GEO Morphix Ltd.

Head Office
36 Main St. N., PO Box 205
Campbellville, ON, Canada L0P 1B0

T 416.920.0926

Ottawa Office
PO Box 336 Woodlawn PO
Dunrobin, Ontario, Canada K0A 1T0

T 613.979.7303

July 23, 2020

Valery (Chedoke Browlands) Developments Inc.
2140 King Street East
Hamilton, Ontario
L8K 1W6

Attention: Ted Valeri

**Re: Meander Belt Width Delineation Update
                Tributary of Chedoke Creek (Scenic Drive and Sanatorium Road)
                City of Hamilton, Ontario
                GEO Morphix Project No. 19110**

This memo summarizes the meander belt width assessment completed for a section of the Chedoke Creek Tributary at Scenic Drive and Sanatorium Road in the City of Hamilton, Ontario. This work, in part, provides support in the definition of environmental constraints associated with future development on site.

To accommodate the development, a section of the Chedoke Creek Tributary is proposed for re-alignment between Scenic Drive and the Niagara Escarpment. Parish Geomorphic (2009) previously completed an assessment of the tributary and suggested a meander belt width of 42.9 m for the feature. GEO Morphix Ltd. was retained to review the Parish (2009) study and provide an update to the meander belt width in the context of available topographic survey, detailed field observations, and proposed future development on site.

In the case of realignment, the meander belt width is a product of the bankfull characteristics of a channel. If a channel is to be realigned, the meander belt width would need to be adjusted to account for the updated or proposed channel configuration. To refine the meander belt width for this section of the Chedoke Creek Tributary, we have reviewed various background data and reporting, completed site reconnaissance to document existing watercourse characteristics, and updated the meander belt width assessment at a reach scale based on existing information and newly collected field observations.

We have determined a range of meander belt widths for the post-restoration condition by defining a potential bankfull channel based on the following assumptions:

- Valley gradient of 0.9% based on the valley gradient determined through our detailed assessment completed November 29, 2019
- Sinuosity of 1.1 and width to depth ratio of 10:1, which is a stable configuration and representative of the system
- 2-year flow of 1.1 m^3/s and 2.6 m^3/s, determined through our detailed assessment completed November 29, 2019

Dillon Consulting summarized previously calculated 2-year flows for the channel in their report titled City of Hamilton Sanatorium Road Realignment Flood and Erosion Impact Assessment (June 2010). A significant range of 2-year flows were determined through various studies (values ranging from 1.7 m^3/s to 8.4 m^3/s). Dillon (2010) also simulated a maximum flow for the channel over a 16-year period, which resulted in a discharge of 10.6 m^3/s. Given that the maximum flow determined by Dillon is similar to the largest reported 2-year flow (8.4 m^3/s) in the Dillon report (2010), we would suggest that the 2-year flow is likely closer to the lower range of 1.7 m^3/s rather than 8.4 m^3/s.

To verify the 2-year flow information outlined by Dillon (2010), we completed a detailed channel survey to document existing bankfull dimensions. Based on our detailed geomorphological field assessment from November 29, 2020, we determined a bankfull discharge of 1.1 m³/s for the channel. The bankfull channel indicators observed on site suggested a lower bankfull width and depth that resulted in the 1.1 m³/s discharge. To be conservative, we also determined a secondary discharge by extending the bankfull channel width to the location where flow would spill into the floodplain. This resulted in a discharge of 2.6 m³/s. Both discharge values still fall within the lower range of values outlined by Dillon (2010). Although the bankfull discharge of a channel is generally lower than the 2-year flow, it is what would normally be implemented for a channel design.

Based on the measured gradient from our detailed survey and the assigned sinuosity, width and depth for the restored channel were back-calculated using the 1.1 m³/s and 2.6 m³/s bankfull discharge determined from our detailed survey. The meander belt width was then determined using the modified Williams (1986) model and the back-calculated channel geometry measurements. The empirical relations from Williams (1986) were modified to include channel width and a 20% factor of safety. The empirical relationships are outlined below:

$$B_w = 18A^{0.65} + W_b \times (1.2) \hspace{5cm} \text{[Eq. 1]}$$

$$B_w = 4.3W_b{}^{1.12} + W_b \times (1.2) \hspace{5cm} \text{[Eq. 2]}$$

Where, B_w is meander belt width (m); A is bankfull cross-sectional area (m²); and W_b is bankfull channel width (m).

The meander belt widths for each discharge scenario are outlined in **Table 1** below. The reported numbers include a 20 percent factor of safety.

Table 1. Meander Belt Widths for Realigned Tributary of Chedoke Creek

Discharge (m³/s) Scenario	Meander Belt Width (m) Williams – Area Method (1986) [Eq. 1]	Meander Belt Width (m) Williams – Width Method (1986) [Eq. 2]
1.1	23.9	21.4
2.6	35.8	30.5

There are a range of meander belt widths provided as a result of different discharges and empirical models. Generally, most of the determined meander belt widths in **Table 1** fall within or around 30 m. Given that the channel can be designed to accommodate a range of discharges, we are confident that the meander belt width for the realigned channel would not exceed 30 m.

We trust this memo meets your current requirements. Should you have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

Paul Villard Ph.D., P.Geo., CAN-CISEC, EP, CERP
Director, Principal Geomorphologist

Kat Woodrow, M.Sc.
Environmental Scientist

References

Dillon Consulting Limited, June 2010. City of Hamilton Sanatorium Road Realignment Flood and Erosion Impact Assessment. Final Report Submitted to City of Hamilton.

Parish Geomorphic, June 2009. Chedoke Creek Flooding and Erosion Control Impact Assessment, Stage 1: Analysis of Existing Conditions. Final Report Submitted to Dillon Consulting Ltd.

Williams, G.P., 1986. River meanders and channel size. Journal of Hydrology, 88 (1-2): 147-164.