Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

April 25, 2019

Version 2.0
Matrix 27873-504

Mr. Kevin A Harper
MINTO COMMUNITIES - CANADA
200-180 Kent St.
Ottawa, ON K1P 0B6

Subject: 762 March Road – Shirley's Brook Meander Belt Width

Dear Mr. Harper:

1 INTRODUCTION

Matrix Solutions Inc. was retained to provide a meander belt width assessment of Shirley's Brook at 762 March Road in Kanata, Ontario. Since original conceptual site plan approval, MVCA has updated regulations mapping for Shirley's Brook including meander belt hazard delineations. Previous meander belt width considerations accounted for a 55 m wide meander, however the meander belt width was updated by MVCA to approximately 85 m through the study area. The MVCA requested a meander belt width assessment be submitted to demonstrate that the proposed development is beyond the hazard. The following report provides a detailed meander belt width assessment based on the less than 100 m reach of Shirley's Brook through the study area. This section of Shirley's Brook is part of a sub-reach extending from the crossing at Klondike Road to Shirley's Brook Drive. Figure 1 presents the extents of Shirley's Brook within the study area.

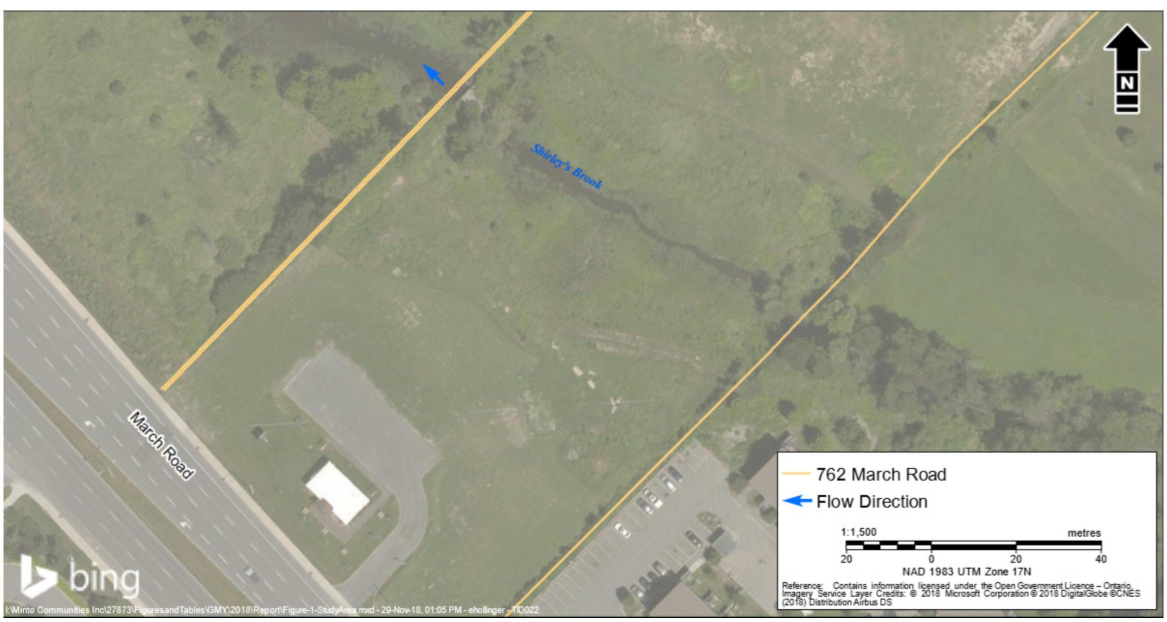

FIGURE 1 Length of Shirley's Brook through the study area

2 BACKGROUND REVIEW

Shirley's Brook & Watt's Creek Phase 2 SWM Study – AECOM, 2015

General findings of Watts Creek, Kizell Drain and Shirley's Brook were summarized as part of this report. Degradation (downcutting and entrenching) was noted through the majority of reaches in the study area. The sediment load in the watercourses appeared to exceed the natural rate of delivery suggesting that flow energy during storm events and spring freshet were not sufficient to flush the system. The watercourses were found to be in a fragile state and in the process of equilibrating to land use changes altering the flow and sediment regimes of the channels. The study suggested that additional development in watersheds could exacerbate rates and locations of erosion, sedimentation, and remobilization of existing silt deposits.

3 EXISTING CONDITIONS – RAPID GEOMORPHIC ASSESSMENTS

3.1 Methods

Rapid Assessments (Rapid Geomorphic Assessment [RGA; COG 1996] and Rapid Stream Assessment Technique [RSAT; MOE 2003]) were completed for the purposes of this study. Appendix A provides a number of photographs taken during the site investigation.

An RGA (MOE 2003) documents observed indicators of channel instability. Observations made during the field investigation are quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, channel widening, and planimetric adjustment. The index produces values that indicate whether the channel is stable/in regime (score less than 0.20), stressed/transitional (score 0.21 to 0.40) or adjusting (score greater than 0.41).

An RSAT (COG 1996) provides a broader assessment of the channel system by also considering the ecological function of the stream. Observations include instream habitat, water quality, riparian conditions, and biological indicators. Additionally, the RSAT approach is based on semi-quantitative measures of bankfull channel dimensions, type of substrate, vegetative cover, and channel disturbance. RSAT scores rank the channel as maintaining a low (less than 20), moderate (20 to 35) or high (greater than 35) degree of stream health.

3.2 Field Observations and Rapid Assessment Results

The section of Shirley's Brook through the study area is approximately 93 m in length and appeared to have been maintained as a straight channel for farming purposes. The channel had an average bankfull top width and depth of approximately 3.0 m and 0.5 m, respectively. At the upstream extent, on the adjacent property east of 762 March Road, a small shale knickpoint produces higher velocities which have created a small pool leading into the study area.

The upstream half of the section of channel investigated as part of this assessment appears to be adjusting more actively than the downstream half. In the upstream half, active lateral migration can be observed into the riparian zone which is composed of tall grasses, herbs, and shrubs. In this area the cross-section is slightly narrower and is composed of small runs and pools. Active adjustment was observed as the channel begins to establish a more natural form.

Downstream of this narrower section, the channel widens (4.3 m bankfull width in areas) and the bottom is composed of unconsolidated silt and organic materials. With a wider cross-section and a lower longitudinal slope, the downstream half of the channel is much more depositional. It is expected that the upstream active adjustment will migrate downstream with time as meanders continue to migrate. These observations of active channel adjustment are in general agreement with the finding by AECOM (2015) that the watercourse is in the process of equilibrating and that these adjustments are likely due to land use changes. At the downstream extent of the reach is an open bottom concrete box culvert approximately 3 m wide in very poor condition. The concrete wing walls on the downstream side of the crossing have completely collapsed and the walls of the structure have partially collapsed and have been braced with a wood beam to prevent them from falling into the channel. The structure is undersized and is likely outflanked seasonally.

TABLE 1 RGA Results Summary

Form/Process	Factor Value	Stability Index	Condition
Aggradation	0.22	0.35	Transitional or Stressed
Degradation	0.29		
Widening	0.75		
Planimetric Form Adjustment	0.14		

TABLE 2 RSAT Results Summary

Characteristic	Given Points	Condition	Stability Ranking
Channel Stability	4	Fair	25 - Moderate
Scour/Deposition	4	Fair	
Instream Habitat	4	Fair	
Water Quality	5	Good	
Riparian Conditions	2	Poor	
Biological Indicators	6	Good	

There were several observations of active channel adjustment within the study reach noted as part of the RGA, resulting in a stability index of 0.35 indicating a transitional channel (see Table 1 for a summary of RGA results). The most common processes observed were related to channel widening in the form of leaning trees and fence posts, the occurrence of large organic debris, exposed tree roots, toe erosion through riffles, steep bank angles through most of the reach, and basal scour throughout. Observations of aggradation, degradation, and evidence of planometric form adjustment in the formation of islands at each extent of the study reach were also made. The more qualitative RSAT resulted in a moderate stability ranking of 25 (see Table 2 for a summary of RSAT results) with good biological and water quality indicators but poor riparian conditions and a lack of balance in scour and deposition.

The following are general recommendations for the enhancement of Shirley's Brook based on the observations made as part of rapid stream assessments conducted during the site investigation:

1. Shirley's Brook will likely continue to migrate laterally and downstream, especially as development continues to expand within its watershed. Given the on-going migration of the channel and the condition of the downstream culvert, culvert removal would prevent the further collapse of the structure into the channel which could obstruct flows resulting in flooding and forcing a re-alignment of the channel. Future culverts should consider a span with consideration for fluvial geomorphic processes to account for future channel evolution.

2. A number of tree stumps with exposed roots along the banks were observed during the site visit. Tree plantings would create rooting systems which can provide erosion protection and can provide significant improvements to a variety of habitats.

4 MEANDER BELT WIDTH

4.1 Historical Land Use and Migration

Earliest aerial photographs from the 1970's suggest that Shirley's Brook was likely maintained as a straight channel for the last 40 to 50 years to prevent encroachment into surrounding lands for farming purposes. The presence of large boulders staggered along the toe of banks may have been placed in an effort to prevent channel migration. Accurate historical erosion rates of migration could not be measured through the study reach using available historical aerial imagery.

4.2 Approach – Unconfined Systems

Figure 2 (attached) provides aerial imagery of the study area and the following delineations:

- Preliminary Meander Belt – the area in which the watercourse is expected to move and change within.
- Erosion Hazard Limit - preliminary meander belt plus all required setbacks based on considerations for channel confinement, slope stability, factors of safety.

Confined and unconfined conditions change how various hazard allowances are implemented. The document entitled River & Stream Systems: Erosion Hazard Limit (OMNR 2002) summarizes how these allowances are applied in confined versus unconfined settings. Shirley's Brook through the study area is unconfined; therefore, the total erosion hazard limit will include the meander belt and an erosion access allowance. For unconfined systems, the meander belt allowance is 20 times the bankfull channel width centred over the meander belt axis or as determined by a study using accepted engineering principles. The erosion access allowance is 6 m on each side of the meander belt width or as determined by a study using acceptable scientific, geotechnical and engineering principles.

Given the history of the channel through the study reach as being historically straightened and its unconfined setting, the meander belt width was determined using empirical relationships which are based on the channel's bankfull geometry (width and cross-sectional area). The appropriateness of the results was considered by compared the calculated values with measurements of the major meander bends of the up and downstream reaches of Shirley's Brook. A table providing the empirical relationships used and resulting meander belt width estimates is provided in Table 3. The standard 6 m erosion access allowance was then added to the recommended preliminary meander belt width.

4.3 Results

Table 3 provides a summary of the results based on empirical relationships used to estimate the preliminary meander belt width for the study reach based on a 3 m bankfull width and calculated bankfull cross-sectional area of 1.3 m^2. A number of empirical relationships are available for a wide variety of channel parameters, including bankfull geometry and catchment area. The relationships used for the purposes of the current study were chosen based on the comparability of the results with up and downstream reaches of Shirley's Brook with major meanders within 20 to 25 m.

TABLE 3 Meander Belt Width Estimates

Reference	Defining Channel Parameter	Meander Belt Width (m)
Williams, 1986	Bankfull Width	14.7
Williams, 1986	Bankfull Cross-Sectional Area	21.3
Ward et al., 2002	Bankfull Width	17.3
Lorenz et al., 1985	Bankfull Width	22.8
Recommended Preliminary Meander Belt Width		**23**

Based on the finding presented in Table 3 and the comparability to up and downstream meander belt widths, a preliminary meander belt width of 23 m is recommended for the study reach. This value represents the total width. A 6 m erosion access allowance is added on each side of the preliminary meander belt width for a total erosion hazard limit of 35 m.

A typical approach taken by Conservation Authorities to estimate meander belt widths and establish delineations is to apply twenty times the maximum bankfull width. This approach can be extremely conservative and is not always a suitable representation of a channel's erosive potential. The results presented above and historical migration of the channel suggests that the approximately 85 m is overly conservative for this section of Shirley's Brook.

5 CONCLUSIONS AND RECOMMENDATIONS

A meander belt width assessment of Shirley's Brook at 762 March Road was completed to provide erosion hazard limits for future development. Based on empirical relationships developed to estimate meander belt widths based on bankfull channel parameters, a preliminary meander belt width of 23 m is recommended. The final erosion hazard limit includes an additional 6 m access allowance on each side of the preliminary meander bet width for a total erosion hazard limit of 35 m.

6 CLOSURE

We trust that this letter report suits your present requirements. If you have any questions or comments, please call either of the undersigned at 343.548.6362.

Yours truly,

MATRIX SOLUTIONS INC.

Matthew McCombs, M.A.Sc., P.Eng
Water Resources Engineer

Reviewed by

Ashraf Zaghal, PhD., P.Eng.
Senior Water Resources Engineer

MM/oa

Attachments

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	09-Nov-2018	Draft	27873_760 March Rd Shirley's Brook MBW 2018-11-09 draft V0.1.docx	Issued to client for review
V1.0	05-Dec-2018	Final	27873_762 March Rd Shirley's Brook MBW 2018-12-05 final V1.0.docx	Issued to client
V2.0	25-Apr-2019	Final	27873_762 March Rd Shirley's Brook MBW 2019-04-25 final V2.0.docx	Issued to client after update to Figure 2

REFERENCES

AECOM. 2015. *Shirley's Brook & Watt's Creek Phase 2 Stormwater Management Study*. Prepared for: City of Ottawa. April, 2015.

Lorenz, J.C., Heinze, D.M., Clark, J.A. and Searls, C.A. 1985. *Determination of widths of meander belt sanstone reservoirs from vertical downhole data, Mesaverde Gropu, Piceance Creek basin*. American Association of Petroleum Geologists, Bulletin, V. 69, pp 710-721.

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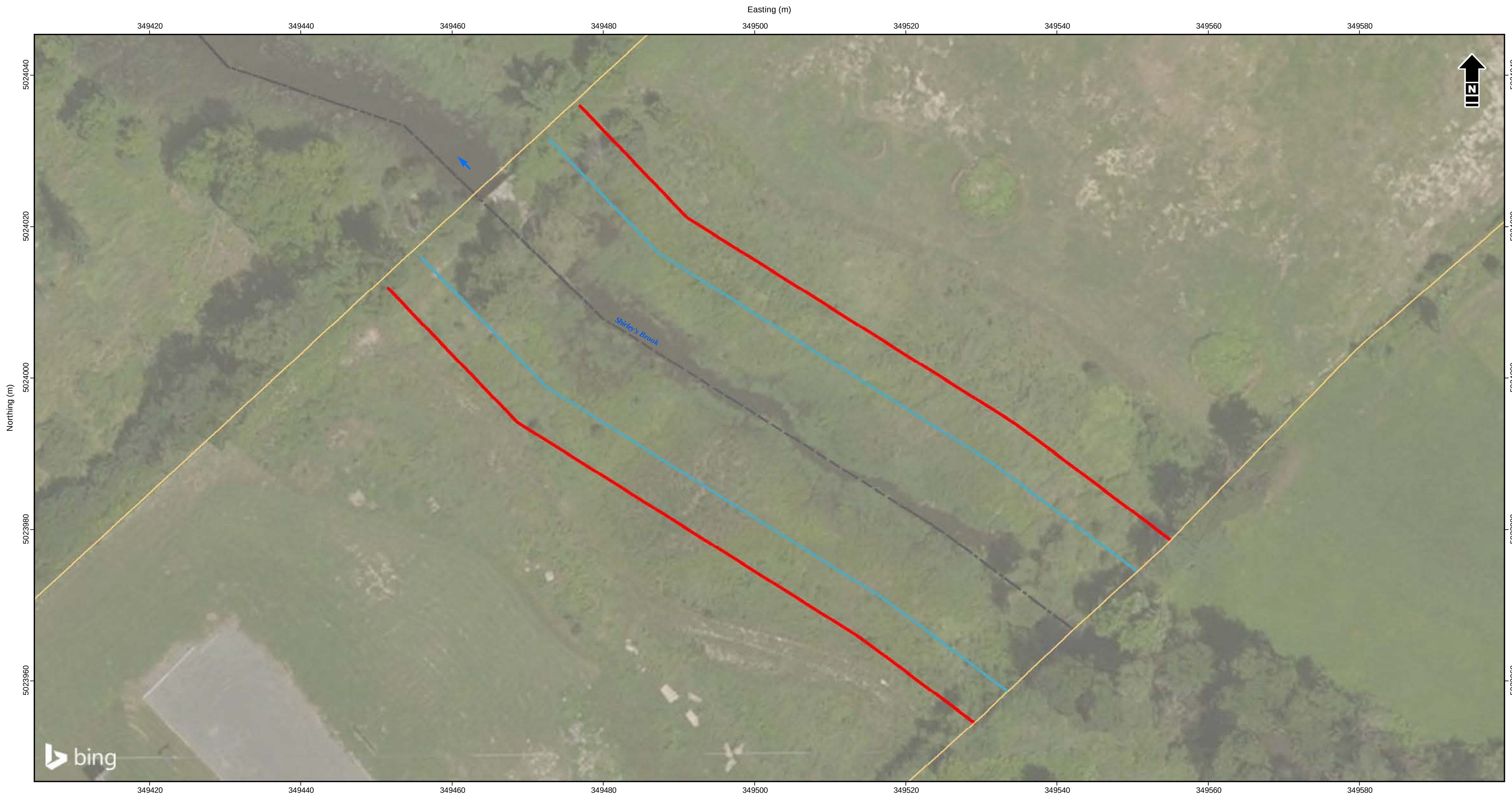
Ward, A. D. Mecklenberg, J. Mathews, and D. Farver. 2002. *Sizing Stream Setbacks to Help Maintain Stream Stability*. Paper Number: 022239 2002 ASAE Annual International Meeting. Chicago, IL, USA. July 28-July 31, 2002

Williams, G.W., 1986. River meanders and channel size. *Journal of Hydrology* 88: 147-164.



762 March Road
Erosion Hazard Limit
Meander Belt Allowance
Meander Axis
Flow Direction

1:500 metres
5 0 5 10
NAD 1983 MTM 9

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Minto Communities - Canada
762 March Road - Shirley's Brook Meander Belt Width

Erosion Hazard Limit

Date:	Project:	Submitter:	Reviewer:
April, 2019	27873	M. McCombs	A. Zaghal

Figure 2

Reference: Service Layer Credits: © 2019 Microsoft Corporation © 2019 DigitalGlobe ©CNES (2019) Distribution Airbus DS

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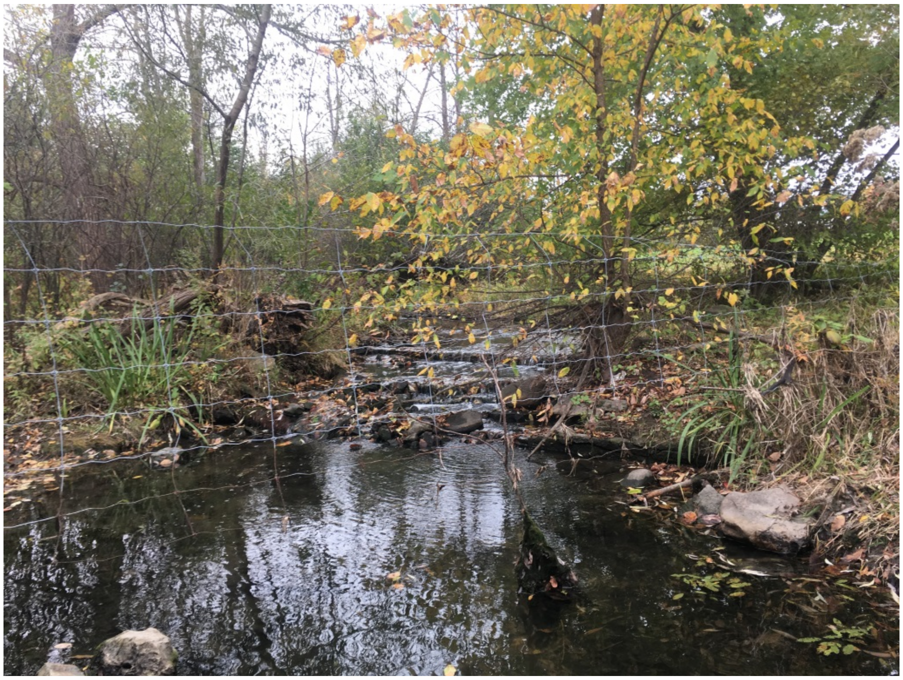
APPENDIX A
Site Photographs



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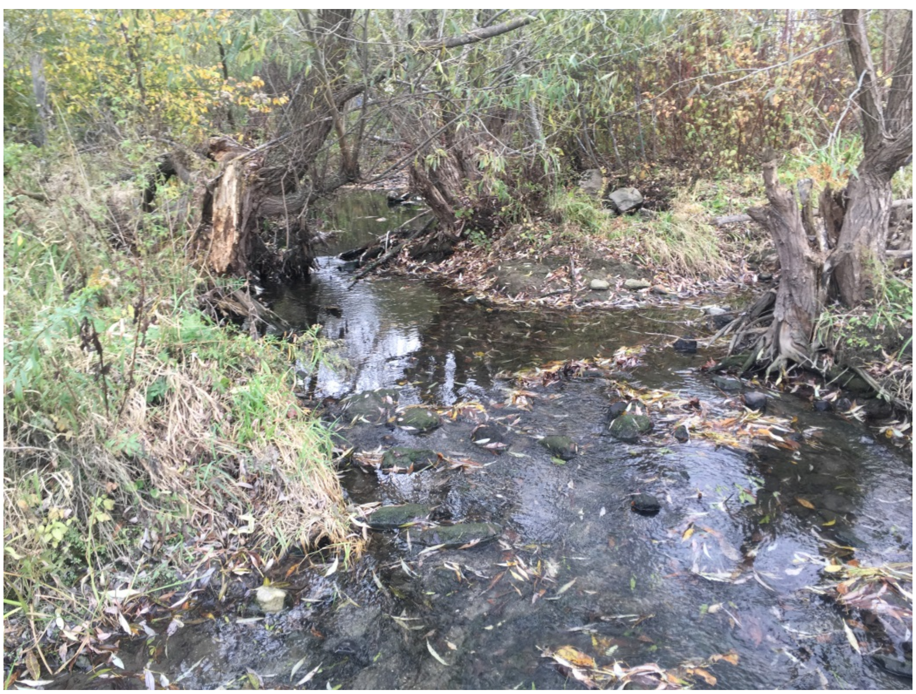
October16, 2018

1. Fence marking the upstream extent of the site with knickpoint/waterfall upstream forming pool at start of the study area.



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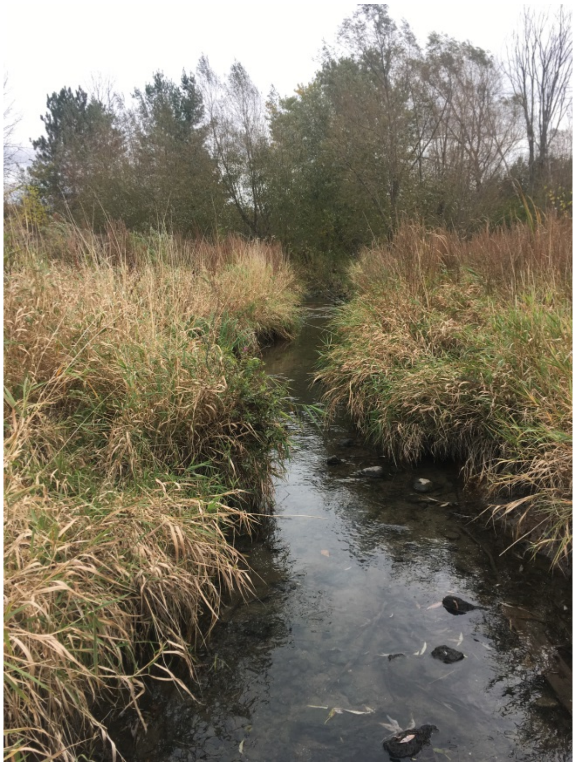
2. Island forming at downstream end of pool to start of riffle/run features downstream.



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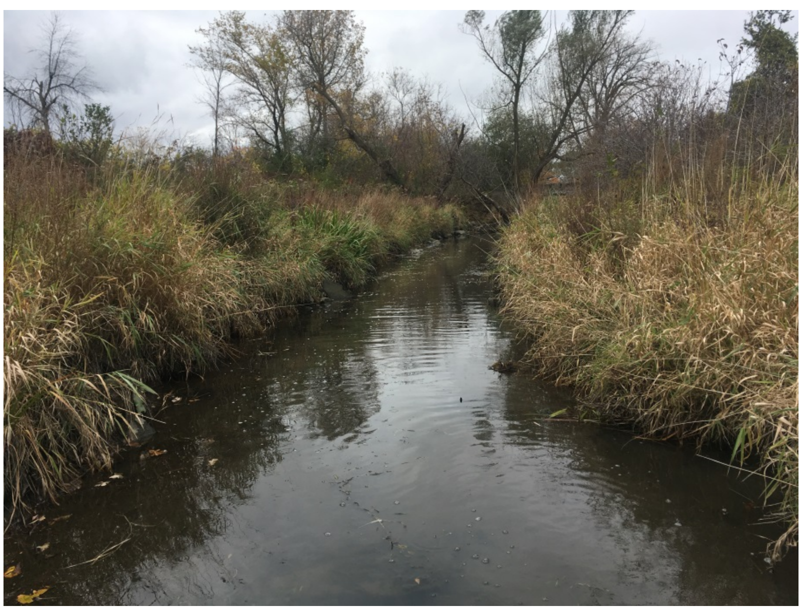
3. Typical cross-section through upstream ~45 m of site where slight sinuosity observed with sings of active channel erosion and relatively coarse bottom.



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4. Typical cross-section through downstream ~ 50 m of site where the channel is wider, straight and aggrading

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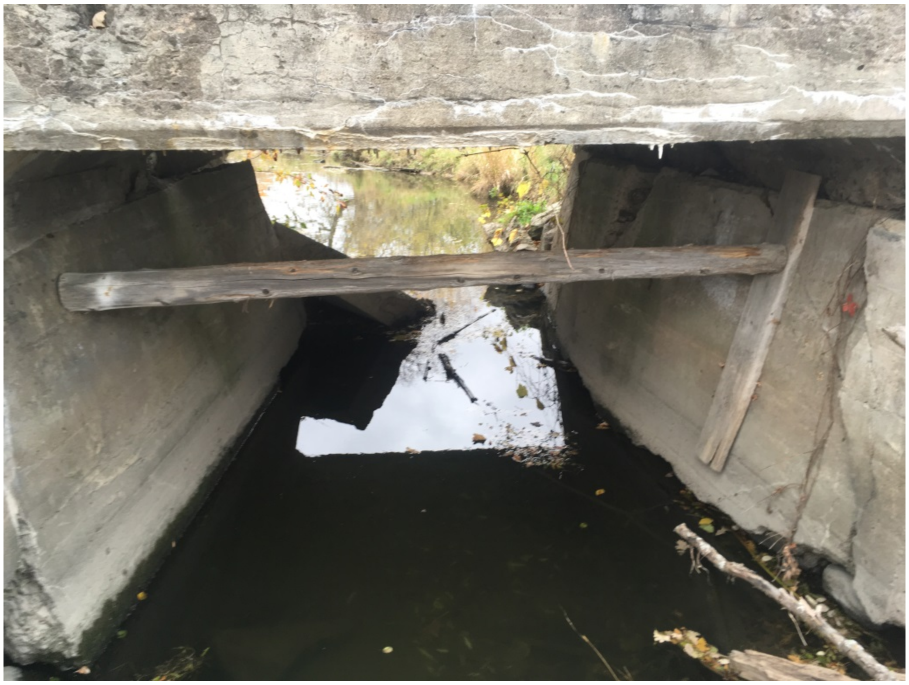

5. Open bottom concrete box culvert marking the downstream extent of the site. The culvert is undersized and in very poor condition as a result of outflanking.