Deltini Commercial Developments Inc.

Primrose Subdivision

Erosion Hazard Assessment

March 31, 2021

Erosion Hazard Assessment

Primrose Subdivision (Town of Mulmur)

Deltini Commercial Developments Inc.

Project No.: 201-12148-00
Date: March 31, 2021

WSP
100 COMMERCE VALLEY DRIVE WEST
THORNHILL, ON, CANADA L3T 0A1

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WSP Canada Inc.

March 31, 2021

Deltini Commercial Developments Inc.
1350 Shawson Drive
Mississauga, ON, L4W 1C5

Attention: Ms. Marika Zigon

Dear Madam:

Subject: Erosion Hazard Assessment

We are pleased to submit the report for the Erosion Hazard Assessment at Primrose Subdivision, Town of Mulmur. This report has been prepared in accordance with the tasks identified in our proposal.

We trust the submission of this documents meets your requirements. Should you have any comments we look forward to your response.

Yours sincerely,

Vladimir Nikolic, Ph.D., P.Eng.
Project Engineer, Water Resources

Revision History

FIRST ISSUE

16.03. 2021	Erosion Hazard Assessment			
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Vladimir Nikolic	Steven van Haren	Steven van Haren		
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Signatures

Prepared by

Vladimir Nikolic, Ph.D., P.Eng.
Project Engineer

Date

Approved[1] by (must be reviewed for technical accuracy prior to approval)

Steven van Haren, P.Eng.
Manager

Date

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Contributors

Client

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1 INTRODUCTION

WSP Canada has been retained by Deltini Commercial Developments Inc. to prepare a floodplain analysis and an erosion hazard assessment for the lands at Lot 1 and Lot 2, Concession 2. This property is located at the northwestern intersection of County Road 19 – Prince of Wales Road and Highway 89, Primrose, Town of Mulmur. The subject property is currently agriculturally cultivated land, while a draft plan of a residential subdivision is proposed for future development.

The subject site is situated within the Boyne River watershed, which falls in the Nottawasaga Valley Conservation Authority (NVCA) jurisdiction. Primrose Creek, a tributary of the Boyne River, flows northerly on the west side of the subject site. At the northwestern end of the property, this creek meets two local headwater features.

To complete the erosion hazard assessment, the scope of work presented in this study includes:

a. A site visit to determine the category of river/valley system;
b. Establishing the Primrose Creek meander belt width recommendation;
c. Determine a draft top of bank line based on topographic relief;
d. Provide recommendations on management requirements to address NVCA policies on erosion hazards.

Please note that this report is prepared for an erosion hazard assessment and should be read in conjunction with the floodplain analysis report prepared under the separate cover by WSP for the subject property in March 2021.

2 NVCA REGULATORY MAPPING

According to the NVCA Natural Hazard Technical Guide, erosion hazard assessment is required for developments located within the NVCA hazard regulatory mapping. The subject property is located within the regulated areas of the Boyne River as shown in an online interactive property map maintained by the NVCA. Existing property boundaries and the current regulated areas are shown in Figure 1. While the hatched regulated areas contain the regulated flood line, they also include additional regulated area due to other hazards, such areas of steep slope.

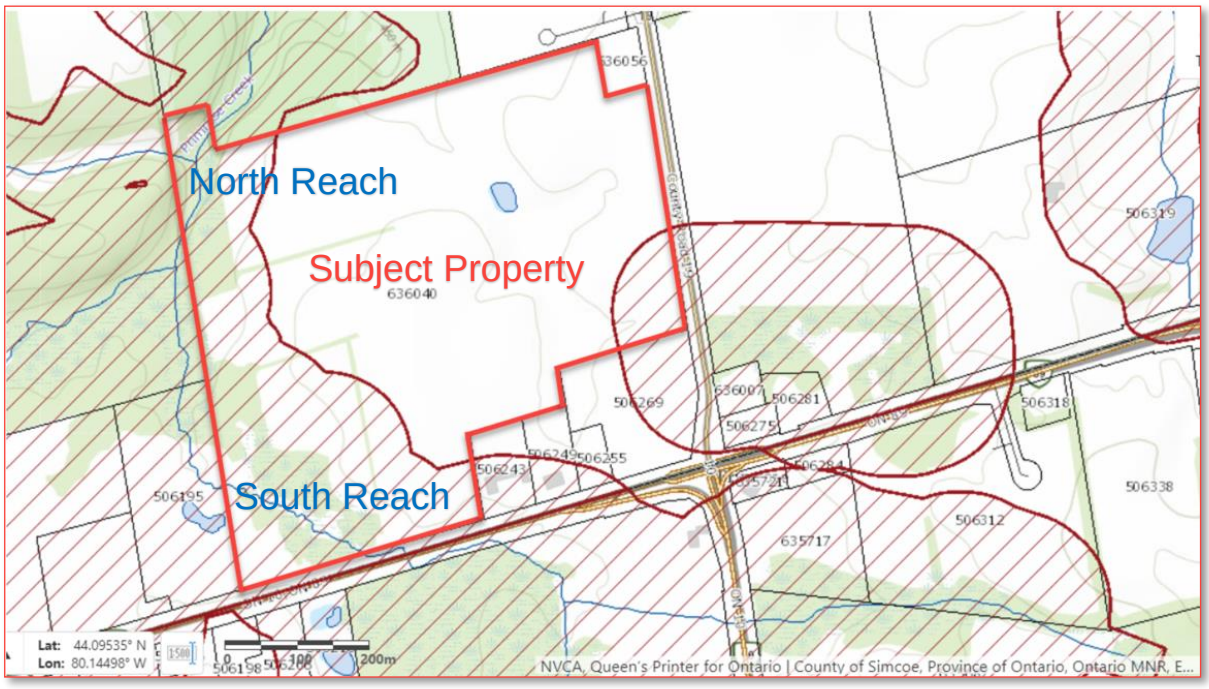

Figure 1 NVCA Regulatory Mapping and the Location of Subject Site

3 CLASSIFICATION OF LOCAL VALLEY SYSTEMS

In order to define the erosion hazard limit for river and stream valleys, Technical Guide – River Systems (MNR, 2002a and MNR 2002b) suggests a two-tier classification that includes apparent (confined) and not-apparent (unconfined) river and valley systems.

Preliminary desktop analysis of topographic information available for the subject site and its vicinity, including Primrose Creek, reveals the presence of two slightly varied valley systems differentiating the South and North reaches.

WSP conducted a site visit on February 3, 2021 with the objective of confirming and determining the category of the local stream valley and the stability of its valley slopes. As presented in Figures 2 to 5, the stream valley of Primrose Creek encroaching the subject property at the southern side of the property appears to be unconfined (not apparent) as the there is no discernable valley slope or bank that can be detected from the surrounding landscape. Just like it was observed on the subject site, this type of valley systems and valley slopes is typically found in fairly flat or gently rolling landscapes. This particular section of Primrose Creek is referred as the South reach in this report.

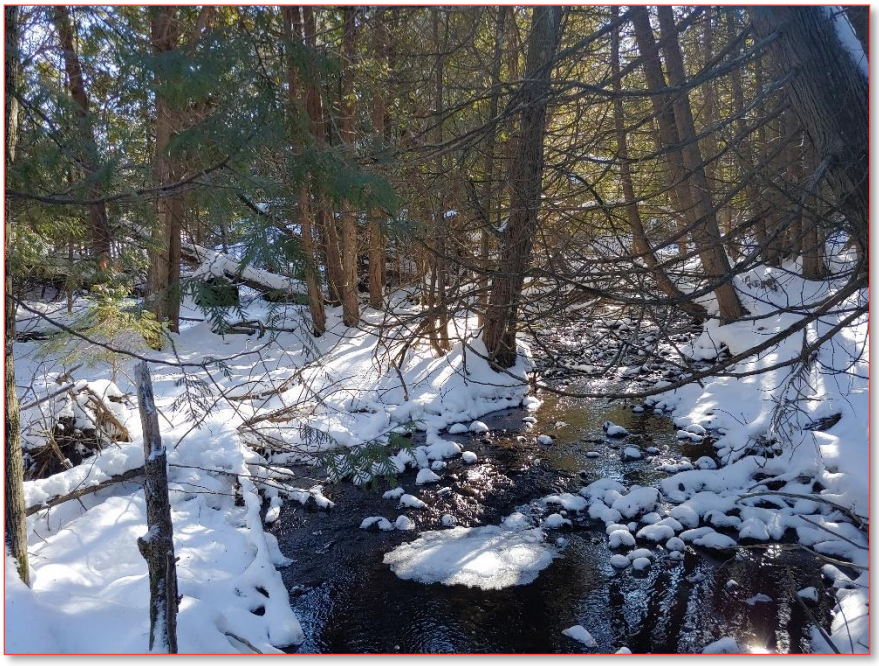

Figure 2 Primrose Creek valley at the subject property, looking south

Figure 3 Primrose Creek valley at the subject property, looking north

Figure 4 Right bank of Primrose Creek at the subject property, looking south

Figure 5 Right bank of Primrose Creek at the subject property, looking north

However, at the north-western end of the property, the southern reach of Primrose Creek meets two head water drainage features (please see Figure 6 for details). Hydrologic flows at this northern section are increased as a result of significantly higher total catchment area.

Based on the desktop analysis of the local topography, it was determined that this northern reach of Primrose Creek characterizes the semi-unconfined valley system within the subject property boundaries, flowing through the wood lands.

On the right bank of North reach of Primrose Creek that occupies the portion of the subject site, the valley slopes are fairly flat with gently rolling landscape, without apparent top of banks and stable top of banks. Table 1 presents the major catchment area characteristics for both South and North Primrose Creek reaches.

Table 1 Characteristics of Catchment Areas for South and North reaches

	SOUTH REACH	NORTH REACH
Total Drainage Area [km^2]	3.1	24.3
Slope of Main Channel (%)	1.389	0.717

4 MEANDER BELT ASSESSMENT

In order to determine the erosion hazard associated with Primrose Creek, the meander belt width for the North and South reaches were estimated and are presented in Figure 6. Calculations supporting these width estimates are presented below.

According to the Planning and Regulation Guidelines (NVCA), determination of the appropriate meander belt width typically involves a wide range of engineering study disciplines. Therefore, due to challenges in assessing the meander belt width, more than one method may be required for any given application, especially when historical information on the water course movement is not available.

Following the guidelines on Planning and Regulation Guidelines (NVCA), the meander belt width was estimated following the procedures outlined in Belt Width Delineation Procedures (TRCA 2001). Belt width estimates were developed using two empirical techniques:

- Stream Power Equation, and,
- Annable's morphological relationship.

4.1 Stream Power Equation

The following empirical relationship, as presented in the Belt Width Delineation Procedures (TRCA, 2004), was utilized to calculate meandering belt width as a function of stream power and drainage area:

$$W_b = -14.827 + 8.3191 * \ln(SP * D_a), R^2 = 0.739, S = 8.64$$

Where:

W_b - Meander Belt Width (m);

D_a - Drainage Area (km^2);

SP - Stream Power (W/m^2) = ωQs

Where:

ω - specific weight of water (kg/m^3);

Q - 2-year flow (m^3/s);

s - Channel Gradient;

In the flood study prepared by WSP for the subject property in February 2021, the hydrologic review was undertaken in order to validate the flow rates coded in the NVCA existing HEC-RAS model.

As stated in previous sections, the subject site is located within the Boyne River watershed, a tributary of the Nottawasaga River. As such, previous hydrologic study "Watershed Hydrology Study for Nottawasaga, Pretty and Batteax Rivers, Black Ash, Silver and Sturgeon Creeks", Volume 1-Technical Report", Canada-Ontario Flood Damage Reduction Program (MacLarenPlansearch, 1988) and associated Basin Figure and Appendix G Design Flows: Nottawasaga Basin were reviewed. The flow nodes located at the study area were identified and the flow rates were compared between the 1988 report and the NVCA supplied model.

Since the above referenced report provides only 5-year to Regional Storm flows for Catchment 404 (location of the subject site), the 2-year flow was estimated using Ontario Flow Assessment Tool (OFAT), Ministry of Natural Resources and Forestry (MNRF).

For the South reach, stream power was calculated using a 2-year flow rate estimate of 1.4 m^3/s. The same tool was used to estimate the main channel gradient value of 1.38%. The drainage area of Primrose Creek at the subject site was estimated at 3.1 km^2.

The resulting meander belt width by the stream power equation is 55 m, and this evaluation includes 8.64 (S) m for potential underestimates of actual meander belt width and natural migration tendencies.

For the Northern reach, the same equation was applied, and same tools were used to estimate the 2-year flow (6.75 m^3/s), which includes the flow from the additional tributary area. Stream power calculated for Northern reach is estimated for the total drainage area of 24.2 km^2.

The resulting meander belt width for the North reach is 82 m, and this evaluation also includes 8.64 (S) m for potential underestimates.

4.2 Annable's morphological relationship

This relationship produces an estimate of bankfull discharge (Q_{bf}) and meander belt width (Γ), as a function of the total drainage area (A_d) as follows:

$$Q_{bf} = 0.52 * A_d^{0.74};\ \Gamma = 35.2 Q_{bf}^{0.53}$$

For the south reach, a bankfull discharge of 1.19 m^3/s was estimated based on the Annable's empirical relationship for rural watercourses in Southern Ontario, and, therefore, a bankfull discharge of 1.19 m^3/s was selected for this reach. Estimated meander belt width based on this discharge is 39 m.

In contrast, for the north Reach, a bankfull discharge of 5.46 m^3/s was estimated, and the meander belt width calculated based on this discharge is 86.5 m.

4.3 Erosion Hazard Limit Allowance

During pre-design consultation meeting, NVCA staff requested that the determination of the development limits on the subject site include a 6-meter allowance to the erosion hazard limit. Therefore, Figure 6 also presents the 6 m allowance applied to the estimated erosion hazard limit.

North Reach

South Reach

2ND LINE W

DUFFERIN COUNTY RD 19

HIGHWAY 10/89

HIGHWAY 89

HIGHWAY 10

0 50 100 200 300 400 Meters

N W E S

Legend

- Watercourse
- Roads
- Study Boundary
- Proposed Lots
- Minor Contours
- Major Contours
- Meander Belt Width
- 6m access allowance of Meander Belt Width
- Regional Floodline (Existing Condition)
- 6m access allowance of the Regional floodline

CLIENT: DELTINI COMMERCIAL DEVELOPMENTS INC.

TITLE: PRIMROSE SUBDIVISION (TOWN OF MULMUR)

MEANDER BELT WIDTH

Checked: V.N.	Drawn: J.C
Date: March 2021	Proj. No.: 201-12148-00
Scale: 1:4,000	Figure No.: **6**

Document Path: \\thfiler1.corp.pbwan.net\ENGCAD$\DIV38\2020\201-12148-00 Primrose\GIS\Figure 6 - Meander Belt Width.mxd

5 CONCLUSION

Local topography and relief on the subject site is characterized by gently rolling landscapes, without discernible top of banks. The northern reach of Primrose Creek, however, enters the semi-confined valley system just north of the subject site based on a desktop review of topographic information.

Table 2 provides a summary on calculated meander belt widths on the subject site using two empirical methods, Stream Power Equation and Annable's Morphological Relationship. Due to the overall similar results from both methods, the selected meander belt width for the Primrose Creek is 55 m for the South reach, while for the northern reach, the meander belt width is 86.5 m. Please see Figure 6 which presents the meander belt limits and applied 6m allowance relative to the relevant flood elevations and the proposed area of development.

Table 2 Estimated Meander Belt Widths for South and North Reaches of Primrose Creek

	STREAM POWER EQUATION [m]	ANNABLE'S MORPHOLOGICAL RELATIONSHIP [m]
South Reach	**55**	39
North Reach	82	**86.5**

It is important to note that the meander belt is established using the most conservative value of the two accepted empirical equations (Stream Power and Annable's Morphological Relationship) and applied a 6-meter allowance based on the specific NVCA requirement. The buffer encroaches on a small portion of the northwest development area (North reach), as presented on Figure 6. However, according to the NVCA Planning and Regulation Guidelines (2009), page 40, development within the allowance may still be permitted by NVCA if it is regulated to ensure that existing erosion and flooding hazards are not aggravated. More specifically, NVCA Guidelines (2009):

> Development within the allowance must be regulated to ensure that existing erosion and flooding hazards are not aggravated, that new hazards are not created, and to ensure that pollution and the conservation of land will not be affected. The allowance provides the conservation authority with the ability to maintain and enhance the natural features and ecological functions of the river or stream valley.