BEACON ENVIRONMENTAL

GUIDING SOLUTIONS IN THE NATURAL ENVIRONMENT

Serson Creek Geomorphic Assessment and Rehabilitation Design Lakeview Village

City of Mississauga

Prepared For:

Lakeview Community Partners Limited

Prepared By:

Beacon Environmental Limited

Date:	*Project:*
December 2020	**217424**

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1. Introduction

Beacon Environmental Limited (Beacon) was retained by Lakeview Community Partners Limited (LCPL) to undertake a geomorphic assessment and channel rehabilitation design of Serson Creek within the property located at 800 Hydro Road in the City of Mississauga ('subject property'). The subject property is located between Lakeshore Road East and Lake Ontario, immediately east of the Region of Peel's G.E. Booth Wastewater Treatment Facility (WWTF), within the former Ontario Power Generation coal plant lands known as the Lakeview Generating Station (**Figure 1**).

Historically, Serson Creek south of Lakeshore Road East, flowed south easterly to Lake Ontario crossing agricultural lands on lands presently occupied by the WWTF. Its confluence with the lake was approximately 250 m to the west of Applewood Creek (**Appendix A**). To facilitate the construction of the Lakeview Generation Station and WWTF in the late 1950's, the lower section of Serson Creek was diverted along the eastern boundary of the subject property and portion of the upper section was diverted south to a ditch along a rail spur line which serviced both sites. Flows in Serson Creek are currently split by an earth plug barrier at the former rail crossing. Low flows are diverted to a pipe under the WWTF that generally follows the historical channel and outlets to the lake through a headwall structure. High flows pass through the constructed ditch between the two site and outlets to the lake at the Jim Tovey Lakeview Conservation Area (JTLCA). The pipe and the diversion barrier prevent upstream fish migration from the lake under seasonal low flow conditions. It is anticipated that the diversion will be removed in 2021, once Serson Creek has been reconstructed.

LCPL are proposing to redevelop the subject property. Referred to as Lakeview Village, the proposed redevelopment will consist of a progressive and sustainable mixed-use community that will include a mix of residential, commercial, institutional and open space uses. Nearly 40% (27 ha) of the site that fronts Lake Ontario will be transferred to the City of Mississauga as public waterfront space. The proposed redevelopment plan for Lakeview Village also includes a plan to realign and rehabilitate the entire Serson Creek corridor south of Lakeshore Road East.

Rehabilitation of this section of Serson Creek was identified as an objective through the City's master planning studies for the former Generating Station land as part of Inspiration Lakeview. Rehabilitation plans for this section of Serson Creek were subsequently developed by Credit Valley Conservation (CVC) through the Lakeview Waterfront Connection (LWC) project. While these rehabilitation plans have been approved by the responsible authorities and agencies, these plans do not give adequate consideration to future land uses being proposed for Lakeview Village. As most of the Serson Creek corridor overlaps with the LCPL property, it is now necessary to review the plans within the context of the future redevelopment proposal to ensure that there is appropriate integration with the future uses. For this reason, the Lakeview Village consultant team has been working with the Region of Peel, City of Mississauga, and CVC to further refine the design for the rehabilitation of Serson Creek in a manner that meets the original environmental design objectives but also achieves better integration with the proposed redevelopment plan for Lakeview Village and addresses existing flooding issues at the Region's G.E. Booth (Lakeview) Wastewater Treatment Facility.

A preliminary design and report was prepared by Beacon in October 2019. Comments on the preliminary design was received by CVC (email dated February 6, 2020) and the City of Mississauga (email dated March 19, 2020). The purpose of this report is to present additional technical information and revised channel design plans that address the City and CVC comments.

2. Policy Context

2.1 Provincial Policy Statement (2014)

Section 3.1 of the Provincial Policy Statement (MNRF 2014) issued under the Planning Act (1990) outlines areas of provincial interest with respect to natural hazards (i.e., flooding, erosion, unstable soils). In support of the Policy Statement, a Technical Guide - Rivers and Streams: Erosion Hazard Limit (MNR 2002) was prepared to outline standardized procedures for the delineation and management of riverine erosion hazards in the Province of Ontario. The guide includes erosion hazard determination protocols based on two generalized landform systems through which watercourses flow: confined and unconfined valley systems.

The Technical Guide defines the erosion hazard limit of unconfined valley systems as the meander belt plus an erosion access allowance. 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), as well as an erosion access allowance.

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. Policy 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 1**).

Table 1. 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

2.2 Region Municipality of Peel Official Plan (2016)

Section 2.4 of the Region of Peel Official Plan contain policies that apply to natural hazards. Specific sections deal with ravine, valley and stream corridors, and riverine floodplains. These policies commit the Region to work in conjunction with area municipalities and Conservation Authorities towards the following three objectives:

Site Location | **Figure 1**

Serson Creek Rehabilitation Design
Lakeview Village, City of Mississauga

BEACON ENVIRONMENTAL

Project: 217424
Last Revised: September, 2019

Client: Lakeview Community Partners Limited

Prepared by: DU
Checked by: AS

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Inset Map:1:50,000

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1. To ensure that development and site alterations are not permitted in areas where site conditions or location may pose a danger to public safety, public health or result in property damage;
2. To encourage a coordinated approach to the use of land and the management of water in areas subject to flooding in order to minimize social disruption; and
3. To ensure that methods used to protect existing development at risk from natural hazards do not negatively impact the integrity of the ecosystem.

2.3 City of Mississauga Official Plan (2017)

Section 6.3 of the Mississauga Official Plan (MOP) contains policies pertaining to the protection of the Green System. The Green System is composed of 1) the Natural Heritage System, 2) the Urban Forest, 3) Natural Hazard Lands; and 4) Parks and Open Spaces. The Natural Heritage System is conceptually illustrated on Schedule 3 of the MOP.

Components of the Green System that overlap with the subject property include the Natural Heritage System and Natural Hazard Lands. Policies pertaining to the Natural Hazard Lands are discussed below.

2.3.1 Natural Hazard Lands

Natural Hazard Lands are associated with valley and watercourse corridors and the Lake Ontario shoreline. These areas are prone to flooding and erosion and are generally unsuitable for development.

With respect to valleylands, it is the policy of the City that:

> *Development adjacent to valleylands and watercourse features must incorporate measures to ensure public health and safety; protection of life and property; as well as enhancements and restoration of the Natural Heritage System*.

Policy 6.3.47 states:

> *Development and site alteration will not be permitted within erosion hazards associated with valleyland and watercourse features. In addition, development and site alteration must provide appropriate buffer to erosion hazards, as established to the satisfaction of the City and appropriate conservation authority.*

Policy 6.3.48 states:

> *Development adjacent to valleyland and watercourse features may be required to be supported by detailed slope stability and stream erosion studies, where appropriate.*

With respect to flood plains, it is the policy of the City that:

> *Lands subject to flooding are a danger to life and property and, as such, development is generally prohibited. However, it is recognized that some historic development has*

> *occurred within flood plains and may be subject to special flood plain policy consideration.*

Policy 6.3.51 states:

> *Development and site alteration is generally prohibited on lands subject to flooding.*

Policy 6.3.52 states:

> *Where historic development has occurred in the flood plain, minor works may be permitted subject to detailed studies to the satisfaction of the City and appropriate conservation authority.*

Policy 6.3.53 states:

> *The construction of buildings or structures permitted in or adjacent to the flood plain will be protected to the elevation of the Regulatory Flood and will not impact upstream or downstream properties. Additional flood protection measures to be implemented relative to individual development applications will be determined by the City and the appropriate conservation authority.*

Policy 6.3.54 states:

> *Access for development adjacent to or within the flood plain will be subject to appropriate conservation authority policies and the policies of the City.*

2.4 Credit Valley Conservation Authority Policies and Regulations

2.4.1 Ontario Regulation 160/06

The Credit Valley Conservation Authority (CVC) regulates activities within and adjacent to wetlands, watercourses and hazard lands under *Ontario Regulation 160/06 - Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* under Section 28 of the *Conservation Authorities Act*. *Regulation 160/06* is implemented by CVC according to their *Watershed Planning and Regulation Policies* (CVC 2010). Section 5.4.4 describes CVC criteria for determining the extent of riverine erosion hazards based on whether or not a valleyland is defined or undefined, and whether or not the valley slopes are stable, unstable and subject to toe erosion.

2.4.2 Slope Stability Definition and Determination Guideline (CVC 2014)

The CVC (2014) *Slope Stability Definition and Determination Guideline* defines the Long-Term Stable Slope Line as consisting of a Stability Component and the Erosion Component. The Erosion Component is further defined as:

> *The regression of the slope toe/channel bank due to erosion over the design life of the structure at the crest of the slope and is measured as a horizontal distance.*

Factors for identified within the Guideline for consideration in the determination of the Erosion Component include:

- Proximity of the slope toe to the watercourse;
- Sediment load carried by the watercourse;
- Average and peak flow rates and velocities of the watercourse;
- Fluvial geomorphological processes affecting the reach within which the site is located;
- Susceptibility of the soils to erosion;
- Increases in surface runoff over the slope;
- Type and extent of vegetation; and
- Weathering of slope face.

Delineation of the Erosion Component consists of two separate factors:

1. Determination of the distance from the toe of the valley wall to the watercourse channel bank; and
2. Determination of the design toe erosion allowance.

The design toe erosion allowance can either be calculated based on historical records for the site or based on suggested allowances as identified in the guideline (**Table 2**).

Table 2. Suggested Design Toe Erosion Allowance (CVC 2014)

Material at Channel Bank or Bankfull	Bank Condition		
	Active Erosion of Bank	**Erosion Not Currently Evident**	**Existing Bank Protection in Place and Maintained Along Bank**
Limestone/Dolostone	2 m	1 m	0 m
Shale	5 m	2 m	0 m
Cohesive Soils (Silty Clays, Clayey Silts)	8 m	4 m	0 m
Cohesionless Soils (Silts, Sands)	15 m	7 m	0 m

A Development Setback Component is applied to the slope hazard area to take into account external conditions which could have an adverse effect on the existing natural conditions of the slope, in consideration of allowance in their Watershed Planning and Regulation Policies (CVC 2010).

2.4.3 Fluvial Geomorphic Guidelines (CVC 2015)

The *CVC Fluvial Geomorphic Guidelines (2015) Fact Sheet I* define geomorphological hazard delineation for watercourses based on whether the valley system through which it flows is confined or unconfined. The guidelines state:

> *In unconfined systems the hazard is from channel erosion and migration. As such, unconfined systems require a meander belt width and associated erosion allowance to be determined. Confined systems, on the other hand, require both channel migration or*

erosion and slope processes to be considered. As such, they require both a toe erosion allowance and a stable slope allowance.

Additional methods for determining meander belt widths are outlined in the Toronto and Region Conservation Authority's Belt Width Delineation Procedure, 2004.

3. Background Review

3.1 Lakeview Waterfront Connection Environmental Assessment – Fluvial Geomorphology Technical Report

As part of the Lakeview Waterfront Connection (LWC) Environmental Assessment (EA), PARISH Geomorphic (2014) produced a Fluvial Geomorphology Technical Report. The purpose of the report was to characterize the existing function of the portions of Serson Creek and Applewood Creek within the study area, and to evaluate design alternatives identified in the LWC with respect to geomorphic considerations. Tasks undertaken in support of the study included reach delineation, field assessment to confirm existing geomorphic conditions, and recommendations of erosion thresholds to inform stormwater management design parameters for both Applewood Creek and Serson Creek.

The report characterized Applewood Creek and Serson Creek as urbanized creeks that respond rapidly to rainfall events and receive minimal sediment supply from the upstream drainage area. Downstream of Lakeshore Road East, the creek conditions were considered depositional due to backwater effects from Lake Ontario and shallow channel gradients.

Serson Creek drains a 270 ha area comprised mainly of urbanized lands. South of Lakeshore Road East, Serson Creek flows through an open channel to the former rail line. Flows are then split. Baseflow is directed easterly through a wooded area and piped south underneath the Region of Peel G.E. Booth WWTF to Lake Ontario. Flood flows are directed south through an open constructed ditch along the easterly boundary of the LCPL property which outlets to Lake Ontario. The report notes that this flow diversion impairs ecological functions within the westerly flood conveyance channel and represents a barrier to upstream fish migration from the lake. The westerly flood conveyance channel is protected along the bed and banks with cobble and rip-rap.

The westerly flood conveyance channel, identified as Reach SC-2 in the report, was classified as 'in-regime' with a score of 0.11 according to a Rapid Geomorphic Assessment (RGA). The report described the channel as heavily overgrown due to a lack of regular discharge. The channel is confined by large berms with few natural characteristics. The Rapid Stream Assessment Technique (RSAT) score for this reach was determined to be 12, resulting in a ranking of 'low' due to limited opportunities to develop natural channel characteristics which support aquatic habitat. Bankfull widths were estimated to range between 2.4-3.1 m and the average bankfull depth was noted as 0.5 m.

The report also recommended design parameters for the proposed extension of lower Serson Creek as part of the LWC Island Beach preferred design alternative. The main goal of the channel design was to adequately convey the 2-year storm event and provide additional capacity for the 5-year flood.

3.2 Preliminary Geotechnical Investigation – 800 Hydro Road

A preliminary geotechnical investigation was completed for the LCPL property by exp Services Inc. (2017). The purpose of the investigation was to determine subsurface soil and groundwater conditions to provide preliminary geotechnical engineering guidelines for site development planning. Boreholes were advanced to assess subsurface conditions, bedrock elevation and quality, and water levels, among other criteria. Results from the boreholes indicated that the soil stratigraphy was generally comprised of fill, followed by native deposits of clayey silt, clayey silt till, sandy silt till, silt till and silt overlying shale bedrock.

3.3 Lakeview Waterfront Connection Project - Applewood and Serson Creeks Design Brief

GHD (2015) was retained by Toronto and Region Conservation Authority (TRCA) on behalf of CVC and the Region of Peel to prepare detailed designs for the restoration and extension of Serson Creek and Applewood Creeks through the LWC project area. Downstream of Lakeshore Road East, the study delineated Serson Creek into three reaches.

Reach S1 is located between the WWTF property fence and Lake Ontario. This reach consisted of the portion of creek influenced by lake levels. The reach was confined and had been heavily modified. The corridor was trapezoidal in shape with no defined banks; however, corridor widths ranged between 10-12 m. A rapid assessment was not completed on this reach due to the lack of a defined channel.

Reach S2, a stormwater corridor, was characterized as ‘in-transition’ or ‘stressed’ using RGA. The RSAT classified this reach as having ‘fair’ overall ecological health owing to poor riparian habitat conditions. Bankfull widths and depths ranged between 2.5-3.0 m, and 0.40-0.60 m, respectively.

Reach S3 was characterized as ‘in adjustment’ based on the RGA and was classified as ‘fair’ under the RSAT due to evidence of channel/scouring and sediment deposition. Bankfull widths and depths for Reach S3 ranged between 2.8-3.2 m and 0.50-0.70 m, respectively. Reach S3a was the section of channel from the outlet pipe to the WWTF property fence at Reach S3. This reach was unconfined and was characterized through the RGA as ‘in regime’ and through the RSAT as having a ‘fair’ degree of ecological health. Bankfull widths and depths ranged between 1.1-1.5 m and 0.20-0.30 m. Reach S3b, located downstream of S3a, was heavily influenced by the backwater effect of the undersized culvert opening north of the WWTF. RGA and RSAT were not completed for this reach.

Field observations by GHD were used to complement the topographic surveys previously completed by TRCA for Serson Creek. Two cross sections each were surveyed within reaches S1, S2, and S3a, and four cross sections were surveyed within reach S3, to characterize bank material and bank angle, channel substrate, root density, and depth. Additionally, pebble counts were conducted at these ten cross sections. The average bankfull width and depth obtained through these surveys were 3.9 m and 0.40 m, respectively. The average channel bankfull gradient was 0.19% and the channel bed gradient was 0.48%. Channel bed substrate consisted of gravel, with a D_{50} of 5 mm and a D_{84} of 45 mm. Applying a Manning’s roughness of 0.035, a ‘reference’ bankfull discharge was back-calculated to be 1.64 m^3/s, with an average velocity of 1.03 m/s.

Referencing detailed geomorphic field data collected within representative cross-sections, a design for Serson Creek was presented with the objective of enhancing stormwater conveyance within the corridor within the identified land creation area. The proposed design would require widening the existing channel corridor by approximately 5.0 m and achieve the following design objectives:

- Redirection of flows below the 5-yr event down the stormwater corridor (flows above approximately the 2-yr event would overflow the bankfull channel and flow down the stormwater corridor;
- Creation of a slightly sinuous bankfull channel through the stormwater corridor which includes pools and riffle morphology;
- Increased riparian area and riparian vegetation;
- Improved flood conveyance;
- Toe of slope protection to prevent erosion into the valley walls; and
- Integration of a stormwater outlet from the WWTF.

4. Desktop Assessment

4.1 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 Oakville Southeast WPCP, southwest of the subject lands, averaged 61 mm per month in winter (November through February), and 77 mm in summer (July and August; Environment Canada 2018). 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.

4.2 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 property is located on the Ordovician grey shale of the Georgian Bay Formation consisting of a light grey siltstone and/or limestone interbeds. The shale is overlain by a thin layer of soil and glacial deposits which, once exposed, weathers rapidly under cycles of melting and drying.

4.3 Valley Slopes

DS Consultants Limited completed a Geotechnical Slope Stability Assessment (2019) for the Serson Creek corridor slopes to assess the stability of the existing west bank slope of Serson Creek and determine the location of the long-term stable top of slope (LTSTOS) line. Stability analysis of the long-term stable slope recommended a stable slope allowance of 2.5H:1V. For long-term stability, a toe erosion allowance of 8 m was also identified, as recommended by Beacon based on the existing channel processes (see Section 6.2). The results of the slope stability assessment have been incorporated into this geomorphic assessment where applicable.

4.4 Historical Assessment

In support of the historical assessment, information presented in the GHD (2015) report based on aerial imagery from 1946, 1954, 1978, 2002, and 2013 was reviewed, with a focus on trends in channel planform and land use change over time. The historical record for the years from the GHD report, are presented in **Appendix A**. The report described land use in 1946 as predominantly agricultural, with trees lining the fields and floodplain. Residential dwellings were located along the north side of Lakeshore Road. Serson Creek was described as a drainage channel flowing east-south-east through fields towards Lake Ontario.

By 1954, extensive development was observed north of Lakeshore Road East while land use within the subject property lands remained unchanged. Aside from shoreline hardening at the outlet of Serson Creek, the channel planform had remained consistent. Between 1954 and 1978 development of the agricultural lands south of Lakeshore Road could be observed. In 1961, the Lakeview WWTF had been established and, by 1962, the OPG Lakeview Generating Station had been constructed southeast of Serson Creek. To accommodate the WWTF and generating station, land reclamation efforts had extended the Lake Ontario shoreline. The construction of these two facilities resulted in the realignment of Serson Creek and the construction of a stormwater drainage channel between the hydro station and the WWTF. Little change in channel planform and surrounding land use was observed in 2002. In 2013, change in land use was limited to the decommissioning of the hydro site in 2005.

4.5 Reach Delineation

Reaches are sections of channel with homogeneous form and function and can, therefore, be expected to respond 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). In support of this study, reach delineation originally completed by PARISH Geomorphic Ltd. (2014) for the LWC Project Environmental Assessment, and GHD (2015) as part of the LWC Project Design Brief for Applewood and Serson Creeks were reviewed. For the purposes of this study, no refinements were made to the previously established reach extents.

5. Existing Conditions

In order to confirm existing geomorphic conditions along the relevant portions of Serson Creek within the subject property, field investigations were conducted on September 21 and 28, 2018. A photographic record of watercourse conditions at the time of assessment is presented in **Appendix B**. Reach limits and photo locations are presented in **Figure 2.**

5.1 Rapid Assessments

5.1.1 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 categorize overall stream health and includes the consideration of biological indicators (Galli 1996). Parameters such as 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, outlined in Thorne et al. 1997) 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.

5.1.2 Results

Results of the rapid assessments are summarized in **Table 3** and **Table 4** below.

5.1.2.1 Serson Creek Reach S2

Reach S2 was characterized as a heavily modified channel situated within a confined valley setting. The channel maintained a low gradient, minimal sinuosity, and a moderate degree of entrenchment. Riparian vegetation was continuous, extending between 1-5 channel widths laterally, and was dominated by shrubs with trees, grasses, and herbaceous plants also present. Bank angles ranged between 30-90 degrees with evidence of erosion along 30-60% of the reach. Banks were composed of clay and silt. Riffle substrate was composed of clay/silt and gravel, pool substrate was composed of clay/silt. Rip-rap substrate was present in pools and riffles throughout the reach. Bankfull widths and depths were between 1.9-3.1 m and 0.4-0.7 m, respectively. Moderate quantities of woody debris were observed in the channel. Beaver activity and an associated backwater influence was observed at the

Legend

- Subject Property
- Watercourse (MNRF 2018)
- Reach Break
- Photo Locations

Reach and Photo Location	**Figure 2**

Serson Creek Rehabilitation Design
Lakeview Village, City of Mississauga

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C:\Dropbox\Dropbox (Beacon)\All GIS Projects\2017\217424 Lakeview DD\MXD\MBW\2019-09-19_Figure02_PhotoLocation_217424_1.mxd downstream end of the reach. The degree of channel entrenchment was high at the upstream extent of the reach but decreased with distance downstream.

RGA results indicated that Reach S2 was 'in transition', with a score of 0.30. Channel widening was identified as the dominant mode of adjustment, as evident by numerous fallen trees, basal scour through both side of channel within riffles, active bank erosion observed in over 50% of the reach, and presence of fracture lines along the top of bank. Degradation was noted as a secondary process due to knickpoint migration, terraces cut through older bar material, exposed fence lines, and exposed overburden. Minor evidence of planimetric form adjustment was observed through thalweg misalignment and poor bar formation. An RSAT score of 20 indicated a 'fair' degree of overall ecological health with physical instream habitat and riparian habitat conditions acting as limiting factors. The Downs model classified this reach as a combination between S – 'stable' and e – 'enlarging' as there was evidence of channel downcutting and entrenchment.

5.1.2.2 Serson Creek Reach S3

Reach S3 was characterized as a well-defined channel situated within a partially confined valley setting (confined right bank, unconfined left bank, looking downstream). The channel was highly entrenched (6-8 m of entrenchment observed in some areas). The channel displayed a low gradient and minimal sinuosity. Riparian vegetation was continuous, extending between 1-5 channel widths laterally, and was dominated by trees and shrubs. Banks were generally steep (>60 degrees) and were composed of clay/silt. Banks had minimal vegetative cover and evidence of erosion was observed along 60-100% of channel banks within the reach. Bankfull widths and depths were between 2.4-3.5 m and 0.6-0.85 m, respectively. Riffle substrate was composed of clay/silt, sand, and gravel, and pool substrate was composed of clay/silt and sand. Low quantities of woody debris were observed in the channel. Backwatering due to beaver activity was observed at the downstream end of the reach.

RGA results indicated that Reach S3 was 'in adjustment', with a score of 0.41. There was evidence of widening in the form of large organic debris, exposed tree roots, and basal scour throughout the reach. Evidence of degradation was observed with knickpoint migration, terracing through older bar materials, cut face on bar forms, and exposed overburden. Minor evidence of aggradation was observed in lobate and medial bar formation and poor longitudinal bed material sorting. Minor evidence of planimetric form adjustment was also present with thalweg misalignment and poorly formed bar forms. An RSAT score of 19 indicated a 'fair' degree of overall ecological health with physical instream habitat and riparian habitat conditions acting as limiting factors. The Downs model classified this reach as C – 'compound' due to the presence of both bank erosion and sediment deposition on the bed.

Table 3. Serson Creek – General Reach Characteristics

Reach	Bankfull Width (m)	Bankfull Depth (m)	Riffle Substrate	Riparian Vegetation	Notes
S2	1.9-3.1	0.4-0.7	Clay/silt, gravel, rip-rap	Shrubs, trees, grasses, herbaceous plants	• Channel confinement reduction downstream • Rip-rap protection on lower banks
S3	2.4-3.5	0.6-0.8	Clay, silt, sand, gravel	Trees, shrubs, grasses	• Minimal root vegetation along banks • Entrenchment on the order of 6-8 m • Approx. 0.9 m flow depth upstream of beaver dam

Table 4. Serson Creek – Rapid Assessment Results

Reach	Rapid Geomorphic Assessment (RGA)			Rapid Stream Assessment Technique (RSAT)			Downs Classification Method
	Score	Condition	Dominant Mode of Adjustment	Score	Condition	Limiting Feature	
S2	0.30	In Transition	Widening	20	Fair	Physical Instream Habitat, Riparian Habitat	S 'stable', e – 'enlarging'
S3	0.41	In Adjustment	Widening	19	Fair	Physical Instream Habitat, Riparian Habitat	C – 'compound'

5.2 Detailed Assessment

In support of the design, a topographic survey was completed by the TRCA in 2014 for Serson Creek. Field observations were conducted by GHD (2015) to complement the topographic survey. A total of ten (10) cross-sections for Serson Creek (two (2) within Reach S1, two (2) within Reach S2, four (4) within Reach S3, and two (2) within Reach S3a) were examined for bank material and bank angle, channel substrate, root density and depth. In addition, pebble counts (Wolman 1954) were conducted at all ten (10) cross-sections in order to characterize the channel substrate. Bankfull discharge and velocity were calculated from these observations, and the results are summarized in **Table 5**.

Table 5. Summary of Detailed Field Results (GHD 2015)

Channel Parameter	Upstream – Reach S3	Stormwater Channel – Reach S2
Field-Based Measurements		
Channel bankfull gradient	0.19 %	N/A
Channel bed gradient	0.48 %	0.99 %
Average bankfull width	3.9 m	N/A
Average bankfull depth	0.4 m	N/A
D_{50}	5 mm	2 mm
D_{84}	45 mm	70 mm
Estimated Manning's 'n' value	0.035	0.035
Derived Parameters		
Bankfull discharge	1.64 m^3/s	N/A
Bankfull velocity	1.03 m/s	N/A
Tractive force (bankfull)	17.2 N/m^2	N/A
Flow competency for D_{50}	0.4 m/s	0.3 m/s
Flow competency for D_{84}	1.1 m/s	1.4 m/s

6. Determination of Erosion Hazard Limits – Existing Conditions

This section of the report includes an analysis of erosion hazard limits for portions of Serson Creek that are associated with the subject property. Procedures for determining the erosion hazard limits for river and stream systems are outlined in the *Technical Guide - Rivers and Streams: Erosion Hazard Limit* (MNR 2002). The erosion hazard limits depend on the type of valley system, confined or unconfined, through which the river or stream flows. A confined valley system is one with visible physical valley slopes discernible from the surrounding landscape (MNR 2002). An unconfined valley system is a system where the valley contains a river or stream but there are no valley slopes discernible from the surrounding landscape (MNR 2002).

6.1 Unconfined Valley System – Meander Belt

According to the *Technical Guide* (MNR 2002), when a river or stream flows within an unconfined valley corridor, the greater of the flood hazard limit or meander belt width allowance (along with the erosion access allowance) represents the erosion hazard limit. 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.

Based on the findings of the field investigations, Reach S3 of Serson Creek was characterized as partially confined. The left bank (looking downstream) is unconfined and the right bank is confined.

As discussed in **Section 6.2**, the long-term stable top of slope was identified by DS Consultants Ltd. (2019) for the right bank of the valley slope. The following section outlines methods applied to determine the meander belt limit for the unconfined portion (left bank) of the valley slope.

Due to the historical channelization of the channel, an empirical modelling approach referencing geomorphic field assessment data was employed as a more appropriate to assess meander belt width dimensions. The approach uses power functions based on average bankfull width (W_b), following relations from Williams (1986; Equation 1) and Ward *et al*. (2002; Equation 2). Research by Ward *et al*. (2002) indicated that the Williams (1986) equation, at times, under-predicted the belt width dimensions. As such, a modified approach to the relation, which incorporates the average bankfull width and a 20% factor of safety, was applied. This approach considers the existing reach stability observed during the geomorphic field assessment.

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

$B_w = [6*W_b^{1.12}]$ (feet converted to meters) **[Eq. 2]**

The results of the empirical analysis are summarized in **Table 5**. An illustration of the recommended meander belt limit for Reach S3 as shown on **Figure 3**. Note that the meander belt limit along the confined (right bank) of the valley slope was adjusted to illustrate the long-term stable top of slope as discussed in **Section 6.2**.

Legend

- Subject Property
- Watercourse (MNRF 2018)
- Reach Break
- Meander Belt Limit (Beacon 2019)
- Long Term Stable Top of Slope (DS Consulting)

Meander Belt

Figure 3

Serson Creek Rehabilitation Design
Lakeview Village, City of Mississauga

BEACON ENVIRONMENTAL

Project: 217424
Last Revised: September, 2019

Client: Lakeview Community Partners Limited

Prepared by: DU
Checked by: AS

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Table 6. Serson Creek – Recommended Meander Belt (Reach S3)

Reach	Rapid Geomorphic Assessment (RGA)			Modelled Meander Belt Width (m)		Recommended Meander Belt (m)
	Score	Condition	Dominant Mode of Adjustment	Williams (1986)	Ward (2002)	
S3	0.41	In Adjustment	Widening	21	24	**23**

6.2 Confined Valley Systems – Toe Erosion Allowance

For the purposes of determining the erosion hazard limit for confined reaches within the subject property (i.e., those reaches where lateral migration is limited by the presence of valley walls), determination of a toe erosion allowance and a stable slope allowance is required. According to the *Technical Guide* (MNR 2002), erosion hazard limits require the inclusion of a toe erosion allowance for areas where the watercourse is within 15 m of the valley toe of slope. Based on the findings of the field evaluation, Reach S2 and portions of Reach S3 of Serson Creek were determined to be in proximity to the valley wall.

The toe erosion allowance can be determined through calculation of the annual recession rate (100-year migration rate) using reliable (historical) data records. However, due to the scale and resolution of available historical aerial imagery, degree of vegetative cover and historical channelization, annual recession rates could not be reliably determined for the subject property. As a result, the recommended toe erosion allowance of 8 m as presented in **Table 6** was determined using suggested ranges provided in the Technical Guidelines (MNR 2002; CVC 2014) and in consideration of the Geotechnical Slope Stability Assessment (DS Consultants Ltd. 2019).

Table 7. Serson Creek – Recommended Toe Erosion Allowance (Reach S2 and S3)

Reach	Rapid Geomorphic Assessment (RGA)			Channel Bank	Toe Erosion Allowance[1]			
	Score	Condition	Dominant Mode of Adjustment	Native Soil Structure	Active Erosion (Y/N)	Within 15 m of toe of slope (Y/N)	Bankfull Width (m)	Setback (m)
S2	0.30	In Transition	Widening	Soft/Firm Cohesive Soil	Y	Y	< 5	**8**
S3 (right bank)	0.41	In Adjustment	Widening	Soft/Firm Cohesive Soil	Y	Y	< 5	**8**

[1] MNR Natural Hazards Technical Guides for River and Stream Systems – Table 3, p. 38.
[2] CVC Slope Stability Definition and Determination Guideline – p 5.

The recommended toe erosion allowance of 8 m has been incorporated in the slope stability assessment for confined valley slopes (DS Consulting Ltd. 2019). As discussed in **Section 6.1**, the meander belt limit for Reach S3 of Serson Creek was adjusted to reflect the recommended long-term stable top of slope along the right bank of the valley slope. The recommended watercourse erosion hazard components (meander belt limit and long-term stable top of slope), are illustrated in **Figure 3**.

6.3 Erosion Access Allowance

An erosion access allowance is the final component used to determine the erosion hazard limit of confined and unconfined river and stream systems (MNR 2002). The erosion access allowance is added to the toe erosion allowance and slope stability allowance for confined valley systems and to the flooding hazard limit or meander belt allowance for unconfined valley systems.

According to MNR (2002) the purpose of the erosion access allowance is for:

- *Providing for emergency access for erosion-prone areas;*
- *Providing for construction access for regular maintenance and access to the site in the event of an erosion event or failure of a structure; and*
- *Providing protection against unforeseen or predicted external conditions which could have an adverse effect on the natural conditions or processes acting on or within an erosion-prone area of provincial interest.*

Under existing conditions, all reaches of Serson Creek are open and fully accessible from the LCPL property. There are no structures or obstructions that would prevent accessing erosion-prone areas or for undertaking maintenance works. Furthermore, within Reach S2 an existing haul road along the west side of the corridor also provides for maintenance access. Under proposed conditions, the rehabilitated corridor will be designed to contain all the natural hazards. For the reasons outlined above, it is our opinion that identification of an erosion access allowance is unwarranted in this case.

In addition to the erosion hazard described above, the flood hazard has also been determined by Urbantech (2020). A plan illustrating the extent of the erosion hazard described above as well as the flood hazard determined by Urbantech (2020) is presented in in **Appendix C.**

6.4 Erosion Hazard Summary

It is our opinion that the existing erosion hazards associated with Serson Creek on the subject lands were determined in accordance with the technical guidance provided in CVC (2014) and MNR (2002).

7. Rehabilitation Design

The realignment of Serson Creek will be completed in two phases: 1) downstream from the flow diversion pipe to the Jim Tovey Lakeview Conservation Area, and 2) upstream from the flow diversion pipe to Lakeshore Road East. The second phase will be designed as part of a future project, dependent on property limits, and will incorporate aquatic and wildlife passage details for the proposed Haig Blvd. extension culvert crossing. The primary objective for phase one is to rehabilitate and enhance the

Serson Creek corridor to carry redirected low flows away from the WWTF while improving flood conveyance, terrestrial and aquatic habitat quality and connectivity to the Jim Tovey Lakeview Conservation Area.

The following sections provide an overview of the proposed corridor and low flow channel design considerations, bioengineering elements, and enhancement details. The design incorporates CVC's Living by the Lake Action Plan (2018) objectives and recommendations for Serson Creek including stormwater management, habitat quality improvement and connectivity objectives. The overall corridor design is being completed by the LCPL consultant team.

The channel rehabilitation design drawings and landscaping plans have been included in the overall submission package completed by Urbantech.

7.1 Design Considerations

The proposed channel design provides a riffle-pool channel with a more sinuous planform within the corridor. The channel is designed as a naturalized channel with bioengineered bank treatments to minimize excessive channel migration and support habitat enhancements. In developing the proposed channel design, the following objectives and constraints were considered:

- Upstream and downstream tie-in elevations – matching the channel bed and banks to the upstream existing outlet pipe and downstream extent of the proposed channel realignment will provide proper transitioning to the channel within the Jim Tovey Lakeview Conservation Area. The downstream tie-in limit will need to be confirmed with TRCA.

- Underground infrastructure – An existing 400 mm diameter watermain currently crosses the channel, encased in concrete. This will be replaced with a 400 mm diameter PVC watermain encased in a 900 mm diameter steel liner at the upstream extent. The depth of cover above this proposed watermain is approximately 2.5 m, while the existing watermain is close to the surface. Appropriately sized stone will be used within the channel, to prevent the watermains from being exposed by channel downcutting.

- Corridor capacity – The proposed design must meet or increase the corridor capacity in order to prevent increase in flood levels along Serson Creek. The channel corridor was designed by Urbantech to meet these objectives for flood storage and conveyance.

- Hazard mitigation – The urbanized peak flow regime and natural tendency of the channel to migrate and adjust must be addressed to ensure long-term stability and limit erosion. This includes a corridor that considers meander belt width requirements and provides for stable slope design to adjacent development lands. The design incorporates appropriately sized bioengineered measures to mitigate potential long-term erosion impacts.

- Aquatic habitat enhancement – The proposed design will enhance the quality and function of existing aquatic habitat conditions, removal of barriers to fish passage, formalization of the low flow and bankfull channel, creation of pool-riffle sequences, introduction of in-stream habitat features, and redirection of base flow down the corridor and increased connectivity to the lake.

- Riparian and terrestrial habitat – The proposed design will enhance the quality and functions of riparian and terrestrial habitat types by introducing a greater diversity of habitat types and micro-habitat features for local wildlife. All created habitat will be vegetated with native species found in the watershed. The riparian and floodplain zones will be planted with lowland and wetland species, while the valley slopes will be planted with native upland species.

- Construction timing – All in-water works will be carried out during the July 1 - March 31 construction window, or as otherwise stipulated by the approval agencies.

7.2 Design Elements

The following section provides an overview and supporting technical analysis for proposed corridor and channel design elements.

7.2.1 Scour Depth Potential

The existing 400 mm diameter watermain currently crosses the channel, will be replaced with a 400 mm diameter PVC watermain encased in a 900 mm diameter steel liner at. In accordance with the Simplified Standard Method (Table 4) of the CVC Fluvial Geomorphic Guidelines: Factsheet VI Scour Analysis (December 2019), the depth of cover above this proposed watermain is approximately 2.5 m. The channel subgrade below has been designed to remain stable over a range of design flows, thereby mitigating risk of excessive erosion into the soils below the channel (**Section 7.2.4**).

7.2.2 Bankfull Channel

Dimensions for the riffles and pools were governed by the bankfull design discharge. Determination of the design discharge for the proposed channel design utilized the available peak flow information from CVC, as well as a field-based approach which utilizes information from the detailed assessment. Data from the detailed topographic survey (GHD 2015) was used to determine a reference flow by entering channel dimensions and governing energy gradient into the Manning's 'n' equation along with an estimated roughness coefficient. Based on this approach, the bankfull discharge was 1.64 m^3/s (GHD 2015). It was noted that Serson Creek upstream of the stormwater corridor had a terraced cross section with a lower bankfull channel and a larger upper terrace which conveyed approximately 6.90 m^3/s. This was similar to the estimated 2-yr flow of 5.0 m^3/s as provided by CVC. This larger corridor was likely formed during past channel realignment and floodplain filling. The smaller defined channel was more representative of a bankfull channel.

Bankfull flows for watercourses in Southern Ontario are typically between the 1 and 2-yr return period. However, when peak flows are considered, it appears that the governing bankfull discharge is much lower than the 2-yr flow. The estimated bankfull discharge was similar to the bankfull discharge of 1.40 m^3/s estimated as part of the EA (Parish Geomorphic, 2014).

Proposed riffle and pool geometries, as well as anticipated bankfull flow conditions, are provided in **Table 8**.

Table 8. Parameters of the Bankfull Channel – Serson Creek

Channel Parameter	Sta. 0+000 to 0+378		Sta. 0+378 to 0+561	
	Riffle	Pool	Riffle	Pool
Gradient (%)	3.00	0.46	3.70	0.73
Roughness (Manning's n)	0.045	0.037	0.045	0.037
Bankfull width (m)	2.50	3.55	2.40	3.55
Average bankfull depth (m)	0.36	0.50	0.35	0.50
Maximum bankfull depth (m)	0.60	0.90	0.60	0.90
Bankfull width-to-depth ratio	7	7	7	7
Discharge to accommodate (m^3/s)	1.64	1.64	1.64	1.64
Mean bankfull velocity (m/s)	1.81	1.05	1.96	1.32
Calc. Bankfull discharge (m^3/s)	1.64	1.87	1.65	2.35
Froude number	0.96	0.47	1.06	0.60
Maximum shear (bed) (N/m^2)	177	41	218	64
Stream power (W/m)	484	84	597	168
Unit stream power (W/m^2)	193	24	249	47
Max. grain size entrained (m)	0.18	0.05	0.22	0.07
Max. grain material	Cobble-Large	Gravel-Very Coarse	Cobble-Large	Cobble-Small
Mean grain size entrained (m)	0.13	0.03	0.15	0.05
Mean grain material	Cobble-Small	Gravel-Coarse	Cobble-Large	Gravel-Very Coarse

7.2.3 Hydraulic Modelling

The updated existing HEC RAS model was modified with the proposed corridor design updates by Urbantech. The design velocities at stations within the lower corridor design are provided below in **Table 9**.

Table 9. Proposed Conditions Stream Velocity Summary for Serson Creek

Station	Range of Proposed Channel Velocities (m/s) (0.5-year to Regional)		
	Channel	Left Floodplain	Right Floodplain
10588.7	0.81-1.12	0.00-0.92	0.00-0.87
10588.4	0.77-1.13	0.00-0.76	0.00-0.77
1055	0.85-1.11	0.00-0.79	0.00-0.70
10466	0.82-1.03	0.00-0.72	0.00-0.72
10465	0.75-1.00	0.00-0.69	0.00-0.71
10464.6	0.75-1.03	0.00-0.73	0.00-0.69
10464	0.92-1.14	0.00-0.79	0.00-0.74
10351	0.84-1.13	0.00-0.75	0.00-0.75

Station	Range of Proposed Channel Velocities (m/s) (0.5-year to Regional)		
	Channel	Left Floodplain	Right Floodplain
10350	0.80-1.17	0.00-0.75	0.00-+0.78
10349.5	0.73-1.28	0.00-0.85	0.00-0.76
10349	0.80-1.35	0.00-0.82	0.00-0.89
10212	0.61-1.33	0.00-0.87	0.00-0.84
10211.9	1.17-1.38	0.00-1.02	0.00-1.03
10211.6	0.98-1.33	0.00-1.00	0.00-0.93
10211.4	1.05-1.24	0.00-0.90	0.00-0.95
10211	0.93-1.10	0.00-0.79	0.00-0.86
10118	0.90-1.01	0.00-0.79	0.00-0.80
10117.4	1.58-1.74	0.00-1.24	0.00-1.19

7.2.4 Substrate Sizing

The sizing of substrate materials was guided by a review of hydraulic conditions (i.e., tractive force, flow competency) within the typical channel cross-sections based on permissible velocities (Komar, 1987; Fischenich, 2001). Substrate sizing varies within the proposed upstream portion of the channel and the steeper downstream portion.

The riffles will be composed of a mixture of approximately 25% 100-150 mm riverstone, 50% 150-250 mm riverstone, and 25% granular ‘b’ between the larger stone. The granular ‘b’ material will fill the interstitial spaces. The larger substrate in the proposed mix will provide stability of the structure at the crest of the riffle and will be overlain with smaller substrate material. Channel stability for grade control is critical, and therefore a factor of safety was incorporated into the material stone sizing at the crest. The pools will be composed of a similar mixture of approximately 25% 100-150 mm riverstone, 50% 150-250 mm riverstone, and 25% granular ‘b’ between the larger stone, within an increasing veneer of granular ‘b’ near the pool invert.

To mitigate erosion long-term erosion impacts on adjacent land uses, vegetated rock buttresses have been proposed along the entire toe of slope for the corridor. A minimum stone size of 300 mm will be used along the toe of slope. The channel banks will be designed with woody debris bank treatments or vegetated layering. Given the hydraulic conditions within the corridor, any deflection or diversion of flows towards the toe of slope due to debris jams or other obstructions could result in higher velocities than the estimated overbank velocity. The factor of safety also takes into account other variables which could influence entrainment such as stone spacing, shape and ice plucking or abrasion.

As noted previously, an existing 400 mm diameter watermain encased in concrete crosses the channel and will be replaced with a 400 mm diameter PVC watermain enclosed in a 900 mm steel liner near the upstream extent. Where the watermain will cross the channel, it will be 2.5 m below the proposed channel invert. To further limit potential impacts from excessive scour, the channel will be lined with hydraulically-sized stone.

7.2.5 Bioengineering Treatments and Habitat Features

- Vegetated rock buttress – will be installed along the entire toe of slope for the corridor to provide offset protection. A vegetated rock buttress consists of the installation of a combination of rocks, vegetation and plantings to provide bank protection and promote flow training and deflection. The stone provides harder bioengineered protection, but also provides roughness to reduce the flow velocity, and morphological variability as plantings establish. The vegetation will also provide additional stability and enhance aquatic habitat by providing shade and overhanging vegetation.

- Woody debris bank treatment – will be installed on the outside meander bends in close proximity to the toe of slope. The woody debris bank treatment consists of the root fan or ball, and a portion of the tree trunk. They are typically installed at the toe of the channel bank and integrated with plantings. The bank is backfilled with stone to provide further bank protection and stability. This treatment acts to deflect erosive flows away from the channel bank while providing aquatic habitat. Scour may be enhanced at the base of the woody debris to provide additional habitat benefit. Woody debris also acts to collect sediment and debris, further protecting the channel bank from erosion.

- Vegetated layering – will be installed on the outside meander bends that are not designed with woody debris bank treatment. The vegetated layering consists of dormant cuttings installed in the channel bank above the low water level, in lifts separated by well-compacted soil and native material mix. The bank treatment is blended with the existing bank to provide a smooth, natural transition. A biodegradable blanket is placed on the bank to provide immediate stabilization. The vegetated layering will reduce flow velocities in the outer meander bends and limit erosion, through the establishment of the plantings. Additionally, vegetation establishment will provide local stream shading and vegetation overhang.

- Offline wetland features – in the lower reach, offline wetland features will be installed on the floodplain next to the channel to provide greater variety in terrestrial habitat and a more natural floodplain form. These features will also provide a short-term water retention function as well as a sediment bank within the floodplain. The irregular form provides an increased perimeter for a given area and thus extensive transition zones between aquatic and terrestrial habitats. Deeper wetland pools have been incorporated for additional variability.

- Woody debris habitat features – micro-habitat features for wildlife to provide greater variety in terrestrial habitat within the floodplain. The features are located sporadically along the floodplain and will consist of mounds of locally sourced stable interconnected wood debris.

- Earth plug – will be installed along the channel at the upstream end to block off the existing bankfull channel redirecting flows along the new bankfull channel. The earth plug will consist of compacted fill protected by a vegetated rock buttress facing the bankfull channel. The lee side of the earth will be composed of cobble sized material mixed with topsoil and plantings to provide stability.

7.2.6 Riparian Zone

To improve the quality and function of the riparian habitats, the riparian zone will be planted with a diverse mix of native shrubs and groundcovers using nursery stock as well as terraseeding. The densities of the proposed plantings in the bioengineered treatments will provide for additional stability.

Landscaping plans for area outside the immediate channel riparian zone have been prepared by NAK Design Strategies (2020) with ecological input from Beacon and CVC ecology staff, and are presented under separate cover.

7.2.7 Interim Erosion Control

A non-woven erosion control blanket (i.e., coir cloth/jute mat) will be installed along the perimeter of the proposed channel bank, immediately following construction to provide immediate soil erosion protection while allowing the native vegetation to establish. Straw mulch cover and a native seed mix will also be placed in disturbed areas beyond the channel.

8. Determination of Erosion Hazards – Proposed Conditions

The proposed stream corridor design provides an opportunity to restore a more natural planform to Serson Creek. The corridor design was sized initially for flood storage and conveyance to confirm minimum corridor dimensions. We note that the proposed corridor dimension must consider the proposed future redevelopment, integration with the future land uses, and the limits of the WWTF. The flood hazard component has been prepared by Urbantech, with an updated HEC RAS model, and is presented under separate cover.

To support the erosion hazard component of the proposed corridor, a range of meander belt widths was calculated based on the design bankfull dimensions. The channel from Sta. 0+000 to 0+378 has a bankfull width of 2.50 m, and the bankfull width from Sta. 0+378 onwards of 2.40 m. Using the empirical models discussed previously (i.e., Williams 1986 and Ward *et al*. 2002 – equations 1 and 2), the meander belt width for the proposed channel corridor has been estimated to range between 11 to 19 m. The range of calculated values are provided in **Table 10**.

Table 10. Proposed Conditions Meander Belt Width Summary for Serson Creek

Station Number	Average Bankfull Width (m)	Williams (1986)	Williams (1986) with 20% F.O.S.	Ward et al. (2002)
0+000 to 0+378	2.50	12	14	19
0+378 to 0+561	2.40	11	14	18

The proposed corridor floor ranges between 11 to 16 m in width and the top width of the corridor ranges between 19 to 25 m, which accommodates the range of modelled meander belt widths (**Table 10**). For comparison, a cursory review of the planform extent for the reach of Serson Creek upstream of Lakeshore Road was approximately 11 m, which accounts for the governing meander amplitude, the bankfull width of the channel and a factor of safety of 20%. In consideration of the higher range of predicted migration limits of the channel, and the existing and proposed infrastructure related to the WWTF, additional design features along the lower valley slopes have been included as a factor of safety against potential long-term erosion impacts.

The corridor width accommodates the range of modelled meander belt widths, recommended stable slope allowance of 2.5:1 and regulatory flood, as determined using accepted scientific, geotechnical and engineering principles. As the average depth of the corridor is approximately 2 m (i.e. confined system), the stable top of slope was identified as the governing erosion hazard criteria.

The limits of the erosion hazard for the proposed corridor are illustrated on the design drawings.

8.1 Erosion Access Allowance / CVC Development Setback

The erosion access allowance is the final component of the erosion hazard limit that can be applied to both confined and unconfined river and stream systems (MNR 2002). The purpose of the erosion access allowance is to provide unimpeded access to the valley for future maintenance and repairs as was outlined in **Section 6.3**. The proposed channel corridor was designed to include a 6 m development setback from the limits of the erosion hazard. This setback was applied to satisfy CVC's technical requirements, as outlined in their Slope Stability Definition & Determination Guideline (CVC 2014) and Watershed Planning and Regulation Policies (CVC 2010).

Application of an erosion access allowance to the rehabilitated corridor would, in our opinion, be redundant with the CVC development setback which already provides for any external conditions that could potentially have an adverse effect on the conditions of the slope as well as access.

9. General Design Parameters Summary

As mentioned, GHD (2015) was retained by Toronto and Region Conservation Authority (TRCA) on behalf of CVC and the Region of Peel to prepare detailed designs for the restoration and extension of Serson Creek and Applewood Creek through the LWC project area. As part of this process, CVC obtained a DFO Authorization for this interim channel design, including planting restoration plans developed through TRCA. These plans have been redesigned within the context of the current redevelopment proposal, to ensure that there is appropriate integration with the future uses for Lakeview Village and WWTF upgrades. Below is a summary of the general design changes and parameters for the interim and proposed designs.

Table 11. Summary of Interim and Proposed Design within LCPL Property

General Design Parameter	Interim Design (GHD and TRCA Restoration Plan)	Current Design
Riparian Planting Area (m²)	6038	7960[1]
Channel Enhancement (m)	571	569[2]
Plantings (Shrubs / Trees)	1475	3634[1]
Barrier Removal	Yes	Yes
Flow Redirection to Serson Storm Channel	Yes	Yes
Low flow channel with permanent habitat including suitable slope and water velocities for fish passage	Yes	Yes
Removal of debris blockage at mouth of creek	Yes – Complete	N/A
Creation and enhancement along storm channel including deep rooted vegetation and woody material - include a mix of woody and herbaceous species including bioengineering.	Yes	Yes
Removal of invasive species	Yes	Yes
Anticipated implementation date	2018 to present	Summer / Fall 2020

[1] Based on the comparison of planting zones RS1 and RS2 from TRCA Restoration Plans to NAK Design Plans.
[2] Based on the comparison of planform chainage on GHD Design Plans to Urbantech/Beacon Design Plans.

The proposed redesign within the context of the current redevelopment proposal, represents a significant enhancement relative to the previously approved interim design and restoration planting plans.

10. Post-Construction Monitoring

A post-construction monitoring program is recommended to assess the performance of the implemented design. Most adjustments to channel form will occur during the first year, and subsequently during large flow events. Therefore, a general field reconnaissance along the entire length of the constructed design should be completed immediately after construction and after the first large flooding event to identify any potential areas of concern. Detailed monitoring of constructed design elements should commence immediately after construction to obtain reference data for comparison to subsequent monitoring efforts.

The following geomorphic monitoring plan was developed following the conditions outlined within the DFO permit for the interim channel design, and in consultation with CVC and TRCA. It is noted that the design elements proposed for the revised design of Reach S2 are similar in nature to those proposed for the downstream channel design. Therefore, a similar monitoring program can be applied.

Based on the agency requirements, following monitoring requirements were included:

- All planted riparian buffer vegetation shall be in good health and overall survival shall be a minimum of 80% for 3 consecutive years;

- All offset structures and features shall be shown to be constructed as designed and stable and shall be assessed by visual inspection, underwater imagery and or geomorphological assessment;
- If monitoring indicates offsetting measures are not complete by date or not functioning, proponent shall give written notice to DFO and shall implement contingency measures and associated monitoring to ensure offsetting is completed and functioning. If deficient, additional adjustments or replacements must be implemented within 1 year or additional measures within 3 years (in consultation with DFO); and
- If unstable or deficient, additional 3 years of inspection and monitoring are required.

To address these monitoring requirements, the following plan was developed:

- Flow monitoring completed for two 'wet events', following precipitation and one 'dry event', completed annually, started 1 year after construction and for a period of 5 years post-construction;
- Electro-fishing the channel annually for a period of three years post-construction to quantify the biodiversity of fish species in the channel;
- Completion of an as-built survey of the channel works, to provide a reference condition for future monitoring surveys;
- Completion of a longitudinal profile through a representative section of the channel (approximately 100 m long);
- Monumented cross sections completed annually through two riffles and two pools for three years post-construction, and consisting of a cross section survey, installation and monitoring of erosion pins, completion of pebble counts, and monumented photographs; and
- Visual inspection of all installed vegetation completed annually for a period of three years post-construction.

Through discussions with CVC staff, it was agreed that flow monitoring and electro-fishing of the constructed reach on the LCPL property will be completed by CVC's restoration team and that monitoring related to channel morphology and vegetation establishment would be completed by the LCPL team.

Post-construction monitoring reports completed on behalf of LCPL will be circulated to approval agencies, including any deficiencies or recommendations within the monitoring period.

In addition to the above monitoring, there will be monitoring related to the future Certificate of Property Use. For further details, please refer to the EXP memorandum of December 18, 2020.

11. Conclusions

Beacon was retained by Lakeview Community Partners Limited to conduct a geomorphic assessment and prepare a channel rehabilitation design for a section of Serson Creek located adjacent to their property a at 800 Hydro Road, in the City of Mississauga. In support of development applications for the subject property, a preliminary design was prepared by Beacon in October 2019. Comments on the preliminary design and associated report was received by CVC (email dated February 6, 2020) and the City of Mississauga (email dated March 19, 2020). This report provides additional technical information and revised channel design plans that address the City and CVC comments. This report also summarizes the design details of the proposed rehabilitation of Serson Creek including characterization existing geomorphic conditions of Serson Creek on the subject property and an erosion hazard assessment for the existing and proposed corridor.

Key study findings of the geomorphic assessment are as follows:

- Reach S2 of Serson Creek was characterized as a historically modified channel situated within a confined valley;
- Reach S3 of Serson Creek was characterized as a well-defined channel situated within a partially confined valley;
- Rapid assessment techniques indicated that Reach S2 and Reach S3 of Serson Creek were characterized as 'in-transition' and 'in adjustment', respectively and both reaches displayed 'fair' overall ecological health;
- The recommended toe erosion allowance for Reach S2 and the confined right bank of Reach S3 is 8 m based on the MNR and CVC Technical Guidelines, and in consideration of the existing flow diversion through the WWTF;
- The erosion hazard limit for Reach S2 of Serson Creek is the long-term stable top of slope as determined by DS Consulting Ltd.; and
- The erosion hazard limit for partially confined Reach S3 is defined as follows:
    - East Side - meander belt limit; and
    - West Side - long-term stable top of slope (DS Consulting Ltd. 2019).

The proposed channel design provides a rehabilitated and enhanced section of the Serson Creek channel that while morphologically diverse, provides the channel stability required to maintain flood conveyance and improve terrestrial and aquatic habitat quality and connectivity. We note that the realignment of Serson Creek upstream to Lakeshore Road will be designed as part of a future project phase and will incorporate wildlife passage details for the proposed Haig Blvd. extension culvert crossing of the channel. To assist with the implementation of the channel rehabilitation design, the following recommendations are provided and should be incorporated, where appropriate, in the design drawings and contract documents:

- Pre-Construction Meeting – A start-up meeting should be held with all project team members to ensure that the contractor and site personnel are aware and familiar with the approved activities, monitoring requirements, and their rationale. All participating approval agencies shall be notified of the meeting, anticipated start-up construction date and schedule.

- Permits – Prior to construction, all applicable permits shall be provided to the project team members and contractor. The permits will be reviewed to ensure that all pertinent timelines and conditions are understood by the responsible parties. Valid copies of the permits shall be kept onsite and by key personnel responsible for carrying out conditions of the permits. The Contract Administrator must be notified if there is any deviation from the permit conditions that may impact implementation of the approved activities.

- Phasing and Erosion and Sediment Control (PESC) – It is recommended that channel works be constructed in the dry and stabilized prior to the introduction of flows. Phasing plans and erosion and sediment control plan have been developed based on the coordination with agencies, proposed development phasing and the WWTF. The erosion and sediment control plan incorporate best management practices (BMPs) and follow pertinent guideline documents during all phases of construction in accordance with site conditions.

- Construction Inspection – A qualified inspector should be present or available during construction to ensure proper implementation of approved drawings, design details, construction techniques, and permit conditions. Inspection will enable immediate and appropriate response to construction issues, ensure function of the design, and that the constructed design elements are stable prior to connection with the active channel system. A construction monitoring report should be completed to document the implementation of the approved activities.

- Site Maintenance – All materials and equipment shall be properly maintained to prevent deleterious substances from entering the water. All vehicles and equipment entering the isolated channel area shall be free of fluid leaks and externally cleaned/degreased to prevent deleterious substances from entering the water. A staging/storage area, with appropriate erosion controls, shall be placed well away from the work area. All vehicle and equipment refuelling and/or maintenance shall be conducted in the staging/storage area.

- Post-Construction Monitoring – Monitoring requirements has been confirmed in consultation with CVC following the conditions outlined within the DFO permit for the interim channel design.
- Monitoring and maintenance requirements related to the future Certificate of Property Use is to be completed as outlined in the EXP memorandum of December 18, 2020.

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Appendix A

Historical Aerial Imagery (GHD, 2015)

Legend

Subject Property

Historical Aerial Imagery	1946

Geomorphic Assessment, Serson Creek
Lakeview Village, City of Mississauga

BEACON ENVIRONMENTAL

Project: 217424
Last Revised: August, 2019

Client: Lakeview Community Partners

Prepared by: DU
Checked by: AS

N

1:12,000

0 150 300 m

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Legend

Subject Property

Historical Aerial Imagery	1954
Geomorphic Assessment, Serson Creek Lakeview Village, City of Mississauga	
BEACON ENVIRONMENTAL	Project: 217424 Last Revised: August, 2019
Client: Lakeview Community Partners	Prepared by: DU Checked by: AS
N 1:12,000	0 150 300 m

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Legend

Subject Property

Historical Aerial Imagery	1978
Geomorphic Assessment, Serson Creek Lakeview Village, City of Mississauga	
BEACON ENVIRONMENTAL	Project: 217424 Last Revised: August, 2019
Client: Lakeview Community Partners	Prepared by: DU Checked by: AS
N 1:12,000	0 150 300 m

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Legend

Subject Property

Historical Aerial Imagery	2002

Geomorphic Assessment, Serson Creek
Lakeview Village, City of Mississauga

BEACON ENVIRONMENTAL

Project: 217424
Last Revised: August, 2019

Client: Lakeview Community Partners

Prepared by: DU
Checked by: AS

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Legend

Subject Property

Historical Aerial Imagery	**2009**
Geomorphic Assessment, Serson Creek Lakeview Village, City of Mississauga	
BEACON ENVIRONMENTAL	Project: 217424 Last Revised: August, 2019
Client: Lakeview Community Partners	Prepared by: DU Checked by: AS
N 1:12,000	0 150 300 m

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Appendix B

Photographic Record

Photo 1. Location 1.
Reach S3. Upstream view of designed cobble lined channel and Lakeshore Road E culvert. September 21, 2018.

Photo 2. Location 1.

Reach S3. Downstream view of designed cobble lined channel. September 21, 2018.

Photo 3. Location 2.

Upstream view of Reach S3 general conditions. September 21, 2018.

Photo 4. Location 3.
Reach S3. Upstream view of rooted knickpoint leading into pool. September 21, 2018.

Photo 1. Location 1.
Reach S3. Upstream view of designed cobble lined channel and Lakeshore Road E culvert. September 21, 2018.

Photo 2. Location 1.

Reach S3. Downstream view of designed cobble lined channel. September 21, 2018.

Photo 3. Location 2.

Upstream view of Reach S3 general conditions. September 21, 2018.

Photo 4. Location 3.
Reach S3. Upstream view of rooted knickpoint leading into pool. September 21, 2018.

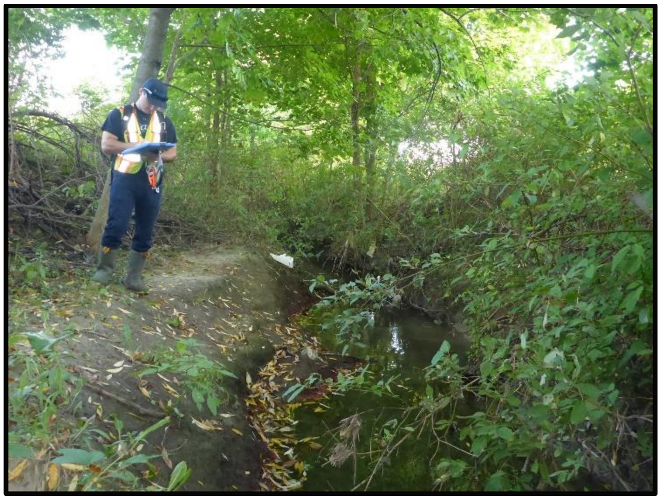


Photo 5. Location 4.
Reach S3. Upstream view of pool with terracing on right bank. September 21, 2018.

Photo 6. Location 5.
Reach S3. Floodplain along top of right bank, view towards Lakeshore Road E. September 21, 2018.

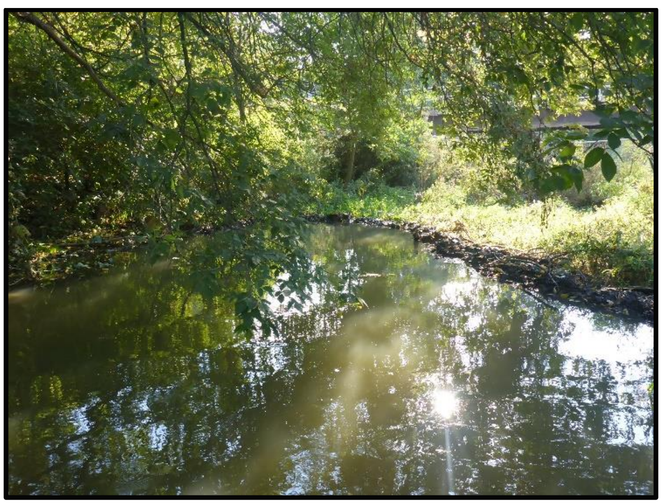


Photo 7. Location 6.
Reach S3. Downstream view of backwatering from beaver activity at channel confluence. September 21, 2018.

Photo 8. Location 7.
Reach S2. Upstream view towards property line at top end of reach. September 28, 2018.

Photo 9. Location 8.
Reach S2. Downstream view of woody debris jam.
September 28, 2018.

Photo 10. Location 9.
Reach S2. Downstream view of typical valley section: confined slope on right bank. September 28, 2018.

Photo 11. Location 10.
Reach S2. Rip-rap protection along lower bank.
September 28, 2018.

Photo 12. Location 11.
General conditions downstream in Reach S2.
September 28, 2018.

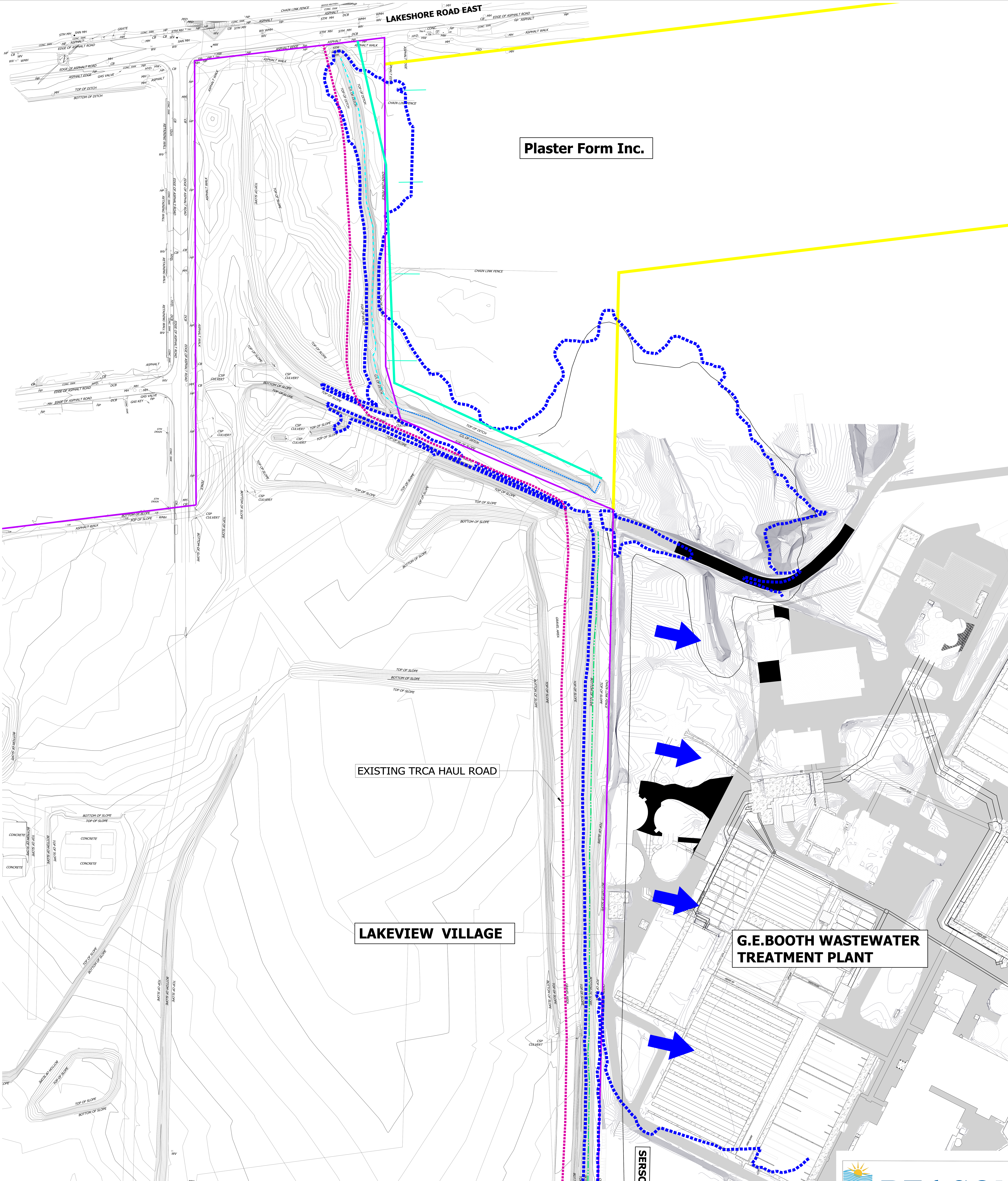
Photo 13. Location 12.
Reach S2. General wooded valley and channel location. September 28, 2018.

Photo 14. Location 13.

Reach S2. Widening channel at property line due to backwatering and variable lake levels. September 28, 2018.

Appendix C

Consolidated Flood and Erosion Hazard Constraints Figure (Urbantech 2019)



LEGEND

242.00	EXISTING CONTOUR AND ELEVATION
	LAKEVIEW PROPERTY LIMIT
	EXISTING REGIONAL FLOODLINE
	MEANDER BELT LIMIT
	LONG TERM STABLE TOP OF SLOPE
	EXISTING OPEN CHANNEL C/L
	EXISTING OPEN DITCH C/L
	EXISTING DISCONNECTED CHANNEL C/L

BEACON ENVIRONMENTAL

urbantech

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LAKE VIEW COMMUNITY

EXISTING VS. MODIFIED GHD DESIGN CONSTRAINT

DWG No A

SCALE: 1:800 | DATE: SEP. 2019 | PROJECT No: 17-549

File: P:\Projects\17-549-OPG Lakeview\Reports\FSR\Figures\17-549-Existing vs modified GHD (9m).dwg - Revised by <DLEE> : Fri, Oct 26 2018 - 2:38pm