BEACON ENVIRONMENTAL

GUIDING SOLUTIONS IN THE NATURAL ENVIRONMENT

51, 53, 55 &75 Bradford St. and 20 Checkley St., Barrie Geomorphic Assessment

Bunker Creek Watershed, City of Barrie

Prepared For:

Barrie Lakeshore Developments

Prepared By:

Beacon Environmental Limited

Date: *Project:*

August 2020 **219403.2**

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1. Introduction

Beacon Environmental Limited (Beacon) was retained by Barrie Lakeshore Developments to undertake a geomorphic assessment in support of a Site Pan Application to redevelop the property located at 51, 53, 55 &75 Bradford St. and 20 Checkley Street (Part of Lot 24 and 25, Concession 5), in the City of Barrie ('subject property'; **Figure 1**). The subject property, which is located within the jurisdiction of the Lake Simcoe and Region Conservation Authority (LSRCA), is approximately 3.5 hectares in size, and is bounded by Lakeshore Drive to the east, Bradford Street to the west, Checkley Street in the north, and Bunker's Creek to the south. A portion of Bunkers Creek traverses the property.

Historically, the property has been used for industrial purposes. Land use currently consists of a vacant commercial building (formally a car dealership). There are existing residential condominium buildings to the north and south and the Lake Simcoe waterfront to the east across Lakeshore Drive. An adjacent natural feature is the Bunker's Creek Eco-park, a ponded / wetland area adjacent to Bunker's Creek. The purpose of this geomorphic assessment is to characterize existing geomorphic conditions along the portion of Bunkers Creek relevant to the subject property, and to delineate meander belt limits.

The following tasks were undertaken in support of this study:

- Background review of available materials including topographic mapping, recent and historical aerial photography, and pertinent studies and reports;
- Historical 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;
- Desktop assessment to delineate reaches based on underlying geomorphic controls;
- A field assessment to characterize existing geomorphic conditions, confirm valley floor dimensions, and document evidence of active channel processes; and
- Following applicable policies and guidelines, delineate the meander belt limit on a reach basis, referencing recent aerial imagery, historical trends in channel planform (where feasible), and empirical modelling.

2. Background Review

2.1 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 Barrie Water Pollution Control Centre averaged 77 mm per month in winter (November through February), and 84 mm in summer (July and August; Environment Canada 2020). This increase over the summer months is likely a result of convective thunderstorms.

The Barrie Creeks, Lovers Creek and Hewitt's Creek Subwatershed Plan (LSRCA 2012) reviewed long-term climate data from 1950 to 2008. The Subwatershed Plan noted that fluctuations in the amount of precipitation, particularly winter precipitation, are somewhat expected at the Barrie WPCC meteorological station due to its close proximity to Lake Simcoe, causing lake effect precipitation events

but, overall the Subwatershed Plan did not identify a significant change in annual precipitation over the 60 year record, but a possible tendency to increasing precipitation since the 1980s.

2.2 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 Barrie Creeks, Lovers Creek and Hewitt's Creek Subwatershed Plan (LSRCA 2012) characterized quaternary geology within the subject property as being within the sandy plain Simcoe Lowlands physiographic region. This physiographic region is described as having lower elevations, with flat-floored valley features that generally correspond to current river systems. The lowlands were flooded by glacial Lake Algonquin and as a result are floored by sand, silt and clay (Chapman and Putnam, 1984).). Soils within the subject property were characterized as high infiltration loamy sands.

2.3 Watershed Conditions

The Barrie Creeks, Lovers Creek and Hewitt's Creek Subwatershed Plan (LSRCA 2012) describes Bunker's Creek as a major tributary in the Barrie Creeks subwatershed, which drains directly into Lake Simcoe. The upper reaches are classified as cold water habitat, but the main branch changes to warm water habitat downstream of the Highway 400. With the steepest slope of all the Barrie Creeks, Bunker's Creek has the second highest drainage density, and these contribute to it being a more flashy system during precipitation events (LSRCA 2012). At the downstream extent of the subject property (at Lakeshore Drive), it has a catchment area of 3.3 km^2 (MNRF 2020).

2.4 Drainage Master Plan (Tatham Engineering Limited, 2019)

A Drainage Master Plan was prepared by Tatham Engineering Limited for the City of Barrie in 2019. Drainage Master Plans are intended to identify drainage deficiencies in the city, evaluate alternative solutions to address the deficiencies, and recommend a preferred alternative solution for implementation. For Bunker's Creek, the Drainage Master Plan identified culvert improvements for the crossing at Bradford Street to satisfy City of Barrie Flow Design Guidelines for Road Crossings, and natural watercourse enhancements from Bradford Street to Lakeshore Drive, to increase conveyance capacity, habitat and canopy (Tatham 2019).

The Drainage Master Plan (Tatham 2019) confirmed that the capacity of the existing crossing at Bradford Street does not satisfy the City's design flood frequency criteria. Therefore, the crossing was recommended to be replaced with a larger structure with twin open bottom span structures. The culvert replacement requires watercourse improvements upstream and downstream of Bradford Street to accommodate the wider plan structure. While upstream improvements were previously recommended through an earlier Bunkers Creek Master Drainage Plan Update by Giffels in 2004, watercourse improvements downstream of Bradford Street were not identified. These would improve the hydraulics of the lower reach of Bunker's Creek from Innisfil Street to Lakeshore Drive (Tatham 2019).

Site Location	Figure 1
51 Bradford Street, Barrie	
BEACON ENVIRONMENTAL	Project: 219403.2 Last Revised: July, 2020
Client: Barrie Lakeshore Developments	Prepared by: DU Checked by: SG
N 1:5,000	Inset Map:1:50,000

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The Drainage Master Plan (Tatham 2019) noted that downstream of Bradford Street, the low flow channel of Bunker's Creek has limited capacity resulting in flooding on private property within a wide floodplain. It notes that the low-flow channel capacity is less than the 1:2-year return frequency storm peak flow. Therefore an opportunity exists to improve the watercourse from Bradford Street to Lakeshore Drive. Improving the watercourse along this section of Bunker's Creek will improve the hydraulics of the drainage system and reduce the extent and frequency of flooding. The individual project evaluation demonstrated that the watercourse improvement will have an overall positive impact on the project environments and be beneficial to the watershed (Tatham 2019).

3. Historical Assessment

The following section presents an overview of historical conditions in the vicinity of the subject property 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, black and white aerial photographs and digital colour imagery were analysed and compared to obtain a simple, qualitative assessment of the degree of land use and channel planform change over time (**Appendix A**). **Table 1** provides a summary of specific observations regarding change in land use based on available historical aerial imagery.

Table 1. Summary of Key Historical Observations

Time Period	Scale, Source	Observations
1986	1:8000, Northway/Photomap/Remote Sensing Ltd.	Land use surrounding the subject property is predominantly urbanized. However, a sparsely vegetated field was noted within the subject property, with a few mature trees. The watercourse appeared to have been straightened previously. West of the subject property, the watercourse was restricted between two adjacent developments. Within the subject property, the banks were noted to be vegetated by shrubs and tall grasses, with few mature trees. There is evidence of ponding near the southeast corner of the property, and appears to be draining into the marina east of Lakeshore Drive.
2008	1:3000, First Base Solutions	Land use remains unchanged within the areas within and surrounding the study area. Improvements along Lakeshore Drive could be observed, mainly through the realignment of the road towards Simcoe Street. The watercourse appears to be more discernible within the aerial photo. Riparian vegetation consisted mainly of tall grasses along the banks, with few mature trees. The ponding in the southeast remains present and remains vegetated by grass and few trees.
2016	1:3000, First Base Solutions	Land use both on site and surrounding the subject property remains the same. However, further improvements could be seen along Lakeshore Drive, including the road widening and addition of a median between the northbound and southbound lanes, as well as the increase in parking space adjacent to the marina.

Time Period	Scale, Source	Observations
		The watercourse is as discernible and vegetated as 2008, however the watercourse now flows underneath Lakeshore Drive through a series of new, larger culverts. There is also a water retention pond in the previous ponding location observed in 1986.

4. Existing Conditions

4.1 Reach Delineation

To facilitate a systematic evaluation of the relevant portion of Bunkers Creek, 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, the section of Bunkers Creek between Bradford Street to Lakeshore Drive was delineated as a single reach (Reach Bu-16; see **Figure 2**), in accordance with the Drainage Master Plan (Tatham 2019). The determination of reach extents was initially based on a desktop assessment of land use, riparian conditions and channel planform. Verification of reach extents was subsequently undertaken during the field assessment.

4.2 Field Assessment

4.2.1 Methods

In order to characterize existing geomorphic conditions along Reach Bu-16, rapid field assessments were conducted on May 4, 2020. 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).

Reach Delineation, Photo Location and Meander Belt

Figure 2

51-57 Bradford Street
Geomorphic Assessment

Legend

- Subject Property
- Photo Locations
- Reach Break
- Watercourse 2016
- Meander Belt (35 m)

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Project: 219403.2
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Checked by: DU

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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.

4.2.2 Results

Results of the rapid assessments 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**.

Reach Bu-16 was characterized as a well-defined channel situated within an unconfined valley setting. The reach displayed a low gradient and low sinuosity. Meander amplitudes were found to measure approximately 12-14 m. Riparian vegetation predominantly consisted of cattails and tall grasses, with some shrubs. Within the subject property, the riparian buffer was narrow, extending less than one channel width in dimension. Bank angles ranged between 60-90 degrees, with undercutting observed (0.05-0.15 m). Bank materials consisted of clay, silt, and sand. Riffle-pool morphology was observed, with bankfull widths ranging between 3.0-4.7 m, and bankfull depths ranging between 0.90-1.2 m. Riffles and pools were spaced 15-30 m apart. Riffle substrate consisted predominantly of sand, while pool substrate was a mixture of sand, silt and clay. Aquatic instream vegetation was absent, but low densities of woody debris were noted in the channel. Undercuts of 5-15 cm were also noted within the outer meander bends.

The RGA results indicated that Reach Bu-16 was stressed, or 'in transition, with a score of 0.39. Widening and degradation were identified as the primary modes of adjustment. Evidence supporting these processes included the prevalence of basal scour along channel banks, scour pool formation downstream of culverts/outfalls and undermining of bank protection measures. An RSAT score of 17 indicated that the reach displayed a 'fair' degree of stream health. Riparian habitat conditions were identified as the primary limiting factor. The Downs model classified this reach as e – 'enlarging' based on the presence of steep banks and evidence of downcutting.

Existing channel disturbances included the Bradford Street and Lakeshore Drive road crossings, an off-property wooden retaining wall along the southern channel bank, as well as storm outfall and offline wetland outlet channels downstream of the subject property. Downstream of the subject property, the backwater influence of Lake Simcoe water levels was also observed as an influence on channel form.

Table 2. General Reach Characteristics – Reach Bu-16

Reach	Bankfull Width (m)	Bankfull Depth (m)	Channel Substrate	Riparian Vegetation	Notes
Bu-16	3.0-4.7	0.90-1.2	Sand, silt and clay	Cattails, tall grasses and shrubs	• Wooden retaining wall along southern channel bank • Low density of woody debris in channel • Backwater influence of lake levels observed within downstream portion of reach

Table 3. Rapid Assessment Results – Reach Bu-16

Reach	Rapid Geomorphic Assessment			Rapid Stream Assessment Technique			Downs Classification Method
	Score	Condition	Dominant Mode of Adjustment	Score	Condition	Limiting Factor	
Bu-16	0.39	In Transition	Widening and Degradation	17	Fair	Riparian habitat conditions	e – 'enlarging'

5. Policy Context

5.1 Provincial Policy Statement (2020)

The Provincial Policy Statement (MNRF 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. 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). In the case of partially confined valley systems, the limits of the erosion hazard are guided by the valley wall in the confined sections, and the greater of the regulatory floodline and meander belt in unconfined sections.

5.2 Lake Simcoe Region Conservation Authority Watershed Policies and Regulations

The LSRCA regulates hazard lands including watercourses, valleylands, flood hazards, shorelines, and wetlands, and lands adjacent to these features under *Ontario Regulation 179/06*. The LSRCA Guidelines for the Implementation of Ontario Regulation 179/06 Development, Interference with Wetlands and Alteration to Shorelines and Watercourses Regulation (2020) implement the *Conservation Authorities Act* (1990), as well as provide details on the requirements for assessing hazard lands. The LSRCA also provides guidance to municipalities on matters related to natural hazards through peer review and technical comment.

Section 7.3 of provides the following guidance with respect to erosion hazards associated with river and stream valleys and the shoreline of Lake Simcoe:

> *7.3.1 in general, development shall be directed to areas outside of lands adjacent to Lake Simcoe and river and stream systems which are impacted by erosion hazards;*
>
> *7.3.2 development proposals within the erosion hazard limit of river and stream systems must be supported by a geotechnical/geomorphological report prepared by a qualified professional to the satisfaction of the LSRCA;*
>
> *7.3.3 development proposals which are within the erosion hazard limit of Lake Simcoe which are impacted by erosion hazards must be supported by a coastal engineering/geotechnical study prepared by a qualified professional to the satisfaction of the LSRCA;*
>
> *7.3.4 all development shall be setback a minimum of 15.0 metres from the stable slope line or top of bank, whichever is greater*

5.2.1 Ontario Regulation 179/06

For unconfined (not apparent) river or stream valleys, Ontario Regulation 179/06 defines the valley extent as the greater of:

> (A*) the distance from a point outside the edge of the maximum extent of the flood plain under the applicable flood event standard, plus 15 metres, to a similar point on the opposite side, and*
>
> *(B) the distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard, plus 15 metres, to a similar point on the opposite side.*

The Belt Width Delineation Procedures (TRCA 2004) document outlines standards of practice for delineating meander belt limits in southern Ontario, including LSRCA jurisdiction.

5.3 City of Barrie Official Plan (2010, Office Consolidation 2018)

On April 23, 2010 The Ministry of Municipal Affairs and Housing (MMAH) approved a new Official Plan for the City of Barrie. According to the plan, "*the City shall protect, maintain and enhance water and water related resources on an integrated watershed management basis.*"

Activities interfering in any way with an existing watercourse, such as channel straightening or diversions, are prohibited except with written approval from the Conservation Authority. Development limits shall be established by the limit of the valley or stream corridor which includes the watercourse, associated riparian vegetation, floodplain or erosion hazard lands, top of bank, and any additional lands.

Development adjacent to a valley and stream corridor must include protections and/or enhancements to the feature and its functions to facilitate a natural, open space corridor. Land uses within the vegetation zone shall be restricted to those that maintain or enhance the natural features and ecological functions of the area.

6. Analysis

6.1 Meander Belt Width

The meander belt width is generally defined as the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. Given the historically modified nature of Reach Bu-16, an empirical modelling approach was used to determine a recommended meander belt dimension. These models use simple power functions based on field-based measurements of the average bankfull width (W_b) following relations from Williams (1986 – Equations 1) and Ward (2001 – Equation 2). Research by Ward et al. (2002) indicated that the Williams (1986) width equation, at times, under-predicted the belt width dimensions. As such, a modified approach to the Williams (1986) relation, which incorporates a 20% factor of safety, was applied.

$$B_w = ([4.3*W_b^{1.12}])*1.2 \quad \text{[Eq. 1]}$$

$$B_w = (6*W_b^{1.12}) \quad \text{[Eq. 2]}$$

Results of the empirical modelling analysis are summarized in **Table 4**. The resultant 35 m meander belt dimension was then reviewed relative to historical and recent aerial imagery, to ensure that the dimension was appropriate and captured current and historical channel locations. Meander belt limits are shown in **Figure 2**.

Table 4. Recommended Meander Belt Width – Reach Bu-16

Reach	Empirical Approach (m)				Recommended Meander Belt Width (m)
	Bankfull Width (m)	Williams (1986) Meander Belt Width (m)	Ward (2001) Meander Belt Width (m)*	Average	
BC-1	4.7	29	39	35	35

*converted from feet

7. Policy Conformance

The procedures used to delineate the meander belt are in accordance with applicable guidelines (TRCA 2004) and provincial policies. Ontario Regulation 179/06 requires an additional setback from the meander belt limit and should be confirmed through consultation with LSRCA.

8. Conclusions

Beacon Environmental Limited (Beacon) was retained by Barrie Lakeshore Developments to undertake a geomorphic assessment in support of a Site Pan Application to redevelop the property located at 51, 53, 55 &75 Bradford St. and 20 Checkley Street, in the City of Barrie. Historically, the property has been used for industrial purposes since approximately 1900. Land use currently consists of a vacant commercial building (formally a car dealership). The purpose of this geomorphic assessment is to characterize existing geomorphic conditions along the portion of Bunkers Creek relevant to the subject property, and to delineate meander belt limits.

The following points summarize the key findings of this study:

- A review of background information and aerial imagery indicated the land use in the immediate vicinity of the study area was primarily urbanized for the entirety of the time period under consideration (1986-2016). The watercourse had been previously straightened (prior to 1986), and the planform remained generally unchanged over the time period under consideration. Improvements along Lakeshore Drive resulted in minor channel realignments at the vicinity of the road, to accommodate a new culvert.

- The RGA scored Reach Bu-16 as 'in transition' with a score of 0.39. The main limiting factors were widening and degradation. The RSAT assessment indicated that the reach displayed a fair degree of stream health (score of 17), with riparian habitat conditions flagged as limiting factors to overall stream health. The Downs model classified this reach as e – 'enlarging'.

- Based on an empirical modelling approach, a meander belt of 35 m has been recommended for Reach Bu-16 as it pertains to the subject property.

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

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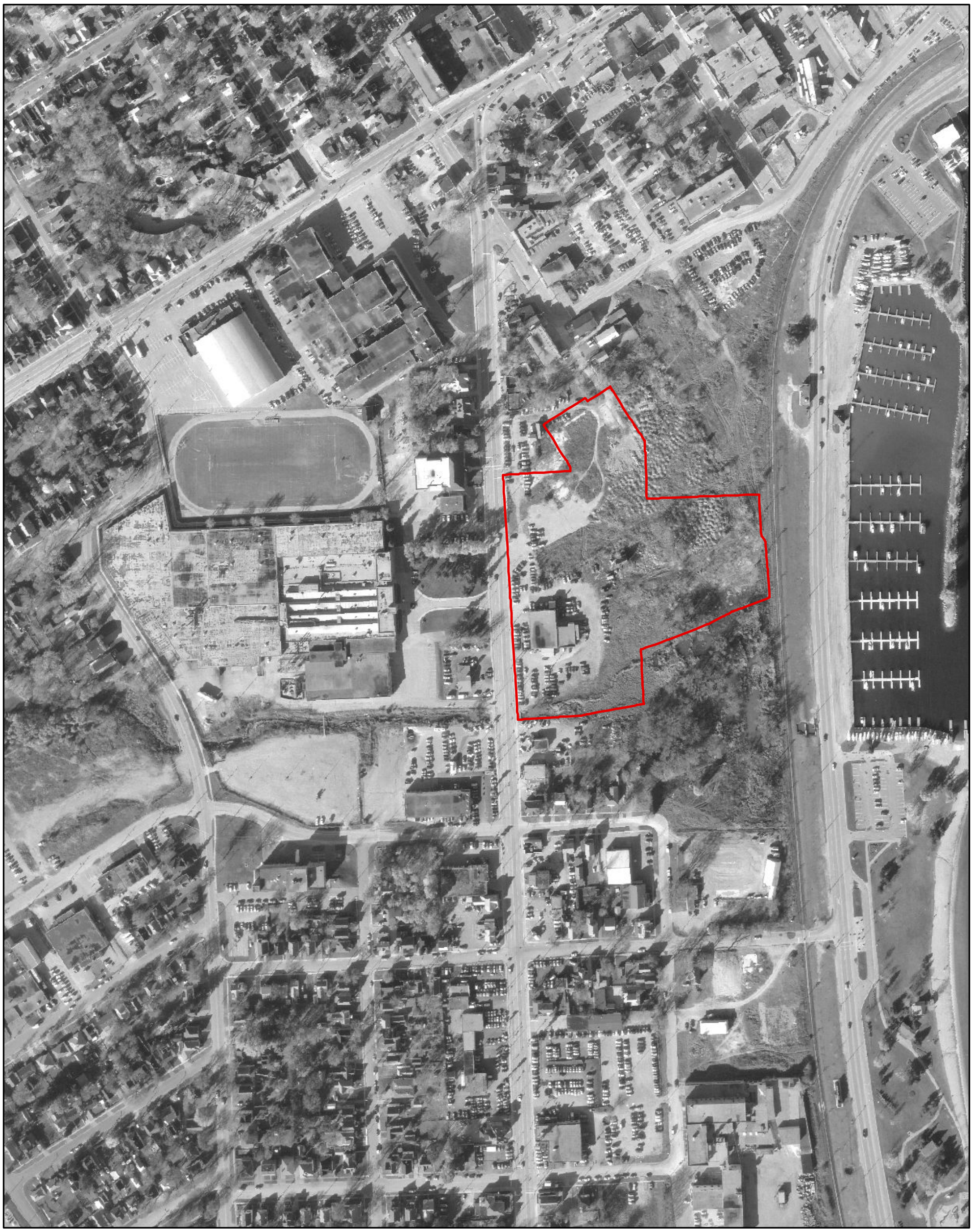
Appendix A

Historical Aerial Imagery



Legend

Subject Property

Historical Aerial Imagery	1986
51 Barrie Street, Barrie	
BEACON ENVIRONMENTAL	Project: 219403.1 Last Revised: July, 2020
Client: Barrie Lakeshore Developments	Prepared by: DU Checked by: SG
N 1:3,000	0 50 100 m

Legend

Subject Property

Historical Aerial Imagery	**2008**
51 Barrie Street, Barrie	
BEACON ENVIRONMENTAL	Project: 219403.1 Last Revised: July, 2020
Client: Barrie Lakeshore Developments	Prepared by: DU Checked by: SG
N 1:3,000	0 50 100 m

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Legend

Subject Property

Historical Aerial Imagery	**2016**
51 Barrie Street, Barrie	
BEACON ENVIRONMENTAL	Project: 219403.1 Last Revised: July, 2020
Client: Barrie Lakeshore Developments	Prepared by: DU Checked by: SG
N	1:3,000
0 50 100 m	

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Appendix B

Photographic Record

Photograph 1. (Photo Location 1)
Upstream view of from Lakeshore Drive crossing. Note: backwater influence associated with Lake levels.

Photograph 2. (Photo Location 2)
Downstream view towards Lakeshore Drive crossing.

Photograph 3. (Photo Location 3)
Upstream view of island formation at offline pond outlet channel confluence with Bunkers Creek.

Photograph 4. (Photo Location 3)
Upstream view of stormwater outlet channel (south side of creek).

Photograph 5. (Photo Location 4)
View of offline pond and outlet channel (north side of creek).

Photograph 6. (Photo Location 5)
Downstream facing view of general conditions downstream of subject property at limit of Lake influence.

Photograph 7. (Photo Location 6)
Downstream view of general conditions within corridor and evidence of active bank erosion (photo right).

Photograph 8. (Photo Location 7)
Downstream view of existing wooden retaining wall along southern channel bank (off property). Note: undermining of retaining wall and leaning hydro poles observed

Photograph 9. (Photo Location 8)
Upstream view of Bradford Street crossing.

Photograph 10. (Photo Location 8)
Downstream view of general conditions from Bradford Street Crossing.