Technical Design Brief: Tributary of Little Beaver River

Lora Bay Heights, Town of the Blue Mountains

Google Earth Pro 2006

Prepared for:
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Earth Science
Observations

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1 Introduction

GEO Morphix Ltd. was retained to conduct a detailed channel design for the realignment of a section of a tributary of the Little Beaver River, as part of a proposed residential development (Lora Bay Heights) located at 188 Peel Street, south-east of the intersection of Peel Street North and High Bluff Lane, in the Town of the Blue Mountains, Ontario. The channel design serves to improve channel form and function, increase aquatic habitat and habitat variability, increase wetted width and low flow habitat, and provide greater substrate and morphological variability.

In developing the design, the following activities were completed:

- A review of the available background materials
- Provide details for the channel design including planform, cross sections, and necessary bioengineering details
- Hydraulic sizing of the channel materials
- Recommendations for design implementation including construction timing, and best management practices
- Development of a post-construction monitoring plan

This design brief is provided to facilitate review of the design, which outlines the current geomorphological condition of the tributary of Little Beaver River, design considerations, provides technical details and recommendations for implementation, and monitoring of the proposed design.

2 Existing Conditions

Channel morphology and planform are largely governed by the flow regime and the availability and type of sediments (i.e., surficial geology) within the stream corridor. Physiography, riparian vegetation and land use also physically influence the channel. These factors are explored as they not only offer insight into what governs stream geomorphology, but also potential changes that could be expected in the future as they relate to a proposed activity. Field observations provide us with an in-depth understanding of the factors that impact stream geomorphology within the study area.

2.1 Geology

The Tributary of Little Beaver River is within the Beaver Valley physiographic region. The subject property is characterized by the sand plains physiographic landform, which at one time was the floor of Glacial Lake Algonquin (Chapman and Putnam, 1984). The surficial geology is comprised of silt and clay, and minor sand and gravel derived from fine-textured glaciolacustrine deposits, which are massive to well-laminated (OGS, 2003).

2.2 Field Observations

Field observations of the Tributary of Little Beaver River were completed on May 23, 2007 by AECOM staff.

Within the subject property the tributary was found to be intermittent and exhibits a sinuous to irregularly meandering channel pattern and functions primarily as an agricultural drain. Agricultural activities have historically modified the tributary, including boulder weir construction, culvert installations, and haphazard rip-rap placement. These features impede fish passage during low to moderate flows. The riparian zone was continuous, highly disturbed scrubland and vegetation consisted mainly of grasses with a few trees. Instream vegetation was present for the majority of the Tributary and consisted mainly of cattails and grasses. Natural bankfull width ranged between 3.0 m to 4.0 m. Banks were poorly defined and erosion was present along some of the tributary. Undercut banks were noted, although most had been blocked with boulder rip-rap. Riffle-pool sequences were present; however, they were discontinuous due to past modifications. Channel substrate was comprised of sandy silt and partly decomposed organic material (AECOM, 2008).

3 Natural Channel Design

3.1 Design Objectives

As previously mentioned, the historically modified tributary has multiple impediments to fish passage and degraded physical instream habitat conditions. The proposed design provides a single thread channel with riffle-pool typology that aims to improve channel form and function, increase habitat variability, increase low flow habitat, and provides greater substrate and morphological variability.

The primary objectives of the design, therefore, are to:

- Restore the physical form of the channel, including planform and in-channel characteristics
- Improve the function of the channel, as well as its interaction with the floodplain
- Enhance aquatic habitat through the provision of a single thread, morphologically diverse channel with spatially varied flows

3.2 Bankfull Channel

A riffle and pool typology is proposed for the realigned channel, which will provide significant improvements to not only the channel as it essentially replicates a natural system, but also to aquatic habitat. When it is assessed to be an appropriate channel type, a riffle-pool system offers numerous benefits:

- Channel bed relief for flow variability
- Water aeration in riffle sections
- Relatively quiescent flows in pool sections to provide refuge for fish during high flows
- Increased depths in pools to provide relatively cool water
- In-channel energy dissipation

Channel dimensions are determined by bankfull discharge, as this represents what is generally considered the channel-forming discharge or the dominant discharge. However, due to the historic impacts to the watercourse, a computed discharge could not be considered accurate or reliable. Additionally, due to changes to the hydrology likely to occur as a result of the development, a more appropriate discharge, based on hydrological modelling was determined for this reach. The bankfull discharge used to model the realignment of the tributary of Little Beaver River was assumed to be equivalent to the modelled 1.5-year flow, approximated using half of the 2-year flow. The bankfull discharge was determined to be 1.15 m^3/s, provided by C. F. Crozier and Associates Inc.

Riffle and pool geometries, as well as anticipated bankfull conditions, are provided in **Table 1.**

A simple Manning's approach was used to iteratively back-calculate bankfull dimensions for the proposed channel. Since pools are designed to contain ineffective space, this model over-predicts the amount of discharge that they convey. However, the modelled values for the riffles give a better prediction of the channel capacity. The channel has an overall gradient of 0.79 % for 194 m. Bankfull width and depth range between 1.85 m to 2.30 m and 0.30 m to 0.45 m, for the riffles and pools, respectively. Average riffle gradient is 3.60 %.

Table 1: Bankfull parameters of the proposed channel

Channel parameter	Riffle	Pool
Bankfull width (m)†	1.85	2.30
Average bankfull depth (m)†	0.22	0.25
Maximum bankfull depth (m)†	0.30	0.45
Bankfull width-to-depth ratio	6.17	5.06
Channel gradient (%)	3.60	0.79
Bankfull gradient (%)	0.79	0.79
Manning's roughness coefficient, *n*	0.04	0.03
Mean bankfull velocity (m/s) *	1.48	1.03
Bankfull discharge (m^3/s) *	0.59	0.59
Discharge to accommodate (m^3/s)	0.58	0.58
Tractive force at bankfull (N/m^2)††	106	35
Stream power (W/m)††	209	46
Unit stream power (W/m^2)††	140	31
Maximum grain size entrained (m)†† **	0.11	0.04
Mean grain size entrained†† **	0.08	0.02

† Based on bankfull gradient
†† Based on riffle gradient
* Based on Manning's equation; as pools contain ineffective space, the velocity and discharge conveyed in them are not presented
** Based on Shields equation, assuming Shields parameter equals 0.06 (gravel)

The sizing of proposed substrate materials was guided by a review of hydraulic conditions (i.e., tractive force, flow competency) in the typical cross sections. To provide for a stable bed and level of sorting, a mix of 15% 100 mm – 150 mm riverstone, 70% granular 'b', and 15% native material is proposed for the riffles. Granular 'b' consists of a mix of stone where approximately 20 % - 50 % of the stone is greater than 0.005 m in diameter, but nothing larger than 0.15 m in diameter. These materials will always have a core of sediment that is not entrained under bankfull flow conditions. This material maintains the character of the native material, while providing slight higher stability and opportunity for sediment sorting.

The channel banks will be restored using native plant species. This includes appropriate species for the various seed mixes as well as woody vegetation. The plantings are intended to enhance the terrestrial habitat through the provision of species and habitat diversity, increase floodplain soil stability, and increase floodplain roughness and sedimentation.

3.3 Natural Erosion Control

Newly constructed channels can be vulnerable to erosion. This is particularly true before vegetation has established along the channel banks. While low-flow events should not intensify erosion, the concern for erosion occurs when there are high flows or precipitation events during construction.

For immediate erosion protection, mechanical stabilization in the form of biodegradable erosion control blankets (i.e., coir cloth, jute mat, etc.) should be used. As the blankets will biodegrade over time, this serves as a short-term stabilization measure.

For long-term stability, implementation of a planting plan is recommended. The planting plan should include deep rooting native grasses and other herbaceous species that are seeded along and within channel sections, prescription of flood tolerant native shrub and tree species, and use of seed banks within the local soil. Shrubs should be planted close to the channel margins to provided maximum benefit with respect to stabilization and channel cover.

Potential erosion locations (i.e., along the outside meander bends, immediately downstream of wetland features, etc.) should be anticipated, and should be reflected in the planting plan. Live staking and shrub stock should be used adjacent to the channel bank to provide immediate benefit as well as long-term infilling. If appropriate live staking methods are followed, this method should provide greater benefits than simple potted or bare root shrub plating. This is because of the potential for higher densities with live staking.

4 Design Implementation

4.1 Construction Timing

Based on resident fish species and their respective life cycles, in-stream work will be restricted to June 15th to March 15th, unless otherwise directed by the Ministry of Natural Resources and Forestry (MNRF).

4.2 Best Management Practices

Site inspection should be performed by an inspector with experience overseeing channel works, as this type of work differs considerably from engineering projects. An experienced inspector will be able to provide quick and appropriate response to issues that may arise, and ensure that construction proceeds in accordance with the approved design and contract.

The limits of construction will be delineated to prevent unanticipated impacts to natural surroundings, including trees and the watercourse. Most of the channel can be constructed without interference to the existing watercourse. When the proposed channel does cross the existing channel, cofferdams will be installed upstream and downstream of the work area and the water will be pumped around.

All isolated work areas will be dewatered to perform work under dry conditions. Water will be pumped to a sediment filtration system located at least 30 m from the receiving creek and be allowed to naturally flow over a well-vegetation surface and ultimately return to the channel downstream of the work area. This will allow particles to settle before reaching the watercourse.

All materials and equipment will be stored and operated in such a manner that prevents any deleterious substances from entering the water. Vehicle and equipment re-fuelling and/or maintenance will be conducted away from the watercourse, and be free of fluid leaks and externally cleaned/degreased to prevent the release of deleterious substances.

4.3 Post-Construction Monitoring

A post-construction monitoring program is recommended to assess the performance of the implemented design. Monitoring observations can also be used to determine the need for remedial works. Monitoring is recommended for five full calendar years following the year of construction.

The following monitoring and reporting activities are proposed:

- General observations of the channel works should be documented after construction and after the first large flooding event to identify any potential areas of erosion concern
- Collection of a photographic record of site conditions
- Total station as-built survey of the channel planform, longitudinal profile and cross sections just after construction to obtain reference data for the following four years
- Installation of erosion pins at monumented cross sections after construction
- A general vegetation survey in the spring and fall of each year
- Re-survey of the longitudinal profile and cross sections, as well as monitoring of erosion pins at monumented cross sections for five years following construction
- A yearly report for the first four years, with a final report at the end of the monitoring period

The monitoring would commence immediately after construction and sites would be reviewed annually to identify natural variability of the system. Reporting would be provided annually, with a summary report at the end of each year.

We trust this report meets your requirements. Should you have any questions, please contact the undersigned.

Respectfully submitted,

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Director, Principal Geomorphologist

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5 References

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