BEACON ENVIRONMENTAL

GUIDING SOLUTIONS IN THE NATURAL ENVIRONMENT

Geomorphic Assessment

720, 735 & 740 Oval Court and 5135 & 5155 Fairview Street, Burlington, Ontario

Prepared For:

Branthaven Development Corporation

Prepared By:

Beacon Environmental Limited

Date: *Project:*

Revised March 2023 **218416.1**

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1. Introduction

Beacon Environmental Limited (Beacon) was retained by Branthaven Development Corporation (Branthaven) to complete a geomorphic assessment in support of a site plan application for the proposed Official Plan and Zoning By-law Amendment (mixed use residential and commercial) for the redevelopment of properties located at 720, 735 and 740 Oval Court and 5135 and 5155 Fairview Street in the City of Burlington ('subject lands'). The subject lands, which are located within the jurisdiction of Conservation Halton, comprise 4.59 hectares of existing commercial and industrial development situated north of Fairview Street and south of the Canadian National (CN) rail line immediately between Appleby Creek and Sherwood Park (**Figure 1**). For the purposes of this assessment, the Study Area includes the portion of Appleby Creek extending from the Metrolinx Corridor to the downstream Centennial Bikeway (multi-use path) south of Fairview Street (**Figure 1**).

Existing land use within the subject lands consists of five (5) low-rise commercial and industrial buildings and associated parking lots. The legal description of the subject lands is Lots 1 to 7, Registered Plan 20M 524, City of Burlington, Regional Municipality of Halton. The proponent intends to redevelop the subject lands into a transit-oriented community designed for residential, retail and commercial uses.

The purpose of this geomorphic assessment is to characterize existing conditions along the portion of Appleby Creek relevant to the subject lands, contribute to the determination of development limits, evaluate potential impacts associated with the proposed redevelopment plan and identify mitigation measures, as applicable, to address potential impacts.

The following tasks were undertaken in support of the study:

- Background review of available materials (topographic mapping, aerial photography, and relevant studies);
- Desktop assessment to delineate reaches based on underlying geomorphic controls, such as land use, degree of valley confinement, sinuosity, and riparian vegetation;
- Historic assessment to determine current and past extents of the watercourse as well as the extent of historical land-use change that could impact the watercourse;
- Field assessment to characterize existing geomorphic conditions and document evidence of active channel processes;
- In accordance with relevant guidelines and policies, recommendation of a toe erosion allowance;
- Evaluation of potential impacts associated with the proposed redevelopment plan; and
- Recommendation of mitigation measures.

2. Policy Context

2.1 Provincial Policy Statement

The Provincial Policy Statement (MMAH 2020) issued under the *Planning Act* (1990) outlines areas of provincial interest with respect to natural hazards. In support of the Policy Statement, a Technical Guide - Rivers and Streams: Erosion Hazard Limit document was prepared by MNR (2002) to outline

standardized procedures for the delineation and management of riverine erosion hazards in the Province of Ontario. The guide presents erosion hazard protocols based on two generalized landform systems through which watercourses flow: confined and unconfined valley systems. Through this approach, the meander belt width plus an erosion access allowance is defined to determine the erosion hazard limit of an unconfined valley system. For confined valley systems, the erosion hazard limit is governed by geotechnical considerations, including the stable slope allowance and an applicable toe erosion allowance (i.e., channel migration component).

2.2 Ontario Regulation 162/06

Conservation Halton (CH) regulates land use activities in and adjacent to wetlands, watercourses and valleylands under Ontario Regulation 162/06 (Regulation for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses) made under the *Conservation Authorities Act*.

2.2.1 Conservation Halton Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document

Subject to conformity with the municipality's Official Plan, the completion of appropriate studies and application for Conservation Authority permits, The Authority may grant permission for development within these areas if it can be proven that control of flooding, erosion, pollution, or the conservation of land will not be affected by the development.

According to Conservation Halton's Policy, development is generally prohibited:

- Within flooding and erosion hazards;
- Within 15 metres of the stable top of bank of a major valley system and 7.5 metres of the stable top of bank of a minor valley system, where a valley is apparent;
- Within 15 metres from the greater of the limit of the flood plain or the predicted meander belt width of a watercourse associated with a major valley system and within 7.5 metres from the greater of the limit of the flood plain or the predicted meander belt width of a watercourse associated with a minor valley system, where a valley is not apparent;
- Within 120 metres of a Provincially Significant Wetland and all wetlands greater than or equal to 2 hectares in size;
- Within 30 metres of wetlands less than 2 hectares in size;
- Within 5 metres of the furthest landward extent of the aggregate of the flooding, erosion and dynamic beach hazards along the Lake Ontario and Hamilton Harbour shorelines; and
- Hazardous lands.

Section 2.19 Alteration to Watercourses and Flood Plains of the document specifies:

> *2.19.1 Major flood plain alterations (including placement of fill to create, or enlarge, a building lot) and major watercourse alterations (including enclosures and diversions from one watershed to another) are generally not permitted. Such alterations may be considered where justification is provided through a subwatershed study, an Environmental Assessment or similar comprehensive study and are subject to conformity with municipal planning documents. The*





Site Location	Figure 1
Oval Court Redevelopment Geomorphic Assessment	
BEACON ENVIRONMENTAL	Project: 218416.1 Last Revised: March 2023
Client: Branthaven Development Corp	Prepared by: DU Checked by: SG
1:5,000	Inset Map:1:45,000

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applicable study or assessment must be current (generally within 5 years) and must be supported by Conservation Halton.

2.19.2 Flood plain and watercourse alterations, that are minor in nature or have been justified under Policy 2.19.1 will be evaluated on an individual basis having consideration for the following:

- *a) Maintenance of the natural topography of the watercourse system, flood conveyance (no increase in off-site flood elevations and on-site increases will only be permitted where it has been shown that it will not result in an increased risk to life or property) and flood storage (maintenance of stage-storage-discharge relationships for a range of rainfall conditions);*
- *b) No adverse impacts on fluvial processes (including the 1:100-year meander belt width);*
- *c) No adverse impacts on groundwater recharge/discharge;*
- *d) Geotechnical (i.e. slope stability) issues are adequately addressed; and,*
- *e) Implementation of recommendations within Conservation Halton approved watershed or subwatershed studies or Environmental Assessment.*

2.19.3 Any watercourse alterations will be required to use natural channel design, to the maximum extent possible.

2.3 Halton Region Official Plan

The Halton Region Official Plan (ROP, 2018) includes environmental policies that are relevant to this application and EER/EIA and provide direction to development and site alteration within and adjacent to the Regional Natural Heritage System (RNHS). The RNHS is defined under policy 115.3. Portions of the RNHS are identified on Map 1.

Policy 115.3 describes the RNHS as being comprised of the following components:

115.3(1) Key Features, which include:

- *a) significant habitat of endangered and threatened species,*
- *b) significant wetlands,*
- *c) significant coastal wetlands,*
- *d) significant woodlands,*
- *e) significant valleylands,*
- *f) significant wildlife habitat,*
- *g) significant areas of natural and scientific interest,*
- *h) fish habitat,*

115.3(2) enhancements to the Key Features including Centres for Biodiversity,
115.3(3) linkages,
115.3(4) buffers,
115.3(5) watercourses that are within a Conservation Authority Regulation Limit or that provide a linkage to a wetland or a significant woodland, and
115.3(6) wetlands other than those considered significant under Section 115.3(1)(b).

2.4 City of Burlington Official Plan

The new City of Burlington Official Plan (November 2020) was appealed by Branthaven Development, and therefore this EER/EIA refers to polices from the City Official Plan (1997 – Office Consolidation 2019). These polices are summarized in the sections below. Notwithstanding there is a new City of Burlington Official Plan, the intent of the policies noted below and how they are implemented are similar. In addition, the City's new (November 2020) NHS policies are consistent with Regional NHS policies. As such, compliance with Regional NHS policies would result in compliance with new City NHS policies.

2.4.1 Natural Heritage Policies

The City of Burlington Official Plan identifies significant natural features using three separate land use designations as follows:

- The Greenlands designation includes lands that form a permanent natural resource base consisting of natural features and open space areas which are ecologically sensitive;
- The Major Parks and Open Space designation applies to community and city-wide parks and other public and private open space lands; and
- The Watercourse designation applies to most of the creeks and drainage features.

The subject lands do not overlap with any Greenlands or Major Parks and Open Space designated areas and is therefore not subject to policies in S. 6.2 and S. 6.3 of the City Official Plan, although Sherwood Forest Park east of the subject lands is designated as Major Parks and Open Space. Additionally, S. 6.4 relates to the Watercourse designation which has been applied to Appleby Creek and includes policies relating to protection of life and property in floodplains. The Watercourse policies prohibit development in floodplains but do encourage degraded watercourses to be restored and enhanced to improve fish habitat. Furthermore, the policy specifies that: “Any works within or near a watercourse shall be reviewed by the City and Conservation Halton for floodplain implications” and that “new development adjacent to watercourses shall be subject to a setback from the stable top of bank, the regulatory floodplain and meander belt width (whichever is the greater) that are associated with the watercourse” as determined by the City, in conjunction with CH.

3. Background Review

3.1 Climate

Climate provides the driving energy for a fluvial system and directly influences basin hydrology and rates of channel erosion, particularly through precipitation. Precipitation records obtained from climate normals (1981-2010) recorded at the Burlington TS climate station (ID 6151064), located approximately 8 km southwest of the subject lands, averaged 67 mm per month in winter (November through February), and 79 mm in summer (July and August; Environment Canada 2020). This increase over the summer months is likely a result of convective thunderstorms. While total precipitation amounts are greater during the summer months, snowmelt and rain-on-snow events tend to produce the highest flows within a watershed.

3.2 Geology

The planimetric form of a watercourse is fundamentally a product of the channel flow regime and the availability of sediments (i.e., surficial geology) within the stream corridor. The 'dynamic equilibrium' of these inputs governs channel planform. These factors are influenced in smaller systems by physiography, riparian vegetation, and land use. The subject lands fall within the Iroquois Plain physiographic region, which borders Lake Ontario (Chapman and Putnam 1984). This region is essentially flat, marked at the landward edge by shore cliffs and valley-mouth gravel bars formed by the waves of glacial Lake Iroquois when its waters were approximately 45 m higher than the current extents of Lake Ontario. Surficial geology mapping suggests that outcropping of shale bedrock is frequent (OGS 2010). This bedrock is of the Upper Ordovician period (Queenston Formation).

3.3 Municipal Class Environmental Assessment for Appleby Creek Flood Mitigation between Fairview Street and New Street

Aquafor Beech Limited (2019) completed a municipal Class Environmental Assessment (Class EA) for Appleby Creek in the City of Burlington. The purpose of the study was to identify flood mitigation opportunities within the Appleby Creek watershed from the Canadian National (CN) Railway to New Street. The primary objective of the study was to identify specific opportunities that reduce flooding risk and protect the natural heritage features and functions within the project study area. Flood risks were identified and quantified in terms of buildings within the flood limit, frequency of road inundation, and hydraulic conveyance capacity of the channel and road crossing structures.

Reach 3 (Fairview Street to the CN Rail) of the study was relevant to the subject lands as this reach flows immediately west of the subject lands and is within the EIA/EER study area. Reach 3 was described as a straightened and confined stream corridor with a relatively steep gradient. Erosion was observed at several locations, including areas of bank and valley erosion and sometimes within shale bedrock. Several sections of the gabions were in a deteriorated state, in particular at the storm sewer outlet for the Appleby GO station parking lot and the gabion grade control structure upstream of Fairview Road. The report noted that, under existing conditions, the Regional floodplain extends into three lots within the subject lands, as well as overtopping Fairview Street with flooding extending to the intersection of Fairview Street and Oval Court.

The Class EA considered a 'do nothing' approach, Fairview Road crossing structure improvements, low impact development (LID) opportunities, local restoration works and channel modifications as alternative design solutions for Reach 3. Ultimately, the report recommended upgrading the existing Fairview Street crossing to provide flood relief up to the 100-year storm within Reach 3. The preferred alternative would still have resulted in the Regional Storm overtopping Fairview Street. Minor channel works were also recommended at the inlet and outlet of the new crossing structure to ensure an optimal hydraulic transition along Appleby Creek. Further, and subject to coordination with relevant private landowners, additional design solutions such as creek widening were discussed within the Class EA as a potential future opportunity to provide additional flood relief for the subject lands east of Appleby Creek.

3.4 Appleby Creek Erosion Control Environmental Assessment

In 2016, the City of Burlington completed the Burlington City-Wide Creek Inventory and Erosion Assessment. The report highlighted priority erosion sites within the City requiring further study. In response to these findings, the City of Burlington retained Aquafor Beech Limited (2020) to complete the Appleby Creek Erosion Control Environmental Assessment. The study area for the EA was defined as the portion of Appleby Creek extending from Lake Ontario to the South Service Road. The intent of this study was to assess the existing conditions within the study area, identify and characterize existing erosion hazards, and develop alternatives to address the hazards.

In support of the field assessment, the study delineated Appleby Creek into seven reaches within the study area; Reach 6 of Appleby Creek (Fairview Street to Harvester Road) is relevant to the subject lands. Erosion and several sections of failing gabion bank protection treatments were noted along the reach within the report; in particular, the Appleby GO Station storm outlet and the gabion grade control structure upstream of Fairview Street were flagged as areas experiencing erosion. It was noted that the Fairview Street structure was likely originally intended to protect an existing watermain that crosses under the channel at that location but was in a degraded state and preventing seasonal fish passage.

Erosion Site 7B was identified along the portion of Reach 6 adjacent to the subject lands. Erosion Site 7A was identified as the portion of Appleby Creek between Fairview Street and the Centennial Bikeway (i.e., south of the subject lands, partially within the EIA/EER study area). While described by the report as a site, Erosion Sites 7A and 7B referred to several areas of bank erosion and undermined/failing gabion baskets observed along the entire length of creek between the Metrolinx Corridor and Centennial Bikeway crossing of Appleby Creek.

The EA considered a 'do nothing' approach, local restoration works, and comprehensive reach-scale works as alternative design solutions for Erosion Sites 7A and 7B. Ultimately, the conceptual design for Erosion Sties 7A and 7B included in the EA report recommended the implementation of reach-scale bed and bank protection works along the entire length of creek between the Metrolinx Corridor and Centennial Bikeway. The conceptual design referred to this approach as an *Engineered Channel Design to Enhance Conveyance and Protect Private Properties.* This approach included the removal of existing gabion baskets, installation of armourstone retaining wall lining both sides of the creek, roundstone riffle-pool features and in-creek vegetation buffer, with retrofit of existing storm outfall into the restorative bank works. The report noted that the integrated channel widening design between Fairview Street and Metrolinx Corridor would allow for flood relief, which will also tie into the recommendation from the Appleby Creek Flood EA study (i.e., widen the Fairview Street bridge). In order to achieve the proposed channel widening, armourstone retaining walls were proposed to form the channel banks/valley slopes. Slopes above the armourstone wall would be restored with native trees and shrubs upon completion of the erosion control works.

Based on the Conceptual Design for Erosion Sites 7A and 7B provided in the EA report and our understanding of design solutions that have been implemented along other urbanized watercourse reaches within the City of Burlington (refer to **Photograph 1**), implementation of reach-scale works will entail the following design elements:

- Removal of existing vegetation within the creek corridor;
- Excavation activities, including:
    - Removal of existing gabion basket bank protection measures;
    - Regrading of the entire corridor to widen the bottom width;

- Reinforcement of the corridor side slopes with armourstone retaining walls; and
- Reconstruction of the low flow (bankfull channel) in the form of an engineered channel design that extends across the entire bottom width of the corridor, with stone bar features to enhance hydraulic roughness.;

- Revegetation of remaining buffer areas between the retaining walls and creek block limits.



Photograph 1. Existing Armourstone-lined Creek Corridor Design in the City of Burlington – Roseland Creek North of Lakeshore Road.

Widening of the existing Fairview Street crossing structure, as identified through the Appleby Creek Flood EA study was also supported. Further, Section 4.4.4 of the EA report discussed additional input from private landowners (i.e., subject lands) in relation to the potential dedication of land along the eastern limit of Appleby Creek in support of a possible channel widening, which could be taken into consideration during the detailed design stage.

4. Historical Assessment

The following section presents an overview of historical conditions in the vicinity of the subject lands with respect to land use, land cover, and channel conditions. Historical analyses provide insight into the scale of natural and human-induced changes within a watershed, particularly the degree to which channel planform adjustment and land use has changed over time. In support of the historical assessment, digital black and white and colour images were analysed and compared to obtain a simple, qualitative assessment of the degree of land use and channel planform change over time (**Table 1**).

Table 1. Summary of Key Historical Observations

Time Period	Scale, Source	Observations
1974	Northway /Photomap/Remote Sensing Ltd. (Scale 1:5,000)	Land use north of the future Centennial multi-use path south of Fairview Street (including the subject lands) is agricultural. South of the future path, land use has transitioned to residential development. The CN Rail line can be observed.
		Adjacent to the subject lands, Appleby Creek can be observed as a slightly sinuous channel situated within a narrow corridor; localized erosion along outer banks is evident. North of the CN Rail line, Appleby Creek takes the form of two well-defined branches with sinuous planforms. Evidence of erosion can be observed along outer bank; channel migration is evident through the formation of oxbow features. South of the future Centennial multi-use path, Appleby Creek has recently been channelized within a narrow corridor.
2002	First Base Solutions (Scale 1:5,000)	Land use has largely transitioned to a mixture of residential and commercial land use surrounding the subject lands. Within the subject lands, commercial development can be observed. The CN Rail line has been widened; the Centennial multi-use path and Fairview Street have been constructed.
		Adjacent to the subject lands and immediately south of the Fairview Street crossing, the Appleby Creek corridor has generally retained its dimensions and tree growth is evident. Upstream of the CN Rail line, the creek has been modified, taking the form of a single channelized drainage feature within a narrow corridor.
2019	First Base Solutions (Scale 1:5,000)	Infill development can be observed south of Fairview Street. Expansion of the Appleby GO station east of Appleby Creek can also be observed. Within the subject lands, the lands have fully developed.
		Adjacent to the subject lands, the Appleby Creek corridor remains relatively unchanged. Upstream of the rail crossing, a new crossing of the creek can be observed, linking the Go station parking lots.

5. Existing Conditions

To ensure that existing geomorphic conditions both adjacent to and immediately downstream of the subject lands were evaluated, the Study Area for the geomorphic assessment included the section of Appleby Creek from the Metrolinx Corridor to the Centennial Bikeway south of Fairview Street (**Figure 2**).



Legend

- Subject Property
- Study Area
- Extent Assessed
- Reach Break
- Watercourse
- Photo Locations

Reach and Photo Locations | **Figure 2**

Oval Court Redevelopment
Geomorphic Assessment

BEACON ENVIRONMENTAL

Project: 218416.1
Last Revised: March 2023

Client: Branthaven Development Corp

Prepared by: DU
Checked by: SG

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5.1 Reach Delineation

To facilitate a systematic evaluation of the relevant portion of Appleby Creek within the Study Area, the watercourse was delineated into reaches. Reaches are homogenous sections of channel with regard to form and function and can, therefore, be expected to behave consistently along their length to changes in hydrology and sediment inputs, as well as to other modifying factors (Montgomery and Buffington 1997; Richards et al. 1997).

For the purposes of this study, Appleby Creek was delineated into two reaches within the Study Area; Reach AC-1 extends downstream of Fairview Street, while Reach AC-2 extends from Fairview Street to the CN Rail line (**Figure 2**). The determination of reach extents was initially based on a desktop assessment of land use, degree of valley confinement, and riparian vegetation. Verification of reach extents was subsequently undertaken in the field.

5.2 Rapid Assessments

A field investigation to characterize existing geomorphic conditions along the relevant reaches of Appleby Creek was conducted by Beacon staff on November 21, 2018.

5.2.1 Methods

The following standardized rapid visual assessment methods were applied:

i. Rapid Geomorphic Assessment (RGA – MOE 2003)

The RGA documents observed indicators of channel instability by quantifying observations using an index that identifies channel sensitivity. Sensitivity is based on evidence of aggradation, degradation, channel widening and planimetric form adjustment. The index produces values that indicate whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40) or in adjustment (score >0.41).

ii. Rapid Stream Assessment Technique (RSAT – Galli 1996)

The RSAT uses an index to quantify overall stream health and includes the consideration of biological indicators (Galli 1996). Observations concerning channel stability, channel scouring/sediment deposition, physical in-stream habitat, water quality, and riparian habitat conditions are used to calculate a rating that indicates whether the channel is in poor (<13), fair (13-24), good (25-34), or excellent (35-42) condition.

iii. Downs Classification Method (Downs 1995)

The Downs (1995) classification method infers present and future potential adjustments based on physical observations, which indicate the stage of evolution, and type of adjustments that can be

anticipated based on the channel evolution model. The resultant index classifies streams as stable, laterally migrating, enlarging, undercutting, aggrading, or recovering.

5.2.2 Results

Rapid assessment results are summarized in **Table 2** and **Table 3** below. A photographic record of site conditions at the time of the assessment is provided in **Appendix B**. Photo locations are shown in **Figure 2**.

5.2.2.1 Reach AC-1

Within the extent assessed, Reach AC-1 was characterized a well-defined, straightened channel. Immediately downstream of Fairview Street, the creek is situated within confined valley setting. With distance downstream, the channel transitions to an unconfined setting. Riparian vegetation consisted of trees, shrubs, grasses, and herbaceous species, but herbaceous species were dominant. Bank angles ranged between 60-90 degrees, with 60-100% of the banks displaying evidence of erosion. Bankfull dimensions ranged between 5.5-7.2 m in width and 0.40-0.80 m in depth. Riffle and pool substrate consisted of gravel, cobble (riprap), boulders, and exposed shale bedrock. Existing channel modifications included the Fairview Street and Centennial multi-use path crossings, as well as bank hardening measures (gabion basket). A large scour pool was observed downstream of the Fairview Street crossing.

An RGA score of 0.39 indicated that Reach AC-1 was in transition (stressed). Widening was identified as the dominant mode of adjustment, as evident through the presence of fallen and leaning trees, the occurrence of large organic debris, exposed tree roots, basal scour extending over 50% of the reach and outflanking of gabion basket. Evidence of degradation and planform adjustment was also noted. An RSAT score of 18 indicated that the reach displayed a fair degree of stream health, with riparian habitat conditions, and channel stability identified as primary limiting factors. The Downs model classified this reach as a combination of 'E' – enlarging and 'm' – lateral migration, which indicates an overall trend in channel widening, with evidence of the initiation of alternating bank erosion along a previously straightened channel.

5.2.2.2 Reach AC-2

Reach AC-2 was characterized as a well-defined channel with minimal sinuosity situated within a confined valley setting. Riparian vegetation consisted of trees, shrubs, grasses, and herbaceous species. Bank angles ranged between 60-90 degrees with 60-100% of the banks displaying evidence of erosion. Riffle substrate consisted of gravel, cobble and boulders, with exposed shale. Pool substrate consisted of clay, silt, sand, gravel, and cobble with exposed clay till and shale. Bankfull widths and depths ranged between 4.8-7.0 m and 0.35-1.0 m, respectively. Existing channel modifications included the CN Rail line and Fairview Street crossings, Appleby GO stormwater outlet (western valley slope), stormwater outlet (eastern valley slope, refer to Photo 21 – **Appendix B**) and gabion bank protection.

An RGA score of 0.42 indicated that Reach AC-2 was 'in adjustment'. Widening was identified as the dominant mode of adjustment, as evident through the presence of fallen and leaning trees, the occurrence of large organic debris, basal scour extending over 50% of channel banks and outflanked

gabion basket. Evidence of degradation and planform adjustment was also observed. The RSAT score of 14.5 indicated that the reach displayed a fair degree of stream health, with riparian habitat conditions, and channel stability identified as primary limiting factors. The Downs model classified this reach as a combination of 'E' – enlarging and 'm' – lateral migration, which indicates an overall trend in channel widening, with evidence of the initiation of alternating bank erosion along a previously straightened channel. Results of the field investigation were consistent with those presented in the Appleby Creek Erosion Control EA (Aquafor 2020).

Table 2. General Reach Characteristics – Appleby Creek

Reach	Bankfull Width (m)	Bankfull Depth (m)	Channel Substrate	Riparian Vegetation	Notes
AC-1	5.50-7.25	0.40-0.80	Gravel, cobble, boulders, rip rap, exposed shale	Trees, shrubs, grasses, and herbaceous plants	• Woody debris present in channel • Channel worn into underlying bedrock • Basal scour and failing banks present • Gabion baskets outflanked • Scour pool downstream of Fairview Street
AC-2	4.75-7.0	0.35-1.0	Clay, silt, sand, gravel, cobble, boulders, exposed till	Trees, shrubs, grasses, and herbaceous plants	• Gabion grade control structure upstream of Fairview Street • Channel worn into underlying till • Basal scour and vertical banks present • Undermined and outflanked gabion baskets

Table 3. Rapid Assessment Results – Appleby Creek

Reach	Rapid Geomorphic Assessment			Rapid Stream Assessment Technique			Downs Classification Method
	Score	Condition	Dominant Mode of Adjustment	Score	Condition	Limiting Factor	
AC-1	0.39	In Transition	Widening, degradation, planform adjustment	18	Fair	Riparian habitat conditions and channel stability	'E' – enlarging and 'm' – lateral migration
AC-2	0.42	In Adjustment	Widening, degradation, planform adjustment	14.5	Fair	Riparian habitat conditions and channel stability	'E' – enlarging and 'm' – lateral migration

6. Analysis

6.1 Toe Erosion Allowance

The Provincial Policy Statement (MMAH 2020) issued under the *Planning Act* (1990) outlines areas of provincial interest with respect to natural hazards. In support of the Policy Statement, a Technical Guide - Rivers and Streams: Erosion Hazard Limit document was prepared (MNR 2002) to outline standardized procedures for the delineation and management of riverine erosion hazards in the Province of Ontario. For confined valley systems, the erosion hazard limit is governed by geotechnical considerations, including the stable slope allowance and an applicable toe erosion allowance (i.e., channel migration component).

The intent of the toe erosion allowance is to mitigate risk to the adjacent tablelands by accounting for the potential of the stream to migrate laterally into the valley wall and erode the toe of slope. This process can result in subsequent slope adjustments or failure and cause the loss of property or pose a risk to human life. The MNR (2002) Technical Guide dictates that, for confined valley systems, an initial screening must be undertaken to determine whether the valley wall is less than 15 m from the watercourse. Where soil conditions are not known, a 15 m toe erosion allowance is recommended. Based on a more detailed evaluation, the Technical Guide provides recommendations for the toe erosion allowance referencing existing soil structure and channel stability conditions (**Table 4**).

Table 4. Minimum Toe Erosion Allowance based on Existing Conditions (MNR 2002)

Type of Material Native Soil Structure	Evidence of Active Erosion or where the Bankfull Flow Velocity is Greater than Competent Flow Velocity	No Evidence of Active Erosion		
		Bankfull Width		
		<5m	5-30m	>30m
Hard Rock (e.g. granite)	0-2 m	0 m	0 m	1 m
Soft Rock (shale, limestone), cobbles, boulders	2-5 m	0 m	1 m	2 m
Clays, clay-silt, gravels	5-8 m	1 m	2 m	4 m
Sand, silt	8-15 m	1-2 m	5 m	7 m

6.1.1 Existing Conditions

The *Slope Stability Assessment* report prepared by DS Consultants Ltd. (2020) included a total of six slope profiles along the subject lands. The report generally characterized the creek bed and toe of slope as consisting of shale bedrock, with some areas protected by gabion basket. Referencing these existing soil and creek conditions, the report recommended an erosion allowance of 2.0 m at the toe of slope be used for the setback of the long-term stable slope. This recommendation is consistent with MNR (2002) Technical Guide recommendations for the minimum toe erosion allowance where the type of material is soft rock (shale, limestone), cobbles, boulders (**Table 4**). Findings of the geomorphic field investigation undertaken in support of this study confirmed the presence of exposed shale bedrock along the toe of slope/channel banks.

7. Description of the Redevelopment Proposal

7.1 Site Plan

The proposed Site Plan (Core Architects Inc. 2023) proposes that the subject lands will be redeveloped into six blocks with eight (8) high-rise buildings ranging between 11 and 30 storeys upon shared podiums and a shared 3 storey underground parking garage that will extend to the north, east, and south property lines, and to within 1 m of the western limit of development.

Land uses include residential, commercial (office and retail), landscaped areas, a daycare and a library. Additionally, a trail system is proposed between Sherwood Forest Park and the Centennial Bikeway, and pedestrian promenade will provide access to Sherwood Forest Park. A rail crash berm is proposed on the northern end of the subject lands as required by Metrolinx.

The proposed redevelopment will be accessed through one entrance on Fairview Street. Additionally, an active transportation link across the Appleby Creek was identified in the draft Precinct Plan for the Appleby GO Station Mobility Hub. A pedestrian crossing of Appleby Creek is also proposed to connect the community to the transit station as shown in the Site Plan (Core Architects Inc. 2023).

To allow for phasing of the development, each block will have its own on-site SWM controls and individual storm, sanitary, water, and utility connections (Urbantech Consulting 2023).

7.2 Grading

7.2.1 Appleby Creek Valley Corridor Grading

As discussed in **Section 5.1** of the FSR/SWM Report (Urbantech Consulting 2023), under existing conditions, private and public property located in the vicinity of Appleby Creek and Fairview Street is impacted by the Regional Storm floodplain. To contain the Regional Storm floodplain within the corridor, a minor widening / re-shaping of the eastern corridor slope, essentially creating a new “top of slope” along the corridor, is proposed. In addition to the proposed grading works, replacement of the existing Fairview Street crossing structure with three (3) culvert structures is proposed. The proposed corridor grading and culvert improvement works address recommendations from the Appleby Creek Flood Mitigation Class EA (Aquafor Beech Ltd. 2019) and will remove flooding from the subject lands, as well as provide safe access/egress for the subject lands as well as existing residential development east of Appleby Creek through the elimination of the overtopping at Fairview Street.

It should be noted that replacement of the existing Fairview Street crossing structure will require in-water works to remove the existing structure. Localized grading is proposed to optimize the transition between the existing watercourse and the culvert inlet/outlet. South of Fairview Street, localized grading is proposed along the corridor side slopes to transition from the proposed structure to existing topography. Existing stormwater outfalls that currently outlet to Appleby Creek along the south side of Fairview Street via headwall structures will be integrated into the replacement structure. Crossing details are to be further investigated at detailed design to confirm that there are no crossing conflicts between the proposed culvert structures and other servicing, utilities, etc. As noted earlier, the City’s Flood Mitigation and Erosion Control EAs also contemplated grade changes upstream and downstream

of the culvert crossing to accommodate the installation of the new crossing structure and reach-scale channel restoration works.

Refer to Drawings CH-1 to CH-3 in the FSR/SWM Report (Urbantech Consulting 2023) for the proposed corridor grading plan.

7.3 Stormwater Management

The existing development was designed with no formal stormwater quality or quantity controls. Stormwater from the existing development is released to Appleby Creek via four outlets – 3 small outlets north of Fairview Street and one main outlet south of Fairview Street. The proposed stormwater management system for the redevelopment has been designed to meet City of Burlington 2020 Stormwater Management Design Criteria in terms of quality and quantity control, water balance and erosion control.

7.3.1 Stormwater Quantity Control

Section 4.5.1 of the FSR/SWM Report (Urbantech Consulting 2023) outlines how stormwater quantity control will be addressed within the subject lands. All flows from the site, regardless of outlet, will enter Appleby Creek via the storm sewer system or direct overland flow. Overall, the FSR/SWM Report (Urbantech Consulting 2023) identified a flow reduction from the site to the Appleby Creek system for all modelled storm events.

Per the City of Burlington 2020 Stormwater management Design Criteria, the following stormwater quantity control criteria will be met with the proposed design:

- All flows draining to Appleby Creek will match post-development to pre-development flows for the 2-year to the 100-year storm return periods;
- For redevelopment sites, a maximum imperviousness of 36% may be applied (equivalent to a runoff coefficient C = 0.5) in cases where the flows discharge to a storm sewer; and
- All flows discharged to the storm sewer on Oval Court will control the 100-year post development storm flows to the available sewer capacity (5-year storm at 85% maximum) within the receiving Fairview Street sewer. Based on the assessment of existing infrastructure, it was determined that the allowable release rate from the proposed Oval Court lands directed to the storm sewer is 0.4 m^3/s. Control to this target during the 100-year event will ensure no increases to the Fairview Street flows. This represents an improvement to the overall storm sewer system, as currently there are no SWM controls on the subject lands and the 100-year storm likely discharges onto the Oval Court and Fairview Street ROW with no controls.

Stormwater quantity control will be provided by six (6) underground storage tanks within the underground parking structure for flows from the development being directed to the Oval Court. All storm tanks are pumped such that there is a 24-hour release rate during the 4-hour 25 mm event. The existing storm sewer on Oval Court will be reconstructed as a 450mm to 600mm to accommodate the needs of the redevelopment proposal. The proposed sewer is designed to convey 100-year controlled flows from each of the development blocks.

Based on the above, the proposed stormwater management approach will remove the three stormwater outfalls from the creek corridor, immediately west of the subject lands and direct the majority of drainage from the subject lands into a new outfall, in approximately the same location as the existing outfall, within the upgraded Fairview Street culvert crossing. This represents an improvement from existing conditions through the removal of infrastructure from within the creek corridor and addresses a concern raised by CH through their review of the first submission.

In order to address water balance, a biofiltration gallery is proposed at the northern limit of the subject lands. This gallery will direct clean drainage to Appleby Creek immediately downstream of the rail line and will serve to supplement low flows to the creek to replace some of the flows removed as a result of combining the existing outfalls.

For further details, refer to the FSR/SWM Report (Urbantech Consulting 2023).

7.3.2 Stormwater Quality Control

As outlined in Section 4.5.2 of the FSR/SWM Report, to achieve MECP “enhanced” level water quality protection (80% TSS removal), oil/grit separators (OGS) will be implemented on each phase, except for Phase 3. Phase 3 does not have any driveway surfaces. All phases will implement the Jellyfish Filter System, which is ETV certified for 88% TSS removal. Model JF4-2-1 is proposed for Phase 2, whereas Model JF4-1-1 is proposed for Phases 1, 4, 5, and 6. The SWM tanks are designed to have two inlets to separate clean roof from surface runoff. The OGSs are placed upstream of all SWM tanks and will treat surface water. All uncontrolled flows from landscaped areas and sidewalks are considered to be clean and as such no treatment is proposed.

Based on the above, the proposed stormwater management approach will result in improved water quality to Appleby Creek through the provision of on-site quality controls in an area that currently has no quality controls.

For further details, refer to the FSR/SWM Report (Urbantech Consulting 2023).

7.4 Site Water Balance

Conservation Halton recommend that pre-development to post-development water balance be met for the proposed development. The City of Burlington design criteria for water balance indicates that the first 5 mm of runoff be retained on site using acceptable LID practices. As described in Section 4.5.3 of the FSR/SWM Report (Urbantech Consulting 2023), for the 4.23 ha of the site area being developed, 211.5 m^3 of water is required to be retained, which equates to an annual requirement of 15,968 m^3/year.

A Hydrogeologic Assessment was prepared by DS Consultants Ltd. (2020) which indicated an unmitigated annual water balance deficit of 2,145 m^3/year. As infiltration design is not feasible due to the full coverage nature of the underground parking structure, filtration through LID’s is proposed rather than infiltration.

7.4.1 Water Balance Measures

As outlined in Section 4.5.3 of the FSR/SWM Report (Urbantech Consulting 2023), measures that can be implemented to achieve the water balance objectives include implementing a combination of potential green roofs, roof top storage to enhance evaporation, irrigation, reuse opportunities and potential passive infiltration within the buffer of Appleby Creek. All storage tanks are designed to account for the storage equivalent to the 5 mm capture target. The end use of this water and refinement of the required sump storage will be determined at detailed design. Water balance calculations provided in Appendix C of the FSR/SWM Report (Urbantech Consulting 2023) identify an annual on-site retention of 4,679 m^3/year though the use of green roofs and the biofiltration gallery which exceeds the annual deficit. The biofiltration gallery is proposed at the northern limit of the subject lands. This gallery will direct clean drainage to Appleby Creek immediately downstream of the rail line. Design of the biofiltration gallery, including the transition of released flows to Appleby Creek will be explored further at detailed design.

7.4.1.1 Erosion Control

City of Burlington erosion control criteria are based on the 4-hour, 25 mm event for a minimum of 24 hours. The propose SWM tanks for all phases will have the 25 mm storm event pumped at a drawdown time of 24 hours to achieve extended detention. The pump will discharge flows to the storm service maintenance hole, located adjacent to the right of way in the private property. Pump details will be coordinated by the mechanical engineer during the detailed design stage. In addition, the overall 4-hour, 25 mm event flow to Appleby Creek under proposed conditions is 61% less than under existing conditions.

8. Impact Assessment

Potential impacts on channel morphology associated with the proposed development activities include:

- Release of sediment to Appleby Creek during and immediately following construction, corridor grading, pedestrian crossing and culvert replacement activities;
- Temporary impacts to flow and channel form during culvert replacement activities; and
- Increase in existing instream erosion rates post-development due to released stormwater.

9. Mitigation Measures

9.1 Erosion and Sediment Control

Section 9 of the FSR/SWM Report (Urbantech Consulting 2023) recommends that erosion and sediment controls (ESC) be implemented for all construction activities undertaken during site works and that these controls will conform to ESC best practices as described in the Erosion and Sediment Control Guide for Urban Construction (TRCA 2019). Additionally, detailed ESC reports and drawings will be

prepared in support of the channel / culvert permit applications and subdivision road (Oval Court) and site plan submissions.

9.2 Appleby Creek Corridor Grading

While the proposed corridor grading activities will result in temporary disturbance to the Appleby Creek corridor, these activities will not include in-water works or modifications to the bankfull (active) channel. Overall, the proposed grading activities are anticipated to benefit Appleby Creek system by enhancing the hydraulic capacity of the corridor and restoring a functional connection between the bankfull channel adjacent floodplain which will reduce flow depths during larger storm events and mitigate risk of instream erosion relative to existing conditions. Further, 3:1 grading of the valley slope avoids the need for armouring of the valley slope.

The proposed corridor grading activities address recommendations from the Appleby Creek Flood Mitigation Class EA (Aquafor Beech Ltd. 2019) and Appleby Creek Erosion Control EA (Aquafor Beech Ltd. 2020), which identified the reach-scale removal of existing gabion basket bank protection measures and widening of the channel/floodplain, but with the additional benefit of avoiding installation of armourstone retaining walls along a portion of the eastern valley wall. The provision of a functional floodplain connection is also consistent with the Class EA recommendation of restoring the form and function of Appleby Creek within this reach.

9.3 Fairview Street Culvert Replacement

The existing Fairview Street twin (3.35 m) box culvert structure is undersized and does not accommodate the channel bankfull width, which ranged from 4.75-7.25 m (refer to **Section 5.2.2**). The proposed 7.32 m central Con/Span Arch culvert structure is sufficient to accommodate the channel bankfull width and provides an improvement over existing conditions by mitigating hydraulic contraction and expansion conditions that have contributed to existing observed issues of erosion at the Fairview Street culvert inlet and outlet. The increased hydraulic capacity provided by the overall structure will further mitigate erosion potential under the proposed condition. While temporary disturbance to the Appleby Creek is required to construct the replacement structure and tie into the existing watercourse, the long-term benefits outweigh these impacts from a geomorphic perspective.

9.4 Pedestrian Bridge

As the proposed pedestrian bridge crossing of Appleby Creek will span the valley, it is sufficient to address geomorphic design consideration with respect to erosion hazard. Further, no impacts to channel morphology are anticipated. Potential impacts associated sediment release to the watercourse during construction can be mitigated through appropriate erosion and sediment control measures (refer to **Section 9.1**).

9.5 Stormwater Management

Under proposed conditions the FSR/SWM Report (Urbantech Consulting 2023) identified a flow reduction from the site to the Appleby Creek system for all modelled storm events and extended (24 hour) detention of the 4-hour, 25 mm event. From a geomorphic perspective, the provision of these erosion control stormwater measures represents an improvement relative to existing conditions as Reaches AC-1 and AC-2 of Appleby Creek were both characterized as exhibiting evidence of active erosion (**Section 5.2.2**) in response to existing flow contributions. Integration of the two existing stormwater outfalls south of Fairview Street into the new culverts will mitigate potential for erosion at these locations. In addition, existing outfalls to Appleby Creek from the subject lands will be removed, mitigating any associated erosion issues. Implementation of green roofs in addition to the biofiltration gallery proposed at the northern limit of the subject lands will address water balance requirements and direct clean drainage to Appleby Creek.

9.5.1 Stormwater Quality Control

The Urbantech Consulting (2023) FSR/SWM Report identifies a quality control objective of enhanced (80%) TSS removal for the proposed stormwater management design. This proposed approach is anticipated to provide an improvement over existing conditions, as it is understood that quality control measures are not currently implemented within the existing development.

10. Conclusion

Beacon was retained by Branthaven Development Corporation to complete a geomorphic assessment in support of a site plan application for the proposed Official Plan and Zoning By-law Amendment (mixed use residential and commercial) for the redevelopment of properties located at 720, 735 and 740 Oval Court and 5135 and 5155 Fairview Street in the City of Burlington. The legal description of the subject lands is Lots 1 to 7, Registered Plan 20M 524, City of Burlington, Regional Municipality of Halton. Existing land use within the subject lands consists of five (5) low-rise commercial and industrial buildings and associated parking lots. Redevelopment opportunities to convert the subject lands to a six (6) Block, high density residential and commercial neighbourhood are currently being considered. The proponent intends to redevelop the subject lands into a transit-oriented community designed for residential, retail and commercial uses.

The following points summarize the findings of this study:

- The reach of Appleby Creek relevant to the subject lands has previously been identified as an area of flooding and erosion concerns through Class EA studies completed by the City of Burlington;
- A review of historic aerial photographs and topographic mapping indicated that the Appleby Creek adjacent to the subject lands is a heavily modified (channelized), well-defined channel situated within a narrow, confined valley system;
- Rapid geomorphic assessment results characterized Reaches AC-1 and AC-2 of Appleby Creek within the Study Area as exhibiting evidence of active erosion in the form of widening, degradation and planform adjustment (RGA scores of 0.39 and 0.42, respectively);

- The Slope Stability Assessment report prepared by DS Consultants Ltd. (2020) recommended a 2 m toe erosion allowance for the subject lands based on existing conditions. This allowance conforms with the MNR (2002) Technical Guide geomorphic field observations of local overburden conditions;
- The proposed corridor grading and culvert replacement activities proposed will limit disturbance to the active channel to the greatest extent possible, and will eliminate flooding impacts within the subject lands, allow safe vehicular and pedestrian access/egress and mitigate instream erosion potential relative to existing conditions; and
- The proposed stormwater management design (Urbantech Consulting 2023) identifies the implementation of quality control, quantity control, erosion control and LID measures, all of which represent an enhancement relative to existing conditions.

Should you have any questions or require any additional information please contact the undersigned.

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Appendix A

Historical Imagery

Legend

Subject Property

Historical Aerial Imagery	**1974**

Oval Court Redevelopment
Geomorphic Assessment

BEACON ENVIRONMENTAL

Project: 218416.1
Last Revised: October, 2020

Client: Branthaven Development Corp	Prepared by: DU Checked by: SG

1:5,000

0 50 100 m

Contains information licensed under the Open Government License–
Ontario Orthoimagery Baselayer: Northway/Photomap/Remote Sensing Ltd.

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Legend

Subject Property

Historical Aerial Imagery	**2002**
Oval Court Redevelopment Geomorphic Assessment	
BEACON ENVIRONMENTAL	Project: 218416.1 Last Revised: October, 2020
Client: Branthaven Development Corp	Prepared by: DU Checked by: SG
1:5,000	0 50 100 m

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Ontario Orthoimagery Baselayer: FBS Halton 2002

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Legend

Subject Property

Historical Aerial Imagery	**2019**

Oval Court Redevelopment
Geomorphic Assessment

BEACON ENVIRONMENTAL

Project: 218416.1
Last Revised: October, 2020

Client: Branthaven Development Corp	Prepared by: DU Checked by: SG

1:5,000

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Ontario Orthoimagery Baselayer: FBS Halton 2019

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Appendix B

Photographic Record



Photograph 1. (Photo Location 1)

Reach AC-1
Downstream view of general conditions from limit of extent assessed.



Photograph 2. (Photo Location 1)

Reach AC-1
Upstream view of general conditions.



Photograph 3. (Photo Location 2)

Reach AC-1
Upstream view of undermined and failing gabion basket.



Photograph 4. (Photo Location 3)

Reach AC-1
Upstream view of undermined and failing gabion basket.



Photograph 5. (Photo Location 4)

Reach AC-1
Downstream view of general conditions from existing pedestrian crossing. Note: gabion lined bank (photo left)



Photograph 6. (Photo Location 4)

Reach AC-1
Upstream view of general conditions from existing pedestrian crossing.



Photograph 7. (Photo Location 5)

Reach AC-1
Upstream view of failed gabion basket in channel (photo left).



Photograph 8. (Photo Location 6)

Reach AC-1
Upstream view of gabion bank protection (right bank).



Photograph 9. (Photo Location 7)

Reach AC-1
Upstream view towards Fairview Street - general conditions.



Photograph 10. (Photo Location 8)

Reach AC-1
Upstream view of secondary channel formation.



Photograph 11. (Photo Location 9)

Reach AC-1
Downstream view (from Fairview Street) of secondary channel formation.



Photograph 12. (Photo Location 9)

Reach AC-1
Upstream (east facing) view of Fairview Street crossing. Note existing stormwater outlet and scour pool formation downstream of crossing.



Photograph 13. (Photo Location 9)

Reach AC-1
Upstream (west facing) view of Fairview Street crossing. Note existing stormwater outlet and scour pool formation downstream of crossing.



Photograph 14. (Photo Location 10)

Reach AC-2
East facing view of existing gabion weir structure (approx. 0.6 m height) at Fairview Street culvert inlet (upstream of culvert).



Photograph 15. (Photo Location 10)

Reach AC-2
Upstream (west facing) view of secondary channel formation from Fairview Street.



Photograph 16. (Photo Location 10)

Reach AC-2
Upstream view of main channel from Fairview Street.



Photograph 17. (Photo Location 11)

Reach AC-2
Upstream view of debris jam.



Photograph 18. (Photo Location 12)

Reach AC-2
Upstream view of undermined and undercut gabion bank protection (right bank).



Photograph 19. (Photo Location 12)

Reach AC-2
Approx. 0.3 m deep undermine of gabion bank protection.



Photograph 20. (Photo Location 13)

Reach AC-2
Upstream view of riffle – basal scour along both banks.



Photograph 21. (Photo Location 14)

Reach AC-2
East facing view of existing stormwater outlet to corridor (left bank).



Photograph 22. (Photo Location 15)

Reach AC-2
Downstream view of exposed shale bank (left bank) and medial bar formation.



Photograph 23. (Photo Location 15)

Reach AC-2
Upstream view of shale and stone cascade (approx. 0.3 m height).



Photograph 24. (Photo Location 16)

Reach AC-2
Upstream view of gabion bank protection (right bank).



Photograph 25. (Photo Location 17)

Reach AC-2
Upstream view of gabion bank protection (right bank – photo left).



Photograph 26. (Photo Location 18)

Reach AC-2
Downstream view general conditions.



Photograph 27. (Photo Location 19)

Reach AC-2
Upstream view of undermined gabion bank protection (right bank).



Photograph 28. (Photo Location 20)

Reach AC-2
West facing view of existing GO Station stormwater outlet (right bank).



Photograph 29. (Photo Location 20)

Reach AC-2
Downstream view of gabion bank protection (right bank) from existing stormwater outlet.



Photograph 30. (Photo Location 21)

Reach AC-2
Downstream view general conditions.



Photograph 31. (Photo Location 21)

Reach AC-2
Upstream view of stone bank protection (photo right).



Photograph 32. (Photo Location 22)

Reach AC-2
Upstream view of bank erosion along existing fence line (left bank).



Photograph 33. (Photo Location 23)

Reach AC-2
Downstream view of bank erosion (left bank) along existing fence line.



Photograph 34. (Photo Location 23)

Reach AC-2
Upstream view of rail line crossing.