

January 9, 20202

Version 2.0
Matrix 28063-788

Mr. Ralph Esposito, Jr.
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Kanata, ON K2K 2X3

Subject: 788 March Road – Shirley's Brook Meander Belt Width

Dear Mr. Esposito:

1 INTRODUCTION

Matrix Solutions Inc. was retained to provide a meander belt width assessment of Shirley's Brook at 788 March Road in Kanata, Ontario. Mississippi Valley Conservation Authority (MVCA) has updated regulations mapping for Shirley's Brook, including meander belt hazard delineations. The meander belt width was updated by MVCA to approximately 85 m through the subject reach. The MVCA requested a meander belt width assessment be submitted to demonstrate that the proposed development at 788 March Road is beyond the erosion hazard allowance of Shirley's Brook. The following report provides a detailed meander belt width assessment based on the approximately 160 m section 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 Section of Shirley's Brook through the current study area – 788 March Road.

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. 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 and resulting alterations to 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.

762 March Road – Shirley's Brook Meander Belt Width– Matrix Solutions Inc., 2018

This report was submitted in support of development of the neighbouring property at 762 March Road. The section of Shirley's Brook investigated in this previous study is an approximately 93 m section of channel immediately upstream of the current study area. At this location the channel was found to have an average bankfull top width and depth of approximately 3.0 m and 0.5 m, respectively. A preliminary meander belt width of 23 m was recommended with an additional 6 m erosion allowance for a total erosion hazard limit of 35 m. The current study evaluates whether or not Shirley's Brook at 762 March Road and 788 March Road are part of the same reach and that the 35 m hazard allowance delineated as part of the 762 March Road is appropriate through 788 March Road.

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 160 m in length and appeared to have been maintained as a straight channel for farming purposes based on aerial photographs dating to 1965. At the time of the survey, channel geometry was inconsistent throughout due to a number of obstructions including large organic debris (fallen trees) and the open bottom concrete box culvert located at the downstream extent of the site area. The culvert spans the approximate bankfull width of the channel (3.0 m). A pool was created upstream of the Klondike Road culvert as part of the culvert's expansion to accommodate road widening.

The upstream 50 m section of Shirley's Brook within the study area is consistent with the finding of the downstream half of the 762 March Road study. The channel appears to have been widened to deter active migration, with an approximate bankfull width of 5.5 m. The channel bottom in this section is composed of unconsolidated silt and organic materials. Approximately 85 m downstream of the eastern study extent is a significant woody debris jam creating a ponded area and backwatered conditions upstream. Debris jams caused by fallen trees and in-channel vegetation creates backwater conditions through the majority of the site. The expansion of the culvert at the downstream extent of the study area has also resulted in the creation of a pond within the study area and backwater conditions upstream of the pond for a short distance. Bankfull conditions, representative of the findings by Matrix (2018) were observed between debris jams and the culvert pond. At this location, the channel has a bankfull width of approximately 3.0 m and a bankfull depth of 0.6 m, which closely matches the observations at the 762 March Road.

Based on observations made in the field and using historical aerial photographs, Shirley's Brook through 762 March Road and 788 March Road are both of the same river reach. The riparian conditions through the current study area are improved with the presence of mature trees and denser and larger vegetation. It appears that the trees in the riparian area through the neighbouring property at 762 March Road has been historically cut. Apart from these differences, both sections share similar riparian surficial geology and vegetation characteristics, dominated by tall grasses and shrubs. Several similarities between the two sites also exist in the rapid field assessments where natural channel processes are noted such as a loose unconsolidated bottom and trees creating channel obstructions. Aggradation was more dominant through the 788 March Road section of channel as a result of several major channel obstructions creating more depositional zones and processes. Evidence of widening in unobstructed areas was also observed.

Table 1 and 2 show the RGA and RSAT results for the 160 m section of channel walked as part of this assessment. While the results vary from the findings of Matrix (2018) within the same river reach, the majority of differences result from more frequent obstructions observed through the current study section of Shirley's Brook.

Table 1 RGA Results Summary

Form/Process	Factor Value	Stability Index	Condition
Aggradation	0.67	0.40	Transitional or Stressed
Degradation	0		
Widening	0.62		
Planimetric Form Adjustment	0.29		

Table 2 RSAT Results Summary

Characteristic	Given Points	Condition	Stability Ranking
Channel Stability	5	Fair	20 - Moderate
Scour/Deposition	2	Poor	
Instream Habitat	2	Poor	
Water Quality	3	Fair	
Riparian Conditions	3	Fair	
Biological Indicators	5	Good	

As stated in the Matrix (2018) report for 762 March Road, the removal of the upstream box culvert would prevent the further collapse of the structure into the channel which could obstruct flows, which could result in flooding and significant channel adjustment. Future culverts should provide a span with consideration for fluvial geomorphic processes which account for future channel evolution.

The box culvert at Klondike Road at the downstream extent of the study area is in good condition and appears to be a relatively new structure; however, its width is only 3.0 m (the approximate bankfull width of the watercourse). The culvert is significantly armoured with rip rap and gabion baskets and a ponded area has been formed upstream, likely to achieve the desired grade for the recent culvert extension works and to dissipate water velocities at the inlet. Given local changes in the channel bed material observed in the immediate vicinity of the Klondike Road culvert, monitoring of the culvert is recommended to ensure capacity is maintained. Unconfined heavily organic fines were observed within the pool, followed by exposed underlying coarse material at the foot of the inlet and within the culvert for a distance before transitioning to deposited gravels near the culvert outlet. These observations could be indicative of a hydraulic thrust resulting from high water conditions in which the ponded water upstream of the culvert creates a pressure head, flushing fines and gravels out of the culvert and channel bed. The culvert spans only the bankfull width of the channel (3.0 m), which does not allow any degree of natural channel adjustment to occur.

4 MEANDER BELT WIDTH

4.1 Historical Land Use and Migration

Earliest aerial photographs from the 1960's suggest that Shirley's Brook was likely maintained as a straight channel to prevent encroachment into surrounding lands for farming purposes. Accurate historical erosion rates of migration could not be measured through the study reach using available historical aerial imagery due to limited areas of consistent and measurable migration and dense tree cover in some sections through summer months.

4.2 Approach – Unconfined Systems

Figure 2 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 generally 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 width. The appropriateness of the results was considered by comparing 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 1. The standard 6 m erosion access allowance was then added to the recommended preliminary meander belt width.

4.3 Results

Given the determination that Shirley's Brook through 762 March Road and 788 March Road are both sections of the same river reach and have similar bankfull cross-sections in unobstructed areas, the results shown are based on a 3.0 m bankfull width. 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	Meander Belt Width (m)
Williams, 1986	14.7
Ward et al., 2002	17.3
Lorenz et al., 1985	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 788 March Road was completed to provide erosion hazard limits for future development. Using 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 belt 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.



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Reviewed by



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January 9, 2020

DISCLAIMER

10731854 Canada Inc. certifies that this report is accurate and complete and accords with the information available during the project. Information obtained during the project or provided by third parties is believed to be accurate but is not guaranteed. Matrix Solutions Inc. has exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

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APPENDIX A

Site Photographs



*Matrix Solutions Inc.
November 14, 2018*

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



*Matrix Solutions Inc.
November 14, 2018*

2. Looking upstream towards culvert in Photograph 1. This section of historically straightened channel is partially backwatered from downstream woody debris obstruction.



*Matrix Solutions Inc.
November 14, 2018*

3. Large woody debris causing backwatered conditions to upstream extent of study area.



*Matrix Solutions Inc.
November 14, 2018*

4. More in-stream vegetation causing further backwatering through the site.



*Matrix Solutions Inc.
November 14, 2018*

5. Channel between major woody debris and downstream culvert and ponding area.



*Matrix Solutions Inc.
November 14, 2018*

6. Open bottom concrete box culvert marking the downstream extent of the site. Culvert extension resulting in the creation of a ponded area upstream of crossing within the study area.