Prepared for:

The City of Guelph

Stormwater Management Master Plan

Appendix N: Geomorphic System Assessment Technical Memorandum – Field Investigations

Prepared by:

Aquafor Beech Ltd.

Guelph, Ontario
55 Regal Road
Guelph, ON, N1K 1B6
T. 519-224-3740 ex 236

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1.0 Introduction

Aquafor Beech has been retained by the City of Guelph to update the 2012 Stormwater Master Plan (SWM-MP). As part of this update, Aquafor is completing an assessment of the watercourse and river conditions within the City of Guelph limits, which included assessing the existing conditions of the stream reaches and conducting Rapid Geomorphic Assessments to classify channel stability based on evidence in the field. The information collected will help inform potential long-term and sustainable restoration approaches and the final prioritization of erosion sites.

2.0 Study Area

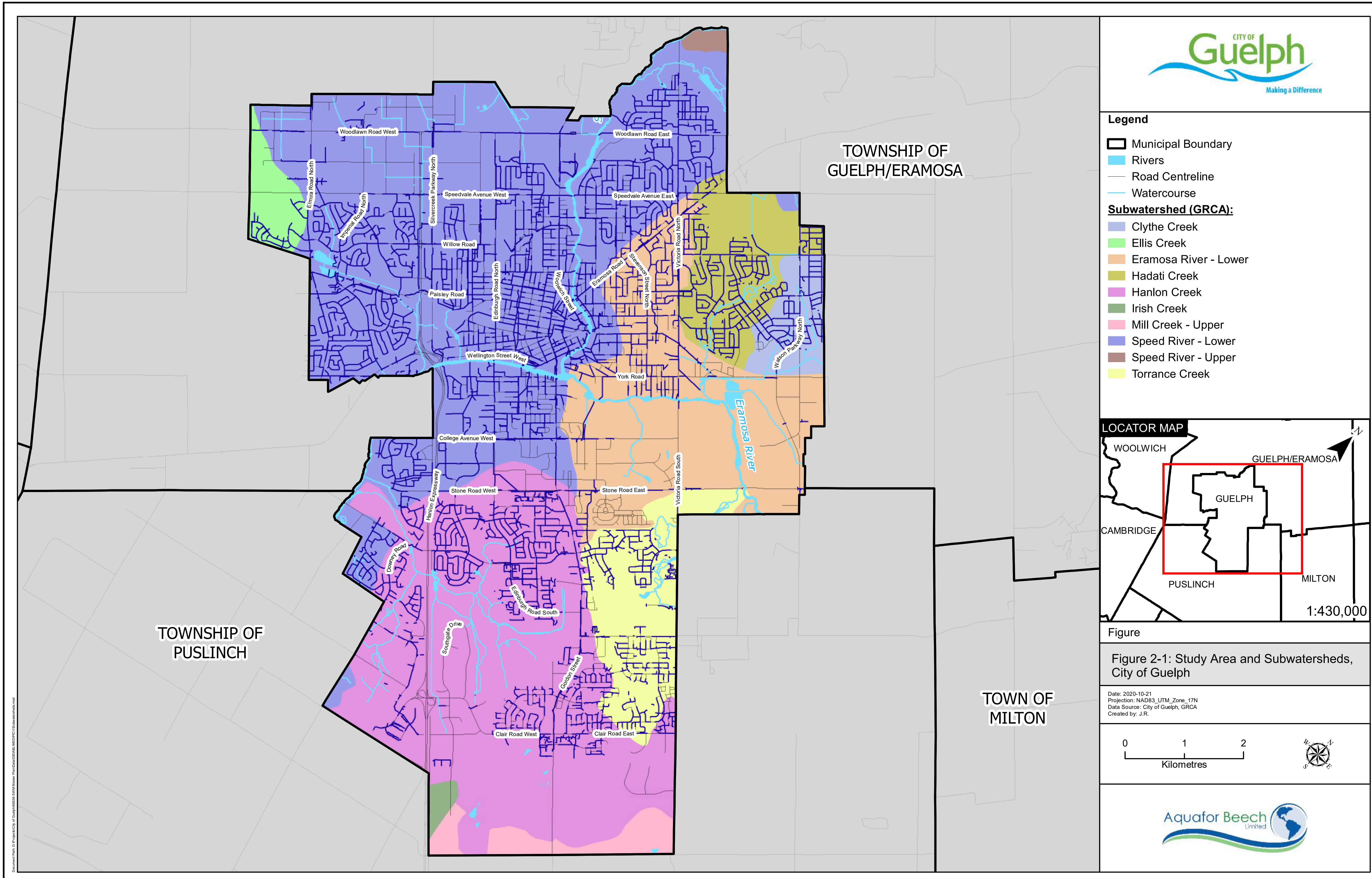
After review of background data provided by the City, Aquafor identified approximately 90km of stream systems that extend through 7 distinct sub-watersheds and catchment areas, all of which ultimately all drain into the Speed River watershed **(Figure 2-1)**. The City of Guelph has a current population of approximately 141,000, adding more than 26,000 since 2006, and has been experience considerable growth during the last decade. Associated with increased development and urbanization are both direct and indirect factors of human activity on stream geomorphology. Direct impacts include changes of channel form, alignment, bank and bed materials; as well as in-stream structures including weirs, culverts, and dams. Indirect impacts relate primarily to changes in catchment land use which significantly influences the pathways and rates of water and sediment routing through the drainage networks.

2.1 Surface Geology

Situated within a post-glacial geologic setting in southern Ontario, the surface geology of the study area is dominated by glacial sediments of variable texture, thickness and depositional origin (**Figure 2-2**).

More specifically, the glacial landforms (i.e. the topographic features) influence the stream longitudinal profiles (and slopes/energy gradients) and the degree of valley confinement (i.e., how deep are the valleys cut into the landscape). Further, the available glacial deposits supply sediments to the streams, influencing the texture and grain size distribution of the channel banks and bed materials. Collectively, these characteristics of the glacial surface geology play an important role in dictating the morphology and processes of the stream systems, representing the geologic template upon which the watercourses have evolved over millennia.

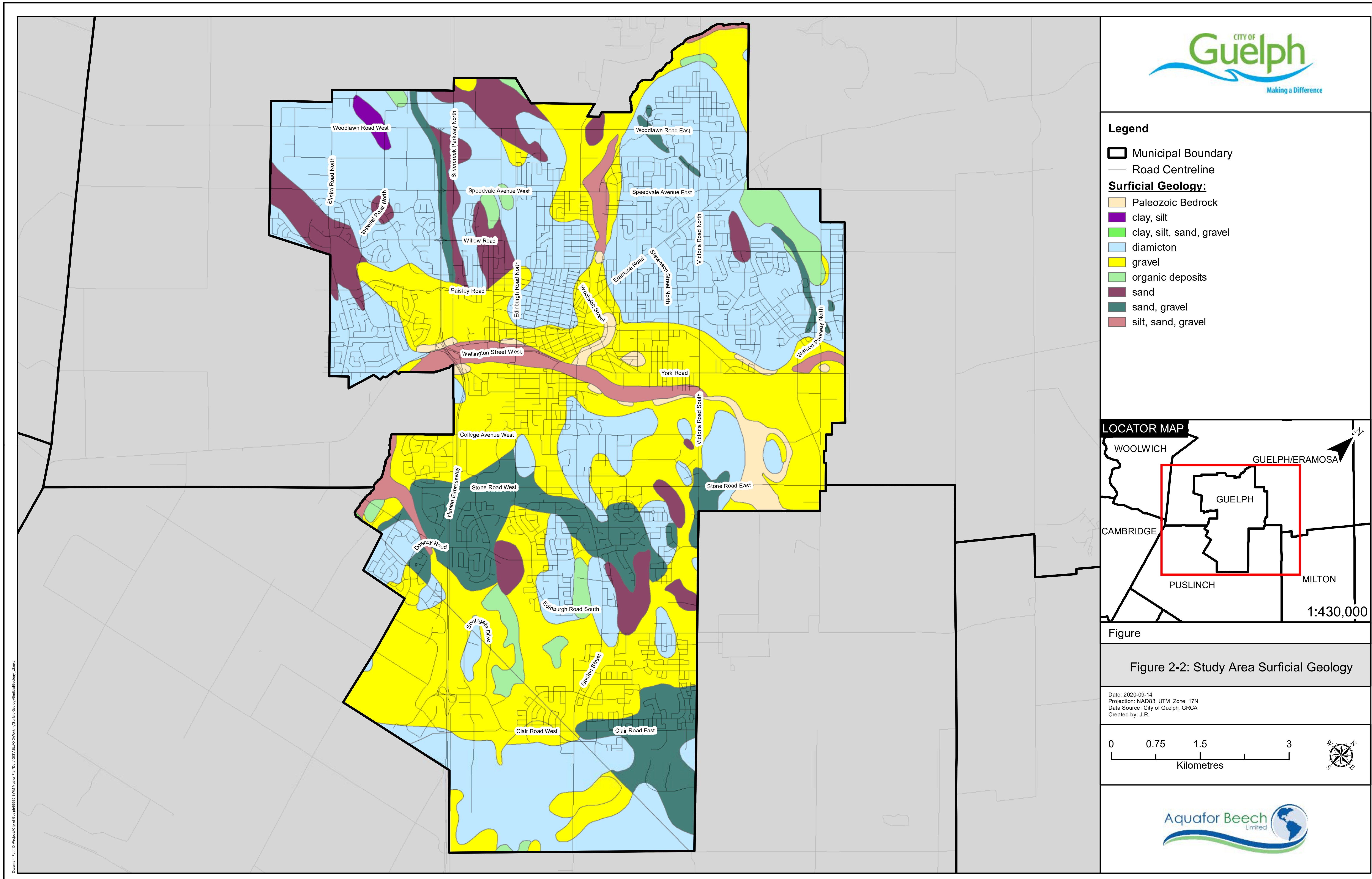
The surface geology characteristics (texture and stratigraphy) also strongly control the surface runoff patterns and hydrogeological connections between the catchments and the streams, with infiltration rates and hydraulic conductivity driving patterns and rates of groundwater and surface water flow. For example, the natural drainage density of streams within sandy deposits is lower (due to higher infiltration rates) as compared to clay-rich surface sediments that limit infiltration and increase runoff.



Figure

Figure 2-1: Study Area and Subwatersheds, City of Guelph

Date: 2020-10-21
Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: J.R.



Figure

Figure 2-2: Study Area Surficial Geology

Date: 2020-09-14
Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: J.R.

2.2 Drainage Networks and Stream Reaches

The stream drainage networks within the City of Guelph are centered around the Lower Speed River which has a drainage area of over 60km^2, 45% of which lie within the city boundaries. Within this subwatershed, there are multiple small streams and un-named channels that drain directly into the Speed River. The second-largest watershed within the City limits, the Hanlon Creek system also drains directly into the Speed River. The other smaller subwatersheds, which include Hadati Creek, Clythe Creek, and Torrance Creek, all first drain into the Eramosa River which ultimately merges with the Speed River and ultimately with the Grand River in Cambridge. Areas to the south and east of these watersheds drain towards the Mill Creek subwatershed basin and are conveyed southwest to rejoin the Grand River downstream of the confluence with the Speed. The Mill Creek subwatershed was not included in this study as no significant channelized tributaries of this catchment lie within the City of Guelph boundary.

Stream reaches were identified and reclassified as part of the 2012 SWM-MP. These reaches and sub-reaches represent convenient watercourse management units that are typically divided by road crossings, pedestrian bridges, or other infrastructure markers within the drainage network (e.g. major outfalls). While these stream reach boundaries often correspond with geomorphically significant changes in channel conditions, these management units are not perfectly consistent with stream morphology reaches and thus may or may not encompass reach-based variations in natural processes.

3.0 Geomorphic Assessment Methods

To complete the geomorphic assessment for watercourses within the City of Guelph, all creeks identified during the background review (as identified in **Figure 2-1**) were walked and visually assessed over the period of June-September 2020. Of the estimated 90km of watercourses measured from the City's GIS mapping database, about 75km was walked continuously. The balance of the watercourses were assessed by walking in and out from road crossings, using satellite imagery, were not accessible due to private property restrictions, or were not visually located in the field as per the referenced mapping information.

3.1 Geomorphic Stream Reaches

Geomorphic stream reaches are relatively uniform lengths of channel in terms of hydrology, slope, boundary materials, and vegetation that control dominant geomorphic processes and sediment transport dynamics. In other words, the physical channel processes and resulting stream morphology are relatively consistent over the length of the reach as compared to the differences between adjacent reaches. While in practice this requires that reaches be discretely divided by "reach breaks", in reality reach breaks may be abrupt or may transition gradually depending on changes in the controlling variables. For example, a sudden change in channel slope may cause an abrupt change in channel processes and thus represent a distinct reach break. In contrast, a gradual change in the boundary materials (increasing sand supply for example) would result in a gradual change in channel processes and the mapped reach break would only approximate the location of this transition.

Reach mapping was provided by the City as a convenient framework of management reaches and sub-reaches. The 2012 SWM-MP prepared by AMEC, had reclassified the stream reaches utilizing topographic mapping, air photos, geologic maps, and field observations. These 2012 stream reaches were used as a base-map when conducting the current geomorphic assessment, however they did not always correspond with representative geomorphic stream reaches as interpreted in the field. The reach delineations were updated by Aquafor to better represent geomorphically significant changes in channel conditions.

Re-evaluation of the reach divisions (i.e. where one reach ends and another begins) were assessed on similarity of channel type, surficial material, degree of channelization and hydraulic conditions. To that end, Reach SR-I1 (**Figure 3-1**) was piped beneath the Wellington St overpass. The new reach break has been adjusted to reflect only the daylighted segment of that reach.

At some point since the digitization of the open-source GIS data and 2012 SWM-MP prepared by AMEC, the Reach TC-1 has been diverted to the south of Stone Rd E. (**Figure 3-2**). This may actually reflect an earlier watercourse alignment since the replacement of the derelict bridge to the south of the new one. No culverts are obvious at the base of the road bank to allow for the previous planform geomorphology.

Reach HAC-1 no longer has a standing body of water before its confluence with the Speed River (**Figure 3-3**). The remnants of an earlier weir structure that has since failed is evident. Consequently, the reach now drains directly southwest instead of its previous alignment due south to join the Speed.

Reach HAC-D-B1 looks to have been realigned to the perimeter of a field that shows evidence of recent agricultural use. The pond that once existed in the field has a failed weir structure and no longer retains a standing body of water through the summer months. The current channel is straight and has foot crossings at 2 locations along a trail at the northern perimeter (**Figure 3-4**).

The reach break that separates Reach SR-O1 and Reach SR-O2 was previously located within the low-lying wetland east of Victoria Rd (**Figure 3-5**). Detailed field investigations assessed the flow characteristics, channel morphology and bank and substrate material to show that the section of Reach SR-O1 that was east of Victoria was identical to those conditions in Reach SR-O2. The Reach SR-O1 shows poor channelization, similar to that of Reach SR-O2. The muddy bed material, gradient and ground cover are also identical in these two reaches east of Victoria. West of Victoria Rd however, the channel shows moderate channelization, a slightly steeper gradient and some pebbles and sand in the substrate. The channel banks, while not very large (20 to 40 cm) have sandy segments and grassy vegetation in a loam rich cover. For this reason the reach break has been moved to the Victoria Rd culvert, and separates the more channelized Reach SR-O1 (**Figure 3-6**) from the wetland Reach SR-O2 east of Victoria Rd (**Figure 3-7**).

A summary of these reach delineation refinements is presented below with reference to their respective figure:

- Reach SR-I1 delineation (**Figure 3-1**) was shortened.
- Reach TC-1 delineation (**Figure 3-2**) was moved.
- Reach HAC-1 delineation (**Figure 3-3**) joins with the Speed River further upstream.
- Reach HAC-D-B1 delineation (**Figure 3-4**) was straightened and moved.
- Reach SR-O1 delineation (**Figure 3-5, Figure 3-6**) was shortened.
- Reach SR-O2 delineation (**Figure 3-5, Figure 3-7**) was lengthened.

Figure 3-1: The assessed Reach SR-I1 (dark blue) begins at the Wellington St overpass where it emerges from a culvert (red).

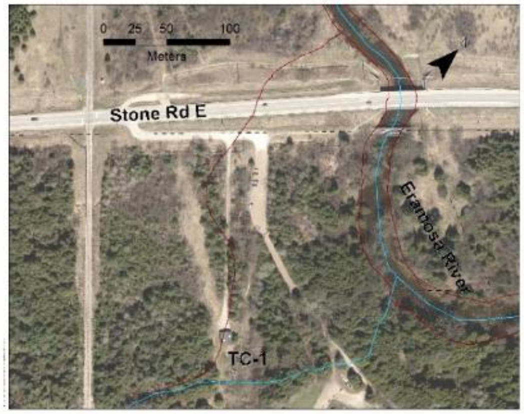


Figure 3-2: Reach TC-1 has been diverted from the north side of the Stone Road bridge (red) to the bend south of Stone Road E (light blue).

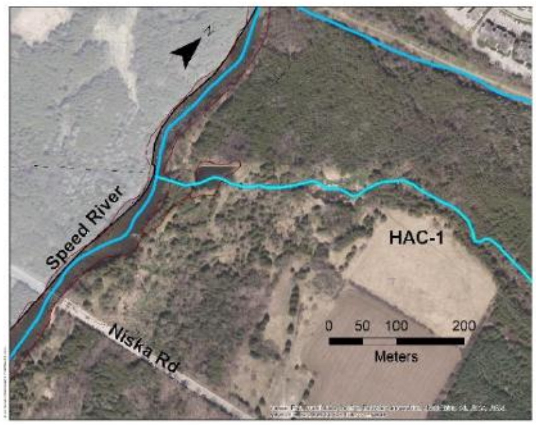


Figure 3-3: The wetland and channel that diverts south on Reach HAC-1 (red) has adjusted to join the Speed River to the west (bright blue).

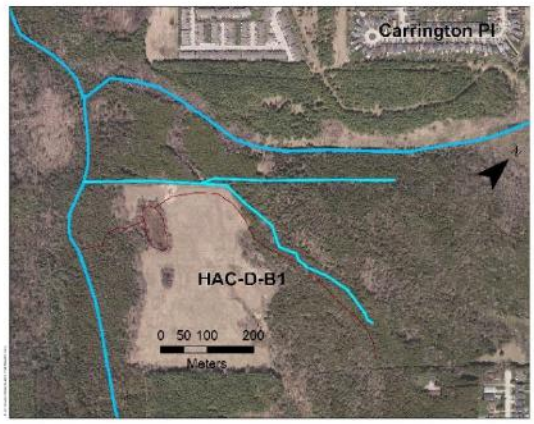


Figure 3-4: Reach HAC -D-B1 is no longer a meandering ditch and SWM pond (red). Now it is a well-defined channel and drains directly west (bright blue).

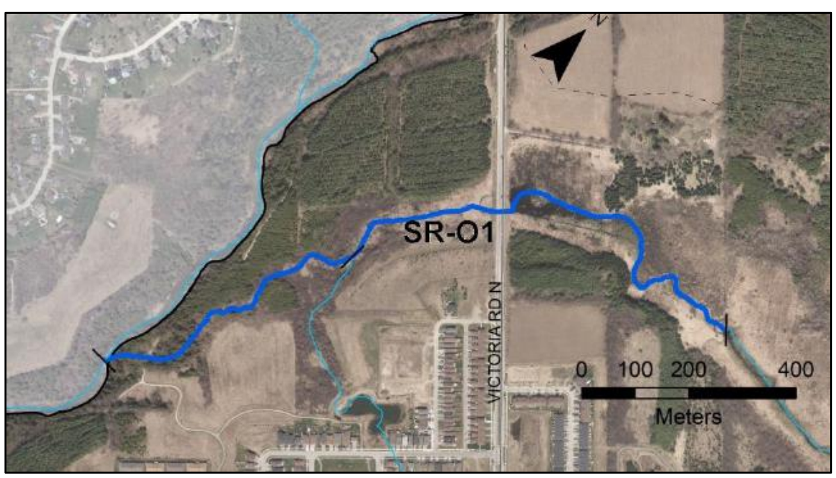


Figure 3-5: The previous delineation of Reach SR-O1 from the wetland east of Victoria Road to the Speed River.

Figure 3-6: The new delineation of Reach SR-O1 at Victoria Rd.

Figure 3-7: Reach SR-O2 now includes all wetland east of Victoria Rd.

3.2 Rapid Geomorphic Assessments

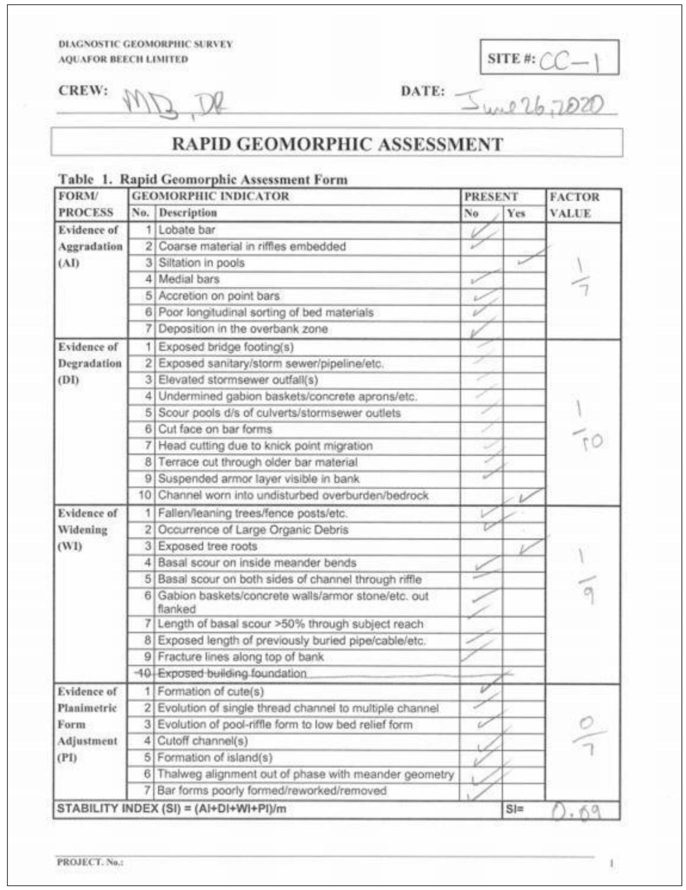
As a tool to help evaluate the existing geomorphic conditions within the channel, Rapid Geomorphic Assessments (RGA) (MOE, 2003) were completed for relevant reaches. The RGA method was completed at a geomorphic reach basis that often involved lumping previously identified management reaches. Further the RGA method is most appropriate for systems with natural or semi-natural alluvial boundaries that are capable of adjusting to flow changes in water and sediment. Therefore, engineered channels that have been completely stabilized (e.g., concrete or gabion basket channels) were not evaluated with an RGA, as this method does not apply.

In wetland areas or SWM facilities where the flow is not channelized, the RGA tool is not appropriate nor able to evaluate the geomorphic erosion indices of that reach. In these instances the RGA will not apply either. Where reaches contain wetland, SWM facilities or segments of concrete/gabion basket lined banks and a RGA score is presented in the results, the scoring will only apply to the unlined, channelized segments of that reach.

The RGA protocol uses a series of visual indicators to determine whether the stream is stable or in adjustment based on a percentage score. The stability of the channel is assessed by adjustments in slope and elevation, either an increase elevation due to sediment deposition or a decrease in elevation due to bed erosion (i.e., aggradation and degradation, respectively). Evidence of increases in bank-to-bank channel width (i.e., widening) and changes in the planform regime (planimetric form adjustment) are also part of the RGA method. **Figure 3-88** shows an example of how the RGA was completed in the field, and how the stability index was calculated. The standard approach adopted for the Guelph erosion inventory was to exclude indicators representing specific features not contained in the reach. For example, the “exposed bridge footings” indicator would be left blank and not included in the factor scoring if no bridges were contained within the reach. **Table 3-1** summarizes the stability classifications associated with the RGA stability index scores and detailed RGA results are provided in **Appendix A**.

Table 3-1: Rapid Geomorphic Assessment Descriptions Based on Stability Index Value

Stability Index Value	Stability Class	Description
0 – 0.2	Stable/ In Regime	Channel morphology is within the expected range of variance for stable channels of similar type. Channels are in good condition with minor adjustments that do not impact the function of the watercourse.
0.21 – 0.40	Transitional	Channel morphology is within the expected range of variance but with evidence of stress. Significant transition has occurred and additional erosion indicators may occur.
0.41 – 1.0	In Adjustment	Metrics are outside of the expected range of variance for channels of similar type. Significant channel adjustments have occurred and are expected to continue under current conditions.



DIAGNOSTIC GEOMORPHIC SURVEY
AQUAFOR BEECH LIMITED

SITE #: CC–1

CREW: MD, DR DATE: June 26, 2020

RAPID GEOMORPHIC ASSESSMENT

Table 1. Rapid Geomorphic Assessment Form

FORM/ PROCESS	No.	Description	PRESENT No	PRESENT Yes	FACTOR VALUE
Evidence of Aggradation (AI)	1	Lobate bar	✓		1/7
	2	Coarse material in riffles embedded	✓		
	3	Siltation in pools		✓	
	4	Medial bars	✓		
	5	Accretion on point bars	✓		
	6	Poor longitudinal sorting of bed materials	✓		
	7	Deposition in the overbank zone	✓		
Evidence of Degradation (DI)	1	Exposed bridge footing(s)	✓		1/10
	2	Exposed sanitary/storm sewer/pipeline/etc.	✓		
	3	Elevated stormsewer outfall(s)	✓		
	4	Undermined gabion baskets/concrete aprons/etc.	✓		
	5	Scour pools d/s of culverts/stormsewer outlets	✓		
	6	Cut face on bar forms	✓		
	7	Head cutting due to knick point migration	✓		
	8	Terrace cut through older bar material	✓		
	9	Suspended armor layer visible in bank	✓		
	10	Channel worn into undisturbed overburden/bedrock		✓	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	✓		1/9
	2	Occurrence of Large Organic Debris	✓		
	3	Exposed tree roots		✓	
	4	Basal scour on inside meander bends	✓		
	5	Basal scour on both sides of channel through riffle	✓		
	6	Gabion baskets/concrete walls/armor stone/etc. out flanked	✓		
	7	Length of basal scour >50% through subject reach	✓		
	8	Exposed length of previously buried pipe/cable/etc.	✓		
	9	Fracture lines along top of bank	✓		
	~~10~~	~~Exposed building foundation~~			
Evidence of Planimetric Form Adjustment (PI)	1	Formation of cute(s)	✓		0/7
	2	Evolution of single thread channel to multiple channel	✓		
	3	Evolution of pool-riffle form to low bed relief form	✓		
	4	Cutoff channel(s)	✓		
	5	Formation of island(s)	✓		
	6	Thalweg alignment out of phase with meander geometry	✓		
	7	Bar forms poorly formed/reworked/removed	✓		
STABILITY INDEX (SI) = (AI+DI+WI+PI)/m				SI=	0.09

PROJECT. No.:

1

Figure 3-8: Example of RGA Completed for Clythe Creek

4.0 Geomorphic Assessment Results

During the field walks, the geomorphology of each watercourse was analyzed to characterize the stream system within the erosion assessment. Erosion is a natural process and natural streams and rivers should be considered dynamic allowing for gradual and long-term channel adjustments that may occasionally include more dramatic changes due to high magnitude flood events.

Sediment aggradation and degradation are processes that create and maintain geomorphic features within a river. However, changes within a watershed (such as deforestation or urbanization) can create an unbalance within these processes resulting in erosion that is unnatural, or unhealthy for the system. Therefore, completing a geomorphic assessment is important in order to identify the natural processes and areas of excessive erosion or sedimentation.

A summary of the representative geomorphic reaches within each of the watercourses is presented in **Appendix A**. For each system, a sub-catchment map is included to show the geographic location and the approximate watershed boundary. The summary presents a general description of the existing channel conditions regarding channel migration, riparian cover and aquatic habitat. Average channel dimensions and RGA scores are included where relevant. A representative photograph of each reach is provided.

The RGA score does not provide a measure of the risk to property, infrastructure, and public safety. Thus, alone, the RGA score is not a means of prioritizing channel restoration works. Rather, as a measure of channel stability, RGA scores can be used as both a predictor and a proxy for locations where erosion-related risks occur.

Of the 101 assessed reaches, 67 were found to be in regime, 11 reaches were in transition, 2 reaches were in adjustment and the RGA tool did not apply to 21 of the study reaches. **Figure 4-1** shows the distribution of the RGA results by catchment basin. It is notable that the only catchments to have reaches in adjustment were Hanlon Creek and immediate tributaries to the Speed River.

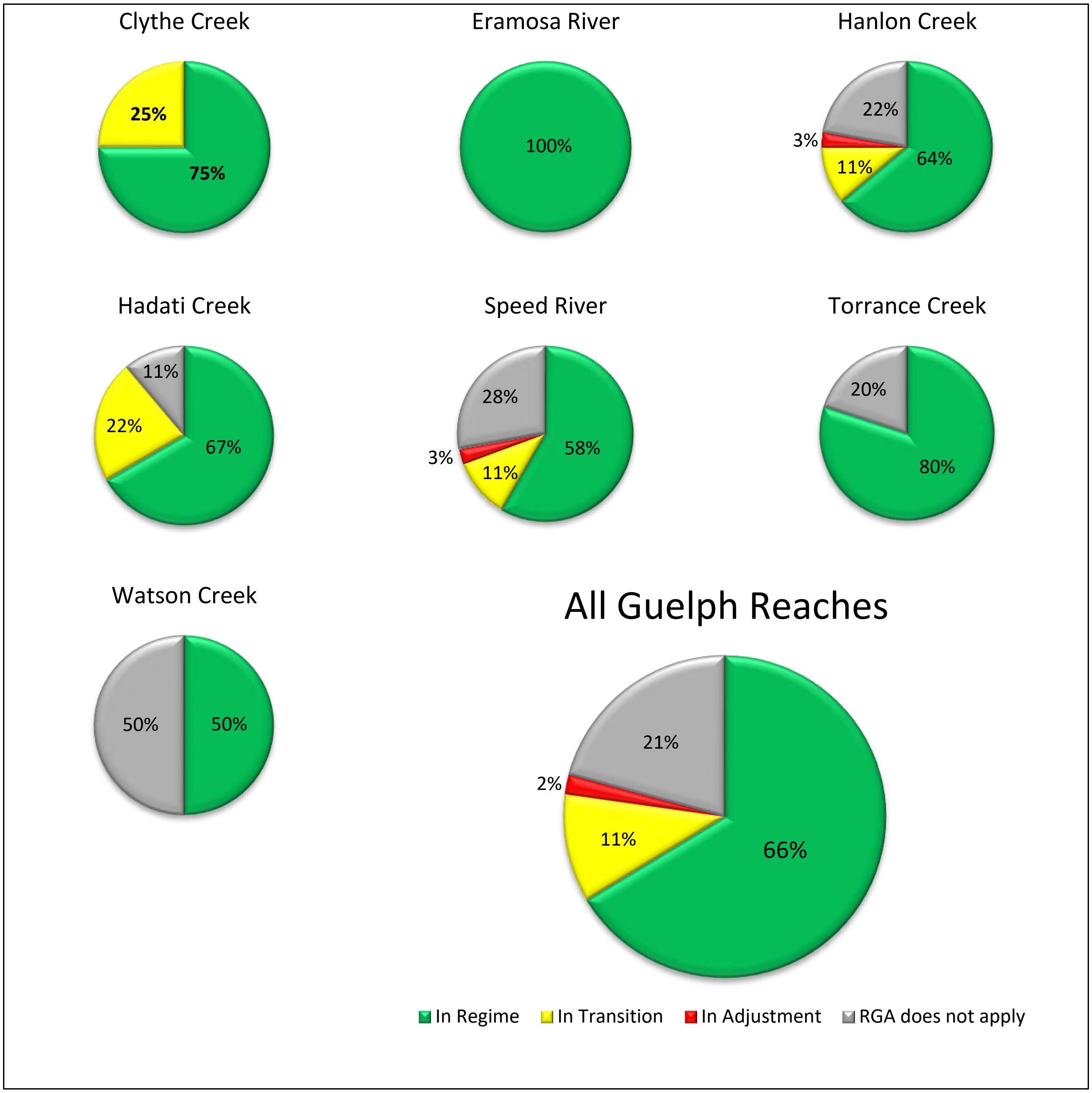


Figure 4-1: Distribution of RGA Stability Classifications by Catchment

5.0 Conclusions, Recommendations and next steps

This technical memo presents the results of the 2020 field-walks and erosion site inventory completed for the City of Guelph in order to assess the existing conditions of the stream reaches. The technical field scoring methodology for stability regime in this study will be used in mapping both erosion risks and the environmental opportunities of potential stream restoration sites. The field scoring is intended to inform a first-order classification of the overall stability of both tributaries and individual reaches.

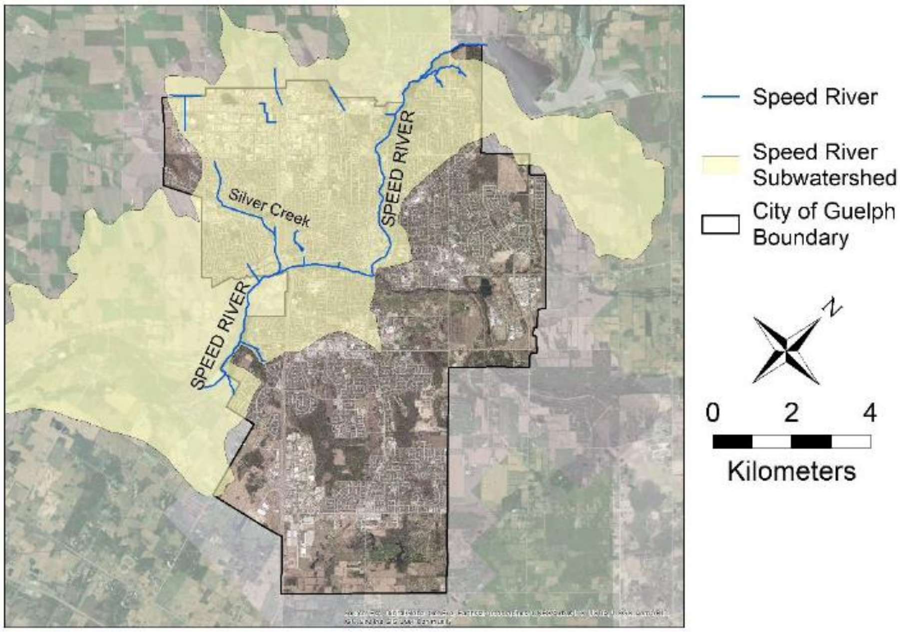
In subsequent tasks of the SWM-MP, this stability regime assessment will be used to rank the system-wide project prioritization and implementation plan for the overall health of watercourses within the City of Guelph. Aquafor will work with City staff to identify other criteria and project opportunities to refine the erosion site priority list and develop and implementation plan that groups the sites into general planning time horizons (e.g., 1 to 5 years, 5 to 10 years, 10 to 15 years, etc.) with some flexibility to select future projects as existing conditions change and/or new opportunities arise within the City's broader public mandate. Higher RGA scores, which indicate less geomorphic stability, may indicate that several smaller isolated erosion sites would be better served if they were incorporated into a larger, reach-wide approach, and reveal more efficient, and therefore better, restoration opportunities.

This assessment, along with the previous work in infrastructure and erosion site identification, will be used to complete Task 3.3 of the Stormwater Management Master Plan, the Prioritization of Erosion Sites. The next deliverable of a prioritization and implementation will also consider broader City interests, priorities, and initiatives under official plans and polices, and across City departments (e.g., stormwater, transportation and roads, parks and recreation). Once these top 30 sites have been ranked and identified, Task 3.4 will begin. Task 3.4 will identify restoration alternatives and produce conceptual designs for the preferred options.

6.0 REFERENCES

Ontario Ministry of the Environment, MOE (2003). Stormwater Management Planning and Design Manual.

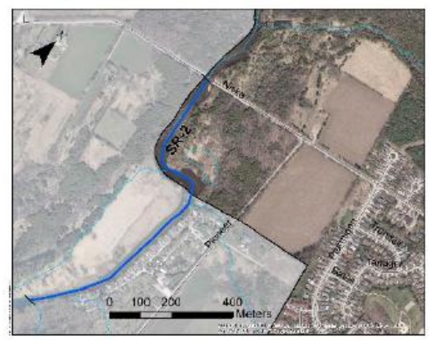
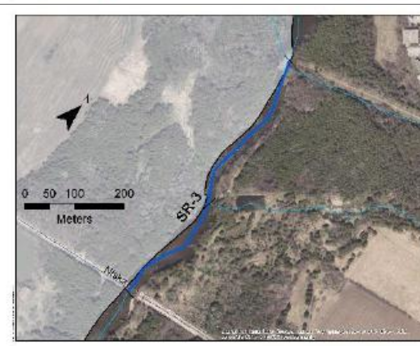
Appendix A

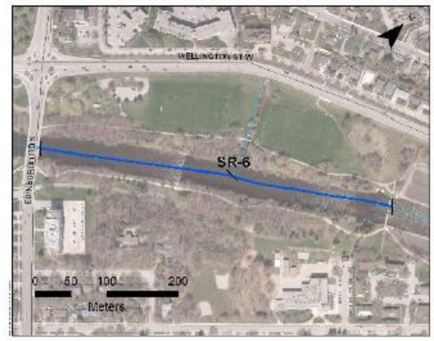
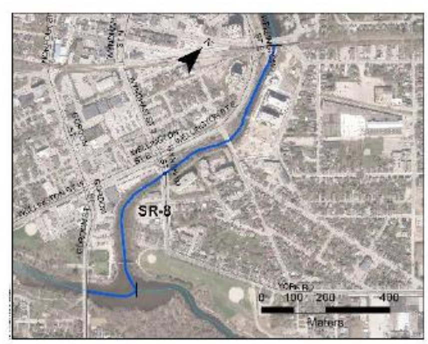


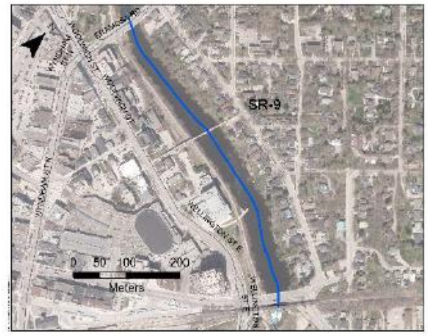
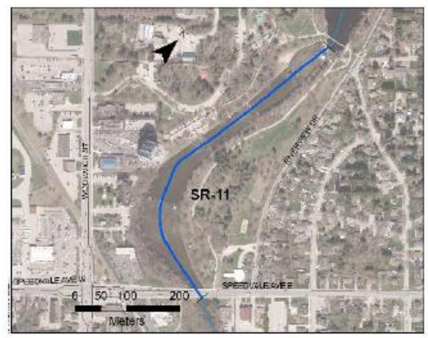
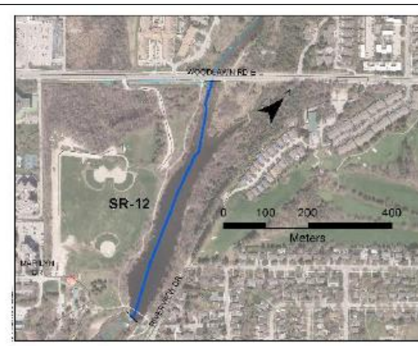
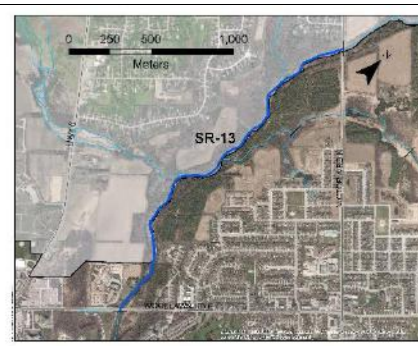
Speed River

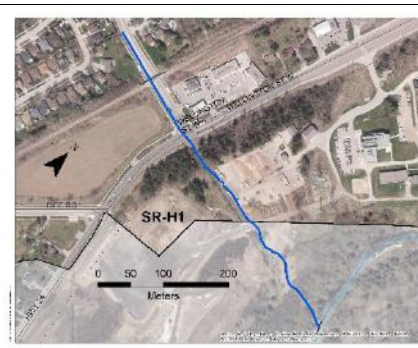
Area of Subwatershed: 110 km^2

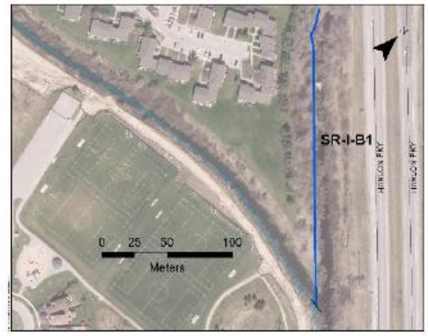
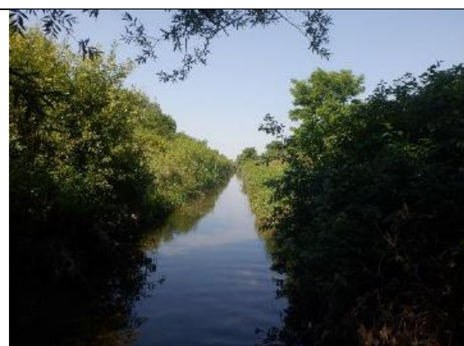
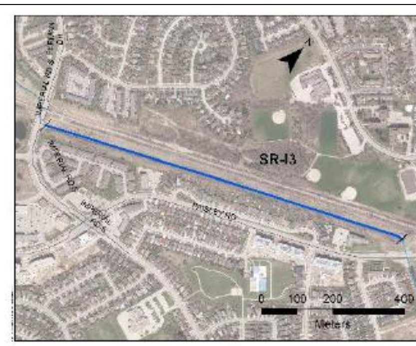
Length of Stream Assessed: 28,689 m

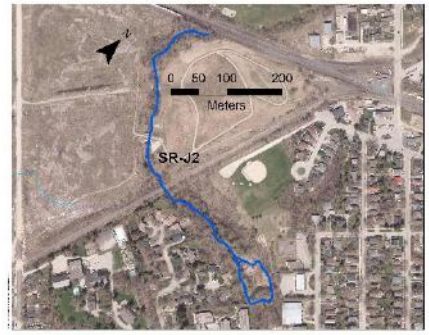
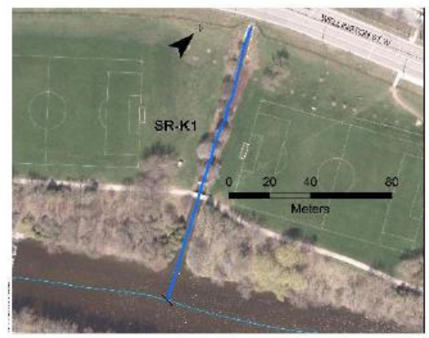
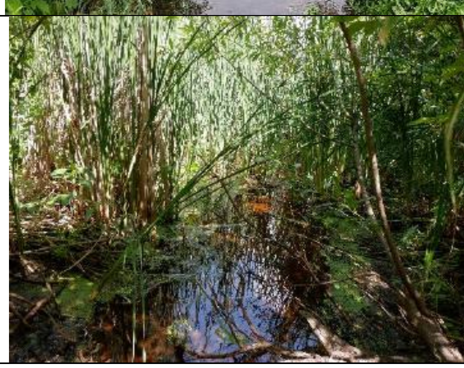
Reach ID	Summary	Representative Photograph	Key Map
SR-2	Natural alluvial meandering channel, with bed material ranging from sand to cobbles and boulders found in riffles. Good riparian cover and high-quality aquatic habitat. <u>RGA Results</u> SI – 0.06 (In Regime)		
SR-3	Natural alluvial channel, with bed material ranging from sand to cobbles and boulders found in riffles. Good riparian cover and high-quality aquatic habitat. <u>RGA Results</u> SI – 0.06 (In Regime)		
SR-4	Natural alluvial channel, with bed material ranging from sand to cobbles and boulders found in riffles. Good riparian cover and high-quality aquatic habitat. At upstream limit there is a quarry on the right bank and the municipal water treatment plant on the left. <u>RGA Results</u> SI – 0.10 (In Regime)		

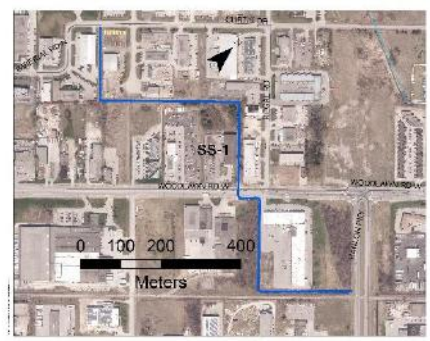
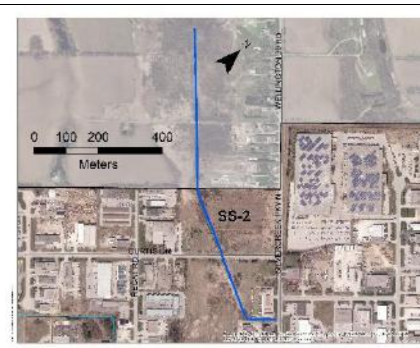
	Dominant Process: Aggradation		
SR-5	Urbanized channel with bed material ranging from coarse sand to cobbles. Multiple concrete weir structures throughout the reach. Good to moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.16 (In Regime) Dominant Process: Aggradation		
SR-6	Urbanized channel with bed material ranging from coarse sand to cobbles. Concrete weir structures throughout the reach with Wellington Street Dam at upstream reach limit. Good to moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.05 (In Regime) Dominant Process: Degradation		
SR-7	Urbanized channel with concrete retaining walls on left and right bank of reach and Wellington Street Dam at downstream reach limit. Fair riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.06 (In Regime)		
SR-8	Urbanized channel with bed material ranging from silt and sand to boulder and bedrock. Part of the reach has concrete retaining walls on right bank. Macdonell street dam is at upstream reach limit and Eramosa River confluence at downstream reach limit. Moderate to good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.20 (In Transition) Dominant Process: Degradation		

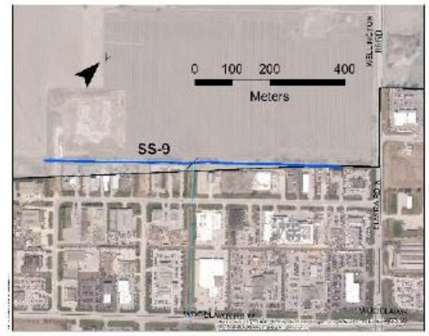
SR-9	Urbanized channel with Macdonell street dam at downstream reach limit. Moderate to good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.22 (In Transition) Dominant Process: Degradation		
SR-10	Natural channel with bed material ranging from sand to cobbles. There is a concrete weir structure near downstream end of reach. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.27 (In Transition) Dominant Process: Aggradation		
SR-11	Urbanized channel with concrete retaining walls and weir structures throughout reach. Dam structure at upstream reach limit. Bed material ranges from sand to boulders. Poor riparian cover, with weir structures acting as fish barriers. <u>RGA Results</u> SI – 0.11 (In Regime) Dominant Process: Degradation		
SR-12	Partially urbanized channel with concrete retaining walls and dam at downstream reach limit. Moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.16 (In Regime) Dominant Process: Aggradation and Widening		
SR-13	Natural alluvial channel with bed material ranging from sand to boulders. Good riparian cover and aquatic habitat <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Aggradation		

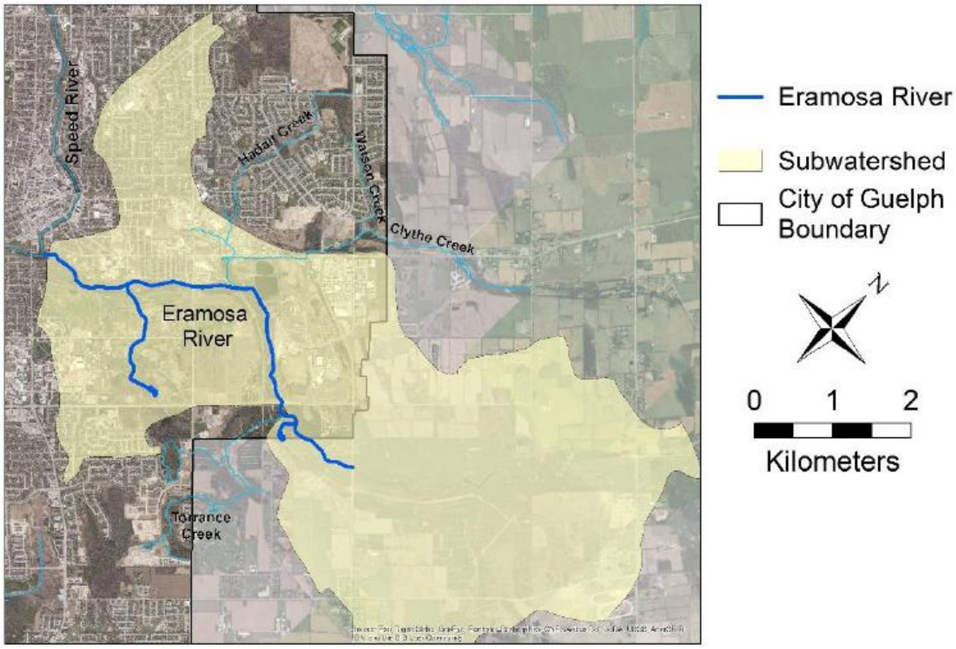
SR-14	Natural alluvial channel with bed material ranging from sand to boulders. Good riparian cover and aquatic habitat. Guelph lake resides at the upstream limit of this reach. <u>RGA Results</u> SI – 0.13 (In Regime) Dominant Process: Aggradation		
SR-E1	Small channel that outlets from SWMF by Pheasant Run Drive. <u>RGA Results</u> Not Assessed		
SR-F1	Channel with bed material ranging from sand to cobbles and boulders. Good riparian cover and moderate to poor aquatic habitat. Upstream end of reach is a concrete stormwater outfall. <u>RGA Results</u> SI – 0.24 (In Transition) Dominant Process: Widening		
SR-F2	Channel with bed material ranging from sand to cobbles and boulders. Good riparian cover and moderate aquatic habitat. Upstream end of reach is a large stormwater outfall, reach empties into Speed River <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening		
SR-H1	Concrete lined channel. Moderate riparian cover, poor aquatic habitat. Upstream end of reach is piped. <u>RGA Results</u> RGA does not apply		

SR-I-B1	Concrete lined channel with layer of sediment (predominately sand and silt) atop; concrete bottom not visible. Moderate riparian cover and poor aquatic habitat. <u>RGA Results</u> RGA does not apply		
SR-I1	Majority of channel is piped. Downstream end of reach is concrete lined with constructed riffle pool morphology and sediment bed. Banks are covered in dense shrubbery. Downstream end of reach empties into Speed River. <u>RGA Results</u> RGA does not apply		
SR-I2	Channel has concrete bottom that is not visible due to thick layer of sediment (predominantly sand and silt). Banks are covered in dense shrubbery; garbage was seen throughout channel. Moderate Riparian cover, poor aquatic habitat. <u>RGA Results</u> RGA does not apply		
SR-I3	Concrete lined channel, some portions of reach have a buildup of silt/sand atop the concrete. Poor riparian cover and aquatic habitat. <u>RGA Results</u> RGA does not apply		
SR-I4	Concrete lined channel with weir structures throughout. Little to no riparian cover and poor aquatic habitat. Watercourse becomes piped at upstream end of reach. <u>RGA Results</u> RGA does not apply		

SR-J1	Small channel off of the Speed River that travels underneath Wellington Street West. Bed Material ranges from silt to cobbles. Concrete retaining walls are in poor condition. Poor riparian cover and moderate aquatic habitat. <u>RGA Results</u> SI – 0.08 (In Regime) Dominant Process: Degradation		
SR-J2	Meandering channel with bed material ranging from silt to cobble. Moderate-Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.46 (In Adjustment) Dominant Process: Aggradation and Widening		
SR-K1	Small channel off of the Speed River. Channel appears to have a concrete bed with some material (silt to cobble) built up on top. Concrete retaining walls are in poor condition. <u>RGA Results</u> SI – 0.13 (In Regime) Dominant Process: Degradation		
SR-L1	Small channel running adjacent to Woodlawn Road East. Moderate-poor riparian cover and aquatic habitat. Channel empties into the Speed River. <u>RGA Results</u> SI – 0 (In Regime)		
SR-L2	Channel runs adjacent to railway tracks, and is fenced. Moderate riparian cover and poor aquatic habitat. <u>RGA Results</u> SI – 0.04 (In Regime)		

SR-L3	Wetland channel running adjacent to railway tracks. RGA Results SI – 0.04 (In Regime)		
SR-O-A1	Small channel that outlets from SWMF off of Ingram Drive. Good riparian cover and moderate aquatic habitat. Bed material ranges from silt to cobble. RGA Results SI – 0.04 (In Regime)		
SR-O1	Minor tributary channel to the Speed River. Headwaters drain forested wetlands. Closer to the speed the channel widens and contains fallen trees and woody debris. Channel shows significant siltation. RGA Results SI – 0.25 (In Transition) Dominant Process: Aggradation and Widening		
SS-1	Concrete lined channel. North end of channel is under-construction. South end of channel has bed ranging from silt-cobble. RGA Results RGA does not apply		
SS-2	Grassy wetland channel. RGA Results SI – 0.04 (In Regime)		

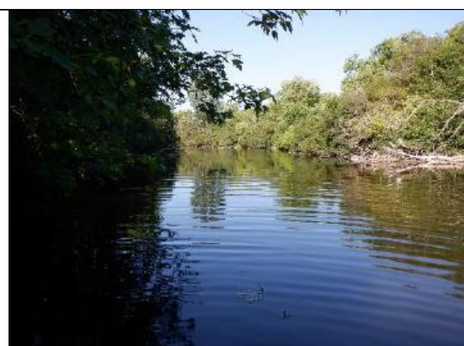
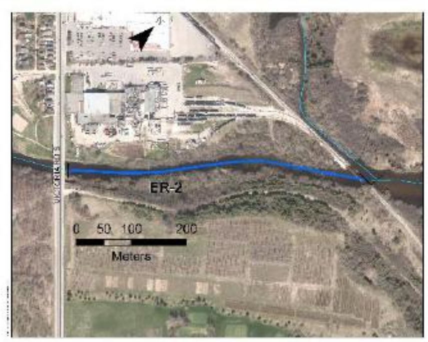
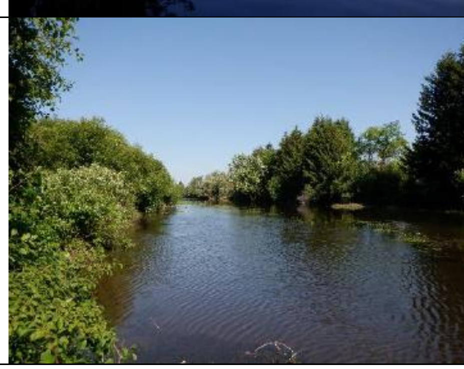
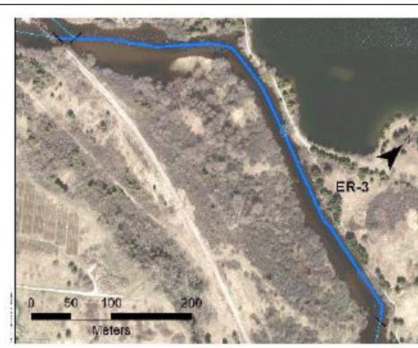
SS-8	Grassy channel with portion North of Woodlawn Rd having concrete lining. Portion of reach South of Woodlawn has thick sediment bed. Poor riparian cover and aquatic habitat. RGA Results RGA does not apply		
SS-9	Grassy channel that runs parallel to large farmland. Good-moderate riparian cover and poor aquatic habitat. RGA Results SI – 0.04 (In Regime)		

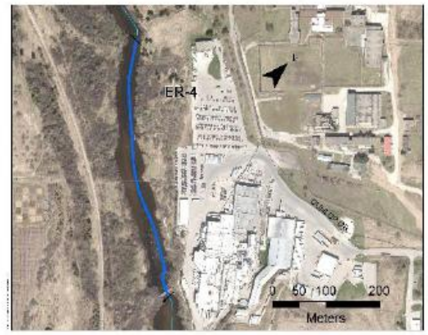
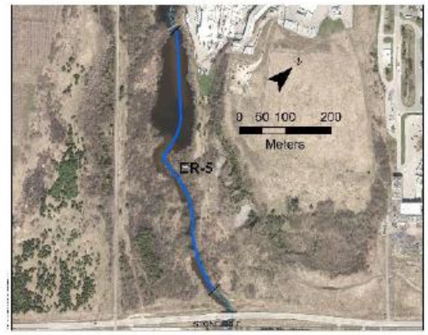
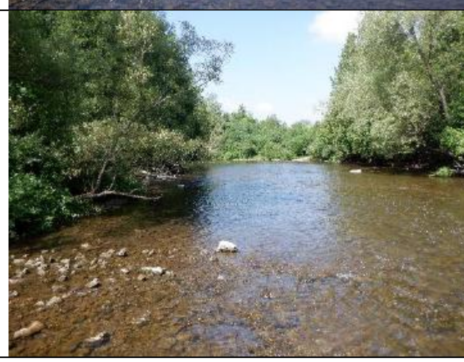


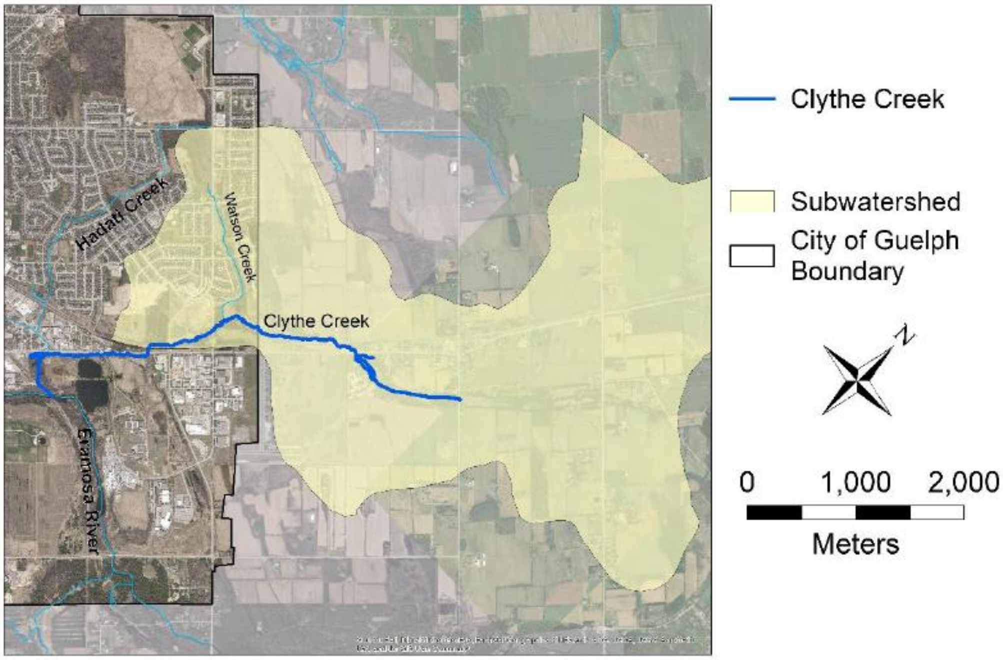
Eramosa River

Area of Subwatershed: 29 km^2

Length of Stream Assessed: 7,417 m

Reach ID	Summary	Representative Photograph	Key Map
ER-1	Natural reach with bed material consisting mostly of silt and sand. Good riparian cover and aquatic habitat. No observable riffle-pool morphology within the reach. Downstream end of reach is the confluence of the Eramosa and the Speed River <u>RGA Results</u> SI – 0.12 (In Regime)		
ER-2	Natural reach with bed material consisting mostly of silt and sand. No observable riffle-pool morphology within the reach. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.06 (In Regime)		
ER-3	Natural reach with bed material ranging from silt to cobble. No observable riffle-pool morphology within the reach. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.09 (In Regime) Dominant Process: Widening		

ER-4	Natural reach with bed material ranging from silt to cobble. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.09 (In Regime) Dominant Process: Widening		
ER-5	Natural reach with bed material ranging from silt and sand to predominantly cobbles at upstream end of reach. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.12 (In Regime) Dominant Process: Widening		
ER-6	Natural reach with bed material ranging from sand to predominantly cobbles. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Aggradation and Widening		
ER-B1	Tributary that flows into the Eramosa River. Channel flows through Guelph Arboretum and Cutten Fields golf course. Channel material mostly consists of silt and sand with grassy banks in Arboretum with the channel becoming more manicured with a grass bed in the golf course. <u>RGA Results</u> SI – 0.07 (In Regime)		

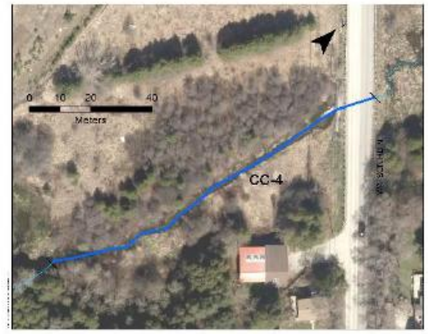
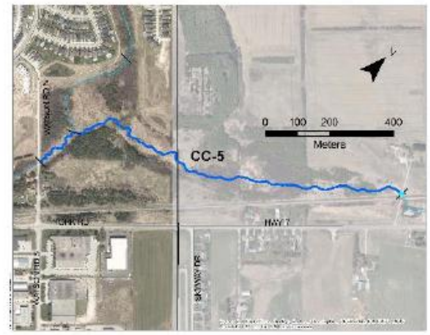


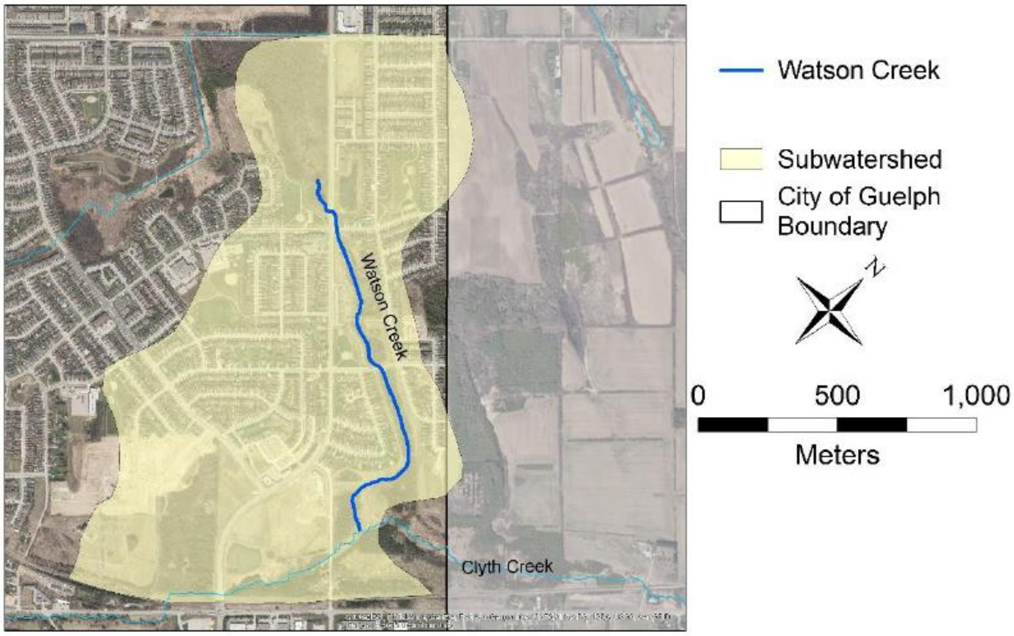
Clythe Creek

Area of Subwatershed: 12 km^2

Length of Stream Assessed: 3,681 m

Reach ID	Summary	Representative Photograph	Key Map
CC-1	Natural channel that flows into Eramosa River at downstream end of reach. Bed material is predominately silt and sand. Moderate to good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.09 (In Regime)		
CC-2	Mixed alluvial and engineered channel with grouted stone grade control structures through reach. Bed material ranges from silt to cobble. Moderate riparian cover and aquatic habitat; grade control structures act as fish barriers. <u>RGA Results</u> SI – 0.12 (In Regime) Dominant Process: Widening		
CC-3	Natural alluvial channel with bed material ranging from sand to cobble. Moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.28 (In Transition) Dominant Process: Widening		

CC-4	Grassy channel with dense shrubs on banks. Bed material predominately silt and sand with some gravel/cobble. Moderate-poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.04 (In Regime)		
CC-5	Natural channel with silt/sand bed. Banks and floodplain are dominated by grasses, poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.07 (In Regime)		



Watson Creek

Area of Subwatershed: 2 km^2

Length of Stream Assessed: 1,484 m

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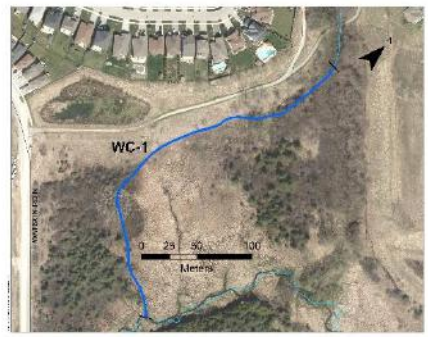
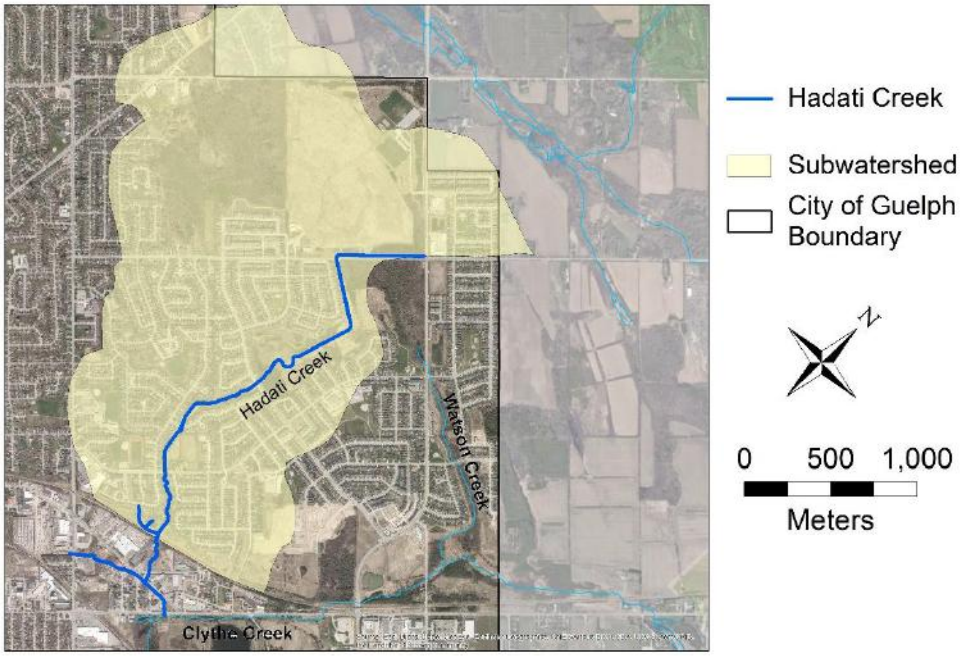
Reach ID	Summary	Representative Photograph	Key Map
WC-1	Channelized drainage in an open grassy wetland. Bed material is mainly silt and clay. Multi-thread channels are occupied at high flow stage. <u>RGA Results</u> SI – 0.13 (In Regime) Dominant Process: Planform Adjustment		
WC-2	Alluvial channel in forested valley. Bed material ranges from silt to cobble. Frequent woody debris jams with good riparian cover and moderate-poor aquatic habitat. <u>RGA Results</u> SI – 0.10 (In Regime)		
WC-3	SWMF near Watson Parkway. The reach shows poor channelization in a grassy and wooded wetland. <u>RGA Results</u> RGA does not apply		

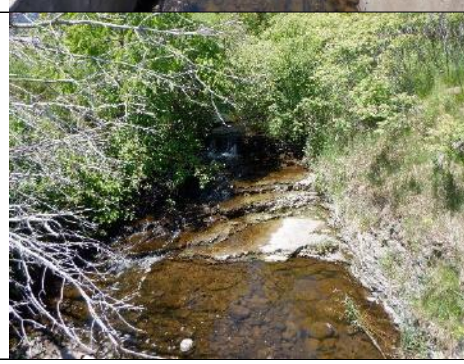
WC-4	Wetland headwaters in broad floodplain corridor. <u>RGA Results</u> RGA does not apply		

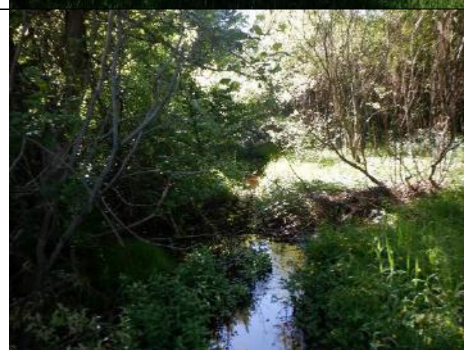
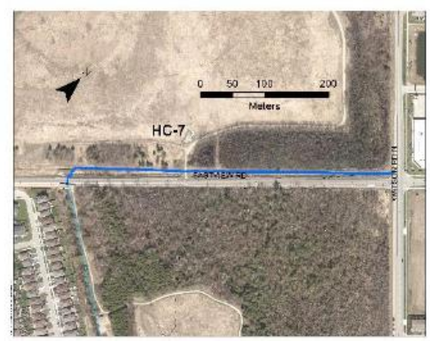
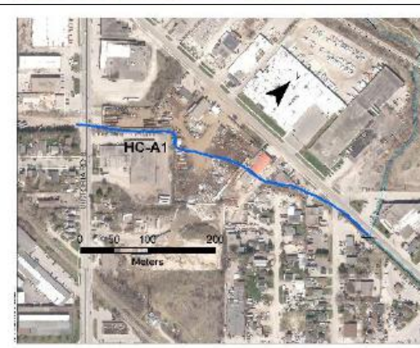


Hadati Creek

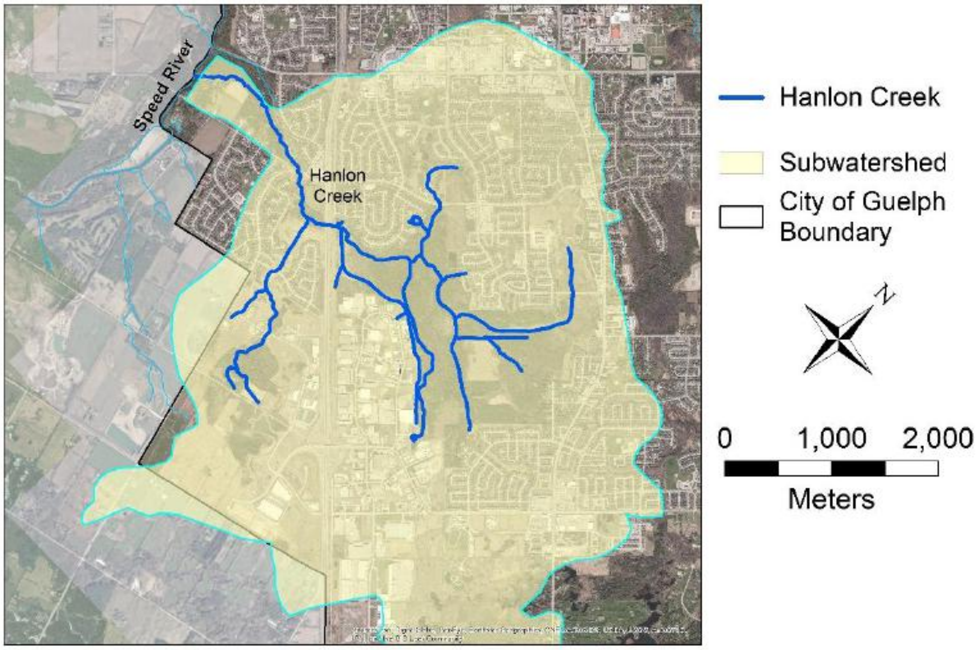
Area of Subwatershed: 5 km^2

Length of Stream Assessed: 4,239 m

Reach ID	Summary	Representative Photograph	Key Map
HC-1	Engineered channel, with mix of concreted/grouted stone retaining walls and steep bedrock banks. Poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.06 (In Regime)		
HC-2	Mix of natural and engineered channel, with bedrock bed. Poor-moderate riparian cover and poor aquatic habitat. Railway and large fish barrier at upstream end of reach. <u>RGA Results</u> SI – 0.05 (In Regime) Dominant Process: Degradation		
HC-3	Mix of natural and engineered channel, with bed material ranging from silt to cobble. Good riparian cover and moderate aquatic habitat, with woody debris jams common throughout reach. <u>RGA Results</u> SI – 0.36 (In Transition) Dominant Process: Aggradation, Widening and Planform Adjustment		

HC-4	Mix of natural and engineered channel, with gabion step structures throughout channel. Moderate-Good riparian cover, and moderate-poor aquatic habitat. <u>RGA Results</u> SI – 0.26 (In Transition) Dominant Process: Widening		
HC-5	Grassy channel that runs through large wetland. Bed material ranges from silt to cobble. <u>RGA Results</u> SI – 0.07 (In Regime)		
HC-6	Grassy channel that runs through large wetland to forested area. Bed material ranges from silt to cobble. <u>RGA Results</u> SI – 0.07 (In Regime)		
HC-7	Grassy drainage channel that runs adjacent to Eastview Road. Poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.04 (In Regime)		
HC-A1	Majority of reach is piped, downstream end of reach flows into HC-1. <u>RGA Results</u> SI – 0.11 (In Regime) Dominant Process: Degradation		

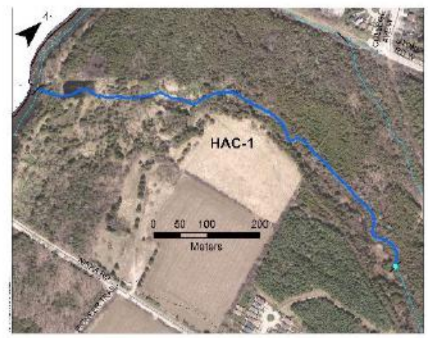
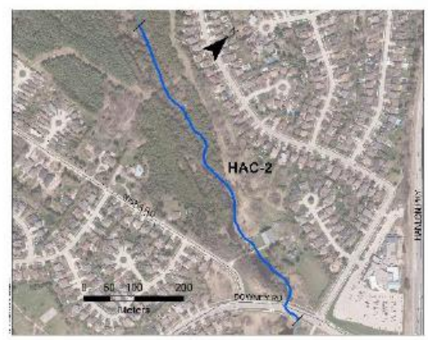
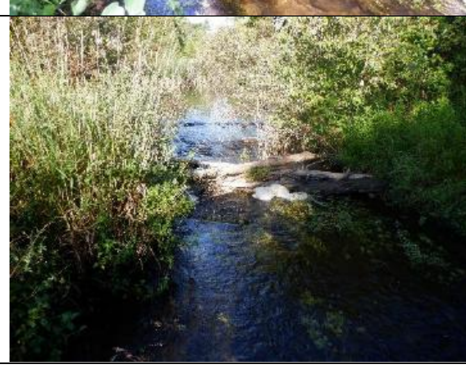
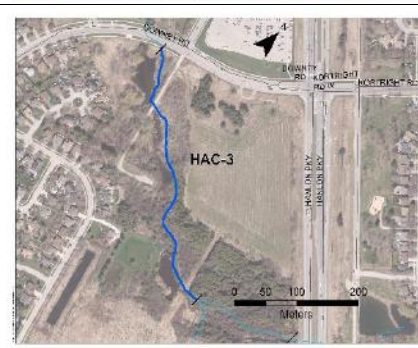
HC-B1	Small channel with silt-gravel bed that runs through a SWMF. Poor-moderate riparian cover and aquatic habitat. <u>RGA Results</u> RGA does not apply		

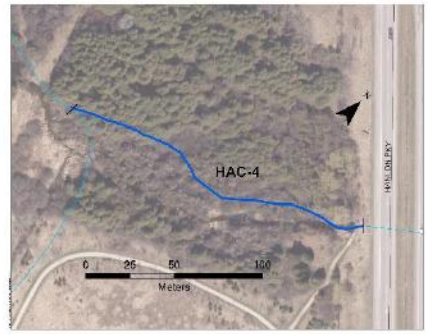
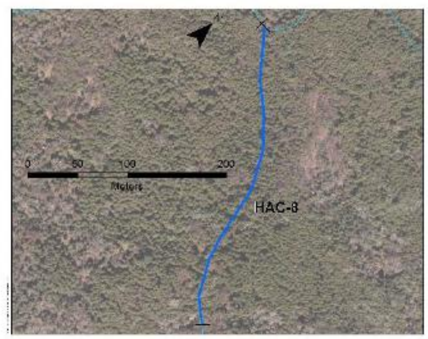
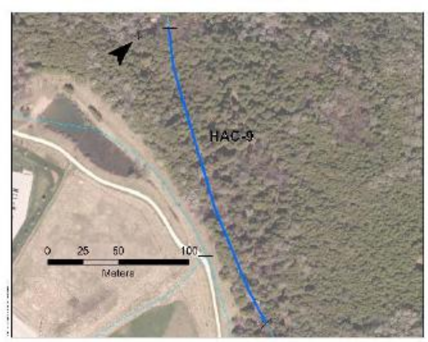


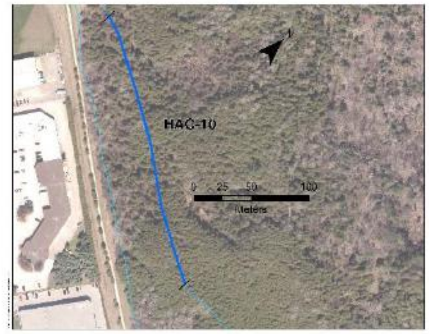
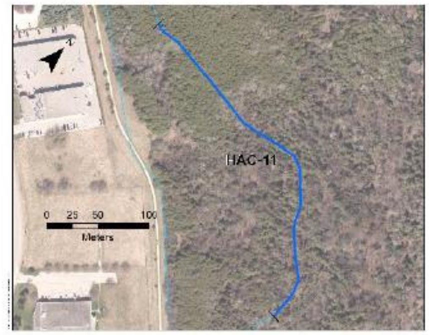
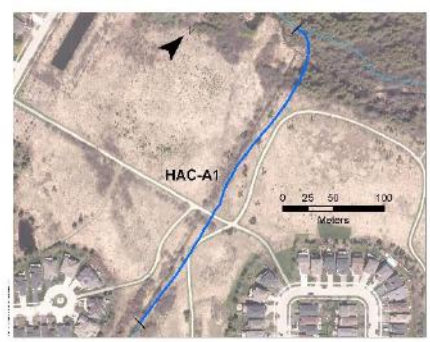
Hanlon Creek

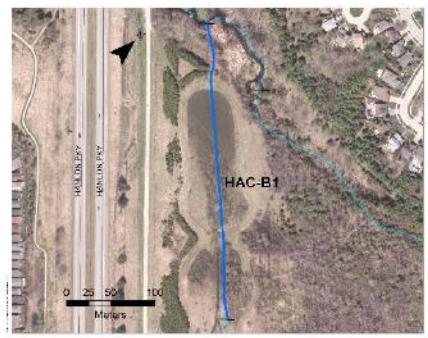
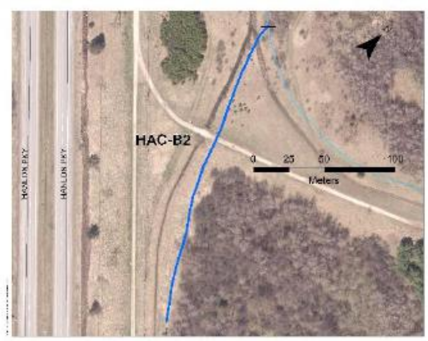
Area of Subwatershed: 21 km^2

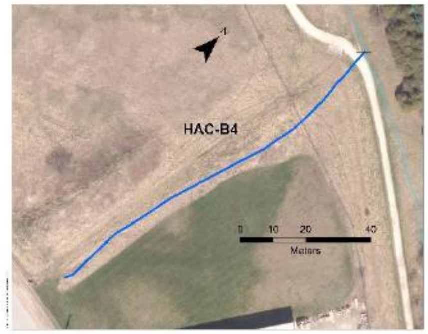
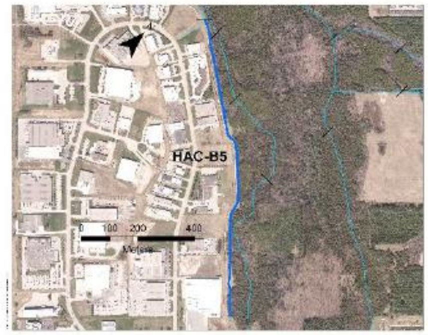
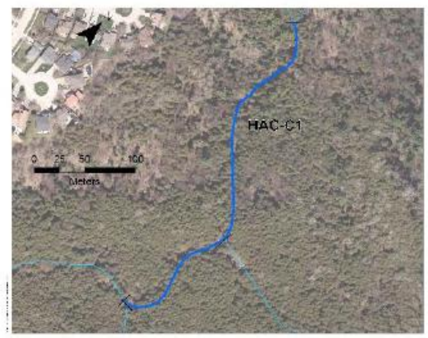
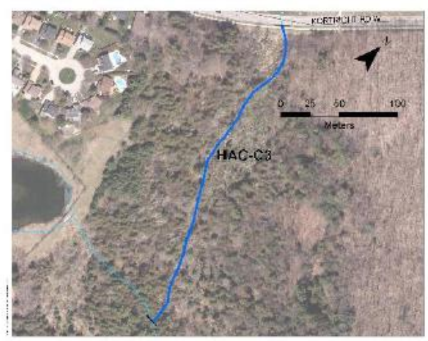
Length of Stream Assessed: 14,216 m

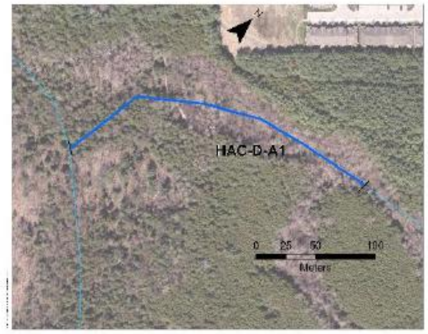
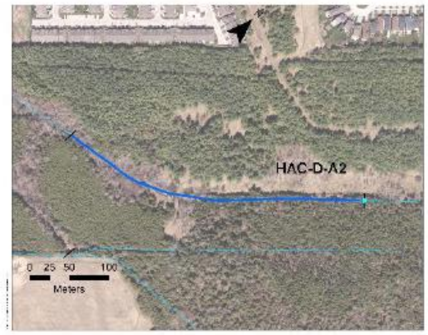
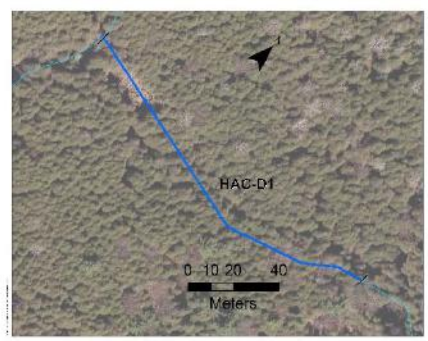
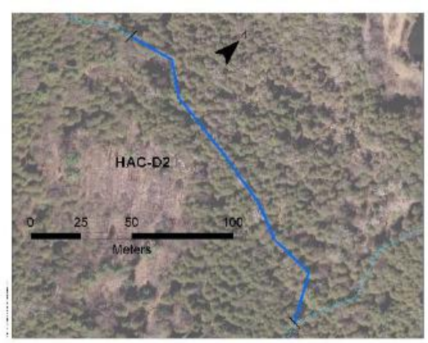
Reach ID	Summary	Representative Photograph	Key Map
HAC-1	Natural channel with bed material ranging from silt to cobble. Poor-moderate riparian cover and moderate-good aquatic habitat. Downstream end of reach flows into Speed River. <u>RGA Results</u> SI – 0.41 (In Adjustment) Dominant Process: Planform adjustment		
HAC-2	Natural channel with bed material ranging from silt to cobble. Good riparian cover and aquatic habitat. Woody debris jams common throughout reach. <u>RGA Results</u> SI – 0.18 (In Regime)		
HAC-3	Natural channel with pebble to silt substrate. Abundant riparian cover and aquatic habitat including grasses and deep pools. Minor woody debris and few riffles. <u>RGA Results</u> SI – 0.10 (In Regime)		

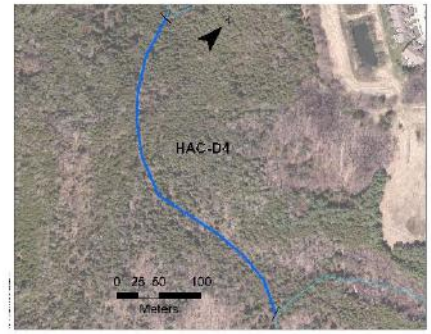
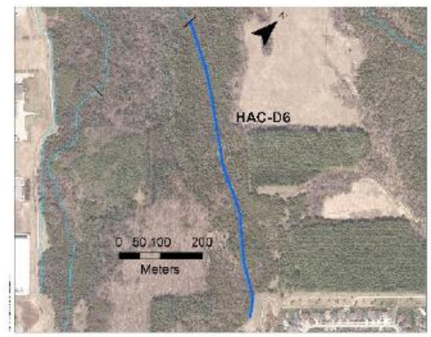
HAC-4	Natural channel with bed material ranging from silt to cobble. Many leaning trees near bank and woody debris jams are common. Good riparian cover and aquatic habitat. Downstream end of reach ends at Hanlon Parkway. <u>RGA Results</u> SI – 0.33 (In Transition) Dominant Process: Widening, Aggradation, and Planform Adjustment		
HAC-6	Natural channel with bed material ranging from silt to cobble. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.25 (In Transition) Dominant Process: Widening and Aggradation		
HAC-7	Natural channel with bed material ranging from silt to cobble. Many leaning trees near bank and woody debris jams are common. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening and Aggradation		
HAC-8	Natural channel with bed material ranging from silt to cobble. Many leaning trees near bank, with cedar forest floodplain and woody debris jams are common. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening and Aggradation		
HAC-9	Natural channel with bed material predominately made up of silt and sand. Channel has grassy banks with leaning trees and some woody debris jams in the channel. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime) Dominant Process: Widening		

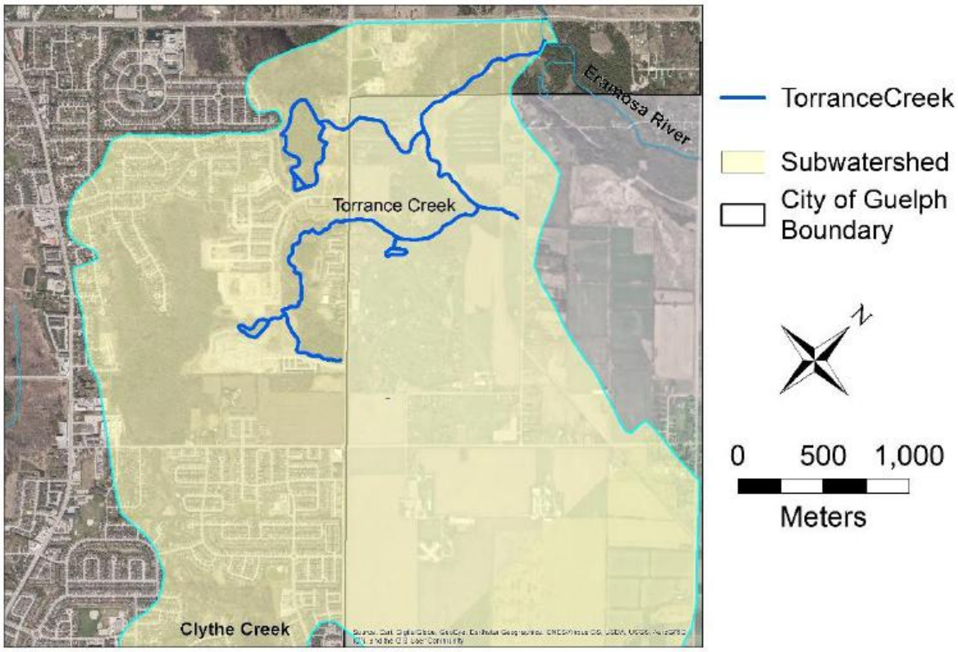
HAC-10	Natural channel with bed material predominately made up of silt and sand. Channel has grassy banks with leaning trees and some woody debris jams in the channel. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime) Dominant Process: Widening		
HAC-11	Natural channel with bed material predominately made up of silt and sand. Channel has grassy banks with leaning trees and some woody debris jams in the channel. Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime) Dominant Process: Widening		
HAC-12	Natural channel with bed material predominately made up of silt and sand. Channel has grassy banks with leaning trees and some woody debris jams in the channel. Good riparian cover and aquatic habitat. SWMF at upstream end outlets into this reach. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening and Planform Adjustment		
HAC-A1	Straightened channel with predominately silt and sand bed. Channel has grassy banks with moderate-poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.07 (In Regime)		
HAC-A2	Straightened channel with predominately silt and sand bed. Channel has grassy banks with poor riparian cover and moderate-poor aquatic habitat. <u>RGA Results</u> SI – 0.11 (In Regime)		

HAC-A3	Grass swale drainage channel. Was dry during inspection. Poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – RGA does not apply		
HAC-A4	Natural channel with bed material ranging from silt to gravel. Poor-moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.07 (In Regime)		
HAC-B1	Reach is primarily made out of large SWMF. Downstream end of reach is a small outlet grassy outlet channel. <u>RGA Results</u> SI – RGA does not apply		
HAC-B2	Grass swale channel. <u>RGA Results</u> SI – 0.04 (In Regime)		
HAC-B3	Grassy swale channel with silt and sand bed. Channel travels through a small SWMF. Poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – RGA does not apply		

HAC-B4	Grass swale channel. <u>RGA Results</u> SI – 0 (In Regime)		
HAC-B5	Grass swale channel. <u>RGA Results</u> SI – 0 (In Regime)		
HAC-C1	Natural channel with predominately silt/sand bed. Channel has grassy banks with moderate riparian cover and aquatic habitat. Woody debris jams common throughout reach. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening and Aggradation		
HAC-C3	Grassy channel with poorly defined banks. Moderate riparian cover and poor aquatic habitat quality. <u>RGA Results</u> SI – 0.11 (In Regime)		
HAC-C4	Large wetland with SWMF at upstream end of reach. <u>RGA Results</u> RGA does not apply		

HAC-D-A1	Natural channel with predominately silt and sand bed. Many leaning trees near bank, with cedar forest floodplain, woody debris jams are common. Good-moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime)		
HAC-D-A2	Natural channel with bed material ranging from silt to cobble. Channel has steep grassy banks, with moderate-poor riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime)		
HAC-D-A3	Reach is predominately made up of a large wetland with the downstream end of the reach transitioning into a grassy channel with steep banks similar to HAC-D-A2. <u>RGA Results</u> SI – 0 (In Regime)		
HAC-D1	Natural channel with predominately silt and sand bed. Many leaning trees near bank, with cedar forest floodplain, woody debris jams are common. Moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.22 (In Transition) Dominant Process: Widening and Aggradation		
HAC-D2	Natural channel with predominately silt and sand bed. Many leaning and fallen trees and woody debris jams. <u>RGA Results</u> SI – 0.22 (In Transition) Dominant Process: Widening and Aggradation		

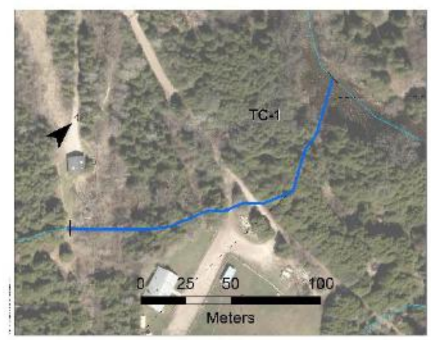
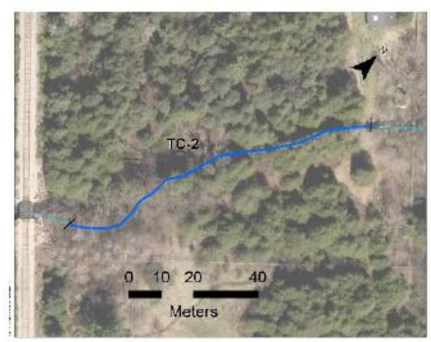
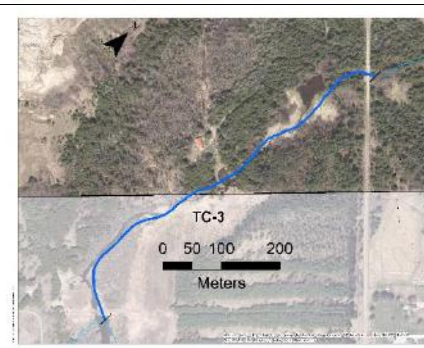
HAC-D4	Natural channel with predominately silt and sand bed. Many leaning trees near bank, with cedar forest floodplain, woody debris jams are common. Good-moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.15 (In Regime) Dominant Process: Widening and Aggradation		
HAC-D6	Natural channel with bed material predominately consisting of silt and sand. Grassy banks have leaning trees and woody debris jams are common in reach. Moderate-Good riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.19 (In Regime) Dominant Process: Widening and Aggradation		

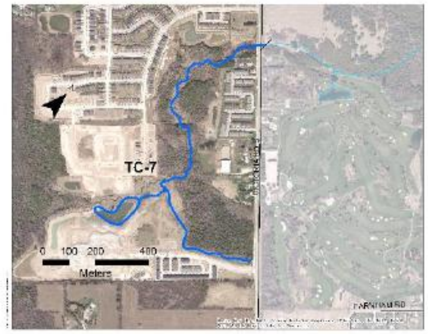


Torrance Creek

Area of Subwatershed: 11 km^2

Length of Stream Assessed: 3,050 m

Reach ID	Summary	Representative Photograph	Key Map
TC-1	Natural channel that with bed material ranging from silt to cobble. Good riparian cover and aquatic habitat. Downstream end of reach drains into Eramosa River. RGA Results SI – 0.15 (In Regime)		
TC-2	Natural channel that with bed material ranging from silt to cobble. Good riparian cover and aquatic habitat. RGA Results SI – 0.15 (In Regime) Dominant Process: Widening and Aggradation		
TC-3	Reach is predominately made up of a large wetland that drains through an old weir structure into a channel. RGA Results SI – 0.17 (In Regime) Dominant Process: Widening and Degradation		

TC-7	Large wetland that is partially channelized in some areas. Channel bed is predominately silt and sand. Poor-moderate riparian cover and aquatic habitat. <u>RGA Results</u> SI – 0.10 (In Regime)		
TC-B3	Wetland that lies adjacent to SWMF. <u>RGA Results</u> RGA does not apply