Areas and Ecological Linkages. Specific to Enhancement Areas (EA), Section 6.3.3.7 includes the identification of the functions for wildlife movement through the linkage area and merging of woodlands for the creation of a Core Area (i.e., proposed restoration of local linkage, EA-6 providing connection of Block C and D to create a 26 ha contiguous woodland) through the proposed enhancements. This analysis references and implements the Enhancement Criteria provided in the Report 3.02 as presented in Table 6.3.1 of the SWS. Through this assessment, the guidance and criteria of the Report 3.02 have been relied upon in the SWS assessment and identification of enhancement areas.

The Enhancement Areas (EA) identified in the SWS are lands that contribute to the NHS by providing supporting functions and opportunities for protecting, restoring, connecting and improving the natural heritage features of the NHS. The SWS has identified six main EAs (EA-1 to EA-6) as described in Section 4.12.3 for inclusion as part of the proposed NHS to provide supporting functions to the key features (illustrated on Figure 4.12.1). The management objectives for improving the natural heritage value of the EAs to support the NHS are outlined in Section 6.3.3.3 of the SWS.

The Region's Sustainable Halton Report 3.02 provides the following five criteria for defining and identifying core area enhancements:

- achieving a minimum threshold size of core area;
- grouping natural heritage areas that are likely to have important inter-dependent ecological functions;

[1] The criteria are age; patch size of the woodland; size of the interior core area; and proximity to a major creek or certain headwater creek. A woodland is considered to be significant if it meets one or more of the criteria as determined through a Watershed Plan, Subwatershed Study or site specific Environmental Impact Assessment.

- reducing the amount of edge of a core area by including embayments within cores;
- increasing the proportion of "interior" conditions (as defined by a 100 m buffer) within cores areas; and,
- including catchments critical to the quantity and quality of water sustaining cores areas.

These criteria have been used as the basis for determining EAs, which is described in Section 6.3.3.7 of the SWS, with the approach for the identification of Enhancement Areas provided in Table 6.3.1. This table outlines the application of the criteria provided in Report 3.02 for the assessment and the approach for the identification of EA and management objectives. The SWS assessment includes a detailed review of the historic to current conditions of the linkage between Block C-D, which has been evaluated as part of the proposed feature refinements and proposed EA (end of Section 6.3.3.7).

With respect to EA-6 between Block C and D, the SWS does provide for the creation of a woodland Core Area (i.e., greater than 20 ha). The increased width in the linkage between Block C and D will result in the creation of a core area woodland of 26 ha in size by functionally combining two woodlands.

Further to the assessment of the Block C-D linkage provided in the SWS, Halton Region is seeking the creation of a linkage in this area that provides a high degree of confidence that the existing functions and connectivity are preserved and enhanced in the context of the future conditions of urban development. Palmer met with Halton Region's ecologist to discuss unresolved issues relating to the Block C-D linkage to identify an agreed line satisfying the respective objectives for the limit of a local linkage and an enhancement area between Block C-D to be included in the NHS. It was agreed that the intent of the linkage and enhancement is to provide for Blocks C and D to function ecologically as one core woodland area. The proposed limit of Enhancement Area (EA) – 6 has therefore been revised as illustrated on the updated Figure 7.3.1.

## 5.4 Key Features

### 5.4.1 Wetlands

Section 4.9.4.1 of the SWS describes the wetlands and locations within the NHS that are considered for potential significance as well as the related local, regional and provincial context and policies for the identification of significance. Consistent with ROPA Section 115.3(1), Section 4.12.1 identifies the components of the NHS for the study area, which includes significant wetlands. Section 4.12.2 discusses the key features and other components of each of the study Block areas. This section of the SWS should recognize that key features found in Block A, Block C and Block D include significant wetlands, as defined in Town's and Region's policies. Specifically, this includes the riparian meadow marsh along Tributary A in Block A, the swamp community in the linkage area between Block C and D, and the riparian swamp along Tributary B in Block D. These are key features that qualify as significant wetlands. The purpose of this Addendum is to confirm and correct this oversight.

The significant wetlands within these Blocks are identified further in Section 5.7.1 as part of the Impact Analysis and Management Requirements. For Block A, Block C and Block D, the SWS identifies which wetlands have been identified as significant based on their associated features and functions (e.g., size, riparian and water attenuation functions). The features and functions are discussed in this section as these are the elements that need to be recognized as part of the management strategy and identification of mitigation measures. Those wetland units identified on Figure 4.9.1 that qualify as significant per the Town's and Region's policies are included on Figure 4.12.1 within the identified Core Area layer of the NHS (i.e., identified on Figure 7.3.1 and Figure 6.3.3 as wetland community in the legend and provided

with a minimum 25 m buffer for NHS wetlands < 2.0 ha and a 30 m buffer for wetlands > 2.0 ha and/or Provincially Significant, the latter in accordance with Conservation Authority Regulations).

Where the locations of the significant wetlands are in proximity to proposed development (i.e., riparian wetland along Tributary A and swamp in linkage between Block C and D), and the wetland limits and associated buffers will influence development boundaries, the wetlands shall be staked and surveyed as part of the EIR/FSS. The riparian wetland along the lower reach of Tributary B is well removed from areas of proposed development and will not require staking.

It is identified in the SWS that due to the small size of the individual wetland units within the study area, small total area of wetland and lack of rare species that are directly supported by the wetland units, an assessment following the *Ontario Wetland Evaluation System* is not recommended. The majority of the wetlands are located within the NHS, while other isolated wetlands have been identified in the SWS as having low ecological function (and will be replicated through restoration within the NHS enhancement area) and are well below the 2.0 ha minimum size typically required to be part of an evaluation. The Town in consultation with the agencies may consider the need to conduct wetland evaluations at the EIR/FSS stage to assess wetlands in accordance with the OWES under specific circumstances.

### 5.4.2 Woodlands

As a supplement to the SWS and for consistency with the vegetation community units identified as part of significant woodlands in Sections 5.7.1 and 7.4.2.3, the associated vegetation community and key feature figures in the SWS have been updated (Appendix E) to show that the Black Locust Unit 16b is part of the Block D woodland. Figure 4.9.1, Figure 4.12.1 and Figure 6.3.3 have therefore been updated to illustrate this unit as part of the significant woodland.

### 5.4.3 Significant Wildlife Habitat

In Ontario, the Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation. During migration, a variety of habitats are used, including forest edges, and early successional clearings (http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Eastern%20Wood-pewee_2013_e.pdf).

During the breeding season, the Wood Thrush is found in moist, deciduous hardwood or mixed stands, often previously disturbed (e.g., small-scale logging and ice storm damage), with a dense deciduous undergrowth and with tall trees for singing perches (Gauthier and Aubry 1995; Friesen et al. 1999; Holmes and Sherry 2001; Friesen 2007; Evans et al. 2011; Suarez-Rubio et al. 2011).

The representation of forest Special Concern bird species in the study area is indicative of functional habitat values of a small to mid-sized woodland in a near urban landscape. Enhancement and management is required to maintain the breeding bird community. Section 5.7.3 of the SWS provides a listing of the specific forest vegetation communities based on the Ecological Land Classification Unit numbers shown on Figure 4.9.1. For Eastern Wood Pewee the forest communities within each Block that have been identified as candidate Significant Wildlife Habitat (SWH)_include: Unit 13 in Block B; Units 6a and 7 in Block C; and, Units 11, 12a, 12b, 1b, 8a, 8c, 17a, 17b, 19 in Block D. For Wood Thrush the identified candidate SWH forest communities include: Units 6b, 6c, and 22 in Block A; and, Unit 13 in Block B.

Section 6.3.3.6 of the SWS recommends improving forest interior habitat function through forest management and enhancements that include reforestation to reduce edge habitat and provide specific benefits to a Special Concern species identified from Block D, Eastern Wood Pewee, as well as provide greater overall habitat opportunities for area-sensitive species.

It is recommended that at the EIR/FSS stage, additional assessments be completed to confirm that ELC communities in Blocks B, C, and D qualify as SWH for Special Concern species specific to Eastern Wood Pewee and Wood Thrush.

## 5.5 Buffers

The variable buffer approach provided in the SWS takes into consideration the natural heritage features and functions to be protected, buffer function, the proposed adjacent land uses, as well as enhancement and mitigation opportunities. ROPA 38 does not prescribe buffer widths outside of the Greenbelt Plan area. Table 7.4.1 of the SWS provides an assessment of the buffer functions identified in Report 3.02 and the proposed enhancements in the SWS for the variable buffer approach to provide the necessary functions. The proposed variable buffer framework is presented in Table 7.4.2, which details for each Block Area the proposed buffers based on feature, function, site condition of buffer lands, land use scenario and respective non-enhanced or enhanced buffer width.

Halton Region has not approved the buffer framework provided in the SWS. The proposed buffer refinement approach described in Section 4.12.5 and 7.4.2.3, illustrated on Figure 4.12.1 and 7.3.1, and the associated buffer ranges provided in Table 7.4.2, are therefore to be considered an initial assessment. Figure 7.3.1 identifies that the illustrated buffers are preliminary and subject to the policies of the Vision Georgetown Secondary Plan. This will allow for the final buffer width to be in accordance with the policy direction set out in the Secondary Plan. The framework that has been provided will require further detailed information on the eventual specific land uses proposed adjacent to the NHS. The final buffer width is to be in accordance with the policy direction set out in the Secondary plan and will be determined through EIR/FSS at the development stage when more detailed site conditions, grading and engineering plans are available to determine the final proposed land uses and potential impacts on the NHS in order to confirm the final buffer widths.

## 5.6 Other Matters

### 5.6.1 Permitted Uses in NHS

Any uses in the NHS must be consistent with the policies of ROPA 38 and the Secondary Plan. These exceptions would be subject to detailed study, would likely have various conditions, and may include:

- Development or land disturbances for required flood and stream bank erosion control and protection of fish, wildlife, and conservation management;
- Infrastructure (such as road or pedestrian crossings) and utility access and crossings; and,
- Public pedestrian trails.

The EIR/FSS would address the placement of such facilities in these areas to ensure that they are compatible with NHS Area management and subject to agency consultation.

Under Section 117.1(9), subject to other polices of ROPA 38, permitted uses in the Regional Natural Heritage System include "*essential* transportation and *utility* facilities".

Under Section 233 the definition for essential "*means that which is deemed necessary to the public interest after all alternatives have been considered*".

The definition of "utility" under Section 228 outlines a number of infrastructure services including water supply, storm water or wastewater system among other works or systems necessary to the public interest.

The land use planning options and the functional servicing requirements within the study have identified the need for an infrastructure connection between Block C and D as illustrated on Figure 7.3.1 of the SWS. To facilitate this is a proposed 10 m wide easement located along the existing open connection (farm lane) between the adjoining agricultural fields

Halton Region has identified concerns regarding permitted uses in the NHS relating to infrastructure/utility access and crossings, and SWM facilities as discussed in Section 7.3.1 of the SWS. The Region has indicated that with respect to infrastructure and crossing (specifically the identified utility across the Block C-D linkage), only critical/essential infrastructure may be permitted. With respect to SWM facilities, such development would not be permitted, contrary to what is stated in Section 7.6.4 of the SWS. Section 6.3.5.4 of the SWS correctly identifies that SWM facilities are not to be located within the NHS. The Region has identified that SWM facilities themselves would not be permitted in the NHS; whereas ancillary pipes, outlets, headwalls, and other infrastructure that is essential to facilitate the conveyance of stormwater from such facilities to receiving bodies could be permitted subject to the findings of the EIR/FSS.

Any proposed minor grading into buffer areas would need to be addressed at the EIR/FSS in consultation with the agencies.

Respectfully submitted,

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# Appendix A

# Conservation Halton and Halton Region Correspondence

# Appendix B

# Tributary A Planning and Hydraulic Analysis

# Appendix C

# Stormwater Management Hydrologic and Hydraulic Analysis

# Appendix D

# Constraint Rankings for Tributary C

# Appendix E

# Terrestrial Ecology and Natural Heritage System