Brookfield Renewable
South March BESS Site Fluvial Geomorphology Assessment
H375142

Engineering Report
Hydrotechnical Engineering

South March Battery Energy Storage System (BESS)
Fluvial Geomorphology Assessment

Report

South March Battery Energy Storage System (BESS) Fluvial Geomorphology Assessment

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1. Introduction

Hatch Ltd. (Hatch) has been retained by Brookfield BRP Canada Corporation (Brookfield) to conduct a fluvial geomorphic assessment at a discrete section of the South March creek (Creek) to support the design and permitting of a proposed development of the South March Battery Energy Storage System (BESS) project (Project). The South March BESS project is directly responding to the Independent Electricity System Operator's (IESO) request to increase supply and capacity to meet Ontario's growing electricity expenditure and demand by constructing an energy storage facility. The facility will increase renewable grid capacity and storage, enhance flexible grid operations and provide a low carbon initiative to avoid greenhouse gas emissions by reducing reliance on higher carbon intensive facilities.

The main objective of the fluvial geomorphic assessment was to confirm an appropriate geomorphic hazard (erosion) limit between the banks of the Creek and the proposed footprint of the development property. The scope of work to delineate this hazard/erosion setback involved the completion of a field reconnaissance and desktop analysis. This information was used to identify the characteristic channel morphology and bank stability of the study reach, coupled with the development of an erosion analysis to predict the long-term erosion potential of the watercourse. The results from the fluvial geomorphic assessment will be used to refine, as needed, a preliminary erosion hazard limit for the Project.

1.1 Project and Site Description

The South March BESS project is directly responding to the Independent Electricity System Operator's (IESO) request to increase supply and capacity to meet Ontario's growing electricity expenditure and demand by constructing an energy storage facility. The facility will increase renewable grid capacity and storage, enhance flexible grid operations and provide a low carbon initiative to avoid greenhouse gas emissions by reducing reliance on higher carbon intensive facilities.

Brookfield is proposing to develop approximately 0.06 km^2 of 0.61 km^2 property at 2555 and 2625 Marchurst Road in Dunrobin, Ontario, which is approximately 26.0 km southwest of Ottawa. The Project will consist of battery energy storage containers, a substation, access roads and associated electrical infrastructure. A key plan outlining the site location is shown on **Figure 1-1**.

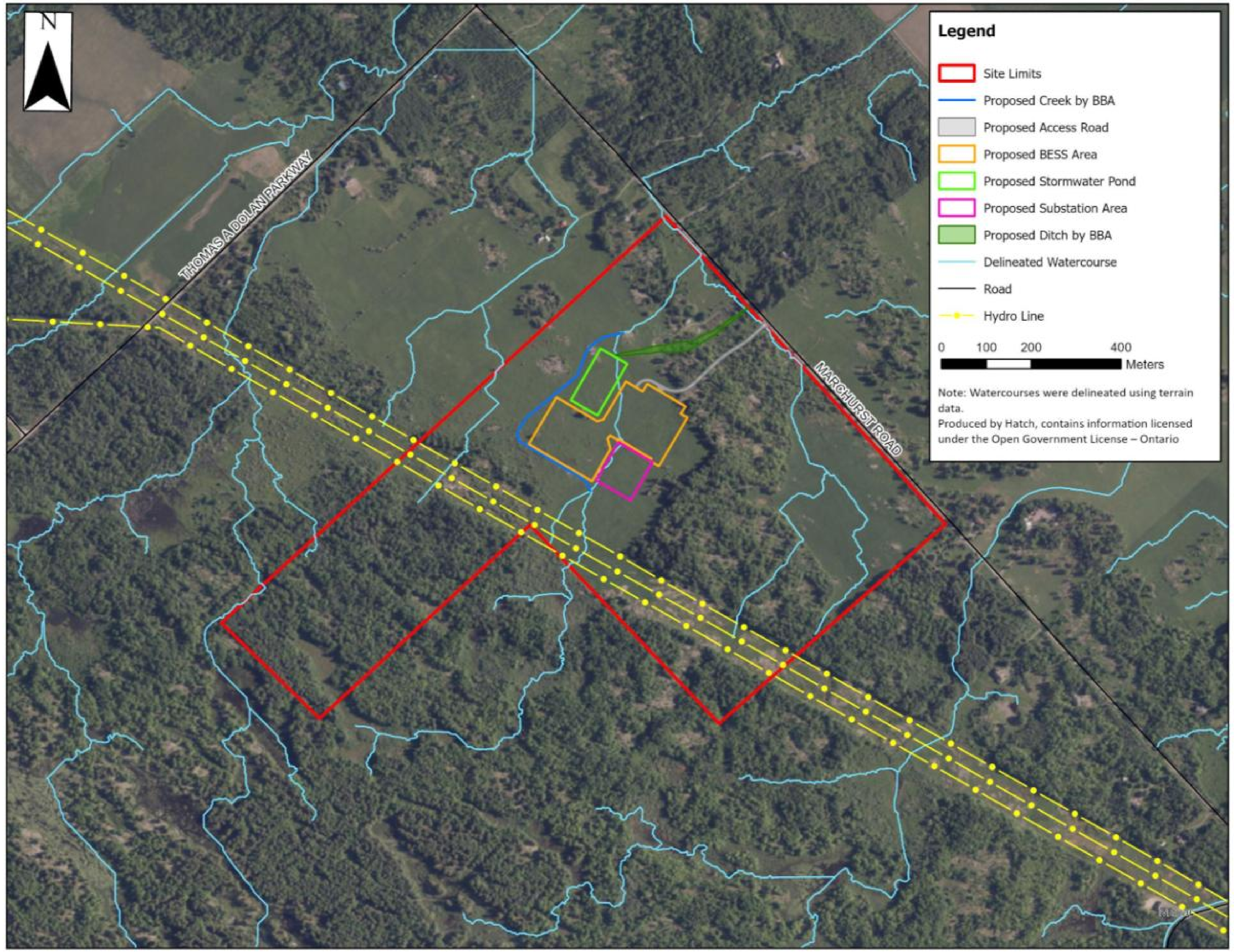


Figure 1-1: Overview of Limits of the South March BESS Project

1.2 Scope of Work

The purpose of this Fluvial Geomorphological Assessment Report is to:

- Review available background information and mapping (e.g., watershed/subwatershed reports, geology, and topography) related to the watercourse and the controlling factors of fluvial geomorphology.
- Examine recent and historical aerial photographs of the site to understand changes in channel form and function over time.
- Undertake a field investigation to document existing channel conditions, including bank characteristics, bed substrate, and geomorphic processes.
- Delineate the watercourse reach based on a desktop assessment followed by field confirmation.
- Assess fluvial geomorphological hazards (e.g., erosion and meander belt migration) and delineate the potential hazard limits.
- Evaluate the impacts of the anticipated post-construction conditions on the Creek.

This report summarizes findings of the desktop and field-based geomorphological assessment and should be reviewed in combination with the completed preliminary geotechnical investigation (Hatch, 2025).

1.3 Background Reference and Guidelines

The following listed information has been used in this study:

<u>Background Reports and Memos</u>

- Hatch, 2025. South March Battery Energy Storage System (BESS) Preliminary Geotechnical Investigation.
- Hatch, 2025. South March Battery Energy Storage System (BESS) Hydrogeological and Terrain Analysis Study.

<u>Background Reference Data</u>

- Historical Aerial Photographs - Extracted from McMaster University Library, Historical Hamilton Portal and Google Earth Pro.
- Soil and Groundwater Data - Extracted from the Geotechnical Investigation (Hatch 2025).

Guideline Requirements

- Ontario Ministry of Natural Resources (MNR) (2002). Technical Guide. River & Stream Systems: Erosion Hazard Limit.
- Credit Valley Conservation (CVC) (2015). Fluvial Geomorphic Guidelines.
- Greater Golden Horseshoe Area Conservation Authorities (2006). Erosion and Sediment Control Guideline for Urban Construction.

This technical report presents the methods and results of the fluvial geomorphic assessment at the reach length of the Creek. The remaining part of the document is organized into four main sections. This includes background review and desktop assessment for the Project site in Section 2.0, field investigation and observations in Section 3.0, fluvial hazard evaluation and hydraulic modelling in Section 4.0, and a discussion of the key findings and recommendations in Section 5.0.

2. Background Review and Desktop Assessment

The Project site includes an approximate area of 0.61 km^2 and is bounded by Marchurst Road to the northeast, 600 m from Thomas A. Dolan Parkway to the northwest, 1.0 km from John Aselford Drive to the southeast, and a creek crosses the middle of the Project site, from northeast to southwest (**Figure 1-1**). The Creek is ultimately draining to the east into Constance Lake, a shallow inland lake located in the Township of West Carleton. Constance Lake is located in the Township of West Carleton and has a shoreline perimeter of approximately 7.4 kilometres and a maximum depth of 3.5 metres. The lake supports a warm water fishery including Northern Pike, Largemouth Bass, Carp, Black Crappie, Yellow Perch, Pumpkinseed, and Brown Bullheads. Shoreline management initiatives have been promoted to protect water quality. The lake's water levels are primarily influenced by direct runoff and local watershed contributions. Most of Constance Lake watershed is characterized by undeveloped or unmaintained land use (i.e., mostly natural and former agriculture) which is where the Project site is located.

The Creek in the Project site drains a watershed area of approximately 0.35 km^2 in the area upstream (west) of the Project site and is located in the beginning of the watershed (the headwater zone of the watershed) which is draining into Constance Lake. Note that the headwater streams have relatively steeper slopes compared to the downstream zones, with a V-shaped valley.

The proposed development at the Project site involves the construction of battery energy storage containers, a substation, access roads and associated electrical infrastructure. This proposed development will utilize approximately 0.06 km^2 (or 9.8%) of the total area of the property.

2.1 Existing Documents and Mapping Review

A comprehensive review of existing documents and mapping products was conducted using data provided by two recent studies at the Project site. The first study is preliminary geotechnical investigations (Hatch 2025) that have been conducted at the Project site to support the design and permitting of the proposed development property. Key findings include:

- Borehole Data: nine boreholes (FY24-1 to FY24-9) were drilled across the site. The borehole logs indicated a consistent soil profile comprising non-organic topsoil (0.1 to 0.6 m below ground surface), underlain by layers of silty clay, with localized occurrences of silty sand and sandy silt at greater depths. Some boreholes encountered glacial till. Final drilling depths ranged from 0.75 m to 9.14 m.
- Groundwater Observations: Groundwater levels were recorded at multiple times during and after drilling. Measurements indicated that groundwater was relatively shallow within the middle of the development area, with measured depths between 1.0 m and 1.3 m below ground surface. No groundwater was recorded at borehole completion in the eastern and western parts of the developed site.
- Mapping Outputs: Detailed site plans were produced showing borehole locations, elevations, and key subsurface stratigraphy.

The second study is hydrogeological and terrain analysis (Hatch 2025) that has been conducted to provide an integrated assessment of the hydrogeological and terrain characteristics of the Project site. Its key contributions include:

- Terrain Characterization: The Project site is underlain by two primary terrain units, compact sandy and silty till, in the northwest and southeast strips, and Offshore Marine Deposits (clay, silty clay, and silt) in the middle portion. The marine deposits exhibit low permeability, which may influence drainage and surface runoff patterns.
- Hydrogeological Conditions: By integrating borehole data from the geotechnical investigation, the study assessed soil conditions, groundwater table elevations, and determined that groundwater generally flows toward the northeast and southwest.
- Mapping Products: The study produced mapping outputs, including a site plan that indicates borehole locations and elevations, terrain unit maps showing the spatial distribution of geological units, and groundwater flow maps generated through interpolation of borehole data.

2.2 Historical Aerial Photographs Assessment

A series of historical aerial photographs were reviewed to determine changes to channels or drainage features on site and surrounding land use and land cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morpho-dynamics. Various aerial photographs and satellite images from 1954 to 2024 were retrieved to complete the historical assessment and inform the erosion hazard delineation. Specifically, aerial photographs for the year 1954 (1:25,000) was retrieved from McMaster University Library (Historical Hamilton Portal); and 2004, 2008, 2009, 2012, 2013, 2014, 2015, 2016, 2017, 2019, 2022, 2023, and 2024 (1:20,000) were retrieved from Google Earth Pro. All historical aerial photographs are provided in Appendix B for reference.

In 1954, the subject property was primarily agricultural land, with rectangular field patterns and a few hedgerows along the northeast portion of the property boundaries. The Creek is not visible crossing the site, and no other drainage features were visible on site.

Between 2004 and 2009, the Creek became visible within the site boundaries. originating from two tributaries that converge near the southeast site boundary. A wet pond feature was also visible along the northern portion of the creek. Surrounding land use during this period remained largely agricultural and undeveloped.

Between 2012 and 2024, the upstream portion of the creek (southeast of the project site) appeared to be changed, with a less distinct footprint of the two tributaries and an expansion of the wet pond area. In the southeast portion of the Creek, the aerial photography shows lateral expansion of the watercourse and less distinct channel banks. No significant changes to surrounding land use were observed during this period compared to the previous aerial photography.

2.3 Desktop and GIS Analysis

A desktop assessment was conducted to delineate the watercourse reach and its contributing watershed using publicly available digital elevation data and GIS-based analysis. The analysis involved processing digital elevation models (DEMs) to extract terrain features, identify flow accumulation paths, and define watershed boundaries. The Eastern Ontario 2021 to 2022 Digital Terrain Model (DTM) topographic survey was obtained from Ontario GeoHub in TIFF format, with a 0.5 m × 0.5 m grid resolution covering the full study area. Based on field observations.

Hydrological analysis, including catchment and stream delineation, was performed using ArcGIS to assess surface flow directions. **Figure 2-1** shows the drainage patterns within the study area using the topographic data.

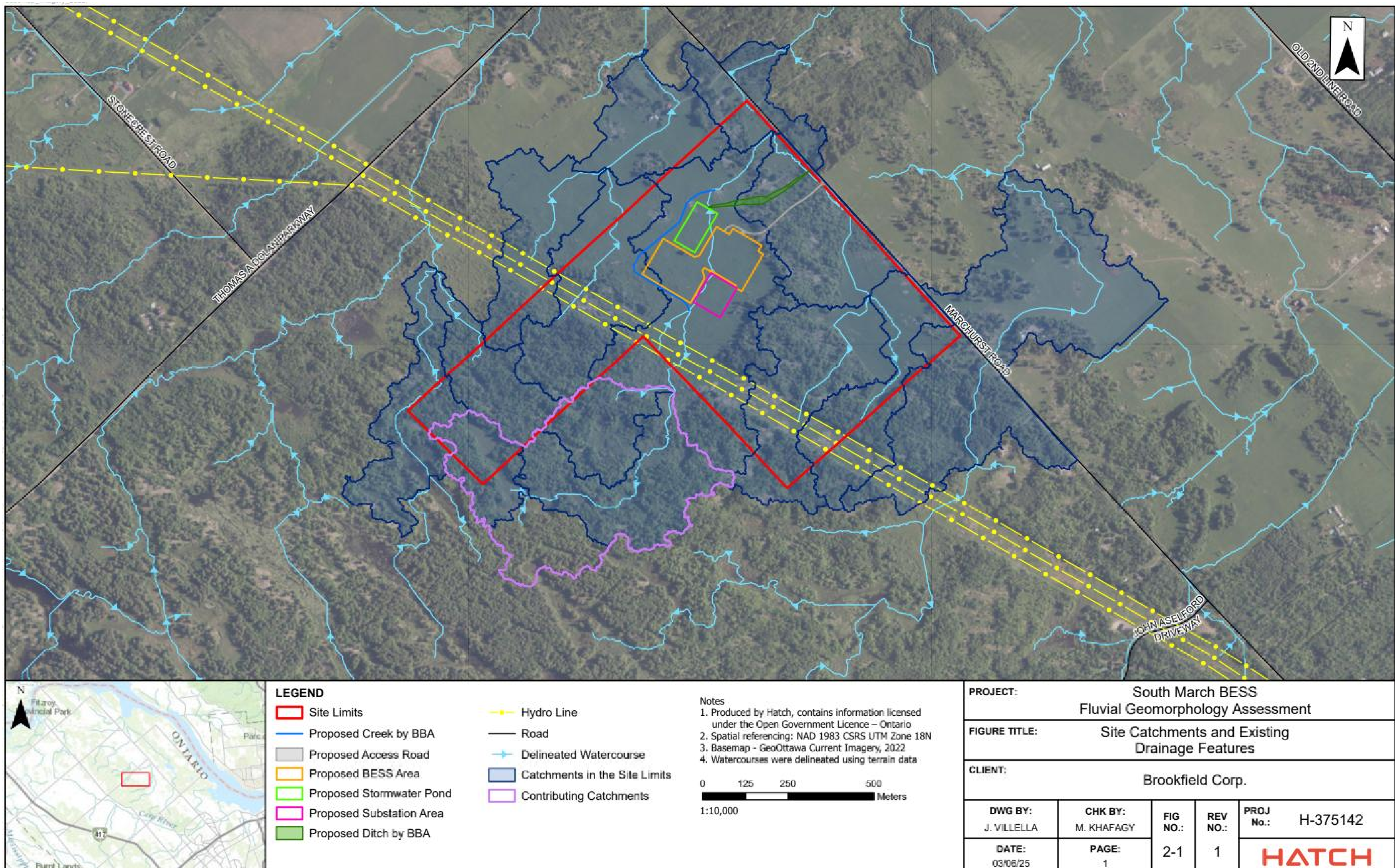


Figure 2-1: Catchments Within the Study Area with Existing Drainage Features and General Drainage Patterns

3. Field Investigation and Observations

A field investigation was conducted on April 7, 2025, to assess the fluvial and geomorphic conditions of the Creek within the Project boundaries. Field observations noted that the Creek exhibits spreading of ponded water in the upstream portion, between locations S1 and S3 (Appendix B). Beginning at location S4, the Creek transitions into a shallow and narrow channel, with an average surface width of approximately 1.5 m and a water depth ranging between 15 and 25 cm.

Two culverts installed in series, each is 80 cm in diameter and 3.5 m in length (Photo 12 in Appendix B) were observed along the creek corridor. These culverts convey flow into a large wet pond located along the northern portion of the Creek, shown in Photo 13 (Appendix B).

Active flow was observed during the site visit, with ponded water present within the upstream ponded/spreading water section, and continuous flow through the downstream channelized reach. At the northeast property boundary, the Creek drains through a 70 cm diameter culvert crossing Marchurst Road, discharging to the northeast (Photos 26 and 27 in Appendix B).

Field observations are supplemented by representative photographs (Photos 1 to 27), the geographic locations of which are shown in **Figure 3-1**, and included in Appendix B.

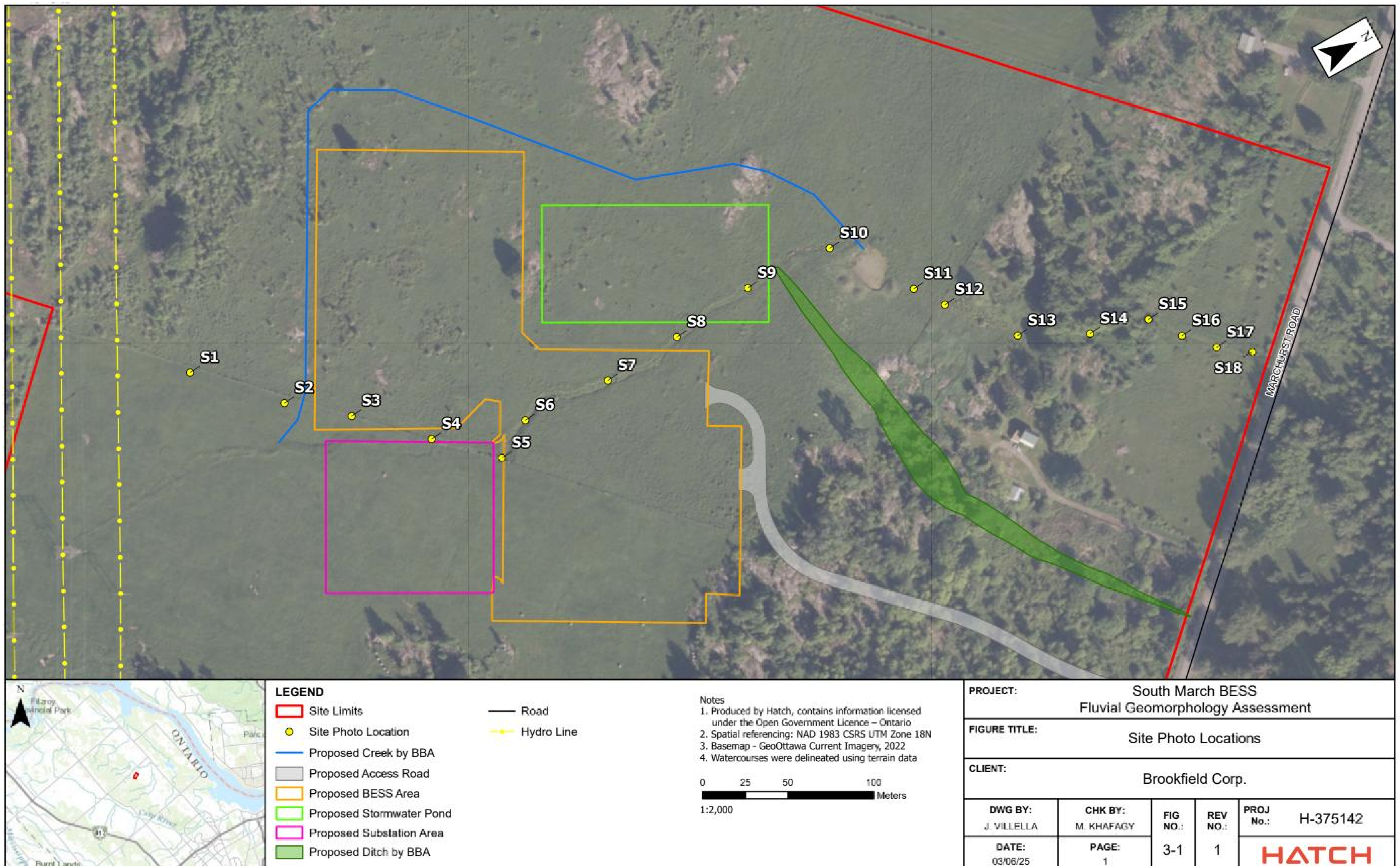


Figure 3-1: Locations of Field Photographs

3.1 Watercourse Conditions

At the southeast boundary of the Project site, stagnant water was observed within two upstream branches of the creek, as shown in Photos 1 to 4 (Appendix B) from locations S1 and S2. The presence of standing water outside the defined channel zone may suggest backwater effects during wet periods, although no well-defined channel was visible in this area. These observations are consistent with the high groundwater table identified in the borehole data from the geotechnical investigation (Hatch, 2025). The lack of defined banks suggests low channel confinement, with water dispersing laterally across the adjacent field. These conditions are characteristic of weak channelization and reduced hydraulic capacity, with potential for overland flow contributions during high-flow events.

The two branches converge near location S4, where the water remains dispersed. Beyond this point, the creek transitions into a more defined, confined system with an increased water depth of approximately 16 cm.

From location S4, the watercourse flows through a vegetated corridor with yellowing grasses and mild side slopes (approximately 3:1). The channel bed consists primarily of fine sediments, organic debris, and high grass. Riparian vegetation includes shrubs, saplings, and deadfall along both banks. No signs of bank slumping or undercutting were observed, and no erosion control measures (e.g., riprap or engineered stabilization) were noted. These conditions support classifying this section of the creek as a stable, shallow, confined system, with minimal erosion activity and limited potential for channel migration under current hydrologic conditions.

At location S5 (Photos 7 and 8), the watercourse temporarily widens to approximately 3 m, with a shallow depth of about 5 cm. The adjacent land in this section was dry and showed no signs of soil saturation.

Further downstream at location S10, the creek discharges into a large wet pond, where the water surface was approximately 1 m below the surrounding ground elevation. At locations S11 and S12 (Photos 14 and 15), the creek again widens slightly to approximately 2 m with a shallow depth of 5 cm, before narrowing to about 0.5 m wide and deepening to roughly 25 cm. A small 7 cm-high waterfall is present along the Creek at location S15.

At the northeast boundary of the Project site (Photos 26 and 27 in Appendix B), the creek exits the property via a 70 cm diameter CSP culvert that crosses Marchhurst Road, conveying flows towards northeast.

3.2 Observed Fluvial Processes

Evidence of localized channel widening was noted in two areas within the confined portion of the creek at locations S5, S11, and S12 (Appendix B). Instances of channel adjustment and planform variability were also observed. At location S14, the creek exhibits minor sinuosity, with lateral deflections in the low-flow path suggesting limited but active fluvial processes. These changes in flow alignment are likely the result of small-scale bank erosion and scour along the outer edges of developing meander features. Such features may indicate the early formation of a meander belt within this reach of the channel.

3.3 Stormwater Management Implications

While a detailed stormwater management (SWM) analysis is beyond the scope of this fluvial geomorphology study, field observations provide important context for future drainage design. Saturated soils along the Creek corridor, the presence of stagnant water zones, and high groundwater levels (as identified in the geotechnical investigation) were observed in the middle area of the site (within the development area). These conditions suggest that infiltration-based SWM measures may be constrained within the unconfined upstream reach. Additionally, the confined nature of the channel downstream indicates limited lateral erosion or channel migration, which may reduce setback requirements but should still be validated through ongoing coordination with SWM designers.

4. Erosion Hazard Evaluation and Hydraulic Modelling

A Hydraulic Analysis was completed for the Creek to support the delineation of the erosion hazard limit and inform the meander belt allowance. The analysis used the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center’s River Analysis System (HEC-RAS) version 6.4.1. Given that the Creek is typically dry outside of storm events, it was assumed that the available Digital Elevation Model (DEM) captured the channel bathymetry with sufficient accuracy. The following subsections outline the development and results of the HEC-RAS 1D model.

4.1 Hydraulic Model Overview

HEC-RAS is a widely accepted software system for simulating one-dimensional water surface profiles along natural and constructed channels. In this study, HEC-RAS was used to model the existing Creek geometry under various design flow events. The software uses the principles of conservation of mass and energy (or momentum) to solve for flow depth and discharge along each cross-section. Outputs from this model are useful for understanding potential overbank flow extents and complement the geomorphological assessment of erosion hazard zones.

4.2 HEC-RAS Model Development

The model geometry was developed using the RAS Mapper toolset. HEC-RAS Mapper is an HEC-RAS extension that provides the user with a set of procedures, tools, and utilities for development of 1D HEC-RAS river hydraulic models. River network, and cross-sections are among the parameters that were developed using the RAS Mapper extension. The HEC-RAS program was designed to evaluate the hydraulic assessment of the Creek and to produce floodplain inundation mapping where required. All input parameters to the HEC-RAS model were defined in geometric data and flow data modules.

4.2.1 Cross-sections

The terrain was created based on the available survey and was used to create cutlines (cross-section lines) within HEC-RAS. The HEC-RAS model includes a total reach length of approximately 950 m. The cutlines are perpendicular to the direction of flow and developed using the RAS Mapper extension. The cross-sections were cut at locations with potential changes (i.e., bends, bridge structure, contraction, expansion, etc.) in the stream. In general, 14 cross-sections were constructed along the river alignment with an average spacing of 60m. **Figure 4-1** shows the HEC-RAS schematic of the cross-sections and river alignment with the terrain. Note that the north reach of the creek had not appeared in the GIS delineation, however, it was observed from the aerial photos and field photos. The cross sections in HEC-RAS were extended to cover both reaches of the creek. It is important to note that the north reach of the creek did not appear in the GIS delineation; however, its presence was confirmed through aerial imagery and field observations. Therefore, the HEC-RAS cross-sections were extended to include both the main and north reaches of the creek.

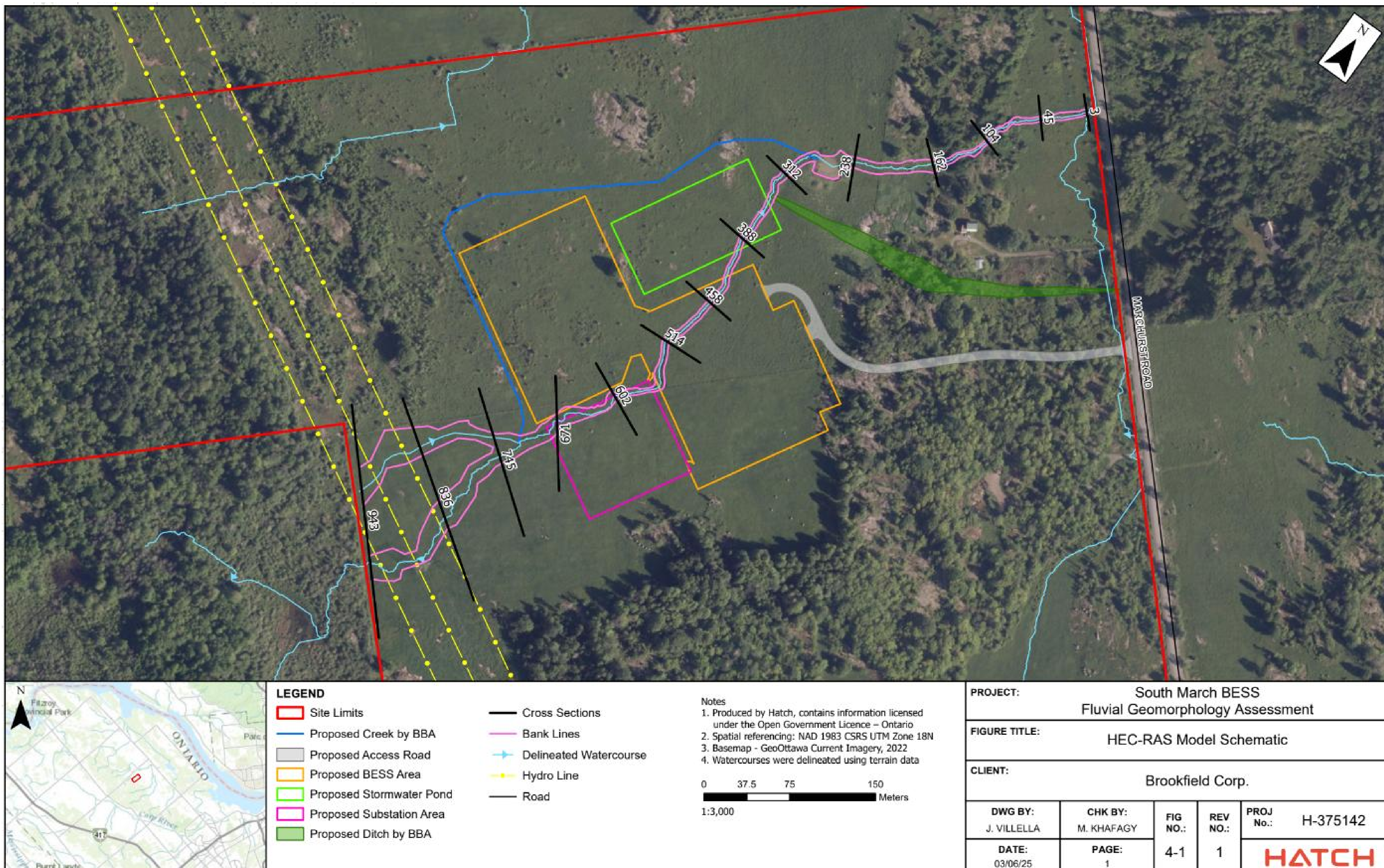


Figure 4-1: HEC-RAS Model Schematic

4.2.2 Flood Flow Estimation

The flow hydrographs were estimated using PCSWMM for the 2- and 100-year events. Hydrologic modelling parameters were determined using the following information as per the City of Ottawa Sewer Design Guidelines:

- 2-year and 100-year 12-hour SCS Type II storm events (6-minute time step).
- The contributing drainage area of the Creek is 0.35 km^2 (**Figure 2-1**).
- The imperviousness value is based on the runoff coefficients, which were determined based on land use type (imperviousness = 7%).
- Initial Abstraction (Detention storage): Detention storage depths of 2 mm for impervious areas and 5 mm for pervious areas were used following InfoWorks CS Basement Flooding Model Studies guideline.
- A Manning's roughness coefficient of 0.25 was used for pervious areas. For impervious areas, a Manning's roughness coefficient of 0.013 was used.
- The sub-catchment width of the watershed area in the current model is calculated based on the shape of the watershed area and the flow streamlines within the watershed area (Width = 382.3 m).
- The average surface slope was based upon the average slope of the catchment (slope = 0.754%).
- Horton Method was used to model infiltration in PCSWMM model to compute the runoff from single-event design. The infiltration rates are selected based on the geotechnical information in the geotechnical report (Hatch, 2025).

The peak flow rates used for the model are summarized in **Table 4-1**.

Table 4-1: Peak Flows of South March Creek

Return Period	2-Year	100-Year
Flow Rate [m^3/s]	0.35	1.03

4.3 Floodplain Results

The Creek alignment was developed in RAS Mapper by creating the river centreline layer based on the flow path generated in ArcGIS Pro showing the location of the lowest points.

The Hydraulic Analysis was performed for the 2- and 100-year events. A Manning's 'n' coefficient of 0.035 was selected for the Creek channel, 0.045 for the Creek banks within the confined system, and 0.035 for the Creek banks within the unconfined system based on vegetation and surface conditions following City of Ottawa Sewer Design Guidelines. A summary of HEC-RAS hydraulic results is provided in Appendix C. A normal depth boundary condition was applied at the downstream end, with slope of 0.87% which aligns with the channel bed slope at the downstream cross-section. Note that the flow in all cross-sections is subcritical ($F_r < 1$) for both storm events, except at station 104, where the flow is critical ($F_r = 1$) for the 100-year storm event. This location corresponds to a small waterfall with an approximate drop of 7 cm, as observed at location S15 (Photos 19, 20, and 21 in Appendix B). **Figure 4-2** shows the water levels in two cross-sections for the 100-year storm event.

(a) Cross-section at Station 104 **(b) Cross-section at Station 836**

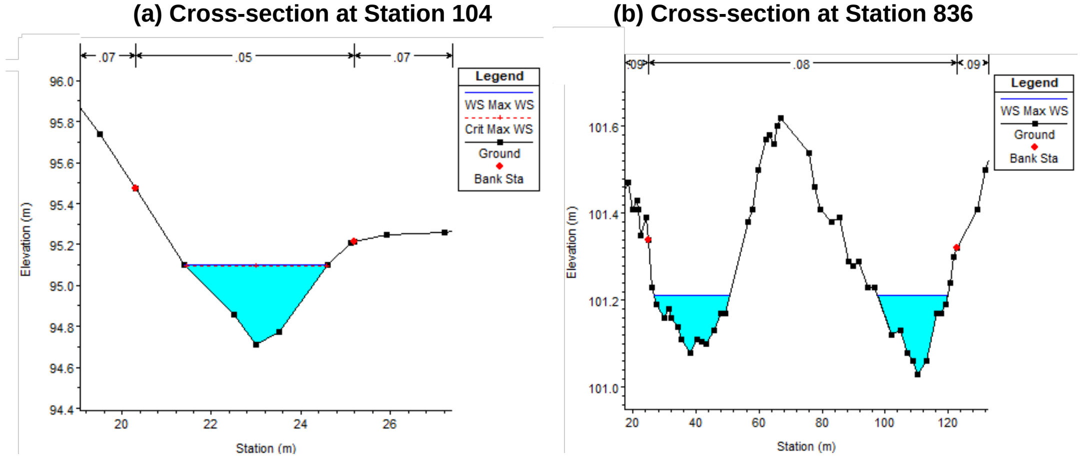


Figure 4-2: Cross-sections with Critical Flow for 100-year Storm Event

Figure 4-3 shows the Creek profile for 2-year and 100-year storm events.

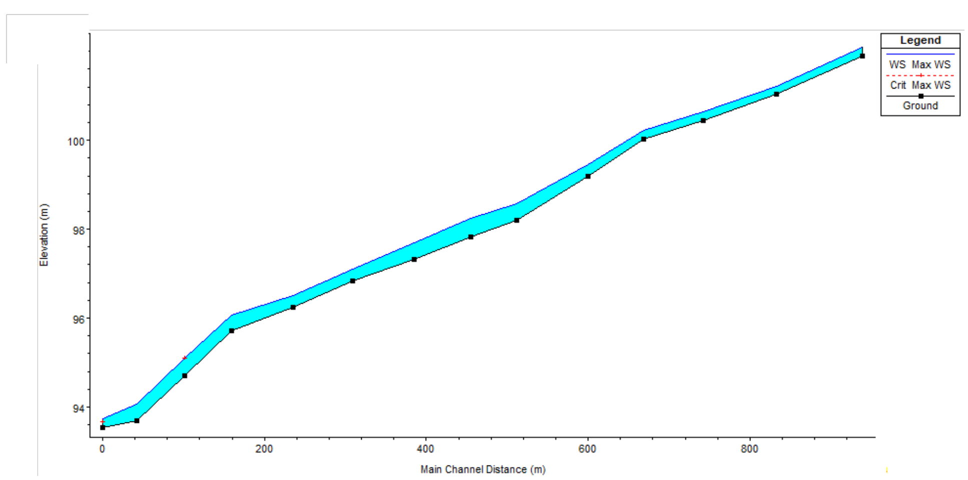


Figure 4-3: South March Creek Profile for 100-year Storm Event

The results of the 100-year flood events at the Creek are shown in **Figure 4-4** below.

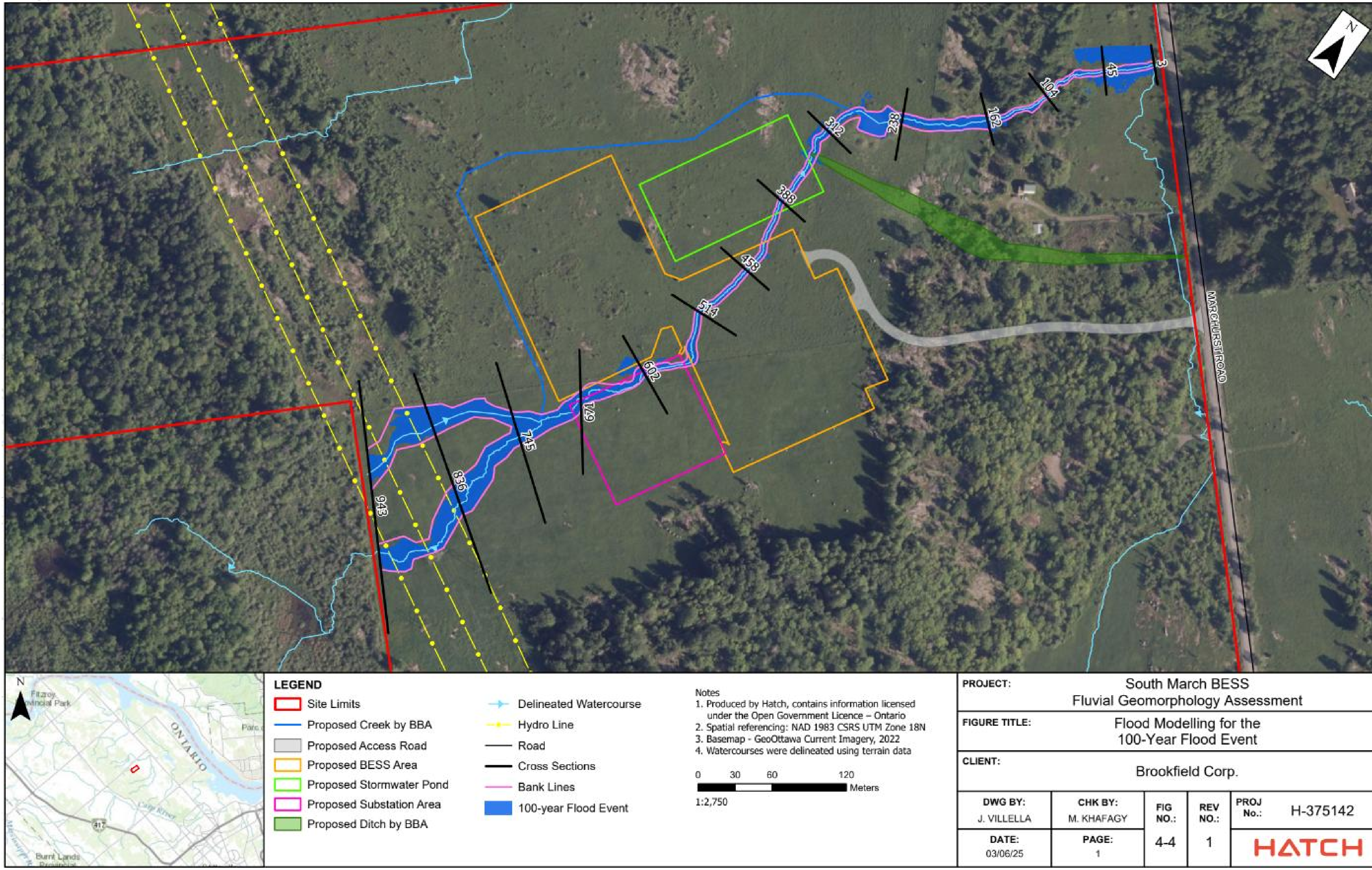


Figure 4-4: Results of South March Creek Floodplain Modelling for the 100-year Flood Event

4.4 Sediment Transport Assessment

For the existing condition, field observations and review of historical aerial imagery did not indicate active sedimentation or significant channel migration that would require further quantitative assessment. Therefore, a qualitative geomorphic assessment was sufficient for the objectives of this study.

4.5 Meander Belt and Erosion Hazard Assessment

The delineation of the erosion hazard limit for the Creek within the study area is based on an integrated methodology that includes: (1) interpretation of historical aerial photography to identify evidence of channel migration and planform change, (2) field-based geomorphic assessment to characterize channel conditions and erosional activity, and (3) hydraulic modeling using HEC-RAS to delineate the 100-year floodplain extent. While HEC-RAS modelling does not determine meander belt widths, its output supports the geomorphic interpretation by identifying flood-prone areas and potential zones of fluvial activity.

4.5.1 Toe Erosion and Stable Slope Allowance

Most watercourses in Ontario have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential erosion hazard to proposed activities adjacent to a given watercourse.

When defining the meander belt width or erosion hazard for a creek system, unconfined and confined valley systems are assessed differently. Confined systems are those where the watercourse is contained within a defined valley, where contact between the watercourse and a valley wall is possible. The erosion hazard for confined systems can be defined based on a toe erosion allowance and stable slope allowance. In contrast, unconfined systems are those with poorly defined valleys or slopes well-outside where the channel could realistically migrate. Unconfined systems are generally found within glaciated plains with flat or gently rolling topography.

As per the fluvial geomorphological assessment based on field observations and desktop review, two distinct geomorphic system types are observed within the study area. The watercourse crossing through the subject property from southeast boundary is characterized as an unconfined system, as there are no steep or significant valley slopes on either side of the watercourse. This is indicated by wider planform adjustments and signs of active erosion visible in the historical aerial imagery (year 2016 in Appendix A), including ponded areas likely resulting from past flood events (Photos 1 to 4 in Appendix B). In contrast, the downstream section of the Creek, north of the Project site, exhibits the characteristics of a confined system, flowing through a vegetated corridor with limited lateral mobility.

The upstream reach of the Creek is defined as an unconfined system. In such systems, the erosion hazard is assessed using a meander belt width approach, which reflects the maximum fixed lateral extent of historical and potential future channel migration. As per MNR Technical Guide (2002), the meander belt width is defined as the summation of meander amplitude and erosion access allowance. In this case, the historical aerial photograph analysis confirms lateral channel migration and expansion of the channel and adjacent wetland features over time. Erosion Access Allowance is a minimum access distance is typically applied at the top of the valley slope to allow space for maintenance or future stabilization works. Regarding the erosion access allowance, MNR Technical Guide (2002) guidelines note that for stiff/hard cohesive soil (clays, clay silt) and coarse granular (gravels) tills, a 5 to 8 m erosion access is to be applied. Given the evidence of erosion along the Creek, erosion access allowance of 6 m is recommended. An appropriate safety factor can be applied to the Erosion Hazard limit as per guideline recommendations, and a 2 m safety factor has been applied. **Figure 4-5** shows the erosion hazard limit for the unconfined system reach of the Creek including the Meander belt Width, erosion access allowance, and safety factor.

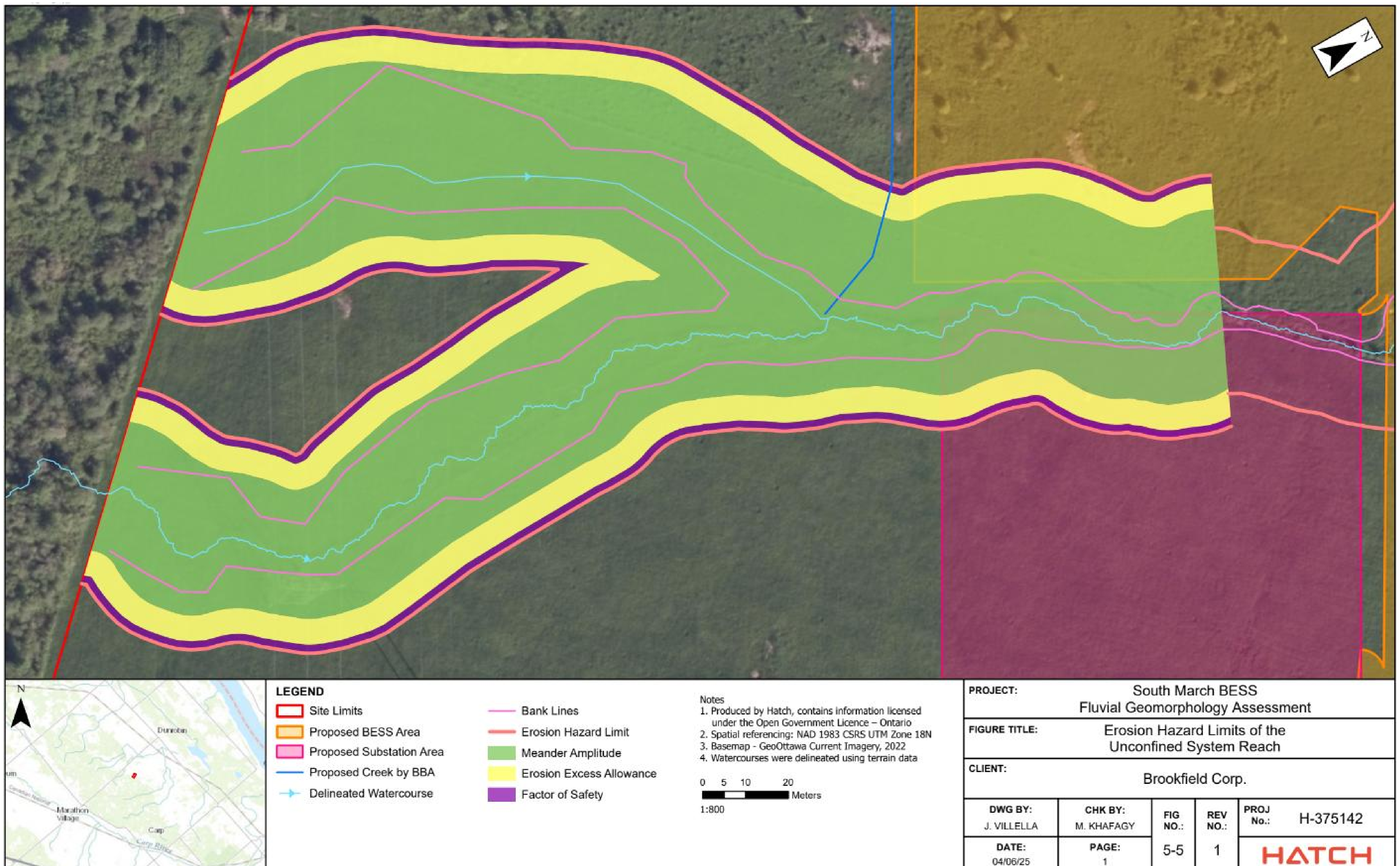


Figure 4-5: Erosion Hazard Limit of the Unconfined System Reach

The downstream reach of the Creek transitions into a confined system. An appropriate approach is to delineate the erosion hazard for the confined systems following MNR Erosion Hazard Limit Technical Guide (2002), where the erosion hazard is comprised of three main components: 1) the toe erosion allowance; 2) the stable slope allowance; and 3) the erosion access allowance. The toe Erosion Allowance represents the potential for channel migration at the base of the valley slope. A toe erosion allowance of 7 m was applied following the MNR Technical Guide (2001). Stable Slope Allowance is to address potential long-term slope instability, where the stable slope allowance is determined based on geotechnical criteria. In accordance with the CVC Watershed Planning and Regulation Policies (2010), a stable slope allowance is required only where specific conditions apply, including: slope gradients steeper than 3:1, slope heights equal to or greater than 2 m, visible evidence of slope instability, proximity of bankfull flow to the valley toe of slope (within 15 m), or a known history of slope failure. Not all of these conditions were observed at the subject site. Therefore, a stable slope allowance is not considered necessary for this reach of the watercourse. An erosion access allowance of 8 m is recommended.

The proposed development area is located within the delineated erosion hazard limit associated with a portion of both the unconfined and confined system reaches of the Creek. **Figure 4-5** and **Figure 4-6** show the overlap between the development footprint and the defined erosion hazard components, including the meander amplitude, toe erosion allowance, and erosion access allowance. This confirms that the development, as currently planned, encroach upon areas identified as geomorphologically sensitive or at risk of fluvial erosion. A new reach of the creek has been proposed by BBA Consultants to realign the channel around the development footprint.

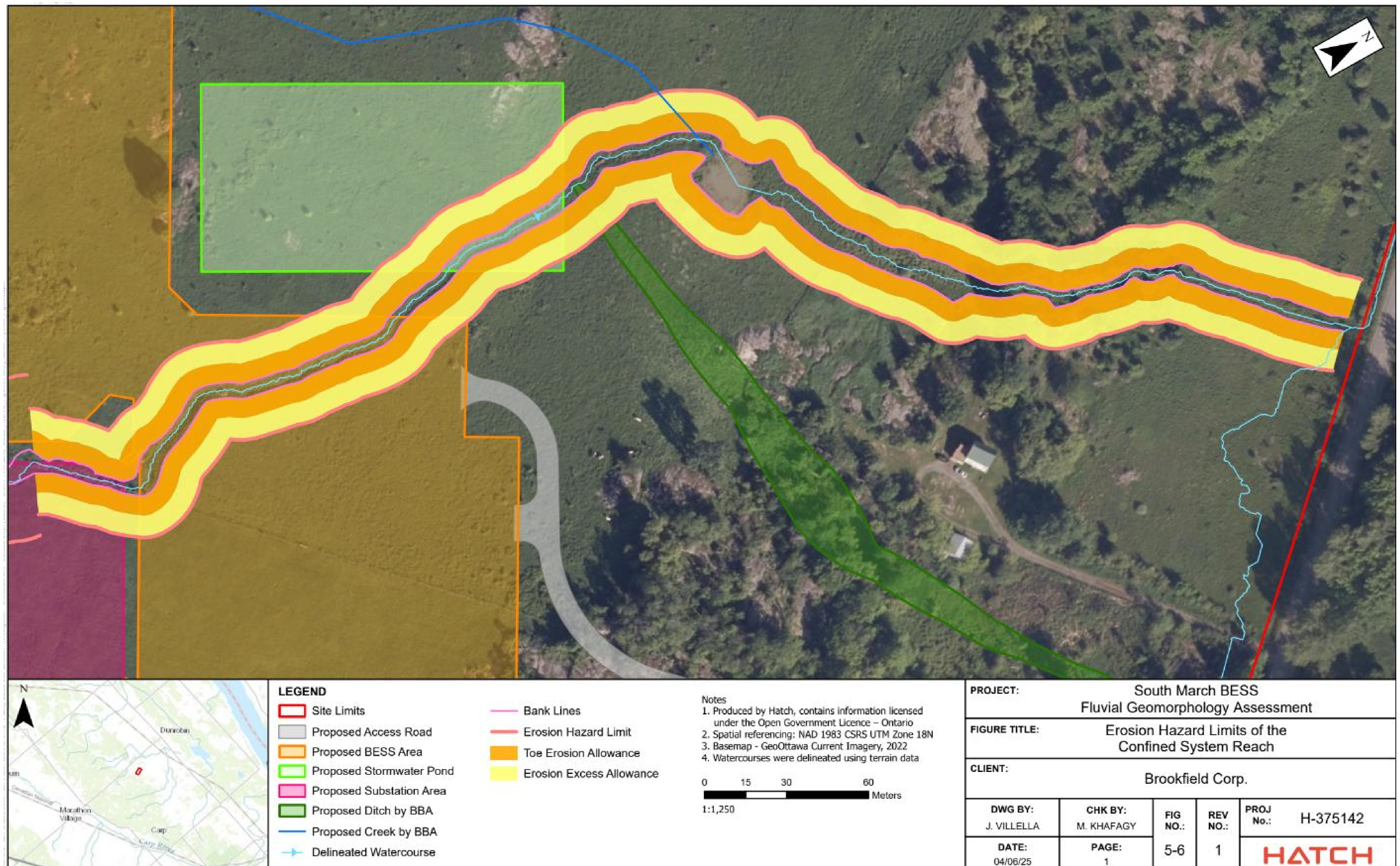


Figure 4-6: Erosion Hazard Limit of the Confined System Reach

4.6 Proposed Creek Realignment Considerations

As part of the South March BESS development, a realignment of the creek has been proposed and designed in the Stormwater Management Plan and Water Budget Assessment report (BBA Consultants, 2025), in the form of a diversion ditch that routes flow around the development area (**Figure 4-4**).

The proposed realigned channel is located between two geomorphic settings. The upstream section of the creek is unconfined and exhibits geomorphic sensitivity, with potential for sediment mobilization (**Figure 4-5**). In contrast, the downstream reach is confined with no significant evidence of active erosion or instability based on field observations (**Figure 4-6**).

As per the Erosion and Sediment Control Guideline for Urban Construction (2006), diversion channels that are expected to remain in place for extended periods (e.g., 6-12 months or longer) and convey moderate flows should be lined with erosion-resistant materials such as turf reinforcement mats or coir matting to ensure stability during operation. These treatments help reduce shear stress on channel boundaries and promote vegetation establishment. Furthermore, the proposed channel should be designed using Natural Channel Design principles by ensuring appropriate sizing, planform, slope, and materials that reflect the natural characteristics to promote long-term stability, as recommended in the CVC Fluvial Geomorphic Guidelines (2015).

5. Conclusions and Recommendations

A fluvial geomorphological assessment was completed for the South March Creek within the Project site to identify erosion hazard limits. The following are the key conclusions of the assessment:

- The Creek drains a small watershed (~0.35 km²) and is characterized by a shallow depth (~15–25 cm) and narrow width (~1.5 m). Flow is generally directed toward Constance Lake to the east.
- Field observations and historical aerial photographs confirmed that the upstream portion of the Creek functions as a weakly defined, unconfined system, while the downstream section transitions into a confined system.
- Saturated soils were observed in the southeast portion of the site, consistent with borehole data. These conditions may limit the viability of infiltration-based stormwater management (SWM) practices within the developed area.
- A 1D HEC-RAS hydraulic model was developed for the Creek to assess floodplain extents and support erosion hazard delineation. The 100-year flood profile was used as a reference to define overbank flow potential and geomorphic hazard limits.

- A sediment transport assessment is recommended for the proposed realigned reach of the creek to evaluate erosion and deposition risks and confirm channel stability.
- The current development footprint overlaps with a portion of the erosion hazard limit associated with a portion of both the unconfined and confined system reaches of the existing creek. A realignment of the creek has been proposed and designed by BBA Consultants in the form of a diversion ditch that routes flow around the development area. The diversion ditch should be lined with erosion-resistant materials such as turf reinforcement mats or coir matting to ensure stability during operation.

6. References

City of Ottawa (October 2012). Sewer Design Guidelines, Second Edition, Document SDG002.

Credit Valley Conservation (CVC) (April 2010). Watershed Planning and Regulation Policies.

Credit Valley Conservation (CVC) (April 2015). Fluvial Geomorphic Guidelines.

Greater Golden Horseshoe Area Conservation Authorities (December 2006). Erosion and Sediment Control Guideline for Urban Construction.

Hatch (April 2025). South March Battery Energy Storage System (BESS) Preliminary Geotechnical Investigation.

Hatch (March 2025). South March Battery Energy Storage System (BESS) Hydrogeological and Terrain Analysis Study.

BBA Consultants (June 2025). Stormwater Management Plan and Water Budget Assessment Report. BBA Document No.-Rev.: 7154023-100000-41-ERA-0001-RAB

McMaster University Library. Historical Hamilton Portal (Link: https://library.mcmaster.ca/maps/aerialphotos/).

Ontario Ministry of Natural Resources (MNR) (2002). Technical Guide. River & Stream Systems: Erosion Hazard Limit.

Ontario Ministry of Natural Resources, Ontario Watershed Information Tool (OWIT).

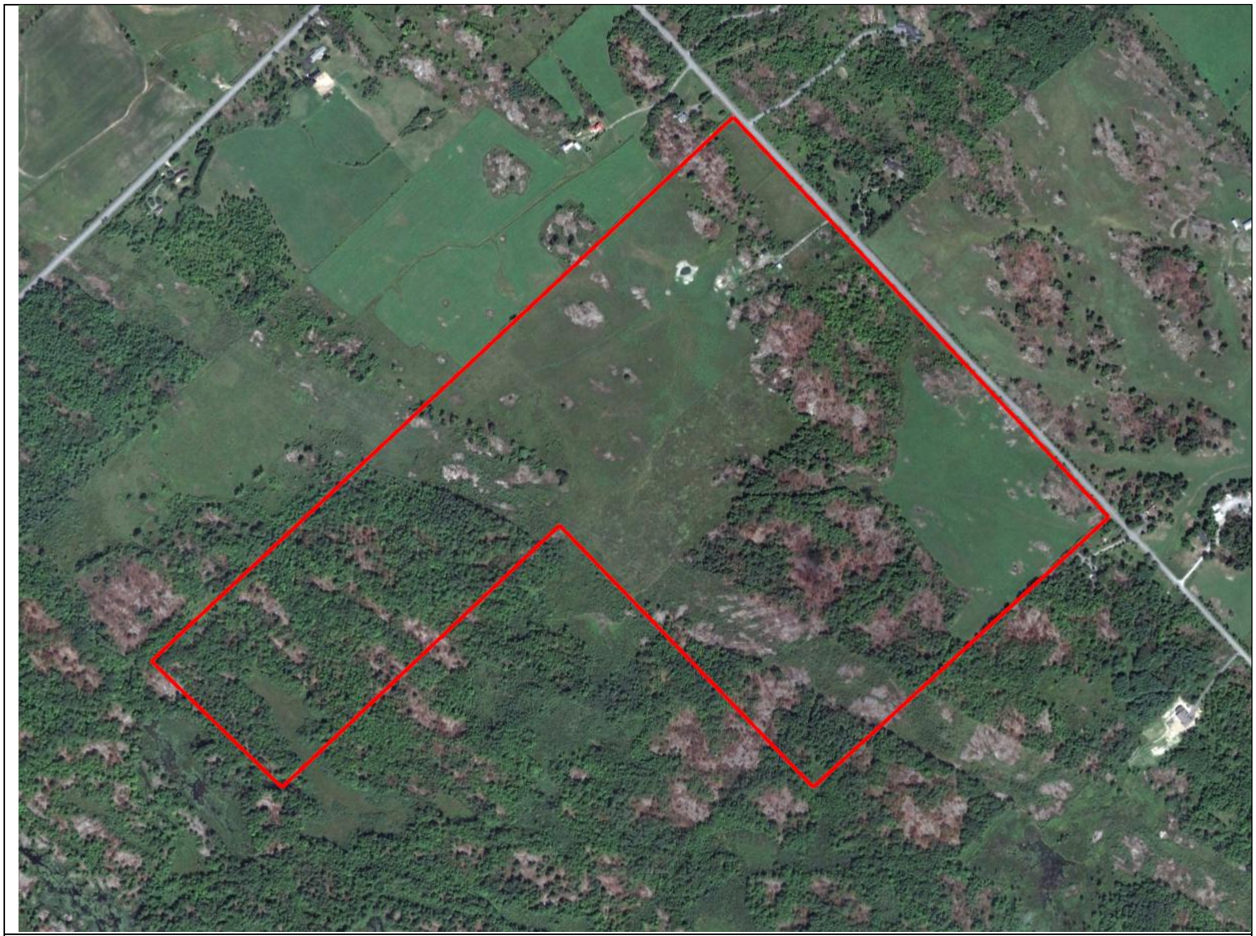
Appendix A
Historical Aerial Photographs

Location: Ottawa, ON
Year: 1954
Scale: 1:25,000
Source: McMaster University Library (Historical Hamilton Portal)
Red Boundary: Site Limits

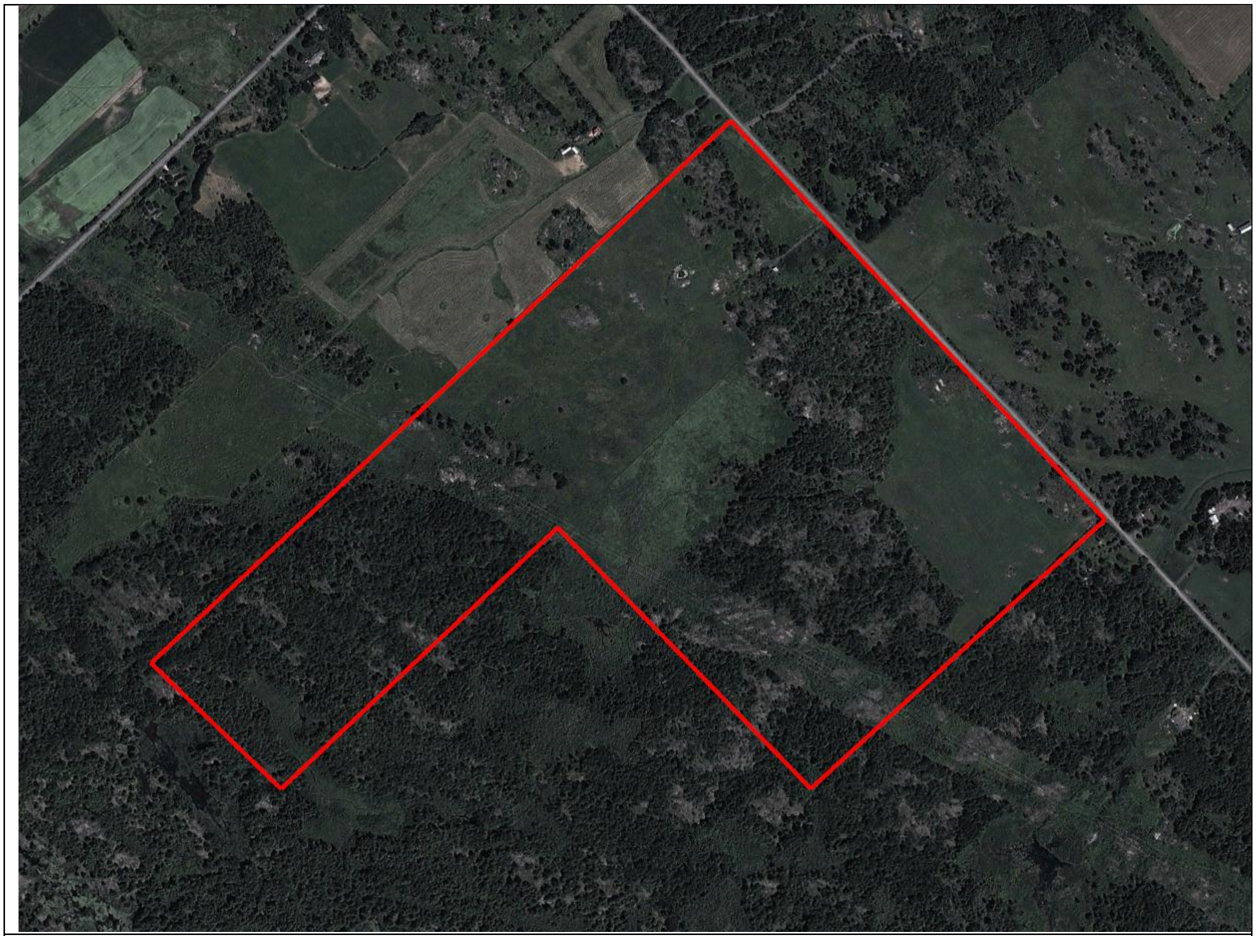
Location: Ottawa, ON
Year: 2004
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

Location: Ottawa, ON
Year: 2008
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

Location: Ottawa, ON
Year: 2009
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



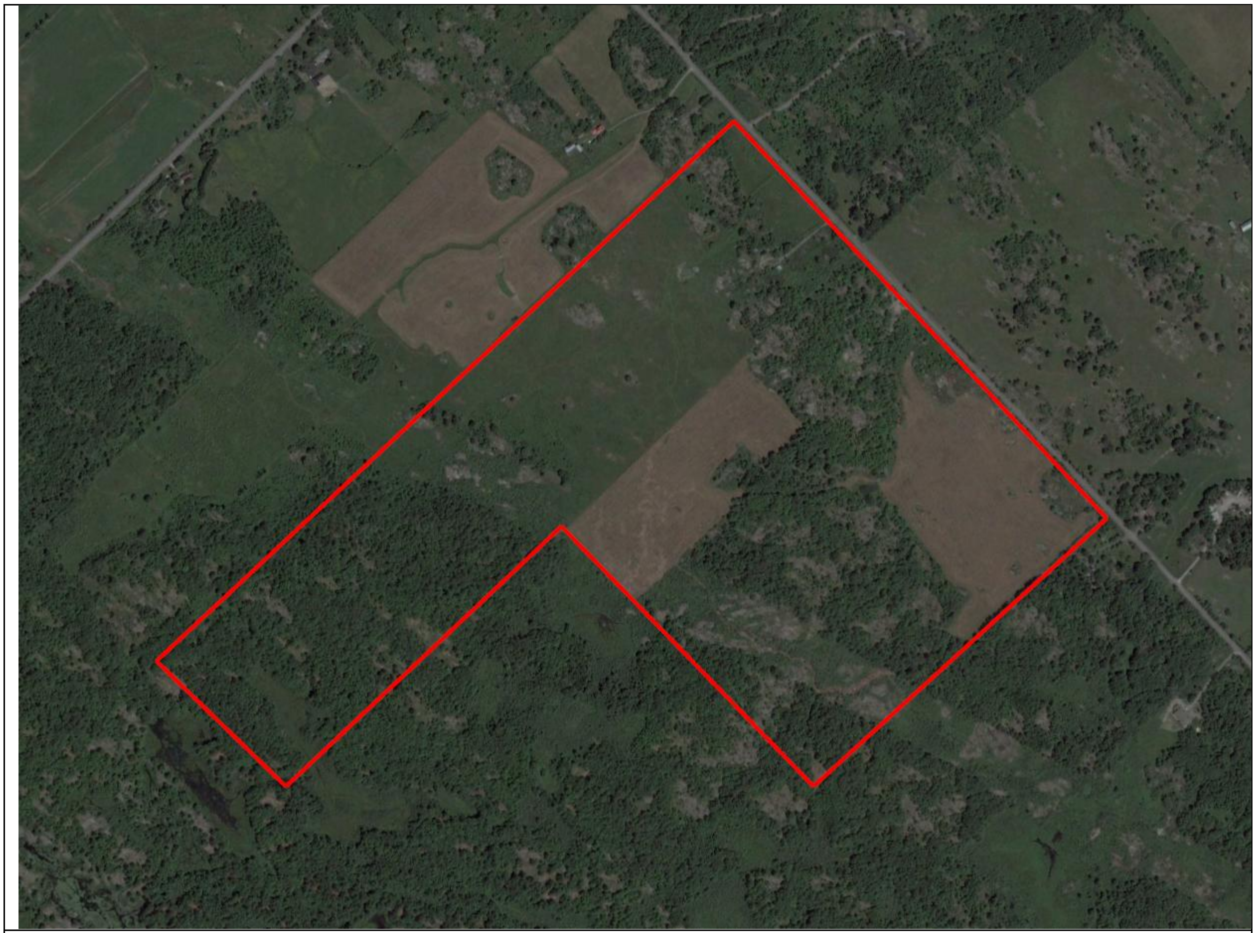
Location: Ottawa, ON
Year: 2012
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



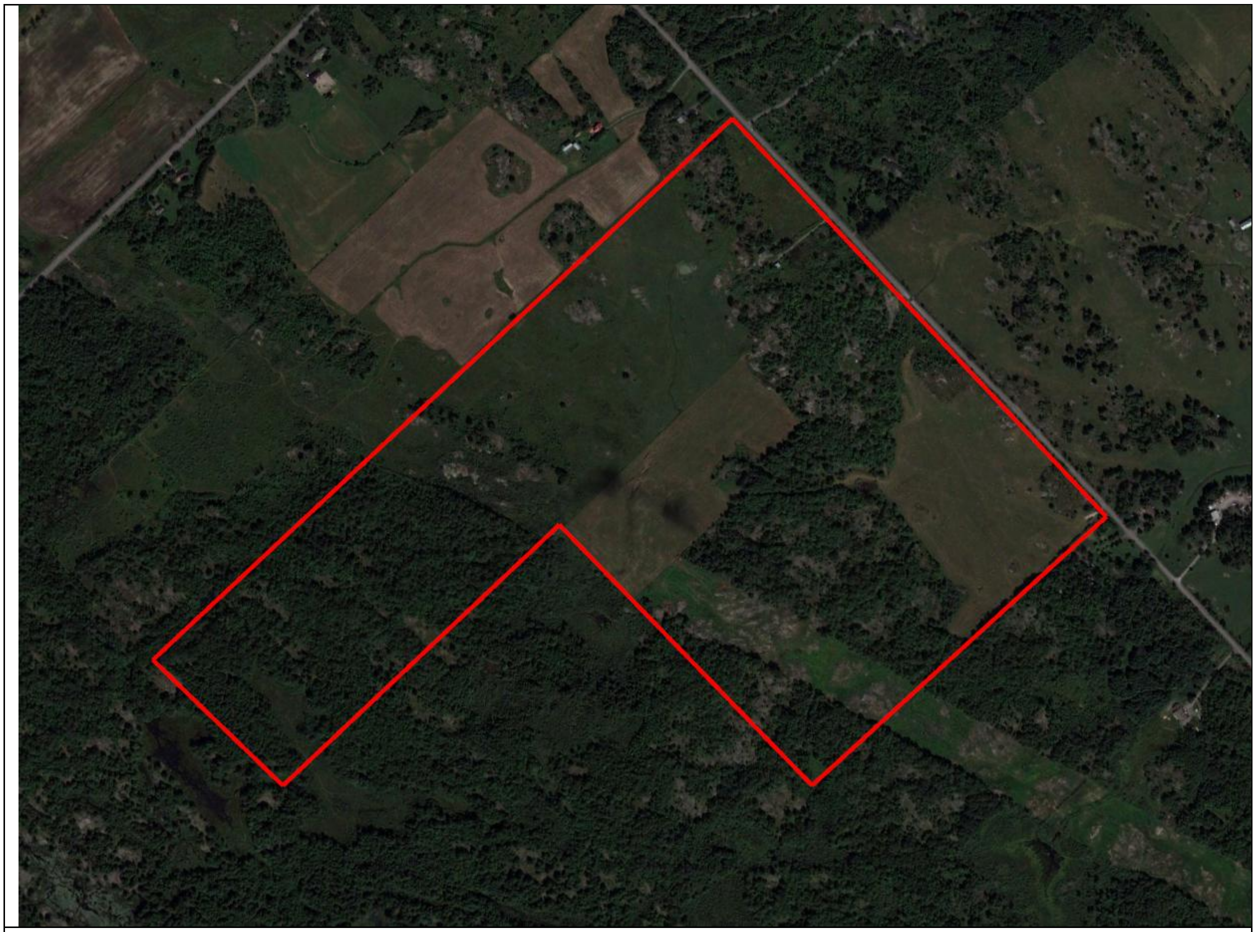
Location: Ottawa, ON
Year: 2013
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

Location: Ottawa, ON
Year: 2014
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

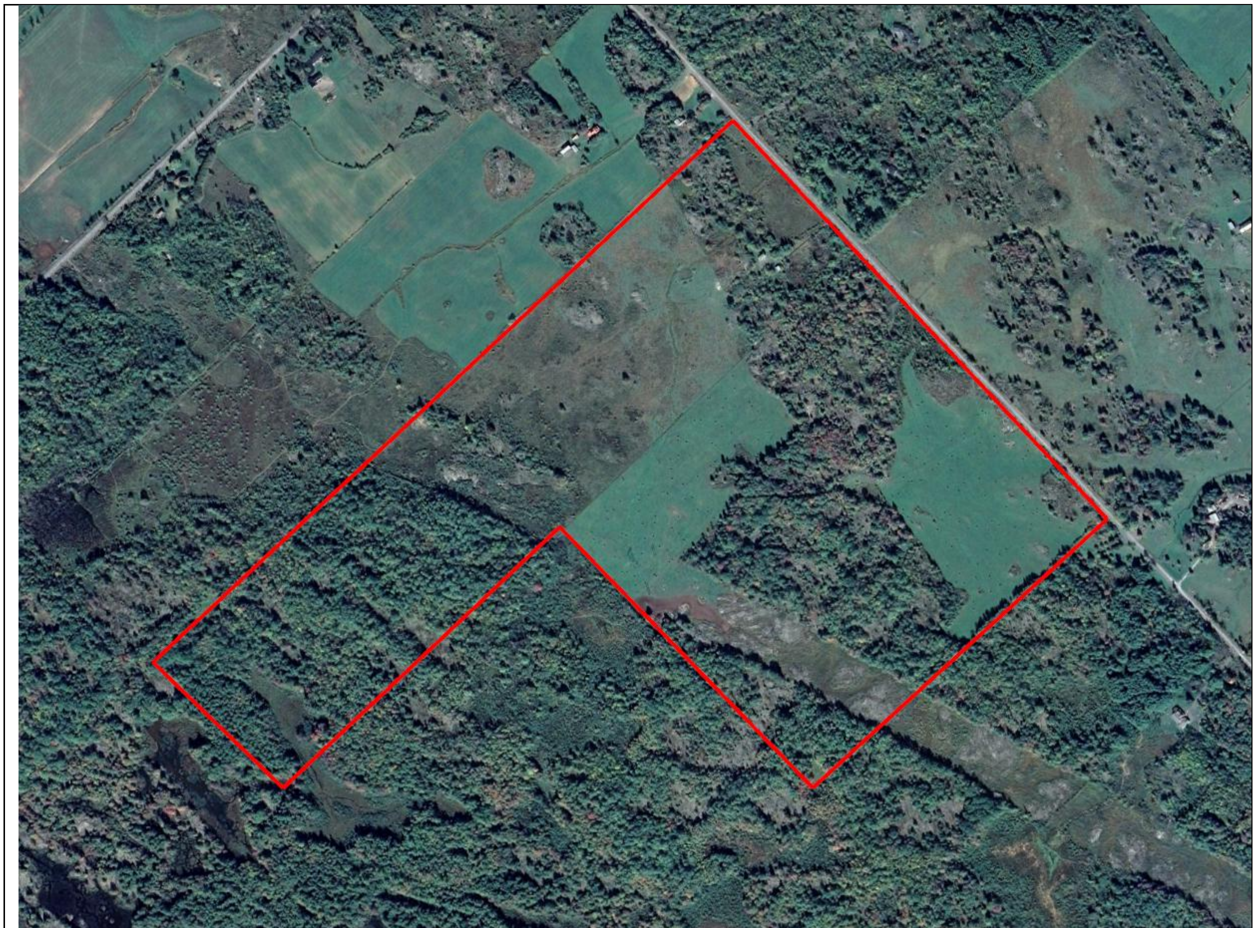
Location: Ottawa, ON
Year: 2015
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



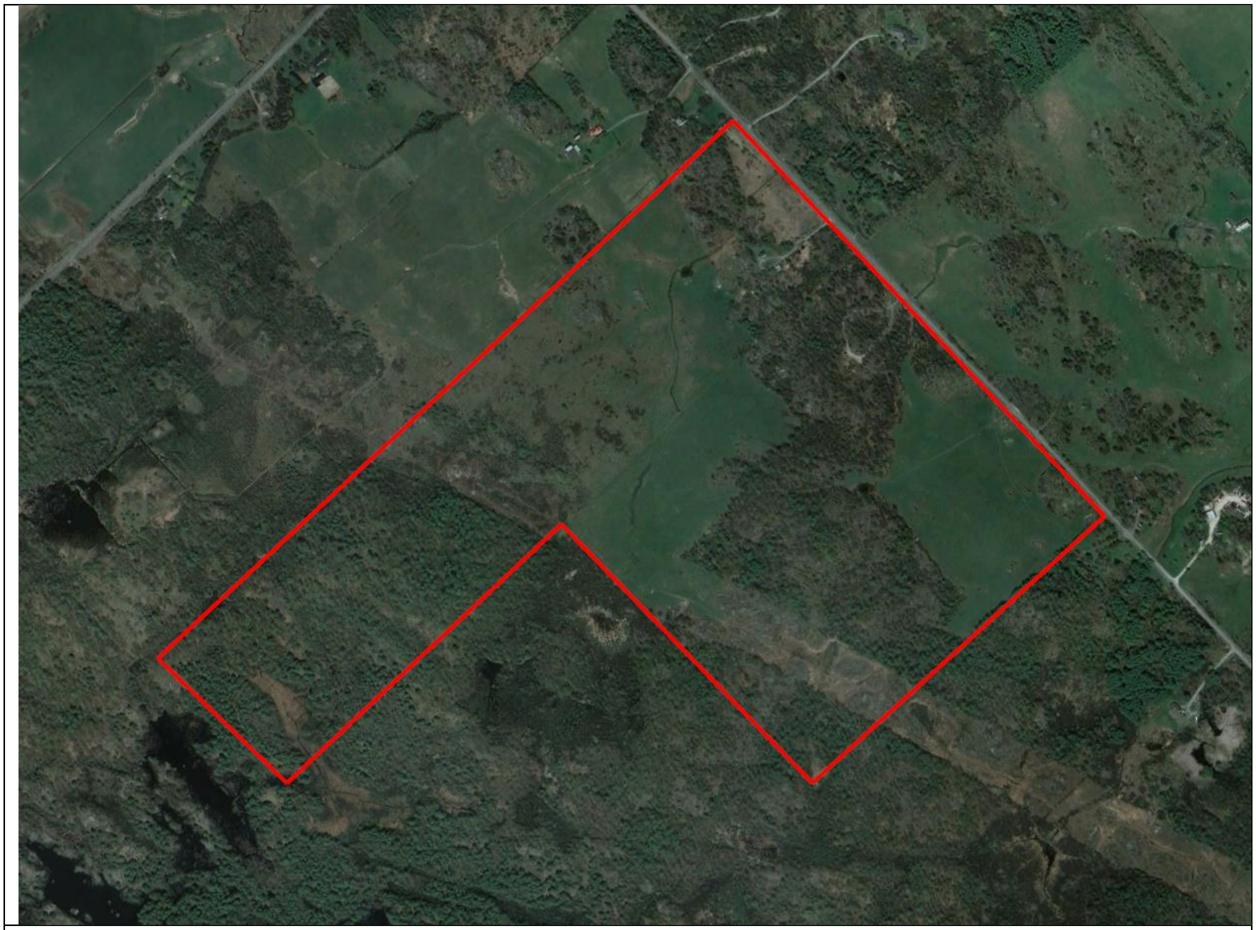
Location: Ottawa, ON
Year: 2016
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



Location: Ottawa, ON
Year: 2017
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

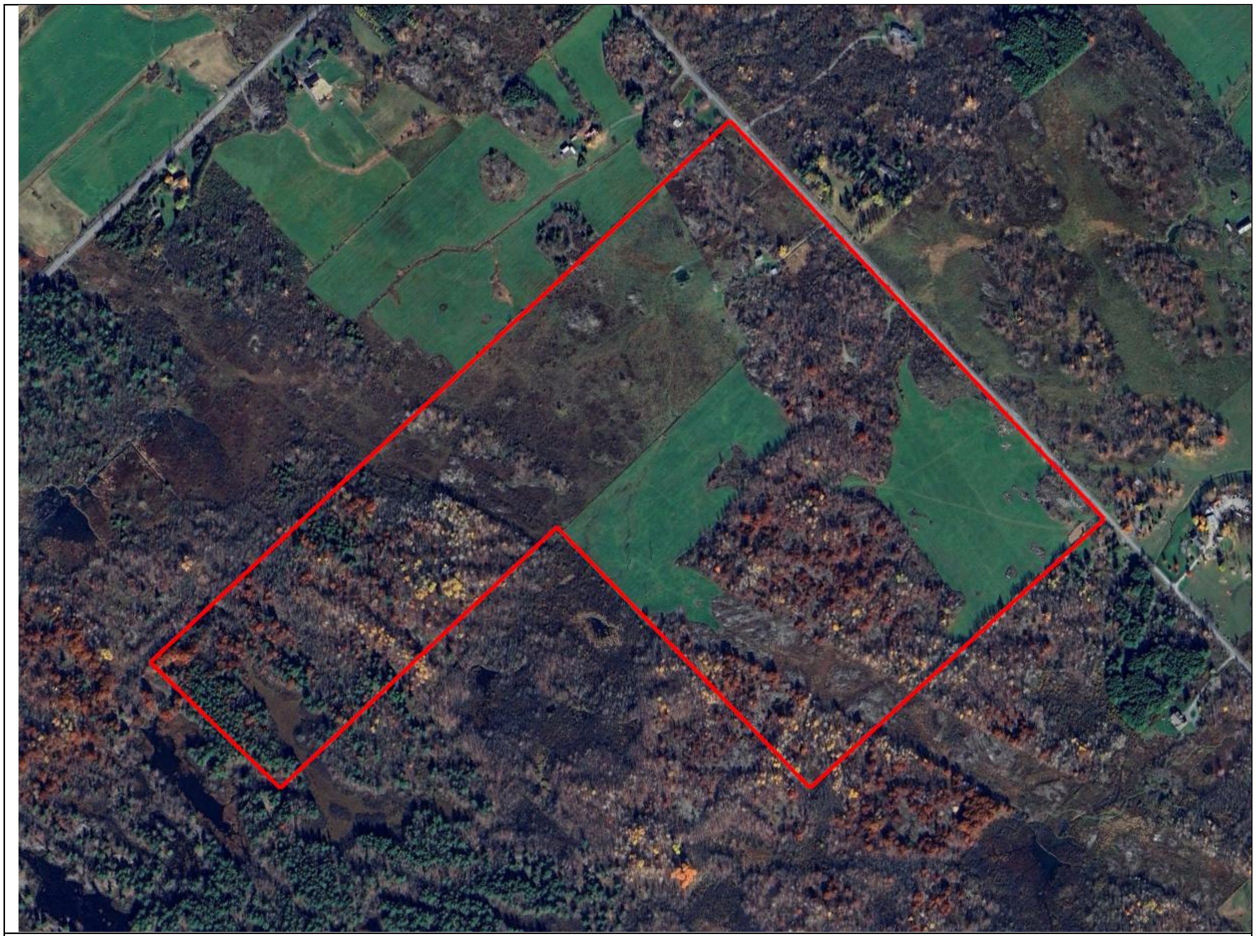


Location: Ottawa, ON
Year: 2019
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



Location: Ottawa, ON
Year: 2022
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

Location: Ottawa, ON
Year: 2023
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits



Location: Ottawa, ON
Year: 2024
Scale: 1:20,000
Source: Google Earth Pro
Red Boundary: Site Limits

Appendix B
Field Photographic Record

Photo 1: View looking south (Upstream) at location S1 (Figure 3-1) on April 7, 2025.

Photo 2: View looking southeast (Upstream) at location S1 (Figure 3-1) on April 7, 2025.

Photo 3: View looking southeast (Upstream) at location S2 (Figure 3-1) on April 7, 2025.

Photo 4: View looking southeast (Upstream) at location S3 (Figure 3-1) on April 7, 2025.

Photo 5: View looking northeast (Downstream) at location S4 (Figure 3-1) on April 7, 2025.

Photo 6: View looking south (Upstream) at location S4 (Figure 3-1) on April 7, 2025.

Photo 7: View looking north (downstream) at location S5 (Figure 3-1) on April 7, 2025.

Photo 8: View looking south (Upstream) at location S5 (Figure 3-1) on April 7, 2025.

Photo 9: View looking north (downstream) at location S6 (Figure 3-1) on April 7, 2025.

Photo 10: View looking north (downstream) at location S7 (Figure 3-1) on April 7, 2025.

Photo 11: View looking north (downstream) at location S8 (Figure 3-1) on April 7, 2025.

Photo 12: View looking northeast (downstream) at location S9 (Figure 3-1) on April 7, 2025.

<table>
<tr><td>
Photo 13: View looking northeast (Downstream) at location S10 (wet pond) (Figure 3-1) (minor sinuosity) on April 7, 2025.</td><td>
Photo 14: View looking west (Upstream) at location S11 (Figure 3-1) (minor sinuosity) on April 7, 2025.</td></tr>
<tr><td>
Photo 15: View looking northeast (downstream) at location S12 (Figure 3-1) on April 7, 2025.</td><td>
Photo 16: Side view at location S12 (Figure 3-1) on April 7, 2025.</td></tr>
<tr><td>
Photo 17: View looking northeast (downstream) at location S13 (Figure 3-1) on April 7, 2025.</td><td>
Photo 18: View looking northeast (downstream) at location S14 (Figure 3-1) on April 7, 2025.</td></tr>
</table>

Photo 19: View looking northeast (Downstream) at location S15 (Small waterfall) (Figure 3-1) on April 7, 2025.

Photo 20: View looking southwest (Upstream) at location S15 (Small waterfall) (Figure 3-1) on April 7, 2025.

Photo 21: Side view at location S15 (Figure 3-1) on April 7, 2025.

Photo 22: View looking northeast (Downstream) at location S16 (Figure 3-1) on April 7, 2025.

Photo 23: Side view at location S16 (Figure 3-1) on April 7, 2 025.

Photo 24: View looking northeast (Downstream) at location S17 (Figure 3-1) on April 7, 2025.

 **Photo 25:** Side view at location S17 (Figure 3-1) on April 7, 2025.	 **Photo 26:** View looking southwest (Upstream) at location S18 (Figure 3-1) on April 7, 2025.
 **Photo 27:** Side view at location S18 (Figure 3-1) on April 7, 2025.	

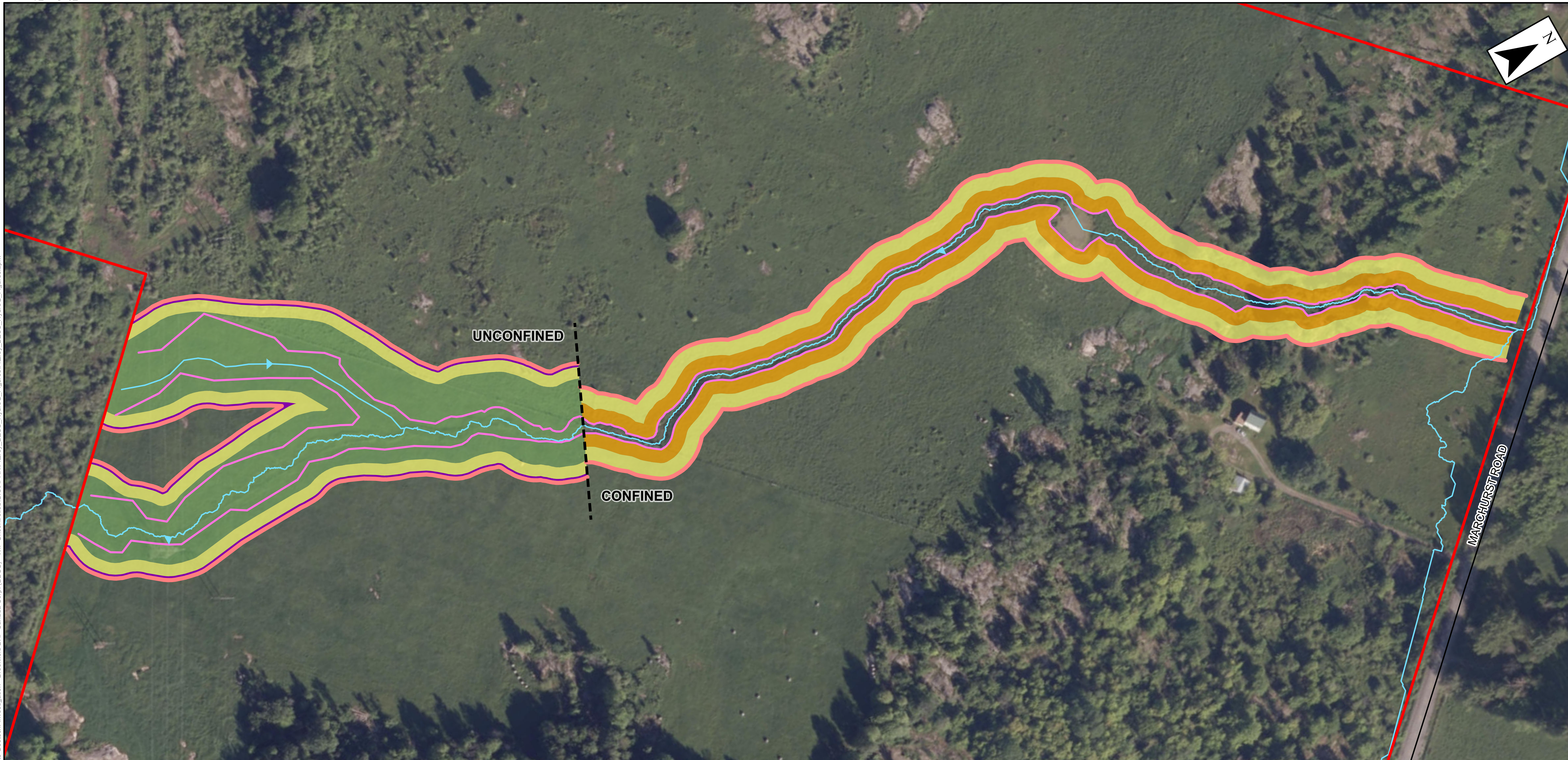
Appendix C
HEC-RAS Hydraulic Results

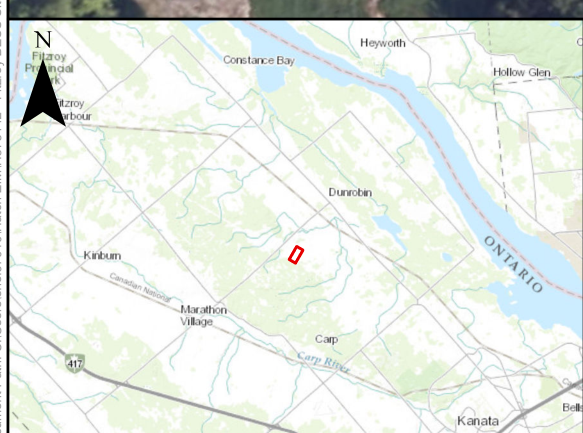
HEC-RAS River: River 1 Reach: Reach 1 Profile: Max WS

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 1	943	Max WS	Plan_100yr	1.02	101.90	102.09		102.09	0.009238	0.28	3.67	40.45	0.29
Reach 1	943	Max WS	Plan_2yr	0.35	101.90	102.00		102.00	0.034102	0.36	0.98	19.75	0.51
Reach 1	836	Max WS	Plan_100yr	0.99	101.03	101.21		101.21	0.011624	0.26	3.86	46.56	0.28
Reach 1	836	Max WS	Plan_2yr	0.31	101.03	101.15		101.15	0.020579	0.24	1.32	27.73	0.34
Reach 1	745	Max WS	Plan_100yr	0.94	100.44	100.65		100.66	0.004497	0.39	2.41	26.89	0.41
Reach 1	745	Max WS	Plan_2yr	0.32	100.44	100.56		100.57	0.008051	0.43	0.73	10.71	0.52
Reach 1	671	Max WS	Plan_100yr	0.94	100.03	100.22		100.23	0.008585	0.58	1.62	15.79	0.58
Reach 1	671	Max WS	Plan_2yr	0.31	100.03	100.12		100.15	0.028679	0.64	0.49	10.20	0.93
Reach 1	602	Max WS	Plan_100yr	0.94	99.20	99.45		99.49	0.014341	0.87	1.09	10.32	0.78
Reach 1	602	Max WS	Plan_2yr	0.32	99.20	99.37		99.39	0.017200	0.69	0.46	5.86	0.78
Reach 1	514	Max WS	Plan_100yr	0.94	98.20	98.58		98.62	0.005729	0.86	1.09	4.24	0.54
Reach 1	514	Max WS	Plan_2yr	0.31	98.20	98.42		98.44	0.005954	0.63	0.50	3.26	0.51
Reach 1	458	Max WS	Plan_100yr	0.94	97.83	98.23		98.28	0.006561	0.95	0.99	3.67	0.58
Reach 1	458	Max WS	Plan_2yr	0.31	97.83	98.07		98.09	0.006655	0.68	0.46	2.82	0.54
Reach 1	388	Max WS	Plan_100yr	0.94	97.31	97.69		97.74	0.009027	0.99	0.95	4.19	0.67
Reach 1	388	Max WS	Plan_2yr	0.31	97.31	97.55		97.58	0.008056	0.70	0.45	3.06	0.59
Reach 1	312	Max WS	Plan_100yr	0.93	96.83	97.10		97.12	0.006971	0.75	1.34	10.00	0.57
Reach 1	312	Max WS	Plan_2yr	0.31	96.83	96.99		97.00	0.006918	0.55	0.57	5.10	0.52
Reach 1	238	Max WS	Plan_100yr	0.93	96.25	96.51		96.54	0.009307	0.79	1.18	7.62	0.64
Reach 1	238	Max WS	Plan_2yr	0.31	96.25	96.41		96.43	0.009090	0.57	0.55	5.63	0.59
Reach 1	162	Max WS	Plan_100yr	0.92	95.71	96.06		96.07	0.002928	0.45	2.03	12.74	0.36
Reach 1	162	Max WS	Plan_2yr	0.31	95.71	95.94		95.95	0.003607	0.43	0.72	5.74	0.39
Reach 1	104	Max WS	Plan_100yr	0.92	94.71	95.10	95.09	95.20	0.043346	1.41	0.65	3.46	1.00
Reach 1	104	Max WS	Plan_2yr	0.31	94.71	94.96	94.96	95.02	0.044387	1.09	0.29	2.11	0.95
Reach 1	45	Max WS	Plan_100yr	0.91	93.69	94.06		94.09	0.007389	0.86	1.61	19.61	0.60
Reach 1	45	Max WS	Plan_2yr	0.31	93.69	93.96		93.98	0.005613	0.64	0.50	4.54	0.50
Reach 1	3	Max WS	Plan_100yr	0.91	93.53	93.73	93.68	93.74	0.008887	0.61	1.74	16.79	0.59
Reach 1	3	Max WS	Plan_2yr	0.31	93.53	93.67	93.64	93.68	0.008961	0.49	0.83	13.20	0.56

Appendix D
Erosion Hazard Limits

Basemap_Imagery_2022:





LEGEND

- Site Limits
- Road
- Delineated Watercourse
- Bank Lines
- Meander Amplitude
- Toe Erosion Allowance
- Erosion Excess Allowance
- Factor of Safety
- Erosion Hazard Limit

Notes
1. Produced by Hatch, contains information licensed under the Open Government Licence – Ontario
2. Spatial referencing: NAD 1983 CSRS UTM Zone 18N
3. Basemap - GeoOttawa Current Imagery, 2022
4. Watercourses were delineated using terrain data

0 25 50 100 Meters

1:2,000

PROJECT:	South March BESS Fluvial Geomorphology Assessment
FIGURE TITLE:	Erosion Hazard Limits of the Confined and Unconfined System Reaches
CLIENT:	Brookfield Corp.

DWG BY:	CHK BY:	APP.:	REV NO.:	PROJ No.:
J. VILLELLA	M. KHAFAGY	D	1	H-375142
DATE: 08/05/25	PAGE: 1			HATCH

Document Path: C:\Users\sne97010\Hatch El\H375142 - Fitzroy BESS Site Geotech. Investigation - Brookfield BRP Canada Corp. (BBCC) - WIP Uncontrolled\GIS\APRX\Fitzroy_BESS_HydroG_Figures\Fitzroy_BESS_HydroG_Figures.aprx