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Municipal Class Environmental Assessment Study: Wolfedale Creek Erosion Control Project from Burnhamthorpe Road West to the Credit River

Project File Appendices - Volume 1 of 2

City of Mississauga

60701082

December 2024

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Appendices - Volume 1 of 2

Appendix A. Fluvial Geomorphological Assessment Report

Appendix B. Hydraulic Assessment Report

Appendix C. Geotechnical Investigation and Design Report

Appendix D. Natural Environment Report

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Appendix A

Fluvial Geomorphological Assessment Report

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Wolfedale Creek Erosion Control and Rehabilitation – From Burnhamthorpe Road West to the Credit River

Fluvial Geomorphological Assessment and Detailed Design

The City of Mississauga

60701082

December 2024

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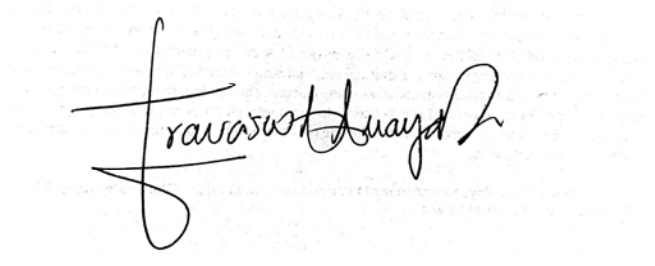

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Junior Fluvial Geomorphologist

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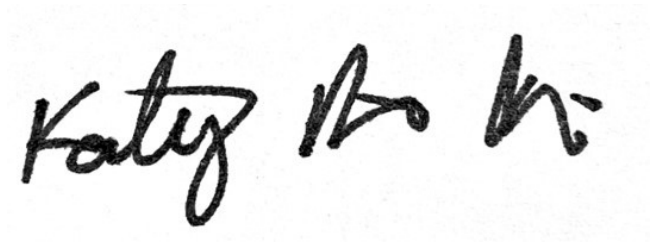

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Executive Summary

AECOM Canada Ltd. (AECOM) has been retained by The City of Mississauga (the City) to undertake a Schedule 'B' Municipal Class Environmental Assessment (MCEA) study and to prepare detailed engineering design and associated construction drawings for the Wolfedale Creek Erosion Control Project (the Project).

This Fluvial Geomorphology Assessment is a standalone report which provides background and context for the Project. This Fluvial Geomorphological Assessment

- Describes the existing environmental conditions (based on information collected through background information review and ecological field investigations); and
- Describes any constraints and opportunities for the design work from a fluvial geomorphological perspective.

The Study Areas include the following watercourse segments:

- **Study Area 1**: Wolfedale Creek from Burnhamthorpe Road West to Dundas Street, including the tributary channel between 3577 and 3599 Wolfedale Road, and
- **Study Area 2:** Tributary outlet to the Credit River, north of Queensway West and west of Stavebank Road.

An Impact Assessment will be completed once the selection of the preferred solution becomes available. To reduce any damages or disturbances caused by the Project, potential environmental impacts from the preferred solution will be identified.

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Appendices

Appendix A. Photographic Log

1. Introduction

AECOM Canada Ltd. (AECOM) has been retained by The City of Mississauga (the City) to undertake a Schedule 'B' Municipal Class Environmental Assessment (MCEA) study and to prepare detailed engineering design and associated construction drawings for the Wolfedale Creek Erosion Control Project (the Project). The Project is in the south-central part of the City and includes segments of Wolfedale Creek extending from Burnhamthorpe Road West to the Credit River for a total creek length of approximately 2,300 m. The following Fluvial Geomorphic Assessment was completed as a standalone report in support of the detailed engineering design services.

This Fluvial Geomorphic Assessment provides background and context for the Project and:

- Describes the existing fluvial geomorphic environmental conditions (based on information collected through background information review and field investigations);
- Evaluates and identifies key reach characteristics;
- Describes the proposed erosion remediation work; and
- Identifies environmental constraints.

Future versions of this Natural Environment Report will include a potential effects assessment once the selection of the preferred solution becomes available.

There are two Study Areas (**Figure 1-1**) for the Project, which include the following segments:

- **Study Area 1**: Wolfedale Creek from Burnhamthorpe Road West to Dundas Street, including the tributary channel between 3577 and 3599 Wolfedale Road.
- **Study Area 2:** Tributary outlet to the Credit River, north of Queensway West and west of Stavebank Road

Where information from this report has been incorporated into other reports, documents, drawings or applications, this report should be referenced in its entirety to provide context and to facilitate the comprehensive implementation of recommendations.

1.1 Project Background

The City has identified the need for erosion control and engineering design within the Wolfedale Creek watercourse between Burnhamthorpe Road West to the Credit River. Wolfedale Creek originates at a storm sewer outlet south of Burnhamthorpe Road West and transitions into an open engineered channel which flows south until Dundas Street West where it is conveyed into a storm sewer. A short (210 m long) side tributary of the creek located between 3577 and 3599 Wolfedale Road joins the main branch near the upstream end of the creek. Wolfedale Creek reappears south of Stavebank Road at Sir Richards Road and outlets into the Credit River.

The study reach consists of a channelized creek with materials that include gabion baskets (stacked and single layered), rock rip-rap, concrete drop structures and armourstones. The majority of the channel was originally constructed approximately 40 to 50 years ago with rehabilitation completed over the years for certain segments.

Through its ongoing erosion monitoring program, the City has identified Wolfedale Creek as a high priority site in need of rehabilitation. Based on the continued erosion and risk to property and infrastructure, the City now wishes to proceed with the design and construction of stabilization works within the reach. Some of the issues within the Study Areas include but are not limited to the following:

- Failed gabion basket and armourstone walls that are slumping and outflanked;

- Storm outfalls which have accumulated sediment and/or are damaged;
- Accumulation of debris and sediment within the creek; and
- Entrenched channel with bank instability and erosion.

Gandhi Way
Summer Park Cres
Pilcom Cres
Pilcom Crt
Wildgrass Rd
Hillcrest Ave
Dundas St W
Mavis Rd
WDL-CRK-1a
WDL-CRK-1b
WDL-CRK-1c
WDL-CRK-1d
WFDL-CRK-1e
Central Pky W
Wolfedale Rd
Eaglemount Cres
Westlock Rd
Consort Cres
Strabane Dr
Forestwood Dr
Blairholm Ave
Stainton Dr
Hawkestone Rd

Basemaps provided by: City of Toronto, ON, Town of Oakville, Maxar, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

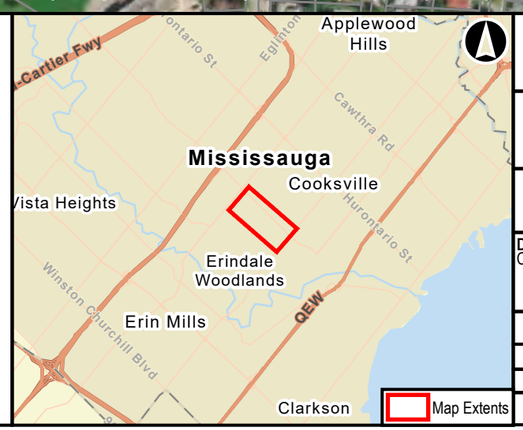
Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads



Wolfedale Creek

Study Area

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Figure: 1-1

Project Location: D:\Projects\60701082\Workspace\WolfedaleCreek\Design\01_Deposit\FLUVIAL\60701082_WolfedaleCreek_FLUVIAL.aprx Layout: Fig 1 - General Study Area
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Legend

Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Study Area

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 1-1

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A key element of this study will be to identify and evaluate the existing conditions of the watercourse, identifying constraints and opportunities to minimize further ravine incision and potential threats to the surrounding infrastructure, in addition to adjacent properties, and even in some cases structures. The creek is located almost entirely within City lands; however, at various locations the creek corridor encroaches into private property, some with existing city easements.

The current investigation aims at providing long term erosion protection that is compatible with the natural tendencies of the creek and protects adjacent properties and infrastructure while maintaining or improving the morphological form and function; hydraulic capacity; and providing environmental enhancements to improve fish habitat and passage within the watercourse. The MCEA planning process will determine an effective erosion control and restoration strategy for Wolfedale Creek that is cost effective, constructable, long lasting, environmentally sound and politically acceptable.

1.2 Goals and Objectives

As part of the restoration efforts for Wolfedale Creek, natural channel design and engineering protocol will be used to reprofile and minimize erosion issues within the creek, enhance natural habitat, and improve conveyance. It is important to consider natural channel processes and the way they are likely to evolve in the future. In this case, this potentially includes lateral movement and widening of the channel reach within the Study Area and enlargement of the creek cross-section in response to urbanized flows. Understanding the existing form and function of Wolfedale Creek and its interaction with the surrounding environment is required to inform the detailed design. This will help to deliver long term ecological and conveyance benefits within the investigated sections of the watercourse and avoid undesirable impacts on the creek and existing infrastructure. Findings of the desk and field-based assessment will be used to characterize the watercourse with respect to geomorphological form and processes, future stability, existing issues, and opportunities for enhancement to inform our input on the evaluation of alternatives as part of the MCEA process.

The current investigation aims at providing long term erosion protection alternatives that are compatible with the natural tendencies of the creek and protects adjacent properties and infrastructure while maintaining or improving the morphological form and function; hydraulic capacity; and providing environmental enhancements to improve fish habitat and passage within the watercourse, where feasible. The study will determine an effective erosion control and restoration strategy for Wolfedale Creek.

2. Desktop Background Assessment

A background review was conducted to better understand the Study Area and any previous inspections or assessment that have been undertaken prior to this study. The background review will also provide a general understanding of the natural and historical conditions that influence the channel morphology and watercourse stability. The review included all available background information from online sources, topographic maps, aerial imagery, and other sources.

The following documents and drawings were reviewed as part of the desktop background assessment:

- Watercourse Relocation, CPR Northerly to Wolfedale Rd., Burnhamthorpe Rd. Drawing No. C-08719 (July 1967) (Missey, 1967);
- Wolfedale Creek South of Stavebank Road Plan and Reprofile. Aquafor Beech Limited. Drawing No. C33737. (June 1997) (Aquafor Beech Limited, 1997);
- Preliminary Design Recommendations for Mississauga Structures Memo, 2015. Completed by Aquafor Beech for the City of Mississauga on behalf of Planmac Engineering Inc. (Aquafor Beech Ltd., 2015);
- Central Parkway West Over Wolfedale Creek Culvert. Biennial Inspection Report, 2021. Prepared by Engineered Management Systems Inc. for the City of Mississauga. (Engineered Management Systems Inc., 2021); and
- City of Mississauga. Natural Areas Fact Sheet, 2021. Area CRR8. (City of Mississauga, 2021).

2.1 Watershed Characteristics

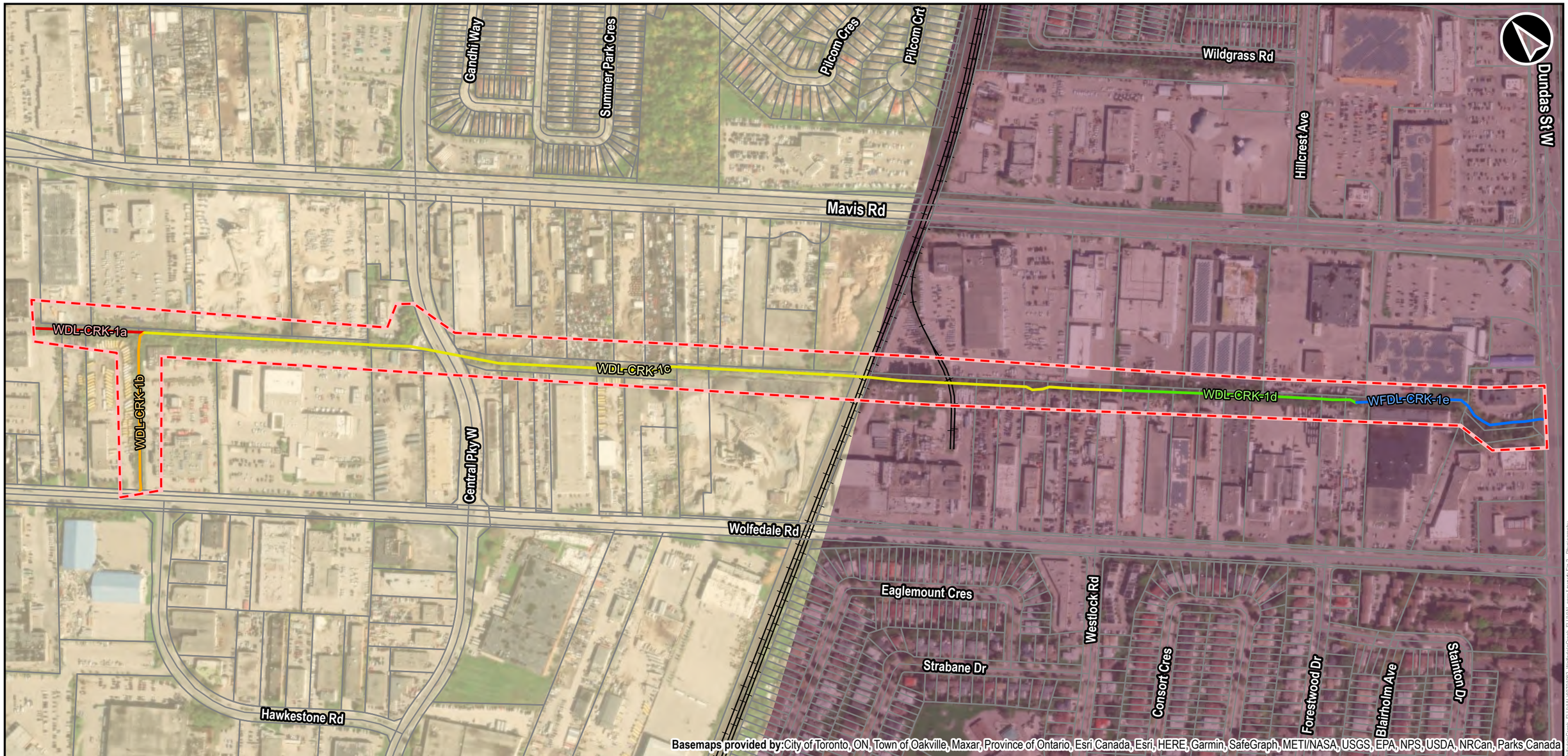
The Study Area is located within the larger Credit River watershed which contains approximately 1,500 kms of tributaries within an area of 1000 km^2 (CVC, 2011; CVC, 2015). Wolfedale Creek is part of the smaller Norval to Port Credit subwatershed, comprising an approximate area of 72.8 km^2 (Peel, 2009).

2.1.1 Physiography and Surficial Geology

The local physiography and surficial geology surrounding any watercourse contribute to stream bedload, dictate the gradient along the feature, and control the morphology along the path of feature. Furthermore, the make up of the substrates surrounding the feature determine the resistance or susceptibility of the watercourse banks to erosional forces.

The major physiographic regions in the Study Areas are presented in **Figure 2-1**. North of the Canadian Pacific Railway (CPR) the Study Area is located within the physiographic region of the Drumlinized Till Plains physiographic landform within the South Slope physiographic region. South of the CPR, the Study Area is located within the Shale Plains physiographic landform, within the Iroquois Plain region. The South Slope and Iroquois Plains gently slope to the south and consist of shallow shale and till plains (Chapman & Putnam, 2007).

The surficial geology of the Study Area is presented in **Figure 2-2.** The Ontario Geological Survey (2010) surficial geology map indicates that the surficial geology of the area is dominated by Paleozoic bedrock (specifically the Georgian Bay Formation) from southeast of Central Parkway West to the confluence with the Credit River, where the dominant surficial geology is modern alluvial deposits of clay, silt, sand, gravel, and organics. The bedrock of the Georgian Formation is characterized by blue-grey shales with interbeds of siltstone, sandstone, limestone and dolostone (CVC, 2011). North of Central Parkway West and beyond Burnhamthorpe Road West, the surficial geology is characterized by glaciolacustrine till deposits of clay and silt.



Legend

Study Area

Reach ID

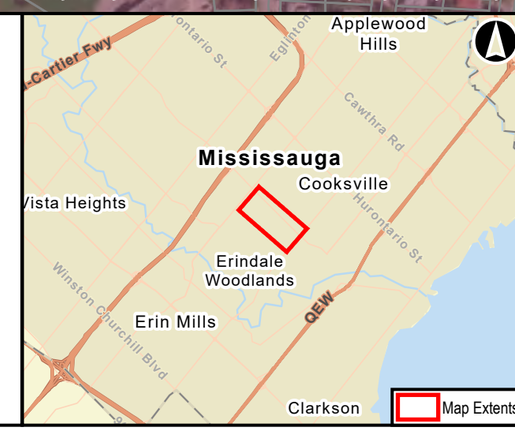
- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

Physiography Description

- 10: Shale Plains
- 6: Till Plains (Drumlinized)

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads



Wolfedale Creek

Physical Geology

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Figure: 2-1

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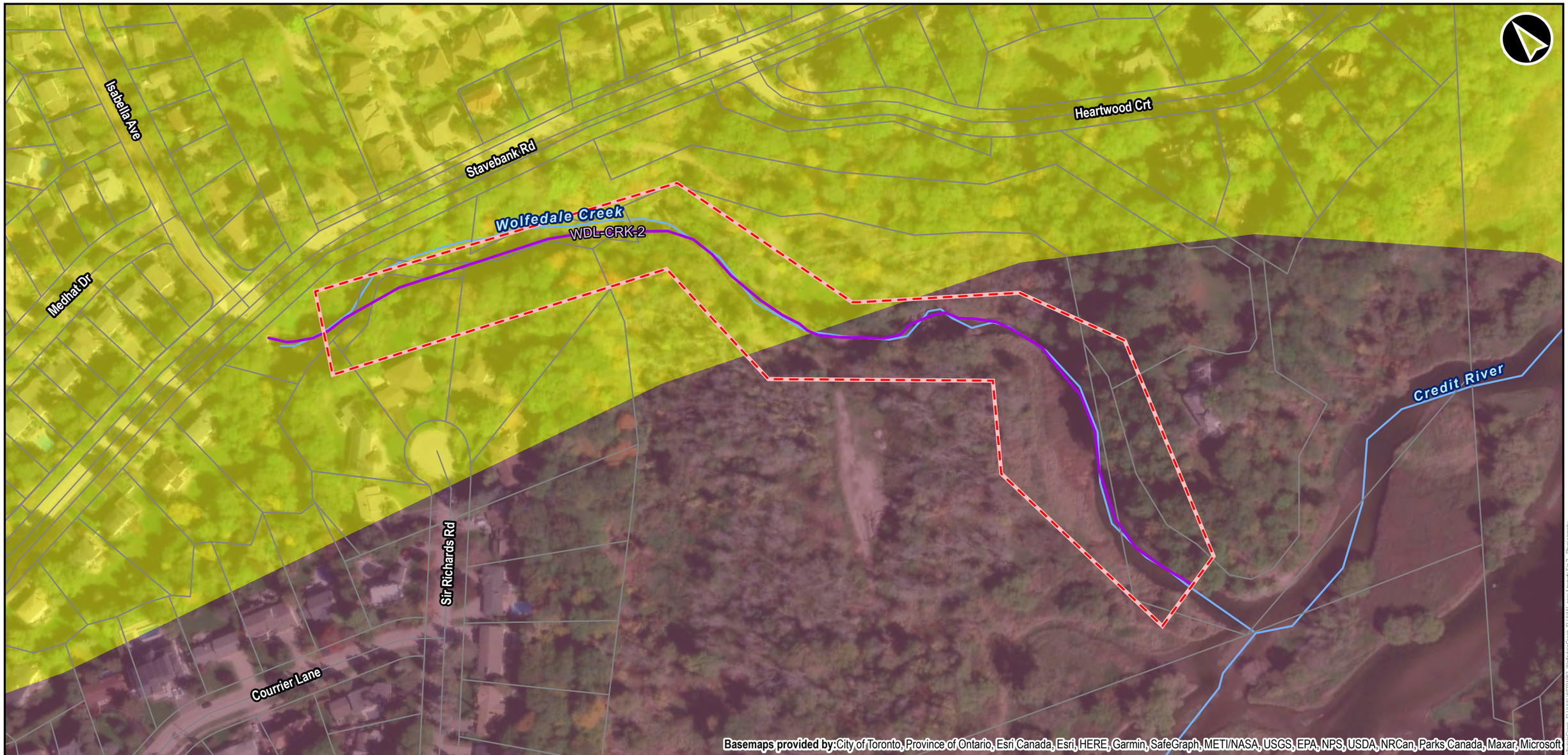

Legend

Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

Physiography Description

- 11: Sand Plains
- 10: Shale Plains

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Physical Geology

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 2-1

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Gandhi Way
Summer Park Cres
Pilcom Cres
Pilcom Crt
Wildgrass Rd
Hillcrest Ave
Dundas St W
Mavis Rd
WDL-CRK-1a
WDL-CRK-1b
WDL-CRK-1c
WDL-CRK-1d
WFDL-CRK-1e
Central Pky W
Wolfedale Rd
Eaglemount Cres
Westlock Rd
Strabane Dr
Consort Cres
Forestwood Dr
Blairholm Ave
Stainton Dr
Hawkestone Rd

Basemaps provided by: City of Toronto, ON, Town of Oakville, Maxar, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

Study Area

Reach ID

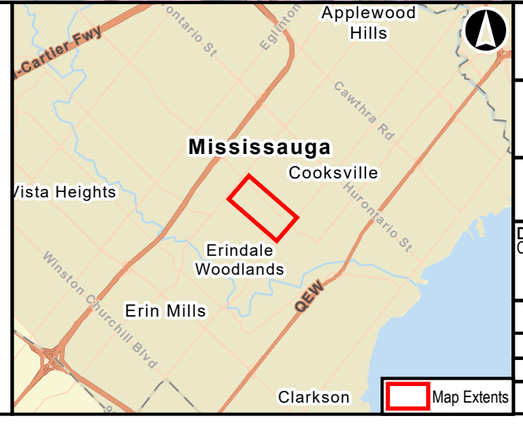
- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WFDL-CRK-1e

Surficial Geology Description

- 3: Paleozoic bedrock
- 5d: Glaciolacustrine-derived silty to clayey till

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads



Wolfedale Creek

Surficial Geology

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

Data Sources:
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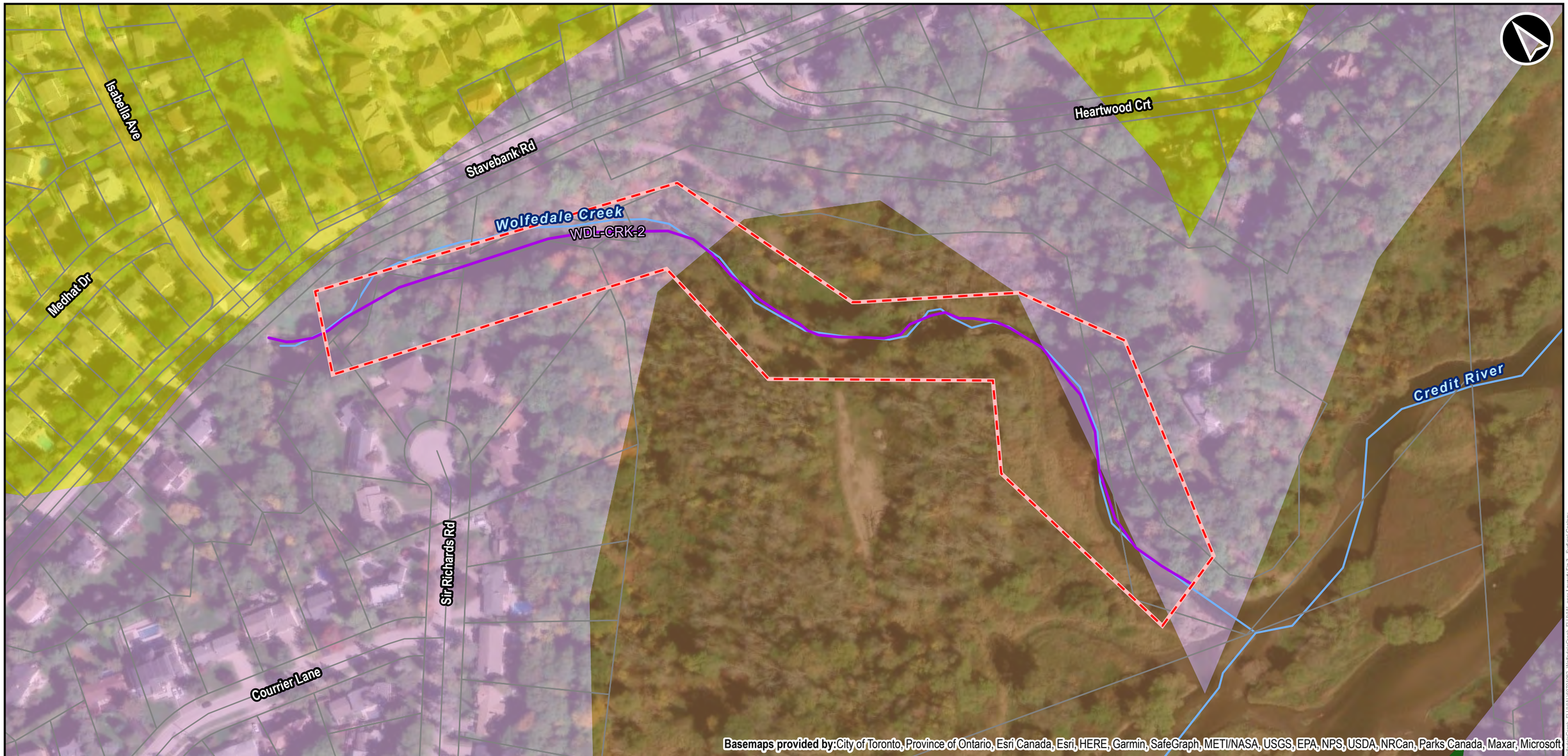

Legend

Study Area

Reach ID

WDL-CRK-2

Surficial Geology Description

3: Paleozoic bedrock

5d: Glaciolacustrine-derived silty to clayey till

9c: Foreshore-basinal deposits

19: Modern alluvial deposits

General Features

Property Line

Minor Roads

Watercourse

Wolfedale Creek

Surficial Geology

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 2-2

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Sections of the investigated area along Wolfedale Creek flow over bedrock. Bedrock is a geologic constraint on rivers, and affects their shape, pattern, and susceptibility to erosion. The erosion rate of bedrock varies greatly, with hard bedrock (e.g., granite) being the most resistant to erosion, and soft bedrock (i.e., limestone) being less resistant to erosion. Soft shale is the most susceptible rock type to erosion, and a number of factors including slope and orientation of individual rock layers will impact its long-term stability (Ontario Ministry of Natural Resources, 2002). A large portion of the surrounding land is covered by Paleozoic bedrock (The Ontario Geological Survey, 2003). Bedrock is relatively impermeable compared to other unconsolidated sediment types. The impermeable surface results in high runoff during spring melt and during periods of rainfall. High runoff leads to larger quantities of water being contained within the channel and faster flow velocities. This can in turn impact the overall long-term stability of the bedrock channel.

2.1.2 Topography

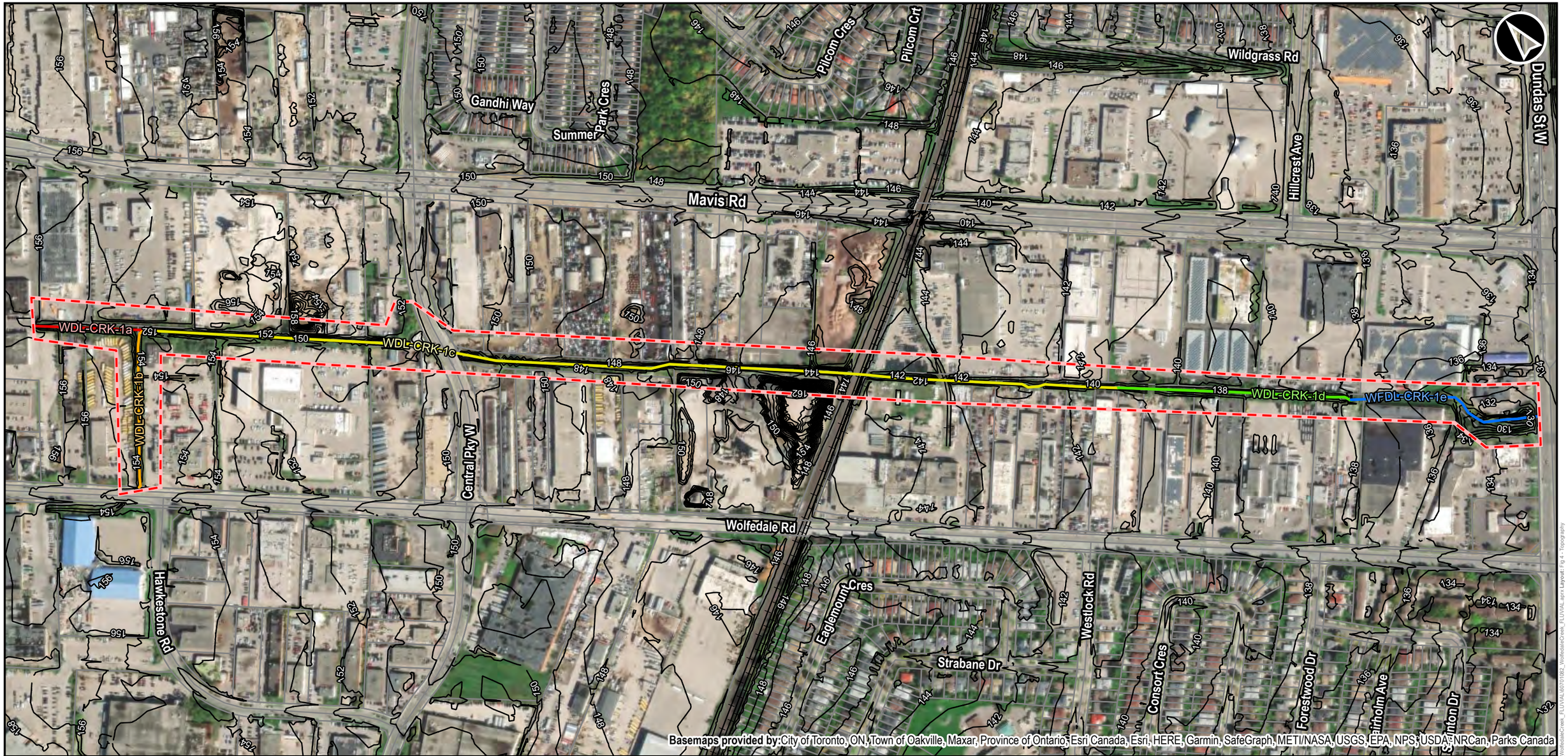
The longitudinal profile identifies channel bed forms and local bed gradients and is an important geomorphological consideration as the bed gradient is a primary control of tractive forces within a reach and is therefore a major determinant of morphological form and function. In general, the steeper the longitudinal profile the greater the ability of the channel to entrain and transport sediment along its boundaries. For channels that are hosted in bedrock, this steep slope could result in the formation of knickpoints as the channel bed material is plucked during high flow events. The topography can also constrain channel migration with flat topographic areas supporting a meandering system and steep valley walls confining channel migration.

The topography ranges from approximately 154 mASL at the northern end of the Study Area 1 to approximately 125 mASL at Dundas Street West, over approximately 2030 m, for an average slope of 1.40%. In Study Area 2 the elevation is steeper and ranges from approximately 83 m to 76 mASL, over approximately 267 m for an average slope of approximately 2.8%. The topography of the Study Area can be observed in **Figure 2-3**. The topographic map indicates that in Study Area 1 the channel is largely confined by steep valley walls, while in Study Area 2 the topography consists of an undulating floodplain between steep valley walls that widen towards the Credit River (City of Mississauga, 2021)

2.1.3 Land Use

The land around Study Area 1 is heavily urbanized, with many industrial and commercial establishments as well as numerous residential subdivisions surrounding the watercourse. The urbanized nature of the surrounding land contributes to increased stormwater runoff during stormwater events due to the higher percentage of impervious surfaces. This increased runoff has the potential to cause significant erosion issues for watercourses downstream of the urbanized area.

In Study Area 2 the watercourse is surrounded by residential development to the west and east and by forested lands/ a large golf course in the south. The watercourse discharges into the Credit River. Forest cover tends to slow runoff and increase infiltration of water into the ground.



Legend

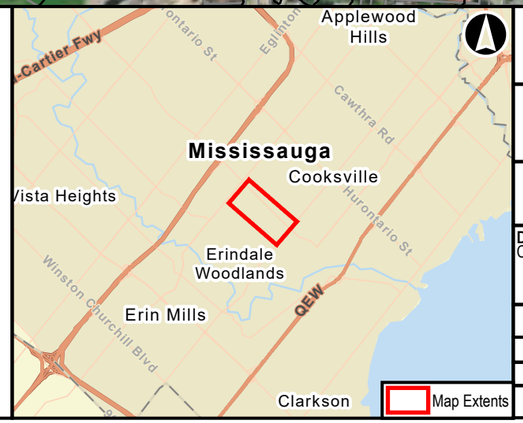
- Study Area
- Contour (1m interval)

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WFDL-CRK-1e

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads



Wolfedale Creek

Topography

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Legend

- Study Area
- Contour (1m interval)

Reach ID

- WDL-CRK-2

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Topographic Map

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 2-3

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2.2 Previous Studies

Watercourse Relocation – CPR Northerly to Wolfedale Rd. – Burnhamthorpe Rd. Drawings No. C-08719, C-08720, C-09738, and C-08723. (1967).

A set of engineering drawings for the proposed realignment were commissioned in 1967 and appear to have been constructed. Drawing C-0870 depicts a proposed total lowering of 4 feet (1.22 m) at two separate locations on the watercourse bed, from Wolfedale Road to approximately 200 m downstream of the 94-degree bend that directs the flow from east to south. At that point, drawing number C-8719 depicts further watercourse realignment and grade alteration.

On drawing C-08791, realignment of Wolfedale Creek is proposed in the vicinity of the CPR. According to the review of the drawings, the realignment would eliminate the section of the channel that flows west, then under the CPR, and finally easterly, parallel to the south of the CPR embankment. The watercourse is proposed to connect the downstream portion in a straight line through a culvert under the CPR embankment. A total profile lowering of 5 feet (1.52 m) is proposed at two separate locations of the channel bed using gabions, upstream of the CPR to tie on to the downstream portion. At this location, drawing C-09783 depicts a further total drop of 3 feet (0.9 m) at two separate locations along the portion of the channel that runs for downstream of the CPR to Dundas Street West.

Trapezoidal cross-section configurations for the banks are also provided in the drawings, varying from 28 to 32 feet in width (8.5 – 9.75 m), to maximum of 10 feet (3.05 m) in depth.

These alterations effectively reduce the watercourse length, increases the gradient, entrench the watercourse, and introduce obstructions to fish migration. They appear to have been implemented.

Lastly, drawing C-0873 is a depiction a storm sewer outfall headwall placed at the end (east) of the Sir Richards Road cul-de-sac.

Wolfedale Creek South of Stavebank Road Plan and Reprofile. Aquafor Beech Limited. Drawing No. C33737. (June 1997).

Drawing C33737 shows the proposed channel works for Wolfedale Creek South of Stavebank Road. It outlines the proposed plan and profile, which involves creating the drop structures that are present along reach WFDL-CRK-2 and directs that the banks should be regraded to 3H:1V with an 8 m nominal channel base width. The structures were constructed.

Preliminary Design Recommendations for Mississauga Structures Memo, 2015. Completed by Aquafor Beech for the City of Mississauga on behalf of Planmac Engineering Inc.

An ecological, geomorphic, and hydraulic assessment of four watercourses was completed to support restoration, repair, or replacements of culverts under various roads, namely:

- Kamato Road over Little Etobicoke Creek
- Kingsbridge Garden Circle over Cooksville Creek
- Wolfedale Road over Wolfedale Creek
- Kos Boulevard over Birchwood Creek

Pertinent to the current fluvial assessment is information related to a tributary of Wolfedale Creek crossing under Wolfedale Road and located west of the current Study Area (immediately upstream of reach WFDL-CRK-1b in this

report). The 2015 memo focused on the conditions of the watercourse in the immediacy of the crossing. Upstream of the Wolfedale Road crossing the tributary is identified as flowing over shale and bedrock limestone with minor evidence of degradation. Its banks are lined with gabion baskets in select sections which appear to be in moderate to good condition. Multiple storm outfalls were noted to discharge into the creek in this area. Downstream (east) of Wolfedale Road (reach WFDL-CRK-1b) the channel was identified as being confined within a corridor without excessive risks of erosion. The vertical gabion basket wall at the culvert outlet was identified to be failing at the base level and causing deposition of riprap into the channel. Refer to **Section 3.1.2** below for observations noted in the field during the 2023 assessment.

Central Parkway West Over Wolfedale Creek Culvert. Biennial Inspection Report. Prepared by Engineered Management Systems Inc. for the City of Mississauga. 2021

Engineered Management Systems Inc. was retained by the City of Mississauga to create an inspection report for Wolfedale Creek over Central Parkway West. This culvert crosses reach WFDL-CRK-1c as identified in this report. The report details that the pre-cast concrete culvert was built in 1980 in a West-East orientation. It is one continuous span and has a crossing span of 3.6 m with a maximum clearance of 2 m. The culvert has a constructed bottom with a surface area of 362 square meters. Light debris accumulation was noted within the culvert consisting of rocks and mud creating a clear blockage, but no immediate rehabilitative action was suggested. The nest biennial inspection should be scheduled before August 2023. A description of the conditions observed during the 2023 fluvial geomorphology inspection is provided in **Section 3.1.3**.

2.3 Reach Delineation

Reaches can be defined as lengths of the channel that display similar physical characteristics and have a setting that remains nearly constant along their length. Reaches are relatively homogeneous in channel form, function, and process. They are influenced by similar controlling (discharge and slope) and modifying factors (vegetation) to which the channel has become or is becoming adjusted.

The desktop background review indicates that the watercourse has undergone historical alterations to its planform and grade. For this reason, geomorphic characteristics generally used in the delineation of reaches were not clearly identified. The reach breaks were based on the presence of physical barriers such as road and railway crossings. The section of Wolfedale Creek from Wolfedale Road to Dundas Street West was labelled as WFDL-CRK-1 and subdivided further into WFDL-CRK-1a to WFDL-CRK-1d, for a total of four sub-reaches. The portion of Wolfedale Creek located south of Stavebank Road was labelled as WFDL-CRK-2.

The sub-reach delineation was subsequently verified and confirmed through field reconnaissance. **Table 2-1** below presents the co-ordinates and the type of physical barrier selected for the reach delineation process and can also be observed in **Figure 1-1**.

Table 2-1: Reach Delineation

Reach	Reach Break	Co-ordinates	Justification
WFDL-CRK-1a	Upstream	608843.00 m E; 4825748.00 m N	Beginning of daylighted watercourse
	Downstream	608945.00 m E; 4825654.00 m N	Confluence with SW-NE trending branch of watercourse (WFDL-CRK-1b)
WFDL-CRK-1b	Upstream	608811.00 m E; 4825503.00 m N	Confluence with SW-NE trending branch of watercourse (WFDL-CRK-1a)
	Downstream	608945.00 m E; 4825654.00 m N	Change in amount of bank/bed hardening

Reach	Reach Break	Co-ordinates	Justification
WFDL-CRK-1c	Upstream	608945.00 m E; 4825654.00 m N	Confluence with SW-NE trending branch of watercourse (WFDL-CRK-1a and WFDL-CRK-1b)
	Downstream	609859.00 m E; 4824791.00 m N	Change in amount of bank/bed hardening
WFDL-CRK-1d	Upstream	609859.00 m E; 4824791.00 m N	Change in amount of bank/bed hardening
	Downstream	610080.00 m E; 4824586.00 m N	Change in riparian vegetation;
WFDL-CRK-1e	Upstream	610080.00 m E; 4824586.00 m N	Change in watercourse orientation; change in riparian vegetation
	Downstream	610247.00 m E; 4824415.00 m N	Confluence with SW-NE trending branch of watercourse
WFDL-CRK-2	Upstream	611572.00 m E; 4823954.00 m N	Culvert outlet.
	Downstream	611860.00 m E; 4823545.00 m N	Confluence point with Credit River.

3. Field Reconnaissance

Field reconnaissance was completed on April 19th and 20th to verify reach breaks and identify local geomorphological form and function within the Study Area. A photographic record has been completed (**Appendix A**) to document channel characteristics, bed and bank materials, riparian vegetation, valley walls, and floodplain dynamics. Locations of geomorphological importance were also photographed including bank erosion sites, channel modifications, and woody material within the watercourse. An overview of site observations and interpretations are provided in the following sections. The reaches delineated for the purposes of the fluvial geomorphology assessment differ slightly from the reaches defined for the Natural Environment Report. Reaches defined for the fluvial geomorphology assessment are based on localized changes in geomorphological form and function.

3.1 Geomorphological Reach Characterization

3.1.1 WFDL-CRK-1a

Reach WFDL-CRK-1a extends from a culvert outlet in the northern portion of Study Area 1 the confluence with WFDL-CRK-1b (refer to **Figure 1-1**). The reach is a permanent, defined watercourse with an average bankfull width of 2.72 m and an average bankfull depth of 0.39 m. On the day of the assessment, the wetted width of the feature varied from 1.5 – 1.8 m and the wetted depth varied from 0.1 – 0.3 m. The reach follows a low channel gradient and has an unnatural channelized planform. Based on the background review this section of Wolfedale Creek has been artificially altered in the past.

The bed substrate consists of coarse sand and gravel with cobble to boulder sized fragments. Exposed bedrock and bedrock fragments are present along the channel banks throughout the reach bed. The channel morphology largely consists of riffles interspersed with runs spaced at approximately 20 – 30 m.

The channel banks are moderate to steep (35 – 45 degrees) and are approximately 2 – 2.6 m in height. The banks are composed of fines interbedded with shale and carbonate bedrock. The watercourse is confined by the tall banks and is partially to fully entrenched with limited assess to the floodplain where the bank slope is moderate, and the top of the bank is lower. Properties on the top of the bank are only approximately 3 – 4 m away from the flow. The riparian vegetation consists of grasses, shrubs and trees. Along the reach, two debris jams causing backwatering were observed.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1 – Figure 4-3):

- Multiple debris jams are present throughout the reach. Evidence of erosion throughout the reach was present in the form of exposed roots, leaning trees, undercut banks (up to 0.3 m in depth), and exposed bedrock along the banks.
- Sediment accumulation was observed at the culvert outlet by the upstream reach break. Evidence of overland erosion was observed behind the culvert wing walls and a failing gabion basket (displaced content at the toe of the gabion) is present on the right (west) bank immediately adjacent to the culvert wingwall.
- A knickpoint and associated bed degradation is present 34 m upstream from the confluence.
- At the confluence with WFDL-CRK-1b, there is evidence of erosion in the form of exposed tree roots, exposed bedrock on the banks, and failed gabion basket. A knickpoint is present immediately downstream of the confluence.

3.1.2 WFDL-CRK-1b

Reach WFDL-CRK-1b extends easterly from east Wolfedale Creek Road, in the western portion of Study Area 1, to the confluence with WFDL-CRK-1a (**refer to Figure 1-1**). The reach is a permanent, defined watercourse with an average bankfull width of 3.24 m and an average bankfull depth of 0.42 m. On the day of the assessment the watercourse had a wetted width of 1.2 – 2.3 m and a wetted depth of 0.1 – 0.4 m. The channel follows a low channel gradient of straight channel planform, with poorly formed bars that add minimal sinuosity in a localized area of the reach. Based on the background review this section of Wolfedale Creek has been artificially altered in the past.

Shale and carbonate bedrock is not as exposed as in the downstream reaches and was only observed in small portions along the banks of the reach. The bed is mostly covered by sediments and detritus. The bed substrate ranges from fines to gravel/ cobble sized material. The reach has a poorly defined pool-riffle bed morphology.

The channel is surrounded by moderate to steep banks that range in size from 2 – 2.5 m high. The steep banks confine and entrench the channel, preventing access to the floodplain. Bank substrate consists of fines, gravel, and shale bedrock. Construction debris was observed in some sections of the banks, particularly on the left (northern) bank. The top of the left (north) bank is in close proximity to the fence line of the adjacent property at the top of the valley walls. The riparian vegetation surrounding the watercourse consists of scrubland-type vegetation.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1 – Figure 4-3:

- In-channel woody debris is present throughout the reach. Woody debris was also observed along the valley slope. Evidence of erosion in form of bank undercutting and exposed tree roots was observed throughout the reach.
- The reach begins at the outlet of the culvert crossing under Wolfedale Creek Road. The culvert is surrounded by gabion baskets. The gabion baskets on the right bank are failing (displaced content and corroded and broken wires). The failing condition was also noted in the study by Aquafor Beech (2015). Riprap and boulders are also present at the bank toe. There is also a lateral bar present downstream of the culvert outlet, which may indicate sediment is being deposited immediately downstream of the culvert due to insufficient sizing.
- Approximately 78 m upstream of the confluence there is a pinch point, where the channel narrows. The valley walls here are steep and the flow is narrow and deep. At this location angular gravel is embedded into the bank and a chain link fence was observed hanging perpendicular to the watercourse from bank to bank. The fence was not observed to impede flow. At this location there are also three large displaced concrete blocks on the left (north) bank.
- Approximately 50 m upstream of the confluence there is a gully present on the right (south) bank upstream of a poorly formed bar. The gully has likely formed as the result of overland flow from the adjacent property.
- A second and larger gully was observed approximately 5 m upstream of the confluence on the left (north) bank and is also likely the results of overland runoff from the parking lot at the top of the valley wall.

3.1.3 WFDL-CRK-1c

The reach is a permanent, defined watercourse. The reach begins at the confluence between WDFL-CRK-1a and WFDL-CRK-1b. it has an average bankfull width and depth of 5.90 m and 0.68, respectively, in the northern half of the reach, which narrows to an average width and depth of 4.59 m and 0.65 m in the south. On the day of the

assessment the reach had a wetted width of 1.8 – 2.0 m and a wetted depth of 0.1 – 0.4 m. It follows a low to moderate channel gradient and has a straight channel planform. Based on the background review this section of Wolfedale Creek has been artificially altered in the past.

Bed substrate consists of fines with lesser amounts of gravel and cobble-sized material. The channel has a riffle-run-pool bed morphology that repeats every 20 to 30 m. There are multiple sections of exposed bedrock throughout the reach.

The channel is surrounded by moderate to steep banks. Banks are composed of fines, gravel, small cobble, and bedrock fragments. The entire watercourse is entrenched and for the most part it lacks access to the floodplain. Only very short sections appear to have limited access to the valley floor.

The reach is surrounded by scrubland-type vegetation.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1 – Figure 4-3):

- Evidence of channel instability is widespread throughout the reach. Multiple woody debris jams are present throughout the entire reach. Erosion is widespread and consists of exposed tree roots and leaning trees, bank undercutting, knickpoints, and exposed bedrock (shale and limestone). Aggradation was observed in deeper sections upstream of Central Parkway West.
- A lot of trash and construction debris have been thrown into the channel.
- The Central Parkway West crossing was noted to contain accumulated sediment within the culvert (fines to slabs of bedrock fragments). Abundant sediment was noted upstream and accumulated soft sediment was observed at the culvert outlet, indicating sediment may not be fully moving through the culvert or into the adjoining watercourse. Downstream the watercourse appeared to be more stable that upstream. The culvert inlet and outlet were both surrounded by concrete wingwalls.. Additionally, concrete bank protection structure remnants were present at the crossing inlet.
- Many different bank treatments have been applied to this reach including gabion baskets, concrete retaining walls, angular riprap, and concrete blocks, as described further in **Section 4.1**.

3.1.4 WFDL-CRK-1d

WDFL-CRK-1d is a permanent, defined watercourse with an average bankfull with of 5.56 m and an average bankfull depth of 0.65 m. On the day of the assessment the reach had a wetted width of 1.0 – 1.3 m and a wetted depth of 0.1 – 0.3 m on average (up to 0.6 m in scoured areas). The watercourse follows a low channel gradient, and it has a straight channel planform. Based on the background review this section of Wolfedale Creek has been artificially altered in the past. The reach ends at the grade control structure.

The bed substrate consists of fines and cobbles, with up to boulder sized riprap. The channel has a poorly defined bed morphology. In multiple sections of the reach the bed of the channel consists of bedrock.

The banks are steep and entrenched. They are approximately 1.5 – 2.2 m high. The bank material largely consists of fines and angular riprap. In many locations the riprap has been partially displaced and has ended up in the channel. The reach is confined and has no access to the floodplain beyond the entrenched banks. The reach is surrounded by scrubland-type vegetation. The properties adjacent to the watercourse store materials and vehicles at the top of the slope. Copious amounts of trash are present throughout the reach.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1 – Figure 4-3):

- Overall, this section of the watercourse appears more stable than the upstream reach however, woody debris and evidence of erosion are still present. Woody debris jams were noted in many locations and often bed degradation was observed immediately downstream of the woody debris jam.
- Several knickpoints are also present throughout the reach.
- Downstream of the upper reach break an outfall is present on the western bank. Downstream of the outfall there is a debris jam and knickpoint.
- There are copious amounts of trash throughout the reach.
- The downstream reach break is marked by a set of grade control structure.

3.1.5 WFDL-CRK-1e

The reach is a permanent, defined watercourse. The bankfull width and depth in this reach could not be determined due to the presence of gabion baskets lining the channel. The top of bank to top of bank width was approximately 5.81 m with a depth of 2.09 m. The reach begins downstream of the grade control structure that mark the end of WDFL-CRK-1d and it continues until the reach passes under Dundas Street West.

The channel has been heavily modified in this reach. A vertical gabion wall lines either side of the reach. The gabion baskets appear to be in good condition. The channel bed consists of interlocking concrete blocks. Sediment has been deposited between the block crevasses, and lateral bars and point bars have started forming in small sections of the reach. The riparian vegetation consists of scrubland-type vegetation. Trees grow through the gabion baskets on both banks.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1 – Figure 4-3):

- The entire reach has been heavily modified but existing infrastructure appears to be in good condition.
- Approximately 45 m northwest of Dundas Street West the channel pinches and the width decrease to approximately 3 m. At this location there is erosion behind the gabion and retaining wall however the channel appears stable, and the gabions are in good condition.
- There is a debris jam and sediment accumulation is occurring upstream of the Dundas Street West culvert crossing possible due to the crossing being insufficiently sized.

3.1.6 WFDL-CRK-2

The watercourse is a permanent feature with a bankfull width of approximately 10.62 m with a bankfull depth of approximately 0.75 m. On the day of the assessment the feature had a wetted width of 5 – 8 m and a wetted depth of 0.2 – 0.8 m. It followed a low channel gradient, with some artificial steps/grade control structure in the middle of the reach. The reach was entrenched upstream of the steps/grade control structure. The banks are steep to moderate and are approximately 1.5 – 1.8 m tall, with the valley wall being over 10 m tall. The banks are composed of fines.

The channel substrate consisted of fines to large cobbles. Sections of the channel bed could not be assessed due to the deep-water depth. It has an artificial riffle-pool bed morphology north of the steps/grade control structure and a poorly defined riffle-pool bed morphology south of them.

The reach has a meandering planform but small sections of the watercourse from Stavebank Road south approximately 300 m appear to have been straightened in the past. Additionally, sections of the watercourse have

been hardened. There are in-channel armourstone grade control structures. The bar/inner meander that is located downstream of the armourstone grade control structure is primarily composed of large cobbles and small boulders with fines. A small chute channel appears to be developing in this location as well.

The watercourse is surrounded by scrubland to meadow-type vegetation. Woody debris was present on the banks of the watercourse, possibly due to beaver activity. The watercourse is confined within a valley and upstream of the steps/grade control structure but downstream of the spillway the watercourse is very confined by bank treatments. However, there is access to the floodplain along the valley floor especially in the downstream portion of the reach.

The watercourse drains into the Credit River. A large point bar close to the confluence with the Credit River is present. The point bar is well vegetated and has a minimally cut face. At the confluence the left (east) valley wall is eroding at the toe.

Key Stability and Infrastructure Observations Summary (also refer to Figure 4-1– Figure 4-3):

- There is evidence of erosion within the watercourse. Rills/gullies have developed on the left (east) bank at more than two locations and the clay layer has been exposed at the toe of the scoured bank immediately downstream of the armourstone grade control structure. The armourstone feature is being outflanked along the right (west) bank and at least four stones have been displaced.
- There is also erosion along the outer meanders which is consistent with natural channel evolution processes.
- Sections of the watercourse have been hardened. There are in-channel armourstone grade control structures.

3.2 Rapid Geomorphic Assessment (RGA)

The Rapid Geomorphic Assessment (RGA) was designed by the Ontario Ministry of the Environment, Conservation and Parks (MECP) (1999) to assess reaches in urban channels. This technique uses visual indicators to document evidence of channel instability using presence/ absence methodology. Stability is determined by adjustment in slope, either an increase (aggradation) due to sediment deposition or a decrease (degradation) due to bed erosion. It also considers an increase in the bank-to-bank width (widening) and by any evidence indicating adjustment in the planimetric form regime. Each of the geomorphic indicators is documented throughout the reach and upon completion, is tallied by category. These data are then used to calculate an overall reach stability index which classifies the reach as ‘stable’, ‘transitional’, or ‘in-adjustment’ corresponding to their relative sensitivity to altered sediment and flow regimes. The classification and interpretation as defined by the factor value (total score) are identified in **Table 3-1** (taken from the MECP, 2003). Results are presented in **Table 3-2**.

Table 3-1: Rapid Geomorphic Classification

Factor Value	Classification	Interpretation
≤ 0.20	In Regime or Stable (Least Sensitive)	Channel morphology is within a range of variance for streams of similar hydrographic characteristics – evidence of instability is isolated or associated with normal river propagation processes.
0.21 – 0.40	Transitional or Stressed (Moderately Sensitive)	Channel morphology is within the range of variance for streams of similar hydrographic characteristics, but the evidence of instability is frequent.
≥ 0.41	In Adjustment (Most Sensitive)	Channel morphology is not within a range of variance and evidence of instability is widespread.

Table 3-2: RGA Results

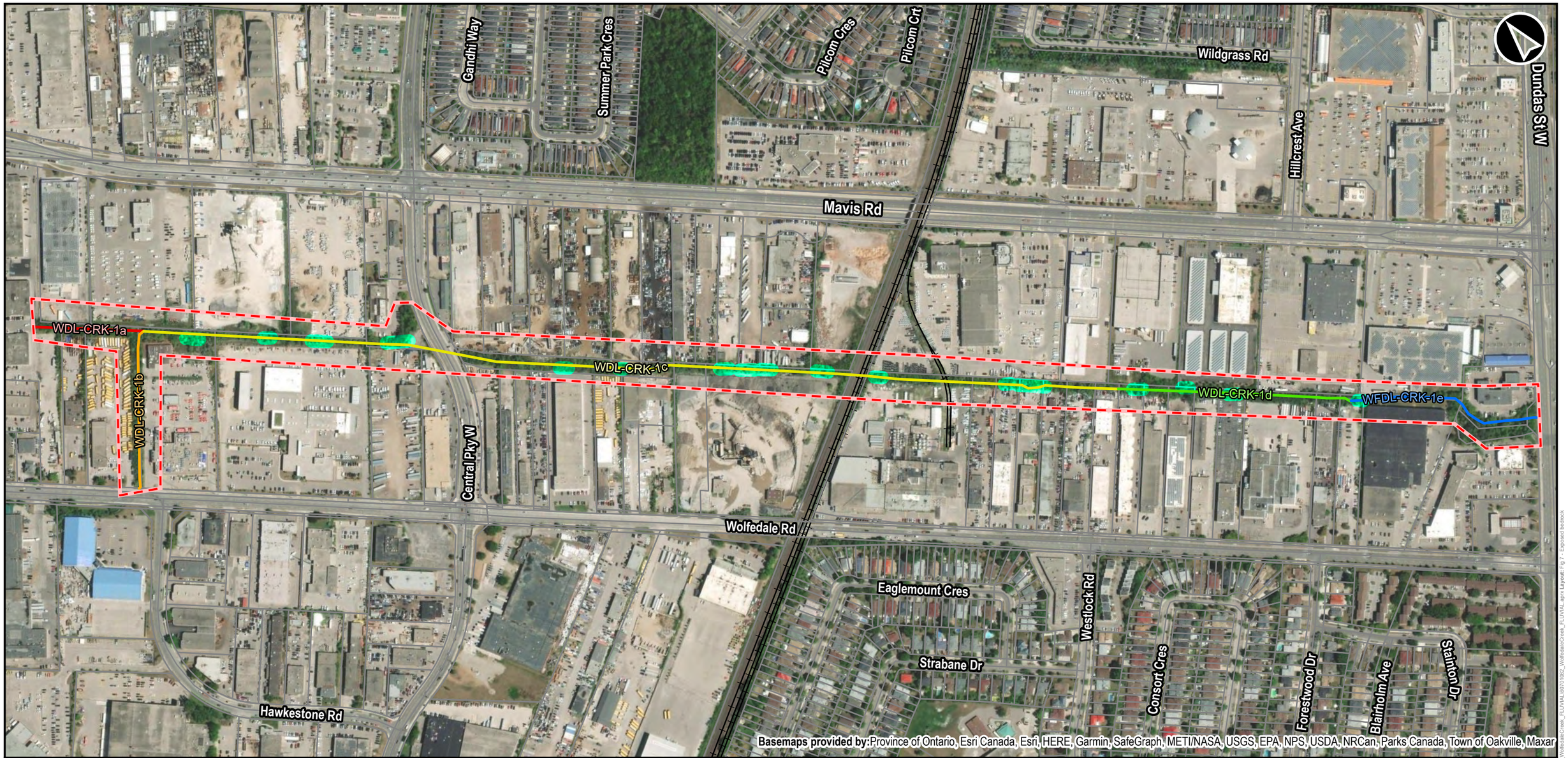
Reach	Date	Factor Value Aggradation	Factor Value Degradation	Factor Value Widening	Factor Value Planimetric Form Adjustment	Stability Index	Condition
WFDL-CRK-1a	5/9/2023	0.14	0.40	0.63	0.14	0.33	**Transitional or stressed**
WFDL-CRK-1b	4/19/2023	0.29	0.20	0.63	0.29	0.35	**Transitional or stressed**
WFDL-CRK-1c (upstream)	4/19/2023	0.00	0.17	0.63	0.14	0.23	**Transitional or stressed**
WFDL-CRK-1c (downstream)	4/19/2023	0.14	0.33	0.63	0.14	0.31	**Transitional or stressed**
WFDL-CRK-1d	4/20/2023	0.29	0.40	0.25	0.00	0.23	**Transitional or stressed**
WFDL-CRK-1e	4/20/2023	0.14	0.00	0.00	0.14	0.07	**In Regime**
WFDL-CRK-2	4/20/2023	0.14	0.40	0.56	0.14	0.31	**Transitional or stressed**

Various channel evolution models (CEM) have been developed, including a recent model proposed by Booth and Fischenich (2015). Channel evolution models provide a simplified depiction of morphologic stages through which a river or stream progress in response to a disturbance such as urbanization. The models often aid in the interpretation of observed channel morphology changes and can assist in the long-term restoration of watercourses. The model proposed by Booth and Fischenich (2015) focuses specifically on urban stream restoration. The classic CEMs typically follow a series of steps including:

"1. An initial disturbance, causing an imposed imbalance between sediment-transporting capacity and sediment supply, commonly expressed through changes in Lane's (1995) balance relationship ($Q \bullet S \sim Q_S \bullet D_{avg}$): increased discharge (Q) – from flow diversions, storms, urbanization; increased slope (S) – from channel straightening, meander cut-offs; and decreased sediment supply (Q_S) – from upland land-surface stabilization, channel armouring, sediment-blocking instream infrastructure. *Increased* sediment supply is also common, but recognized as typically short-lived, and changes to the last of Lane's variables, average grain size (D_{avg}), are typically identified only as a secondary response
2. Incision of the channel bed
3. Mass failure of the channel banks as they become over steepened and/or exceed a stable height, with consequent channel widening
4. The reestablishment of a lower, 'inset' floodplain/ channel system, regarded as the new stable condition" (Booth & Fischenich, 2015)

Since channel evolution models are simplified depictions of the stages through which a river or stream progresses in response to a disturbance, there are situations in which classic CEMs do not apply to natural watercourse systems. Where urban streams are confined in the vertical and/or horizontal direction (e.g., due to the presence of bedrock or bank/bed armouring), the channel is no longer considered an alluvial channel, rendering many assumptions of the classic CEM model cannot be applied in the same way. Where incision or bed downcutting is constrained, channel widening is amplified if the banks are erodible. Alternatively, if channel widening is constrained, channel incision or downcutting will be amplified. Where the entire channel is constrained by static channel bed and bank boundaries, mobile sediment and obstructions will be swept down-stream and in-channel material will be limited. Even discontinuous constraints, including sporadic instances of exposed bedrock along the channel banks and/ or beds can result in reach-scale impacts (Booth & Fischenich, 2015).

In a study on lateral and vertical bedrock erosion in limestone and shale bedrock (Marcotte, Naudorf, & Langston, 2021), the rate lateral and vertical bedrock erosion is complex and depends on wetting and drying cycles, discharge rate, and fracture spacing. Lateral erosion rates also are reported to increase in watercourses with a high sediment supply (Marcotte, Naudorf, & Langston, 2021). A map showing where the channel was constrained by exposed bedrock along the bed of the channel has been provided in **Figure 3-1**.



Legend

- Study Area

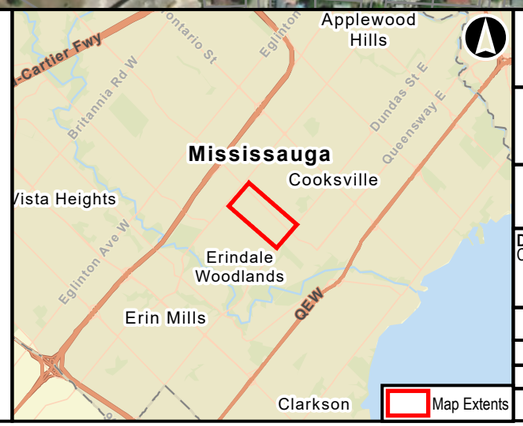
Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

- Exposed Bedrock

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads



Wolfedale Creek

Locations of Exposed Bedrock Along Channel Bed

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Figure: 3-1

Project Location: U:\Projects\60701082\Wolfedale\Wolfedale Creek\Design\01_Reports\FLUVIAL\60701082_WolfedaleCreek_FLUVIAL.aprx Layout: Fig 7 - Exposed bedrock
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Legend

Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Locations of Exposed Bedrock Along Channel Bed

0 50 100 M

NAD 1983 UTM Zone 17N

Data Sources:
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Figure: 3-1

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3.2.1 WFDL-CRK-1a and WFDL-CRK-1b

Many sections of Wolfedale Creek are constrained due to the presence of bedrock along the channel banks and/or the channel bed. Specifically, reaches WFDL-CRK-1a and WFDL-CRK-1b were constrained on their banks by exposed bedrock at more than half of the cross-section locations but were not limited by in-channel bedrock. Both channel reaches have been altered by human activity in the past. Abundant evidence of channel widening was observed along these two reaches, in the form of fallen/ leaning trees/ fence posts, presence of large organic debris deposits, exposed tree roots, basal scour on both sides of the channel through the riffle, and length of basal scour >50% through the subject reach. Channel widening typically occurs due to the channel attempting to enlarge its cross-section in response to changes in flow regime, such as those resulting from increased urbanization (i.e., increased stormwater flows due to a higher percentage of impervious surfaces and therefore elevated runoff). Over widened cross-sections have the potential to become disconnected from their floodplains, which could result in larger flows being contained within the channel. The larger flows exert larger erosive forces on the channel boundary. Over widening can result in bank failure and cause the slumped bank material to be deposited into the watercourse.

Softer bedrock typically erodes via channel widening when small grains or easily weathered blocks of bedrock from the valley wall collapse and collect at the base of the wall (Marcotte, Naudorf, & Langston, 2021). Due to the increased exposure to erosive forces and the wetting and drying cycle, the bottom of the bank tends to erode more quickly than the top of the bank. The sediment is then washed away during higher flow events. Many studies conclude that channels will erode laterally for a long period of time, interspersed with periods of rapid vertical bedrock incision (Marcotte, Naudorf, & Langston & references therein., 2001). Evidence of bedrock incision including knickpoints and evidence of degradation which were apparent in WFDL-CRK-1a in the form of cut face on bar forms and channel worn into undisturbed overburden/bedrock. Evidence of bed degradation in WFDL-CRK-1b was limited to the presence of a cut face on bar forms. This may indicate that both lateral and vertical erosion is occurring in reaches WFDL-CRK-1a and WFDL-CRK-1b.

Aggradation is also influenced by discharge, sediment load, morphological changes, and changes in flow regime due to human activity. Aggradation occurs due to the building up of streambed elevation through sediment deposition. This occurs when the channel can no longer transport the sediment load, and velocity and shear stresses fall below the entrainment and transport capacity (for a given discharge and slope). WFDL-CRK-1a showed limited evidence of aggregation (poor longitudinal sorting of bed materials) and planimetric form adjustment (bar forms poorly formed/reworked/removed). WFDL-CRK-1b showed more pronounced evidence of aggradation (siltation in pools and poor longitudinal sorting of bed materials), and planimetric form adjustment (formation of chute(s) and bar forms poorly formed/ reworked/removed). Structures that hold back water such as undersized culverts could also result in sediment deposition upstream and downstream of the structure.

3.2.2 WFDL-CRK-1c

Reach WFDL-CRK-1c begins at the confluence of WFDL-CRK-1a and WFDL-CRK-1b. WFDL-CRK-1c is constrained along its bed and bank due to abundant bedrock outcroppings. Bedrock was exposed along the bank of the watercourse at most cross-section locations within this reach. Two Rapid Geomorphic Assessments (RGAs) were collected for this reach due to slight differences in stability. Overall, the upstream portion of the reach appears to be more stable than the downstream portion. Like the upstream reaches (WFDL-CRK-1a and WFDL-CRK-1b), evidence of widening was prevalent throughout the reach in the form of fallen/ leaning trees/ fence posts, presence of large organic debris deposits, exposed tree roots, basal scour on both sides of the channel through the riffle, and length of basal scour >50% through the subject reach. Evidence of planimetric form adjustment also remained consistent through the entire reach, in the form of poorly formed/ reworked/ removed bar forms. Evidence of aggradation increased in the downstream direction, with no aggradation noted upstream, but siltation in pools present in the downstream portion of the reach. Evidence of degradation also increased in the downstream direction, with evidence

of an elevated storm sewer outfall present in the upstream portion of the reach, and undermined gabion baskets/ concrete apron and evidence of the channel worn into undisturbed overburden/ bedrock prevalent in the downstream portion of the reach.

3.2.3 WFDL-CRK-1d and WFDL-CRK-1e

Reaches WFDL-CRK-1d, and WFDL-CRK-1e were constrained along their channel beds due to the presence of exposed bedrock in the channel and they were limited along their channel banks by erosion control structures including riprap along the banks of reach WFDL-CRK-1d and gabion baskets along the banks of WFDL-CRK-1e. The dominant process occurring in reach WFDL-CRK-1d was bed degradation. Evidence included head cutting due to knickpoint migration and evidence of the channel being worn into undisturbed overburden/ bedrock. It also displayed significant evidence of aggradation in the form of poor longitudinal sorting of bed materials and deposition in the overbank zone, and evidence of channel widening in the form of fallen/ leaning trees/ fence posts, and the presence of large organic debris jams.

Reach WFDL-CRK-1e showed limited evidence of instability. Only minor evidence of aggradation (poor longitudinal sorting of bed materials)) and planimetric form adjustment (bar forms poorly formed/ reworked/ removed) were observed. This can likely be attributed to the fact that the entire channel has been altered, with gabion baskets lining both banks and the channel bed consisting of interlocking concrete blocks.

3.2.4 WFDL-CRK-2

Reach WFDL-CRK-2 is also limited along its channel banks due to the presence of gabion baskets, riprap, and/or armourstone at nearly half of the cross-section locations. Additionally, this reach contains multiple grade control structure, which affects channel bed profile development. Overall, the reach showed abundant evidence of widening in the form of fallen/ leaning trees/ fence posts/ etc., exposed tree roots, basal scour on both sides of the channel through the riffle, outflanked gabion baskets/ concrete walls/ armourstone, and >50% basal scour through the subject reach. It showed lesser evidence of degradation including cut face on bar forms and channel worn into undisturbed overburden/ bedrock. And it showed limited evidence of aggradation (siltation in pools) and planimetric form adjustment (formation of chutes).

3.2.5 Summary

Overall, all reaches except one were given a “Transitional or stressed” RGA rating. A “Transitional or stressed” rating indicates the channel morphology is within the range of variance for streams of similar hydrographic characteristics, but evidence of instability is frequent. This indicates that the watercourses are still adjusting to historical changes. These changes may include changes in flow being contained within the channel due to urbanization, changes in planform and/or profile (refer to **Section 2.2**), or changes in bank/ bed armouring (i.e., gabion baskets, rip rap, concrete slabs, etc.) which could make it difficult for the watercourse to adjust.

WFDL-CRK-1e was assigned an In Regime rating, which applies to streams that show limited evidence of instability or where evidence of instability is associated with normal river propagation processes. This reach was heavily engineered, with erosion control structures lining the channel bed and banks, limiting the possible evidence of erosion within the reach.

4. Quantitative and Qualitative Data Analysis

Qualitative geomorphological data was analyzed based on the cross-sectional and longitudinal profile surveys taken in the field in April and May 2023. The following sections present the results together with the fluvial geomorphological analysis undertaken to inform input into the preferred channel design and restoration. Pre-existing infrastructure and areas of slope instability were also noted, as outlined in **Section 4.1**.

More details about the cross-sections including details regarding the location of all cross-sections has been provided in **Section 4.2**. Bed and bank characterization data was also collected at each cross-section location.

4.1 Pre-Existing Infrastructure and Key Areas of Slope Instability

Wolfedale Creek has been historically extensively altered. During the field reconnaissance survey instances of bank treatment, pre-existing infrastructure, and key areas of slope instability were identified. These structures must be considered because they may help to inform the likelihood of success of various bank treatment options that have been implemented in the past and they may limit the space available to regrade the channel banks during the design stage. A summary of the pre-existing infrastructure and key areas of significant erosion concerns has been provided in **Figure 4-1**. The condition of the infrastructure was also noted.

4.2 Cross-Sectional Surveys and Bank Characterization

A series of cross-sections were taken across the Study Area, as shown in **Figure 4-2**. An overview of channel dimensions is provided in the following sections. The cross-sectional metrics will be used to define the hydraulic characteristics of each reach to design typical cross-sections that will convey bankfull flow and allow floodplain access, where possible, for overbank flooding.

Rooting depth, vegetation, and degree of undercutting were documented for both the left bank and right bank at each of the surveyed cross-sections. The data are used to identify the stability of the channel banks.

Concrete Retaining wall at top of slope on right bank. Structure is 10-11m long. Located at the top of slope. No signs of failure. A second similar structure is located further down stream on same bank. Also appears stable and is partially buried. Concrete fragments are present down the slope and some in the channel.

Culvert at start of reach. Downstream of culvert there is failed gabion on the right bank and overland scour behind the culvert wingwalls.

Fence along top of bank along the portion of creek - monitor for littering

Riprap on left bank. Culvert outfall on right bank and failed gabion at outfall location.

On right bank. Double span outfall partially submerged. Large debris jam upstream. Sediment accumulation. Surrounded by gabion baskets upstream and downstream. Gabion is failing. Bed downcutting/ degradation

Knick points and bed degradation

Slope stability issues along the left bank.

Knickpoint and bed degradation

Top of slope on the left bank, it appears that the fence is leaning towards the channel

Right bank has erosion undermining fence. Knickpoint and bed degradation present downstream. Concrete slab present which protects an outfall

Failed gabion structure

Culvert outlet on right bank

Bed and slope Degrading

Knickpoint, bed degradation, and debris jam

Bed degradation. Verysteep left bank that is being eroded

Undermined outfall and Erosion on right bank. Heavy erosion upstream and downstream of this location.

CSP Culvert on the right bank. Perforated and corroded

Bed degradation at location of concrete debris jam

Riprap around outfall on right bank and concrete headwall

Bed degradation and location of failed bank protection. Erosion present on left bank across from collapsed concrete blocks. Failed gabion present upstream of erosion.

Failed gabion baskets on both banks

Gully on left bank due to overland flow from parking lot at top of bank

Failed gabion structure

Outfall protected by gabion on the left bank. Poor condition

Gabion in poor condition on the Right bank

Gabion (failing) surround an outfall

Overland erosion creating a gully.

Gabion basket protecting outfall. Gabion basket is corroding and is undercut. Some contents displaced. On right bank

Failed Concrete apron and undermined concrete retaining wall. Vehicles are parking at the top of the slope and pose a slope stability risk

Undermined gabion basket on right bank.

Bed degradation at debris jam. Constricting flow.

At wolfedale road the gabion basket on the right bank is broken. The contents are being displaced at toe of gabion.

Pilcom Crt

Basemaps provided by: Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada, Town of Oakville, Maxar

Legend

- Study Area
- Flood Lines

General Features

- Railway
- Minor Roads

Reach Breaks

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-1e
- WDL-CRK-2

- Displaced concrete boulders at toe of slope on right bank

Wolfedale Creek

Structure Observation Map

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Figure: 4-1

Project Location: U:\Projects\60701082\Wolfedale\WolfedaleCreek\Design\1_Reports\FLUVIAL\60701082_WolfedaleCreek_FLUVIAL\60701082_WolfedaleCreek_FLUVIAL.aprx Layout: Fig 0 - Fluvial Structures
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On right bank. Double span outfall partially submerged. Large debris jam upstream. Sediment accumulation. Surrounded by gabion baskets upstream and downstream. Gabion is failing. Bed downcutting/ degradation

Knickpoint and bed degradation

outlet bank

Bed and slope Degrading

Knickpoint, bed degradation, and debris jam

Top of slope on the left bank, it appears that the fence is leaning towards the channel

Bed degradation. Verysteep left bank that is being eroded

Right bank has erosion undermining fence. Knickpoint and bed degradation present downstream. Concrete slab present which protects an outfall

Gabion in poor condition at top of slope. Poured concrete present at toe of gabion. Parking lot present at top of slope which poses a slope stability risk

Failing gabion wall (leaning into channel), knickpoint, bed downcutting, and debris jam

Within gabion trapezoidal section the channel bed is missing some conc blocks. Additionally, in a small section the gabion basket at toe of gabion wall on right bank has failed and needs to be fixed. Options could be to fix structure if possible or replace wall to avoid future issues

Debris jam at culvert

Riprap around outfall on right bank and concrete headwall

Gabion (failing) surround an outfall

Bed degradation and location of failed bank protection. Erosion present on left bank across from collapsed concrete blocks. Failed gabion present upstream of erosion.

Failed gabion baskets on both banks

Knickpoints, debris jam and bed degradation present. Outfall on right bank downstream of knickpoint

Knickpoints present

Culvert outlet on right bank

Significant bed scour

Manhole present on the right bank

The concrete mat is broken in this section and must be fixed.

Failed Concrete apron and undermined concrete retaining wall. Vehicles are parking at the top of the slope and pose a slope stability risk

Undermined gabion basket on right bank.

Palisander Ave

Kingsberry Cres

Hillcrest Ave

Chisholm Crt

Morrison Ave

Chisholm Ave

Pollard Dr

Westlock Rd

Consort Cres

Forestwood Dr

Stainton Dr

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada, Town of Oakville, Maxar

Legend

- Study Area
- Flood Lines

General Features

- Railway
- Minor Roads

Reach Breaks

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-1e
- WDL-CRK-2

- Angular riprap present at the toe of the slope over entire reach.
- Gabion wall surrounds watercourse for entire reach. Channel bed consists of interlocking concrete bricks

Wolfedale Creek

Structure Observation Map

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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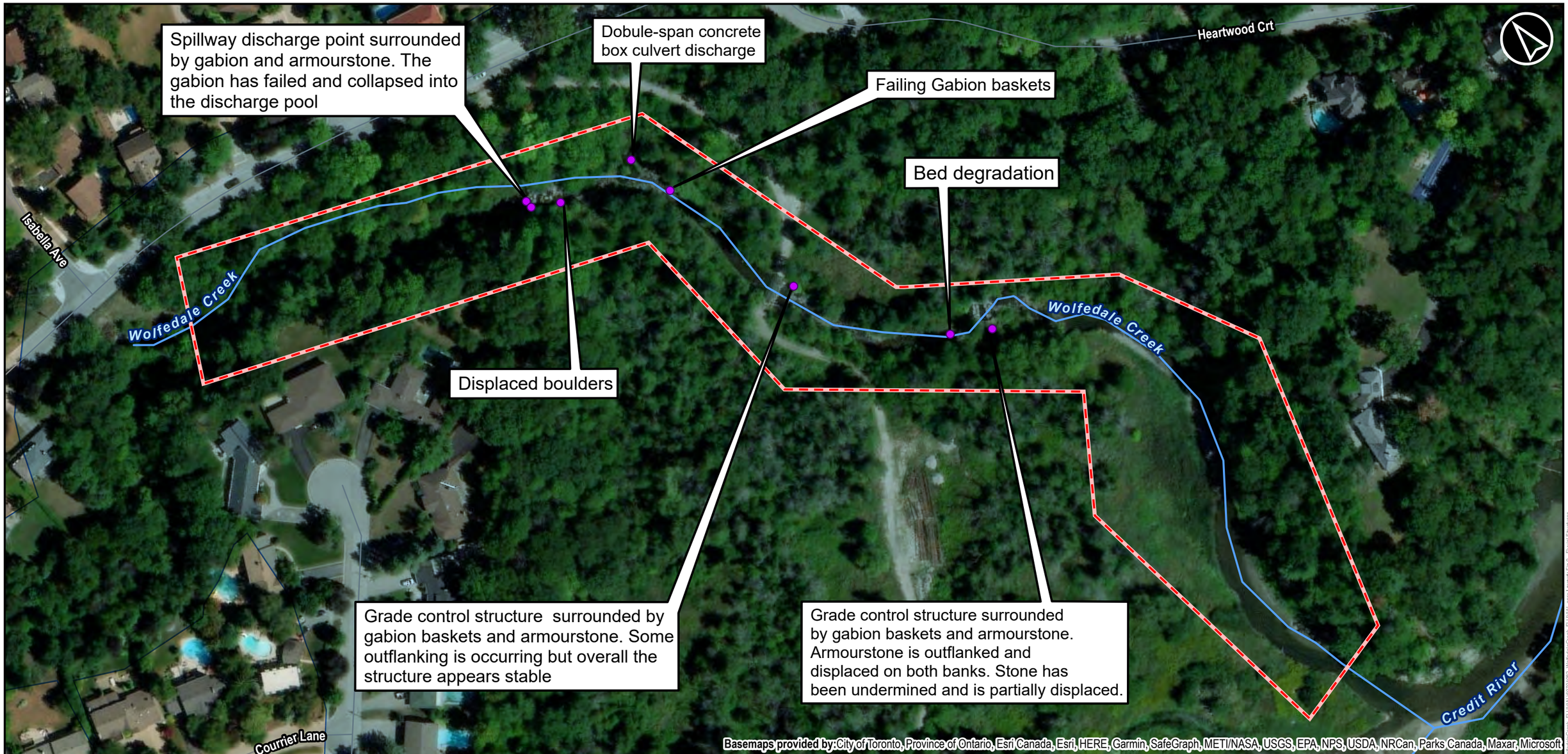
Figure: 4-1



Legend

- Study Area
- Flood Lines

General Features

- Minor Roads
- Watercourse

Reach Breaks

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-1e
- WDL-CRK-2

Wolfedale Creek

Structure Observation Map

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 4-1

Legend

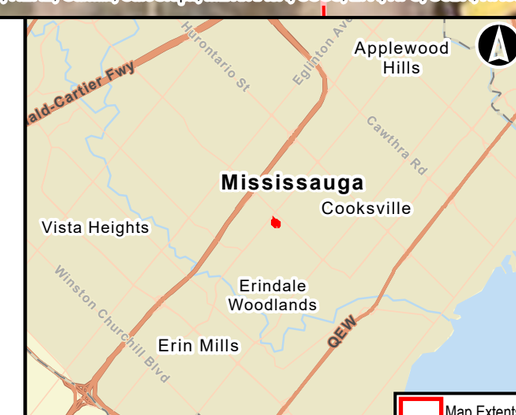
- Study Area
- Cross-Section

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c

General Features

- Property Line



Wolfedale Creek

Cross Section Map

0 15 30 M

NAD 1983 UTM Zone 17N

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Figure: 4-2

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Legend

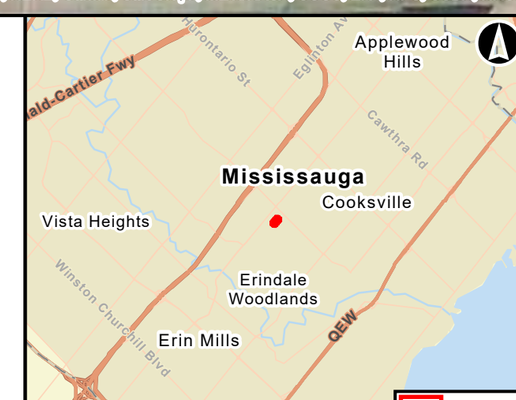
- Study Area
- Cross-Section

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c

General Features

- Property Line
- Minor Roads



Wolfedale Creek

Cross Section Map

0 15 30 M

NAD 1983 UTM Zone 17N

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Figure: 4-2

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Summer Park Cres

Mavis Rd

XS-30 XS-29a XS-29 XS-28 XS-27 XS-26 XS-25 XS-24 XS-23 XS-22 WDL-CRK-1c Xs-21 Xs-20 XS-19 Xs-18 XS-17 XS-16 XS-15 XS-14 XS-13

Central Pky W

Wolfedale Rd

Hawkestone Rd

Eaglemount Cres

Westlock Rd

Basemaps provided by: Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada, City of Toronto, ON, Town of Oakville, Maxar, Microsoft

Legend

- Study Area
- Cross-Section

Reach ID

- WDL-CRK-1c

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads

Wolfedale Creek

Cross Section Map

0 15 30 60 90 120 150 180 210 240 M

NAD 1983 UTM Zone 17N

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Figure: 4-2

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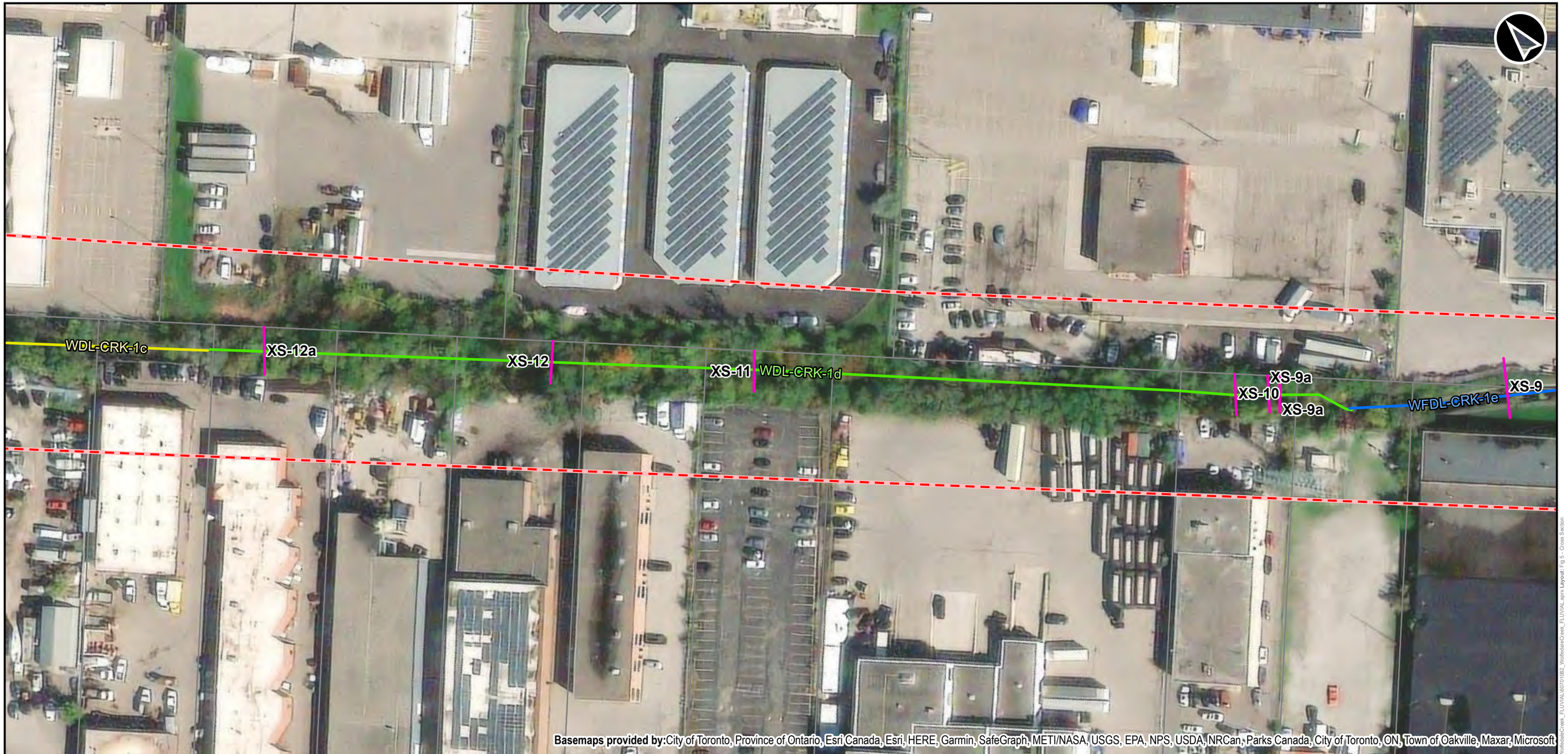


Legend

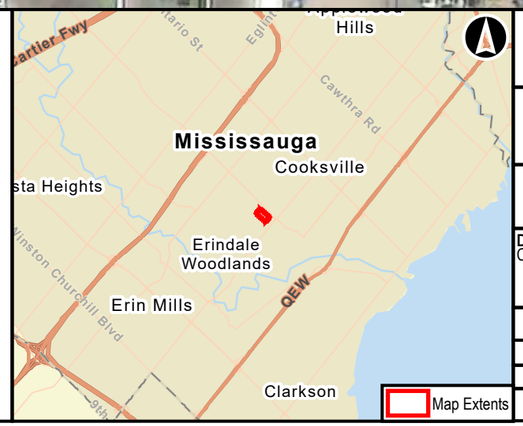
- Study Area
- Cross-Section

Reach ID

- WDL-CRK-1c
- WDL-CRK-1d
- WFDL-CRK-1e

General Features

- Property Line



Wolfedale Creek

Cross Section Map

0 15 30 60 M

NAD 1983 UTM Zone 17N

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Figure: 4-2

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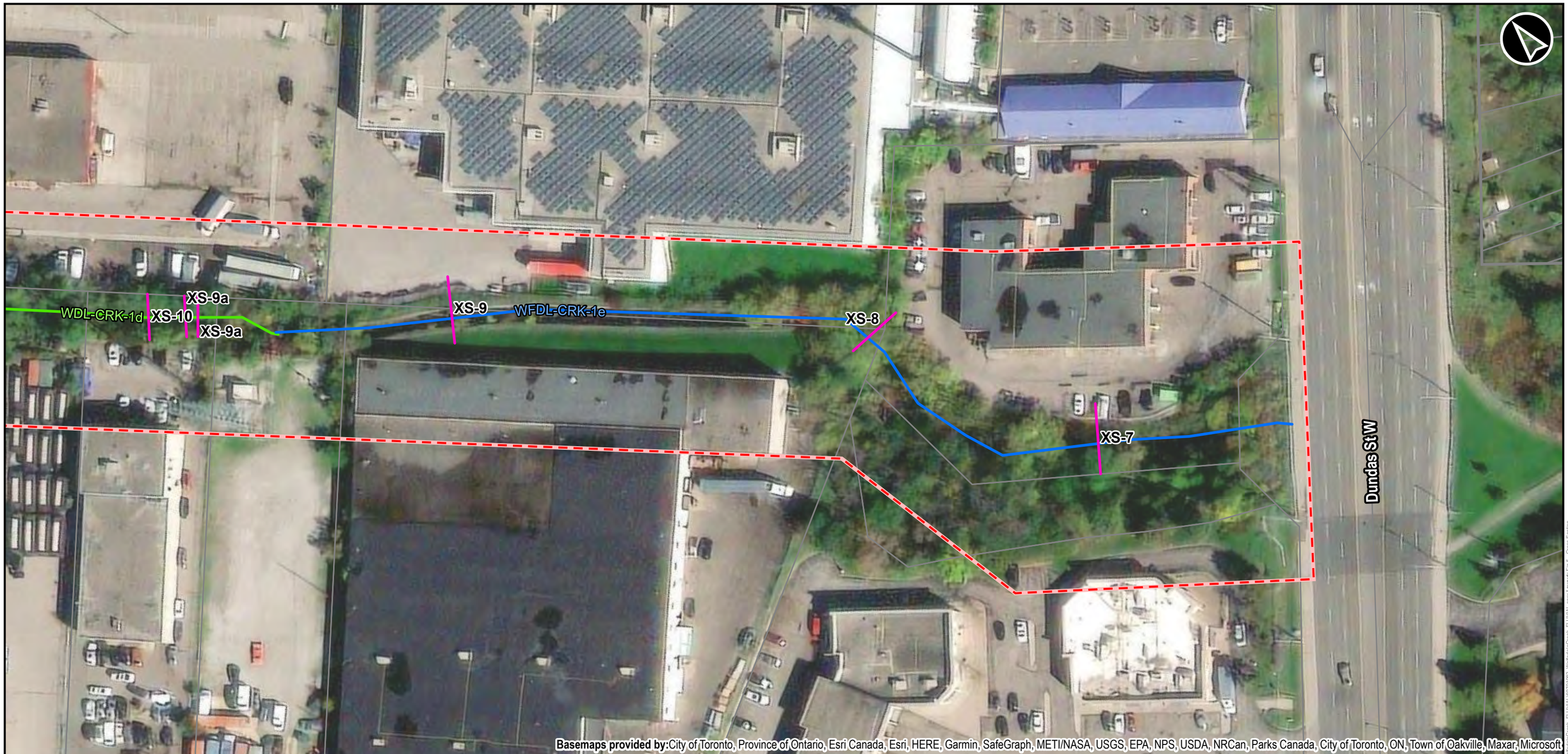


Legend

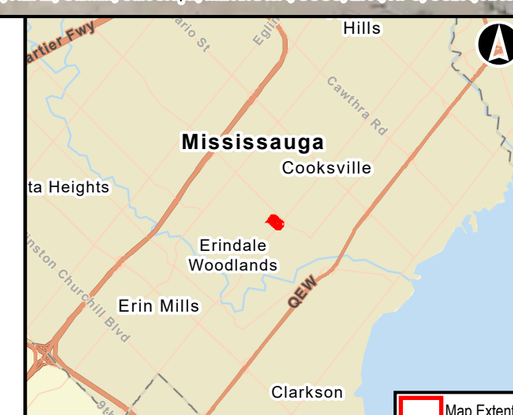
- Study Area
- Cross-Section

Reach ID

- WDL-CRK-1d
- WFDL-CRK-1e

General Features

- Property Line
- Minor Roads



Wolfedale Creek

Cross Section Map

0 15 30 60 M

NAD 1983 UTM Zone 17N

Data Sources:
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Figure: 4-2

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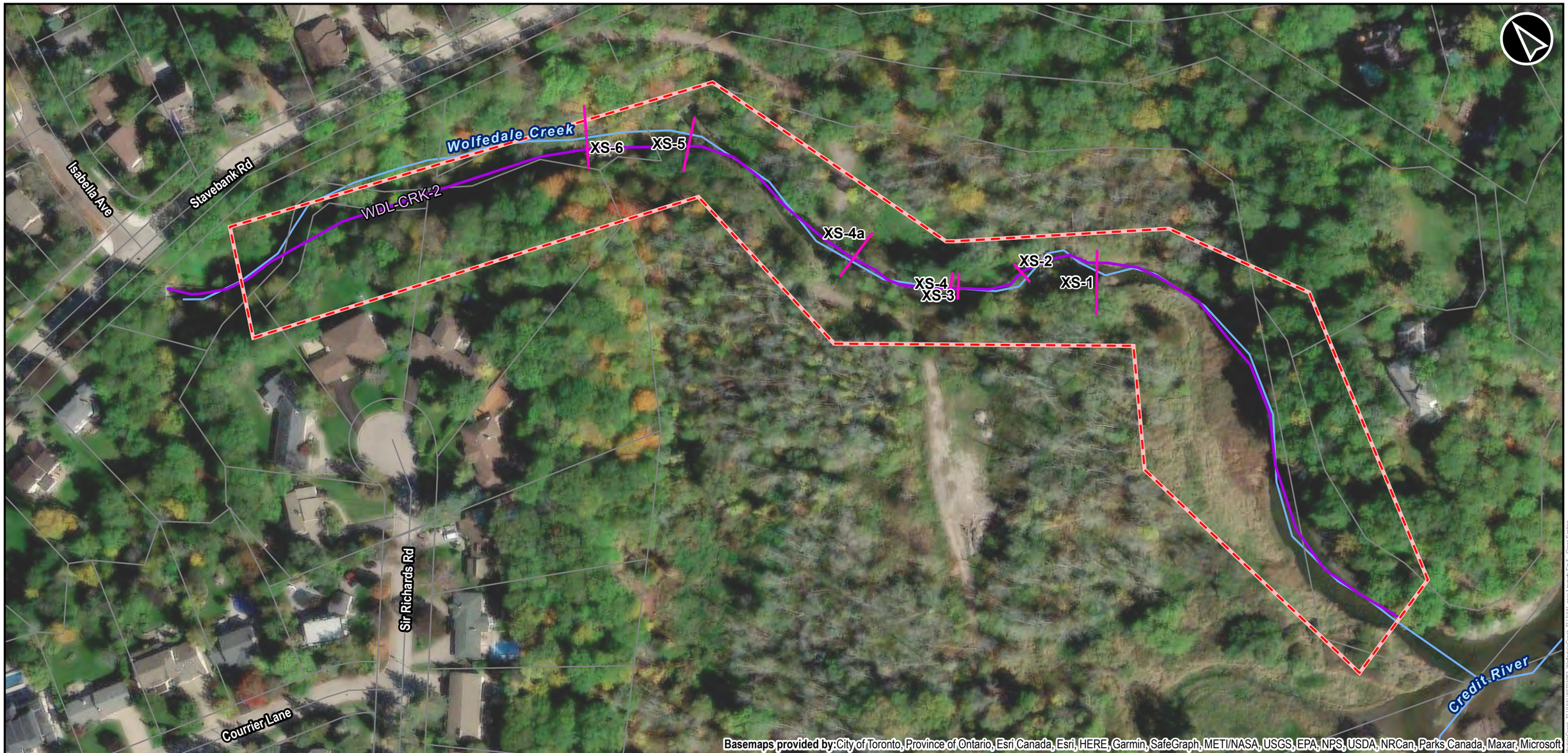

Legend

- Study Area
- Cross-Section

Reach ID

- WDL-CRK-2

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Cross Section Map

0 15 30 60 90 M

NAD 1983 UTM Zone 17N

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Figure: 4-2

Project Location: U:\Projects\60701082\Workspace\WolfedaleCreek\Design\1_Reports\FLUVIAL\60701082_WolfedaleCreek_FLUVIAL.aprx Layout: Fig 5 - Cross Section
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4.2.1 WFDL-CRK-1a

The cross-sections taken for reach WFDL-CRK-1a indicate that the channel narrows and deepens in the downstream direction. Overall, the banks are moderate to steep and have a relatively high percentage of vegetative bank protection and rooting density. Bedrock is often exposed along the channel banks but not along the channel bed. There was bank undercutting noted at two of the three cross-sections. Additionally, two knickpoints downstream of debris jams are present in the reach between XS-33 and XS-32.

The following notes are provided on the cross-sections:

- XS-34 was taken immediately downstream of the culvert outlet that signifies the beginning of the reach. It has the widest bankfull width and has the lowest bank angles.
- XS-33 was taken downstream of a concrete outfall and a debris jam where a tree has fallen causing bed degradation immediately downstream. This cross-section has the deepest maximum bankfull depth and has the largest bankfull width:depth ratio.
- XS-32 was taken upstream of the confluence, a set of failed gabion baskets (displaced content, corroded wires, nearly no stone left).
- XS-33 and XS-32 have low width to depth ratios indicating that at these locations the channel is narrower and deeper with larger stress forces being present along the bottom of the channel.

Table 4-1: Cross-Sectional Metrics and Bank Characterization for WFDL-CRK-1a

	Cross-section ID			
	XS-34 Riffle	XS-33 Run	XS-32 Riffle	Average
Bankfull Width (m)	3.52	2.54	2.10	**2.72**
Average Bankfull Depth (m)	0.27	0.44	0.46	**0.39**
Maximum Bankfull Depth (m)	0.47	0.70	0.61	**0.59**
Bankfull Width:Depth	13.02	5.80	4.52	**7.78**
Bankfull Cross-sectional Area (m^2)	0.92	1.11	1.00	**1.01**
Left Bank				
Left Bank Angle (°)	26.7	79.6	48.7	**51.67**
Left Bank Height (m)	0.27	0.55	0.61	**0.48**
Left Bank Substrate	Fines	Fines	Fines, Bedrock	/
L.B. Undercut (Height/ amount) (cm)	No	Yes (60/ 15)	Yes (40 / 1.5)	/
L.B. Rooting Density (1-5)	3	5	4	**4**
L.B. % Protected by Veg	60	80	70	**70**
Right Bank				
Right Bank Angle (°)	39.0	30.1	59.6	**42.91**
Right Bank Height (m)	0.44	0.62	0.56	**0.54**
Right Bank Substrate	Fines, Gravel, Cobbles, Bedrock	Fines	Fines, Bedrock	/
R.B. Undercut (Height/ amount) (cm)	No	Yes (25/ 10)	Yes (40/ 10)	/
R.B. Rooting Density (1-5)	4	4	3	**3.7**
R.B. % Protected by Veg	40	75	70	**62**

4.2.2 WFDL-CRK-1b

There is very little change in the bankfull width and depth in reach WFDL-CRK-1b. Overall, the banks are low to moderate and have a relatively high percentage of vegetative bank protection and rooting density. Bedrock was exposed along the channel banks at 3/5 cross-sections however, no in-channel bedrock was exposed. Bank undercutting was observed at 2/5 cross-sections.

The following notes are provided on the cross-sections:

- XS-35 was taken immediately downstream of the culvert outlet from Wolfedale Road. At this location the right bank has been protected by gabion and armourstone was present along both banks.
- XS-36 was collected downstream of a large debris jam where a pool is present. This pool had the deepest maximum bankfull depth.
- XS-37 was taken downstream of a large pinch point where the channel narrows and deepens for a short interval. This cross-section has the narrowest bankfull width.
- XS-38 was collected before a gully that formed from overland flow off a parking lot.
- XS-39 was taken at the location a large gully off of a parking lot. Due to parking at the top of the slope, the gully poses a major erosional/ slope stability concern. There is also a set of gabion baskets that have failed. The gabion baskets have displaced content and corroded wires with nearly no stone left.
- XS-36 and XS-37 have low width to depth ratios indicating that at these locations the channel is narrower and deeper with larger stress forces being present along the bottom of the channel.

Table 4-2: Cross-Sectional Metrics and Bank Characterization for WFDL-CRK-1b

	Cross-section ID					
	XS-35 Riffle/ Run	XS-36 Pool/ Run	XS-37 Run	XS-38 Pool/ Run	XS-39 Pool/ Run	Average
Bankfull Width (m)	3.43	3.23	2.80	3.29	3.68	**3.29**
Average Bankfull Depth (m)	0.42	0.47	0.48	0.35	0.36	**0.42**
Maximum Bankfull Depth (m)	0.69	0.78	0.71	0.63	0.64	**0.69**
Bankfull Width:Depth	8.17	6.83	5.85	9.37	10.18	**8.08**
Bankfull Cross-sectional Area (m^2)	1.36	1.68	1.44	1.13	1.64	**1.45**
Left Bank						
Left Bank Angle (°)	24.0	42.9	50.6	27.9	53.3	**39.74**
Left Bank Height (m)	0.63	0.65	0.58	0.52	0.40	**0.55**
Left Bank Substrate	Fines, Cobbles	Fines	Fines, Gravel	Fines, Concrete Rubble	Fines, Bedrock	/
L.B. Undercut (Height/ amount) (cm)	No	Yes (15/ 10)	No	No	No	/
L.B. Rooting Density (1-5)	2	4	4	3	4	**3.4**
L.B. % Protected by Veg	95	65	75	60	40	**67**
Right Bank						
Right Bank Angle (°)	34.3	59.1	51.7	44.1	37.9	**45.43**
Right Bank Height (m)	0.52	0.49	0.62	0.62	0.38	**0.53**
Right Bank Substrate	Fines, Cobbles, Gabion	Fines, Cobbles, Bedrock	Fines, Gravel	Fines, Cobbles, Bedrock	Fines, Cobbles, Bedrock	/
R.B. Undercut (Height/ amount) (cm)	Yes	Yes (20/ 8)	No	No	No	/
R.B. Rooting Density (1-5)	1	4	4	3	4	3.2
R.B. % Protected by Veg	95	60	60	85	50	70

4.2.3 WFDL-CRK-1c

In general, in WFDL-CRK-1c the bankfull width and bankfull depth increase in the downstream direction. The banks have a moderate bank angle and have a relatively moderate percentage of vegetation protection and rooting density. Bedrock was exposed along the channel banks at nearly every cross-section, and bedrock was exposed along the channel bottom at many locations throughout the reach. Bank undercutting was only observed at 3 of 20 cross-sections within this reach.

The following notes are provided on the cross-sections:

- XS-31 was taken immediately downstream of a debris accumulation at the confluence with WFDL-CRK-1a and WFDL-CRK-1b. A knickpoint is present immediately downstream of the cross-section.
- XS-29 was collected immediately before a knickpoint.
- XS-28 was taken where the channel was armoured with riprap and gabion baskets.
- XS-27 has exposed bedrock.
- XS-26 was taken where bank had been armoured with concrete rubble, gabion, and riprap.
- XS-25 has exposed bedrock and was taken where there are serious slope stability issues proximal to parking lots on both banks. On the right (southwest) bank a collapsed concrete bank treatment is also present at the toe of the slope.
- XS-24 was taken at the location of a debris accumulation and proximal to where there is a pile of concrete rubble at the top of the slope on the northeast bank.
- Two large debris jams are present between XS-24 and XS-23.
- XS-23 was taken at the location of a construction debris jam. A large retaining wall is also present at this location, but it has been well placed beyond the toe of the slope.
- XS-21 was taken at the location of a major slope stability issue. A concrete apron is present on the bank and has failed. Concrete blocks are falling into the channel.
- XS-20 was taken where a large amount bedrock has been exposed and is the site of a major slope stability issue. Stockpiled sediment is present at the top of the slope and poses a serious bank stability issue.
- XS-19 was taken where bedrock along the channel bed has been exposed and at the site of a major slope stability issue. Large concrete blocks at the top of the slope are leaning into the channel along the right (southwest) bank.
- XS-18 was collected where large concrete blocks are present at the top of the slope. Failed gabion baskets, concrete debris, and woody debris jams are also present at this location.
- XS-17 was collected proximal to a knickpoint and a concrete structure that protects a portion of the southwest bank.
- XS-16 was taken downstream of a set of gabion baskets that surround an outfall discharge point.
- XS-14 was taken in an area with exposed channel bedrock.
- XS-13 was taken in an area with exposed channel bedrock downstream of a large knickpoint and debris jam.
- XS-31, XS-30, XS-27, XS-25, XS-23 and XS-20 have low width to depth ratios indicating that at these locations the channel is narrower and deeper with larger stress forces being present along the bottom of the channel.

Table 4-3: Cross-Sectional Metrics and Bank Characterization for WFDL-CRK-1c

	Cross-section ID									
	XS-31 Pool	XS-30 Riffle	XS-29A Run	XS-29 Run	XS-28 Run	XS-27 Pool	XS-26 Riffle	XS-25 Riffle/ Run	XS-24 Pool/ Run	XS-23 Pool/ Run
Bankfull Width (m)	4.45	3.31	5.61	4.48	5.30	4.50	5.17	4.07	5.26	3.74
Average Bankfull Depth (m)	0.68	0.59	0.48	0.53	0.59	0.91	0.60	0.72	0.72	0.69
Maximum Bankfull Depth (m)	1.04	0.87	0.75	0.92	0.88	1.34	0.91	0.97	1.13	1.13
Bankfull Width:Depth	6.55	5.57	11.68	8.42	8.94	4.93	8.61	5.64	7.32	5.43
Bankfull Cross-sectional Area (m^2)	3.02	1.99	2.19	2.21	2.79	3.68	2.80	2.94	2.80	2.83
Left Bank										
Left Bank Angle (°)	54.56	37.08	13.00	29.49	16.21	34.54	17.83	49.67	23.03	37.34
Left Bank Height (m)	0.56	0.76	0.78	0.91	0.78	1.20	0.81	0.75	0.91	0.87
Left Bank Substrate	Fines, Cobbles, Bedrock	Fines, Cobbles Bedrock	Fines, Gravel, Cobbles, Bedrock	Fines, Gravel, Cobbles	Riprap, Fines, Cobbles, Bedrock	Fines, Bedrock	Fines, Cobbles, Concrete Rubble	Fines, Bedrock	Fines, Cobbles, Bedrock	Fines, Gravel, Cobbles, Construction Debris
L.B. Undercut (Height/ amount) (cm)	Yes (80/ 50)	Np	No	No	No	No	No	Yes	No	No
L.B. Rooting Density (1-5)	4	5	3	3	2	4	3	4	4	4
L.B. % Protected by Veg	40	60	40	50	50	90	80	30	60	50
Right Bank										
Right Bank Angle (°)	33.89	52.13	59.86	26.35	43.96	52.52	52.82	41.75	24.85	66.20
Right Bank Height (m)	0.86	0.80	0.83	0.88	0.83	1.03	0.85	0.93	1.01	0.95
Right Bank Substrate	Fines, Gravel, Cobbles, Bedrock	Fines, Gravels, Cobbles, Bedrock	Fines, Gravel, Cobbles, Bedrock	Fines, Cobbles	Gabion, Fines, Bedrock	Fines, Cobbles, Bedrock	Gabion, Riprap, Fines	Fines, Cobbles, Bedrock	Fines, Cobbles, Bedrock	Fines, Cobbles, Bedrock, Construction Debris
R.B. Undercut (Height/ amount) (cm)	No	No	No	No	Yes (25 / 20)	Yes (25/ 10)	No	No	No	Yes (15/ 10)
R.B. Rooting Density (1-5)	4	5	4	3	4	4	2	3	4	4
R.B. % Protected by Veg	50	40	60	70	50	70	60	50	50	40

Table 4-4: Cross-Sectional Metrics and Bank Characterization for WFDL-CRK-1c (continued)

	Cross-section ID										
	XS-22 Riffle	XS-21 Riffle/ Run	XS-20 Run	XS-19 Pool	XS-18 Riffle	XS-17 Riffle	XS-16 Riffle/ Run	XS-15 Run	XS-14 Pool	XS-13 Riffle	Average
Bankfull Width (m)	5.91	5.04	4.62	6.23	5.77	6.00	6.89	5.47	5.88	7.22	**5.25**
Average Bankfull Depth (m)	0.61	0.61	0.71	0.75	0.60	0.72	0.86	0.63	0.66	0.67	**0.67**
Maximum Bankfull Depth (m)	0.92	0.99	1.12	1.19	0.91	1.04	1.25	0.97	1.07	0.96	**1.02**
Bankfull Width:Depth	9.73	8.31	6.52	8.28	9.68	8.34	8.02	8.73	8.97	10.79	**8.02**
Bankfull Cross-sectional Area (m^2)	3.35	3.08	3.47	5.51	3.62	4.12	5.33	3.72	4.05	4.35	**3.39**
Left Bank											
Left Bank Angle (°)	30.56	40.94	43.02	48.31	24.58	18.45	35.05	37.48	39.65	13.20	**32.20**
Left Bank Height (m)	0.79	0.84	1.08	0.87	0.80	0.77	1.25	0.92	0.75	0.93	**0.87**
Left Bank Substrate	Fines, Cobbles, Bedrock	Fines, Cobbles, Bedrock	Fines, Bedrock	Fines, Cobbles, Bedrock	Fines, Cobbles, Bedrock	Fines, gravel, cobbles, Bedrock	Fines, Gravel, Cobbles, Bedrock	Fines, Gravel, Cobbles	Fines, Cobbles	Fines, Cobbles	/
L.B. Undercut (Height/ amount) (cm)	No	No	Yes (30/ 25)	Yes	No	No	Yes (30/ 15)	No	No	No	/
L.B. Rooting Density (1-5)	3	3	4	2	3	4	3	4	2	3	**3.35**
L.B. % Protected by Veg	40	65	30	40	50	30	50	40	50	60	**50.25**
Right Bank											
Right Bank Angle (°)	16.84	25.83	34.83	47.68	30.47	53.06	37.59	46.90	29.77	46.90	**41.21**
Right Bank Height (m)	0.84	0.68	1.09	1.10	0.77	0.94	1.14	0.97	0.90	0.96	**0.92**
Right Bank Substrate	Fines	Fines, Bedrock	Fines	Fines, Cobbles, Bedrock, Asphalt	Fines, Cobbles, Bedrock	Fines, Gravel, Cobbles, Bedrock	Fines, Gravel, Cobbles, Bedrock	Fines, Cobbles	Fines, Cobbles, Construction Debris	Gabion	/
R.B. Undercut (Height/ amount) (cm)	No	No	No	Yes	No	No	No	Yes (20/ 10)	No	No	/
R.B. Rooting Density (1-5)	3	1	3	1	3	4	3	3	1	/	**3.11**
R.B. % Protected by Veg	50	50	40	20	50	20	50	30	30	/	**45.32**

4.2.4 WDFL-CRK-1d

The cross-sections taken for reach WFDL-CRK-1d indicate that the bankfull width and depth of the channel vary but in general they tend to be slightly wider upstream and narrow in the downstream direction. Overall, the banks are low to moderate with a relatively low percentage of vegetative bank protection and a moderate rooting density. The low percentage of vegetative bank protection can likely be attributed to the protective riprap along the channel banks that was present throughout the reach. There was no exposed bedrock present on the channel banks, but bedrock was exposed along the channel bed in multiple areas, especially in the northern half of the reach. Bank undercutting noted at only one cross-section location. Multiple knickpoints are present throughout the reach.

The following notes are provided on the cross-sections:

- XS-12a was taken upstream of a knickpoint, debris jam, and drainage culvert.
- XS-12 was taken immediately upstream of a culvert outlet that contributes flow to the watercourse.
- At XS-11 the protective angular riprap that was on the banks is almost completely displaced. Riprap is still present in some sections along the bank toe.
- Two knickpoints are present between XS-11 and XS-10.

Table 4-5: Cross-Sectional Metrics and Bank Characterization for WFDL-CRK-1d

	Cross-section ID					
	XS-12A Pool	XS-12 Run	XS-11 Pool/ Run	XS-10 Riffle	XS-9a	Average
Bankfull Width (m)	6.50	6.28	5.02	4.44	5.56	6.50
Average Bankfull Depth (m)	0.63	0.78	0.68	0.54	0.65	0.63
Maximum Bankfull Depth (m)	1.03	1.19	1.13	0.83	1.04	1.03
Bankfull Width:Depth	10.37	8.09	7.41	8.26	8.53	10.37
Bankfull Cross-sectional Area (m^2)	3.79	3.99	3.14	2.20	3.28	3.79
Left Bank						
Left Bank Angle (°)	18.66	28.90	53.92	28.25	32.43	18.66
Left Bank Height (m)	0.93	1.07	0.96	0.69	0.91	0.93
Left Bank Substrate	Fines	Fines, Riprap	Fines, Cobbles, Riprap	Fines, Cobbles, Riprap	Fines, Gravel, Riprap	/
L.B. Undercut (Height/ amount) (cm)	No	No	No	No	Yes (50/ 15)	/
L.B. Rooting Density (1-5)	2	3	4	3	4	3.2
L.B. % Protected by Veg	60	40	60	30	20	42
Right Bank						
Right Bank Angle (°)	30.78	22.60	20.84	25.55	24.94	30.78
Right Bank Height (m)	0.69	1.06	0.94	0.71	0.85	0.69
Right Bank Substrate	Fines, Cobbles	Fines, Riprap	Fines, Cobbles	Fines, Cobbles, Riprap	Fines, Gravel, Riprap	/
R.B. Undercut (Height/ amount) (cm)	No	No	No	No	Yes (30/ 12)	/
R.B. Rooting Density (1-5)	1	3	4	4	3	3
R.B. % Protected by Veg	60	50	60	20	20	42

4.2.5 WDFL-CRK-1e

It was not possible to define an appropriate bankfull width due to the gabion basket walls lining either side of the channel. For this reason, cross-sections were taken from top of bank to top of bank. Overall, the bank angles generated using the cross-sectional metrics are very steep due to the artificial channel margins. Similarly, due to the bank protection the banks are reported to be completely unprotected by natural vegetation with 0 rooting density.

The following notes are provided on the cross-sections:

- XS-9 was taken downstream of a large grade control structure.
- XS-8 was collected downstream of a step down.
- XS-7 taken immediately upstream of a pinch point. Erosion occurs behind the gabion baskets after the pinch point.
- All three cross-sections have very low width to depth ratios indicating that at these locations the channel is narrower and deeper with larger stress forces being present along the bottom of the channel. Reach WFDL-CRK-1e was entirely lined with gabion baskets and concrete indicating these are not natural width to depth ratios.

Table 4-6: Cross-Sectional Metrics and Bankfull Characterization for WFDL-CRK-1e

	Cross-section ID			
	XS-9 Run	XS-8 Run	XS-7 Run	Average
Bankfull Width (m)	4.22	7.31	5.89	5.81
Average Bankfull Depth (m)	2.50	2.59	1.19	2.09
Maximum Bankfull Depth (m)	2.76	2.90	1.33	2.33
Bankfull Width:Depth	1.68	2.83	4.94	3.15
Bankfull Cross-sectional Area (m^2)	10.75	19.75	7.18	12.56
Left Bank				
Left Bank Angle (°)	87.99	85.79	78.97	84.25
Left Bank Height (m)	2.49	2.73	1.23	2.15
Left Bank Substrate	Gabion	Gabion	Gabion	/
L.B. Undercut (Height/ amount) (cm)	No	No	No	/
L.B. Rooting Density (1-5)	1	1	1	1
L.B. % Protected by Veg	0	0	0	0
Right Bank				
Right Bank Angle (°)	82.24	87.77	74.27	81.43
Right Bank Height (m)	2.69	2.60	1.15	2.15
Right Bank Substrate	Gabion	Gabion	Gabion	/
R.B. Undercut (Height/ amount) (cm)	No	No	No	/
R.B. Rooting Density (1-5)	1	1	1	1
R.B. % Protected by Veg	0	0	0	0

4.2.6 WFDL-CRK-2

In general, the bankfull width along WFDL-CRK-2 decreases in the downstream direction, with an average bankfull width of 10.62 m and the bank angle is moderate throughout the reach, with an average slope of 40 degrees (~3:1). Drawing C33737 indicates that in 1997 the channel was altered to have regraded banks 3H:1V with an 8 m nominal channel base width, which may explain why the channel is wider with shallower banks than the upstream reaches. The banks have a relatively low rooting density and a low percentage of the bank protected by vegetation. The low

amount of bank protection can be attributed to the presence of riprap, gabion basket, and armourstone which line the bank at 4 of 7 cross-sections. Bedrock was not exposed along the channel bed or banks throughout the reach. Bank undercutting was observed at 4 of 7 cross-sections.

The following notes are provided on the cross-sections:

- XS-6 was taken at the concrete spillway discharge point and has banks protected by riprap and gabion baskets.
- XS-5 was collected upstream of where a twin box culvert contributes flow to the watercourse. The twin culvert is located north of where the cross-section was collected.
- XS-4a was taken at the second grade control structure, which is also protected by gabion baskets and armour stone.
- XS-4 and XS-3 were collected in close proximity to each other.
- A knickpoint and debris jam is present between XS-3 and XS-2.
- XS-2 was collected at grade control structure that is surrounded by roundstone. The roundstone is outflanked and displaced on both banks.
- XS-1 was taken at a riffle near the confluence between WDFL-CRK-2 and the Credit River.
- XS-5, XS-4a, and XS-1 have large width to depth ratios. This indicates that here the channel is shallow and wide. These types of channels tend to experience higher hydraulic stresses against the channel bank, as well as deposition of sediment load due to the over-widened channel losing its ability to transport sediment caused by decreases in shear stress and velocity.

Table 4-7: Cross-Sectional Metrics and Bankfull Characterization for WFDL-CRK-2

	Cross-section ID							
	XS-6 Pool at Spillway Discharge Point	XS-5 Riffle	XS-4a Riffle/ Run	XS-4 Grade control structure/ Pool	XS-3 Pool	XS-2 Grade control structure Pool	XS-1 Riffle	Average
Bankfull Width (m)	13.16	12.86	10.46	9.44	8.37	9.02	11.04	10.62
Average Bankfull Depth (m)	1.14	0.58	0.53	0.63	0.92	0.89	0.52	0.75
Maximum Bankfull Depth (m)	1.72	0.85	0.77	1.01	1.46	1.24	0.72	1.11
Bankfull Width:Depth	11.51	22.11	19.68	15.02	9.05	10.10	21.40	15.55
Bankfull Cross-sectional Area (m^2)	15.50	7.88	5.24	6.57	8.50	8.25	5.76	8.24
Left Bank								
Left Bank Angle (°)	68.76	46.97	21.90	65.28	31.67	31.09	13.05	39.82
Left Bank Height (m)	1.65	0.59	0.70	0.79	0.76	0.89	0.62	0.86
Left Bank Substrate	Fines, Cobbles, Riprap, Gabion	Fines, Riprap, Gabion	/	Armour Stone	Fines, Gravel, Cobbles	Fines, Gravel, Cobbles, Armour Stone	Fines, Cobbles, Boulder	
L.B. Undercut (Height/ amount) (cm)	No	Yes (40, 50)	/	No	No	No	No	
L.B. Rooting Density (1-5)	1	1	/	1	3	2	4	2
L.B. % Protected by Veg	20	20	/	0	20	50	90	33.3
Right Bank								
Right Bank Angle (°)	22.26	26.44	11.61	74.66	36.59	69.61	38.46	39.95
Right Bank Height (m)	1.50	0.54	0.62	0.84	0.99	1.15	0.71	0.91
Right Bank Substrate	Fines, Cobbles, Gabion	Fines, Cobbles	/	Armour Stone	Fines, Gravel, Cobbles	Fines, Gravel, Cobbles, Armour Stone	Fines, Clayey till	
R.B. Undercut (Height/ amount) (cm)	No	No	/	No	Yes (80, 20)	Yes (120, 20)	Yes (100, 30)	
R.B. Rooting Density (1-5)	1	4	/	1	1	3	2	2
R.B. % Protected by Veg	10	90	/	0	10	50	10	28.3

4.3 Longitudinal Profile

The longitudinal profile of the channel thalweg extending through the study area was surveyed on the days that cross-sections were collected. The longitudinal profile is an important geomorphological consideration, as the bed gradient is a primary control of tractive forces within a reach and, therefore, is a major determinant of morphological form and function.

4.3.1 Longitudinal Profile of Reach WFDL-CRK-1a

The longitudinal profile for reach WFDL-CRK-1a is presented in **Figure 4-3**. Overall, the bed gradient has a rise of 1.22 m and a run of 110.16 m between cross-section XS-34 and XS-32 for an overall bankfull channel gradient of 1.11%.

Figure 4-3: Longitudinal Profile of Reach WFDL-CRK-1a

4.3.2 Longitudinal Profile of Reach WFDL-CRK-1b

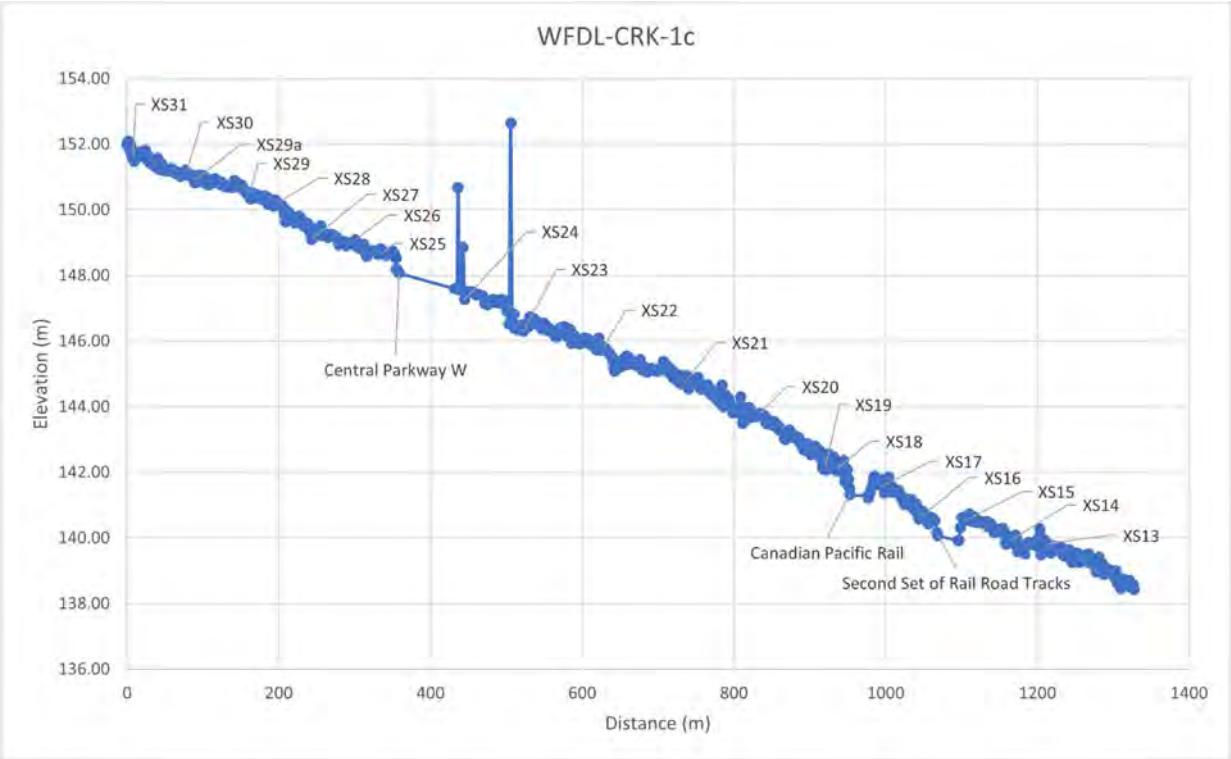
The longitudinal profile for reach WFDL-CRK-1b is presented in **Figure 4-4**. Overall, the bed gradient has a rise of 0.89 m and a run of 195.53 m between cross-section XS-35 and XS-39 for an overall bankfull channel gradient of 0.46%. The longitudinal profile shows a slight plateau between XS-36 – XS-38, with very little change in thalweg elevation. Between XS-38 and XS-39 the channel experiences a steep drop (rise of 0.48 m over a run of 58.29 m) resulting in an overall channel gradient of 0.83% for this portion. The longitudinal bed profile in this section is likely impacted by the confluence.

Figure 4-4: Longitudinal Profile of Reach WFDL-CRK-1b

4.3.3 Longitudinal Profile of Reach WFDL-CRK-1c

The longitudinal profile for reach WFDL-CRK-1c is presented in **Figure 4-5**. Overall, the bed gradient has a rise of 11.94 m and a run of 1205.28 m between cross-section XS-31 and XS-13 for an overall bankfull channel gradient of 0.99%.

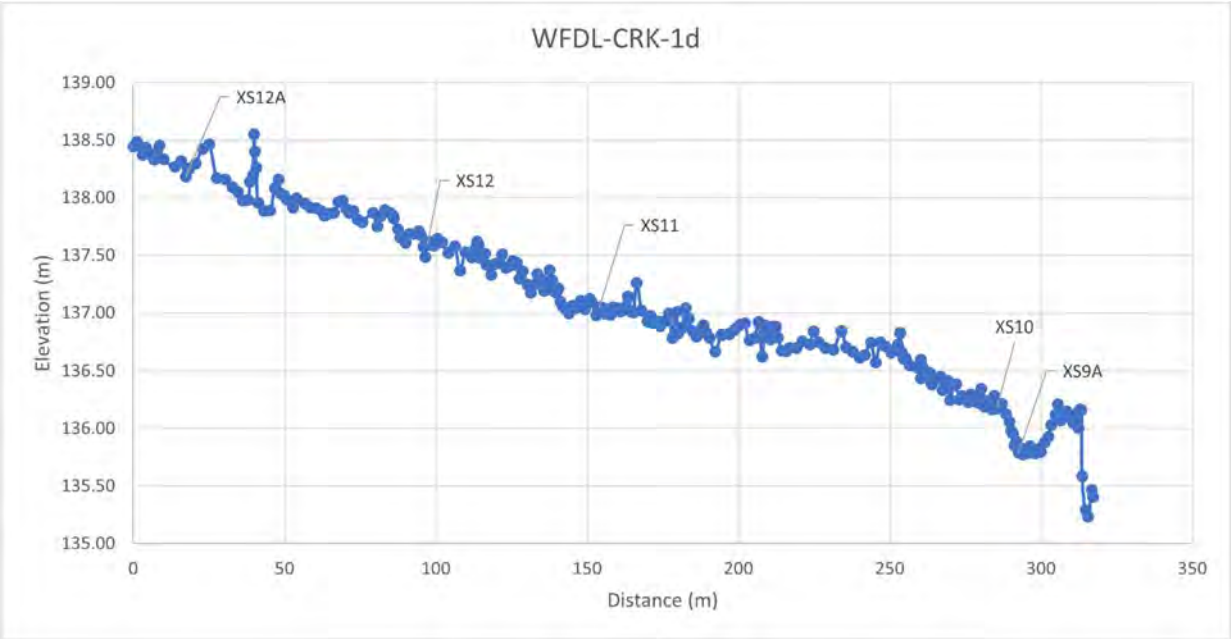
Figure 4-5: Longitudinal Profile of Reach WFDL-CRK-1c



4.3.4 Longitudinal Profile of Reach WFDL-CRK-1d

The longitudinal profile for reach WFDL-CRK-1d is presented in **Figure 4-6**. Overall, the bed gradient has a rise of 2.66 m and a run of 275.19 m between cross-section XS-12A and XS-9A for an overall bankfull channel gradient of 0.97%.

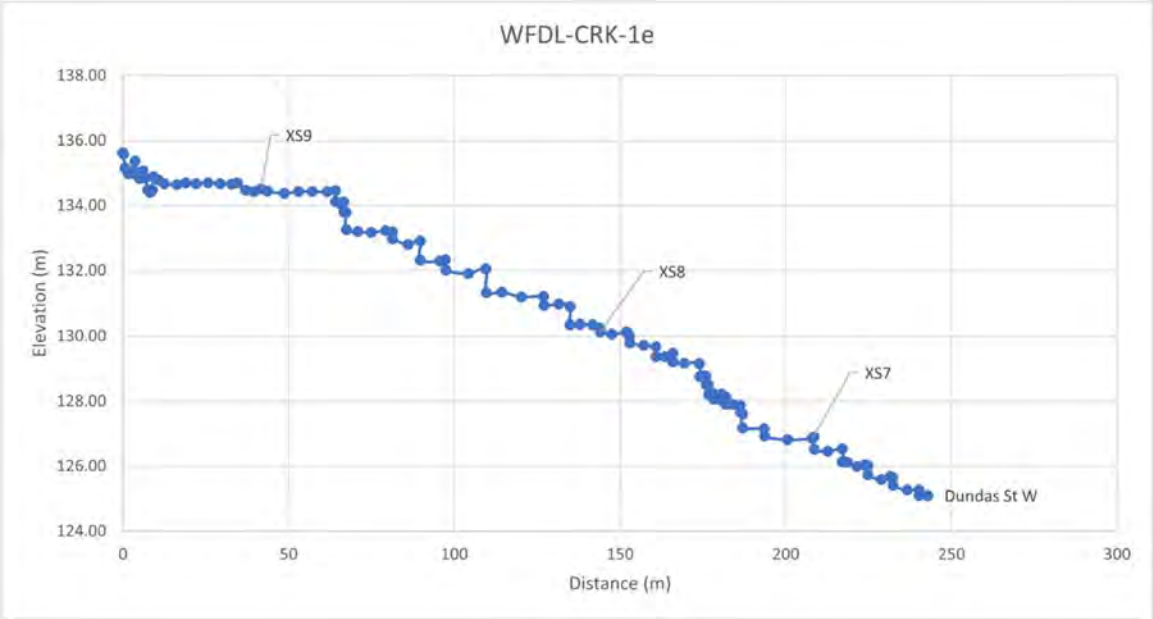
Figure 4-6: Longitudinal Profile of Reach WFDL-CRK-1d



4.3.5 Longitudinal Profile of Reach WFDL-CRK-1e

The longitudinal profile for reach WFDL-CRK-1e is presented in **Figure 4-7**. Overall, the bed gradient has a rise of 9.04 m and a run of 166.35 m between cross-section XS-9 and XS-7 for an overall bankfull channel gradient of 5.44%. This is a steep overall grade, which typically is associated with higher amounts of erosion. The channel has likely been lined with concrete and sided with gabion baskets to minimize erosion through this section.

Figure 4-7: Longitudinal Profile of Reach WFDL-CRK-1e



4.3.6 Longitudinal Profile of Reach WFDL-CRK-2

The longitudinal profile for reach WFDL-CRK-1e is presented in **Figure 4-8**. Overall, the bed gradient has a rise of 7.52 m and a run of 267.10 m between cross-section XS-9 and XS-7 for an overall bankfull channel gradient of 2.82%.

Figure 4-8: Longitudinal Profile of Reach WFDL-CRK-2

4.4 Bed Sediment Characterization

The Wolman (1954) pebble count method was used to determine the grain size distribution of in-channel substrate. The grain size distribution influences sediment transport and flow resistance within a given reach. A modified Wentworth (1922) grain size scale was used to classify particles into discrete groupings. A step-toe procedure was used to select 100 grains along each cross-section. The b-axis of each selected stone was measured using a ruler. Grains that were less than 2 mm were assigned to a fine sediment category according to the modified Wentworth grain size scale.

Grain size distributions were then calculated based on the Wolman (1954) pebble counts completed at each of the surveyed cross-sections. The D16 (16% of the same is equal to or smaller than), D50 (medium grain size), and D84 (84% of the sample is equal to or smaller than) are summarized in **Sections 4.4.1 – 4.4.6**

4.4.1 WFDL-CRK-1a

The results of the pebble count assessment **Table 4-8** indicate that sediment coarsens in the downstream direction from XS-34 to XS-32 and corresponds with the channel narrowing and deepening in the downstream direction.

Table 4-8: Bed Sediment Characterization WFDL-CRK-1a

Percentile	Cross-section ID			
	XS-34 Riffle	XS-33 Run	XS-32 Riffle	Average
D_{16} (mm)	0.03	0.06	0.40	**0.16**
D_{50} (mm)	2.52	2.04	9.10	**4.55**
D_{84} (mm)	21.00	42.34	49.36	**37.57**

4.4.2 WFDL-CRK-1b

In general, the bed sediment is variable along WDFL-CRK-1b. The longitudinal profile plateaus between XS-36 – XS-38, which may account for why there is very little change in grain size between these cross-sections. The channel was deepest at XS-36, which is located downstream of a large debris jam, which may account for the fact that this cross-section has the largest grain size. XS-39 is at a much lower elevation than the previous cross-sections and corresponds with a significant drop in grain size.

Table 4-9: Bed Sediment Characterization WFDL-CRK-1b

Percentile	Cross-section ID					
	XS-35 Riffle/ Run	XS-36 Pool/ Run	XS-37 Run	XS-38 Pool/ Run	XS-39 Pool/ Run	Average
D_{16} (mm)	0.11	0.004	0.57	0.84	0.09	**0.32**
D_{50} (mm)	7.11	2.94	7.19	6.84	2.84	**5.38**
D_{84} (mm)	33.84	44.04	31.71	31.17	18.71	**31.89**

4.4.3 WFDL-CRK-1c

In general, the bed sediment is variable along WFDL-CRK-1c. The sediment size tends to be higher where the banks are better protected, for instance at XS-28 and XS-26 where the banks have been armoured by gabion

baskets, riprap, and concrete rubble, and at XS-17 which was taken close to a concrete structure that protects the banks. This may be due to the failing structures like gabion baskets, which will empty riprap into the channel when the structure fails, impacting sediment conveyance and erosion as the sediment moves downstream. The grain size tends to be lower downstream of knickpoints (e.g., XS-29) debris jams (e.g., XS-23), and in areas with exposed bedrock on the channel bed (e.g., XS-25 and XS-20).

Table 4-10: Bed Sediment Characterization WFDL-CRK-1c

Percentile	Cross-section ID									
	XS-31 Pool	XS-30 Riffle	XS-29A Run	XS-29 Run	XS-28 Run	XS-27 Pool	XS-26 Riffle	XS-25 Riffle/Run	XS-24 Pool/ Run	XS-23 Pool/ Run
D_{16} (mm)	0.75	0.66	0.65	0.43	0.99	0.69	0.78	0.04	0.49	0.08
D_{50} (mm)	7.45	11.88	6.78	3.13	9.33	7.45	11.63	6.78	7.21	6.33
D_{84} (mm)	52.50	37.84	34.00	16.00	81.36	43.36	62.84	21.84	51.52	39.68

Table 4-11: Bed Sediment Characterization WFDL-CRK-1c (continued)

Percentile	Cross-section ID										Average
	XS-22 Riffle	XS-21 Riffle/ Run	XS-20 Run	XS-19 Pool	XS-18 Riffle	XS-17 Riffle	XS-16 Riffle/Run	XS-15 Run	XS-14 Pool	XS-13 Riffle	
D_{16} (mm)	0.80	0.39	0.55	No pebble count	0.45	0.50	0.51	0.10	0.11	0.63	**0.504**
D_{50} (mm)	11.25	3.19	1.41		3.38	7.45	7.38	2.63	1.02	5.23	**6.361**
D_{84} (mm)	48.84	56.84	12.84		74.56	96.04	68.44	52.52	47.40	68.80	**50.906**

4.4.4 WFDL-CRK-1d

The results of the pebble count assessment indicate that sediment coarsens in the downstream direction from XS-12A to XS-10, which correspond with the channel narrowing in the downstream direction.

Table 4-12: Bed Sediment Characterization WFDL-CRK-1d

Percentile	Cross-section ID					Average
	XS-12A Pool	XS-12 Run	XS-11 Pool/ Run	XS-10 Riffle	XS-9a	
D_{16} (mm)	0.08	0.35	0.45	0.11	No Pebble Count	**0.25**
D_{50} (mm)	3.10	7.23	9.10	7.45		**6.72**
D_{84} (mm)	48.20	47.84	57.44	68.50		**55.50**

4.4.5 WFDL-CRK-1e

The results of the pebble count assessment indicate that sediment is variable throughout the reach. This may be attributed to the fact that the entire channel has been artificially altered, with gabion baskets and riprap along the channel banks and interlocking concrete blocks along the channel bed. Field observations indicate there is little natural sediment along the channel bed, indicating sediment is moving in the downstream direction and is likely being flushed out of the channel during heavy flow events.

Table 4-13: Bed Sediment Characterization WFDL-CRK-1e

Percentile	Cross-section ID			Average
	XS-9 Run	XS-8 Run	XS-7 Run	
D_{16} (mm)	0.55	0.38	0.83	**0.59**
D_{50} (mm)	4.33	7.16	6.78	**6.09**
D_{84} (mm)	18.00	33.68	20.76	**24.15**

4.4.6 WFDL-CRK-2

The results show a slight increase in grain size along the grade control structure structures (XS-6, XS-4, XS-2) and a slight increase in the D16 and D50 in the riffle features in the downstream direction.

Table 4-14: Bed Sediment Characterization WFDL-CRK-2

Percentile	Cross-section ID							Average
	XS-6 Pool at Spillway Discharge Point	XS-5 Riffle	XS-4a Riffle/ Run	XS-4 Grade control structure/ Pool	XS-3 Pool	XS-2 Grade control structure Pool	XS-1 Riffle	
D_{16} (mm)	0.51	0.62	No Pebble Count Collected	0.75	0.08	0.12	0.07	**0.36**
D_{50} (mm)	8.43	13.50		9.10	2.89	12.50	17.50	**10.65**
D_{84} (mm)	47.72	110.88		58.60	23.52	61.26	97.80	**66.63**

4.4.7 Summary

Overall, the results of the bed sediment characterization indices that on average the sediment is moving downstream, with the average D60 and D84 consistently increasing in the downstream direction. The only exception is the sediment size observed in reach WFDL-CRK-1e, which had a larger D16 than other reaches, but a significantly lower D50 and D84. This may be due to the concrete lining the channel bed and gabion baskets lining the channel banks, which does not allow for the watercourse to pick up and carry sediment in the downstream direction.

5. Proposed Project Works

Alternative solutions selected will be evaluated based on the agreed-to criteria as described below. At this time preliminary alternative solutions or strategies include:

1. Do Nothing will be used as a base case comparison to other more viable alternatives or strategies.
2. Full replacement of failed bank protection with structural bank protection options to maintain long term erosion protection, such as reinforced soil slope walls, cast-in-place re-enforced concrete walls, or steel sheet pile. Structural grade control could include concrete weir structures. Incorporation of a natural channel bed will be included to improve fish habitat and passage. Consideration of top of bank land-use modification and enforcement.
3. Full replacement of failed bank protection with non-structural bank protection options to maintain long term erosion protection, such as rock, armourstone walls, green gabion, or geogrid retaining walls. Non-structural grade control could include rock weir structures. Incorporation of a natural channel bed will be included to improve fish habitat and passage. Consideration of top of bank land-use modification and enforcement.
4. A combination of both structural and non-structural bank protection and grade control structures to maintain long term erosion protection. Incorporation of a natural channel bed will be included to improve fish habitat and passage. Consideration of top of bank land-use modification and enforcement.
5. Enclose the watercourse in storm sewer and landscape a trail over top.

6. Assessment of Potential Impacts

Evaluation of alternatives has been provided in the Project File Report.

7. Future Opportunities, Constraints and Other Considerations

7.1 Design Objectives

The process of creating a channel design for any watercourse draws upon principles of fluvial geomorphology, flow hydraulics and ecology. The design process is iterative since all components of the design are inherently linked (i.e., cross-section, profile, and planform). Constraints, considerations, and the design flow must be identified prior to the design process beginning. These were identified through background review/desktop analysis and then confirmed with reconnaissance and detailed field work.

Channel design elements can be incorporated into the design to maintain the form and function of the restoration work, delivering long term ecological and conveyance benefits. Variability in channel form can be accomplished by incorporating both natural and structural vertical bed morphology in the form of pools and riffles, to provide diversity in bed configuration or grade control structures. The channel dimensions can be designed to reduce erosion risk and provide velocities and depths suitable for fish passage, including during low flow conditions. The narrow corridor, due to existing infrastructure and urbanization, limits the opportunity to include a sinuous planform pattern, but typically sinuosity is only advantageous when the meander configuration approaches natural conditions to restore function. Results from the cross-section design analysis and proposed conditions HEC-RAS model data will be used to determine appropriate substrate gradation and bank protection to prevent scour and erosion for extreme events (i.e., 100-year flow return). Fish habitat features that could be incorporated into the design include pools, and in-stream features such as placed boulders. The proposed restoration works should ensure that fish passage is enhanced by the proposed design elements.

7.2 Baseline Characteristics

The following summarizes the key findings of the fluvial geomorphological assessment. They will be used as a basis for developing design objectives for the conceptual design and will be considered during the EA process.

- Exposed bedrock along the channel banks and bed is a major constraint for the Study Area, impacting the watercourse shape, pattern, and susceptibility to erosion. Bedrock may also limit where bank treatment options can be applied.
- Shale is considered a soft bedrock and is susceptible to erosion.
- Shale and limestone are impermeable, resulting in higher runoff which leads to larger discharge quantities and faster flow velocities.
- The land surrounding Study Area 1 is heavily urbanized, which also contributes to increased stormwater runoff.
- Forest cover in Study Area 2 helps to slow runoff and increase infiltration of water into the ground.
- Many portions of the watercourse in both Study Areas have been altered by human activity, which have effectively reduced the watercourse length, increased the gradient, entrenched the watercourse, and introduced obstructions to fish migration (Missey, 1967).
- In section 1 the creek is confined, limiting or eliminating access to the surrounding floodplain. The confined valley setting of the creek does not allow it to effectively dissipate energy from large storm flows.

- Erosion of the creek banks was identified throughout most of the Study Area. Undercutting of the creek banks was observed in most areas, in addition to evidence of bed degradation, knickpoints, and multiple debris jams.
- There are a number of bank protection structures within the creek that have been applied historically to channelize flow. Many of the structures are now failing and may need to be removed or replaced.
- Significant slope stability concerns were identified in multiple spots in the Study Area.

- **WFDL-CRK-1a**
  - **Average bankfull width and depth:** 2.72 and 0.39, respectively. Channel narrows and deepens in the downstream direction.
  - **Channel Gradient:** 1.11% overall (bankfull gradient).
  - **Channel Planform:** Straight (has likely been straightened).
  - **Bedrock:** Exposed along channel banks. No in channel bedrock exposed.
  - **Bed Substrate:** Coarse sand, gravel, cobbles. Sediment coarsens in the downstream direction
  - **Channel Banks:** Fines with exposed shale. Bank angles are moderate to steep with a high percentage of vegetative bank protection.
  - **Confinement:** Confined (limited access to floodplain).
  - **Entrenchment:** Partially to fully entrenched.
  - **Riparian Vegetation:** Grasses and shrubs.
  - **Erosion:** Multiple debris jams and a knickpoint present, sections with bank undercutting
  - **RGA:** Transitional/ stressed (abundant evidence of widening and degradation).
  - **Bank Protection:** Gabion present in sections.
  - **Additional:** None.
  - **Significant slope stability issues:** None identified.

- **WFDL-CRK-1b**
  - **Average bankfull width and depth:** 3.29 and 0.42, respectively. There is very little change in the bankfull width and depth throughout the reach.
  - **Channel Gradient:** 0.46% with a slight plateau between XS36 and XS38 (bankfull gradient).
  - **Channel Planform:** Straight (has likely been straightened).
  - **Bedrock:** Limited bedrock exposure along the banks. No in-channel bedrock outcroppings observed.
  - **Bed Substrate:** Fines, gravel, cobbles. Little change in bed substrate sizing between XS36 and XS38 due to channel gradient plateau.
  - **Channel Banks:** Fines, gravel, and shale. Bank angles are low to moderate and have a high percentage of vegetative bank protection.
  - **Confinement:** Confined (no access to floodplain).
  - **Entrenchment:** Entrenched.
  - **Riparian Vegetation:** Scrubland.
  - **Erosion:** Multiple debris jams and bank undercutting present in areas.
  - **RGA:** Transitional/ stressed (abundant evidence of widening, aggradation, and planimetric form adjustment).
  - **Bank protection:** riprap, concrete blocks, gabion.
  - **Additional:** Construction debris present in some sections on northern bank.
  - **Significant slope stability issues:** None identified.

- **WFDL-CRK-1c**
  - **Average bankfull width and depth:** 5.25 and 0.67, respectively. The northern half of the reach is slightly wider and deeper than the southern half of the reach.
  - **Channel Gradient:** 0.99% overall (bankfull gradient).
  - **Channel Planform:** Straight (has likely been straightened).
  - **Bedrock:** Multiple sections of exposed bedrock throughout the reach along the channel banks and bed.
  - **Substrate:** Fines with gravel and cobble. The sediment size is variable throughout the reach but tends to be higher where the banks are protected and lower downstream of knickpoints/ debris jams, or where bedrock is exposed on the channel bed.
  - **Channel Banks:** Fines, gravel, small cobbles, bedrock fragments. Bank angles are moderate and the reach has a moderate percentage of vegetative bank protection.
  - **Entrenchment:** Entrenched (very limited access to floodplain in short sections).
  - **Riparian Vegetation:** Scrubland.
  - **Erosion:** Multiple woody debris jams and knickpoints, limited bank undercutting.
  - **RGA:** Transitional/ stressed (abundant evidence of widening and degradation).
  - **Bank Protection:** Many different bank treatments have bene applied (gabion baskets, concrete retaining walls, riprap, concrete blocks, riprap).
  - **Additional:** A lot of trash and construction debris is present in the channel and along banks.
  - **Significant slope stability issues:** Multiple properties adjacent to the watercourse throughout the reach store material and vehicles at the top of the slope.

- **WFDL-CRK-1d**
  - **Average bankfull width and depth:** 6.5 and 0.63, respectively. The bankfull width and depth vary but narrow slightly in the downstream direction.
  - **Channel Gradient:** 0.97% overall (bankfull gradient).
  - **Channel Planform:** Straight (has likely been straightened).
  - **Bedrock:** No exposed bedrock along channel banks. Bedrock has been exposed along the channel bed in multiple areas, especially in the northern half of the reach.
  - **Bed Substrate:** Fines and cobbles. Bed substrate coarsens in the downstream direction, which corresponds with the channel narrowing in the downstream direction.
  - **Channel Banks:** Fines and angular riprap. Bank angles are low to moderate, and banks have a low percentage of vegetative bank protection.
  - **Confinement:** Confined (No access to the floodplain).
  - **Entrenchment:** Entrenched.
  - **Riparian Vegetation:** Scrubland.
  - **Erosion:** Appears more stable overall than reach WFDL-CRK-1c, but erosion still present throughout. Multiple woody debris jams and knickpoints. Limited bank undercutting.
  - **RGA:** Transitional/ stressed (abundant evidence of degradation, aggradation, and widening).
  - **Bank Protection:** The banks through most of the reach are lined with angular riprap. In many sections the riprap has been displaced.
  - **Additional:** A lot of trash is present throughout the reach.
  - **Significant slope stability issues:** Some properties adjacent to the watercourse store material and vehicles at the top of the slope.

- **WFDL-CRK-1e**
  - **Average bankfull width and depth:** 5.81 and 2.09 (not true bankfull).

- **Channel Gradient:** 5.44% overall for engineered channel (bankfull gradient).
- **Channel Planform:** Straight (entire reach has been altered).
- **Bedrock:** No exposed bedrock along channel bed or banks.
- **Bed Substrate:** Channel bed consists of interlocking concrete bricks. Some sediment has been deposited between blocks. Bed substrate sizing is variable throughout the reach. Field observations indicate that there is little natural sediment along the channel bed indicating that sediment is moving in the downstream direction and is likely being flushed out of the channel during heavy flow events.
- **Channel Banks:** Gabion baskets line channel banks and of this reason, channel banks are very steep. No vegetative bank protection.
- **Confinement:** Confined by stacked gabion baskets (no access to floodplain).
- **Entrenchment:** Not entrenched.
- **Riparian Vegetation:** Scrubland.
- **Erosion:** There is a debris jam present and sediment is accumulating upstream of the Dundas Street West culvert crossing.
- **RGA:** In Regime (Limited evidence of aggradation and planimetric form adjustment).
- **Bank Protection:** Entire reach has been altered. The channel banks are lined with gabion baskets and the channel bed consists of interlocking concrete blocks.
- **Additional:** None.
- **Significant slope stability issues:** None.

WFDL-CRK-2

- **Average bankfull width and depth:** 10.62 and 0.75, respectively.
- **Channel Gradient: 2.82%** (bankfull gradient) with three grade control structure structures present.
- **Channel Planform:** Meandering (has likely been straightened in the past).
- **Bedrock:** Bedrock is not exposed along the channel bed or banks.
- **Bed Substrate:** Fines to large cobbles**.** Overall, there is a slight increase in grain size along the grade control structure structures, and a slight increase in the sediment size in the riffle features in the downstream direction.
- **Channel Banks:** Fines. Bank angles are moderate throughout the reach with a percentage of the bank protected by vegetation.
- **Confinement:** Confined within a valley upstream of the grade control structure. Downstream of the spillway the watercourse is very confined by bank treatment structures. There is still access to the floodplain along the valley floor, especially in the downstream portion of the reach.
- **Entrenchment:** Only entrenched upstream of the first set of grade control structures.
- **Riparian Vegetation:** Scrubland and meadow type vegetation.
- **Erosion:** Woody debris present on the banks and bank undercutting/ toe erosion has exposed the bottom clay layer in sections. Rills/ gullies have developed at two locations.
- **RGA:** Transitional/ stressed (abundant evidence of widening and degradation).
- **Bank Protection:** In-channel armourstone in sections, three grade control structure structures, armourstone and gabion baskets present along the banks.
- **Additional:** None.
- **Significant slope stability issues:** None.

7.3 Constraints and Opportunities

The following summarizes the constraints and opportunities identified for the proposed Wolfedale Creek rehabilitation. Opportunities and constraints are identified through a background review of previous reports as well as recent field work, updated analysis, and overall project goals. These constraints are identified at the outset of the design process to that they can be appropriately integrated into the final design. The constraints and opportunities will feed into the EA problem and opportunity statement and alternative solutions and will be further refined as the EA progress continues.

7.3.1 Constraints

- **Pre-Existing Infrastructure**

  Pre-existing infrastructure including storm sewer outfalls and channel hardening measures (armourstone, gabion baskets, etc.) must be considered within the proposed design. Opportunities to rehabilitate or replace structures along the watercourse will be reviewed to ensure the capacity of the creek is not unnecessarily reduced. We will review the requirement for energy dissipation at stormwater outfalls. Space requirements for dissipation will need to be considered for the channel design work as well as consideration for the elevation of the outfalls and the channel grade to not to create any backflow conditions.

- **Underground Infrastructure**

  Urbanized area with likelihood of underground infrastructure. Channel design profile will need to consider the depth of cover requirements for the infrastructure. Channel bed grade and length of restoration works could be impacted by unground infrastructure. The reconstruction limits include five watermain crossings, and seven sanitary wastewater crossings.

- **Limited Lateral Space**

  Land availability throughout the Study Area is limited by the extent of existing property and infrastructure. The channel design work must consider the close proximity of the public and private lands adjacent to the watercourse to ensure long-term stability. Care should be taken to avoid the loss of channel length during detailed design as this can affect the slope and thus the energy environment of the channel. If possible, channel length should be increased during channel design, but due to the corridor constraints this option is very limited. Further consideration into a design of a slightly meandering low flow channel (flows less than 1-year discharge) or within the Study Area downstream of Stavebank Road where the channel is more open will be considered.

  Hardening the banks to fix them in place may prevent further erosion along the banks. Since the banks are nearly vertical in some locations, options for bank protection would require either cutting the banks back to a stable 3:1 slope, or using vertical protection measures (i.e., armourstone revetments). Vertical protection measures must avoid decreasing the cross-section of the channel, as narrowing of the cross-section would increase velocity, likely resulting in increased erosion along the channel bed and banks.

- **Existing Bridges and Culverts**

  The proposed works do not include any adjustment to the existing crossing structures. The channel restoration measures must therefore take into account the need for continuity through the crossings.

- **Channel Gradient and Tie-in Points**

  The longitudinal profile identifies channel bed forms and local bed gradients and is an important geomorphological consideration, as the bed gradient is a primary control of tractive forces within a reach and therefore, is a major determinant of morphological form and function. The channel gradient is controlled by the upstream and downstream tie-in elevations. Consideration for tie-in locations must be considered to maintain channel stability.

  In Study Area 2 any alterations to the slope must consider the fixed elevation at the upstream end of the channel and the confluence elevation with the Credit River as confluences can be highly dynamic. The bed elevation of the Credit River confluence controls the overall grade of Wolfedale Creek.

- **Bio-engineering and Hard Engineering**

  Limited space to regrade channel banks. Consideration of both bio-engineering and hard engineering bank options to protect the channel banks will need to be considered and will also be dependent on channel hydraulics.

7.3.2 Opportunities

- **Fish Passage**

  Fish passage can be improved through the creation of a low flow channel to ensure fish passage during low flow conditions. Additionally, hydraulics can be evaluated to ensure flows are not creating an impediment to fish passage.

- **Improve Natural Channel Function**

  The watercourse is laterally confined, and sediment deposition is present along the channel bed creation of a low flow channel would allow for integration of small pooled areas throughout the channel. Creation of a low flow channel could also help reduce sedimentation.

- **Habitat Enhancement Opportunity**

  An opportunity exists to incorporate habitat features to provide resting areas for aquatic habitat as well as overhanging vegetation. The watercourse is laterally confined, and sediment deposition is present along the channel bed. Creation of a low flow channel could allow for integration of small, pooled areas throughout the channel. Creation of a low flow channel could also help reduce sedimentation.

- **Existing Terrestrial Vegetation**

  The existing terrestrial vegetation present along the banks provide habitat and bank stability, consideration to little or no impact on existing vegetation, or providing additional vegetation (where possible) will need to be considered as part of the channel restoration.

7.4 Design Objectives

The design objectives will be refined as the EA process continues.

8. Conclusions and Recommendations

Channel design including defining design flow, the planform, longitudinal profile, and cross-sections will be confirmed in subsequent design stages. Channel protection, substrate sizing, and any aquatic habitat design features will also be updated during the next phase of detailed design.

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Appendix A

Photographic Log

Reach Wfdl-Crk-1a

Photograph 1. ↑

Looking upstream (northwest). Upstream reach break.

Photograph 2. ↑

Looking at right bank (west). Upstream reach break. Gabion on right bank in fair condition. Contents displaced at the toe. Overland erosion behind outfall wing walls.

Photograph 3. ↑

Looking upstream (southeast) from cross section location (XS-34). Steep right bank displaying toe erosion.

Photograph 4. ↑

Looking downstream from cross section location (XS-34). Toe scour on right bank. Leaning trees and exposed roots. Fragments of bedrock present on the right bank.

Photograph 5. ↑

Looking downstream. Erosion at bank toes. Bedrock fragments on watercourse bed

Photograph 6. ↑

Looking downstream. Exposed tree roots, leaning trees undercut right bank, and exposed bedrock fragments at to of bank.

Photograph 7. ↑

Looking south at right bank. Outfall embedded in bank. Exposed bedrock fragments on the banks. Exposed tree roots.

Photograph 8. ↑

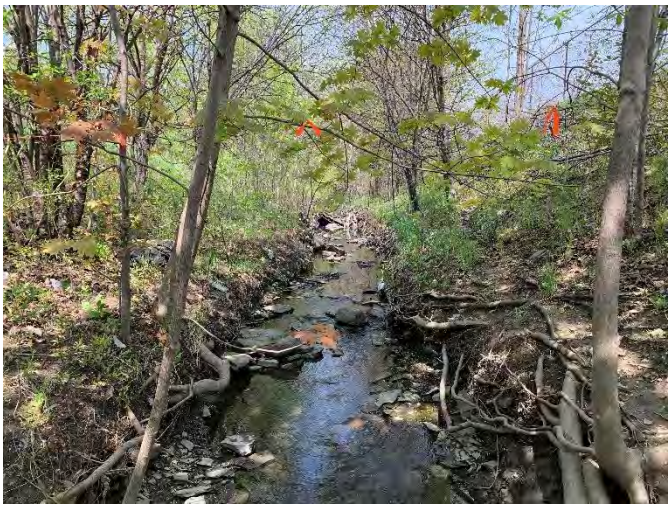
Looking upstream from cross section location (XS-33). Exposed tree roots and leaning trees.

Photograph 9. ↑

Looking downstream from cross section location (XS-33). Erosion present on both banks. Leaning trees and exposed roots.

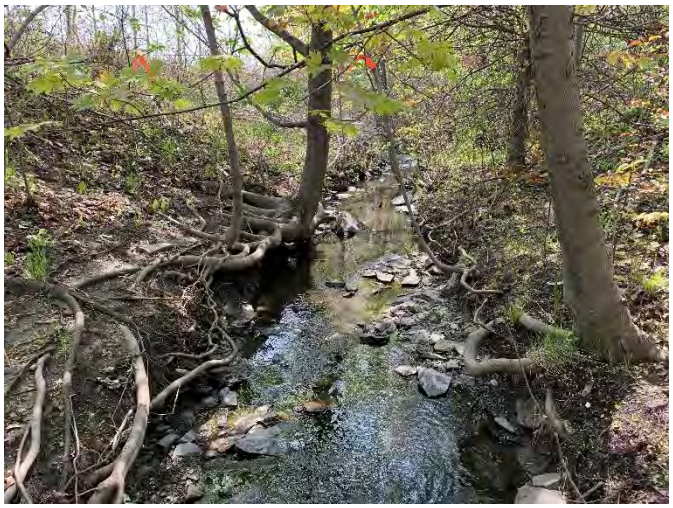
Photograph 10. ↑

Looking upstream at right bank from debris jam, downstream of cross section XS-33. Toe scour present on right and left banks. Exposed tree roots.



Photograph 11. ↑

Looking upstream from cross section location (XS-32). Scoured banks, exposed roots and leaning trees. Bedrock fragments visible on the banks and deposited on the channel bed. A debris jam is present further upstream.



Photograph 12. ↑

Looking downstream, from cross section location (XS-32). Scoured banks, exposed roots and leaning trees. Bedrock fragments visible on the banks and deposited on the channel bed.

Reach Wfdl-Crk-1b

Photograph 1. ↑

Looking upstream (west) from cross section (XS-35). Crossing under Wolfedale Rd. Gabion in good/fair condition on right (south) bank. Minimal displacement at toe of gabion.

Photograph 2. ↑

Looking downstream (east) from cross section (XS-35). Gabion in good/fair condition on right (south) bank. Lateral bar forming on left (north) bank. Minimal displacement at toe of gabion.

Photograph 3. ↑

Looking at left bank. Bank scour exposing fragments of bedrock downstream of lateral bar. Exposed roots and leaning trees.

Photograph 4. ↑

Looking downstream. Debris jam. Exposed tree roots. Exposed bedrock fragments on left (north) bank.

Photograph 5. ↑

Looking upstream (west) from cross section (XS-36). Downstream of debris jam. Exposed and undercut tree roots. Bedrock fragments exposed on right (south) bank.

Photograph 6. ↑

Looking at right (south) bank from cross section (XS-36). Undercut bank, exposed roots and exposed bedrock fragments.

Photograph 7. ↑

Looking downstream (east). Location of pinch point. Chain link fence hanging over the watercourse from bank to bank.

Photograph 8. ↑

Looking at right bank. Chain link fence and aggregates present on the bank.

Photograph 9. ↑

Looking downstream (east). Lateral bar downstream of pinch point.

Photograph 10. ↑

Looking downstream (east). Exposed tree roots. Bedrock fragments exposed on left (north) bank.

Photograph 11. ↑

Gully present on left (north) bank exposing bedrock fragments. Located upstream of the confluence with Wfdl-Crk-1a.

Photograph 12. ↑

Looking upstream from cross section (XS-39). Gully visible on left (north) bank.

Photograph 13. ↑

Looking downstream (east) from cross section (XS-39). Failed gabion on left (north) bank. Exposed tree roots woody debris within the channel. Confluence located just downstream of the cross section.

Photograph 14. ↑

Looking at failed gabion on left (north) bank.

Reach Wfdl-Crk-2

Photograph 1. ↑

Overland erosion behind concrete spillway right (south) bank. Upstream of discharge pool by the upstream reach break.

Photograph 2. ↑

Overland erosion on right bank between concrete channel and gabion by the spillway discharge point.

Photograph 3. ↑

Looking at right (south) bank across discharge pool. Collapsed gabion.

Photograph 4. ↑

Looking at left (north) bank. Collapsed gabion basket on left bank.

Photograph 5. ↑

Looking upstream (west). Erosion behind spill on the left bank. Collapse gabion basket.

Photograph 6. ↑

Looking at the left (north) bank. Erosion adjacent to displaced gabion basket. Exposed bedrock fragment on the bank.

Photograph 7. ↑

Looking upstream (west) at discharge spillway outlet from cross section (XS-6). Displaced gabion on right and left banks.

Photograph 8. ↑

Looking upstream (west) at discharge pool outlet from the left (north) bank. Displaced armour stone and boulders.

Photograph 9. ↑

Looking downstream (southeast) from downstream of spillway discharge pool. Bedrock fragments present on the channel bed and banks. Displaced boulders, exposed roots and leaning trees.

Photograph 10. ↑

Looking upstream (west). Bedrock fragments present on the channel bed and banks. Displaced boulders, exposed roots and leaning trees.

Photograph 11. ↑

Looking upstream (west) for left (east) bank. Lateral and medial bars forming at the confluence to the watercourse and the double span culvert.

Photograph 12. ↑

Looking at left (north) bank. Double span culvert off the left bank.

Photograph 13. ↑

Looking downstream (south) from left bank at cross section (XS-5).

Photograph 14. ↑

Looking downstream (south) from cross section (XS-5). Bedrock fragments present on the channel bed. Failed gabion basket on the left (east) bank downstream of the double span culvert.

Photograph 15. ↑

Looking at left (east) bank. Failed and undermined gabion basket downstream of the double span culvert.

Photograph 16. ↑

Looking at the left (east) bank, downstream of the failed gabion. Bank scour present exposing bedrock fragments and undermining a tree.

Photograph 17. ↑

Looking downstream (south) from downstream of gabion. Scour on left (east) bank.

Photograph 18. ↑

Looking upstream (north) from waterfall/weir feature.

Photograph 19. ↑

Looking east from waterfall/weir feature.

Photograph 20. ↑

Looking downstream (south) from right (west) bank of weir. Erosion/outflanking and woody debris accumulation behind armour stone.

Photograph 21. ↑

Looking upstream (north). Debris accumulation by weir downstream of double span culvert.

Photograph 22. ↑

Looking downstream from cross section (XS-4). Scoured banks further downstream.

Photograph 23. ↑

Looking upstream (north) from cross section (XS-2a), downstream of weir. Scour on both banks and accumulation of sediments off the left (east) bank.

Photograph 24. ↑

Looking downstream (south) from cross section location (XS-2a). Scours on both left and right banks. Deep pool.

Photograph 25. ↑

View from right (west) bank at most downstream weir. Armour stone is outflanked on the right bank with displaced boulders.

Photograph 26. ↑

Looking downstream from right bank.

Photograph 27. ↑

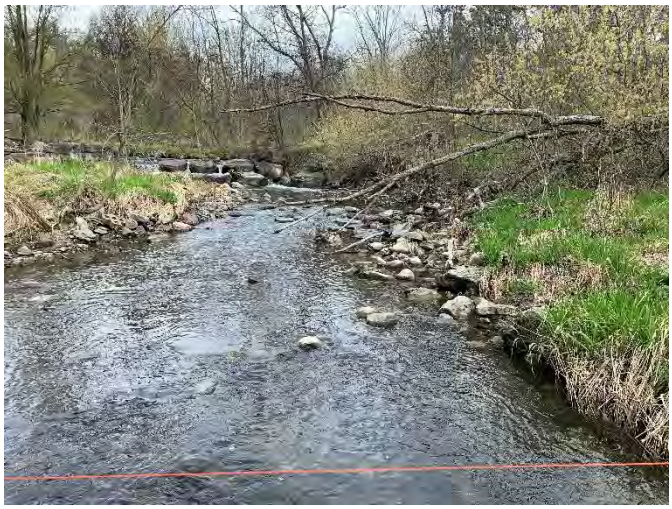
Looking downstream (south) from left (east). Outflanked and displaced. armour stone.

Photograph 28. ↑

Looking upstream (north) from right (west) bank. Displaced armour stones at weir feature. An erosional channel is forming on the right bank downstream of the area where the armour stones is being outflanked.

Photograph 29. ↑

Looking downstream (south) from right (west) bank. Bank scour present further downstream.



Photograph 30. ↑

Looking upstream from cross section location (XS-1). Displaced armour stone visible at the weir.

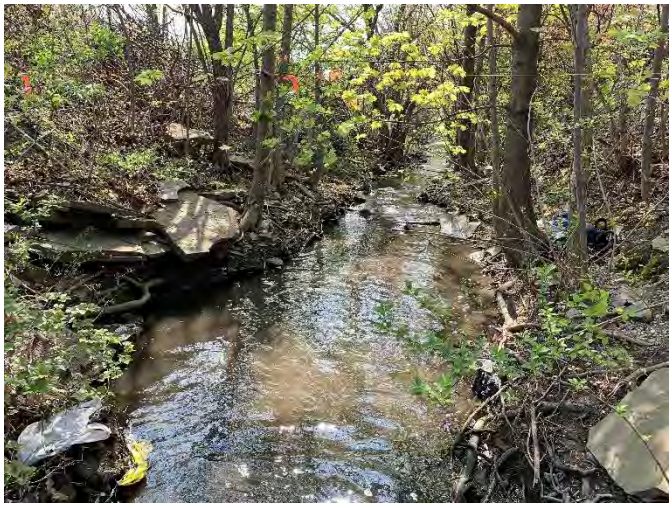
Photograph 31. ↑

Looking downstream (south) from cross section location (XS-1). Scour present on right (west) bank.

Reach Wfdl-Crk-1c

Photograph 1. ↑

Looking upstream at confluence point from cross section XS-31. Areas of active bank erosion (exposed bedrock fragments). Failed gabions on the left (east) bank and right (west) banks.



Photograph 2. ↑

Looking downstream. Active erosion on both banks. Exposed and undercut bedrock fragments. Outfall is present on the left bank downstream of this location.

Photograph 3. ↑

Looking at left bank. Outfall protected by gabions located downstream of cross section XS-31. Banks exposed upstream and downstream of the gabions.

Photograph 4. ↑

Looking upstream from cross section XS-30.

Photograph 5. ↑

Looking downstream from cross section XS-30. Exposed bedrock fragments on left (east) bank and scoured right (west) bank and exposed roots.

Photograph 6. ↑

Looking upstream. Debris jam. A large bed scour in present adjacent to the left bank, just downstream of the debris jam.

Photograph 7. ↑

Looking at the left bank from cross section XS-28. Riprap revetment. A pond is located beyond the slope and appears to discharge where the riprap is located

Photograph 8. ↑

Looking upstream, downstream of cross section XS-28. Bedrock fragments present on channel bed. Outfall located off the right bank.

Photograph 9. ↑

Looking at left bank. Concrete wall at the top of slope.

Photograph 10. ↑

Looking upstream from cross section XS-26. Gabion basket in poor condition located on right bank.

Photograph 11. ↑

Looking up downstream from cross section XS-26. An outfall is present on the right bank.

Photograph 12. ↑

Looking up upstream from cross section XS-25. Exposed roots and evidence of erosion on both banks. Collapsed concrete blocks present on at the toe of the right bank. Exposed bedrock fragments on the left fragment.

Photograph 13. ↑

Looking downstream from cross section XS-25. Crossing under Central Parkway. Heavily scoured left bank. Failed and displaced concrete protection at the toe of the right bank.

Photograph 14. ↑

Looking at left bank from cross section XS-25. Steep bank displaying erosion and exposed bedrock at the toe.

Photograph 15. ↑

Looking upstream from culvert inlet at Central Parkway W. Knickpoint at entrance of road crossing. Heavily eroded left bank. Displaced concrete fragment off the right bank.

Photograph 16. ↑

Culvert under Central Parkway West outlet. Sediment accumulation within and downstream of culvert.

Photograph 17. ↑

Looking upstream from cross section XS-24. Woody debris accumulation on both banks. Area of channel bed scour.

Photograph 18. ↑

Looking upstream, upstream of cross section XS-23. Knick point and bank erosion.

Photograph 19. ↑

Looking upstream, upstream of cross section XS-22. Exposed bedrock fragments on left bank.

Photograph 20. ↑

Looking downstream, downstream of cross section XS-22. Sediment aggradation upstream of a debris jam adjacent to a double span culvert present on the right bank.

Photograph 21. ↑

Looking upstream. Channel bed degradation downstream of debris jam. Erosion and exposed bedrock fragments on left bank.

Photograph 22. ↑

Looking at left bank from cross section XS-21. Collapsed outfall apron and undermined retaining wall. Scoured bank toe.

Photograph 23. ↑

Looking upstream at left bank, upstream of cross section XS-20. Scoured bank, exposed bedrock fragments.

Photograph 24. ↑

Looking downstream, downstream of cross section XS-20. Undermined and displaced concrete block on right bank.

Photograph 25. ↑

Looking downstream at CN rail crossing inlet point. Gabion baskets in poor condition on both sides of the culvert crossing. Sediment accumulation within the crossing.

Photograph 26. ↑

Looking upstream at CN rail crossing outlet point. Gabion baskets in poor condition on both sides of the culvert crossing.

Photograph 27. ↑

Looking at right bank, upstream of cross section XS-16. Exposed and undermined bedrock. Gabion at bottom outfall.

Photograph 28. ↑

Looking downstream, downstream of cross section XS-19. Inlet point of second rail crossing. Gabion baskets in poor condition.

Photograph 29. ↑

Looking upstream at crossing outlet, upstream of cross section XS-15. Gabion baskets in poor condition and sediment accumulation within the culvert.

Photograph 30. ↑

Looking downstream, downstream of crossing. Scoured banks.

Photograph 31. ↑

Looking at right bank, downstream of cross section XS-15. Exposed bedrock fragments and undermined chain link fence.

Photograph 32. ↑

Looking downstream, upstream of cross section XS-13. Gabion wall in fair/poor condition. Wall is leaning, experiencing undermining and has displaced contents in a section. Debris jam by the tree in the channel.

Photograph 33. ↑

Looking upstream from cross section XS-13. Undermined gabion, displaced contents, and exposed bed rock.

Photograph 34. ↑

Looking downstream, downstream of cross section XS-13. Downstream reach break. Scour marks on left bank.

Reach Wfdl-Crk-1d

Photograph 1. ↑

Looking downstream. Reach start point. Concrete and gabion treatment on right bank. Woody debris accumulation present on both banks.

Photograph 2. ↑

Looking downstream. Upper portion of reach. Bank treatment present on right (west) bank. Accumulation of woody debris on both banks.

Photograph 3. ↑

Looking at right bank. Area of bank and bed degradation/down cut, upstream of debris jam. Outfall present off right bank.

Photograph 4. ↑

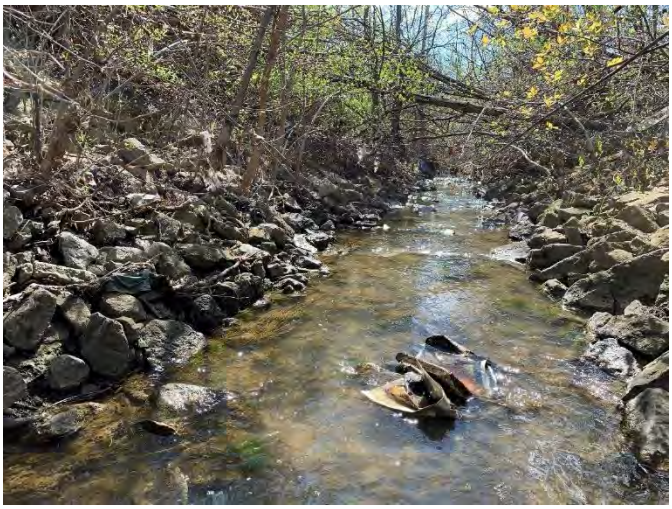
Looking upstream. Debris jam and area of bed degradation/down cut.

Photograph 5. ↑

Looking upstream from cross section XS-12. Riprap lining both banks. Some woody debris present on banks.

Photograph 6. ↑

Looking at left bank. Bank scour and exposed tree roots (adjacent to storage site)



Photograph 7. ↑

Looking downstream, upstream of cross section XS-11. Riprap present at toes of both banks. No signs of major erosion.

Photograph 8. ↑

Looking upstream from cross section XS-11. Riprap partially embedded in the left bank, exposed tree roots.

Photograph 9. ↑

Looking downstream. Riprap present on both banks.

Photograph 10. ↑

Looking upstream from cross section XS-10. Riprap present on both banks and within the flow.

Photograph 11. ↑

Looking downstream from cross section XS-10. Downstream portion of reach.

Reach Wfdl-Crk-1e

Photograph 1. ↑

Looking downstream. Reach starts at an artificial waterfall/cascade.

Photograph 2. ↑

Looking upstream. Some of the boulders appear to have been displaced. A location of bed scour is present adjacent to the left bank.

Photograph 3. ↑

Looking downstream. Bed scour present adjacent to left bank.

Photograph 4. ↑

Looking downstream. Gabion basket wall. Gabion appear to be in good/fair condition. Small accumulation of sediments by the left bank. Some vegetation is observed growing within the gabions.

Photograph 5. ↑

Looking downstream. Multiple drops along the watercourse path. Corroded wire and exposed riprap on right bank. Some contents displaced

Photograph 6. ↑

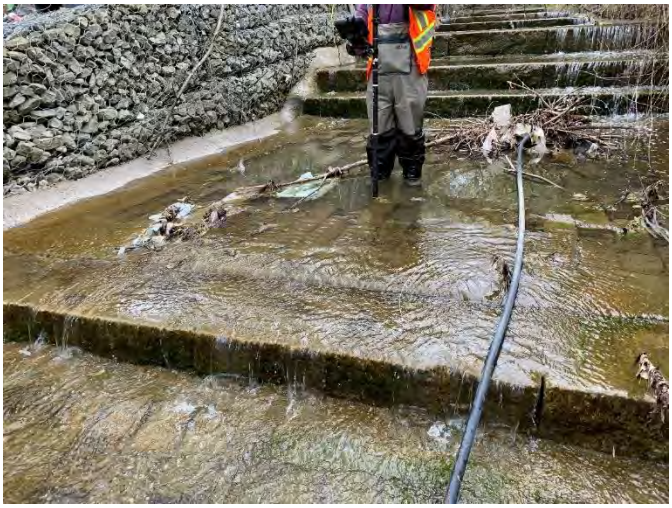
Looking at right bank. Displaced gabion contents at toe.

Photograph 7. ↑

Looking upstream. Gabion deformed at toe. Contents in place

Photograph 8. ↑

Looking downstream. Sediment accumulation of right bank.



Photograph 9. ↑

Looking upstream. Area of bed scour. Displaced concrete pavers/blocks

Photograph 10. ↑

Looking upstream. Pinch point location. A scour was observed behind the left (east) bank treatment (concrete block wall and gabion) on the overbank zone

Photograph 11. ↑

Looking downstream. Lower section of reach. Woody debris accumulating on the channel bed.

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Appendix B

Hydraulic Assessment Report

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Wolfedale Creek Erosion Control

Hydraulic Assessment Report

City of Mississauga

60701082

December 2024

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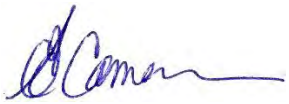

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1. Introduction

1.1 Project Description

AECOM was retained by the City of Mississauga (the City) to undertake a Schedule 'B' Municipal Class Environmental Assessment (Class EA) study and detailed design for the Wolfedale Creek Erosion Control Project. The study area is along two sections of Wolfedale Creek. The north section extends from Burnhamthorpe Road West to Dundas Street West, and the south section is from Sir Richards Road to the Credit River outlet. Between Dundas Street West and Sir Richards Road the creek is piped through the development and not part of the scope of work. The study area falls entirely within the jurisdiction of the Credit Valley Conservation (CVC). The study area is shown in **Figure 1-1**.

The purpose of this project is to identify aspects of the existing conditions study area where there is an opportunity to mitigate existing erosion problems and provide long-term stability to the channel corridor, while also considering constraints and challenges. While alternative improvements are considered, the hydraulic conditions of the creek will be analyzed to ensure there are no negative impacts on both the natural and social environment.

1.2 Project Goals and Objectives

- To reduce and control the erosion process through stabilization of the creek bed and banks;
- To implement the City of Mississauga's mandate concerning the protection of private and public property from erosion hazards;
- To contribute significant positive impacts to Wolfedale Creek in terms of enhancing the natural environment and aesthetics of the area;
- To maintain and/or restore the creek system in a manner which is both environmentally and hydraulically acceptable;
- To reduce the flood risk potential created by blocked culverts, loss of property and infrastructure loss; and
- Minimize capital and maintenance costs.

1.3 Background Review

Wolfedale Creek is fed by storm sewer outlets south of Burnhamthorpe Road West and transitions into an open engineered channel which flows south until Dundas Street West where it is conveyed into a storm sewer. Wolfedale Creek reappears south of Stavebank Road at Sir Richards Road and outlets into the Credit River. At 3557 and 3599 Wolfedale Road, a reach joins the main branch near the upstream end of the creek.

Most of the channel was constructed 40 to 50 years ago with some sections rehabilitated as needed. The channelized creek has gabion baskets stacked as banks in some sections. There are also five drop structures or weirs constructed of concrete or armourstone along the channel.

The City has flagged Wolfedale Creek as a high priority site in need of rehabilitation, with issues such as failed gabion baskets, storm outfalls and creek bed with accumulated sediment, and entrenched channel with bank instability and erosion.

Gandhi Way
Summer Park Cres
Pilcom Cres
Pilcom Crt
Wildgrass Rd
Hillcrest Ave
Dundas St W
Mavis Rd
WDL-CRK-1a
WDL-CRK-1b
WDL-CRK-1c
WDL-CRK-1d
WFDL-CRK-1e
Central Pky W
Wolfedale Rd
Eaglemount Cres
Westlock Rd
Strabane Dr
Consort Cres
Forestwood Dr
Blairholm Ave
Stainton Dr
Hawkestone Rd

Basemaps provided by: City of Toronto, ON, Town of Oakville, Maxar, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

General Features

- Property Line
- Ontario Railway Network (ORWN) Track
- Minor Roads

Wolfedale Creek

Study Area

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

Data Sources:
Contains Information licensed under the Open Government License Ontario.

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Rev:00
1:4,900

AECOM

Figure: 1-1

Legend

Study Area

Reach ID

- WDL-CRK-1a
- WDL-CRK-1b
- WDL-CRK-1c
- WDL-CRK-1d
- WDL-CRK-2
- WFDL-CRK-1e

General Features

- Property Line
- Minor Roads
- Watercourse

Wolfedale Creek

Study Area

0 50 100 M

NAD 1983 UTM Zone 17N

Data Sources:
Contains Information licensed under the Open Government License Ontario.

Jun, 2023

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Rev:00

1:2,000

AECOM

Figure: 1-1

The following reports should also be reviewed to understand the full scope and analysis of the study area;

- Wolfedale Creek Erosion Control and Rehabilitation – From Burnhamthorpe Road West to the Credit River, Fluvial Assessment and Detailed Design (AECOM, 2023)
- Wolfedale Creek Erosion Control Study - Natural Environment Report (AECOM, 2023)

After its ongoing monitoring program, the City has decided to proceed with rehabilitation of Wolfedale Creek to design and construct stabilization works within the study area. This report will assess the hydraulic components of the creek, which will be considered as the proposed design is determined.

1.4 Regulatory Agency Consultation

The CVC has been and will continue to be consulted throughout this study to address their concerns and requirements for the area. Two representatives from the CVC were present at the site visit on February 23, 2023, as was a representative from the City. CVC has since provided information such as the hydraulic model and floodline mapping.

2. Design Criteria

2.1 Design Criteria

The existing analyses and proposed design will reference the following documents for different design criteria:

- **City of Mississauga - Transportation and Works Department, Development Requirements Manual (January 2020)**
  - Channels, Culverts, and Overland flow
  - Culverts and Bridges
  - Watercourse Erosion and Bank Stability
  - Erosion and Sediment Control
- **Ministry of Transportation, Drainage Management Manual (1997) and Highway Drainage Design Standards (2008)**
  - Hydraulic modelling
- **Ministry of Natural Resources (MNR), Technical Guide – River and Stream Systems for Flood Hazard Limit (2002)**

The Credit Valley Conservation, Stormwater Management Criteria (August 2012) does not seem to apply to this project, as it describes different criteria that should be applied to developments. As this project does not involve the development of a site, or addition of impervious area, the criteria do not apply. The CVC will want to ensure that the proposed design does not have any negative impacts that may increase existing erosion and flooding issues.

3. Methodology and Approach

3.1 Hydrology

As the project does not involve any development or changes to the existing hydrology, the flows in the HEC-RAS model received from the CVC will not be changed as part of this project. The model contains flows for existing and future conditions, most of which are the same, and so the future flows will be used for the existing conditions analysis and proposed design alternatives (for comparison purposes). It will be assumed that the future flows in the HEC-RAS model accurately and conservatively represent flows entering the study area for the different storm events.

Where storm sewer outfalls discharge to the study area, estimations will be made regarding peak flow based on location and outfall diameter. Erosion control measures may be required and flows and velocities will be a factor in the proposed design. As specific flow information was not received from the City, AECOM will make some conservative estimates as to these flows and velocities but will not complete a full hydrology analysis.

3.2 Hydraulics

The existing hydraulics of the study area will be analyzed using the hydraulic modelling software HEC-RAS. The original model received from CVC will be updated based on the latest survey data to ensure the model is current and accurate. Once the existing model is updated, the hydraulic results with flood water levels and flow velocities will determine locations where there may be flooding or erosion concerns. These locations will be identified and verified with site photos and field records. Mitigation measures will be considered when proposed design alternatives are developed and evaluated.

4. Existing Conditions Drainage

4.1 Study Area Conditions

Land use along the study area is industrial, with residential, commercial, and industrial beyond the block bounded by Wolfedale Road, Mavis Road, Dundas Street West and Burnhamthorpe Road West. The very impervious nature of the upstream development results in high water levels and fast peak times, which likely contributes to erosion along the creek. The south portion of the site near the Credit River is mainly forested.

Within the creek easement there are trees and other different types of vegetation. The ground cover varies from grass with a natural channel to a completely impervious engineered cross-section.

The general topography of the site slopes to the south where the Credit River discharges into Lake Ontario. Within the study area block, the adjacent properties slope slightly towards the creek that flows down the centre from north to south. The slope of creek channel itself has an average slope of 1.4% along the north section of the study area (approximately 2,030 m), whereas the south portion, the channel slope is slightly steeper at 2.8%.

According to the Ontario Soils Maps for Peel Region, the soils in the area are mainly Fox sand with ‘good’ natural drainage.

4.2 Site Visit

A site visit was completed on February 23, 2023, including representatives from AECOM, the City and CVC. As access to the creek is limited, six selected sites were chosen to observe existing conditions, erosion concerns and any other issues that may impact the channel stabilization design.

The main take-away from the site visit were as follows:

- The study area is very confined in several locations, where abutting properties have parking lots, stockpiles and other debris right up to the property line, and in some cases beyond. The limited space will cause some difficulty with access for construction and constraints to develop design improvement options.
- There was a lot of garbage along the creek, possibly discarded by the abutting businesses. A clean up of all the unnecessary debris will be required.
- There were a few locations where the structural integrity of creek retaining walls was questionable. Gabion baskets and other engineered bank solutions are failing in several locations.
- The massive concrete channel along the south section of the study area looks to be in good condition and has a large conveyance capacity. No major upgrades are expected along this section.

Photos from the site visit with description of erosion problems observed in the field can be found in **Appendix A.**

4.3 Survey

Two surveys were completed within the study area, one by AECOM and one by JD Barnes. AECOM’s survey was completed by cutting cross-sections at regular intervals along the channel to obtain accurate ground elevations. Creek bed elevations were also captured along the watercourse alignment as well as at any areas of concern. Several photos were taken by AECOM staff and added to a .kmz file to show photo locations.

The JD Barnes survey captures alignments such as C/L of creek, waters edge, and top of slope. It also notes locations, diameters and inverts of storm outfall, locations of fences, retaining walls and other features along the study area. Spot elevations are captured along the many alignments within the study area. These elevations are considered more accurate than AECOM's elevations and should be referenced first where the two surveys overlap.

4.4 Utilities

T2 Utility Engineers completed a utility records review and field investigation near Central Parkway West, to locate information on utilities near the study area that may impact the project. A report and drawings were submitted to AECOM on July 7, 2023. These drawings and information will be referenced in our existing analysis and proposed design.

The utilities on the drawings include water, gas, sanitary and storm sewers, fibre optic cables, street lighting and more. The location of these utilities is focused on the roads crossing and abutting the creek. There are no utilities along the creek itself except for some Bell lines at the north end of the site.

4.5 Fluvial Geomorphology

As erosion concerns are the focus of this project, the "Fluvial Geomorphological Assessment and Detailed Design" prepared by AECOM should be referenced for additional information about the creek and study area. It details the existing environmental conditions and describes constraints and opportunities for the design work from a fluvial geomorphology perspective.

5. Existing Hydraulics

The study area is very confined with often steep and occasionally vertical side slopes and so in large storm events water levels along the creek are quick to increase. In locations where the creek is confined to a concrete lined channel with vertical side walls, flow velocities will become quite high in large storms due to the smooth surfaces. High velocities may create erosion concerns. The following sections describe the completed hydraulic modelling and results for existing conditions.

5.1 Hydraulic Modelling

A HEC-RAS model of the study area was received from CVC from February 2023, modelled in version 5.0.7. The cross-sections were updated to reflect the latest survey data completed by AECOM and JD Barnes as well as site photos. The updates include station and elevation data, bank locations, and manning's roughness values to reflect the existing hydraulic conditions of the creek most accurately. Ineffective flow areas and levees were also reviewed and adjusted.

From the original CVC HEC-RAS model, cross-section station and elevation values were compared against the JD Barnes and AECOM survey data. In most cases the JD Barnes data was selected to adjust the cross-section values, however, in some cases the site photos showed that either the AECOM survey data or the original data was most reflective of the cross-section or a portion of it.

The manning's n value of the cross-sections was also reviewed. It is important that roughness values were selected accurately, since the surface material or ground cover may change under proposed conditions, in which case the roughness values would be updated in the model. A realistic comparison between existing and proposed is required to establish impacts of the proposed design. MTO Design Chart 2.01, found in **Appendix B**, was referenced in selecting appropriate manning's roughness coefficients. As a result, some manning's n values were updated from the original CVC HEC-RAS model.

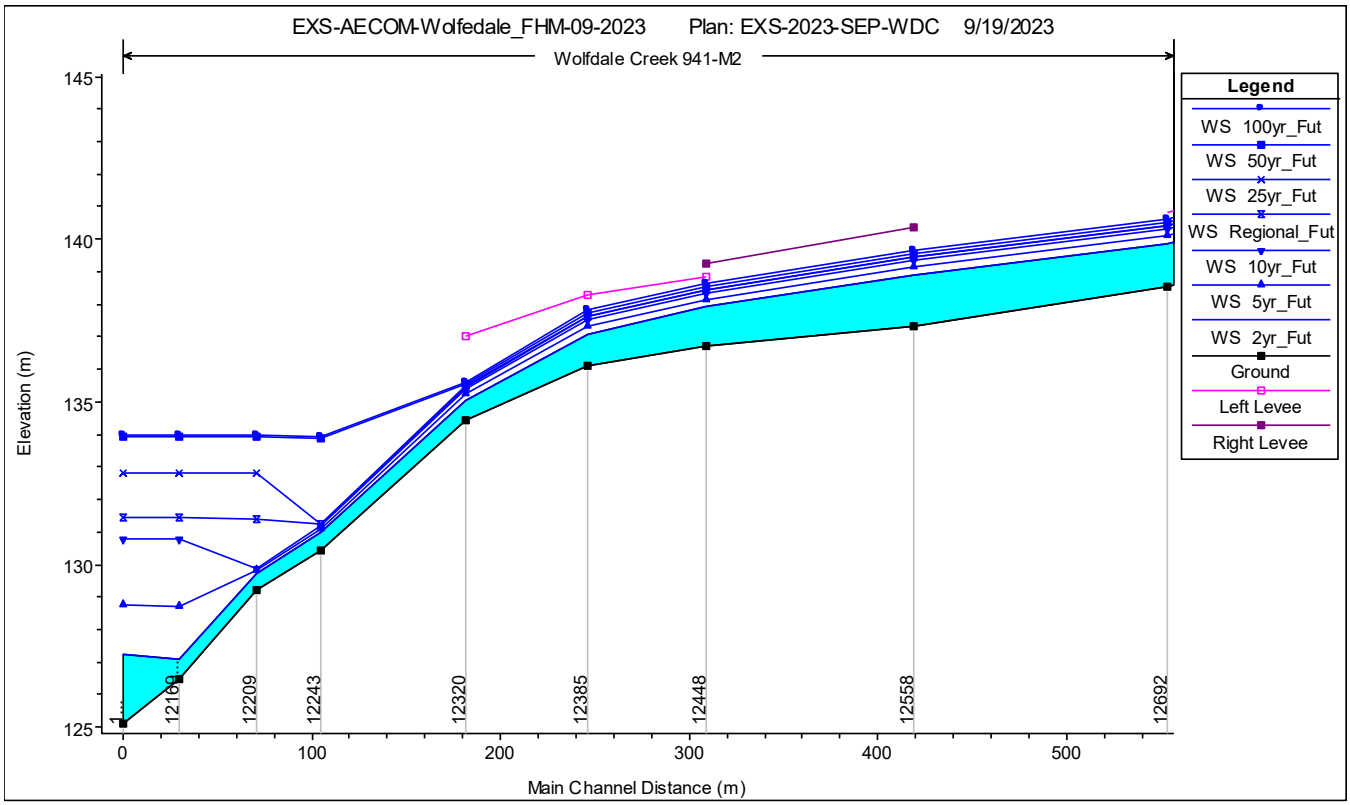
Three cross-sections were also added to better simulate three drop structures along the south portion of the study area. The cascade drop at the downstream end of the north section, shown in **Figure 2**, was analyzed to see if additional cross-sections would improve the simulation, however, the hydraulics are governed by the rating curve that serves as the downstream boundary condition for the reach as shown in the reach profile in **Figure 3**, especially for the larger storm events. The rating curve, representing the stage-flow relationship at the downstream culvert / storm inlet was not checked, as additional information would be required to do so. The cascade drop was therefore left as is. All changes to the hydraulic model are summarized in **Appendix B**.

It should be noted that the model was run using a mixed flow regime, which will give sub-critical and/or super-critical flows as determined by the model. Sometimes a sub-critical flow regime is run forcing slower velocities to give conservative water surface elevations, however, for this project there are sections where the flows will legitimately be super-critical, and velocities will be high. If the sub-critical regime is forced, velocities will be underestimated, and water levels will be overestimated. The existing conditions HEC-RAS model was run using version 6.3.1.

Figure 2: Photo of Cascade Drop

Reach 941-M2, XS 12209 - 12169 (just north of Dundas Street West)

Figure 3: Hydraulic Gradeline Profiles at Downstream End of North Reach



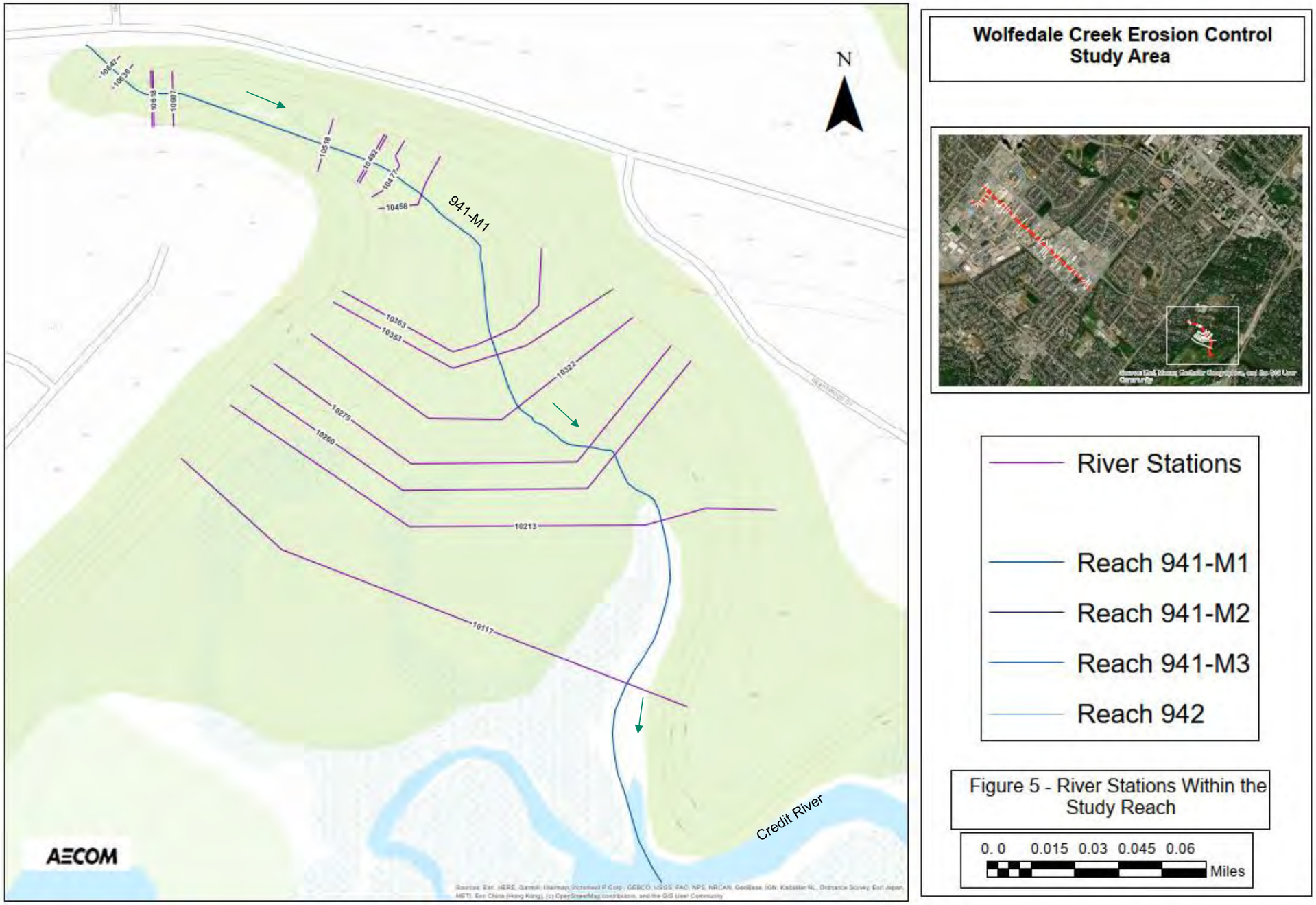
5.2 Hydraulic Results

The existing condition hydraulic modelling results are presented and discussed for both original model (received from CVC) and updated version modified by AECOM. **Figure 4** and **Figure 5** illustrate cross-section locations within study area reaches where results were estimated. Hydraulic modelling output can be found in **Appendix C** and is further discussed in the following sections.

A summary of the changes made to the hydraulic model can be found in **Appendix B**. Profiles for all the creek reaches can be found in **Appendix C**.

Figure 4: River Stations within the Study Reach

Figure 5: River Stations within the Study Reach

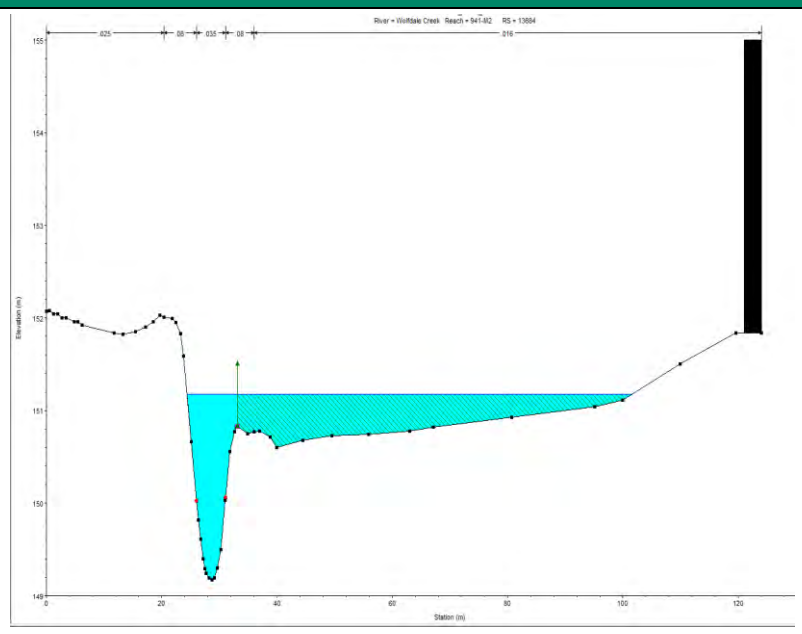
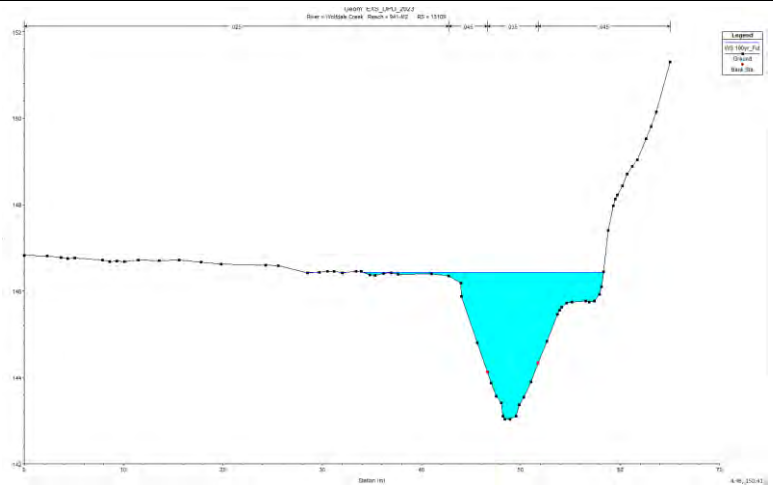
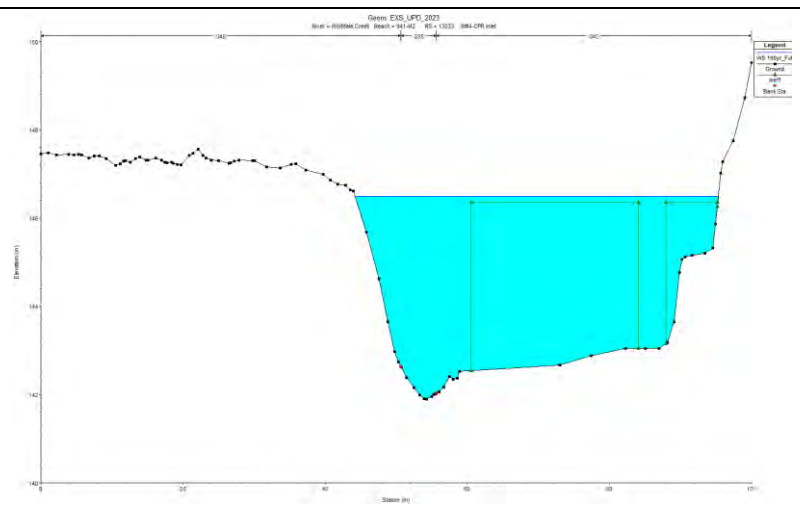
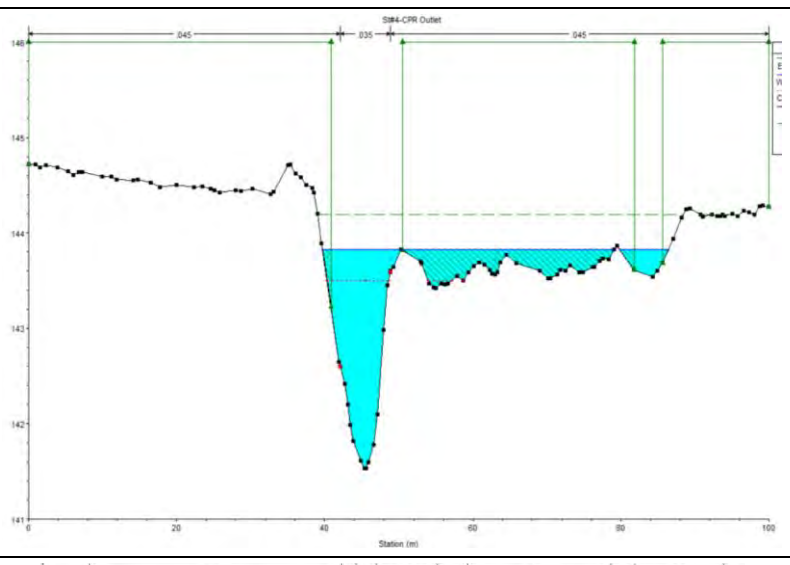
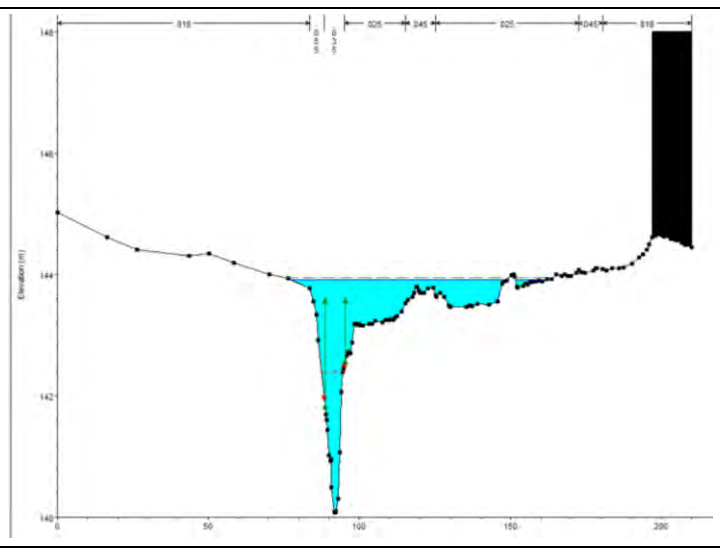


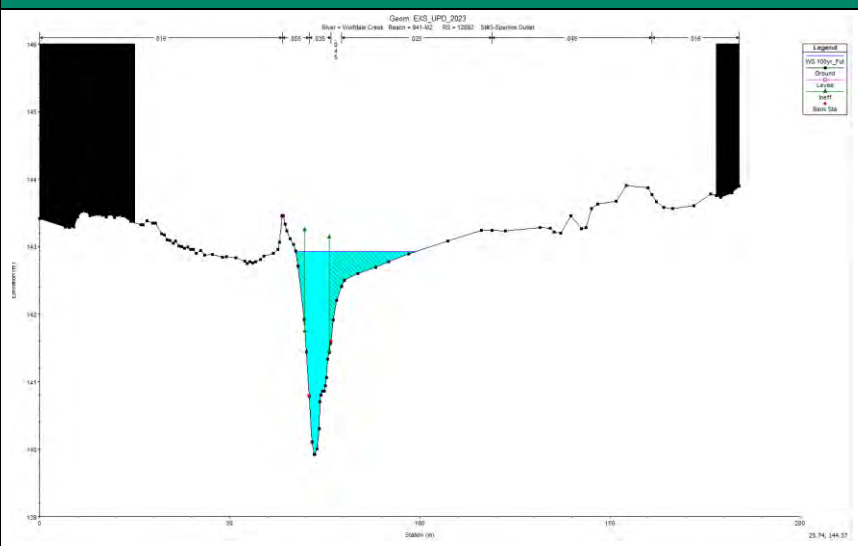
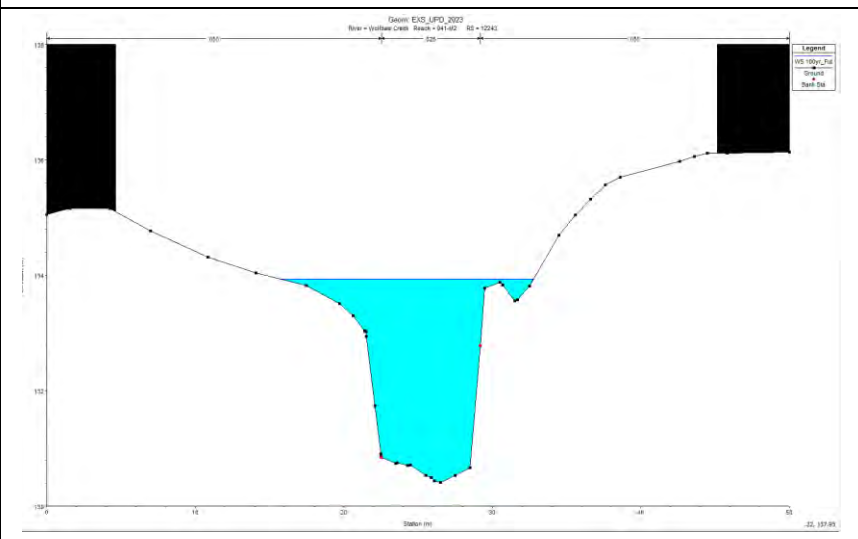
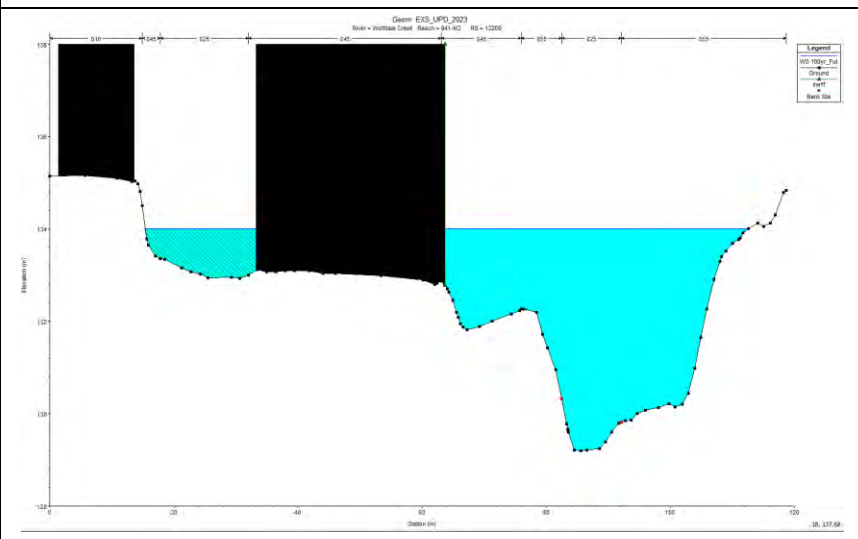
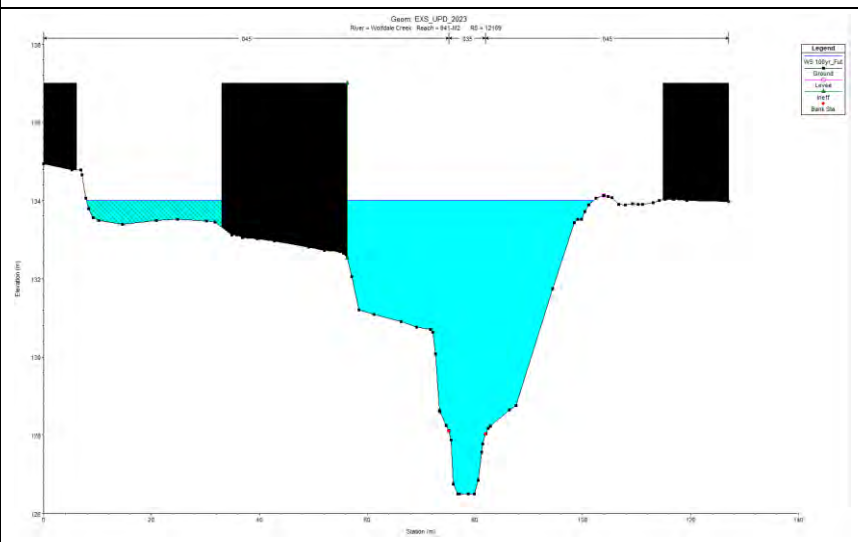
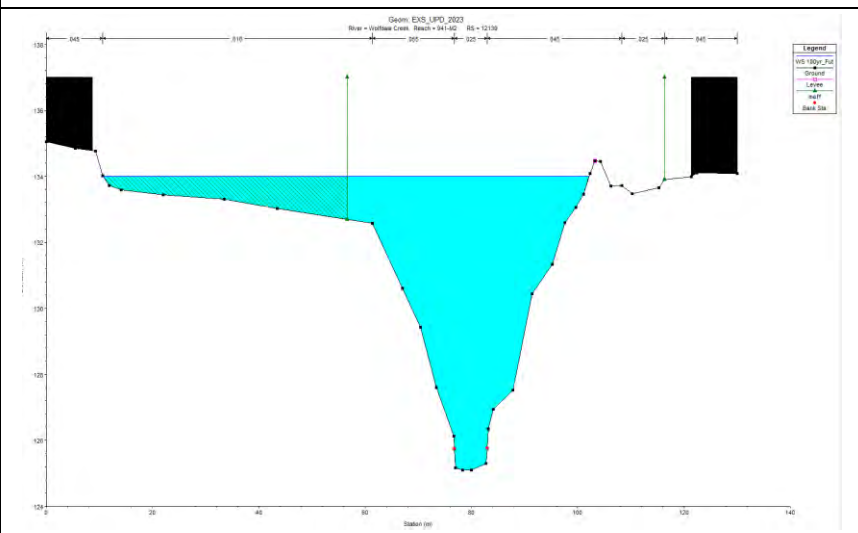
5.2.1 Existing Condition Original Model vs. Updated Model

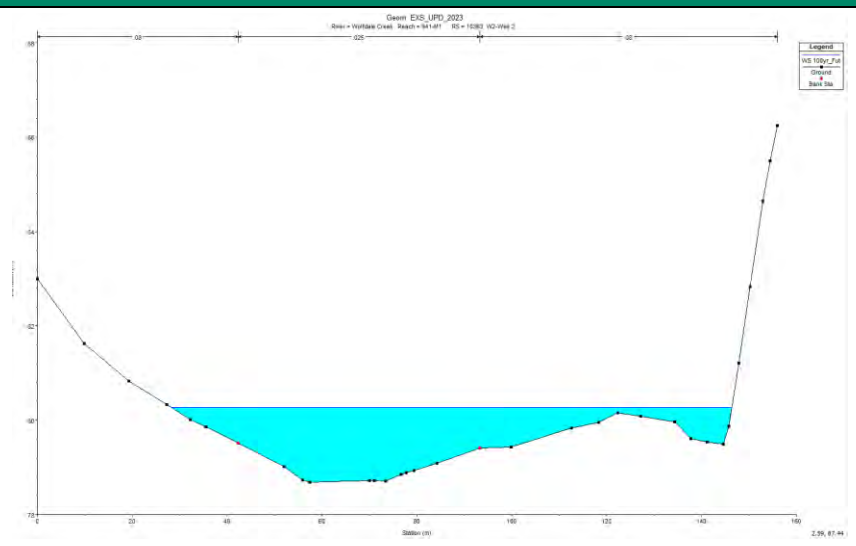
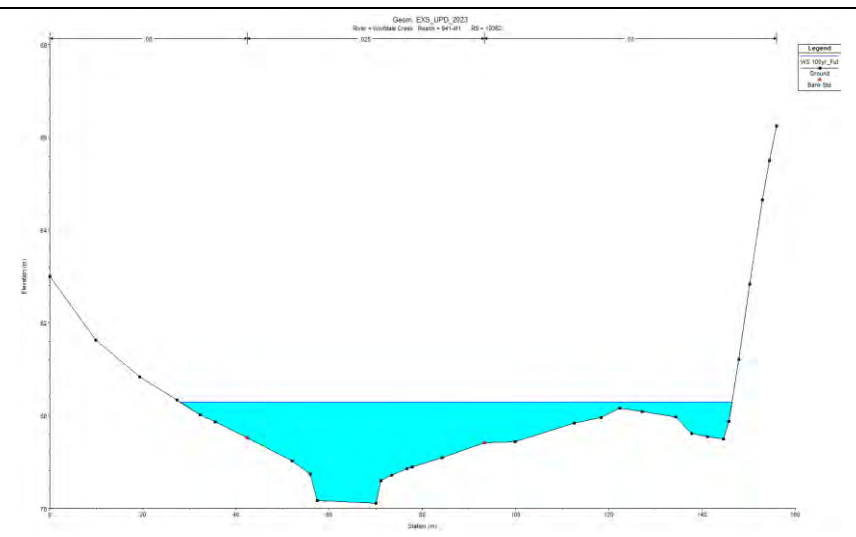
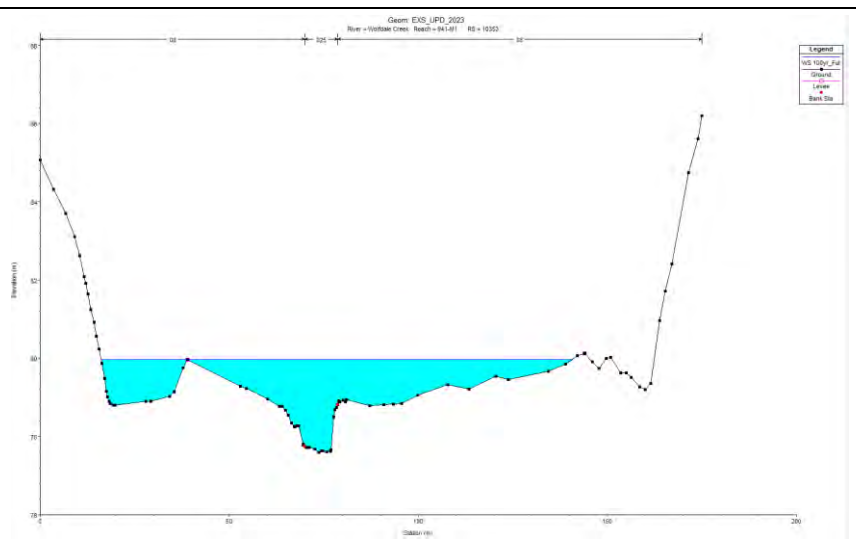
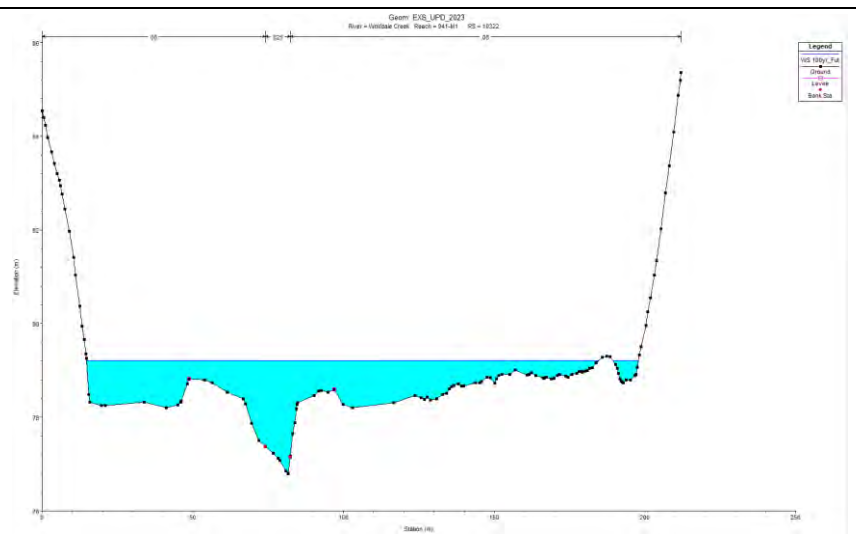
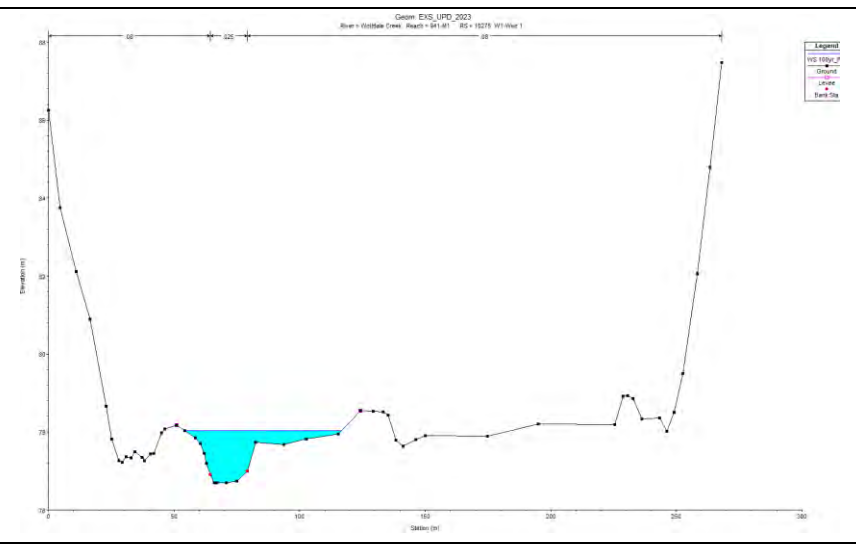
Original hydraulic model results show a number of flooded cross-sections and several sections with high velocities during different design storms. The updated model results are similar to the original with only slightly different water levels and velocities along most cross-sections throughout. The main cause for the different results are the alternations to the cross-section resulting in a larger of smaller flow area for the different storms. Adjustments to the manning's roughness would also change cross-section hydraulics. A comparison of the original and updated existing conditions model results are shown in **Tables 1** and **2** where flooding occurs. Where flooding beyond the creek banks occurs, water levels are shown in **bold**. Where flooding occurs in a new cross-section, the original model water level would not exist and so 'N/A' in shown.

In some cases, velocities are higher for smaller storm events where the channel is narrower, which are not summarized in the tables. Flooding and velocity results for the 100-year storm are compared in the tables below, however, full model output for all storms can be found in **Appendix C**.

Table 1: Flooded Cross-Sections Hydraulic Model Comparison: 100-Year Storm

Reach	Cross-section	Updated Cross-section	Water Surface Elevation-m	
			Original Model	Updated Ex. Model
941-M2	13684		**151.20**	**151.17**
941-M2	13109		145.72	**146.43**
941-M2	13033		**145.90**	**146.50**
941-M2	13002		**143.86**	**143.83**
941-M2	12921		**143.90**	**143.91**

Reach	Cross-section	Updated Cross-section	Water Surface Elevation-m	
			Original Model	Updated Ex. Model
941-M2	12892		**142.78**	**142.92**
941-M2	12243		**133.94**	**133.93**
941-M2	12209		**134.00**	**134.00**
941-M2	12169		**134.00**	**134.01**
941-M2	12139		**134.00**	**134.00**

Reach	Cross-section	Updated Cross-section	Water Surface Elevation-m	
			Original Model	Updated Ex. Model
941-M1	10363		**79.61**	**80.27**
941-M1	10362		N/A	**80.29**
941-M1	10353		**79.31**	**79.97**
941-M1	10322		**78.69**	**79.21**
941-M1	10275		**77.92**	**78.03**

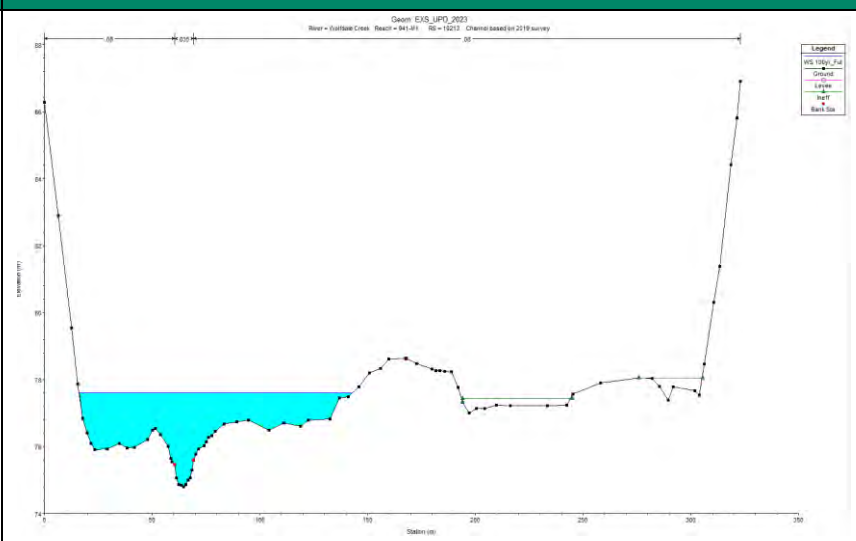
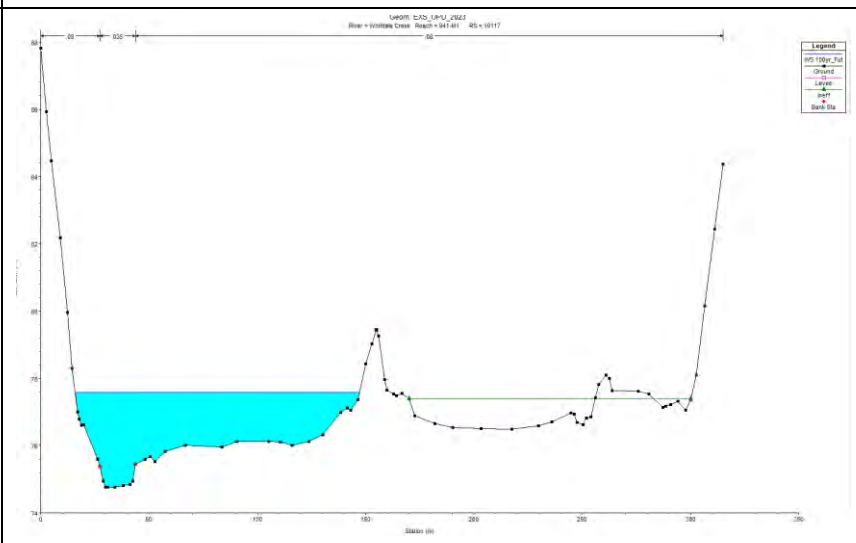
Reach	Cross-section	Updated Cross-section	Water Surface Elevation-m	
			Original Model	Updated Ex. Model
941-M1	10213		**77.60**	**77.60**
941-M1	10117		**77.58**	**77.58**

Table 2 below shows cross-sections with very high velocity (higher than 6 m/s) during a 100-year storm. For new cross-sections, which do not exist in the original model, 'N/A' is shown.

Table 2: Velocities More than 6 m/s Throughout the Study Reach

Cross-Section Name	Reach	Velocity (m/s)	
		Original	Updated Ex.
10638	941-M1	19.58	19.58
10647	941-M1	17.83	17.83
10618	941-M1	17.36	17.31
10619 W5-Weir 5	941-M1	16.63	16.63
10607	941-M1	16.09	16.02
10518	941-M1	10.44	11.85
10476	941-M1	N/A	10.32
10491	941-M1	10.35	10.05
10492 W4-Weir 4	941-M1	8.83	9.91
10458	941-M1	8.69	9.31
10477 W3-Weir 3	941-M1	9.30	9.13
10260	941-M1	6.93	6.49
10322	941-M1	6.87	3.51
10353	941-M1	6.27	3.66
10275 W1-Weir 1	941-M1	6.21	5.34
12320	941-M2	5.80	6.01

5.2.2 Results Comparison

Results between the two model versions are similar, but with specific updates completed to better simulate crossings and drops/weirs, the updated model results are more accurate for the current state of the creek.

The total number of flooded cross-sections (where flow spills beyond natural banks) in the updated model has increase by two as compared to the original model, where one cross-section (XS 13109) has a higher water level which now spill the banks, and one cross-section (XS 10362) was added to better simulate a drop structure/weir.

The total number of cross-sections with velocity more than 6 m/s in updated model has reduced by one as compared to the original model.

Results for all other design storms are provided in **Appendix C**.

All but one of the cross-sections exceeding 6 m/s are in the southern portion of the study area, where the entire channel consists of a massive concrete structure, designed to contain and convey high-velocity flows. This section does not present any erosion or flooding concerns. The one cross-section in the north portion of the study area is near the south end just north of Dundas Street West, where the side walls are vertical, and the channel bed is smooth. During smaller storms velocities are high here as well, and so this will be considered during the evaluation and selection of proposed alternatives.

6. Proposed Project Works

Alternative solutions selected will be evaluated based on the agreed-to criteria as described below. Currently preliminary alternative solutions or strategies include:

- Do Nothing will be used as a base case comparison to other more viable alternatives or strategies.
- Full replacement of failed bank protection with structural bank protection options to maintain long term erosion protection, such as RSS walls, cast-in-place re-enforced concrete walls, or steel sheet pile. Structural grade control could include concrete weir structures. Incorporation of a natural channel bed will be included to improve fish habitat and passage.
- Full replacement of failed bank protection with non-structural bank protection options to maintain long term erosion protection, such as rock, armourstone walls, green gabion, or geogrid retaining walls. Non-structural grade control could include rock weir structures. Incorporation of a natural channel bed will be included to improve fish habitat and passage.
- A combination of both structural and non-structural bank protection and grade control structures to maintain long term erosion protection. Incorporation of a natural channel bed will be included to improve fish habitat and passage.
- Enclose the watercourse in storm sewer and landscape a trail over top.

7. Future Design Considerations

The following outlines potential opportunities, constraints, and other considerations that should be assessed during future works once the selection of the preferred solution becomes available:

- The cross-sections of the proposed design should be reflected in the proposed conditions hydraulic model to determine that where narrower banks may be proposed or where cross-sections have a reduced flow area, water levels are not increased.
- Proposed land use and materials should be considered and simulated in the hydraulic model by updating the manning's roughness coefficient.
- Where the proposed design involves local improvements along a small section of the creek, cross-sections may be added to the hydraulic model to simulate the local change, rather than apply it to a longer reach than necessary.
- Proposed water levels and channel velocities should be analyzed and compared to existing conditions to ensure flooding and erosion concerns are not worse along any section of the study area.
- Proposed velocities should also be considered when choosing design solutions to ensure it meets sheer stress criteria.
- Clean out of existing storm sewer outfalls and the clean up of the creek itself should be considered as part of the EA process.
- Runoff velocities should be estimated at storm sewer outfalls into the creek to enable proper sizing of erosion protection at outfalls.

AECOM

Appendix A

Site Photos

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfedale Creek Erosion Control Study –Hydraulics Assessment	6070182

Photo No.	Date
1	2/23/2023

Direction Photo Taken

East

Description

North of Dundas St. W at cascading drop. Channel bed is lined with blocks. Vertical walls line the creek with a mixture of block and gabion baskets. Gabion baskets look to be failing in some locations.

Photo No.	Date
2	2/23/2023

Direction Photo Taken

South

Description

North side of Central Pkwy W, Bridge seems to be in good condition. Turbid water at inlet.

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfedale Creek Erosion Control Study –Hydraulics Assessment	6070182

Photo No.	Date
3	2/23/2023

Direction Photo Taken

South

Description

South of Burnhamthorpe Rd. North end of study area. Small natural cross-section channel fed by storm sewers. Garbage and debris can be seen along the creek.

Photo No.	Date
4	2/23/2023

Direction Photo Taken

East

Description

East of Wolfedale Rd. West branch of creek at north end of the site. Creek fed by storm sewers. Erosion visible along the banks.

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfedale Creek Erosion Control Study –Hydraulics Assessment	6070182

Photo No.	Date
5	2/23/2023

Direction Photo Taken

East

Description

East of Wolfedale Rd. West branch of creek at north end of the site. Creek fed by storm sewers. Creek banks are very steep or vertical with gabion walls. Adjacent properties abut creek. One tree along bank has been undermined by erosion.

Photo No.	Date
6	2/23/2023

Direction Photo Taken

East

Description

North of Central Pkwy on east side of Creek. Adjacent property has stockpiles abutting the creek. There appears to be debris along the creek banks as well as downed trees.

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfedale Creek Erosion Control Study –Hydraulics Assessment	6070182

Photo No.	Date
7	2/23/2023

Direction Photo Taken

Northwest

Description

South of Stavebank Rd at south portion of the site. Creek reappears from underground section via two circular culverts along steep concrete channel.

Photo No.	Date
8	2023

Direction Photo Taken

Northwest

Description

One of the many drops with a weir along the south portion of the channel. Note the misshapen gabion baskets along the banks and the downed trees.

AECOM

Appendix B

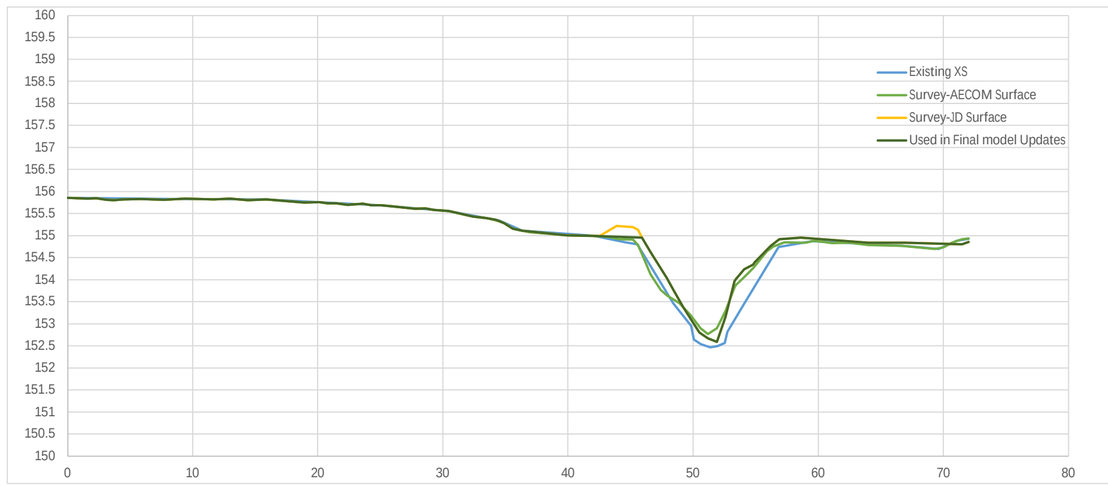
Hydraulic Model Updates Summary – Existing Conditions

Existing XS	
Station	Elevation
0	155.86
8.72	155.83
15.73	155.82
24.91	155.69
30.47	155.56
34.49	155.34
36.34	155.11
42.01	155
44.6	154.85
45.55	154.8
48.42	153.47
49.83	152.95
50.07	152.64
50.63	152.54
51.36	152.47
51.93	152.49
52.53	152.56
52.75	152.82
54.08	153.46
54.63	153.71
56.83	154.74
59.51	154.87
63.26	154.82
66.8	154.77
69.63	154.7
70.34	154.79
71.05	154.88
72	154.93

Survey-AECOM Surface	
Station	Elevation
0.00	155.86
1.60	155.84
2.30	155.85
3.10	155.81
3.70	155.80
4.50	155.82
5.90	155.83
7.70	155.81
9.40	155.84
11.70	155.82
13.00	155.84
14.40	155.80
15.80	155.82
18.90	155.75
20.10	155.76
20.80	155.73
21.50	155.73
22.40	155.70
23.60	155.72
24.30	155.69
25.10	155.69
26.40	155.65
27.80	155.61
28.60	155.62
29.30	155.58
30.00	155.57
30.50	155.56
32.40	155.43
33.50	155.40
34.50	155.33
34.90	155.28
35.60	155.16
36.30	155.11
36.90	155.08
39.90	155.01
42.00	155.00
43.40	154.96
44.10	154.92
45.20	154.91
45.60	154.79
46.60	154.12
47.40	153.77
47.90	153.64
48.42	153.55
48.90	153.47
49.80	153.19
50.60	152.90
51.20	152.77
51.90	152.90
52.60	153.29
53.30	153.82
53.40	153.87
54.08	154.06
54.80	154.26
55.90	154.64
56.40	154.75
57.30	154.85
59.00	154.84
59.70	154.88
61.10	154.83
62.50	154.84
64.00	154.79
66.70	154.77
69.30	154.70
70.00	154.73
70.70	154.84
71.50	154.92
72.00	154.94

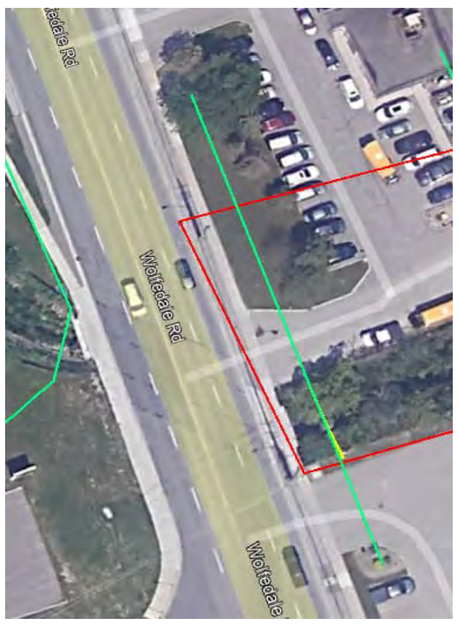
Survey-JD Surface	
Station	Elevation
0	155.86
1.6	155.84
2.3	155.85
3.1	155.81
3.7	155.80
4.5	155.82
5.9	155.83
7.7	155.81
9.4	155.84
11.7	155.82
13	155.84
14.4	155.80
15.9	155.82
18.9	155.75
20.1	155.76
20.8	155.73
21.5	155.73
22.4	155.70
23.6	155.72
24.3	155.69
25.1	155.69
27.8	155.61
28.6	155.62
29.3	155.58
30.5	155.56
32.4	155.43
33.5	155.40
34.2	155.36
34.9	155.28
35.6	155.16
36.3	155.11
39.9	155.01
42.5	154.99
43.9	155.22
45.2	155.19
45.6	155.13
45.9	154.95
46.6	154.63
47.9	154.03
48.42	153.77
49.2	153.39
50.5	152.80
51.2	152.67
51.9	152.59
52.6	153.16
53.3	153.96
53.4	154.01
54.08	154.23
54.1	154.24
54.8	154.34
54.9	154.39
56.2	154.77
56.9	154.92
58.6	154.95
64	154.84
67	154.84
71.5	154.80
72	154.86

Used in Final model Updates	
Station	Elevation
0	155.86
1.6	155.84
2.3	155.85
3.1	155.81
3.7	155.80
4.5	155.82
5.9	155.83
7.7	155.81
9.4	155.84
11.7	155.82
13	155.84
14.4	155.80
15.9	155.82
18.9	155.75
20.1	155.76
20.8	155.73
21.5	155.73
22.4	155.70
23.6	155.72
24.3	155.69
25.1	155.69
27.8	155.61
28.6	155.62
29.3	155.58
30.5	155.56
32.4	155.43
33.5	155.40
34.2	155.36
34.9	155.28
35.6	155.16
36.3	155.11
39.9	155.01
42.5	154.99
45.9	154.95
46.6	154.63
47.9	154.03
48.42	153.77
49.2	153.39
50.5	152.80
51.2	152.67
51.9	152.59
52.6	153.16
53.3	153.96
53.4	154.01
54.08	154.23
54.1	154.24
54.8	154.34
54.9	154.39
56.2	154.77
56.9	154.92
58.6	154.95
64	154.84
67	154.84
71.5	154.80
72	154.86



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0	155.86	0.045
8.72	155.83	
15.73	155.82	
24.91	155.69	
30.47	155.56	
34.49	155.34	0.025
36.34	155.11	
42.01	155.00	
44.6	154.85	
45.55	154.80	0.08
48.42	153.47	0.035
49.83	152.95	
50.07	152.64	
50.63	152.54	
51.36	152.47	
51.93	152.49	
52.53	152.56	
52.75	152.82	
54.08	153.46	0.08
54.63	153.71	
56.83	154.74	
59.51	154.87	0.025
63.26	154.82	
66.8	154.77	
69.63	154.70	0.045
70.34	154.79	
71.05	154.88	
72	154.93	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0	155.86	0.045
1.6	155.84	
2.3	155.85	
3.1	155.81	
3.7	155.80	
4.5	155.82	
5.9	155.83	
7.7	155.81	
9.4	155.84	
11.7	155.82	
13	155.84	
14.4	155.80	
15.9	155.82	
18.9	155.75	
20.1	155.76	
20.8	155.73	
21.5	155.73	
22.4	155.70	
23.6	155.72	
24.3	155.69	
25.1	155.69	
27.8	155.61	
28.6	155.62	
29.3	155.58	
30.5	155.56	
32.4	155.43	
33.5	155.40	
34.2	155.36	0.025
34.9	155.28	
35.6	155.16	
36.3	155.11	
39.9	155.01	
42.5	154.99	
45.9	154.95	0.08
46.6	154.63	
47.9	154.03	
48.42	153.77	0.035
49.2	153.39	
50.5	152.80	
51.2	152.67	
51.9	152.59	
52.6	153.16	
53.3	153.96	
53.4	154.01	
54.08	154.23	0.08
54.1	154.24	
54.8	154.34	
54.9	154.39	
56.2	154.77	
56.9	154.92	
58.6	154.95	0.025
64	154.84	
67	154.84	
71.5	154.80	0.045
72	154.86	

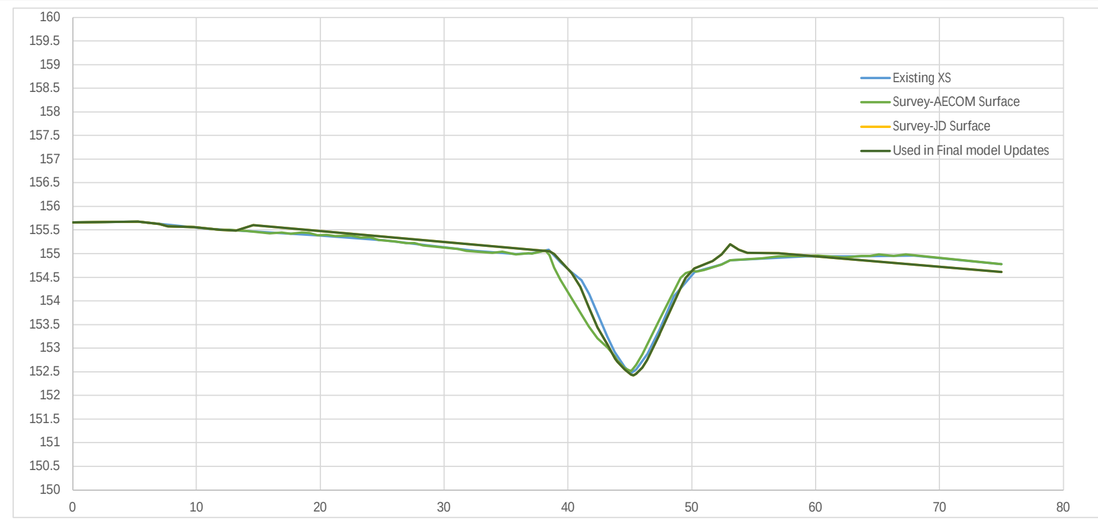


Existing XS	
Station	Elevation
0	155.66
5.26	155.68
10.81	155.53
19.66	155.39
25.18	155.28
32.53	155.06
35.8	154.99
37.12	155.01
38.45	155.08
39.42	154.81
40.32	154.6
41.11	154.44
41.74	154.14
43.16	153.25
43.76	152.92
44.58	152.6
45.09	152.48
45.51	152.55
46.42	152.88
47.41	153.39
48.55	154.1
50.24	154.61
52.37	154.77
53.11	154.86
59.19	154.94
63.18	154.94
67.96	154.96
75	154.78

Survey-AECOM Surface	
Station	Elevation
0.00	155.660
5.30	155.680
7.00	155.630
7.70	155.580
9.80	155.560
11.90	155.500
12.70	155.500
14.10	155.480
15.90	155.430
16.90	155.450
17.60	155.420
18.50	155.450
19.10	155.440
19.80	155.390
20.50	155.400
21.20	155.370
22.50	155.380
23.30	155.340
24.00	155.350
24.70	155.290
26.10	155.260
26.90	155.220
27.60	155.220
28.30	155.170
31.10	155.100
31.80	155.060
33.90	155.020
34.70	155.040
35.80	154.980
36.80	155.010
37.10	155.000
38.20	155.070
38.50	154.970
38.90	154.700
39.40	154.450
41.10	153.710
41.70	153.460
42.40	153.210
43.16	153.020
43.20	153.010
43.80	152.820
44.00	152.740
44.60	152.570
45.10	152.520
45.30	152.570
45.50	152.650
46.00	152.870
47.41	153.607
49.10	154.490
49.50	154.590
50.10	154.640
50.40	154.620
51.00	154.650
52.40	154.770
53.10	154.860
55.70	154.900
57.00	154.940
60.20	154.960
62.30	154.920
63.70	154.950
64.40	154.950
65.10	154.980
66.30	154.950
67.30	154.980
75.00	154.780

Survey-JD Surface	
Station	Elevation
0	155.66
5.3	155.68
7	155.63
7.7	155.58
9.8	155.56
11.9	155.5
13.2	155.49
14.6	155.6
38.5	155.05
38.9	154.99
40.3	154.59
41	154.3
41.7	153.86
42.4	153.44
43.16	153.0817
43.8	152.78
44	152.71
44.6	152.55
45.1	152.44
45.3	152.43
45.5	152.46
46	152.59
46.4	152.75
47.4	153.29
47.41	153.2958
49.1	154.27
49.5	154.49
50.2	154.69
51.7	154.84
52.4	154.98
53.1	155.2
53.8	155.08
54.5	155.02
57	155.01
75	154.61

Used in Final model Updates	
Station	Elevation
0	155.66
5.3	155.68
7	155.63
7.7	155.58
9.8	155.56
11.9	155.5
13.2	155.49
14.6	155.6
38.5	155.05
38.9	154.99
40.3	154.59
41	154.3
41.7	153.86
42.4	153.44
43.16	153.0817
43.8	152.78
44	152.71
44.6	152.55
45.1	152.44
45.3	152.43
45.5	152.46
46	152.59
46.4	152.75
47.4	153.29
47.41	153.2958
49.1	154.27
49.5	154.49
50.2	154.69
51.7	154.84
52.4	154.98
53.1	155.2
53.8	155.08
54.5	155.02
57	155.01
75	154.61



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

Station	Elevation	n Value
0	155.66	0.025
5.26	155.68	
10.81	155.53	
19.66	155.39	
25.18	155.28	
32.53	155.06	
35.8	154.99	
37.12	155.01	
38.45	155.08	0.08
39.42	154.81	
40.32	154.6	
41.11	154.44	
41.74	154.14	
43.16	153.25	0.035
43.76	152.92	
44.58	152.6	
45.09	152.48	
45.51	152.55	
46.42	152.88	
47.41	153.39	0.08
48.55	154.1	
50.24	154.61	
52.37	154.77	
53.11	154.86	0.025
59.19	154.94	
63.18	154.94	
67.96	154.96	
75	154.78	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

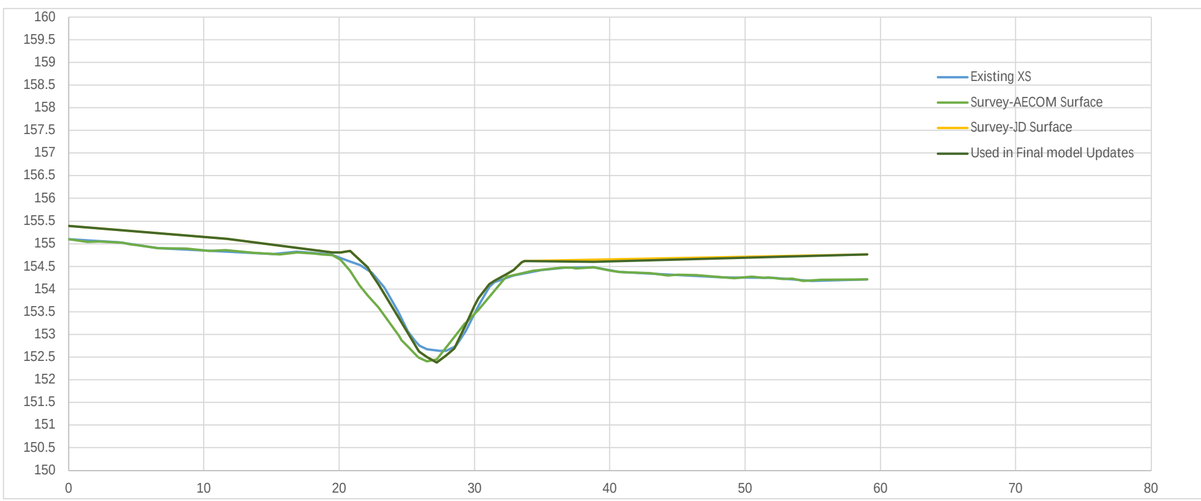
Station	Elevation	n Value
0	155.66	0.016
5.3	155.68	
7	155.63	
7.7	155.58	
9.8	155.56	
11.9	155.5	
13.2	155.49	
14.6	155.6	
38.5	155.05	0.08
38.9	154.99	
40.3	154.59	
41	154.3	
41.7	153.86	
42.4	153.44	
43.16	153.0817	0.035
43.8	152.78	
44	152.71	
44.6	152.55	
45.1	152.44	
45.3	152.43	
45.5	152.46	
46	152.59	
46.4	152.75	
47.4	153.29	0.08
47.41	153.2958	
49.1	154.27	
49.5	154.49	
50.2	154.69	
51.7	154.84	
52.4	154.98	
53.1	155.2	0.016
53.8	155.08	
54.5	155.02	
57	155.01	
75	154.61	

Existing XS	
Station	Elevation
0	155.1
3.75	155.03
6.62	154.9
15.12	154.77
16.89	154.82
19.38	154.76
20.85	154.6
21.52	154.53
22.43	154.36
23.35	154.03
24.36	153.51
25.07	153.07
25.6	152.86
25.93	152.75
26.49	152.67
27.4	152.64
27.91	152.64
28.62	152.74
29.33	153.07
30.34	153.66
31.09	154.05
31.47	154.15
32.89	154.3
34.96	154.42
36.67	154.47
38.84	154.48
40.71	154.38
48.45	154.26
52.08	154.25
54.92	154.18
59	154.21

Survey-AECOM Surface	
Station	Elevation
0.00	155.100
1.40	155.040
2.30	155.050
4.00	155.020
4.50	154.990
5.00	154.970
6.60	154.900
8.70	154.890
10.40	154.840
11.60	154.860
13.70	154.800
15.60	154.760
16.90	154.810
18.20	154.780
18.70	154.760
19.50	154.750
20.10	154.640
20.80	154.400
21.50	154.080
22.10	153.860
22.90	153.590
24.40	152.970
24.60	152.870
25.07	152.729
25.80	152.510
25.90	152.480
26.50	152.410
27.20	152.450
28.80	153.050
29.30	153.240
29.33	153.249
30.30	153.540
32.20	154.220
32.40	154.270
34.30	154.400
36.40	154.470
37.20	154.470
37.50	154.450
38.80	154.480
40.10	154.400
40.70	154.380
43.00	154.350
44.30	154.300
45.00	154.320
46.40	154.310
49.20	154.240
50.50	154.270
51.40	154.250
51.70	154.260
52.80	154.220
53.50	154.230
54.30	154.180
55.60	154.200
59.00	154.210

Survey-JD Surface	
Station	Elevation
0	155.4
11.7	155.11
19.5	154.81
20.1	154.81
20.8	154.84
22.1	154.48
22.4	154.33
22.9	154.1
25.07	153.03
25.8	152.67
25.9	152.62
26.5	152.5
27.2	152.38
27.9	152.53
28.5	152.69
28.6	152.74
29.33	153.2093
30	153.64
30.3	153.8
30.8	153.99
31.1	154.11
31.5	154.19
32.4	154.33
32.9	154.42
33.5	154.59
33.7	154.62
59	154.76

Used in Final model Updates	
Station	Elevation
0	155.4
11.7	155.11
19.5	154.81
20.1	154.81
20.8	154.84
22.1	154.48
22.4	154.33
22.9	154.1
25.07	153.03
25.8	152.67
25.9	152.62
26.5	152.5
27.2	152.38
27.9	152.53
28.5	152.69
28.6	152.74
29.33	153.2093
30	153.64
30.3	153.8
30.8	153.99
31.1	154.11
31.5	154.19
32.4	154.33
32.9	154.42
33.5	154.59
33.7	154.62
38.8	154.6
59	154.76



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

Station	Elevation	n Value
0	155.1	0.025
3.75	155.03	
6.62	154.9	
15.12	154.77	
16.89	154.82	
19.38	154.76	0.08
20.85	154.6	
21.52	154.53	
22.43	154.36	
23.35	154.03	
24.36	153.51	
25.07	153.07	0.035
25.6	152.86	
25.93	152.75	
26.49	152.67	
27.4	152.64	
27.91	152.64	
28.62	152.74	
29.33	153.07	0.08
30.34	153.66	
31.09	154.05	
31.47	154.15	
32.89	154.3	
34.96	154.42	
36.67	154.47	
38.84	154.48	0.025
40.71	154.38	
48.45	154.26	
52.08	154.25	
54.92	154.18	
59	154.21	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

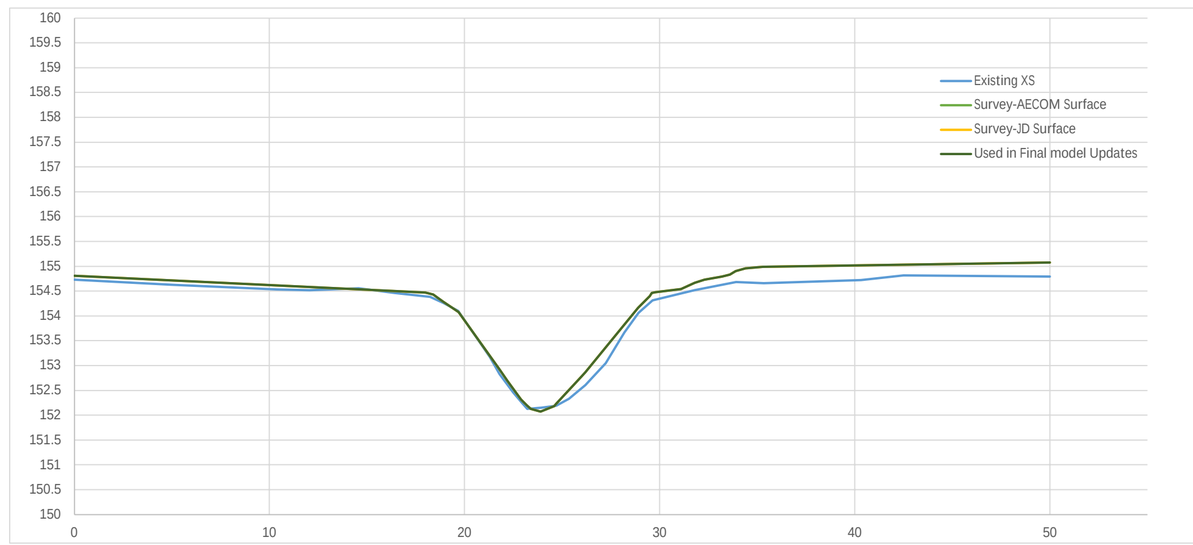
Station	Elevation	n Value
0.000	155.4	0.016
11.700	155.11	
19.500	154.81	0.08
20.100	154.81	
20.800	154.84	
22.100	154.48	
22.400	154.33	
22.900	154.1	
25.070	153.03	0.035
25.800	152.67	
25.900	152.62	
26.500	152.5	
27.200	152.38	
27.900	152.53	
28.500	152.69	
28.600	152.74	
29.330	153.2093	0.08
30.000	153.64	
30.300	153.8	
30.800	153.99	
31.100	154.11	
31.500	154.19	
32.400	154.33	
32.900	154.42	
33.500	154.59	
33.700	154.62	
38.800	154.6	0.016
59.000	154.76	

Existing XS	
Station	Elevation
0	154.73
4.99	154.63
10.39	154.53
12.05	154.52
14.58	154.56
16.41	154.46
18.23	154.38
18.94	154.26
19.67	154.1
21.3	153.17
21.79	152.83
22.5	152.46
22.93	152.25
23.22	152.13
23.93	152.15
24.7	152.19
25.35	152.33
26.19	152.61
27.23	153.05
28.2	153.67
28.92	154.06
29.63	154.31
31.77	154.52
33.91	154.68
35.33	154.66
40.32	154.72
42.51	154.82
50	154.79

Survey-AECOM Surface	
Station	Elevation
NA	

Survey-JD Surface	
Station	Elevation
0	154.81
18	154.47
18.4	154.43
18.9	154.29
19.7	154.08
21.79	152.918
22.2	152.69
22.9	152.32
23.2	152.2
23.4	152.13
23.9	152.08
24.6	152.18
24.7	152.23
26	152.78
26.19	152.8704
28.9	154.16
29.5	154.4
29.6	154.46
29.8	154.48
31.1	154.54
31.8	154.67
32.3	154.73
33.2	154.79
33.6	154.83
33.9	154.9
34.4	154.96
35.3	154.99
50	155.08

Used in Final model Updates	
Station	Elevation
0	154.81
16.4	154.5
18	154.47
18.4	154.43
18.9	154.29
19.7	154.08
21.79	152.918
22.2	152.69
22.9	152.32
23.2	152.2
23.4	152.13
23.9	152.08
24.6	152.18
24.7	152.23
26	152.78
26.19	152.8704
28.9	154.16
29.5	154.4
29.6	154.46
29.8	154.48
31.1	154.54
31.8	154.67
32.3	154.73
33.2	154.79
33.6	154.83
33.9	154.9
34.4	154.96
35.3	154.99
50	155.08



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

Station	Elevation	n Value
0	154.73	0.025
4.99	154.63	
10.39	154.53	
12.05	154.52	
14.58	154.56	
16.41	154.46	0.08
18.23	154.38	
18.94	154.26	
19.67	154.1	
21.3	153.17	
21.79	152.83	0.035
22.5	152.46	
22.93	152.25	
23.22	152.13	
23.93	152.15	
24.7	152.19	
25.35	152.33	
26.19	152.61	0.08
27.23	153.05	
28.2	153.67	
28.92	154.06	
29.63	154.31	
31.77	154.52	
33.91	154.68	0.025
35.33	154.66	
40.32	154.72	
42.51	154.82	
50	154.79	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 942

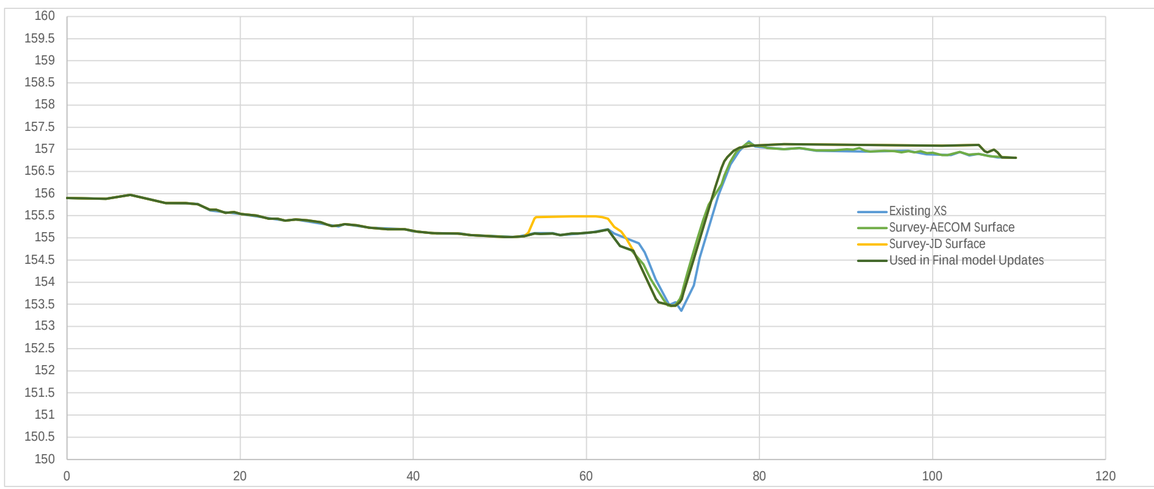
Station	Elevation	n Value
0.000	154.81	0.016
16.400	154.5	0.08
18.000	154.47	
18.400	154.43	
18.900	154.29	
19.700	154.08	
21.790	152.918	0.035
22.200	152.69	
22.900	152.32	
23.200	152.2	
23.400	152.13	
23.900	152.08	
24.600	152.18	
24.700	152.23	
26.000	152.78	
26.190	152.8704	0.08
28.900	154.16	
29.500	154.4	
29.600	154.46	
29.800	154.48	
31.100	154.54	
31.800	154.67	
32.300	154.73	
33.200	154.79	
33.600	154.83	
33.900	154.9	0.016
34.400	154.96	
35.300	154.99	
50.000	155.08	

Existing XS	
Station	Elevation
0	155.9
4.48	155.88
7.27	155.97
9.56	155.87
11.41	155.79
15.1	155.77
16.52	155.62
20.05	155.54
25.21	155.39
26.42	155.42
31.37	155.26
32.05	155.31
34.95	155.23
39.01	155.2
39.86	155.15
42.69	155.1
45.52	155.1
46.56	155.06
51.88	155.02
54.01	155.11
56.13	155.11
56.95	155.06
60.37	155.12
62.47	155.2
63.2	155.1
66.03	154.88
66.74	154.68
67.1	154.51
67.99	154.07
69.57	153.49
70.28	153.55
70.98	153.36
72.4	153.93
73.1	154.55
75.23	155.96
76.64	156.66
77.66	156.97
78.76	157.18
79.47	157.06
82.83	157
84.56	157.03
86.54	156.97
92.2	156.95
97.15	156.97
99.28	156.89
102.1	156.87
103.14	156.94
104.23	156.86
105.26	156.9
107.5	156.82
109.56	156.81

Survey-AECOM Surface	
Station	Elevation
0.00	155.900
4.50	155.880
7.30	155.970
11.40	155.790
13.70	155.790
15.10	155.760
16.50	155.640
17.20	155.640
18.30	155.570
19.30	155.580
20.10	155.540
21.90	155.500
23.30	155.430
24.30	155.430
25.20	155.390
26.40	155.420
27.10	155.410
29.30	155.350
30.00	155.300
30.60	155.270
31.40	155.280
32.10	155.310
33.50	155.280
34.90	155.230
37.00	155.200
39.00	155.200
40.40	155.140
42.70	155.100
45.10	155.100
46.60	155.060
51.40	155.020
52.80	155.040
54.00	155.100
54.70	155.090
56.10	155.100
57.00	155.060
58.30	155.100
59.00	155.100
61.10	155.130
62.50	155.190
63.20	154.990
63.90	154.820
65.20	154.720
66.60	154.400
67.40	154.080
67.99	153.895
68.90	153.610
69.40	153.480
69.80	153.460
70.30	153.490
70.80	153.620
71.00	153.720
71.20	153.870
71.70	154.230
72.40	154.713
72.70	154.920
73.50	155.410
74.10	155.750
75.60	156.210
75.90	156.400
76.60	156.710
77.30	156.950
77.70	157.010
78.10	157.060
78.50	157.130
78.80	157.150
79.50	157.080
80.40	157.070
80.90	157.030
82.80	157.000
84.60	157.030
86.50	156.980
88.60	156.980
90.10	157.000
90.80	156.990
91.50	157.030
92.20	156.970
92.80	156.950
94.40	156.970
95.60	156.960
96.40	156.930
97.20	156.960
97.90	156.930
98.60	156.960
99.30	156.910
100.00	156.920
101.10	156.870
101.70	156.870
103.10	156.940
104.20	156.880
104.60	156.890
105.30	156.900
106.60	156.840
109.60	156.810

Survey-JD Surface	
Station	Elevation
0	155.9
4.5	155.9
7.3	156.0
11.4	155.8
13.7	155.8
15.1	155.8
16.5	155.6
17.2	155.6
18.3	155.6
19.3	155.6
20.1	155.5
21.9	155.5
23.3	155.4
24.3	155.4
25.2	155.4
26.4	155.4
27.7	155.4
29.3	155.4
30	155.3
30.6	155.3
31.4	155.3
32.1	155.3
33.5	155.3
34.9	155.2
37	155.2
39	155.2
40.4	155.1
42.2	155.1
45.1	155.1
46.6	155.1
50.5	155.0
51.4	155.0
52.8	155.0
53.3	155.1
54	155.4
54.2	155.5
58.3	155.5
61.1	155.5
61.8	155.5
62.5	155.4
63.2	155.3
64	155.1
64.6	155.0
65.4	154.7
67.99	153.6
68	153.6
68.2	153.6
68.3	153.6
69.6	153.5
69.8	153.5
70.3	153.5
70.8	153.6
71	153.6
71.2	153.8
72.4	154.5
74.9	156.2
75.6	156.6
75.9	156.7
76.3	156.8
77	157.0
77.7	157.0
79	157.1
82.8	157.1
101.1	157.1
105.3	157.1
106	157.0
106.3	156.9
107.1	157.0
107.5	156.9
108	156.8
109.6	156.8

Used in Final model Updates	
Station	Elevation
0	155.90
4.5	155.88
7.3	155.97
11.4	155.79
13.7	155.79
15.1	155.76
16.5	155.64
17.2	155.64
18.3	155.57
19.3	155.58
20.1	155.54
21.9	155.50
23.3	155.43
24.3	155.43
25.2	155.39
26.4	155.42
27.7	155.40
29.3	155.35
30	155.30
30.6	155.27
31.4	155.28
32.1	155.31
33.5	155.28
34.9	155.23
37	155.20
39	155.20
40.4	155.14
42.2	155.11
45.1	155.10
46.6	155.06
50.5	155.02
51.4	155.02
52.8	155.04
54.00	155.10
54.70	155.09
56.10	155.10
57.00	155.06
58.30	155.10
59.00	155.10
61.10	155.13
62.50	155.19
63.20	154.99
63.90	154.82
65.4	154.71
67.99	153.63
68	153.63
68.2	153.58
68.3	153.55
69.6	153.49
69.8	153.47
70.3	153.47
70.8	153.55
71	153.62
71.2	153.75
72.4	154.53
74.9	156.15
75.6	156.58
75.9	156.73
76.3	156.83
77	156.97
77.7	157.04
79	157.08
82.8	157.12
101.1	157.08
105.3	157.10
106	156.96
106.3	156.93
107.1	156.99
107.5	156.93
108	156.82
109.6	156.81



Original

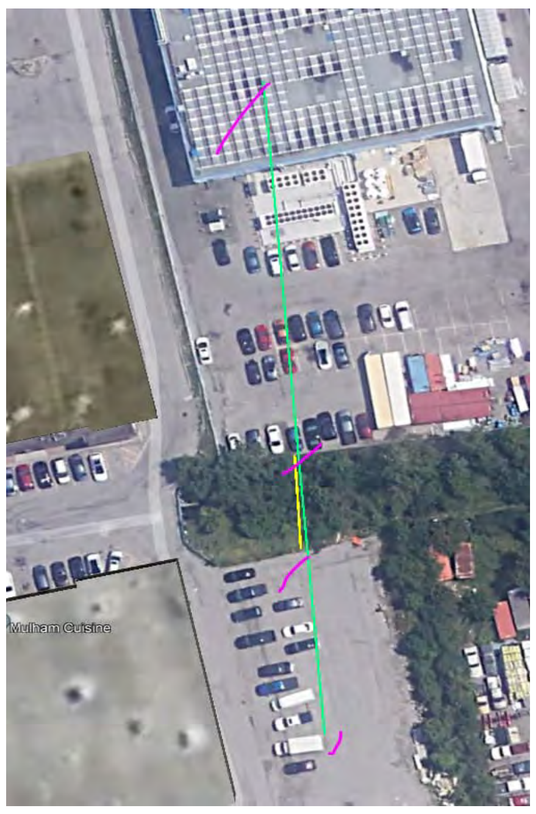
Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M3

Station	Elevation	n Value
0	155.9	0.025
4.48	155.88	
7.27	155.97	
9.56	155.87	
11.41	155.79	
15.1	155.77	
16.52	155.62	
20.05	155.54	
25.21	155.39	
26.42	155.42	
31.37	155.26	
32.05	155.31	
34.95	155.23	
39.01	155.2	
39.86	155.15	
42.69	155.1	
45.52	155.1	
46.56	155.06	
51.88	155.02	
54.01	155.11	
56.13	155.11	
56.95	155.06	
60.37	155.12	
62.47	155.2	
63.2	155.1	0.08
66.03	154.88	
66.74	154.68	
67.1	154.51	
67.99	154.07	0.035
69.57	153.49	
70.28	153.55	
70.98	153.36	
72.4	153.93	0.08
73.1	154.55	
75.23	155.96	
76.64	156.66	
77.66	156.97	
78.76	157.18	0.025
79.47	157.06	
82.83	157	
84.56	157.03	
86.54	156.97	
92.2	156.95	
97.15	156.97	
99.28	156.89	
102.1	156.87	
103.14	156.94	
104.23	156.86	
105.26	156.9	
107.5	156.82	
109.56	156.81	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M3

Station	Elevation	n Value
0.000	155.9	0.016
4.500	155.88	
7.300	155.97	
11.400	155.79	
13.700	155.79	
15.100	155.76	
16.500	155.64	
17.200	155.64	
18.300	155.57	
19.300	155.58	
20.100	155.54	
21.900	155.5	
23.300	155.43	
24.300	155.43	
25.200	155.39	
26.400	155.42	
27.700	155.4	
29.300	155.35	
30.000	155.3	
30.600	155.27	
31.400	155.28	
32.100	155.31	
33.500	155.28	
34.900	155.23	
37.000	155.2	
39.000	155.2	
40.400	155.14	
42.200	155.11	
45.100	155.1	
46.600	155.06	
50.500	155.02	
51.400	155.02	
52.800	155.04	
54.000	155.1	
54.700	155.09	
56.100	155.1	
57.000	155.06	
58.300	155.1	
59.000	155.1	
61.100	155.13	
62.500	155.19	
63.200	154.99	0.08
63.900	154.82	
65.400	154.71	
67.990	153.6342	0.035
68.000	153.63	
68.200	153.58	
68.300	153.55	
69.600	153.49	
69.800	153.47	
70.300	153.47	
70.800	153.55	
71.000	153.62	
71.200	153.75	
72.400	154.5284	0.08
74.900	156.15	
75.600	156.58	
75.900	156.73	
76.300	156.83	
77.000	156.97	
77.700	157.04	
79.000	157.08	0.016
82.800	157.12	
101.100	157.08	
105.300	157.1	
106.000	156.96	
106.300	156.93	
107.100	156.99	
107.500	156.93	
108.000	156.82	
109.600	156.81	

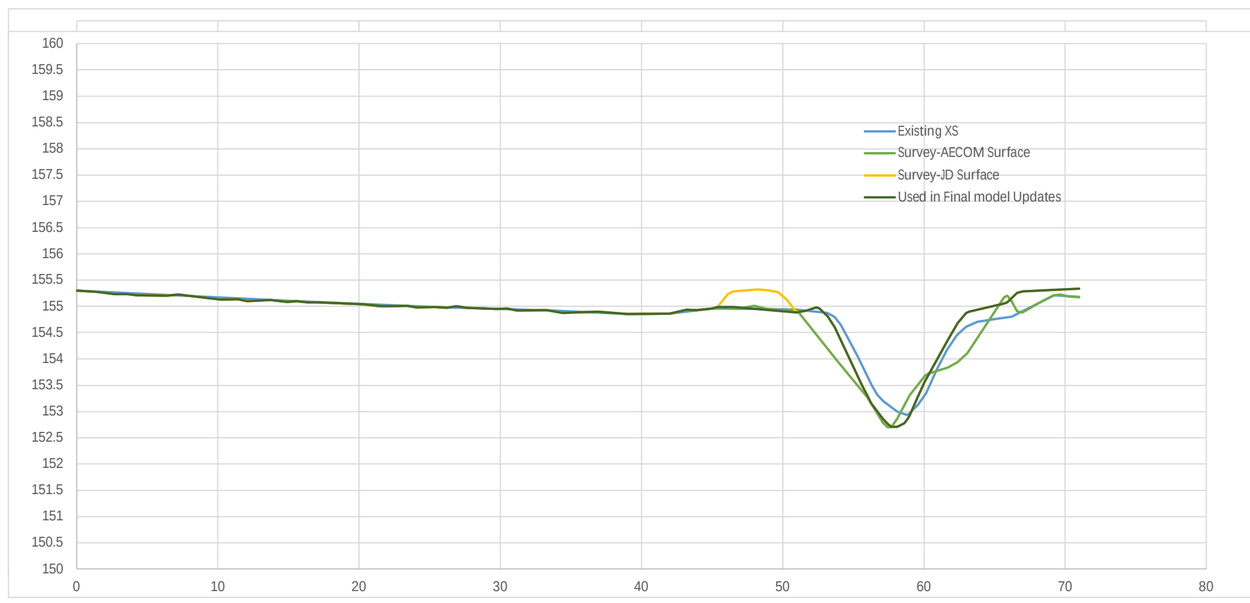


Existing XS	
Station	Elevation
0.0	155.30
15.6	155.10
25.4	154.99
33.7	154.92
39.0	154.85
42.0	154.86
45.0	154.96
48.9	154.95
51.1	154.94
53.2	154.88
53.7	154.80
54.1	154.65
55.3	154.06
56.3	153.50
56.7	153.32
57.1	153.20
58.1	153.00
58.8	152.93
59.5	153.12
60.1	153.35
61.0	153.81
61.7	154.18
62.4	154.45
63.0	154.61
63.8	154.71
65.2	154.77
66.2	154.80
69.2	155.21
71.0	155.18

Survey-AECOM Surface	
Station	Elevation
0.0	155.30
1.4	155.28
2.7	155.23
3.6	155.24
4.3	155.21
6.4	155.20
7.2	155.22
10.2	155.13
11.4	155.14
12.1	155.10
13.7	155.12
14.9	155.09
15.6	155.10
16.3	155.08
17.0	155.08
20.3	155.04
21.3	155.00
22.7	155.00
23.4	155.01
24.1	154.98
25.4	154.99
26.2	154.97
26.9	155.00
27.6	154.97
29.7	154.95
30.5	154.96
31.2	154.92
33.3	154.93
34.4	154.88
36.9	154.90
39.0	154.85
41.7	154.86
42.0	154.86
43.2	154.94
43.9	154.93
45.7	154.98
47.0	154.95
47.5	154.99
48.0	155.01
48.9	154.95
49.6	154.94
50.3	154.93
51.0	154.94
53.9	153.95
56.0	153.26
56.3	153.14
56.3	153.13
57.1	152.79
57.4	152.70
57.7	152.70
58.1	152.86
59.0	153.31
60.1	153.69
60.1	153.70
60.3	153.72
61.7	153.84
62.4	153.94
63.1	154.11
65.7	155.17
65.9	155.20
66.2	155.10
66.6	154.91
67.0	154.89
68.3	155.09
69.2	155.21
69.7	155.22
70.2	155.19
71.0	155.17

Survey-JD Surface	
Station	Elevation
0.0	155.30
1.4	155.28
2.7	155.23
3.6	155.24
4.3	155.21
6.4	155.20
7.2	155.22
10.2	155.13
11.4	155.14
12.1	155.10
13.7	155.12
14.9	155.09
15.6	155.10
16.3	155.08
17.0	155.08
20.3	155.04
21.7	155.00
23.4	155.01
24.1	154.98
25.4	154.99
26.2	154.97
26.9	155.00
27.6	154.97
29.7	154.95
30.5	154.96
31.2	154.92
33.3	154.93
34.4	154.88
36.9	154.90
39.0	154.85
42.0	154.86
43.2	154.94
43.9	154.93
45.0	154.96
45.4	154.99
46.1	155.23
46.5	155.29
48.2	155.32
48.9	155.31
49.7	155.27
50.3	155.12
51.0	154.89
51.7	154.92
52.4	154.98
52.6	154.96
53.2	154.81
53.7	154.60
54.1	154.37
55.6	153.50
56.0	153.30
56.3	153.15
56.3	153.14
57.1	152.86
57.4	152.77
57.7	152.71
58.1	152.71
58.6	152.78
58.8	152.84
59.0	152.93
59.5	153.25
60.1	153.59
60.1	153.61
61.7	154.37
62.4	154.68
63.0	154.88
63.1	154.89
63.2	154.90
65.7	155.05
65.9	155.08
66.6	155.26
67.0	155.29
71.0	155.34

Used in Final model Updates	
Station	Elevation
0.0	155.30
1.4	155.28
2.7	155.23
3.6	155.24
4.3	155.21
6.4	155.20
7.2	155.22
10.2	155.13
11.4	155.14
12.1	155.10
13.7	155.12
14.9	155.09
15.6	155.10
16.3	155.08
17.0	155.08
20.3	155.04
21.7	155.00
23.4	155.01
24.1	154.98
25.4	154.99
26.2	154.97
26.9	155.00
27.6	154.97
29.7	154.95
30.5	154.96
31.2	154.92
33.3	154.93
34.4	154.88
36.9	154.90
39.0	154.85
42.0	154.86
43.2	154.94
43.9	154.93
45.0	154.96
45.4	154.99
46.1	154.99
46.5	154.99
51.0	154.89
51.7	154.92
52.4	154.98
52.6	154.96
53.2	154.81
53.7	154.60
54.1	154.37
55.6	153.50
56.0	153.30
56.3	153.15
56.3	153.14
57.1	152.86
57.4	152.77
57.7	152.71
58.1	152.71
58.6	152.78
58.8	152.84
59.0	152.93
59.5	153.25
60.1	153.59
60.1	153.61
61.7	154.37
62.4	154.68
63.0	154.88
63.1	154.89
63.2	154.90
65.7	155.05
65.9	155.08
66.6	155.26
67.0	155.29
71.0	155.34



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M3

Station	Elevation	n Value
0.0	155.30	0.025
15.6	155.10	
25.4	154.99	
33.7	154.92	
39.0	154.85	
42.0	154.86	
45.0	154.96	
48.9	154.95	
51.1	154.94	0.08
53.2	154.88	
53.7	154.80	
54.1	154.65	
55.3	154.06	
56.3	153.50	0.035
56.7	153.32	
57.1	153.20	
58.1	153.00	
58.8	152.93	
59.5	153.12	
60.1	153.35	0.08
61.0	153.81	
61.7	154.18	
62.4	154.45	
63.0	154.61	
63.8	154.71	
65.2	154.77	0.045
66.2	154.80	
69.2	155.21	
71.0	155.18	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M3

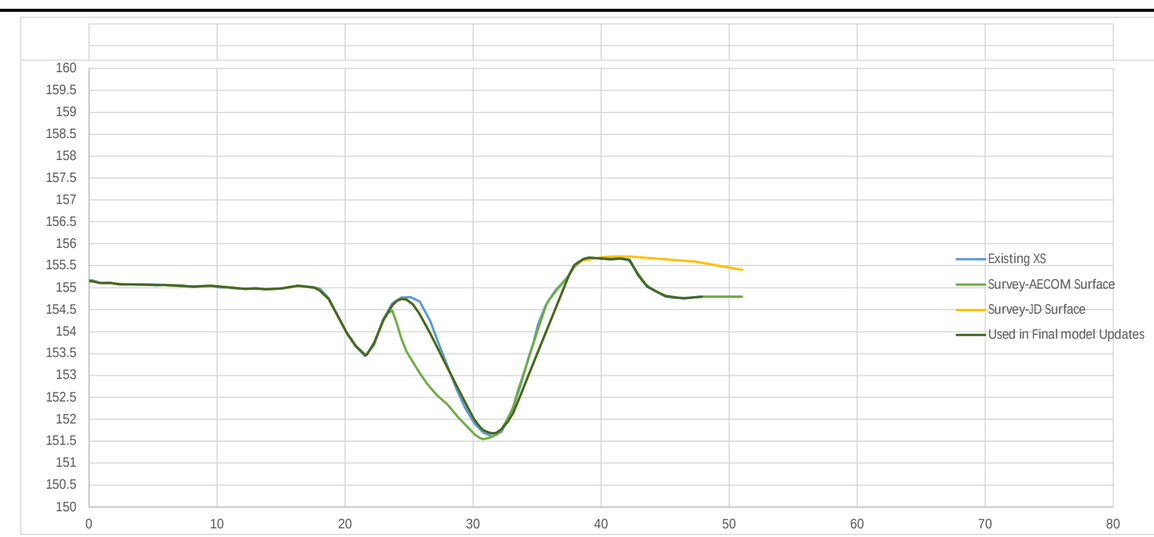
Station	Elevation	n Value
0.0	155.30	0.016
1.4	155.28	
2.7	155.23	
3.6	155.24	
4.3	155.21	
6.4	155.20	
7.2	155.22	
10.2	155.13	
11.4	155.14	
12.1	155.10	
13.7	155.12	
14.9	155.09	
15.6	155.10	
16.3	155.08	
17.0	155.08	
20.3	155.04	
21.7	155.00	
23.4	155.01	
24.1	154.98	
25.4	154.99	
26.2	154.97	
26.9	155.00	
27.6	154.97	
29.7	154.95	
30.5	154.96	
31.2	154.92	
33.3	154.93	
34.4	154.88	
36.9	154.90	
39.0	154.85	
42.0	154.86	
43.2	154.94	
43.9	154.93	
45.0	154.96	
45.4	154.99	
46.1	154.99	
46.5	154.99	
51.0	154.89	0.08
51.7	154.92	
52.4	154.98	
52.6	154.96	
53.2	154.81	
53.7	154.60	
54.1	154.37	
55.6	153.50	
56.0	153.30	
56.3	153.15	0.035
56.3	153.14	
57.1	152.86	
57.4	152.77	
57.7	152.71	
58.1	152.71	
58.6	152.78	
58.8	152.84	
59.0	152.93	
59.5	153.25	
60.1	153.59	
60.1	153.61	0.08
61.7	154.37	
62.4	154.68	
63.0	154.88	
63.1	154.89	
63.2	154.90	
65.7	155.05	0.045
65.9	155.08	
66.6	155.26	
67.0	155.29	
71.0	155.34	

Existing XS	
Station	Elevation
0.0	155.170
0.2	155.170
1.0	155.110
1.7	155.120
2.4	155.070
3.4	155.080
3.8	155.070
4.5	155.070
5.2	155.050
5.9	155.060
7.3	155.050
8.1	155.020
9.5	155.040
10.2	155.010
10.9	155.010
11.1	154.990
12.2	154.970
13.0	154.990
13.8	154.960
15.0	154.980
16.3	155.040
17.3	155.020
18.0	154.980
18.7	154.760
20.1	153.980
20.5	153.830
20.9	153.650
21.6	153.440
22.3	153.690
22.8	154.100
23.0	154.270
23.7	154.640
24.4	154.770
25.1	154.780
25.8	154.680
26.6	154.240
27.2	153.790
27.9	153.260
28.7	152.720
29.4	152.270
30.1	151.910
30.8	151.700
31.5	151.610
32.2	151.710
32.9	152.150
33.1	152.260
33.6	152.730
34.4	153.430
34.7	153.730
35.1	154.150
35.7	154.600
35.9	154.720
36.5	154.960
37.0	155.100
37.5	155.280
37.9	155.490
38.6	155.660
39.1	155.680
40.0	155.670
40.7	155.650
41.5	155.670
42.2	155.630
42.9	155.280
43.6	155.030
44.3	154.910
45.0	154.810
45.7	154.770
46.4	154.760
47.9	154.790
51.0	154.790

Survey-AECOM Surface	
Station	Elevation
0.0	155.150
0.2	155.150
0.9	155.110
1.7	155.110
2.4	155.080
5.9	155.060
8.1	155.030
9.5	155.040
12.2	154.970
13.0	154.980
13.8	154.960
15.0	154.980
16.3	155.040
16.9	155.030
17.6	155.000
18.0	154.940
18.7	154.740
20.2	153.940
20.8	153.670
21.5	153.480
21.6	153.460
21.7	153.480
22.3	153.750
23.0	154.260
23.3	154.420
23.7	154.470
24.0	154.200
24.4	153.840
24.8	153.550
25.8	153.070
26.4	152.810
27.2	152.540
28.0	152.340
28.7	152.104
28.7	152.090
30.1	151.660
30.5	151.570
30.8	151.550
31.2	151.570
31.8	151.650
32.2	151.760
32.7	152.020
33.1	152.260
33.6	152.750
33.6	152.786
35.1	154.100
35.7	154.600
35.9	154.720
36.5	154.940
37.0	155.100
37.5	155.280
37.9	155.470
38.3	155.580
38.6	155.640
39.0	155.680
40.6	155.650
41.5	155.660
42.1	155.650
42.9	155.300
43.4	155.090
43.8	155.000
44.3	154.910
45.0	154.820
45.7	154.780
46.4	154.760
47.8	154.790
51.0	154.790

Survey-JD Surface	
Station	Elevation
0.0	155.150
0.2	155.150
0.9	155.110
1.7	155.110
2.4	155.080
5.9	155.060
8.1	155.030
9.5	155.040
12.2	154.970
13.0	154.980
13.8	154.960
15.0	154.980
16.3	155.040
16.9	155.030
17.6	155.000
18.0	154.940
18.7	154.740
20.2	153.940
20.8	153.670
21.5	153.480
21.6	153.460
21.7	153.480
22.3	153.750
23.0	154.260
23.3	154.420
23.7	154.600
24.0	154.700
24.4	154.740
24.8	154.730
25.3	154.620
25.8	154.410
26.6	153.970
28.7	152.796
29.6	152.260
30.1	151.990
30.5	151.830
30.8	151.750
31.2	151.700
31.5	151.680
31.8	151.690
32.2	151.770
32.7	151.950
32.9	152.030
33.1	152.130
33.6	152.517
34.3	152.990
37.5	155.290
37.9	155.520
38.3	155.600
40.0	155.690
40.8	155.710
42.2	155.710
47.3	155.590
51.0	155.400

Used in Final model Updates	
Station	Elevation
0.0	155.150
0.2	155.150
0.9	155.110
1.7	155.110
2.4	155.080
5.9	155.060
8.1	155.030
9.5	155.040
12.2	154.970
13.0	154.980
13.8	154.960
15.0	154.980
16.3	155.040
16.9	155.030
17.6	155.000
18.0	154.940
18.7	154.740
20.2	153.940
20.8	153.670
21.5	153.480
21.6	153.460
21.7	153.480
22.3	153.750
23.0	154.260
23.3	154.420
23.7	154.600
24.0	154.700
24.4	154.740
24.8	154.730
25.3	154.620
25.8	154.410
26.6	153.970
28.7	152.796
29.6	152.260
30.1	151.990
30.5	151.830
30.8	151.750
31.2	151.700
31.5	151.680
31.8	151.690
32.2	151.770
32.7	151.950
32.9	152.030
33.1	152.130
33.6	152.517
34.3	152.990
37.5	155.290
37.9	155.520
38.6	155.660
39.1	155.680
40.0	155.670
40.7	155.650
41.5	155.670
42.2	155.630
42.9	155.280
43.6	155.030
44.3	154.910
45.0	154.810
45.7	154.770
46.4	154.760
47.9	154.790
51.0	154.790



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
0.0	155.170	0.035
0.2	155.170	
1.0	155.110	0.045
1.7	155.120	
2.4	155.070	
3.4	155.080	
3.8	155.070	
4.5	155.070	
5.2	155.050	
5.9	155.060	
7.3	155.050	
8.1	155.020	
9.5	155.040	
10.2	155.010	
10.9	155.010	
11.1	154.990	
12.2	154.970	
13.0	154.990	
13.8	154.960	
15.0	154.980	
16.3	155.040	
17.3	155.020	
18.0	154.980	
18.7	154.760	
20.1	153.980	
20.5	153.830	
20.9	153.650	
21.6	153.440	
22.3	153.690	
22.8	154.100	
23.0	154.270	
23.7	154.640	
24.4	154.770	0.080
25.1	154.780	
25.8	154.680	
26.6	154.240	
27.2	153.790	
27.9	153.260	
28.7	152.720	0.035
29.4	152.270	
30.1	151.910	
30.8	151.700	
31.5	151.610	
32.2	151.710	
32.9	152.150	
33.1	152.260	
33.6	152.730	0.080
34.4	153.430	
34.7	153.730	
35.1	154.150	
35.7	154.600	
35.9	154.720	
36.5	154.960	
37.0	155.100	
37.5	155.280	
37.9	155.490	
38.6	155.660	
39.1	155.680	
40.0	155.670	
40.7	155.650	
41.5	155.670	
42.2	155.630	
42.9	155.280	
43.6	155.030	
44.3	154.910	
45.0	154.810	
45.7	154.770	
46.4	154.760	
47.9	154.790	
51.0	154.790	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

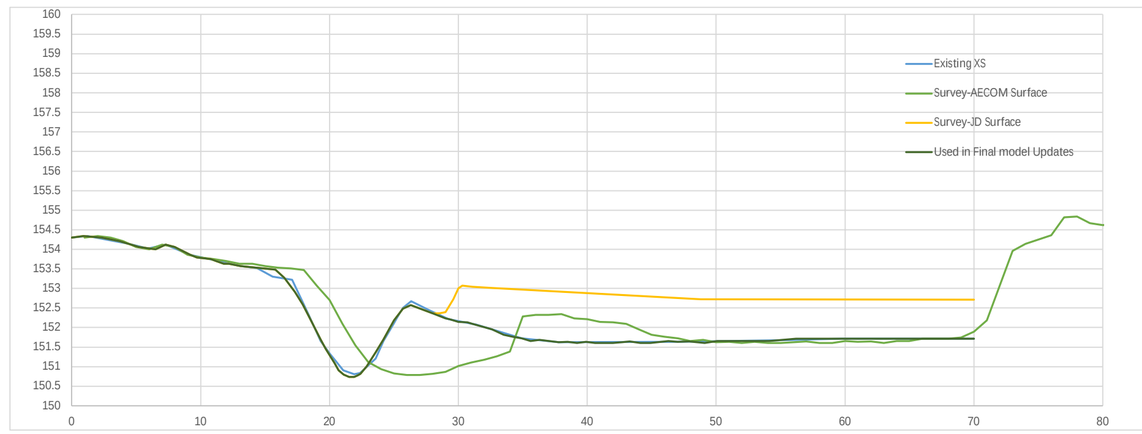
Station	Elevation	n Value
0.0	155.150	0.035
0.2	155.150	
0.9	155.110	0.045
1.7	155.110	
2.4	155.080	
5.9	155.060	
8.1	155.030	
9.5	155.040	
12.2	154.970	
13.0	154.980	
13.8	154.960	
15.0	154.980	
16.3	155.040	
16.9	155.030	
17.6	155.000	
18.0	154.940	
18.7	154.740	
20.2	153.940	
20.8	153.670	
21.5	153.480	
21.6	153.460	
21.7	153.480	
22.3	153.750	
23.0	154.260	
23.3	154.420	
23.7	154.600	
24.0	154.700	
24.4	154.740	0.08
24.8	154.730	
25.3	154.620	
25.8	154.410	
26.6	153.970	
28.7	152.796	0.035
29.6	152.260	
30.1	151.990	
30.5	151.830	
30.8	151.750	
31.2	151.700	
31.5	151.680	
31.8	151.690	
32.2	151.770	
32.7	151.950	
32.9	152.030	
33.1	152.130	
33.6	152.517	0.08
34.3	152.990	
37.5	155.290	
37.9	155.520	
38.6	155.660	
39.1	155.680	
40.0	155.670	
40.7	155.650	
41.5	155.670	
42.2	155.630	
42.9	155.280	
43.6	155.030	
44.3	154.910	
45.0	154.810	
45.7	154.770	
46.4	154.760	
47.9	154.790	
51.0	154.790	

Existing XS	
Station	Elevation
0.0	154.300
1.2	154.340
4.4	154.140
5.9	154.020
7.3	154.120
9.2	153.860
13.1	153.570
14.4	153.520
15.6	153.300
17.1	153.220
18.4	152.310
19.3	151.660
20.0	151.330
21.1	150.910
21.9	150.810
22.4	150.840
23.6	151.210
24.2	151.660
25.0	152.100
25.3	152.250
25.7	152.500
26.3	152.670
27.7	152.450
29.3	152.210
31.4	152.070
34.9	151.730
37.8	151.620
47.0	151.630
54.8	151.670
59.7	151.710
70.0	151.710

Survey-AECOM Surface	
Station	Elevation
0.0	154.300
0.9	154.340
2.3	154.300
3.7	154.210
5.2	154.060
6.5	154.000
7.3	154.120
8.0	154.060
9.2	153.860
9.7	153.790
10.8	153.750
11.2	153.700
11.8	153.630
12.2	153.630
13.1	153.570
14.3	153.530
14.4	153.510
14.4	153.470
15.1	153.070
15.8	152.700
17.1	152.100
18.4	151.550
19.3	151.114
19.7	150.940
20.0	150.830
20.4	150.790
20.7	150.790
21.1	150.810
21.5	150.870
22.2	151.020
22.9	151.110
23.6	151.170
24.2	151.261
25.0	151.390
27.7	152.290
27.8	152.330
28.0	152.330
28.5	152.340
29.0	152.240
29.3	152.210
30.0	152.150
30.7	152.130
31.1	152.100
32.6	151.950
33.5	151.820
34.2	151.760
34.9	151.730
35.6	151.660
36.3	151.680
37.8	151.620
38.5	151.630
39.2	151.610
39.9	151.630
40.6	151.610
42.0	151.610
42.7	151.620
43.3	151.650
44.1	151.610
44.9	151.610
46.3	151.660
47.0	151.630
47.9	151.650
49.1	151.610
50.1	151.660
54.1	151.660
56.2	151.710
59.4	151.710
59.7	151.710
60.2	151.750
60.5	151.890
60.7	152.190
61.2	153.070
61.7	153.960
61.9	154.140
62.0	154.250
62.6	154.360
63.2	154.820
63.3	154.840
64.0	154.670
64.6	154.620
64.8	154.630
66.0	154.280
66.8	153.850
67.3	153.660
67.5	153.530
67.8	153.380
68.2	153.250
68.6	153.170
69.0	153.140
69.4	153.220
69.7	153.300
70.0	153.510

Survey-JD Surface	
Station	Elevation
0.0	154.300
0.9	154.340
2.3	154.300
3.7	154.210
5.2	154.060
6.5	154.000
7.3	154.120
8.0	154.060
9.2	153.860
9.7	153.790
10.8	153.750
11.2	153.700
11.8	153.630
12.2	153.630
13.1	153.570
15.8	153.480
16.5	153.270
17.3	152.910
17.9	152.600
18.4	152.290
19.3	151.696
19.7	151.460
20.4	151.080
20.7	150.910
21.1	150.800
21.5	150.740
21.9	150.740
22.2	150.770
22.4	150.820
22.9	151.010
23.6	151.360
24.2	151.700
25.0	152.180
25.7	152.480
26.3	152.570
28.0	152.370
28.5	152.360
29.0	152.390
29.6	152.730
30.0	153.000
30.3	153.070
31.1	153.040
32.6	153.010
48.8	152.720
70.0	152.710

Used in Final model Updates	
Station	Elevation
0.0	154.300
0.9	154.340
2.3	154.300
3.7	154.210
5.2	154.060
6.5	154.000
7.3	154.120
8.0	154.060
9.2	153.860
9.7	153.790
10.8	153.750
11.2	153.700
11.8	153.630
12.2	153.630
13.1	153.570
15.8	153.480
16.5	153.270
17.3	152.910
17.9	152.600
18.4	152.290
19.3	151.696
19.7	151.460
20.4	151.080
20.7	150.910
21.1	150.800
21.5	150.740
21.9	150.740
22.2	150.770
22.4	150.820
22.9	151.010
23.6	151.360
24.2	151.700
25.0	152.180
25.7	152.480
26.3	152.570
28.0	152.370
29.0	152.240
29.3	152.210
30.0	152.150
30.7	152.130
31.1	152.100
32.6	151.950
33.5	151.820
34.2	151.760
34.9	151.730
35.6	151.660
36.3	151.680
37.8	151.620
38.5	151.630
39.2	151.610
39.9	151.630
40.6	151.610
42.0	151.610
42.7	151.620
43.3	151.650
44.1	151.610
44.9	151.610
46.3	151.660
47.0	151.630
47.9	151.650
49.1	151.610
50.1	151.660
54.1	151.660
56.2	151.710
59.4	151.710
59.7	151.710
70.0	151.710



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0.0	154.300	0.025
0.9	154.340	
2.3	154.300	
3.7	154.210	
5.2	154.060	
6.5	154.000	
7.3	154.120	0.08
8.0	154.060	
9.2	153.860	
9.7	153.790	
10.8	153.750	
11.2	153.700	0.035
11.8	153.630	
12.2	153.630	
13.1	153.570	
14.3	153.530	
14.4	153.510	
14.4	153.470	0.08
15.1	153.070	
15.8	152.700	
17.1	152.100	
18.4	151.550	
19.3	151.114	
19.7	150.940	0.025
20.0	150.830	
20.4	150.790	
20.7	150.790	
21.1	150.810	
21.5	150.870	
22.2	151.020	
22.9	151.110	
23.6	151.170	
24.2	151.261	
25.0	151.390	
27.7	152.290	
27.8	152.330	
28.0	152.330	
28.5	152.340	
29.0	152.240	
29.3	152.210	
30.0	152.150	
30.7	152.130	
31.1	152.100	
32.6	151.950	
33.5	151.820	
34.2	151.760	
34.9	151.730	
35.6	151.660	
36.3	151.680	
37.8	151.620	
38.5	151.630	
39.2	151.610	
39.9	151.630	
40.6	151.610	
42.0	151.610	
42.7	151.620	
43.3	151.650	
44.1	151.610	
44.9	151.610	
46.3	151.660	
47.0	151.630	
47.9	151.650	
49.1	151.610	
50.1	151.660	
54.1	151.660	
56.2	151.710	
59.4	151.710	
59.7	151.710	
60.2	151.750	
60.5	151.890	
60.7	152.190	
61.2	153.070	
61.7	153.960	
61.9	154.140	
62.0	154.250	
62.6	154.360	
63.2	154.820	
63.3	154.840	
64.0	154.670	
64.6	154.620	
64.8	154.630	
66.0	154.280	
66.8	153.850	
67.3	153.660	
67.5	153.530	
67.8	153.380	
68.2	153.250	
68.6	153.170	
69.0	153.140	
69.4	153.220	
69.7	153.300	
70.0	153.510	

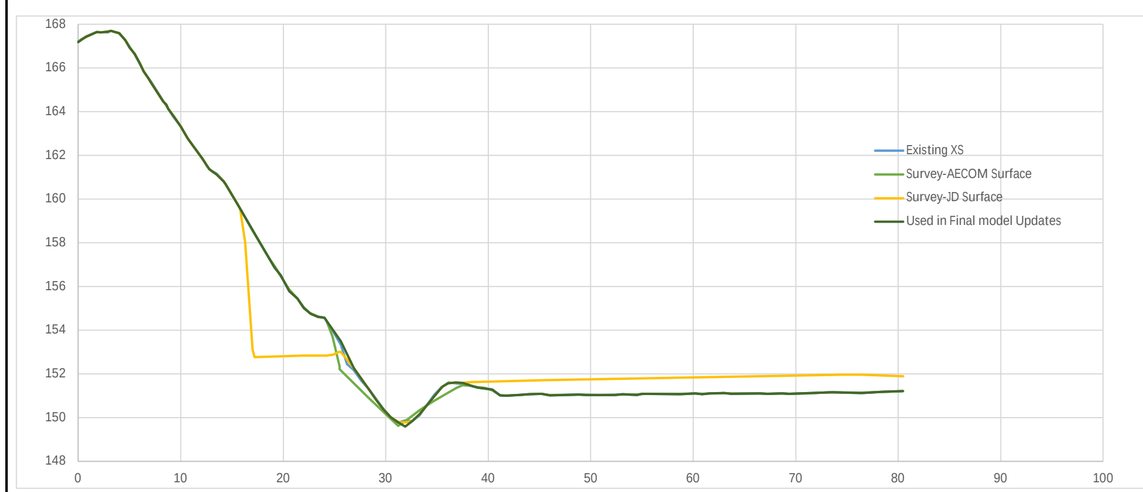
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0.0	154.300	0.025
0.9	154.340	
2.3	154.300	0.08
3.7	154.210	
5.2	154.060	
6.5	154.000	
7.3	154.120	
8.0	154.060	
9.2	153.860	
9.7	153.790	
10.8	153.750	
11.2	153.700	
11.8	153.630	
12.2	153.630	
13.1	153.570	
15.8	153.480	
16.5	153.270	
17.3	152.910	
17.9	152.600	
18.4	152.290	
19.3	151.696	0.035
19.7	151.460	
20.4	151.080	
20.7	150.910	
21.1	150.800	
21.5	150.740	
21.9	150.740	
22.2	150.770	
22.4	150.820	
22.9	151.010	
23.6	151.360	
24.2	151.700	0.08
25.0	152.180	
25.7	152.480	
26.3	152.570	
28.0	152.370	
29.0	152.240	
29.3	152.210	
30.0	152.150	
30.7	152.130	
31.1	152.100	
32.6	151.950	
33.5	151.820	0.025
34.2	151.760	
34.9	151.730	
35.6	151.660	
36.3	151.680	
37.8	151.620	
38.5	151.630	
39.2	151.610	
39.9	151.630	
40.6	151.610	
42.0	151.610	
42.7	151.620	
43.3	151.650	
44.1	151.610	
44.9	151.610	
46.3	151.660	
47.0	151.630	
47.9	151.650	
49.1	151.610	
50.1	151.660	
54.1	151.660	
56.2	151.710	
59.4	151.710	
59.7	151.710	
60.2	151.750	
60.5	151.890	
60.7	152.190	
61.2	153.070	
61.7	153.960	
61.9	154.140	
62.0	154.250	
62.6	154.360	
63.2	154.820	
63.3	154.840	
64.0	154.670	
64.6	154.620	
64.8	154.630	
66.0	154.280	
66.8	153.850	
67.3	153.660	
67.5	153.530	
67.8	153.380	
68.2	153.250	
68.6	153.170	
69.0	153.140	
69.4	153.220	
69.7	153.300	
70.0	153.510	

Existing XS	
Station	Elevation
0.0	167.210
0.8	167.440
1.8	167.640
2.9	167.620
3.2	167.700
4.0	167.590
4.6	167.270
5.5	166.640
6.4	165.820
7.1	165.330
9.3	163.780
10.0	163.340
10.7	162.760
12.1	161.880
12.8	161.350
13.5	161.160
14.2	160.820
15.5	159.840
17.2	158.420
19.2	156.870
19.7	156.510
20.6	155.780
21.4	155.440
22.0	155.010
22.7	154.750
23.4	154.600
24.0	154.570
24.8	153.980
25.6	153.340
26.2	152.440
26.9	152.170
27.7	151.670
28.4	151.280
29.7	150.420
30.5	150.010
31.2	149.780
31.9	149.870
32.6	149.840
33.3	150.110
34.7	151.030
35.4	151.370
36.1	151.600
37.6	151.540
39.0	151.380
40.4	151.290
41.2	151.020
41.8	151.000
44.0	151.070
45.2	151.080
46.0	151.020
48.9	151.050
49.6	151.040
52.4	151.040
53.1	151.070
54.5	151.040
55.0	151.080
58.8	151.070
60.2	151.110
60.9	151.070
61.6	151.110
63.0	151.120
63.7	151.090
66.5	151.110
67.3	151.080
68.7	151.110
69.4	151.080
73.6	151.150
76.4	151.130
78.3	151.180
80.5	151.210

Survey-AECOM Surface	
Station	Elevation
0.0	167.170
0.4	167.320
0.8	167.430
1.8	167.640
2.2	167.630
2.9	167.650
3.2	167.700
4.0	167.590
4.6	167.270
5.0	166.930
5.5	166.640
6.0	166.220
6.4	165.840
6.9	165.490
7.1	165.320
8.3	164.460
8.6	164.310
8.8	164.120
9.3	163.790
10.0	163.320
10.7	162.770
11.2	162.440
12.1	161.860
12.6	161.490
12.8	161.370
13.0	161.280
13.5	161.120
14.0	160.890
14.2	160.800
14.4	160.680
15.8	159.570
17.0	158.550
18.6	157.310
19.2	156.890
19.7	156.500
20.6	155.860
21.4	155.440
22.0	155.060
22.6	154.790
23.4	154.630
24.0	154.570
24.1	154.530
24.2	154.450
24.8	153.690
25.5	152.330
25.5	152.220
25.6	152.160
28.4	150.880
29.8	150.240
31.2	149.630
31.9	149.830
33.3	150.340
34.0	150.560
34.7	150.759
36.9	151.360
37.5	151.480
38.2	151.470
39.0	151.390
39.7	151.350
40.4	151.250
41.2	151.020
41.8	151.010
43.2	151.030
43.9	151.070
45.2	151.080
46.0	151.030
48.9	151.050
50.8	151.040
53.1	151.060
54.0	151.050
55.5	151.090
58.8	151.080
60.2	151.100
60.9	151.080
61.6	151.100
62.3	151.100
63.0	151.120
63.7	151.100
66.2	151.110
67.2	151.090
68.7	151.100
69.4	151.090
71.2	151.110
73.2	151.150
76.4	151.140
80.5	151.210

Survey-JD Surface	
Station	Elevation
0.0	167.170
0.4	167.320
0.8	167.430
1.8	167.640
2.2	167.630
2.9	167.650
3.2	167.700
4.0	167.590
4.6	167.270
5.0	166.930
5.5	166.640
6.0	166.220
6.4	165.840
6.9	165.490
7.1	165.320
8.3	164.460
8.6	164.310
8.8	164.120
9.3	163.790
10.0	163.320
10.7	162.770
11.2	162.440
12.1	161.860
12.6	161.490
12.8	161.370
13.0	161.280
13.5	161.120
14.2	160.800
14.4	160.680
15.8	159.570
16.3	158.020
17.0	153.110
17.2	152.770
22.0	152.840
24.2	152.840
24.8	152.880
25.5	153.020
25.6	153.000
26.2	152.670
26.9	152.250
28.4	151.261
29.1	150.800
29.8	150.350
30.5	150.010
31.2	149.810
31.9	149.790
32.6	149.840
33.3	150.160
34.7	150.960
35.5	151.400
36.1	151.570
36.8	151.600
37.5	151.590
38.3	151.620
45.5	151.710
74.6	151.960
76.4	151.960
80.5	151.890

Used in Final model Updates		
Station	Elevation	
0.0	167.170	
0.4	167.320	
0.8	167.430	
1.8	167.640	
2.2	167.630	
2.9	167.650	
3.2	167.700	
4.0	167.590	
4.6	167.270	
5.0	166.930	
5.5	166.640	
6.0	166.220	
6.4	165.840	
6.9	165.490	
7.1	165.320	
8.3	164.460	
8.6	164.310	
8.8	164.120	
9.3	163.790	
10.0	163.320	
10.7	162.770	
11.2	162.440	
12.1	161.860	
12.6	161.490	
12.8	161.370	
13.0	161.280	
13.5	161.120	
14.2	160.800	
14.4	160.680	
15.5	159.840	
17.2	158.420	
19.2	156.870	Changed to remove the stich effect
19.7	156.510	
20.6	155.780	
21.4	155.440	
22.0	155.010	
22.7	154.750	
23.4	154.600	
24.0	154.570	
25.6	153.500	
26.9	152.250	
28.4	151.261	
29.1	150.800	
29.8	150.350	
30.5	150.010	Modified based on AECOM surveyed TWG
31.2	149.790	
31.9	149.590	
32.6	149.840	
33.3	150.160	
34.7	150.960	
35.5	151.400	
36.1	151.570	
36.8	151.600	
37.5	151.590	
39.0	151.380	Changed to remove the stich effect
40.4	151.290	
41.2	151.020	
41.8	151.000	
44.0	151.070	
45.2	151.080	
46.0	151.020	
48.9	151.050	
49.6	151.040	
52.4	151.040	
53.1	151.070	
54.5	151.040	
55.0	151.080	
58.8	151.070	
60.2	151.110	
60.9	151.070	
61.6	151.110	
63.0	151.120	
63.7	151.090	
66.5	151.110	
67.3	151.080	
68.7	151.110	
69.4	151.080	
73.6	151.150	
76.4	151.130	
78.3	151.180	
80.5	151.210	



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
0.0	167.210	0.025
0.8	167.440	
1.8	167.640	
2.9	167.620	
3.2	167.700	
4.0	167.590	
4.6	167.270	
5.5	166.640	
6.4	165.820	
7.1	165.330	
9.3	163.780	
10.0	163.340	
10.7	162.760	
12.1	161.880	
12.8	161.350	
13.5	161.160	
14.2	160.820	
15.5	159.840	
17.2	158.420	
19.2	156.870	
19.7	156.510	
20.6	155.780	
21.4	155.440	
22.0	155.010	
22.7	154.750	
23.4	154.600	
24.0	154.570	0.045
24.8	153.980	
25.6	153.340	0.08
26.2	152.440	
26.9	152.170	
27.7	151.670	
28.4	151.280	0.035
29.7	150.420	
30.5	150.010	
31.2	149.780	
31.9	149.870	
32.6	149.840	
33.3	150.110	
34.7	151.030	0.08
35.4	151.370	
36.1	151.600	
37.6	151.540	
39.0	151.380	
40.4	151.290	0.045
41.2	151.020	
41.8	151.000	0.025
44.0	151.070	
45.2	151.080	
46.0	151.020	
48.9	151.050	
49.6	151.040	
52.4	151.040	
53.1	151.070	
54.5	151.040	
55.0	151.080	
58.8	151.070	
60.2	151.110	
60.9	151.070	
61.6	151.110	
63.0	151.120	
63.7	151.090	
66.5	151.110	
67.3	151.080	
68.7	151.110	
69.4	151.080	
73.6	151.150	
76.4	151.130	
78.3	151.180	
80.5	151.210	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

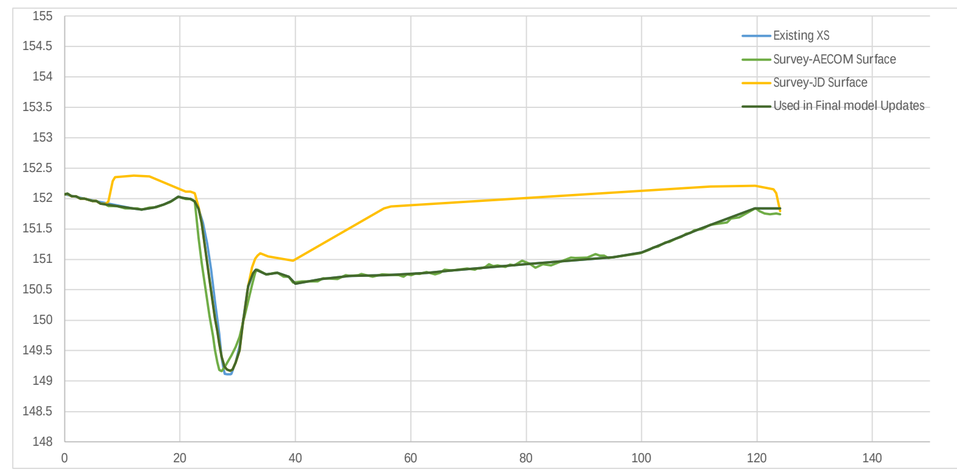
Station	Elevation	n Value
0.0	167.170	0.025
0.4	167.320	
0.8	167.430	
1.8	167.640	
2.2	167.630	
2.9	167.650	
3.2	167.700	
4.0	167.590	
4.6	167.270	
5.0	166.930	
5.5	166.640	
6.0	166.220	
6.4	165.840	
6.9	165.490	
7.1	165.320	
8.3	164.460	
8.6	164.310	
8.8	164.120	
9.3	163.790	
10.0	163.320	
10.7	162.770	
11.2	162.440	
12.1	161.860	
12.6	161.490	
12.8	161.370	
13.0	161.280	
13.5	161.120	
14.2	160.800	
14.4	160.680	
15.5	159.840	
17.2	158.420	
19.2	156.870	
19.7	156.510	
20.6	155.780	
21.4	155.440	
22.0	155.010	
22.7	154.750	
23.4	154.600	
24.0	154.570	0.045
25.6	153.500	0.08
26.9	152.250	
28.4	151.261	0.035
29.1	150.800	
29.8	150.350	
30.5	150.010	
31.2	149.790	
31.9	149.590	
32.6	149.840	
33.3	150.160	
34.7	150.960	0.08
35.5	151.400	
36.1	151.570	
36.8	151.600	
37.5	151.590	
39.0	151.380	
40.4	151.290	0.045
41.2	151.020	
41.8	151.000	0.016
44.0	151.070	
45.2	151.080	
46.0	151.020	
48.9	151.050	
49.6	151.040	
52.4	151.040	
53.1	151.070	
54.5	151.040	
55.0	151.080	
58.8	151.070	
60.2	151.110	
60.9	151.070	
61.6	151.110	
63.0	151.120	
63.7	151.090	
66.5	151.110	
67.3	151.080	
68.7	151.110	
69.4	151.080	
73.6	151.150	
76.4	151.130	
78.3	151.180	
80.5	151.210	

Existing XS	
Station	Elevation
0.0	152.070
5.6	151.950
11.8	151.840
13.3	151.820
15.4	151.850
17.2	151.900
18.6	151.960
19.7	152.030
20.4	152.010
21.8	151.990
22.5	151.950
23.2	151.830
24.0	151.610
24.7	151.260
25.4	150.840
26.1	150.310
26.8	149.770
27.2	149.390
27.5	149.200
27.7	149.120
28.2	149.110
28.8	149.110
28.9	149.120
29.6	149.310
30.3	149.570
31.0	150.080
31.7	150.490
31.8	150.560
32.6	150.770
33.0	150.820
33.2	150.830
34.9	150.750
36.0	150.770
36.9	150.780
38.8	150.710
40.0	150.600
44.5	150.680
49.5	150.730
55.9	150.740
63.0	150.780
67.1	150.820
80.7	150.930
95.1	151.040
100.0	151.110
110.0	151.500
119.7	151.840
124.0	151.840

Survey-AECOM Surface	
Station	Elevation
0.0	152.070
0.5	152.080
1.2	152.040
2.0	152.040
2.7	152.000
3.4	152.000
4.8	151.960
5.5	151.960
6.2	151.920
6.9	151.920
7.6	151.880
9.0	151.880
10.5	151.840
12.6	151.840
13.3	151.820
14.7	151.850
15.9	151.860
18.3	151.940
19.7	152.030
21.0	151.990
21.8	151.990
22.5	151.950
22.6	151.910
23.2	151.350
23.8	150.940
25.1	150.070
25.7	149.740
26.1	149.507
26.4	149.310
26.8	149.180
27.2	149.160
27.7	149.220
28.9	149.420
29.6	149.560
30.3	149.730
31.0	150.000
31.0	150.016
32.5	150.580
33.0	150.780
33.2	150.820
33.4	150.830
34.9	150.750
35.3	150.750
36.5	150.780
36.9	150.780
38.0	150.720
38.8	150.710
39.6	150.620
41.1	150.640
43.8	150.640
44.8	150.690
47.3	150.680
48.7	150.740
49.5	150.730
50.9	150.740
51.4	150.760
53.4	150.710
55.0	150.750
57.9	150.740
58.7	150.720
59.3	150.750
60.1	150.740
60.8	150.770
61.5	150.760
62.7	150.790
64.2	150.750
65.1	150.780
65.8	150.830
67.1	150.820
69.8	150.850
71.1	150.830
71.5	150.850
72.0	150.850
72.9	150.880
73.5	150.920
74.3	150.890
75.0	150.900
76.4	150.880
77.2	150.910
77.9	150.900
79.3	150.980
80.7	150.930
81.6	150.860
82.9	150.920
84.3	150.900
87.8	151.030
88.5	151.020
90.6	151.030
92.0	151.090
92.8	151.060
93.5	151.060
94.2	151.020
99.7	151.100
101.3	151.160
102.0	151.200
102.8	151.210
104.1	151.280
104.8	151.290
105.9	151.340
106.9	151.370
107.7	151.420
108.4	151.430
109.1	151.480
110.5	151.500
111.9	151.570
114.8	151.610
115.5	151.670
116.9	151.690
119.7	151.840
119.8	151.840
120.4	151.790
121.3	151.750
122.3	151.740
123.3	151.750
124.0	151.740

Survey-JD Surface	
Station	Elevation
0.0	152.070
0.5	152.080
1.2	152.040
2.0	152.040
2.7	152.000
3.4	152.000
4.8	151.960
5.5	151.960
6.2	151.920
7.1	151.910
7.6	151.950
8.3	152.290
8.7	152.350
12.0	152.380
14.7	152.360
21.0	152.110
21.8	152.110
22.5	152.090
22.6	152.070
23.2	151.860
23.8	151.590
25.1	150.660
26.1	150.027
26.4	149.820
26.8	149.610
27.2	149.400
27.5	149.290
27.7	149.240
28.2	149.190
28.7	149.170
29.1	149.190
29.6	149.300
30.3	149.500
31.0	150.030
31.0	150.057
31.8	150.560
32.5	150.870
33.0	151.010
33.4	151.060
33.9	151.100
35.3	151.050
39.6	150.980
55.3	151.840
56.6	151.870
111.9	152.200
119.7	152.210
122.9	152.150
123.3	152.090
124.0	151.790

Used in Final model Updates		
Station	Elevation	
0.0	152.070	
0.5	152.080	
1.2	152.040	
2.0	152.040	
2.7	152.000	
3.4	152.000	
4.8	151.960	
5.5	151.960	
6.2	151.920	
11.8	151.840	
13.3	151.820	
15.4	151.850	
17.2	151.900	
18.6	151.960	Changed to remove the stich effect
19.7	152.030	
20.4	152.010	
21.8	151.990	
22.5	151.950	
23.2	151.830	
23.8	151.590	
25.1	150.660	
26.1	150.027	
26.4	149.820	
26.8	149.610	
27.2	149.400	
27.5	149.290	
27.7	149.240	
28.2	149.190	
28.7	149.170	
29.1	149.190	
29.6	149.300	
30.3	149.500	
31.0	150.030	
31.0	150.057	
31.8	150.560	
32.6	150.770	
33.0	150.820	
33.2	150.830	
34.9	150.750	Changed to remove the stich effect
36.0	150.770	
36.9	150.780	
38.8	150.710	
40.0	150.600	
44.5	150.680	
49.5	150.730	
55.9	150.740	
63.0	150.780	
67.1	150.820	
80.7	150.930	
95.1	151.040	
100.0	151.110	
110.0	151.500	
119.7	151.840	
124.0	151.840	



Original

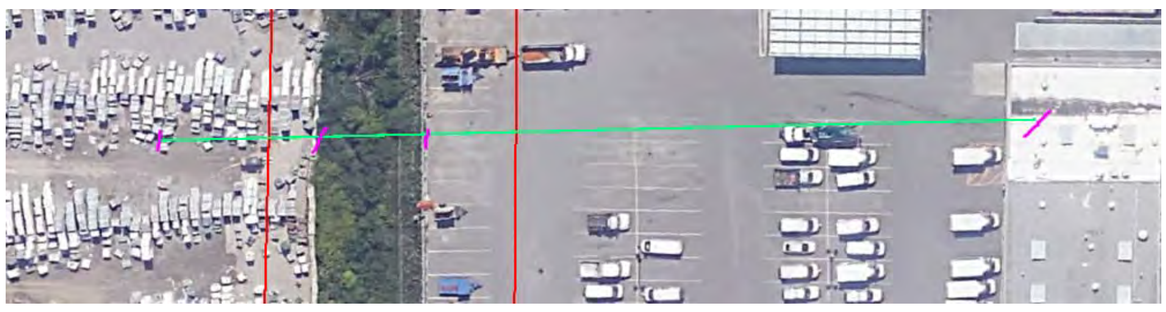
Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
0.0	152.070	0.025
5.6	151.950	
11.8	151.840	
13.3	151.820	
15.4	151.850	
17.2	151.900	
18.6	151.960	
19.7	152.030	
20.4	152.010	0.08
21.8	151.990	
22.5	151.950	
23.2	151.830	
24.0	151.610	
24.7	151.260	
25.4	150.840	
26.1	150.310	0.035
26.8	149.770	
27.2	149.390	
27.5	149.200	
27.7	149.120	
28.2	149.110	
28.8	149.110	
28.9	149.120	
29.6	149.310	
30.3	149.570	
31.0	150.080	0.08
31.7	150.490	
31.8	150.560	
32.6	150.770	
33.0	150.820	
33.2	150.830	
34.9	150.750	
36.0	150.770	0.025
36.9	150.780	
38.8	150.710	
40.0	150.600	
44.5	150.680	
49.5	150.730	
55.9	150.740	
63.0	150.780	
67.1	150.820	
80.7	150.930	
95.1	151.040	
100.0	151.110	
110.0	151.500	
119.7	151.840	
124.0	151.840	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
0.0	152.070	0.025
0.5	152.080	
1.2	152.040	
2.0	152.040	
2.7	152.000	
3.4	152.000	
4.8	151.960	
5.5	151.960	
6.2	151.920	
11.8	151.840	
13.3	151.820	
15.4	151.850	
17.2	151.900	
18.6	151.960	
19.7	152.030	
20.4	152.010	0.08
21.8	151.990	
22.5	151.950	
23.2	151.830	
23.8	151.590	
25.1	150.660	
26.1	150.027	0.035
26.4	149.820	
26.8	149.610	
27.2	149.400	
27.5	149.290	
27.7	149.240	
28.2	149.190	
28.7	149.170	
29.1	149.190	
29.6	149.300	
30.3	149.500	
31.0	150.030	
31.0	150.057	0.08
31.8	150.560	
32.6	150.770	
33.0	150.820	
33.2	150.830	
34.9	150.750	
36.0	150.770	0.016
36.9	150.780	
38.8	150.710	
40.0	150.600	
44.5	150.680	
49.5	150.730	
55.9	150.740	
63.0	150.780	
67.1	150.820	
80.7	150.930	
95.1	151.040	
100.0	151.110	
110.0	151.500	
119.7	151.840	
124.0	151.840	

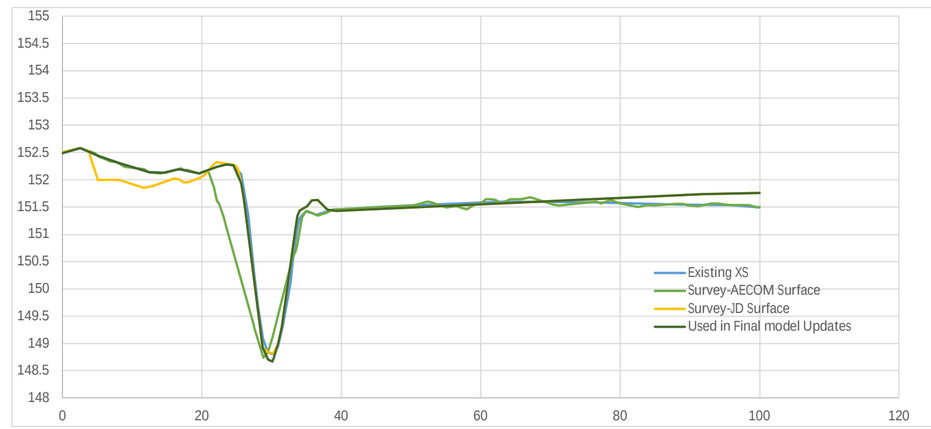


Existing XS	
Station	Elevation
0.0	152.490
2.6	152.580
5.1	152.440
8.2	152.300
11.0	152.200
12.4	152.140
14.6	152.130
16.7	152.200
19.6	152.120
22.2	152.240
23.5	152.280
24.5	152.270
25.6	152.100
26.6	151.360
27.5	150.310
28.0	149.690
28.7	149.080
29.5	148.840
30.1	148.800
30.9	148.940
31.6	149.300
32.7	150.130
33.0	150.440
33.4	150.830
33.7	151.150
34.0	151.300
34.9	151.420
35.8	151.390
36.5	151.360
38.7	151.450
41.9	151.470
44.0	151.490
49.8	151.530
63.5	151.600
76.0	151.590
88.9	151.550
95.7	151.540
100.0	151.490

Survey-AECOM Surface	
Station	Elevation
0.0	152.500
2.5	152.580
4.6	152.490
5.3	152.420
6.0	152.390
6.8	152.340
7.8	152.320
8.9	152.240
11.7	152.190
12.4	152.140
13.9	152.120
14.8	152.130
17.0	152.210
17.4	152.180
17.9	152.180
19.6	152.120
20.9	152.170
21.7	151.870
22.2	151.610
22.4	151.580
22.6	151.510
23.1	151.320
23.5	151.130
27.5	149.323
27.5	149.300
28.8	148.740
29.5	148.850
30.1	149.100
32.7	150.440
32.7	150.444
33.0	150.570
33.4	150.680
33.7	150.820
34.4	151.310
34.9	151.420
35.1	151.430
36.6	151.350
38.0	151.400
38.7	151.450
50.3	151.530
52.4	151.600
52.9	151.590
55.0	151.490
56.5	151.520
58.0	151.460
59.0	151.540
59.3	151.560
59.6	151.560
60.0	151.570
60.7	151.640
61.4	151.640
62.1	151.630
62.9	151.570
64.2	151.640
65.8	151.640
67.1	151.680
70.4	151.550
71.3	151.530
75.6	151.590
76.6	151.600
77.3	151.570
78.7	151.630
80.0	151.570
82.6	151.500
83.9	151.540
84.8	151.530
87.9	151.560
89.0	151.560
89.8	151.530
91.2	151.520
93.1	151.570
94.0	151.570
95.7	151.540
98.4	151.540
99.7	151.490
100.0	151.500

Survey-JD Surface	
Station	Elevation
0.0	152.500
2.5	152.580
3.2	152.550
3.8	152.520
3.9	152.490
4.0	152.410
5.1	151.990
6.8	152.000
8.2	151.990
11.7	151.850
13.0	151.890
16.0	152.030
16.7	152.010
17.4	151.950
17.9	151.950
19.5	152.020
20.2	152.070
20.9	152.160
21.7	152.290
22.2	152.320
24.8	152.270
25.2	152.190
25.6	151.940
25.9	151.730
26.1	151.530
27.5	150.175
28.7	148.920
29.5	148.840
30.1	148.820
30.3	148.830
30.9	148.980
31.4	149.300
32.7	150.479
33.4	151.100
33.7	151.340
34.0	151.440
35.1	151.520
35.8	151.620
36.6	151.630
38.0	151.450
39.3	151.430
91.9	151.740
100.0	151.760

Used in Final model Updates		
Station	Elevation	
0.0	152.490	
2.6	152.580	
5.1	152.440	
8.2	152.300	
11.0	152.200	
12.4	152.140	
14.6	152.130	
16.7	152.200	
19.6	152.120	
22.2	152.240	
23.5	152.280	Changed to remove the stich effect
24.5	152.270	
25.6	151.940	
25.9	151.730	
26.1	151.530	
27.5	150.175	
28.7	148.920	
29.5	148.700	
30.1	148.670	Modified based on AECOM surveyed TWG
30.3	148.720	
30.9	148.980	
31.4	149.300	
32.7	150.479	
33.4	151.100	
33.7	151.340	
34.0	151.440	
35.1	151.520	
35.8	151.620	
36.6	151.630	
38.0	151.450	
39.3	151.430	
91.9	151.740	
100.0	151.760	



Original	
Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M2
Station	Elevation	n Value
0.0	152.490	0.025
2.6	152.580	
5.1	152.440	
8.2	152.300	
11.0	152.200	
12.4	152.140	
14.6	152.130	
16.7	152.200	
19.6	152.120	
22.2	152.240	0.08
23.5	152.280	
24.5	152.270	
25.6	152.100	
26.6	151.360	
27.5	150.310	0.035
28.0	149.690	
28.7	149.080	
29.5	148.840	
30.1	148.800	
30.9	148.940	
31.6	149.300	
32.7	150.130	0.08
33.0	150.440	
33.4	150.830	
33.7	151.150	
34.0	151.300	
34.9	151.420	0.025
35.8	151.390	
36.5	151.360	
38.7	151.450	
41.9	151.470	
44.0	151.490	
49.8	151.530	
63.5	151.600	
76.0	151.590	
88.9	151.550	
95.7	151.540	
100.0	151.490	

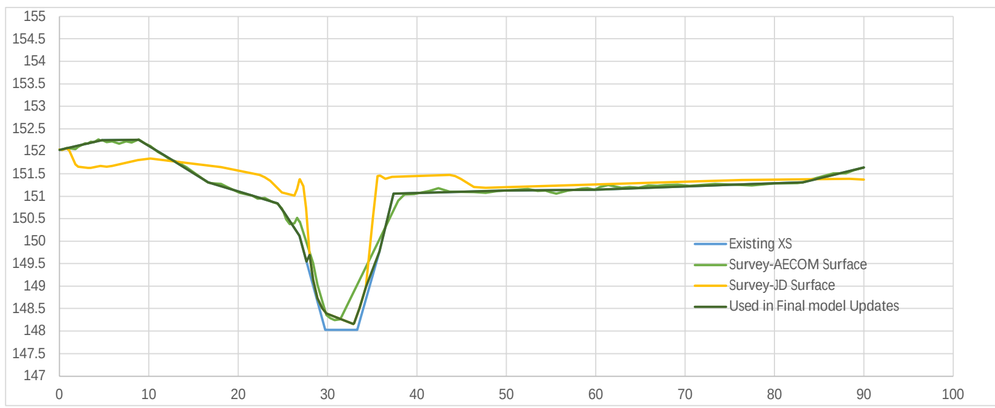
Updated Existing	
Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M2
Station	Elevation	n Value
0.0	152.490	0.016
2.6	152.580	
5.1	152.440	
8.2	152.300	
11.0	152.200	
12.4	152.140	
14.6	152.130	
16.7	152.200	
19.6	152.120	
22.2	152.240	0.08
23.5	152.280	
24.5	152.270	
25.6	151.940	
25.9	151.730	
26.1	151.530	
27.5	150.175	0.035
28.7	148.920	
29.5	148.700	
30.1	148.670	
30.3	148.720	
30.9	148.980	
31.4	149.300	
32.7	150.479	0.08
33.4	151.100	
33.7	151.340	
34.0	151.440	
35.1	151.520	0.016
35.8	151.620	
36.6	151.630	
38.0	151.450	
39.3	151.430	
91.9	151.740	
100.0	151.760	

Existing XS	
Station	Elevation
0.0	152.030
4.8	152.250
8.9	152.260
12.8	151.780
16.6	151.310
21.6	151.010
24.4	150.840
25.1	150.650
26.9	150.120
27.6	149.550
29.7	148.030
33.3	148.030
35.8	149.770
37.4	151.060
49.9	151.130
59.9	151.140
75.4	151.260
83.2	151.310
90.0	151.640

Survey-AECOM Surface	
Station	Elevation
0.0	152.040
0.3	152.030
0.8	152.070
1.8	152.050
2.1	152.100
2.9	152.180
3.2	152.170
3.5	152.210
3.9	152.200
4.4	152.260
4.6	152.240
4.8	152.250
5.3	152.200
5.9	152.220
6.7	152.170
7.5	152.220
8.1	152.190
8.9	152.270
9.6	152.170
10.2	152.120
11.0	151.990
11.7	151.910
12.4	151.810
13.4	151.750
13.8	151.690
14.2	151.650
16.6	151.310
16.9	151.290
18.1	151.270
18.8	151.200
20.2	151.070
21.6	151.010
22.2	150.940
23.0	150.960
23.9	150.870
24.4	150.840
24.9	150.730
25.1	150.650
25.4	150.480
25.8	150.380
26.3	150.400
26.6	150.520
26.9	150.433
26.9	150.430
28.4	149.510
28.9	149.030
29.4	148.680
29.9	148.360
30.3	148.290
30.8	148.250
31.4	148.260
31.6	148.320
35.8	150.044
37.9	150.900
38.6	151.040
39.7	151.050
41.4	151.120
42.4	151.180
43.7	151.100
46.4	151.090
47.7	151.070
49.1	151.120
51.3	151.140
52.4	151.160
53.5	151.120
54.4	151.130
54.9	151.090
55.6	151.060
56.9	151.130
57.7	151.140
58.5	151.170
59.1	151.180
59.9	151.140
60.5	151.200
61.4	151.250
62.9	151.190
63.8	151.200
64.8	151.190
65.9	151.240
66.9	151.230
67.8	151.250
69.2	151.260
70.5	151.230
73.4	151.270
77.5	151.240
79.9	151.280
82.6	151.290
83.2	151.310
83.9	151.360
86.6	151.510
88.0	151.510
88.9	151.580
90.0	151.640

Survey-JD Surface	
Station	Elevation
0.0	152.040
0.3	152.030
0.8	152.070
1.1	152.020
1.8	151.710
2.1	151.660
3.2	151.630
3.5	151.630
4.6	151.670
5.3	151.660
5.9	151.670
8.8	151.800
10.2	151.840
18.1	151.650
22.4	151.470
23.0	151.420
23.6	151.340
24.9	151.080
26.3	151.010
26.6	151.160
26.9	151.373
26.9	151.380
27.3	151.220
27.6	150.730
28.0	149.690
28.4	149.140
28.9	148.730
29.4	148.510
29.9	148.390
32.9	148.160
33.0	148.170
33.6	148.510
34.3	148.970
35.1	150.510
35.6	151.450
35.8	151.457
35.9	151.460
36.5	151.390
37.2	151.430
43.7	151.470
44.3	151.450
44.9	151.390
46.4	151.200
47.7	151.190
76.4	151.360
88.4	151.390
90.0	151.370

Used in Final model Updates		
Station	Elevation	
0.0	152.030	
4.8	152.250	
8.9	152.260	
12.8	151.780	
16.6	151.310	
21.6	151.010	
24.4	150.840	
25.1	150.650	
26.9	150.120	
27.6	149.550	Changed to remove the stich effect
28.0	149.690	
28.4	149.140	
28.9	148.730	
29.4	148.510	
29.9	148.390	
32.9	148.160	
33.0	148.170	
33.6	148.510	
34.3	148.970	
35.8	149.770	
37.4	151.060	
49.9	151.130	
59.9	151.140	
75.4	151.260	
83.2	151.310	
90.0	151.640	Changed to remove the stich effect



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	152.030	0.08
4.8	152.250	
8.9	152.260	
12.8	151.780	
16.6	151.310	
21.6	151.010	
24.4	150.840	
25.1	150.650	
26.9	150.120	0.035
27.6	149.550	
29.7	148.030	
33.3	148.030	
35.8	149.770	0.08
37.4	151.060	0.025
49.9	151.130	
59.9	151.140	
75.4	151.260	
83.2	151.310	
90.0	151.640	

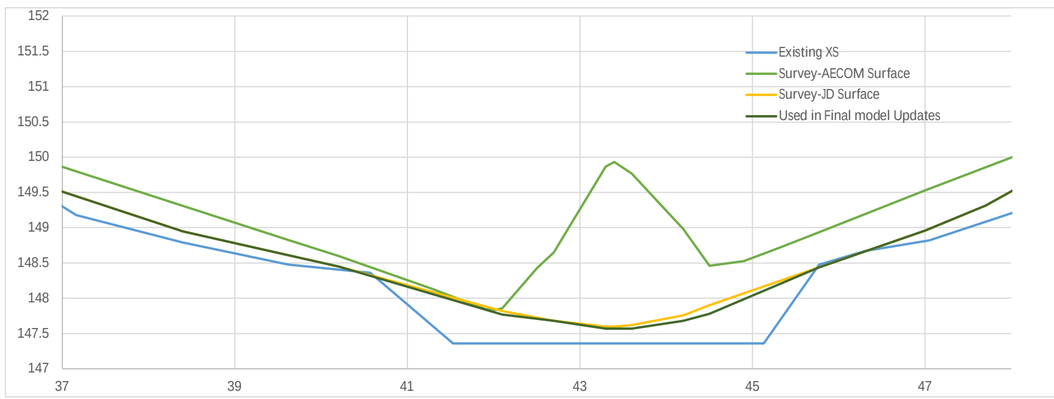
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	152.030	0.08
4.8	152.250	
8.9	152.260	
12.8	151.780	
16.6	151.310	
21.6	151.010	
24.4	150.840	
25.1	150.650	
26.9	150.120	0.035
27.6	149.550	
28.0	149.690	
28.4	149.140	
28.9	148.730	
29.4	148.510	
29.9	148.390	
32.9	148.160	
33.0	148.170	
33.6	148.510	
34.3	148.970	
35.8	149.770	0.08
37.4	151.060	0.016
49.9	151.130	
59.9	151.140	
75.4	151.260	
83.2	151.310	
90.0	151.640	

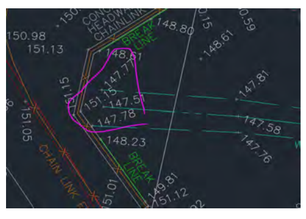
Existing XS	
Station	Elevation
0.0	150.470
7.6	150.630
15.5	150.580
25.5	150.610
31.6	150.590
32.7	150.700
33.3	150.830
34.1	150.720
35.1	150.550
35.9	150.130
37.2	149.180
38.4	148.790
39.6	148.480
40.6	148.360
41.5	147.360
45.1	147.360
45.8	148.480
46.3	148.670
47.1	148.820
48.8	149.510
49.9	150.410
50.7	150.840
51.9	151.010
53.4	151.010
60.1	150.990
63.9	151.100
66.2	150.990
70.6	150.850
75.0	150.750

Survey-AECOM Surface	
Station	Elevation
0.0	150.470
2.7	150.510
4.2	150.570
6.9	150.600
7.6	150.630
8.3	150.600
9.0	150.590
9.8	150.570
14.8	150.590
15.5	150.580
17.6	150.640
19.6	150.550
23.6	150.600
26.1	150.610
29.8	150.580
31.3	150.590
32.0	150.610
32.7	150.700
33.5	150.840
34.1	150.720
34.7	150.590
35.0	150.550
35.6	150.430
35.9	150.320
36.3	150.150
36.8	149.940
39.6	148.829
40.2	148.600
41.3	148.130
41.9	147.850
42.0	147.830
42.1	147.860
42.5	148.430
42.7	148.650
43.3	149.870
43.4	149.930
43.6	149.770
44.2	148.980
44.5	148.460
44.9	148.530
45.3	148.710
45.8	148.937
47.0	149.530
48.2	150.090
48.5	150.110
48.8	149.990
49.2	149.880
49.5	149.990
49.9	150.410
50.6	150.800
50.7	150.840
51.9	151.010
52.1	151.020
55.2	151.030
56.3	150.990
57.3	150.990
59.5	150.960
60.7	151.010
62.6	151.020
63.1	151.040
63.7	151.100
63.9	151.100
65.8	151.020
66.9	150.960
67.5	150.910
67.9	150.850
70.2	150.860
71.1	150.840
71.7	150.790
72.1	150.780
72.5	150.820
73.2	150.850
75.0	150.750

Survey-JD Surface	
Station	Elevation
0.0	150.470
2.7	150.510
4.2	150.570
6.9	150.600
7.6	150.630
8.3	150.600
9.0	150.590
9.8	150.570
11.3	150.570
11.9	150.650
12.6	150.860
12.8	150.860
14.5	150.810
16.2	150.690
19.9	150.600
20.5	150.630
22.4	150.860
22.7	150.870
23.4	150.830
24.8	150.660
25.5	150.690
26.2	150.820
26.5	150.830
30.5	150.780
34.7	151.000
34.8	150.950
35.6	150.190
35.9	149.960
38.4	148.950
39.6	148.611
40.2	148.450
42.1	147.820
42.7	147.680
43.3	147.600
43.4	147.600
43.6	147.620
44.2	147.760
44.5	147.900
45.8	148.439
47.0	148.960
47.7	149.310
48.2	149.650
48.5	149.930
48.8	150.040
49.5	150.610
49.9	150.890
50.5	151.040
50.6	151.040
50.7	151.070
51.9	151.370
52.1	151.420
53.1	151.340
54.2	151.250
54.4	151.240
55.2	151.150
56.0	151.160
56.3	151.140
57.3	151.140
59.5	150.970
59.9	150.960
60.5	150.910
61.6	150.630
61.7	150.650
62.3	150.610
62.6	150.710
63.1	150.930
63.3	150.980
63.7	151.100
65.8	151.020
67.0	150.950
67.9	150.850
70.2	150.860
71.1	150.840
71.7	150.790
72.1	150.780
72.5	150.820
73.2	150.850
75.0	150.750

Used in Final model Updates		
Station	Elevation	
0.0	150.470	
2.7	150.510	
4.2	150.570	
6.9	150.600	
7.6	150.630	
8.3	150.600	
9.0	150.590	
9.8	150.570	
11.3	150.570	
11.9	150.650	
12.6	150.860	
12.8	150.860	
14.5	150.810	
16.2	150.690	
19.9	150.600	
20.5	150.630	
22.4	150.860	
22.7	150.870	
23.4	150.830	
24.8	150.660	
25.5	150.690	
26.2	150.820	
26.5	150.830	
30.5	150.780	
34.7	151.000	
34.8	150.950	
35.6	150.190	
35.9	149.960	
38.4	148.950	
39.6	148.611	
40.2	148.450	
42.1	147.770	
42.7	147.680	
43.3	147.570	Updated based on JDB survey
43.4	147.570	
43.6	147.570	
44.2	147.680	
44.5	147.780	
45.8	148.439	
47.0	148.960	
47.7	149.310	
48.2	149.650	
48.5	149.930	
48.8	150.040	
49.5	150.610	
49.9	150.890	
50.5	151.040	
50.6	151.040	
50.7	151.070	
51.9	151.370	
52.1	151.420	
53.1	151.340	
54.2	151.250	
54.4	151.240	
55.2	151.150	
56.0	151.160	
56.3	151.140	
57.3	151.140	
59.5	150.970	
59.9	150.960	
60.5	150.910	
61.6	150.630	
61.7	150.650	
62.3	150.610	
62.6	150.710	
63.1	150.930	
63.3	150.980	
63.7	151.100	
65.8	151.020	
67.0	150.950	
67.9	150.850	
70.2	150.860	
71.1	150.840	
71.7	150.790	
72.1	150.780	
72.5	150.820	
73.2	150.850	
75.0	150.750	





Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	150.470	0.025
7.6	150.630	
15.5	150.580	
25.5	150.610	
31.6	150.590	
32.7	150.700	
33.3	150.830	
34.1	150.720	0.08
35.1	150.550	
35.9	150.130	
37.2	149.180	
38.4	148.790	
39.6	148.480	0.035
40.6	148.360	
41.5	147.360	
45.1	147.360	
45.8	148.480	0.08
46.3	148.670	
47.1	148.820	
48.8	149.510	
49.9	150.410	
50.7	150.840	
51.9	151.010	0.045
53.4	151.010	0.025
60.1	150.990	
63.9	151.100	
66.2	150.990	
70.6	150.850	
75.0	150.750	

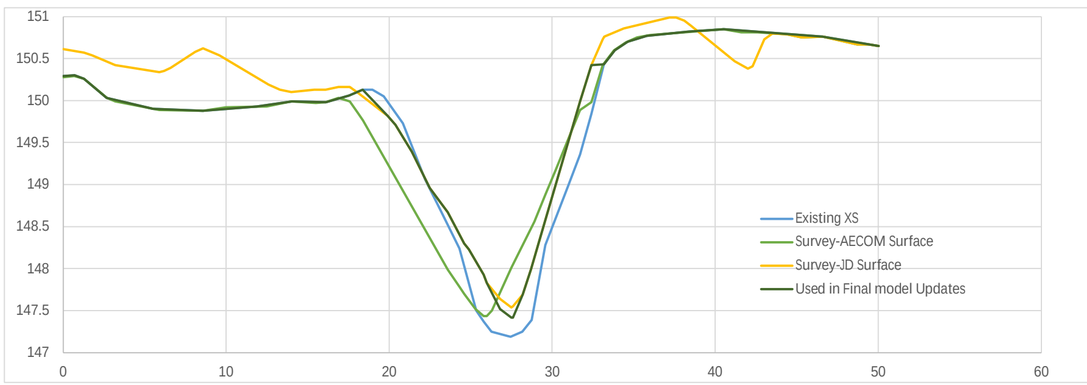
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	150.470	0.025
2.7	150.510	
4.2	150.570	
6.9	150.600	
7.6	150.630	
8.3	150.600	
9.0	150.590	
9.8	150.570	
11.3	150.570	
11.9	150.650	
12.6	150.860	
12.8	150.860	
14.5	150.810	
16.2	150.690	
19.9	150.600	
20.5	150.630	
22.4	150.860	
22.7	150.870	
23.4	150.830	
24.8	150.660	
25.5	150.690	
26.2	150.820	
26.5	150.830	
30.5	150.780	
34.7	151.000	0.08
34.8	150.950	
35.6	150.190	
35.9	149.960	
38.4	148.950	
39.6	148.611	0.035
40.2	148.450	
42.1	147.770	
42.7	147.680	
43.3	147.570	
43.4	147.570	
43.6	147.570	
44.2	147.680	
44.5	147.780	
45.8	148.439	0.08
47.0	148.960	
47.7	149.310	
48.2	149.650	
48.5	149.930	
48.8	150.040	
49.5	150.610	
49.9	150.890	
50.5	151.040	
50.6	151.040	
50.7	151.070	
51.9	151.370	0.045
52.1	151.420	
53.1	151.340	0.025
54.2	151.250	
54.4	151.240	
55.2	151.150	
56.0	151.160	
56.3	151.140	
57.3	151.140	
59.5	150.970	
59.9	150.960	
60.5	150.910	
61.6	150.630	
61.7	150.650	
62.3	150.610	
62.6	150.710	
63.1	150.930	
63.3	150.980	
63.7	151.100	
65.8	151.020	
67.0	150.950	
67.9	150.850	
70.2	150.860	
71.1	150.840	
71.7	150.790	
72.1	150.780	
72.5	150.820	
73.2	150.850	
75.0	150.750	

Existing XS	
Station	Elevation
0.0	150.290
0.7	150.300
1.3	150.260
2.7	150.030
5.5	149.900
8.6	149.880
11.9	149.930
14.0	149.990
16.1	149.980
17.6	150.060
18.4	150.130
19.0	150.130
19.7	150.050
20.8	149.730
22.2	149.060
23.2	148.670
24.3	148.240
25.3	147.500
25.8	147.370
26.3	147.250
27.3	147.200
27.5	147.190
28.2	147.250
28.7	147.390
29.6	148.280
31.0	148.990
31.7	149.360
32.4	149.840
33.2	150.430
33.8	150.600
34.6	150.700
35.8	150.770
38.4	150.820
40.5	150.850
46.6	150.760
50.0	150.650

Survey-AECOM Surface	
Station	Elevation
0.0	150.280
0.7	150.290
1.3	150.260
2.7	150.030
3.2	149.990
5.9	149.890
8.6	149.880
10.0	149.920
12.5	149.930
14.0	149.990
15.5	149.970
16.1	149.980
16.9	150.030
17.6	149.990
18.1	149.850
18.4	149.760
23.6	147.990
24.3	147.784
24.6	147.700
25.3	147.520
25.8	147.440
26.0	147.440
26.3	147.500
27.5	148.010
28.9	148.560
29.6	148.879
30.2	149.170
31.7	149.890
32.4	149.980
33.1	150.420
33.8	150.600
34.5	150.690
35.2	150.750
36.0	150.780
40.5	150.850
41.6	150.810
42.6	150.810
44.4	150.790
45.3	150.750
46.6	150.760
48.7	150.670
49.4	150.670
50.0	150.650

Survey-JD Surface	
Station	Elevation
0.0	150.610
1.3	150.570
1.8	150.540
3.2	150.420
5.9	150.340
6.2	150.350
6.6	150.390
8.1	150.580
8.6	150.620
9.6	150.540
12.6	150.190
13.3	150.130
14.0	150.100
15.4	150.130
16.1	150.130
16.9	150.160
17.6	150.160
18.1	150.090
19.9	149.820
20.4	149.710
21.4	149.390
22.5	148.960
23.6	148.670
24.3	148.407
24.6	148.300
24.9	148.230
25.8	147.930
26.0	147.830
26.8	147.640
27.5	147.540
27.6	147.550
28.2	147.690
28.7	147.990
29.6	148.577
31.7	149.990
32.4	150.420
33.1	150.730
33.2	150.760
34.4	150.860
37.2	150.990
37.6	150.990
38.1	150.950
38.5	150.890
41.2	150.470
42.0	150.380
42.3	150.410
43.0	150.730
43.5	150.800
44.4	150.790
45.3	150.750
46.6	150.760
48.7	150.670
49.4	150.670
50.0	150.650

Used in Final model Updates		
Station	Elevation	
0.0	150.290	
0.7	150.300	
1.3	150.260	
2.7	150.030	
5.5	149.900	
8.6	149.880	
11.9	149.930	
14.0	149.990	
16.1	149.980	Changed to remove the stich effect
17.6	150.060	
18.4	150.130	
19.9	149.820	
20.4	149.710	
21.4	149.390	
22.5	148.960	
23.6	148.670	
24.3	148.407	
24.6	148.300	
24.9	148.230	
25.8	147.930	
26.0	147.830	
26.8	147.520	
27.5	147.420	
27.6	147.420	
28.2	147.690	
28.7	147.990	
29.6	148.577	
31.7	149.990	
32.4	150.420	
33.2	150.430	Modified based on AECOM surveyed TWG
33.8	150.600	
34.6	150.700	
35.8	150.770	
38.4	150.820	Changed to remove the stich effect
40.5	150.850	
46.6	150.760	
50.0	150.650	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	150.290	0.025
0.7	150.300	
1.3	150.260	
2.7	150.030	
5.5	149.900	
8.6	149.880	
11.9	149.930	
14.0	149.990	
16.1	149.980	
17.6	150.060	0.08
18.4	150.130	
19.0	150.130	
19.7	150.050	
20.8	149.730	
22.2	149.060	
23.2	148.670	
24.3	148.240	0.035
25.3	147.500	
25.8	147.370	
26.3	147.250	
27.3	147.200	
27.5	147.190	
28.2	147.250	
28.7	147.390	
29.6	148.280	0.08
31.0	148.990	
31.7	149.360	
32.4	149.840	
33.2	150.430	0.025
33.8	150.600	
34.6	150.700	
35.8	150.770	
38.4	150.820	
40.5	150.850	
46.6	150.760	
50.0	150.650	

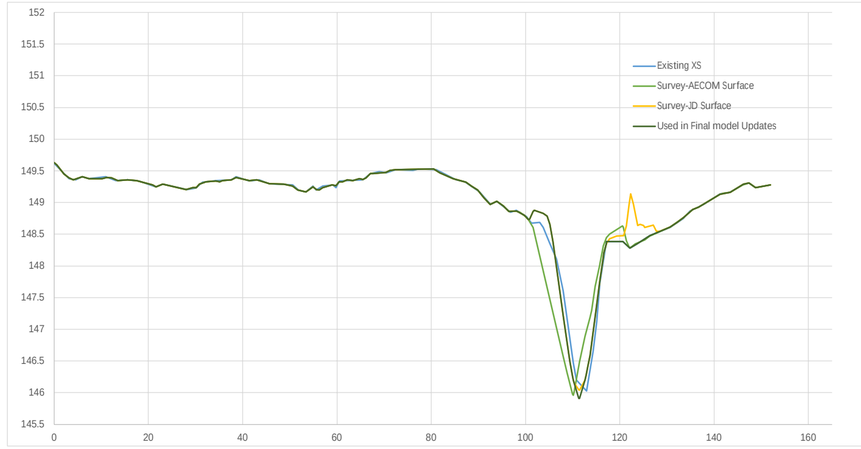
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	150.290	0.025
0.7	150.300	
1.3	150.260	
2.7	150.030	
5.5	149.900	
8.6	149.880	
11.9	149.930	
14.0	149.990	
16.1	149.980	
17.6	150.060	0.08
18.4	150.130	
19.9	149.820	
20.4	149.710	
21.4	149.390	
22.5	148.960	
23.6	148.670	
24.3	148.407	0.035
24.6	148.300	
24.9	148.230	
25.8	147.930	
26.0	147.830	
26.8	147.520	
27.5	147.420	
27.6	147.420	
28.2	147.690	
28.7	147.990	
29.6	148.577	0.08
31.7	149.990	
32.4	150.420	
33.2	150.430	0.025
33.8	150.600	
34.6	150.700	
35.8	150.770	
38.4	150.820	
40.5	150.850	
46.6	150.760	
50.0	150.650	

Existing XS	
Station	Elevation
0.0	149.620
3.2	149.380
4.6	149.360
6.0	149.410
7.4	149.380
11.0	149.410
13.1	149.350
15.6	149.360
18.0	149.340
21.6	149.250
23.1	149.290
28.3	149.210
30.1	149.230
31.5	149.320
34.3	149.350
37.6	149.360
38.6	149.410
41.4	149.340
43.5	149.360
45.7	149.300
50.6	149.280
51.9	149.190
53.5	149.170
54.9	149.260
55.6	149.200
57.0	149.260
59.1	149.280
59.8	149.240
60.5	149.340
65.5	149.360
67.1	149.460
69.0	149.490
70.5	149.470
72.4	149.520
76.1	149.510
77.2	149.530
81.1	149.520
85.3	149.360
87.2	149.330
90.3	149.170
92.5	148.970
93.9	149.020
96.8	148.850
98.1	148.880
100.2	148.780
101.3	148.680
103.0	148.690
103.7	148.610
105.1	148.370
106.6	148.110
108.0	147.610
110.1	146.470
110.8	146.200
113.0	146.030
114.4	146.660
115.1	147.120
115.8	147.730
117.2	148.390
120.7	148.390
122.2	148.280
123.8	148.360
126.4	148.480
130.7	148.610
133.5	148.750
134.9	148.870
137.7	148.970
141.3	149.140
143.4	149.160
146.1	149.280
147.4	149.310
148.8	149.240
151.9	149.280

Survey-AECOM Surface	
Station	Elevation
0.0	149.630
0.6	149.590
2.1	149.450
3.2	149.390
4.1	149.360
6.0	149.410
7.4	149.380
10.2	149.380
11.1	149.400
12.2	149.390
13.5	149.350
15.6	149.360
17.5	149.350
20.9	149.280
21.6	149.250
23.0	149.290
28.0	149.210
29.4	149.240
30.1	149.240
30.8	149.290
32.2	149.330
34.3	149.340
35.1	149.330
35.7	149.350
37.6	149.360
38.6	149.400
41.4	149.350
43.0	149.360
45.7	149.300
48.7	149.290
50.6	149.260
51.7	149.200
53.4	149.170
54.9	149.250
55.6	149.210
56.2	149.200
57.0	149.240
59.0	149.280
59.8	149.270
60.5	149.330
61.2	149.330
62.2	149.360
63.4	149.350
64.8	149.380
65.5	149.370
66.2	149.390
67.1	149.460
70.4	149.480
71.2	149.510
72.4	149.520
80.5	149.530
81.8	149.470
84.6	149.380
87.4	149.320
88.5	149.260
89.8	149.200
91.2	149.080
92.5	148.970
93.9	149.020
95.3	148.950
96.5	148.860
97.9	148.870
98.8	148.850
100.2	148.770
100.6	148.730
100.9	148.700
101.6	148.610
101.9	148.530
105.9	147.240
108.0	146.577
108.8	146.320
109.9	145.980
110.1	145.960
110.3	146.010
111.5	146.490
112.6	146.890
113.7	147.190
114.0	147.300
114.8	147.680
115.8	148.023
115.8	148.030
116.5	148.320
117.2	148.450
117.8	148.500
120.6	148.630
120.7	148.620
121.4	148.400
122.0	148.300
122.2	148.290
123.3	148.350
125.3	148.410
126.4	148.470
130.7	148.620
133.5	148.760
135.4	148.890
136.7	148.930
141.3	149.130
142.1	149.150
143.4	149.160
146.1	149.280
146.9	149.300
147.4	149.310
148.8	149.240
151.9	149.280

Survey-JD Surface	
Station	Elevation
0.0	149.630
0.6	149.590
2.1	149.450
3.2	149.390
4.1	149.360
6.0	149.410
7.4	149.380
10.2	149.380
11.1	149.400
12.2	149.390
13.5	149.350
15.6	149.360
17.5	149.350
20.9	149.280
21.6	149.250
23.0	149.290
28.0	149.210
29.4	149.240
30.1	149.240
30.8	149.290
32.2	149.330
34.3	149.340
35.1	149.330
35.7	149.350
37.6	149.360
38.6	149.400
41.4	149.350
43.0	149.360
45.7	149.300
48.7	149.290
50.6	149.260
51.7	149.200
53.4	149.170
54.9	149.250
55.6	149.210
56.2	149.200
57.0	149.240
59.0	149.280
59.8	149.270
60.5	149.330
61.2	149.330
62.2	149.360
63.4	149.350
64.8	149.380
65.5	149.370
66.2	149.390
67.1	149.460
67.6	149.460
70.4	149.480
71.2	149.510
72.4	149.520
80.5	149.530
81.8	149.470
84.6	149.380
87.4	149.320
88.5	149.260
89.8	149.200
91.2	149.080
92.5	148.970
93.9	149.020
95.3	148.950
96.5	148.860
98.1	148.870
99.8	148.800
100.6	148.730
100.9	148.740
101.6	148.860
101.9	148.880
103.7	148.830
104.6	148.790
105.2	148.660
105.8	148.380
108.0	147.227
108.8	146.800
109.4	146.500
109.9	146.260
110.1	146.200
110.3	146.160
111.3	146.050
111.5	146.040
112.6	146.200
112.9	146.280
113.3	146.440
113.7	146.590
115.8	147.766
116.3	148.060
116.5	148.140
116.6	148.200
117.2	148.360
117.8	148.430
119.3	148.470
120.8	148.480
121.4	148.630
122.0	148.970
122.3	149.140
122.9	148.980
123.8	148.640
124.3	148.660
125.0	148.640
125.3	148.610
127.1	148.650
127.8	148.550
128.4	148.550
130.7	148.620
132.1	148.690
133.5	148.760
135.4	148.890
136.7	148.930
141.3	149.130
143.4	149.160
146.2	149.290
147.4	149.310
148.8	149.240
151.9	149.280

Used in Final model Updates		
Station	Elevation	
0.0	149.630	
0.6	149.590	
2.1	149.450	
3.2	149.390	
4.1	149.360	
6.0	149.410	
7.4	149.380	
10.2	149.380	
11.1	149.400	
12.2	149.390	
13.5	149.350	
15.6	149.360	
17.5	149.350	
20.9	149.280	
21.6	149.250	
23.0	149.290	
28.0	149.210	
29.4	149.240	
30.1	149.240	
30.8	149.290	
32.2	149.330	
34.3	149.340	
35.1	149.330	
35.7	149.350	
37.6	149.360	
38.6	149.400	
41.4	149.350	
43.0	149.360	
45.7	149.300	
48.7	149.290	
50.6	149.260	
51.7	149.200	
53.4	149.170	
54.9	149.250	
55.6	149.210	
56.2	149.200	
57.0	149.240	
59.0	149.280	
59.8	149.270	
60.5	149.330	
61.2	149.330	
62.2	149.360	
63.4	149.350	
64.8	149.380	
65.5	149.370	
66.2	149.390	
67.1	149.460	
67.6	149.460	
70.4	149.480	
71.2	149.510	
72.4	149.520	
80.5	149.530	
81.8	149.470	
84.6	149.380	
87.4	149.320	
88.5	149.260	
89.8	149.200	
91.2	149.080	
92.5	148.970	
93.9	149.020	
95.3	148.950	
96.5	148.860	
98.1	148.870	
99.8	148.800	
100.6	148.730	
100.9	148.740	
101.6	148.860	
101.9	148.880	
103.7	148.830	
104.6	148.790	
105.2	148.660	
105.8	148.380	
108.0	147.227	
108.8	146.800	
109.4	146.500	
109.9	146.260	
110.1	146.200	
110.3	146.160	
111.3	145.910	
111.5	145.910	Modified based on AECOM surveyed TWG
112.6	146.200	
112.9	146.280	
113.3	146.440	
113.7	146.590	
115.8	147.766	
116.3	148.060	
116.5	148.140	
116.6	148.200	
117.2	148.360	
117.2	148.390	
120.7	148.390	
122.2	148.280	
123.8	148.360	Changed to remove the stich effect
126.4	148.480	
130.7	148.620	
132.1	148.690	
133.5	148.760	
135.4	148.890	
136.7	148.930	
141.3	149.130	
143.4	149.160	
146.2	149.290	
147.4	149.310	
148.8	149.240	
151.9	149.280	



Original	
Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M2

Station	Elevation	n Value
0.0	149.620	0.025
3.2	149.380	
4.6	149.360	
6.0	149.410	
7.4	149.380	
11.0	149.410	
13.1	149.350	
15.6	149.360	
18.0	149.340	
21.6	149.250	
23.1	149.290	
28.3	149.210	
30.1	149.230	
31.5	149.320	
34.3	149.350	
37.6	149.360	
38.6	149.410	
41.4	149.340	
43.5	149.360	
45.7	149.300	
50.6	149.280	
51.9	149.190	
53.5	149.170	
54.9	149.260	
55.6	149.200	
57.0	149.260	
59.1	149.280	
59.8	149.240	
60.5	149.340	
65.5	149.360	
67.1	149.460	
69.0	149.490	
70.5	149.470	
72.4	149.520	
76.1	149.510	
77.2	149.530	
81.1	149.520	
85.3	149.360	
87.2	149.330	
90.3	149.170	
92.5	148.970	
93.9	149.020	
96.8	148.850	
98.1	148.880	
100.2	148.780	
101.3	148.680	
103.0	148.690	
103.7	148.610	
105.1	148.370	0.045
106.6	148.110	
108.0	147.610	0.035
110.1	146.470	
110.8	146.200	
113.0	146.030	
114.4	146.660	
115.1	147.120	
115.8	147.730	0.08
117.2	148.390	
120.7	148.390	
122.2	148.280	
123.8	148.360	0.025
126.4	148.480	
130.7	148.610	
133.5	148.750	
134.9	148.870	
137.7	148.970	
141.3	149.140	
143.4	149.160	
146.1	149.280	
147.4	149.310	
148.8	149.240	
151.9	149.280	

Updated Existing	
Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M2

Station	Elevation	n Value
0.0	149.630	0.025
0.6	149.590	
2.1	149.450	
3.2	149.390	
4.1	149.360	
6.0	149.410	
7.4	149.380	
10.2	149.380	
11.1	149.400	
12.2	149.390	
13.5	149.350	
15.6	149.360	
17.5	149.350	
20.9	149.280	
21.6	149.250	
23.0	149.290	
28.0	149.210	
29.4	149.240	
30.1	149.240	
30.8	149.290	
32.2	149.330	
34.3	149.340	
35.1	149.330	
35.7	149.350	
37.6	149.360	
38.6	149.400	
41.4	149.350	
43.0	149.360	
45.7	149.300	
48.7	149.290	
50.6	149.260	
51.7	149.200	
53.4	149.170	
54.9	149.250	
55.6	149.210	
56.2	149.200	
57.0	149.240	
59.0	149.280	
59.8	149.270	
60.5	149.330	
61.2	149.330	
62.2	149.360	
63.4	149.350	
64.8	149.380	
65.5	149.370	
66.2	149.390	
67.1	149.460	
67.6	149.460	
70.4	149.480	
71.2	149.510	
72.4	149.520	
80.5	149.530	
81.8	149.470	
84.6	149.380	
87.4	149.320	
88.5	149.260	
89.8	149.200	
91.2	149.080	
92.5	148.970	
93.9	149.020	
95.3	148.950	
96.5	148.860	
98.1	148.870	
99.8	148.800	
100.6	148.730	
100.9	148.740	
101.6	148.860	
101.9	148.880	
103.7	148.830	
104.6	148.790	
105.2	148.660	0.045
105.8	148.380	
108.0	147.227	0.035
108.8	146.800	
109.4	146.500	
109.9	146.260	
110.1	146.200	
110.3	146.160	
111.3	145.910	
111.5	145.910	
112.6	146.200	
112.9	146.280	
113.3	146.440	
113.7	146.590	
115.8	147.766	0.08
116.3	148.060	
116.5	148.140	
116.6	148.200	
117.2	148.360	
117.2	148.390	
120.7	148.390	
122.2	148.280	
123.8	148.360	0.016
126.4	148.480	
130.7	148.620	
132.1	148.690	
133.5	148.760	
135.4	148.890	
136.7	148.930	
141.3	149.130	
143.4	149.160	
146.2	149.290	
147.4	149.310	
148.8	149.240	
151.9	149.280	

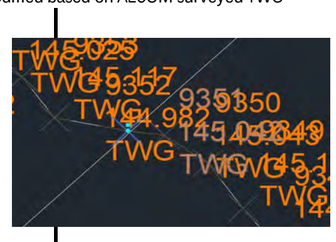
Existing XS	
Station	Elevation
0.0	148.630
2.9	148.610
3.6	148.580
4.5	148.510
7.2	148.400
7.9	148.330
8.6	148.360
9.3	148.280
11.5	148.150
12.8	148.100
14.2	148.080
15.0	148.090
15.4	148.050
16.4	148.060
17.8	148.020
19.2	148.050
19.8	148.040
21.3	147.980
22.0	147.990
22.9	147.960
23.4	147.980
24.0	147.630
24.3	147.500
24.9	147.200
25.7	146.930
26.3	146.800
26.8	146.580
27.2	146.370
27.7	146.020
28.4	145.580
29.1	145.210
29.8	145.000
30.1	145.000
31.9	145.080
32.9	145.680
33.7	146.260
34.0	146.540
34.8	146.820
35.5	146.960
36.2	147.280
36.9	147.340
37.6	147.370
38.7	147.380
41.1	147.470
42.1	147.470
42.5	147.520
43.0	147.490
43.9	147.550
44.5	147.530
45.4	147.540
46.2	147.610
47.5	147.600
48.8	147.660
49.6	147.610
50.2	147.650
51.0	147.620
52.4	147.660
53.9	147.650
55.3	147.700
56.0	147.680
57.4	147.800
58.1	147.790
58.7	147.850
59.5	147.800
60.9	147.800
61.5	147.820
62.3	147.790
62.9	147.820
63.8	147.810
65.1	147.810

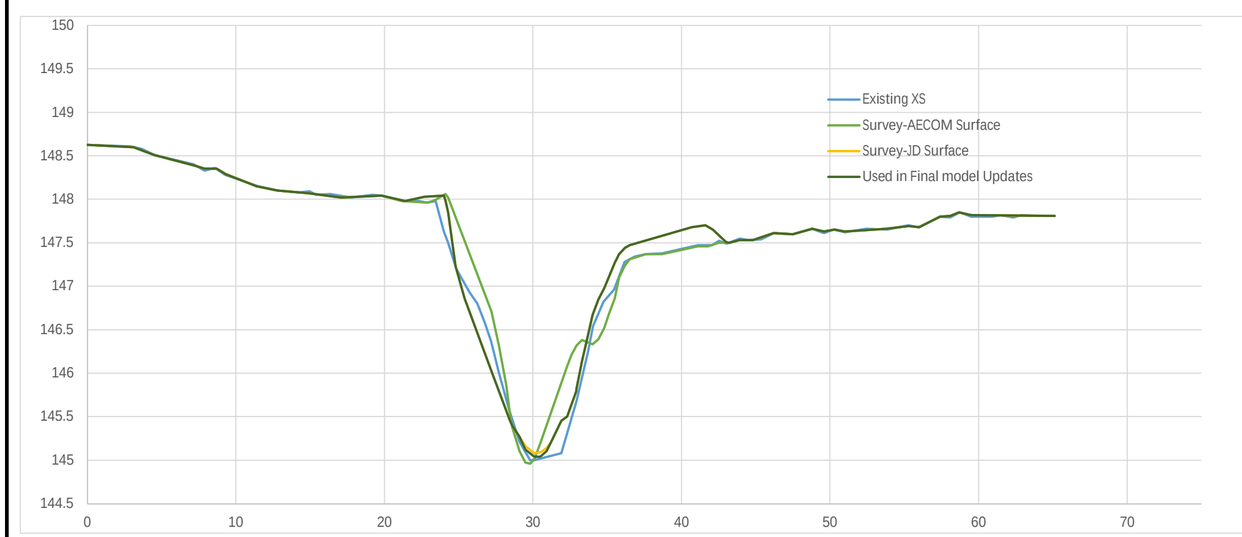
Survey-AECOM Surface	
Station	Elevation
0.0	148.630
3.1	148.600
4.5	148.510
7.2	148.390
7.9	148.350
8.7	148.350
9.3	148.290
11.4	148.150
12.8	148.100
14.9	148.070
15.7	148.050
17.1	148.020
19.8	148.040
21.2	147.980
22.9	147.960
23.4	147.990
24.1	148.060
24.3	148.020
27.2	146.710
27.7	146.320
28.2	145.860
28.4	145.623
28.4	145.610
28.6	145.380
29.1	145.100
29.5	144.970
29.8	144.960
30.1	145.010
30.5	145.190
32.3	146.080
32.6	146.210
32.9	146.310
32.9	146.317
33.3	146.380
34.0	146.330
34.4	146.390
34.8	146.520
35.1	146.670
35.5	146.860
35.8	147.100
36.2	147.240
36.5	147.310
37.6	147.370
38.7	147.370
41.1	147.460
41.8	147.460
42.5	147.500
43.2	147.500
43.9	147.530
44.8	147.530
46.2	147.610
47.5	147.600
48.8	147.660
49.6	147.630
50.3	147.650
51.0	147.630
53.8	147.660
55.3	147.690
56.0	147.680
57.4	147.800
58.1	147.810
58.7	147.850
59.5	147.820
65.1	147.810

Survey-JD Surface	
Station	Elevation
0.0	148.630
3.1	148.600
4.5	148.510
7.2	148.390
7.9	148.350
8.7	148.350
9.3	148.290
11.4	148.150
12.8	148.100
14.9	148.070
15.7	148.050
17.1	148.020
19.8	148.040
21.4	147.980
22.7	148.030
24.0	148.040
24.1	147.990
24.3	147.850
24.8	147.230
25.4	146.860
27.2	146.020
28.4	145.485
28.4	145.480
28.6	145.400
29.1	145.270
29.5	145.160
30.1	145.080
30.5	145.090
30.9	145.140
31.2	145.200
31.9	145.450
32.3	145.500
32.9	145.790
32.9	145.825
33.3	146.140
33.7	146.430
34.0	146.670
34.4	146.850
34.8	146.980
35.5	147.270
35.8	147.370
36.2	147.440
36.5	147.470
40.7	147.680
41.6	147.700
42.1	147.650
43.0	147.510
43.2	147.500
43.9	147.530
44.8	147.530
46.2	147.610
47.5	147.600
48.8	147.660
49.6	147.630
50.3	147.650
51.0	147.630
53.8	147.660
55.3	147.690
56.0	147.680
57.4	147.800
58.1	147.810
58.7	147.850
59.5	147.820
65.1	147.810

Used in Final model Updates	
Station	Elevation
0.0	148.630
3.1	148.600
4.5	148.510
7.2	148.390
7.9	148.350
8.7	148.350
9.3	148.290
11.4	148.150
12.8	148.100
14.9	148.070
15.7	148.050
17.1	148.020
19.8	148.040
21.4	147.980
22.7	148.030
24.0	148.040
24.1	147.990
24.3	147.850
24.8	147.230
25.4	146.860
27.2	146.020
28.4	145.485
28.4	145.480
28.6	145.400
29.1	145.270
29.5	145.120
30.1	145.040
30.5	145.040
30.9	145.100
31.2	145.200
31.9	145.450
32.3	145.500
32.9	145.790
32.9	145.825
33.3	146.140
33.7	146.430
34.0	146.670
34.4	146.850
34.8	146.980
35.5	147.270
35.8	147.370
36.2	147.440
36.5	147.470
40.7	147.680
41.6	147.700
42.1	147.650
43.0	147.510
43.2	147.500
43.9	147.530
44.8	147.530
46.2	147.610
47.5	147.600
48.8	147.660
49.6	147.630
50.3	147.650
51.0	147.630
53.8	147.660
55.3	147.690
56.0	147.680
57.4	147.800
58.1	147.810
58.7	147.850
59.5	147.820
65.1	147.810

Modified based on AECOM surveyed TWG





Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	148.630	0.025
2.9	148.610	
3.6	148.580	
4.5	148.510	
7.2	148.400	
7.9	148.330	
8.6	148.360	
9.3	148.280	
11.5	148.150	
12.8	148.100	
14.2	148.080	
15.0	148.090	
15.4	148.050	
16.4	148.060	
17.8	148.020	
19.2	148.050	
19.8	148.040	
21.3	147.980	
22.0	147.990	
22.9	147.960	
23.4	147.980	
24.0	147.630	
24.3	147.500	0.045
24.9	147.200	
25.7	146.930	0.08
26.3	146.800	
26.8	146.580	
27.2	146.370	
27.7	146.020	
28.4	145.580	0.035
29.1	145.210	
29.8	145.000	
30.1	145.000	
31.9	145.080	
32.9	145.680	0.08
33.7	146.260	
34.0	146.540	
34.8	146.820	
35.5	146.960	
36.2	147.280	
36.9	147.340	0.025
37.6	147.370	
38.7	147.380	
41.1	147.470	
42.1	147.470	
42.5	147.520	
43.0	147.490	
43.9	147.550	
44.5	147.530	
45.4	147.540	
46.2	147.610	
47.5	147.600	
48.8	147.660	
49.6	147.610	
50.2	147.650	0.045
51.0	147.620	
52.4	147.660	
53.9	147.650	
55.3	147.700	
56.0	147.680	
57.4	147.800	
58.1	147.790	
58.7	147.850	
59.5	147.800	
60.9	147.800	
61.5	147.820	
62.3	147.790	
62.9	147.820	
63.8	147.810	
65.1	147.810	

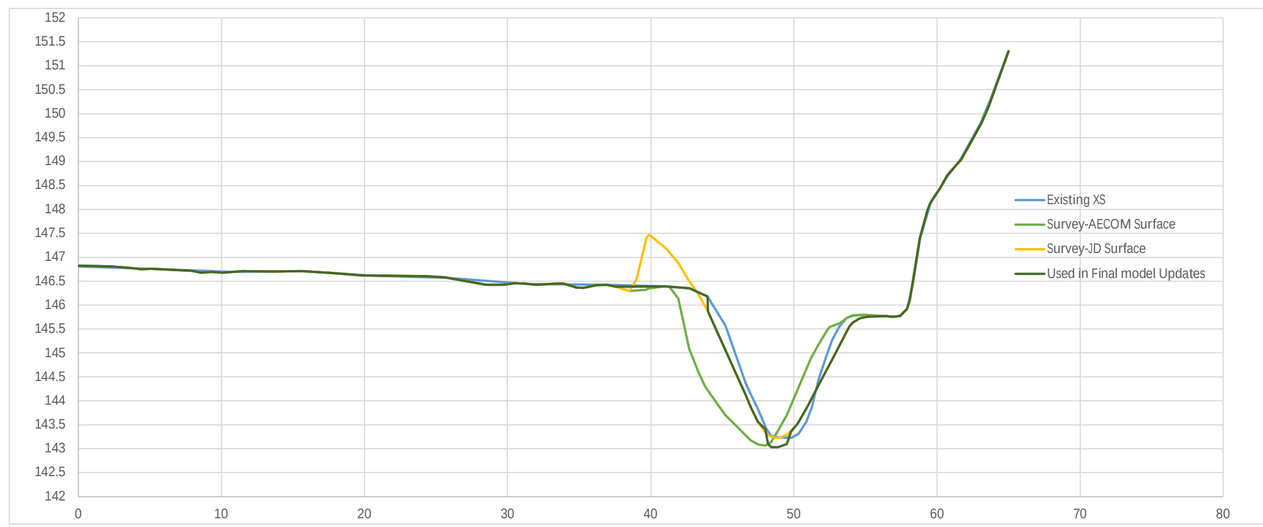
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	148.630	0.016
3.1	148.600	
4.5	148.510	
7.2	148.390	
7.9	148.350	
8.7	148.350	
9.3	148.290	
11.4	148.150	
12.8	148.100	
14.9	148.070	
15.7	148.050	
17.1	148.020	
19.8	148.040	
21.4	147.980	
22.7	148.030	
24.0	148.040	
24.1	147.990	
24.3	147.850	0.045
24.8	147.230	
25.4	146.860	0.08
27.2	146.020	
28.4	145.485	0.035
28.4	145.480	
28.6	145.400	
29.1	145.270	
29.5	145.120	
30.1	145.040	
30.5	145.040	
30.9	145.100	
31.2	145.200	
31.9	145.450	
32.3	145.500	
32.9	145.790	
32.9	145.825	0.08
33.3	146.140	
33.7	146.430	
34.0	146.670	
34.4	146.850	
34.8	146.980	
35.5	147.270	
35.8	147.370	
36.2	147.440	
36.5	147.470	0.025
40.7	147.680	
41.6	147.700	
42.1	147.650	
43.0	147.510	
43.2	147.500	
43.9	147.530	
44.8	147.530	
46.2	147.610	
47.5	147.600	
48.8	147.660	
49.6	147.630	
50.3	147.650	0.045
51.0	147.630	
53.8	147.660	
55.3	147.690	
56.0	147.680	
57.4	147.800	
58.1	147.810	
58.7	147.850	
59.5	147.820	
65.1	147.810	

Existing XS	
Station	Elevation
0.0	146.810
5.7	146.750
10.7	146.690
15.8	146.710
20.6	146.610
25.7	146.570
31.4	146.440
36.9	146.420
41.0	146.390
42.7	146.350
44.0	146.180
45.2	145.570
46.1	144.830
46.6	144.360
47.0	144.130
47.5	143.810
48.0	143.430
48.4	143.270
48.9	143.240
49.8	143.230
50.3	143.310
50.9	143.560
51.2	143.870
51.8	144.460
52.3	144.950
52.7	145.270
53.2	145.540
53.7	145.730
54.1	145.780
54.6	145.800
56.0	145.770
56.9	145.750
57.4	145.770
57.9	145.920
58.3	146.440
58.8	147.400
59.5	148.120
60.7	148.710
61.7	149.040
63.1	149.810
63.8	150.320
65.0	151.310

Survey-AECOM Surface	
Station	Elevation
0.0	146.820
2.3	146.810
3.7	146.780
4.4	146.750
5.1	146.760
7.9	146.720
8.6	146.680
9.3	146.690
10.1	146.680
11.5	146.710
13.6	146.700
15.6	146.710
17.8	146.670
19.8	146.620
24.3	146.600
25.6	146.580
28.5	146.420
29.7	146.430
30.5	146.460
31.2	146.450
32.0	146.420
33.4	146.450
33.9	146.450
34.8	146.370
35.3	146.360
36.2	146.410
36.9	146.420
37.6	146.380
38.5	146.290
39.6	146.320
39.9	146.350
41.0	146.390
41.3	146.380
41.9	146.140
42.7	145.090
43.3	144.620
43.8	144.300
44.7	143.910
45.2	143.710
46.6	143.280
46.6	143.273
47.0	143.180
47.5	143.090
48.0	143.070
48.2	143.100
48.4	143.140
48.9	143.380
49.5	143.700
51.2	144.890
51.8	145.183
51.8	145.210
52.3	145.470
52.5	145.540
53.2	145.620
53.7	145.730
54.1	145.790
55.1	145.800
56.9	145.750
57.4	145.770
57.9	145.920
58.1	146.100
58.3	146.440
58.8	147.400
59.3	147.970
59.5	148.120
59.7	148.220
60.2	148.430
60.7	148.710
61.2	148.880
61.7	149.040
62.6	149.520
63.1	149.810
63.6	150.140
65.0	151.300

Survey-JD Surface	
Station	Elevation
0.0	146.820
2.3	146.810
3.7	146.780
4.4	146.750
5.1	146.760
7.9	146.720
8.6	146.680
9.3	146.690
10.1	146.680
11.5	146.710
13.6	146.700
15.6	146.710
17.8	146.670
19.8	146.620
24.3	146.600
25.6	146.580
28.5	146.420
29.7	146.430
30.5	146.460
31.2	146.450
32.0	146.420
33.4	146.450
33.9	146.450
34.8	146.370
35.3	146.360
36.2	146.410
36.9	146.420
37.6	146.380
38.5	146.290
39.0	146.540
39.7	147.420
39.9	147.470
41.1	147.170
41.9	146.880
42.7	146.500
43.3	146.240
44.0	145.870
45.6	144.800
46.6	144.116
47.0	143.870
47.5	143.560
48.0	143.340
48.2	143.290
48.4	143.250
48.9	143.220
49.5	143.290
49.8	143.370
50.3	143.540
51.0	143.900
51.8	144.336
52.6	144.830
53.7	145.460
53.9	145.560
54.1	145.630
54.6	145.720
55.1	145.750
56.5	145.770
56.9	145.750
57.4	145.770
57.9	145.920
58.1	146.100
58.3	146.440
58.8	147.400
59.3	147.970
59.5	148.120
59.7	148.220
60.2	148.430
60.7	148.710
61.2	148.880
61.7	149.040
62.6	149.520
63.1	149.810
63.6	150.140
65.0	151.300

Used in Final model Updates		
Station	Elevation	
0.0	146.820	
2.3	146.810	
3.7	146.780	
4.4	146.750	
5.1	146.760	
7.9	146.720	
8.6	146.680	
9.3	146.690	
10.1	146.680	
11.5	146.710	
13.6	146.700	
15.6	146.710	
17.8	146.670	
19.8	146.620	
24.3	146.600	
25.6	146.580	
28.5	146.420	
29.7	146.430	
30.5	146.460	
31.2	146.450	
32.0	146.420	
33.4	146.450	
33.9	146.450	
34.8	146.370	
35.3	146.360	
36.2	146.410	
36.9	146.420	
37.6	146.380	
41.0	146.390	
42.7	146.350	Changed to remove the stich effect
44.0	146.180	
44.0	145.870	
45.6	144.800	
46.6	144.116	
47.0	143.870	
47.5	143.560	
48.0	143.410	
48.2	143.100	
48.4	143.030	Modified based on AECOM surveyed TWG
48.9	143.030	
49.5	143.100	
49.8	143.360	
50.3	143.540	
51.0	143.900	
51.8	144.336	
52.6	144.830	
53.7	145.460	
53.9	145.560	
54.1	145.630	
54.6	145.720	
55.1	145.750	
56.5	145.770	
56.9	145.750	
57.4	145.770	
57.9	145.920	
58.1	146.100	
58.3	146.440	
58.8	147.400	
59.3	147.970	
59.5	148.120	
59.7	148.220	
60.2	148.430	
60.7	148.710	
61.2	148.880	
61.7	149.040	
62.6	149.520	
63.1	149.810	
63.6	150.140	
65.0	151.300	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0.0	146.810	0.025
5.7	146.750	
10.7	146.690	
15.8	146.710	
20.6	146.610	
25.7	146.570	
31.4	146.440	
36.9	146.420	
41.0	146.390	
42.7	146.350	0.045
44.0	146.180	
45.2	145.570	
46.1	144.830	
46.6	144.360	0.035
47.0	144.130	
47.5	143.810	
48.0	143.430	
48.4	143.270	
48.9	143.240	
49.8	143.230	
50.3	143.310	
50.9	143.560	
51.2	143.870	
51.8	144.460	0.045
52.3	144.950	
52.7	145.270	
53.2	145.540	
53.7	145.730	
54.1	145.780	
54.6	145.800	
56.0	145.770	
56.9	145.750	
57.4	145.770	
57.9	145.920	
58.3	146.440	
58.8	147.400	
59.5	148.120	
60.7	148.710	
61.7	149.040	
63.1	149.810	
63.8	150.320	
65.0	151.310	

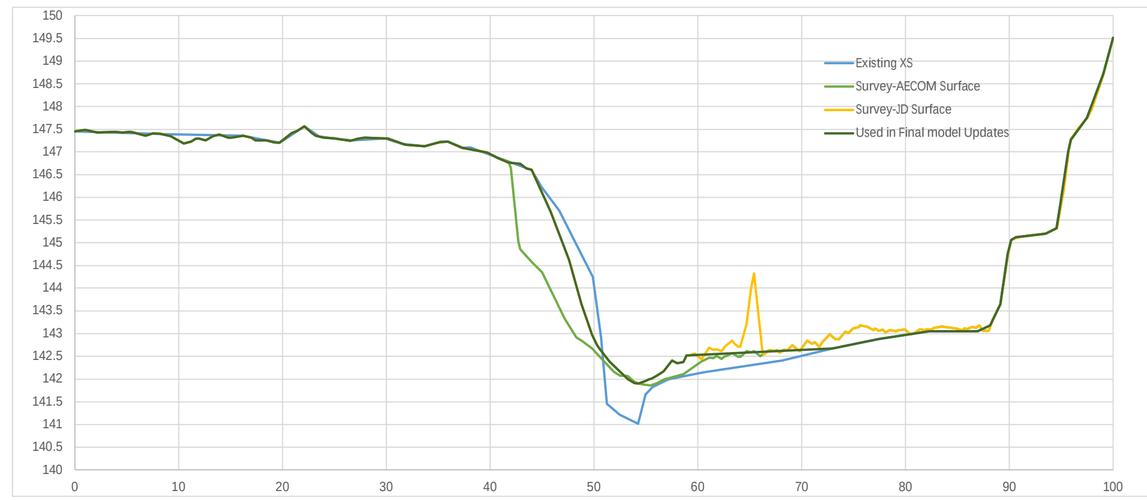
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	942	
Station	Elevation	n Value
0.0	146.820	0.025
2.3	146.810	
3.7	146.780	
4.4	146.750	
5.1	146.760	
7.9	146.720	
8.6	146.680	
9.3	146.690	
10.1	146.680	
11.5	146.710	
13.6	146.700	
15.6	146.710	
17.8	146.670	
19.8	146.620	
24.3	146.600	
25.6	146.580	
28.5	146.420	
29.7	146.430	
30.5	146.460	
31.2	146.450	
32.0	146.420	
33.4	146.450	
33.9	146.450	
34.8	146.370	
35.3	146.360	
36.2	146.410	
36.9	146.420	
37.6	146.380	
41.0	146.390	
42.7	146.350	0.045
44.0	146.180	
44.0	145.870	
45.6	144.800	
46.6	144.116	0.035
47.0	143.870	
47.5	143.560	
48.0	143.410	
48.2	143.100	
48.4	143.030	
48.9	143.030	
49.5	143.100	
49.8	143.360	
50.3	143.540	
51.0	143.900	
51.8	144.336	0.045
52.6	144.830	
53.7	145.460	
53.9	145.560	
54.1	145.630	
54.6	145.720	
55.1	145.750	
56.5	145.770	
56.9	145.750	
57.4	145.770	
57.9	145.920	
58.1	146.100	
58.3	146.440	
58.8	147.400	
59.3	147.970	
59.5	148.120	
59.7	148.220	
60.2	148.430	
60.7	148.710	
61.2	148.880	
61.7	149.040	
62.6	149.520	
63.1	149.810	
63.6	150.140	
65.0	151.300	

Existing XS	
Station	Elevation
0.0	147.450
8.6	147.390
16.1	147.360
19.7	147.200
22.1	147.560
23.5	147.340
25.6	147.280
26.7	147.250
29.8	147.300
31.6	147.180
33.7	147.130
34.9	147.200
35.9	147.230
37.4	147.090
38.1	147.100
40.4	146.900
42.0	146.770
44.0	146.600
45.0	146.220
46.7	145.710
49.9	144.250
50.7	142.920
51.2	141.450
52.5	141.210
54.2	141.020
55.0	141.660
55.7	141.820
57.2	142.000
60.6	142.150
68.1	142.410
73.0	142.670
77.4	142.880
82.3	143.050
85.1	143.050
87.0	143.050
88.2	143.180
89.1	143.650
89.9	144.760
90.2	145.060
90.6	145.120
91.6	145.150
93.5	145.200
94.6	145.320
95.0	145.860
95.7	147.010
96.0	147.270
97.5	147.750
99.1	148.720
100.0	149.510

Survey-AECOM Surface	
Station	Elevation
0.0	147.450
1.0	147.480
2.2	147.430
3.9	147.440
4.6	147.430
5.3	147.440
5.7	147.430
6.8	147.360
7.5	147.410
8.2	147.400
9.2	147.350
10.5	147.190
11.2	147.230
11.6	147.290
11.9	147.300
12.6	147.260
13.3	147.350
13.9	147.380
14.8	147.310
15.1	147.310
16.2	147.360
17.0	147.310
17.4	147.260
17.7	147.250
18.4	147.260
18.6	147.240
19.2	147.210
19.7	147.200
20.9	147.420
21.4	147.460
22.1	147.560
22.8	147.420
23.2	147.360
24.0	147.310
25.0	147.300
26.5	147.240
26.7	147.250
27.2	147.290
27.9	147.310
29.8	147.300
30.1	147.300
31.8	147.160
33.7	147.130
35.2	147.220
35.9	147.230
37.3	147.090
39.7	146.990
40.7	146.860
41.8	146.790
42.0	146.650
42.7	145.040
42.9	144.860
44.0	144.580
45.0	144.350
47.2	143.330
48.3	142.910
48.8	142.840
49.8	142.670
50.7	142.459
51.9	142.160
52.5	142.080
53.1	142.080
53.3	142.060
53.9	141.940
54.6	141.880
55.5	141.860
55.7	141.872
56.0	141.900
56.8	141.990
58.6	142.110
60.4	142.390
61.1	142.470
61.5	142.460
61.8	142.510
62.3	142.440
62.6	142.500
62.7	142.500
63.3	142.570
63.9	142.490
64.0	142.510
64.1	142.490
64.7	142.620
65.1	142.590
65.4	142.620
66.0	142.500
66.2	142.530
66.3	142.540
66.9	142.640
67.5	142.610
67.6	142.640
67.9	142.580
68.3	142.650
68.6	142.630
69.1	142.740
69.8	142.610
70.5	142.840
71.0	142.780
71.3	142.810
71.7	142.710
72.0	142.810
72.7	142.980
73.0	142.920
73.3	142.870
73.4	142.880
73.6	142.870
74.2	143.040
74.5	143.010
74.9	143.110
75.5	143.140
75.6	143.180
76.3	143.160
76.9	143.080
77.1	143.110
77.4	143.060
77.8	143.090
78.1	143.030
78.5	143.080
79.1	143.050
79.2	143.070
79.8	143.090
79.9	143.100
80.5	142.980
80.8	143.000
81.4	143.100
81.8	143.080
82.1	143.100
82.5	143.090
82.8	143.130
83.5	143.160
84.9	143.110
85.5	143.070
85.7	143.120
85.8	143.090
86.4	143.140
86.8	143.130
87.1	143.180
87.5	143.060
88.0	143.060
88.4	143.320
89.1	143.650
89.9	144.760
90.2	145.060
90.6	145.110
91.3	145.140
93.5	145.200
94.6	145.320
95.0	145.860
95.2	146.140
95.7	147.010
95.9	147.270
96.6	147.500
97.5	147.750
97.9	147.940
99.0	148.640
100.0	149.510

Survey-JD Surface	
Station	Elevation
0.0	147.450
1.0	147.480
2.2	147.430
3.9	147.440
4.6	147.430
5.3	147.440
5.7	147.430
6.8	147.360
7.5	147.410
8.2	147.400
9.2	147.350
10.5	147.190
11.2	147.230
11.6	147.290
11.9	147.300
12.6	147.260
13.3	147.350
13.9	147.380
14.8	147.310
15.1	147.310
16.2	147.360
17.0	147.310
17.4	147.260
17.7	147.250
18.4	147.260
18.6	147.240
19.2	147.210
19.7	147.200
20.9	147.420
21.4	147.460
22.1	147.560
22.8	147.420
23.2	147.360
24.0	147.310
25.0	147.300
26.5	147.240
26.7	147.250
27.2	147.290
27.9	147.310
29.8	147.300
30.1	147.300
31.8	147.160
33.7	147.130
35.2	147.220
35.9	147.230
37.3	147.090
39.7	146.990
40.7	146.860
41.8	146.760
42.9	146.740
43.5	146.640
44.0	146.610
45.8	145.680
47.6	144.620
48.8	143.650
49.8	142.970
50.3	142.740
50.7	142.629
50.7	142.620
51.5	142.380
52.5	142.160
53.3	141.990
53.9	141.910
54.3	141.900
55.0	141.960
55.3	142.000
55.5	142.010
55.7	142.025
56.0	142.060
56.7	142.170
57.5	142.410
58.0	142.350
58.6	142.370
58.9	142.520
73.0	142.670
77.4	142.880
82.3	143.050
85.1	143.050
87.0	143.050
88.2	143.180
89.1	143.650
89.9	144.760
90.2	145.060
90.6	145.110
91.3	145.140
93.5	145.200
94.6	145.320
95.0	145.860
95.2	146.140
95.7	147.010
96.6	147.500
97.5	147.750
97.9	147.940
99.0	148.640
100.0	149.510

Used in Final model Updates	
Station	Elevation
0.0	147.450
1.0	147.480
2.2	147.430
3.9	147.440
4.6	147.430
5.3	147.440
5.7	147.430
6.8	147.360
7.5	147.410
8.2	147.400
9.2	147.350
10.5	147.190
11.2	147.230
11.6	147.290
11.9	147.300
12.6	147.260
13.3	147.350
13.9	147.380
14.8	147.310
15.1	147.310
16.2	147.360
17.0	147.310
17.4	147.260
17.7	147.250
18.4	147.260
18.6	147.240
19.2	147.210
19.7	147.200
20.9	147.420
21.4	147.460
22.1	147.560
22.8	147.420
23.2	147.360
24.0	147.310
25.0	147.300
26.5	147.240
26.7	147.250
27.2	147.290
27.9	147.310
29.8	147.300
30.1	147.300
31.8	147.160
33.7	147.130
35.2	147.220
35.9	147.230
37.3	147.090
39.7	146.990
40.7	146.860
41.8	146.760
42.9	146.740
43.5	146.640
44.0	146.610
45.8	145.680
47.6	144.620
48.8	143.650
49.8	142.970
50.3	142.740
50.7	142.629
50.7	142.620
51.5	142.380
52.5	142.160
53.3	141.990
53.9	141.910
54.3	141.900
55.0	141.960
55.3	142.000
55.5	142.010
55.7	142.025
56.0	142.060
56.7	142.170
57.5	142.410
58.0	142.350
58.6	142.370
58.9	142.520
73.0	142.670
77.4	142.880
82.3	143.050
85.1	143.050
87.0	143.050
88.2	143.180
89.1	143.650
89.9	144.760
90.2	145.060
90.6	145.120
91.6	145.150
93.5	145.200
94.6	145.320
95.0	145.860
95.7	147.010
96.0	147.270
97.5	147.750
99.1	148.720
100.0	149.510



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Manning's n

LOB	Channel	ROB
0.045	0.035	0.045

Station	Elevation	n Value
0.0	147.450	
8.6	147.390	
16.1	147.360	
19.7	147.200	
22.1	147.560	
23.5	147.340	
25.6	147.280	
26.7	147.250	
29.8	147.300	
31.6	147.180	
33.7	147.130	
34.9	147.200	
35.9	147.230	
37.4	147.090	
38.1	147.100	
40.4	146.900	
42.0	146.770	
44.0	146.600	
45.0	146.220	
46.7	145.710	
49.9	144.250	
50.7	142.920	
51.2	141.450	
52.5	141.210	
54.2	141.020	
55.0	141.660	
55.7	141.820	
57.2	142.000	
60.6	142.150	
68.1	142.410	
73.0	142.670	
77.4	142.880	
82.3	143.050	
85.1	143.050	
87.0	143.050	
88.2	143.180	
89.1	143.650	
89.9	144.760	
90.2	145.060	
90.6	145.120	
91.6	145.150	
93.5	145.200	
94.6	145.320	
95.0	145.860	
95.7	147.010	
96.0	147.270	
97.5	147.750	
99.1	148.720	
100.0	149.510	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Manning's n

LOB	Channel	ROB
0.045	0.035	0.045

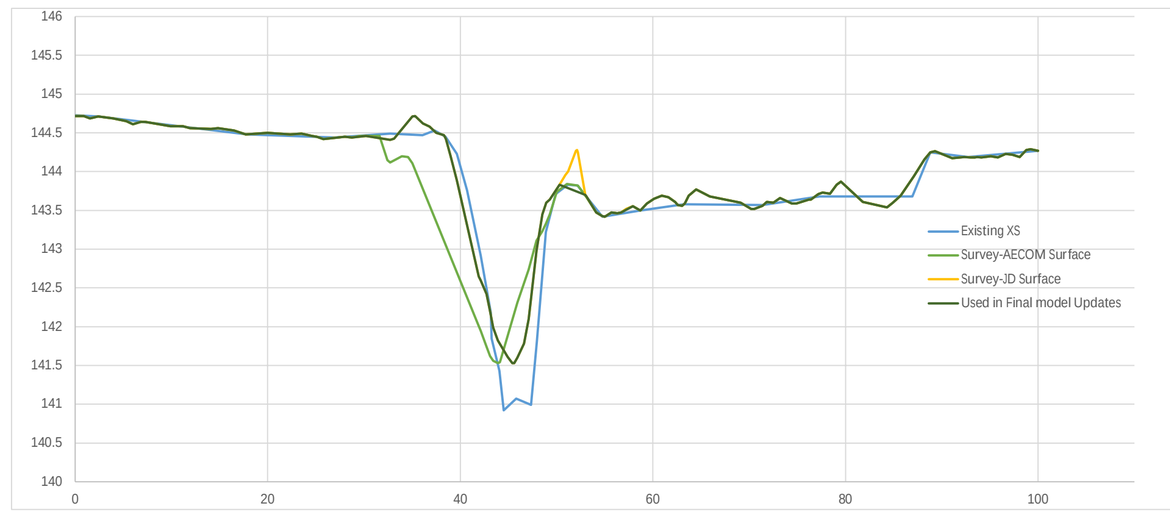
Station	Elevation	n Value
0.0	147.450	
1.0	147.480	
2.2	147.430	
3.9	147.440	
4.6	147.430	
5.3	147.440	
5.7	147.430	
6.8	147.360	
7.5	147.410	
8.2	147.400	
9.2	147.350	
10.5	147.190	
11.2	147.230	
11.6	147.290	
11.9	147.300	
12.6	147.260	
13.3	147.350	
13.9	147.380	
14.8	147.310	
15.1	147.310	
16.2	147.360	
17.0	147.310	
17.4	147.260	
17.7	147.250	
18.4	147.260	
18.6	147.240	
19.2	147.210	
19.7	147.200	
20.9	147.420	
21.4	147.460	
22.1	147.560	
22.8	147.420	
23.2	147.360	
24.0	147.310	
25.0	147.300	
26.5	147.240	
26.7	147.250	
27.2	147.290	
27.9	147.310	
29.8	147.300	
30.1	147.300	
31.8	147.160	
33.7	147.130	
35.2	147.220	
35.9	147.230	
37.3	147.090	
39.7	146.990	
40.7	146.860	
41.8	146.760	
42.9	146.740	
43.5	146.640	
44.0	146.610	
45.8	145.680	
47.6	144.620	
48.8	143.650	
49.8	142.970	
50.3	142.740	
50.7	142.629	
50.7	142.620	
51.5	142.380	
52.5	142.160	
53.3	141.990	
53.9	141.910	
54.3	141.900	
55.0	141.960	
55.3	142.000	
55.5	142.010	
55.7	142.025	
56.0	142.060	
56.7	142.170	
57.5	142.410	
58.0	142.350	
58.6	142.370	
58.9	142.520	
73.0	142.670	
77.4	142.880	
82.3	143.050	
85.1	143.050	
87.0	143.050	
88.2	143.180	
89.1	143.650	
89.9	144.760	
90.2	145.060	
90.6	145.120	
91.6	145.150	
93.5	145.200	
94.6	145.320	
95.0	145.860	
95.7	147.010	
96.0	147.270	
97.5	147.750	
99.1	148.720	
100.0	149.510	

Existing XS	
Station	Elevation
0.0	144.730
2.4	144.710
17.9	144.480
26.9	144.440
32.7	144.490
36.1	144.470
37.3	144.530
38.5	144.450
39.6	144.230
40.7	143.760
42.1	142.920
43.1	142.180
43.2	141.850
44.0	141.430
44.5	140.920
45.8	141.070
47.4	140.990
48.0	141.810
48.9	143.220
49.9	143.710
51.2	143.830
52.2	143.820
54.7	143.420
58.7	143.500
63.3	143.580
71.4	143.570
77.3	143.680
85.1	143.680
86.9	143.680
88.8	144.250
92.7	144.190
100.0	144.270

Survey-AECOM Surface	
Station	Elevation
0.0	144.720
0.9	144.720
1.5	144.690
2.4	144.710
3.9	144.690
5.3	144.650
6.0	144.610
6.8	144.640
7.3	144.640
9.9	144.590
11.2	144.590
11.9	144.560
14.1	144.550
14.8	144.560
16.5	144.530
17.7	144.480
20.0	144.500
22.3	144.480
23.5	144.490
24.6	144.460
25.1	144.450
25.8	144.420
28.0	144.450
28.7	144.440
29.5	144.460
31.6	144.460
31.7	144.430
32.4	144.150
32.7	144.120
33.9	144.200
34.6	144.190
35.0	144.110
41.9	142.010
42.1	141.949
42.7	141.740
43.1	141.620
43.4	141.560
43.9	141.530
44.1	141.540
44.2	141.570
45.9	142.310
47.1	142.740
47.9	143.110
48.5	143.230
48.9	143.329
49.3	143.450
50.0	143.740
51.1	143.840
52.2	143.820
53.1	143.670
54.1	143.470
54.7	143.430
55.0	143.420
55.7	143.470
56.3	143.460
56.7	143.470
57.2	143.520
57.9	143.550
58.7	143.500
59.4	143.590
60.1	143.650
60.9	143.690
61.6	143.670
62.3	143.610
62.6	143.570
63.0	143.560
63.3	143.590
63.7	143.690
64.5	143.770
65.9	143.680
69.1	143.600
70.2	143.520
70.3	143.520
70.5	143.520
71.4	143.560
71.8	143.610
72.5	143.660
73.2	143.660
74.4	143.590
74.9	143.590
76.2	143.640
76.4	143.640
77.2	143.710
77.6	143.730
78.4	143.720
79.1	143.830
79.5	143.870
81.8	143.610
84.3	143.540
84.9	143.600
85.7	143.690
87.1	143.940
88.2	144.160
88.8	144.250
89.3	144.260
90.8	144.190
91.1	144.170
92.3	144.190
93.0	144.180
93.4	144.180
93.7	144.190
94.1	144.180
95.1	144.200
95.8	144.180
96.6	144.230
97.3	144.220
98.1	144.190
98.8	144.280
99.2	144.290
100.0	144.270

Survey-JD Surface	
Station	Elevation
0.0	144.720
0.9	144.720
1.5	144.690
2.4	144.710
3.9	144.690
5.3	144.650
6.0	144.610
6.8	144.640
7.3	144.640
9.9	144.590
11.2	144.590
11.9	144.560
14.1	144.550
14.8	144.560
16.5	144.530
17.7	144.480
20.0	144.500
22.3	144.480
23.5	144.490
24.6	144.460
25.1	144.450
25.8	144.420
28.0	144.450
28.7	144.440
30.2	144.460
32.7	144.410
33.1	144.430
35.0	144.710
35.3	144.720
36.1	144.620
36.8	144.580
37.5	144.500
38.3	144.470
38.5	144.420
39.0	144.200
39.6	143.890
41.9	142.650
42.1	142.598
42.7	142.420
43.1	142.200
43.4	141.990
43.9	141.820
44.9	141.610
45.4	141.530
45.6	141.530
45.9	141.600
46.6	141.780
47.1	142.100
47.9	142.980
48.5	143.450
48.9	143.585
48.9	143.600
49.3	143.640
50.3	143.830
53.0	143.700
53.1	143.680
54.1	143.470
54.7	143.430
55.0	143.420
55.7	143.470
56.3	143.460
56.7	143.470
57.9	143.550
58.7	143.500
59.4	143.590
60.1	143.650
60.9	143.690
61.6	143.670
62.3	143.610
62.6	143.570
63.0	143.560
63.3	143.590
63.7	143.690
64.5	143.770
65.9	143.680
69.1	143.600
70.2	143.520
70.3	143.520
70.5	143.520
71.4	143.560
71.8	143.610
72.5	143.600
73.2	143.660
74.4	143.590
74.9	143.590
76.2	143.640
76.4	143.640
77.2	143.710
77.6	143.730
78.4	143.720
79.1	143.830
79.5	143.870
81.8	143.610
84.3	143.540
84.9	143.600
85.7	143.690
87.1	143.940
88.2	144.160
88.8	144.250
89.3	144.260
90.8	144.190
91.1	144.170
92.3	144.190
93.0	144.180
93.4	144.180
93.7	144.190
94.1	144.180
95.1	144.200
95.8	144.180
96.6	144.230
97.3	144.220
98.1	144.190
98.8	144.280
99.2	144.290
100.0	144.270

Used in Final model Updates	
Station	Elevation
0.0	144.720
0.9	144.720
1.5	144.690
2.4	144.710
3.9	144.690
5.3	144.650
6.0	144.610
6.8	144.640
7.3	144.640
9.9	144.590
11.2	144.590
11.9	144.560
14.1	144.550
14.8	144.560
16.5	144.530
17.7	144.480
20.0	144.500
22.3	144.480
23.5	144.490
24.6	144.460
25.1	144.450
25.8	144.420
28.0	144.450
28.7	144.440
30.2	144.460
32.7	144.410
33.1	144.430
35.0	144.710
35.3	144.720
36.1	144.620
36.8	144.580
37.5	144.500
38.3	144.470
38.5	144.420
39.0	144.200
39.6	143.890
41.9	142.650
42.1	142.598
42.7	142.420
43.1	142.200
43.4	141.990
43.9	141.820
44.9	141.610
45.4	141.530
45.6	141.530
45.9	141.600
46.6	141.780
47.1	142.100
47.9	142.980
48.5	143.450
48.9	143.585
48.9	143.600
49.3	143.640
50.3	143.830
53.0	143.700
53.1	143.680
54.1	143.470
54.7	143.430
55.0	143.420
55.7	143.470
56.3	143.460
56.7	143.470
57.9	143.550
58.7	143.500
59.4	143.590
60.1	143.650
60.9	143.690
61.6	143.670
62.3	143.610
62.6	143.570
63.0	143.560
63.3	143.590
63.7	143.690
64.5	143.770
65.9	143.680
69.1	143.600
70.2	143.520
70.3	143.520
70.5	143.520
71.4	143.560
71.8	143.610
72.5	143.600
73.2	143.660
74.4	143.590
74.9	143.590
76.2	143.640
76.4	143.640
77.2	143.710
77.6	143.730
78.4	143.720
79.1	143.830
79.5	143.870
81.8	143.610
84.3	143.540
84.9	143.600
85.7	143.690
87.1	143.940
88.2	144.160
88.8	144.250
89.3	144.260
90.8	144.190
91.1	144.170
92.3	144.190
93.0	144.180
93.4	144.180
93.7	144.190
94.1	144.180
95.1	144.200
95.8	144.180
96.6	144.230
97.3	144.220
98.1	144.190
98.8	144.280
99.2	144.290
100.0	144.270



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.045	0.035	0.045
Station	Elevation	n Value
0.0	144.730	
2.4	144.710	
17.9	144.480	
26.9	144.440	
32.7	144.490	
36.1	144.470	
37.3	144.530	
38.5	144.450	
39.6	144.230	
40.7	143.760	
42.1	142.920	
43.1	142.180	
43.2	141.850	
44.0	141.430	
44.5	140.920	
45.8	141.070	
47.4	140.990	
48.0	141.810	
48.9	143.220	
49.9	143.710	
51.2	143.830	
52.2	143.820	
54.7	143.420	
58.7	143.500	
63.3	143.580	
71.4	143.570	
77.3	143.680	
85.1	143.680	
86.9	143.680	
88.8	144.250	
92.7	144.190	
100.0	144.270	

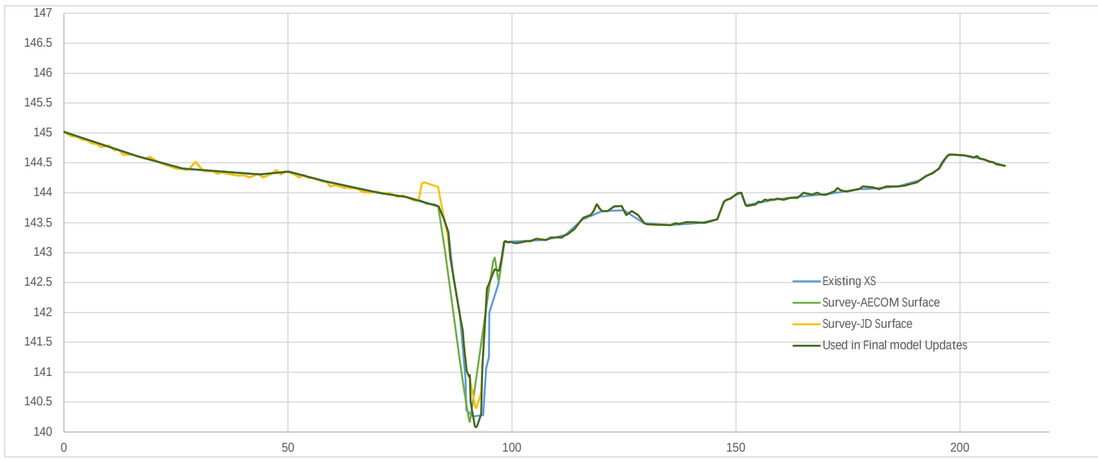
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.045	0.035	0.045
Station	Elevation	n Value
0.0	144.720	
0.9	144.720	
1.5	144.690	
2.4	144.710	
3.9	144.690	
5.3	144.650	
6.0	144.610	
6.8	144.640	
7.3	144.640	
9.9	144.590	
11.2	144.590	
11.9	144.560	
14.1	144.550	
14.8	144.560	
16.5	144.530	
17.7	144.480	
20.0	144.500	
22.3	144.480	
23.5	144.490	
24.6	144.460	
25.1	144.450	
25.8	144.420	
28.0	144.450	
28.7	144.440	
30.2	144.460	
32.7	144.410	
33.1	144.430	
35.0	144.710	
35.3	144.720	
36.1	144.620	
36.8	144.580	
37.5	144.500	
38.3	144.470	
38.5	144.420	
39.0	144.200	
39.6	143.890	
41.9	142.650	
42.1	142.598	
42.7	142.420	
43.1	142.200	
43.4	141.990	
43.9	141.820	
44.9	141.610	
45.4	141.530	
45.6	141.530	
45.9	141.600	
46.6	141.780	
47.1	142.100	
47.9	142.980	
48.5	143.450	
48.9	143.585	
48.9	143.600	
49.3	143.640	
50.3	143.830	
53.0	143.700	
53.1	143.680	
54.1	143.470	
54.7	143.430	
55.0	143.420	
55.7	143.470	
56.3	143.460	
56.7	143.470	
57.9	143.550	
58.7	143.500	
59.4	143.590	
62.3	143.610	
62.6	143.570	
63.0	143.560	
70.2	143.520	
70.3	143.520	
70.5	143.520	
71.4	143.560	
71.8	143.610	
72.5	143.600	
73.2	143.660	
74.4	143.590	
74.9	143.590	
76.2	143.640	
76.4	143.640	
77.2	143.710	
77.6	143.730	
78.4	143.720	
79.1	143.830	
79.5	143.870	
81.8	143.610	
84.3	143.540	
84.9	143.600	
85.7	143.690	
87.1	143.940	
88.2	144.160	
88.8	144.250	
89.3	144.260	
90.8	144.190	
91.1	144.170	
92.3	144.190	
93.0	144.180	
93.4	144.180	
93.7	144.190	
94.1	144.180	
95.1	144.200	
95.8	144.180	
96.6	144.230	
97.3	144.220	
98.1	144.190	
98.8	144.280	
99.2	144.290	
100.0	144.270	

Existing XS	
Station	Elevation
0.0	145.020
16.3	144.610
26.5	144.410
43.6	144.310
50.1	144.350
58.5	144.190
70.2	144.000
76.4	143.930
83.6	143.770
84.8	143.560
85.7	143.340
86.9	142.582
88.4	142.005
89.6	140.890
89.8	140.370
91.4	140.260
93.6	140.280
94.2	141.070
94.9	141.250
95.0	142.000
96.9	142.470
98.4	143.180
107.6	143.210
112.0	143.300
115.7	143.550
120.1	143.700
125.0	143.710
129.5	143.490
135.4	143.460
142.2	143.500
145.8	143.560
147.3	143.850
149.8	143.950
151.2	144.000
152.2	143.790
158.5	143.880
163.3	143.930
170.6	143.980
173.0	144.010
177.0	144.060
179.7	144.070
186.1	144.100
191.1	144.210
195.3	144.410
197.5	144.640
201.7	144.620
206.0	144.540
210.0	144.450

Survey-AECOM Surface	
Station	Elevation
0.0	145.020
1.9	144.940
2.8	144.940
4.1	144.890
5.1	144.880
6.1	144.830
7.3	144.820
8.2	144.760
10.0	144.790
10.4	144.770
11.2	144.710
12.2	144.720
13.2	144.640
15.2	144.640
18.2	144.570
19.2	144.600
21.3	144.500
25.3	144.400
26.3	144.410
27.3	144.380
28.0	144.410
29.3	144.520
30.7	144.400
31.3	144.360
33.3	144.360
34.2	144.320
35.1	144.340
38.7	144.290
40.5	144.290
41.4	144.260
43.4	144.320
44.4	144.260
46.4	144.320
47.4	144.380
48.4	144.310
49.5	144.360
51.5	144.310
52.5	144.260
53.5	144.300
54.5	144.250
55.8	144.240
57.6	144.190
58.5	144.190
59.5	144.110
60.5	144.130
62.1	144.090
65.6	144.070
66.6	144.020
68.6	144.000
69.6	144.020
71.6	143.980
72.6	144.000
74.6	143.930
75.6	143.950
78.2	143.870
79.6	143.870
80.9	143.820
82.8	143.810
83.5	143.770
85.0	143.050
88.4	141.211
89.3	140.710
89.9	140.430
90.4	140.200
90.6	140.170
90.8	140.240
94.4	142.160
95.0	142.440
95.8	142.860
96.2	142.920
96.7	142.660
96.9	142.540
97.1	142.560
97.6	142.840
98.2	143.120
98.3	143.180
98.5	143.190
99.1	143.170
99.8	143.180
100.5	143.160
101.2	143.160
103.3	143.190
104.2	143.190
105.4	143.230
107.6	143.210
108.6	143.250
109.7	143.250
110.1	143.260
111.1	143.250
111.8	143.290
112.5	143.310
113.9	143.390
115.3	143.530
116.0	143.580
117.6	143.630
118.2	143.690
118.9	143.800
119.0	143.800
119.6	143.730
120.1	143.690
120.5	143.690
121.4	143.690
122.8	143.770
124.5	143.780
125.2	143.660
125.5	143.630
126.7	143.690
128.1	143.630
129.5	143.490
130.2	143.470
135.4	143.460
136.6	143.490
137.3	143.480
139.0	143.510
143.0	143.500
145.8	143.560
147.3	143.850
147.9	143.880
148.8	143.900
150.3	143.990
151.2	144.000
151.4	143.960
152.2	143.790
152.5	143.780
154.3	143.810
155.0	143.850
155.7	143.840
156.4	143.880
156.6	143.880
157.1	143.870
157.7	143.890
158.5	143.880
159.2	143.900
160.6	143.880
162.1	143.920
163.7	143.920
165.1	144.000
167.0	143.970
168.1	144.000
169.1	143.970
170.1	143.970
172.0	144.030
172.7	144.080
173.4	144.040
174.6	144.020
177.6	144.070
178.3	144.100
178.5	144.100
180.5	144.090
181.9	144.060
183.6	144.100
186.0	144.100
187.6	144.120
190.4	144.180
192.5	144.280
193.9	144.330
195.3	144.410
196.0	144.500
197.1	144.610
197.9	144.640
200.8	144.630
203.1	144.590
203.8	144.610
204.5	144.570
205.2	144.560
206.7	144.520
207.4	144.510
208.1	144.480
210.0	144.450

Survey-JD Surface	
Station	Elevation
0.0	145.020
1.9	144.940
2.8	144.940
4.1	144.890
5.1	144.880
6.1	144.830
7.3	144.820
8.2	144.760
10.0	144.790
10.4	144.770
11.2	144.710
12.2	144.720
13.2	144.640
15.2	144.640
18.2	144.570
19.2	144.600
21.3	144.500
25.3	144.400
26.3	144.410
27.3	144.380
28.0	144.410
29.3	144.520
30.7	144.400
31.3	144.360
33.3	144.360
34.2	144.320
35.1	144.340
38.7	144.290
40.5	144.290
41.4	144.260
43.4	144.320
44.4	144.260
46.4	144.320
47.4	144.380
48.4	144.310
49.5	144.360
51.5	144.310
52.5	144.260
53.5	144.300
54.5	144.250
55.8	144.240
57.6	144.190
58.5	144.190
59.5	144.110
60.5	144.130
62.1	144.090
65.6	144.070
66.6	144.020
68.6	144.000
69.6	144.020
71.6	143.980
72.6	144.000
74.6	143.930
75.6	143.950
78.2	143.870
78.9	143.870
79.2	143.910
79.9	144.150
80.4	144.180
81.4	144.150
83.3	144.100
83.5	144.090
83.6	144.050
84.2	143.810
85.6	143.300
86.3	142.920
88.4	141.972
89.0	141.690
89.1	141.600
89.3	141.440
89.9	141.020
90.4	140.930
90.6	140.950
90.8	140.500
91.7	140.090
92.0	140.080
92.3	140.100
93.1	140.300
93.4	141.070
94.1	142.070
94.4	142.400
94.8	142.460
95.0	142.492
95.8	142.660
96.2	142.720
97.1	142.700
97.6	142.880
98.3	143.180
98.5	143.190
99.1	143.170
99.8	143.180
100.5	143.160
101.2	143.160
103.3	143.190
104.2	143.190
105.4	143.230
107.6	143.210
108.6	143.250
109.7	143.250
110.1	143.260
111.1	143.250
111.8	143.290
112.5	143.310
113.9	143.390
115.3	143.530
116.0	143.580
117.6	143.630
118.2	143.690
118.9	143.800
119.0	143.800
119.6	143.730
120.1	143.690
120.5	143.690
121.4	143.690
122.8	143.770
124.5	143.780
125.2	143.660
125.5	143.630
126.7	143.690
128.1	143.630
129.5	143.490
130.2	143.470
135.4	143.460
136.6	143.490
137.3	143.480
139.0	143.510
143.0	143.500
145.8	143.560
147.3	143.850
147.9	143.880
148.8	143.900
150.3	143.990
151.2	144.000
151.4	143.960
152.2	143.790
152.5	143.780
154.3	143.810
155.0	143.850
155.7	143.840
156.4	143.880
156.6	143.880
157.1	143.870
157.7	143.890
158.5	143.880
159.2	143.900
160.6	143.880
162.1	143.920
163.7	143.920
165.1	144.000
167.0	143.970
168.1	144.000
169.1	143.970
170.1	143.970
172.0	144.030
172.7	144.080
173.4	144.040
174.6	144.020
177.6	144.070
178.3	144.100
178.5	144.100
180.5	144.090
181.9	144.060
183.6	144.100
186.0	144.100
187.6	144.120
190.4	144.180
192.5	144.280
193.9	144.330
195.3	144.410
196.0	144.500
197.1	144.610
197.9	144.640
200.8	144.630
203.1	144.590
203.8	144.610
204.5	144.570
205.2	144.560
206.7	144.520
207.4	144.510
208.1	144.480
210.0	144.450

Used in Final model Updates		
Station	Elevation	
0.0	145.020	
16.3	144.610	
26.5	144.410	Changed to remove the stich effect
43.6	144.310	
50.1	144.350	
58.5	144.190	
70.2	144.000	
76.4	143.930	
83.6	143.770	
84.8	143.560	
85.7	143.340	
86.3	142.920	
88.4	141.972	
89.0	141.690	
89.1	141.600	
89.3	141.440	
89.9	141.020	
90.4	140.930	
90.6	140.950	
90.8	140.500	
91.7	140.090	
92.0	140.080	Modified based on AECOM surveyed TWG
92.3	140.100	
93.1	140.300	
93.4	141.070	
94.1	142.070	
94.4	142.400	
94.8	142.460	
95.0	142.492	
95.8	142.660	
96.2	142.720	
97.1	142.700	
97.6	142.880	
98.3	143.180	
98.5	143.190	
99.1	143.170	
99.8	143.180	
100.5	143.160	
101.2	143.160	
103.3	143.190	
104.2	143.190	
105.4	143.230	
107.6	143.210	
108.6	143.250	
109.7	143.250	
110.1	143.260	
111.1	143.250	
111.8	143.290	
112.5	143.310	
113.9	143.390	
115.3	143.530	
116.0	143.580	
117.6	143.630	
118.2	143.690	
118.9	143.800	
119.0	143.800	
119.6	143.730	
120.1	143.690	
120.5	143.690	
121.4	143.690	
122.8	143.770	
124.5	143.780	
125.2	143.660	
125.5	143.630	
126.7	143.690	
128.1	143.630	
129.5	143.490	
130.2	143.470	
135.4	143.460	
136.6	143.490	
137.3	143.480	
139.0	143.510	
143.0	143.500	
145.8	143.560	
147.3	143.850	
147.9	143.880	
148.8	143.900	
150.3	143.990	
151.2	144.000	
151.4	143.960	
152.2	143.790	
152.5	143.780	
154.3	143.810	
155.0	143.850	
155.7	143.840	
156.4	143.880	
156.6	143.880	
157.1	143.870	
157.7	143.890	
158.5	143.880	
159.2	143.900	
160.6	143.880	
162.1	143.920	
163.7	143.920	
165.1	144.000	
167.0	143.970	
168.1	144.000	
169.1	143.970	
170.1	143.970	
172.0	144.030	
172.7	144.080	
173.4	144.040	
174.6	144.020	
177.6	144.070	
178.3	144.100	
178.5	144.100	
180.5	144.090	
181.9	144.060	
183.6	144.100	
186.0	144.100	
187.6	144.120	
190.4	144.180	
192.5	144.280	
193.9	144.330	
195.3	144.410	
196.0	144.500	
197.1	144.610	
197.9	144.640	
200.8	144.630	
203.1	144.590	
203.8	144.610	
204.5	144.570	
205.2	144.560	
206.7	144.520	
207.4	144.510	
208.1	144.480	
210.0	144.450	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	145.020	0.025
16.3	144.610	
26.5	144.410	
43.6	144.310	
50.1	144.350	
58.5	144.190	
70.2	144.000	
76.4	143.930	
83.6	143.770	0.055
84.8	143.560	
85.7	143.340	
86.9	142.582	
88.4	142.005	0.035
89.6	140.890	
89.8	140.370	
91.4	140.260	
93.6	140.280	
94.2	141.070	
94.9	141.250	
95.0	142.000	0.025
96.9	142.470	
98.4	143.180	
107.6	143.210	
112.0	143.300	
115.7	143.550	0.045
120.1	143.700	
125.0	143.710	0.025
129.5	143.490	
135.4	143.460	
142.2	143.500	
145.8	143.560	
147.3	143.850	
149.8	143.950	
151.2	144.000	
152.2	143.790	
158.5	143.880	
163.3	143.930	
170.6	143.980	
173.0	144.010	0.045
177.0	144.060	
179.7	144.070	0.025
186.1	144.100	
191.1	144.210	
195.3	144.410	
197.5	144.640	
201.7	144.620	
206.0	144.540	
210.0	144.450	

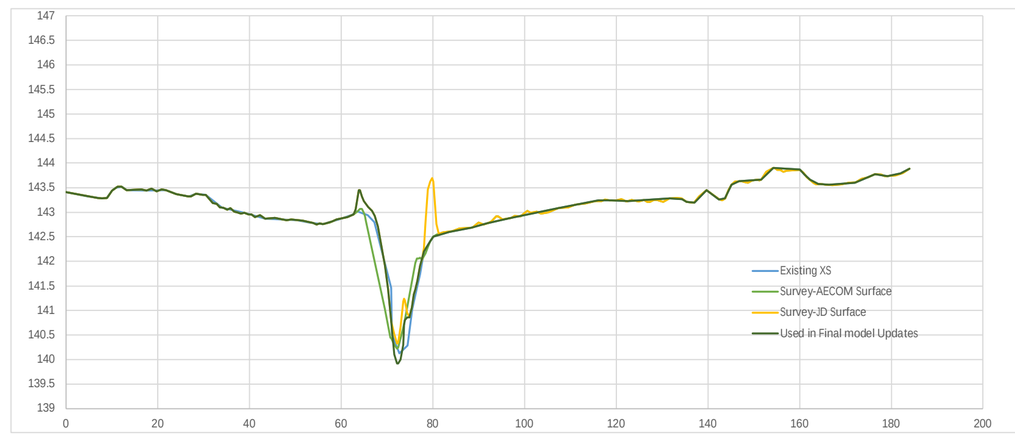
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	145.020	0.016
16.3	144.610	
26.5	144.410	
43.6	144.310	
50.1	144.350	
58.5	144.190	
70.2	144.000	
76.4	143.930	
83.6	143.770	0.055
84.8	143.560	
85.7	143.340	
86.3	142.920	
88.4	141.972	0.035
89.0	141.690	
89.1	141.600	
89.3	141.440	
89.9	141.020	
90.4	140.930	
90.6	140.950	
90.8	140.500	
91.7	140.090	
92.0	140.080	
92.3	140.100	
93.1	140.300	
93.4	141.070	
94.1	142.070	
94.4	142.400	
94.8	142.460	
95.0	142.492	0.025
95.8	142.660	
96.2	142.720	
97.1	142.700	
97.6	142.880	
98.3	143.180	
98.5	143.190	
99.1	143.170	
99.8	143.180	
100.5	143.160	
101.2	143.160	
103.3	143.190	
104.2	143.190	
105.4	143.230	
107.6	143.210	
108.6	143.250	
109.7	143.250	
110.1	143.260	
111.1	143.250	
111.8	143.290	
112.5	143.310	
113.9	143.390	
115.3	143.530	0.045
116.0	143.580	
117.6	143.630	
118.2	143.690	
118.9	143.800	
119.0	143.800	
119.6	143.730	
120.1	143.690	
120.5	143.690	
121.4	143.690	
122.8	143.770	
124.5	143.780	
125.2	143.660	0.025
125.5	143.630	
126.7	143.690	
128.1	143.630	
129.5	143.490	
130.2	143.470	
135.4	143.460	
136.6	143.490	
137.3	143.480	
139.0	143.510	
143.0	143.500	
145.8	143.560	
147.3	143.850	
147.9	143.880	
148.8	143.900	
150.3	143.990	
151.2	144.000	
151.4	143.960	
152.2	143.790	
152.5	143.780	
154.3	143.810	
155.0	143.850	
155.7	143.840	
156.4	143.880	
156.6	143.880	
157.1	143.870	
157.7	143.890	
158.5	143.880	
159.2	143.900	
160.6	143.880	
162.1	143.920	
163.7	143.920	
165.1	144.000	
167.0	143.970	
168.1	144.000	
169.1	143.970	
170.1	143.970	
172.0	144.030	
172.7	144.080	0.045
173.4	144.040	
174.6	144.020	
177.6	144.070	
178.3	144.100	
178.5	144.100	
180.5	144.090	0.016
181.9	144.060	
183.6	144.100	
186.0	144.100	
187.6	144.120	
190.4	144.180	
192.5	144.280	
193.9	144.330	
195.3	144.410	
196.0	144.500	
197.1	144.610	
197.9	144.640	
200.8	144.630	
203.1	144.590	
203.8	144.610	
204.5	144.570	
205.2	144.560	
206.7	144.520	
207.4	144.510	
208.1	144.480	
210.0	144.450	

Existing XS	
Station	Elevation
0.0	143.410
4.6	143.330
7.8	143.280
8.8	143.290
10.0	143.440
10.8	143.500
12.1	143.520
13.2	143.450
17.4	143.440
21.8	143.450
24.3	143.360
26.9	143.320
28.3	143.380
30.4	143.350
34.0	143.090
38.9	142.990
43.4	142.870
50.3	142.840
53.1	142.790
56.0	142.760
59.6	142.860
62.4	142.950
63.5	143.020
64.6	142.980
65.8	142.940
67.3	142.800
70.9	141.460
71.1	140.510
72.7	140.130
74.5	140.290
75.5	141.020
76.6	141.500
77.2	141.729
78.1	142.200
79.4	142.410
80.1	142.500
83.6	142.600
88.4	142.690
91.7	142.770
97.1	142.890
107.3	143.080
116.2	143.240
119.0	143.240
122.6	143.230
131.6	143.280
134.3	143.270
135.3	143.210
137.0	143.200
139.7	143.450
142.4	143.260
143.8	143.280
145.1	143.560
146.8	143.630
151.6	143.670
154.2	143.900
160.0	143.870
161.0	143.770
162.2	143.660
164.1	143.580
166.4	143.560
172.1	143.600
176.5	143.780
178.0	143.750
179.2	143.730
182.0	143.790
184.0	143.890

Survey-AECOM Surface	
Station	Elevation
0.0	143.410
6.8	143.290
7.8	143.280
8.9	143.290
10.0	143.440
11.2	143.520
12.1	143.520
13.2	143.450
16.4	143.460
17.5	143.440
18.6	143.480
19.7	143.430
20.8	143.460
21.8	143.450
24.0	143.370
26.6	143.320
27.2	143.320
28.3	143.380
29.7	143.350
30.4	143.350
32.0	143.190
32.8	143.170
33.5	143.100
34.3	143.090
35.1	143.050
35.8	143.080
36.6	143.010
37.4	143.000
38.1	142.970
38.9	142.990
39.7	142.960
40.4	142.960
41.2	142.900
42.3	142.940
43.4	142.870
45.5	142.880
48.1	142.840
49.1	142.850
51.6	142.830
53.9	142.780
54.6	142.750
55.3	142.770
56.0	142.760
57.5	142.790
59.0	142.860
61.4	142.900
62.7	142.960
63.5	143.010
64.1	143.070
64.5	143.070
65.0	142.990
65.2	142.920
65.4	142.830
69.5	141.020
70.8	140.450
70.9	140.433
71.6	140.300
72.2	140.220
72.4	140.240
73.0	140.430
73.5	140.650
73.9	140.800
76.2	141.970
76.5	142.060
76.6	142.060
76.9	142.060
77.2	142.080
77.6	142.030
78.0	142.110
78.4	142.160
78.9	142.290
79.4	142.410
80.1	142.500
80.8	142.540
82.2	142.590
84.3	142.610
85.8	142.670
88.6	142.690
90.0	142.790
91.1	142.750
92.1	142.780
92.8	142.810
93.8	142.920
94.2	142.920
95.2	142.860
97.1	142.890
97.8	142.930
99.2	142.920
99.9	142.970
100.6	143.030
101.3	142.990
102.7	143.010
103.6	142.970
105.1	143.000
107.3	143.080
109.6	143.100
111.1	143.150
113.3	143.180
115.4	143.230
116.8	143.230
117.6	143.260
118.5	143.240
120.0	143.240
121.1	143.270
122.2	143.220
123.3	143.250
124.9	143.220
126.1	143.250
126.8	143.210
127.4	143.210
128.2	143.250
128.9	143.250
130.3	143.210
131.6	143.280
133.2	143.290
134.3	143.280
135.3	143.210
136.7	143.200
137.0	143.200
138.1	143.320
139.7	143.450
142.4	143.270
143.1	143.240
143.8	143.280
144.5	143.450
145.1	143.560
145.9	143.620
147.3	143.630
148.3	143.610
148.7	143.600
149.7	143.650
150.9	143.660
151.2	143.650
151.6	143.660
152.7	143.820
154.2	143.900
154.6	143.900
155.1	143.860
155.8	143.860
156.5	143.820
157.2	143.850
160.0	143.860
160.8	143.810
161.4	143.730
161.5	143.720
163.1	143.590
163.6	143.570
164.6	143.580
165.7	143.560
167.2	143.550
169.1	143.570
170.7	143.600
172.2	143.610
173.5	143.680
175.0	143.710
176.4	143.780
177.8	143.770
178.5	143.730
178.9	143.730
181.0	143.750
182.5	143.800
184.0	143.890

Survey-JD Surface	
Station	Elevation
0.0	143.410
6.8	143.290
7.8	143.280
8.9	143.290
10.0	143.440
11.2	143.520
12.1	143.520
13.2	143.450
16.4	143.460
17.5	143.440
18.6	143.480
19.7	143.430
20.8	143.460
21.8	143.450
24.0	143.370
26.6	143.320
27.2	143.320
28.3	143.380
29.7	143.350
30.4	143.350
32.0	143.190
32.8	143.170
33.5	143.100
34.3	143.090
35.1	143.050
35.8	143.080
36.6	143.010
37.4	143.000
38.1	142.970
38.9	142.990
39.7	142.960
40.4	142.960
41.2	142.900
42.3	142.940
43.4	142.870
45.5	142.880
48.1	142.840
49.1	142.850
51.6	142.830
53.9	142.780
54.6	142.750
55.3	142.770
56.0	142.760
56.7	142.770
58.1	142.810
59.0	142.860
61.4	142.900
62.7	142.960
63.1	143.060
63.8	143.450
64.1	143.450
64.5	143.330
65.0	143.230
65.9	143.110
66.8	143.030
67.3	142.930
68.0	142.710
69.5	141.920
70.2	141.440
70.9	140.789
70.9	140.780
71.6	140.520
72.2	140.330
72.3	140.330
72.4	140.350
73.0	140.660
73.5	141.180
73.7	141.240
73.9	141.210
74.4	140.960
74.9	140.860
75.1	140.940
75.4	141.060
75.8	141.330
76.2	141.430
76.5	141.560
76.6	141.595
77.2	141.910
77.6	142.030
78.0	142.280
78.4	142.800
78.7	143.250
78.9	143.470
79.4	143.620
79.8	143.700
80.1	143.620
80.8	142.760
81.3	142.560
82.2	142.590
84.3	142.610
85.8	142.670
88.6	142.690
90.0	142.790
91.1	142.750
92.1	142.780
92.8	142.810
93.8	142.920
94.2	142.920
95.2	142.860
97.1	142.890
97.8	142.930
99.2	142.920
99.9	142.970
100.6	143.030
101.3	142.990
102.7	143.010
103.6	142.970
105.1	143.000
107.3	143.080
109.6	143.100
111.1	143.150
113.3	143.180
115.4	143.230
116.8	143.230
117.6	143.260
118.5	143.240
120.0	143.240
121.1	143.270
122.2	143.220
123.3	143.250
124.9	143.220
126.1	143.250
126.8	143.210
127.4	143.210
128.2	143.250
128.9	143.250
130.3	143.210
131.6	143.280
133.2	143.290
134.3	143.280
135.3	143.210
136.7	143.200
137.0	143.200
138.1	143.320
139.7	143.450
142.4	143.270
143.1	143.240
143.8	143.280
144.5	143.450
145.1	143.560
145.9	143.620
147.3	143.630
148.3	143.610
148.7	143.600
149.7	143.650
150.9	143.660
151.2	143.650
151.6	143.660
152.7	143.820
154.2	143.900
154.6	143.900
155.1	143.860
155.8	143.860
156.5	143.820
157.2	143.850
160.0	143.860
160.8	143.810
161.4	143.730
161.5	143.720
163.1	143.590
163.6	143.570
164.6	143.580
165.7	143.560
167.2	143.550
169.1	143.570
170.7	143.600
172.2	143.610
173.5	143.680
175.0	143.710
176.4	143.780
177.8	143.770
178.5	143.730
178.9	143.730
181.0	143.750
182.5	143.800
184.0	143.890

Used in Final model Updates		
Station	Elevation	
0.0	143.410	
6.8	143.290	
7.8	143.280	
8.9	143.290	
10.0	143.440	
11.2	143.520	
12.1	143.520	
13.2	143.450	
16.4	143.460	
17.5	143.440	
18.6	143.480	
19.7	143.430	
20.8	143.460	
21.8	143.450	
24.0	143.370	
26.6	143.320	
27.2	143.320	
28.3	143.380	
29.7	143.350	
30.4	143.350	
32.0	143.190	
32.8	143.170	
33.5	143.100	
34.3	143.090	
35.1	143.050	
35.8	143.080	
36.6	143.010	
37.4	143.000	
38.1	142.970	
38.9	142.990	
39.7	142.960	
40.4	142.960	
41.2	142.900	
42.3	142.940	
43.4	142.870	
45.5	142.880	
48.1	142.840	
49.1	142.850	
51.6	142.830	
53.9	142.780	
54.6	142.750	
55.3	142.770	
56.0	142.760	
56.7	142.770	
58.1	142.810	
59.0	142.860	
61.4	142.900	
62.7	142.960	
63.1	143.060	
63.8	143.450	
64.1	143.450	
64.5	143.330	
65.0	143.230	
65.9	143.110	
66.8	143.030	
67.3	142.930	
68.0	142.710	
69.5	141.920	
70.2	141.440	
70.9	140.789	
70.9	140.780	
71.6	140.100	
72.2	139.920	
72.3	139.920	Modified based on AECOM surveyed TWG
72.4	139.920	
73.0	140.000	
73.5	140.300	
73.7	140.700	
73.9	140.800	
74.4	140.860	
74.9	140.860	
75.1	140.940	
75.4	141.060	
75.8	141.330	
76.2	141.430	
76.5	141.560	
76.6	141.595	
77.2	141.910	
78.1	142.200	
79.4	142.410	
80.1	142.500	
83.6	142.600	
88.4	142.690	
91.7	142.770	
97.1	142.890	
107.3	143.080	
116.2	143.240	
119.0	143.240	
122.6	143.230	
131.6	143.280	
134.3	143.270	Changed to remove the stich effect
135.3	143.210	
137.0	143.200	
139.7	143.450	
142.4	143.260	
143.8	143.280	
145.1	143.560	
146.8	143.630	
151.6	143.670	
154.2	143.900	
160.0	143.870	
161.0	143.770	
162.2	143.660	
164.1	143.580	
166.4	143.560	
172.1	143.600	
176.5	143.780	
178.0	143.750	
179.2	143.730	
182.0	143.790	
184.0	143.890	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	143.410	0.025
4.6	143.330	
7.8	143.280	
8.8	143.290	
10.0	143.440	
10.8	143.500	
12.1	143.520	
13.2	143.450	
17.4	143.440	
21.8	143.450	
24.3	143.360	
26.9	143.320	
28.3	143.380	
30.4	143.350	
34.0	143.090	
38.9	142.990	
43.4	142.870	
50.3	142.840	
53.1	142.790	
56.0	142.760	
59.6	142.860	
62.4	142.950	
63.5	143.020	0.055
64.6	142.980	
65.8	142.940	
67.3	142.800	
70.9	141.460	0.035
71.1	140.510	
72.7	140.130	
74.5	140.290	
75.5	141.020	
76.6	141.500	0.045
77.2	141.729	
78.1	142.200	
79.4	142.410	0.025
80.1	142.500	
83.6	142.600	
88.4	142.690	
91.7	142.770	
97.1	142.890	
107.3	143.080	
116.2	143.240	
119.0	143.240	0.045
122.6	143.230	
131.6	143.280	
134.3	143.270	
135.3	143.210	
137.0	143.200	
139.7	143.450	
142.4	143.260	
143.8	143.280	
145.1	143.560	
146.8	143.630	
151.6	143.670	
154.2	143.900	
160.0	143.870	
161.0	143.770	0.025
162.2	143.660	
164.1	143.580	
166.4	143.560	
172.1	143.600	
176.5	143.780	
178.0	143.750	
179.2	143.730	
182.0	143.790	
184.0	143.890	

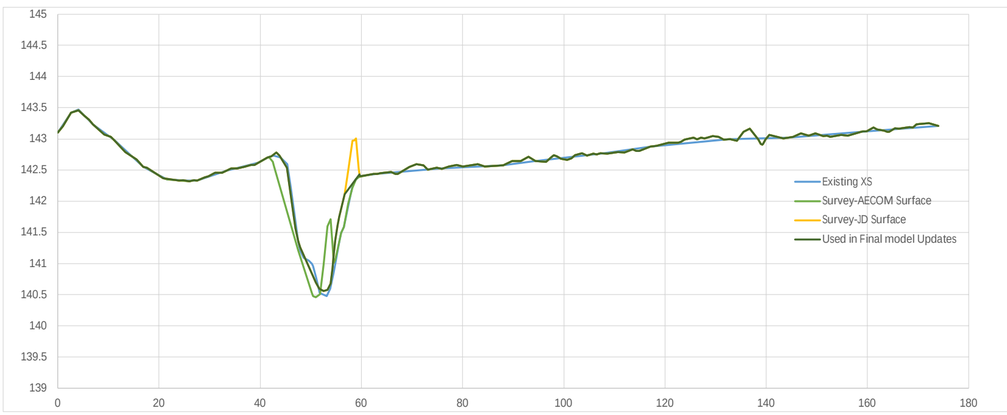
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	143.410	0.016
6.8	143.290	
7.8	143.280	
8.9	143.290	
10.0	143.440	
11.2	143.520	
12.1	143.520	
13.2	143.450	
16.4	143.460	
17.5	143.440	
18.6	143.480	
19.7	143.430	
20.8	143.460	
21.8	143.450	
24.0	143.370	
26.6	143.320	
27.2	143.320	
28.3	143.380	
29.7	143.350	
30.4	143.350	
32.0	143.190	
32.8	143.170	
33.5	143.100	
34.3	143.090	
35.1	143.050	
35.8	143.080	
36.6	143.010	
37.4	143.000	
38.1	142.970	
38.9	142.990	
39.7	142.960	
40.4	142.960	
41.2	142.900	
42.3	142.940	
43.4	142.870	
45.5	142.880	
48.1	142.840	
49.1	142.850	
51.6	142.830	
53.9	142.780	
54.6	142.750	
55.3	142.770	
56.0	142.760	
56.7	142.770	
58.1	142.810	
59.0	142.860	
61.4	142.900	
62.7	142.960	
63.1	143.060	
63.8	143.450	0.055
64.1	143.450	
64.5	143.330	
65.0	143.230	
65.9	143.110	
66.8	143.030	
67.3	142.930	
68.0	142.710	
69.5	141.920	
70.2	141.440	
70.9	140.789	0.035
70.9	140.780	
71.6	140.100	
72.2	139.920	
72.3	139.920	
72.4	139.920	
73.0	140.000	
73.5	140.300	
73.7	140.700	
73.9	140.800	
74.4	140.860	
74.9	140.860	
75.1	140.940	
75.4	141.060	
75.8	141.330	
76.2	141.430	
76.5	141.560	
76.6	141.595	0.045
77.2	141.910	
78.1	142.200	
79.4	142.410	0.025
80.1	142.500	
83.6	142.600	
88.4	142.690	
91.7	142.770	
97.1	142.890	
107.3	143.080	
116.2	143.240	
119.0	143.240	0.045
122.6	143.230	
131.6	143.280	
134.3	143.270	
135.3	143.210	
137.0	143.200	
139.7	143.450	
142.4	143.260	
143.8	143.280	
145.1	143.560	
146.8	143.630	
151.6	143.670	
154.2	143.900	
160.0	143.870	
161.0	143.770	0.016
162.2	143.660	
164.1	143.580	
166.4	143.560	
172.1	143.600	
176.5	143.780	
178.0	143.750	
179.2	143.730	
182.0	143.790	
184.0	143.890	

Existing XS	
Station	Elevation
0.0	143.100
2.6	143.420
4.1	143.470
7.0	143.230
11.2	142.980
16.9	142.560
19.0	142.460
21.6	142.350
25.4	142.330
27.6	142.330
33.3	142.490
39.7	142.620
41.8	142.710
42.7	142.730
44.0	142.700
45.3	142.590
46.1	142.220
46.8	141.810
47.5	141.350
47.9	141.210
48.6	141.090
49.6	141.050
50.2	141.000
50.5	140.960
51.0	140.770
51.8	140.530
52.5	140.500
53.2	140.480
53.9	140.600
54.6	140.860
55.6	141.340
56.0	141.490
56.5	141.590
57.4	141.950
58.1	142.210
58.9	142.350
59.7	142.400
63.0	142.440
75.5	142.530
87.8	142.570
94.4	142.640
107.9	142.770
117.1	142.880
132.6	143.000
144.5	143.020
159.8	143.120
174.0	143.210

Survey-AECOM Surface	
Station	Elevation
0.0	143.100
1.0	143.200
2.6	143.420
4.1	143.460
5.3	143.370
6.2	143.310
7.0	143.230
9.2	143.070
10.5	143.030
11.2	142.980
13.4	142.790
15.6	142.670
16.9	142.550
17.6	142.540
20.8	142.370
21.6	142.350
26.0	142.320
26.9	142.340
27.6	142.330
29.0	142.380
29.8	142.400
31.1	142.460
32.5	142.460
34.3	142.530
35.4	142.530
36.8	142.550
38.2	142.580
38.9	142.580
41.4	142.700
42.2	142.660
42.5	142.630
42.7	142.580
47.5	141.210
50.2	140.530
50.4	140.480
50.5	140.478
51.0	140.460
51.8	140.510
52.5	140.980
53.3	141.600
53.9	141.710
54.3	141.290
54.6	141.019
54.6	141.010
54.9	141.060
55.3	141.230
56.0	141.490
56.5	141.590
57.4	141.960
58.2	142.220
58.9	142.350
59.5	142.390
62.4	142.440
63.1	142.440
63.8	142.450
65.9	142.470
66.7	142.440
67.2	142.440
69.5	142.550
70.9	142.590
72.3	142.570
73.1	142.510
74.9	142.540
75.9	142.520
77.3	142.560
78.8	142.580
80.1	142.560
83.0	142.590
84.4	142.560
88.0	142.570
89.8	142.640
91.5	142.640
93.0	142.710
94.4	142.640
96.5	142.630
97.7	142.720
98.1	142.740
98.7	142.720
99.4	142.680
100.7	142.660
101.5	142.690
102.2	142.740
103.6	142.770
104.6	142.730
105.8	142.760
106.5	142.750
107.2	142.770
108.6	142.760
110.7	142.790
112.0	142.780
113.6	142.830
114.3	142.810
114.9	142.810
117.1	142.880
118.3	142.890
120.7	142.940
122.6	142.940
123.1	142.950
123.9	142.990
125.7	143.020
126.3	143.000
126.4	143.000
127.1	143.020
127.8	143.010
129.4	143.040
130.6	143.030
131.6	142.990
132.9	143.000
134.2	142.970
135.5	143.110
136.8	143.160
138.5	142.990
138.9	142.920
139.2	142.910
139.4	142.920
139.9	142.990
140.6	143.060
143.4	143.010
145.3	143.030
146.9	143.090
148.4	143.050
149.7	143.090
151.3	143.040
152.0	143.050
152.7	143.030
154.8	143.060
156.1	143.050
159.1	143.120
159.8	143.120
161.2	143.180
161.9	143.150
163.3	143.130
163.9	143.110
164.3	143.110
165.5	143.170
166.2	143.160
168.3	143.190
169.0	143.180
169.7	143.230
170.3	143.240
172.2	143.250
174.0	143.210

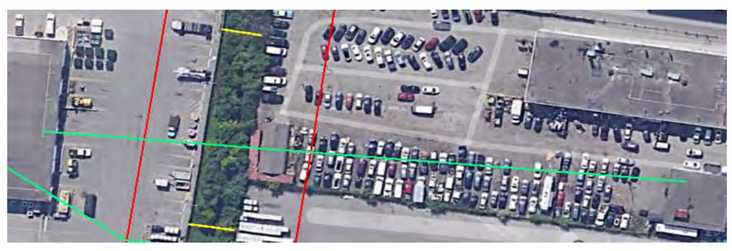
Survey-JD Surface	
Station	Elevation
0.0	143.100
1.0	143.200
2.6	143.420
4.1	143.460
5.3	143.370
6.2	143.310
7.0	143.230
9.2	143.070
10.5	143.030
11.2	142.980
13.4	142.790
15.6	142.670
16.9	142.550
17.6	142.540
20.8	142.370
24.0	142.330
24.8	142.340
26.0	142.320
26.9	142.340
27.6	142.330
29.0	142.380
29.8	142.400
31.1	142.460
32.5	142.460
34.3	142.530
35.4	142.530
36.8	142.550
38.2	142.580
38.9	142.580
41.4	142.700
42.2	142.720
43.2	142.780
43.8	142.730
45.3	142.540
46.6	141.780
47.0	141.560
47.5	141.360
47.9	141.260
50.5	140.799
51.0	140.700
51.7	140.600
52.5	140.560
53.3	140.580
53.9	140.680
54.3	140.930
54.6	141.148
54.9	141.380
55.3	141.620
55.6	141.750
56.7	142.110
57.4	142.490
58.2	142.970
58.6	142.980
58.9	143.010
59.5	142.520
59.6	142.430
59.7	142.400
62.4	142.440
63.1	142.440
63.8	142.450
65.9	142.470
66.7	142.440
67.2	142.440
69.5	142.550
70.9	142.590
72.3	142.570
73.1	142.510
74.9	142.540
75.9	142.520
77.3	142.560
78.8	142.580
80.1	142.560
83.0	142.590
84.4	142.560
88.0	142.570
89.8	142.640
91.5	142.640
93.0	142.710
94.4	142.640
96.5	142.630
97.7	142.720
98.1	142.740
98.7	142.720
99.4	142.680
100.7	142.660
101.5	142.690
102.2	142.740
103.6	142.770
104.6	142.730
105.8	142.760
106.5	142.750
107.2	142.770
108.6	142.760
110.7	142.790
112.0	142.780
113.6	142.830
114.3	142.810
114.9	142.810
117.1	142.880
118.3	142.890
120.7	142.940
122.6	142.940
123.1	142.950
123.9	142.990
125.7	143.020
126.3	143.000
126.4	143.000
127.1	143.020
127.8	143.010
129.4	143.040
130.6	143.030
131.6	142.990
132.9	143.000
134.2	142.970
135.5	143.110
136.8	143.160
138.5	142.990
138.9	142.920
139.2	142.910
139.4	142.920
139.9	142.990
140.6	143.060
143.4	143.010
145.3	143.030
146.9	143.090
148.4	143.050
149.7	143.090
151.3	143.040
152.0	143.050
152.7	143.030
154.8	143.060
156.1	143.050
159.1	143.120
159.8	143.120
161.2	143.180
161.9	143.150
163.3	143.130
163.9	143.110
164.3	143.110
165.5	143.170
166.2	143.160
168.3	143.190
169.0	143.180
169.7	143.230
170.3	143.240
172.2	143.250
174.0	143.210

Used in Final model Updates	
Station	Elevation
0.0	143.100
1.0	143.200
2.6	143.420
4.1	143.460
5.3	143.370
6.2	143.310
7.0	143.230
9.2	143.070
10.5	143.030
11.2	142.980
13.4	142.790
15.6	142.670
16.9	142.550
17.6	142.540
20.8	142.370
24.0	142.330
24.8	142.340
26.0	142.320
26.9	142.340
27.6	142.330
29.0	142.380
29.8	142.400
31.1	142.460
32.5	142.460
34.3	142.530
35.4	142.530
36.8	142.550
38.2	142.580
38.9	142.580
41.4	142.700
42.2	142.720
43.2	142.780
43.8	142.730
45.3	142.540
46.6	141.780
47.0	141.560
47.5	141.360
47.9	141.260
50.5	140.799
51.0	140.700
51.7	140.600
52.5	140.560
53.3	140.580
53.9	140.680
54.3	140.930
54.6	141.148
54.9	141.380
55.3	141.620
55.6	141.750
56.7	142.110
59.6	142.430
59.7	142.400
62.4	142.440
63.1	142.440
63.8	142.450
65.9	142.470
66.7	142.440
67.2	142.440
69.5	142.550
70.9	142.590
72.3	142.570
73.1	142.510
74.9	142.540
75.9	142.520
77.3	142.560
78.8	142.580
80.1	142.560
83.0	142.590
84.4	142.560
88.0	142.570
89.8	142.640
91.5	142.640
93.0	142.710
94.4	142.640
96.5	142.630
97.7	142.720
98.1	142.740
98.7	142.720
99.4	142.680
100.7	142.660
101.5	142.690
102.2	142.740
103.6	142.770
104.6	142.730
105.8	142.760
106.5	142.750
107.2	142.770
108.6	142.760
110.7	142.790
112.0	142.780
113.6	142.830
114.3	142.810
114.9	142.810
117.1	142.880
118.3	142.890
120.7	142.940
122.6	142.940
123.1	142.950
123.9	142.990
125.7	143.020
126.3	143.000
126.4	143.000
127.1	143.020
127.8	143.010
129.4	143.040
130.6	143.030
131.6	142.990
132.9	143.000
134.2	142.970
135.5	143.110
136.8	143.160
138.5	142.990
138.9	142.920
139.2	142.910
139.4	142.920
139.9	142.990
140.6	143.060
143.4	143.010
145.3	143.030
146.9	143.090
148.4	143.050
149.7	143.090
151.3	143.040
152.0	143.050
152.7	143.030
154.8	143.060
156.1	143.050
159.1	143.120
159.8	143.120
161.2	143.180
161.9	143.150
163.3	143.130
163.9	143.110
164.3	143.110
165.5	143.170
166.2	143.160
168.3	143.190
169.0	143.180
169.7	143.230
170.3	143.240
172.2	143.250
174.0	143.210



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	143.100	0.025
2.6	143.420	
4.1	143.470	
7.0	143.230	
11.2	142.980	
16.9	142.560	
19.0	142.460	
21.6	142.350	
25.4	142.330	
27.6	142.330	
33.3	142.490	
39.7	142.620	
41.8	142.710	
42.7	142.730	0.08
44.0	142.700	
45.3	142.590	
46.1	142.220	
46.8	141.810	
47.5	141.350	
47.9	141.210	
48.6	141.090	
49.6	141.050	
50.2	141.000	
50.5	140.960	0.035
51.0	140.770	
51.8	140.530	
52.5	140.500	
53.2	140.480	
53.9	140.600	
54.6	140.860	0.08
55.6	141.340	
56.0	141.490	
56.5	141.590	
57.4	141.950	
58.1	142.210	
58.9	142.350	
59.7	142.400	0.025
63.0	142.440	
75.5	142.530	
87.8	142.570	
94.4	142.640	
107.9	142.770	
117.1	142.880	
132.6	143.000	
144.5	143.020	
159.8	143.120	
174.0	143.210	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	143.100	0.016
1.0	143.200	
2.6	143.420	
4.1	143.460	
5.3	143.370	
6.2	143.310	
7.0	143.230	
9.2	143.070	
10.5	143.030	
11.2	142.980	
13.4	142.790	
15.6	142.670	
16.9	142.550	
17.6	142.540	
20.8	142.370	
24.0	142.330	
24.8	142.340	
26.0	142.320	
26.9	142.340	
27.6	142.330	
29.0	142.380	
29.8	142.400	
31.1	142.460	
32.5	142.460	
34.3	142.530	
35.4	142.530	
36.8	142.550	
38.2	142.580	
38.9	142.580	
41.4	142.700	
42.2	142.720	0.08
43.2	142.780	
43.8	142.730	
45.3	142.540	
46.6	141.780	
47.0	141.560	
47.5	141.360	
47.9	141.260	
50.5	140.799	0.035
51.0	140.700	
51.7	140.600	
52.5	140.560	
53.3	140.580	
53.9	140.680	
54.3	140.930	
54.6	141.148	0.08
54.9	141.380	
55.3	141.620	
55.6	141.750	
56.7	142.110	
59.6	142.430	
59.7	142.400	0.025
62.4	142.440	
63.1	142.440	
63.8	142.450	
65.9	142.470	
66.7	142.440	
67.2	142.440	
69.5	142.550	
70.9	142.590	
72.3	142.570	
73.1	142.510	
74.9	142.540	
75.9	142.520	
77.3	142.560	
78.8	142.580	
80.1	142.560	
83.0	142.590	
84.4	142.560	
88.0	142.570	
89.8	142.640	
91.5	142.640	
93.0	142.710	
94.4	142.640	
96.5	142.630	
97.7	142.720	
98.1	142.740	
98.7	142.720	
99.4	142.680	
100.7	142.660	
101.5	142.690	
102.2	142.740	
117.1	142.880	
118.3	142.890	
120.7	142.940	
122.6	142.940	
123.1	142.950	
123.9	142.990	
125.7	143.020	
126.3	143.000	
126.4	143.000	
127.1	143.020	
127.8	143.010	
129.4	143.040	
130.6	143.030	
131.6	142.990	
132.9	143.000	
134.2	142.970	
135.5	143.110	
136.8	143.160	
138.5	142.990	
138.9	142.920	
139.2	142.910	
139.4	142.920	
139.9	142.990	
140.6	143.060	
143.4	143.010	
145.3	143.030	
146.9	143.090	
148.4	143.050	
149.7	143.090	
151.3	143.040	
152.0	143.050	
152.7	143.030	
154.8	143.060	
156.1	143.050	
159.1	143.120	
159.8	143.120	
161.2	143.180	
161.9	143.150	
163.3	143.130	
163.9	143.110	
164.3	143.110	
165.5	143.170	
166.2	143.160	
168.3	143.190	
169.0	143.180	
169.7	143.230	
170.3	143.240	
172.2	143.250	
174.0	143.210	

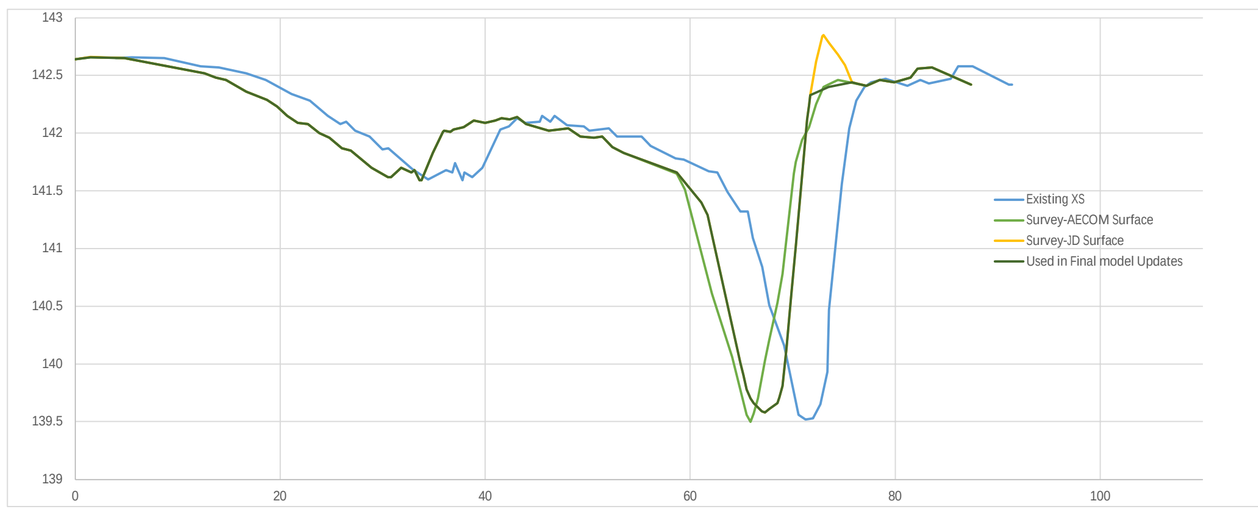


Existing XS	
Station	Elevation
4.0	142.650
5.5	142.660
8.7	142.650
12.3	142.580
14.0	142.570
16.7	142.520
18.6	142.460
21.1	142.340
22.9	142.280
24.7	142.150
25.9	142.080
26.4	142.100
27.3	142.020
28.7	141.970
30.0	141.860
30.5	141.870
32.9	141.690
34.4	141.600
36.2	141.680
36.8	141.660
37.1	141.740
37.8	141.590
38.0	141.660
38.7	141.620
39.7	141.700
41.5	142.030
42.3	142.060
43.1	142.130
43.9	142.090
45.3	142.100
45.6	142.150
46.4	142.100
46.8	142.150
48.0	142.070
49.6	142.060
50.2	142.020
52.1	142.040
52.9	141.970
55.3	141.970
56.1	141.890
58.6	141.780
59.4	141.770
61.8	141.670
62.6	141.660
63.6	141.490
64.9	141.320
65.6	141.320
66.1	141.090
67.0	140.840
67.7	140.510
69.2	140.160
70.6	139.560
71.3	139.520
72.0	139.530
72.7	139.650
73.4	139.930
73.6	140.470
74.8	141.560
75.5	142.040
76.2	142.280
77.0	142.400
77.6	142.440
79.1	142.470
81.2	142.410
82.5	142.460
83.3	142.430
85.4	142.470
86.1	142.580
87.6	142.580
91.1	142.420
91.4	142.420

Survey-AECOM Surface	
Station	Elevation
0.0	142.640
1.5	142.660
4.8	142.650
12.6	142.520
13.7	142.480
14.7	142.460
16.7	142.360
18.7	142.290
19.7	142.230
20.7	142.150
21.7	142.090
22.7	142.080
23.8	142.000
24.8	141.960
26.0	141.870
26.9	141.850
28.9	141.700
30.5	141.620
30.8	141.620
31.8	141.700
32.8	141.660
33.1	141.680
33.6	141.590
33.8	141.590
34.9	141.830
35.9	142.010
36.0	142.020
36.6	142.010
36.9	142.030
37.9	142.050
38.9	142.110
40.0	142.090
41.0	142.110
41.6	142.130
42.4	142.120
43.1	142.140
44.0	142.080
46.2	142.020
48.1	142.040
49.3	141.970
50.6	141.960
51.4	141.970
52.4	141.880
53.5	141.830
58.7	141.650
59.5	141.510
62.1	140.610
64.1	140.060
65.5	139.560
65.9	139.500
66.2	139.570
66.6	139.700
67.3	140.030
67.7	140.209
68.5	140.530
69.0	140.780
69.4	141.080
70.1	141.650
70.3	141.750
70.9	141.940
71.6	142.050
72.3	142.250
73.0	142.400
73.6	142.424
74.4	142.460
77.2	142.410
78.5	142.460
79.9	142.440
81.5	142.480
82.2	142.560
83.6	142.570
87.4	142.420

Survey-JD Surface	
Station	Elevation
0.0	142.640
1.5	142.660
4.8	142.650
12.6	142.520
13.7	142.480
14.7	142.460
16.7	142.360
18.7	142.290
19.7	142.230
20.7	142.150
21.7	142.090
22.7	142.080
23.8	142.000
24.8	141.960
26.0	141.870
26.9	141.850
28.9	141.700
30.5	141.620
30.8	141.620
31.8	141.700
32.8	141.660
33.1	141.680
33.6	141.590
33.8	141.590
34.9	141.830
35.9	142.010
36.0	142.020
36.6	142.010
36.9	142.030
37.9	142.050
38.9	142.110
40.0	142.090
41.0	142.110
41.6	142.130
42.4	142.120
43.1	142.140
44.0	142.080
46.2	142.020
48.1	142.040
49.3	141.970
50.6	141.960
51.4	141.970
52.4	141.880
53.5	141.830
58.7	141.660
61.1	141.400
61.7	141.290
62.1	141.120
64.9	140.010
65.2	139.900
65.5	139.780
65.9	139.700
66.2	139.660
67.0	139.590
67.3	139.580
67.7	139.609
68.5	139.660
68.7	139.710
69.0	139.810
69.4	140.130
69.9	140.620
70.3	141.020
71.4	142.120
71.6	142.240
71.7	142.330
72.3	142.620
72.9	142.840
73.0	142.850
73.6	142.782
74.4	142.680
75.1	142.590
75.8	142.440
77.2	142.410
78.5	142.460
79.9	142.440
81.5	142.480
82.2	142.560
83.6	142.570
87.4	142.420

Used in Final model Updates	
Station	Elevation
0.0	142.640
1.5	142.660
4.8	142.650
12.6	142.520
13.7	142.480
14.7	142.460
16.7	142.360
18.7	142.290
19.7	142.230
20.7	142.150
21.7	142.090
22.7	142.080
23.8	142.000
24.8	141.960
26.0	141.870
26.9	141.850
28.9	141.700
30.5	141.620
30.8	141.620
31.8	141.700
32.8	141.660
33.1	141.680
33.6	141.590
33.8	141.590
34.9	141.830
35.9	142.010
36.0	142.020
36.6	142.010
36.9	142.030
37.9	142.050
38.9	142.110
40.0	142.090
41.0	142.110
41.6	142.130
42.4	142.120
43.1	142.140
44.0	142.080
46.2	142.020
48.1	142.040
49.3	141.970
50.6	141.960
51.4	141.970
52.4	141.880
53.5	141.830
58.7	141.660
61.1	141.400
61.7	141.290
62.1	141.120
64.9	140.010
65.2	139.900
65.5	139.780
65.9	139.700
66.2	139.660
67.0	139.590
67.3	139.580
67.7	139.609
68.5	139.660
68.7	139.710
69.0	139.810
69.4	140.130
69.9	140.620
70.3	141.020
71.4	142.120
71.6	142.240
71.7	142.330
73.5	142.400
75.8	142.440
76.2	142.430
77.2	142.410
78.5	142.460
79.9	142.440
81.5	142.480
82.2	142.560
83.6	142.570
87.4	142.420



Original

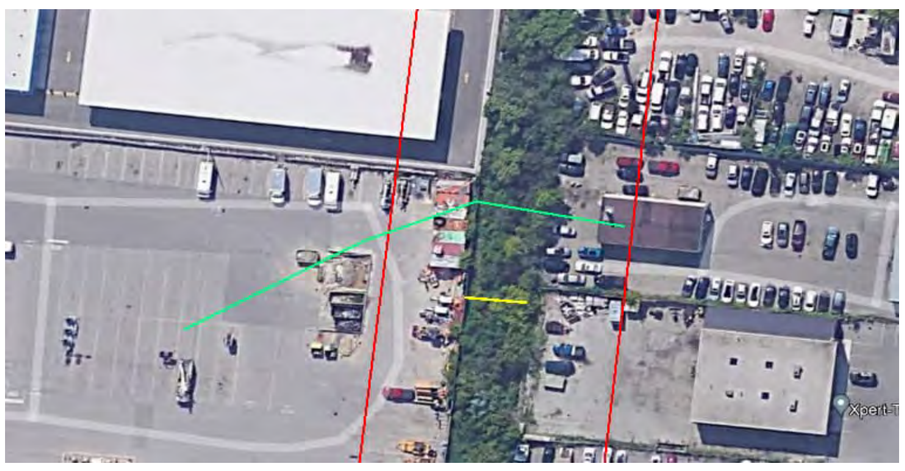
Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
4.0	142.650	0.025
5.5	142.660	
8.7	142.650	
12.3	142.580	
14.0	142.570	
16.7	142.520	
18.6	142.460	
21.1	142.340	
22.9	142.280	
24.7	142.150	
25.9	142.080	
26.4	142.100	
27.3	142.020	
28.7	141.970	
30.0	141.860	
30.5	141.870	
32.9	141.690	
34.4	141.600	
36.2	141.680	
36.8	141.660	
37.1	141.740	
37.8	141.590	
38.0	141.660	
38.7	141.620	
39.7	141.700	
41.5	142.030	
42.3	142.060	
43.1	142.130	
43.9	142.090	
45.3	142.100	
45.6	142.150	
46.4	142.100	
46.8	142.150	
48.0	142.070	
49.6	142.060	
50.2	142.020	
52.1	142.040	
52.9	141.970	
55.3	141.970	
56.1	141.890	
58.6	141.780	
59.4	141.770	
61.8	141.670	0.045
62.6	141.660	
63.6	141.490	0.055
64.9	141.320	
65.6	141.320	
66.1	141.090	
67.0	140.840	
67.7	140.510	0.035
69.2	140.160	
70.6	139.560	
71.3	139.520	
72.0	139.530	
72.7	139.650	
73.4	139.930	
73.6	140.470	0.055
74.8	141.560	
75.5	142.040	0.045
76.2	142.280	0.025
77.0	142.400	
77.6	142.440	
79.1	142.470	
81.2	142.410	
82.5	142.460	
83.3	142.430	
85.4	142.470	
86.1	142.580	
87.6	142.580	
91.1	142.420	
91.4	142.420	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M2

Station	Elevation	n Value
0.0	142.640	0.016
1.5	142.660	
4.8	142.650	
12.6	142.520	
13.7	142.480	
14.7	142.460	
16.7	142.360	
18.7	142.290	
19.7	142.230	
20.7	142.150	
21.7	142.090	
22.7	142.080	
23.8	142.000	
24.8	141.960	
26.0	141.870	
26.9	141.850	
28.9	141.700	
30.5	141.620	
30.8	141.620	
31.8	141.700	
32.8	141.660	
33.1	141.680	
33.6	141.590	
33.8	141.590	
34.9	141.830	
35.9	142.010	
36.0	142.020	
36.6	142.010	
36.9	142.030	
37.9	142.050	
38.9	142.110	
40.0	142.090	
41.0	142.110	
41.6	142.130	
42.4	142.120	
43.1	142.140	
44.0	142.080	
46.2	142.020	
48.1	142.040	
49.3	141.970	
50.6	141.960	
51.4	141.970	
52.4	141.880	
53.5	141.830	
58.7	141.660	0.045
61.1	141.400	0.055
61.7	141.290	
62.1	141.120	0.035
64.9	140.010	
65.2	139.900	
65.5	139.780	
65.9	139.700	
66.2	139.660	
67.0	139.590	
67.3	139.580	
67.7	139.609	
68.5	139.660	
68.7	139.710	
69.0	139.810	
69.4	140.130	
69.9	140.620	
70.3	141.020	0.055
71.4	142.120	
71.6	142.240	
71.7	142.330	
73.5	142.400	
75.8	142.440	0.045
76.2	142.430	0.016
77.2	142.410	
78.5	142.460	
79.9	142.440	
81.5	142.480	
82.2	142.560	
83.6	142.570	
87.4	142.420	

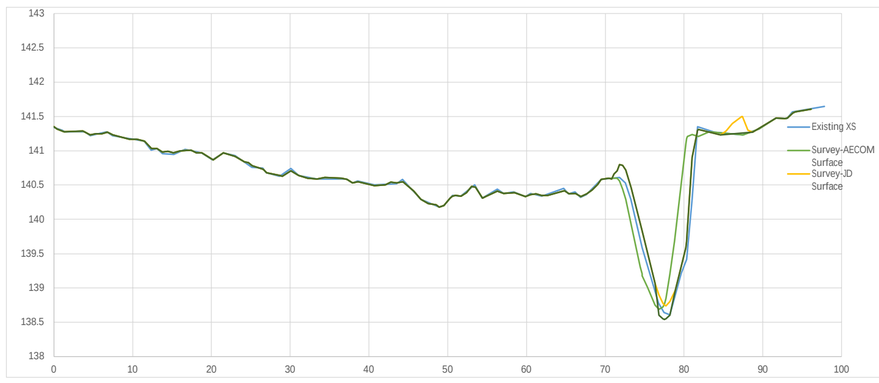


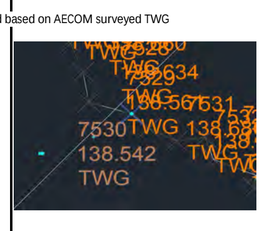
Existing XS	
Station	Elevation
0.0	141.340
1.1	141.300
1.4	141.280
3.9	141.280
4.6	141.220
6.7	141.280
7.4	141.220
11.5	141.140
12.4	141.010
13.1	141.030
13.8	140.960
15.2	140.950
16.6	141.020
18.7	140.970
20.1	140.870
21.5	140.970
23.0	140.930
25.1	140.760
26.5	140.750
27.0	140.680
28.7	140.630
30.1	140.740
31.1	140.640
33.4	140.590
37.2	140.590
37.9	140.530
38.6	140.560
40.7	140.500
43.5	140.520
44.2	140.580
46.6	140.290
48.9	140.180
49.5	140.200
50.6	140.350
51.6	140.340
53.4	140.500
54.4	140.310
56.3	140.440
57.1	140.380
58.4	140.400
59.9	140.330
60.5	140.380
61.9	140.340
64.8	140.450
65.3	140.370
66.2	140.400
66.9	140.320
67.6	140.360
69.5	140.580
71.8	140.610
72.5	140.530
73.2	140.290
74.7	139.590
76.8	138.780
77.5	138.640
78.2	138.610
79.6	139.210
80.3	139.420
81.0	140.290
81.7	141.350
83.9	141.270
87.4	141.230
89.5	141.320
91.6	141.480
93.1	141.470
93.8	141.570
97.8	141.650

Survey-AECOM Surface	
Station	Elevation
0.0	141.350
0.4	141.320
1.3	141.280
3.7	141.290
4.6	141.230
5.3	141.250
6.1	141.250
6.8	141.270
7.5	141.230
9.6	141.170
10.5	141.170
11.5	141.140
12.4	141.030
13.1	141.030
13.8	140.980
14.5	140.990
15.2	140.970
16.0	141.000
17.4	141.010
18.1	140.970
18.8	140.970
20.2	140.870
21.5	140.970
23.0	140.920
24.2	140.840
24.7	140.830
25.2	140.780
26.6	140.730
27.0	140.680
28.7	140.640
29.0	140.630
30.1	140.710
31.1	140.640
32.2	140.600
33.4	140.590
34.4	140.610
36.5	140.600
37.2	140.580
37.9	140.530
38.6	140.550
40.7	140.490
42.1	140.500
42.8	140.540
43.5	140.530
44.3	140.550
45.7	140.410
46.6	140.290
47.5	140.230
48.5	140.210
48.9	140.180
49.5	140.200
50.3	140.310
50.6	140.340
51.0	140.350
51.7	140.340
52.4	140.390
53.0	140.480
53.5	140.470
54.4	140.310
54.9	140.340
56.3	140.410
57.1	140.380
58.5	140.390
59.9	140.330
60.5	140.360
61.2	140.370
61.9	140.350
62.7	140.350
64.8	140.420
65.4	140.370
66.2	140.380
66.9	140.330
67.6	140.370
68.3	140.430
69.0	140.510
69.5	140.580
70.4	140.600
71.5	140.600
71.8	140.560
72.2	140.440
72.6	140.290
74.4	139.310
74.7	139.202
74.7	139.180
75.0	139.090
75.4	139.010
76.3	138.750
76.8	138.690
77.3	138.720
77.5	138.760
77.7	138.850
78.2	139.200
78.8	139.680
80.2	141.100
80.3	141.180
80.3	141.183
80.4	141.210
81.0	141.240
81.8	141.210
83.2	141.280
87.5	141.230
89.5	141.320
91.7	141.480
92.8	141.470
93.1	141.480
93.8	141.550
94.1	141.570
96.1	141.610

Survey-JD Surface	
Station	Elevation
0.0	141.350
0.4	141.320
1.3	141.280
3.7	141.290
4.6	141.230
5.3	141.250
6.1	141.250
6.8	141.270
7.5	141.230
9.6	141.170
10.5	141.170
11.5	141.140
12.4	141.030
13.1	141.030
13.8	140.980
14.5	140.990
15.2	140.970
16.0	141.000
17.4	141.010
18.1	140.970
18.8	140.970
20.2	140.870
21.5	140.970
23.0	140.920
24.2	140.840
24.7	140.830
25.2	140.780
26.6	140.730
27.0	140.680
28.7	140.640
29.0	140.630
30.1	140.710
31.1	140.640
32.2	140.600
33.4	140.590
34.4	140.610
36.5	140.600
37.2	140.580
37.9	140.530
38.6	140.550
40.7	140.490
42.1	140.500
42.8	140.540
43.5	140.530
44.3	140.550
45.7	140.410
46.6	140.290
47.5	140.230
48.5	140.210
48.9	140.180
49.5	140.200
50.3	140.310
50.6	140.340
51.0	140.350
51.7	140.340
52.4	140.390
53.0	140.480
53.5	140.470
54.4	140.310
54.9	140.340
56.3	140.410
57.1	140.380
58.5	140.390
59.9	140.330
60.5	140.360
61.2	140.370
61.9	140.350
62.7	140.350
64.8	140.420
65.4	140.370
66.2	140.380
66.9	140.330
67.6	140.370
68.3	140.430
69.0	140.510
69.5	140.580
70.4	140.600
70.8	140.590
71.1	140.660
71.5	140.710
71.8	140.800
72.2	140.790
72.6	140.720
73.3	140.460
74.7	139.835
76.3	139.070
76.8	138.900
77.3	138.780
77.5	138.750
77.7	138.740
78.2	138.800
78.9	138.970
80.2	139.590
80.3	139.680
80.3	139.697
81.0	140.900
81.7	141.300
81.8	141.310
84.6	141.230
85.3	141.290
86.1	141.400
87.3	141.500
87.4	141.500
88.1	141.300
88.7	141.270
91.7	141.480
92.8	141.470
93.1	141.480
93.8	141.550
94.1	141.570
96.1	141.610

Used in Final model Updates		
Station	Elevation	
0.0	141.350	
0.4	141.320	
1.3	141.280	
3.7	141.290	
4.6	141.230	
5.3	141.250	
6.1	141.250	
6.8	141.270	
7.5	141.230	
9.6	141.170	
10.5	141.170	
11.5	141.140	
12.4	141.030	
13.1	141.030	
13.8	140.980	
14.5	140.990	
15.2	140.970	
16.0	141.000	
17.4	141.010	
18.1	140.970	
18.8	140.970	
20.2	140.870	
21.5	140.970	
23.0	140.920	
24.2	140.840	
24.7	140.830	
25.2	140.780	
26.6	140.730	
27.0	140.680	
28.7	140.640	
29.0	140.630	
30.1	140.710	
31.1	140.640	
32.2	140.600	
33.4	140.590	
34.4	140.610	
36.5	140.600	
37.2	140.580	
37.9	140.530	
38.6	140.550	
40.7	140.490	
42.1	140.500	
42.8	140.540	
43.5	140.530	
44.3	140.550	
45.7	140.410	
46.6	140.290	
47.5	140.230	
48.5	140.210	
48.9	140.180	
49.5	140.200	
50.3	140.310	
50.6	140.340	
51.0	140.350	
51.7	140.340	
52.4	140.390	
53.0	140.480	
53.5	140.470	
54.4	140.310	
54.9	140.340	
56.3	140.410	
57.1	140.380	
58.5	140.390	
59.9	140.330	
60.5	140.360	
61.2	140.370	
61.9	140.350	
62.7	140.350	
64.8	140.420	
65.4	140.370	
66.2	140.380	
66.9	140.330	
67.6	140.370	
68.3	140.430	
69.0	140.510	
69.5	140.580	
70.4	140.600	
70.8	140.590	
71.1	140.660	
71.5	140.710	
71.8	140.800	
72.2	140.790	
72.6	140.720	
73.3	140.460	
74.7	139.835	
76.3	139.070	
76.8	138.600	
77.3	138.550	
77.5	138.540	Modified based on AECOM surveyed TWG
77.7	138.550	
78.2	138.600	
78.9	138.970	
80.2	139.590	
80.3	139.680	
80.3	139.697	
81.0	140.900	
81.7	141.300	
81.8	141.310	
84.6	141.230	
88.7	141.270	
91.7	141.480	
92.8	141.470	
93.1	141.480	
93.8	141.550	
94.1	141.570	
96.1	141.610	





Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	141.340	0.045
1.1	141.300	
1.4	141.280	
3.9	141.280	
4.6	141.220	
6.7	141.280	
7.4	141.220	
11.5	141.140	
12.4	141.010	
13.1	141.030	
13.8	140.960	
15.2	140.950	
16.6	141.020	
18.7	140.970	
20.1	140.870	
21.5	140.970	
23.0	140.930	
25.1	140.760	
26.5	140.750	
27.0	140.680	
28.7	140.630	
30.1	140.740	
31.1	140.640	
33.4	140.590	
37.2	140.590	
37.9	140.530	
38.6	140.560	
40.7	140.500	
43.5	140.520	
44.2	140.580	
46.6	140.290	
48.9	140.180	
49.5	140.200	
50.6	140.350	
51.6	140.340	
53.4	140.500	
54.4	140.310	
56.3	140.440	
57.1	140.380	
58.4	140.400	
59.9	140.330	
60.5	140.380	
61.9	140.340	
64.8	140.450	
65.3	140.370	
66.2	140.400	
66.9	140.320	
67.6	140.360	
69.5	140.580	
71.8	140.610	
72.5	140.530	0.055
73.2	140.290	
74.7	139.590	0.035
76.8	138.780	
77.5	138.640	
78.2	138.610	
79.6	139.210	
80.3	139.420	0.055
81.0	140.290	
81.7	141.350	
83.9	141.270	0.025
87.4	141.230	
89.5	141.320	
91.6	141.480	
93.1	141.470	
93.8	141.570	
97.8	141.650	

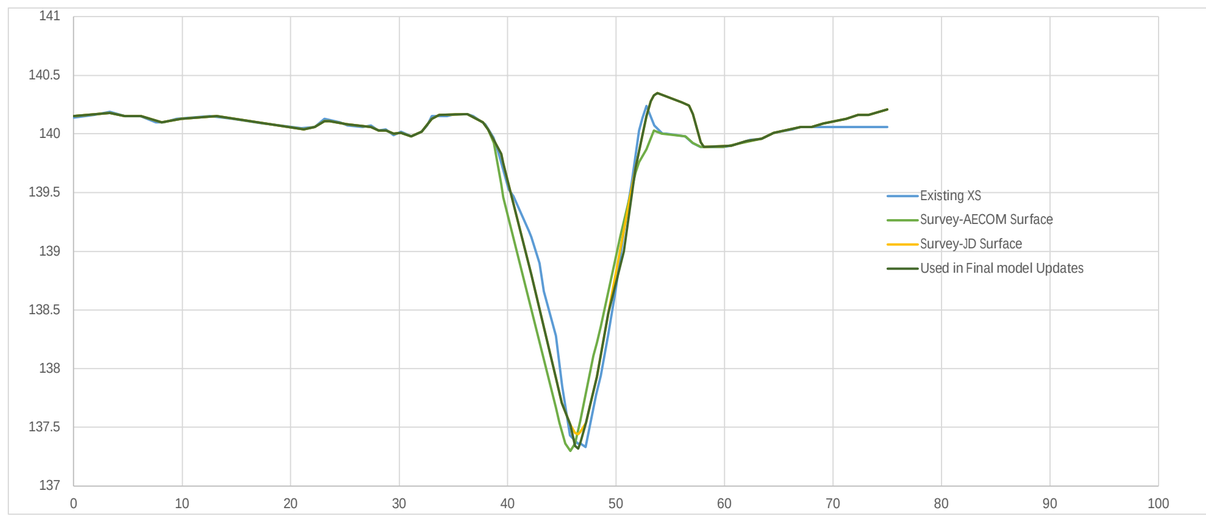
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	141.350	0.045
0.4	141.320	
1.3	141.280	
3.7	141.290	
4.6	141.230	
5.3	141.250	
6.1	141.250	
6.8	141.270	
7.5	141.230	
9.6	141.170	
10.5	141.170	
11.5	141.140	
12.4	141.030	
13.1	141.030	
13.8	140.980	
14.5	140.990	
15.2	140.970	
16.0	141.000	
17.4	141.010	
18.1	140.970	
18.8	140.970	
20.2	140.870	
21.5	140.970	
23.0	140.920	
24.2	140.840	
24.7	140.830	
25.2	140.780	
26.6	140.730	
27.0	140.680	
28.7	140.640	
29.0	140.630	
30.1	140.710	
31.1	140.640	
32.2	140.600	
33.4	140.590	
34.4	140.610	
36.5	140.600	
37.2	140.580	
37.9	140.530	
38.6	140.550	
40.7	140.490	
42.1	140.500	
42.8	140.540	
43.5	140.530	
44.3	140.550	
45.7	140.410	
46.6	140.290	
47.5	140.230	
48.5	140.210	
48.9	140.180	
49.5	140.200	
50.3	140.310	
50.6	140.340	
51.0	140.350	
51.7	140.340	
52.4	140.390	
53.0	140.480	
53.5	140.470	
54.4	140.310	
54.9	140.340	
56.3	140.410	
57.1	140.380	
58.5	140.390	
59.9	140.330	
60.5	140.360	
61.2	140.370	
61.9	140.350	
62.7	140.350	
64.8	140.420	
65.4	140.370	
66.2	140.380	
66.9	140.330	
67.6	140.370	
68.3	140.430	
69.0	140.510	
69.5	140.580	
70.4	140.600	
70.8	140.590	
71.1	140.660	
71.5	140.710	
71.8	140.800	
72.2	140.790	
72.6	140.720	0.055
73.3	140.460	
74.7	139.835	0.035
76.3	139.070	
76.8	138.600	
77.3	138.550	
77.5	138.540	
77.7	138.550	
78.2	138.600	
78.9	138.970	
80.2	139.590	
80.3	139.680	
80.3	139.697	0.055
81.0	140.900	
81.7	141.300	
81.8	141.310	
84.6	141.230	0.016
88.7	141.270	
91.7	141.480	
92.8	141.470	
93.1	141.480	
93.8	141.550	
94.1	141.570	
96.1	141.610	

Existing XS	
Station	Elevation
0.0	140.140
1.9	140.160
3.3	140.190
4.7	140.150
6.2	140.150
7.6	140.100
8.3	140.100
9.5	140.130
12.5	140.150
14.6	140.130
15.4	140.120
17.5	140.090
18.2	140.080
21.0	140.050
22.2	140.060
23.1	140.130
24.5	140.100
25.3	140.070
26.7	140.060
27.4	140.070
28.1	140.030
28.8	140.040
29.5	139.990
30.2	140.020
31.1	139.980
32.1	140.020
32.6	140.070
33.0	140.150
34.4	140.150
35.2	140.170
36.3	140.170
36.8	140.150
38.0	140.080
38.7	139.970
39.1	139.850
40.1	139.530
40.5	139.470
42.0	139.170
42.2	139.120
42.9	138.900
43.4	138.660
44.5	138.280
45.0	137.850
45.8	137.430
46.5	137.360
46.7	137.360
47.2	137.330
48.2	137.780
48.6	137.940
49.3	138.290
50.0	138.670
50.7	139.170
51.4	139.580
52.1	140.030
52.4	140.140
52.8	140.240
53.5	140.070
54.2	140.000
54.7	140.000
56.4	139.980
57.1	139.920
57.8	139.890
59.9	139.890
60.6	139.900
62.3	139.950
63.4	139.960
64.5	140.010
66.3	140.040
67.0	140.060
75.0	140.060

Survey-AECOM Surface	
Station	Elevation
0.0	140.150
3.3	140.180
4.7	140.150
6.2	140.150
8.1	140.100
9.9	140.130
13.2	140.150
21.2	140.040
22.2	140.060
23.1	140.110
23.6	140.110
25.2	140.080
27.4	140.060
28.1	140.030
28.8	140.030
29.5	140.000
30.2	140.010
31.1	139.980
32.1	140.020
33.0	140.130
33.7	140.160
36.3	140.170
37.7	140.100
38.2	140.040
38.7	139.920
39.4	139.570
39.6	139.460
44.5	137.666
44.8	137.540
45.3	137.360
45.8	137.300
46.2	137.360
46.7	137.550
47.9	138.110
48.2	138.220
48.6	138.360
49.3	138.655
50.4	139.130
51.8	139.670
52.1	139.760
52.8	139.870
53.5	140.030
54.2	140.000
56.4	139.980
57.1	139.920
57.8	139.890
59.9	139.890
63.4	139.960
64.5	140.010
67.0	140.060
68.0	140.060
69.1	140.090
71.2	140.130
72.3	140.160
73.3	140.160
75.0	140.210

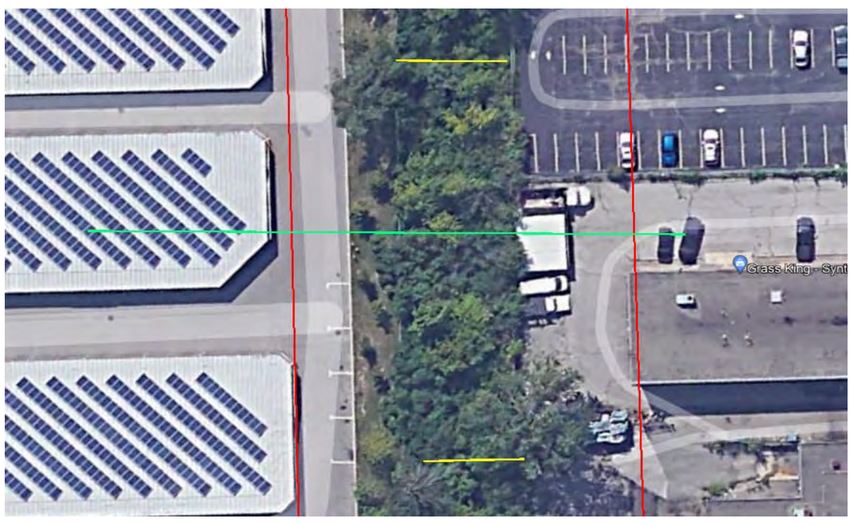
Survey-JD Surface	
Station	Elevation
0.0	140.150
3.3	140.180
4.7	140.150
6.2	140.150
8.1	140.100
9.9	140.130
13.2	140.150
21.2	140.040
22.2	140.060
23.1	140.110
23.6	140.110
25.2	140.080
27.4	140.060
28.1	140.030
28.8	140.030
29.5	140.000
30.2	140.010
31.1	139.980
32.1	140.020
33.0	140.130
33.7	140.160
36.3	140.170
37.7	140.100
38.2	140.040
39.4	139.830
39.6	139.750
42.2	138.800
44.5	137.920
45.0	137.710
45.8	137.520
46.2	137.450
46.5	137.440
46.7	137.460
47.2	137.540
47.6	137.680
48.2	137.930
49.3	138.469
51.8	139.710
52.4	139.980
52.8	140.150
53.2	140.280
53.5	140.330
53.8	140.350
56.1	140.270
56.7	140.240
57.1	140.170
57.8	139.930
58.1	139.890
60.6	139.900
62.0	139.940
63.4	139.960
64.5	140.010
67.0	140.060
68.0	140.060
69.1	140.090
71.2	140.130
72.3	140.160
73.3	140.160
75.0	140.210

Used in Final model Updates		
Station	Elevation	
0.0	140.150	
3.3	140.180	
4.7	140.150	
6.2	140.150	
8.1	140.100	
9.9	140.130	
13.2	140.150	
21.2	140.040	
22.2	140.060	
23.1	140.110	
23.6	140.110	
25.2	140.080	
27.4	140.060	
28.1	140.030	
28.8	140.030	
29.5	140.000	
30.2	140.010	
31.1	139.980	
32.1	140.020	
33.0	140.130	
33.7	140.160	
36.3	140.170	
37.7	140.100	
38.2	140.040	
39.4	139.830	
39.6	139.750	
42.2	138.800	
44.5	137.920	
45.0	137.710	
45.8	137.520	
46.2	137.340	
46.5	137.320	Modified based on AECOM surveyed TWG
46.7	137.360	
47.2	137.540	
47.6	137.680	
48.2	137.930	
49.3	138.469	
50.7	139.000	
51.8	139.710	
52.4	139.980	
52.8	140.150	
53.2	140.280	
53.5	140.330	
53.8	140.350	
56.1	140.270	
56.7	140.240	
57.1	140.170	
57.8	139.930	
58.1	139.890	
60.6	139.900	
62.0	139.940	
63.4	139.960	
64.5	140.010	
67.0	140.060	
68.0	140.060	
69.1	140.090	
71.2	140.130	
72.3	140.160	
73.3	140.160	
75.0	140.210	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	140.140	0.025
1.9	140.160	
3.3	140.190	
4.7	140.150	
6.2	140.150	
7.6	140.100	
8.3	140.100	
9.5	140.130	
12.5	140.150	
14.6	140.130	
15.4	140.120	
17.5	140.090	
18.2	140.080	
21.0	140.050	
22.2	140.060	
23.1	140.130	
24.5	140.100	
25.3	140.070	
26.7	140.060	
27.4	140.070	
28.1	140.030	
28.8	140.040	
29.5	139.990	
30.2	140.020	
31.1	139.980	
32.1	140.020	
32.6	140.070	0.045
33.0	140.150	
34.4	140.150	
35.2	140.170	
36.3	140.170	
36.8	140.150	
38.0	140.080	
38.7	139.970	
39.1	139.850	
40.1	139.530	
40.5	139.470	
42.0	139.170	0.055
42.2	139.120	
42.9	138.900	
43.4	138.660	
44.5	138.280	0.035
45.0	137.850	
45.8	137.430	
46.5	137.360	
46.7	137.360	
47.2	137.330	
48.2	137.780	
48.6	137.940	
49.3	138.290	0.055
50.0	138.670	
50.7	139.170	0.045
51.4	139.580	
52.1	140.030	
52.4	140.140	
52.8	140.240	
53.5	140.070	0.025
54.2	140.000	
54.7	140.000	
56.4	139.980	
57.1	139.920	
57.8	139.890	
59.9	139.890	
60.6	139.900	
62.3	139.950	
63.4	139.960	
64.5	140.010	
66.3	140.040	
67.0	140.060	
75.0	140.060	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	140.150	0.016
3.3	140.180	
4.7	140.150	
6.2	140.150	
8.1	140.100	
9.9	140.130	
13.2	140.150	
21.2	140.040	
22.2	140.060	
23.1	140.110	
23.6	140.110	
25.2	140.080	
27.4	140.060	
28.1	140.030	
28.8	140.030	
29.5	140.000	
30.2	140.010	
31.1	139.980	
32.1	140.020	0.045
33.0	140.130	
33.7	140.160	
36.3	140.170	
37.7	140.100	
38.2	140.040	
39.4	139.830	
39.6	139.750	
42.2	138.800	0.055
44.5	137.920	0.035
45.0	137.710	
45.8	137.520	
46.2	137.340	
46.5	137.320	
46.7	137.360	
47.2	137.540	
47.6	137.680	
48.2	137.930	
49.3	138.469	0.055
50.7	139.000	0.045
51.8	139.710	
52.4	139.980	
52.8	140.150	
53.2	140.280	
53.5	140.330	0.016
53.8	140.350	
56.1	140.270	
56.7	140.240	
57.1	140.170	
57.8	139.930	
58.1	139.890	
60.6	139.900	
62.0	139.940	
63.4	139.960	
64.5	140.010	
67.0	140.060	
68.0	140.060	
69.1	140.090	
71.2	140.130	
72.3	140.160	
73.3	140.160	
75.0	140.210	

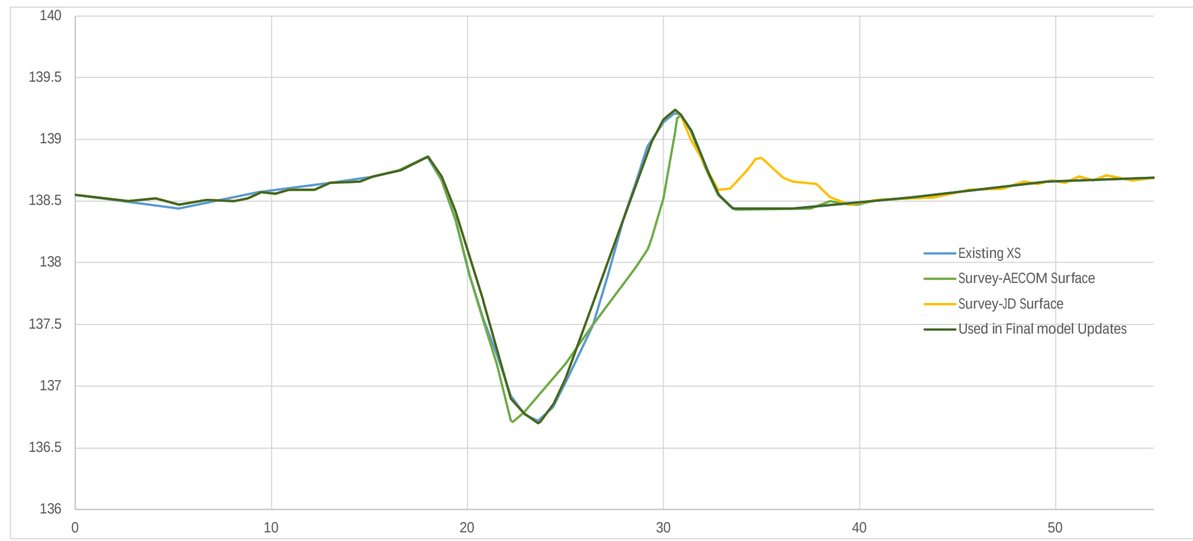


Existing XS	
Station	Elevation
0.0	138.550
5.3	138.440
9.3	138.570
13.0	138.650
15.2	138.700
16.5	138.750
18.0	138.860
18.7	138.670
19.4	138.340
20.1	137.900
20.8	137.540
21.5	137.240
22.2	136.920
22.9	136.770
23.6	136.720
24.4	136.830
25.1	137.070
26.4	137.490
27.2	137.900
28.0	138.380
28.6	138.650
29.2	138.940
30.0	139.140
30.6	139.210
30.9	139.200
31.4	139.070
32.3	138.720
32.8	138.550
33.6	138.440
36.6	138.440
42.7	138.530
49.6	138.660
55.0	138.690

Survey-AECOM Surface	
Station	Elevation
0.0	138.550
2.7	138.500
4.1	138.520
5.3	138.470
6.7	138.510
8.1	138.500
8.8	138.520
9.5	138.570
10.2	138.560
10.9	138.590
12.2	138.590
13.0	138.650
14.5	138.660
15.2	138.700
16.5	138.750
17.3	138.810
18.0	138.860
18.7	138.670
19.4	138.360
20.1	137.900
20.8	137.525
21.5	137.180
22.2	136.720
22.3	136.710
22.9	136.790
25.0	137.180
26.4	137.498
26.4	137.500
28.6	137.960
29.2	138.110
29.4	138.200
30.0	138.520
30.6	139.060
30.7	139.170
30.9	139.200
31.4	139.070
32.1	138.780
32.8	138.550
33.4	138.460
33.7	138.430
37.5	138.440
38.5	138.500
39.5	138.470
39.9	138.470
40.9	138.510
43.8	138.530
45.6	138.590
47.3	138.600
48.4	138.660
49.1	138.640
49.8	138.670
50.5	138.650
51.2	138.700
51.9	138.670
52.6	138.710
53.9	138.670
55.0	138.690

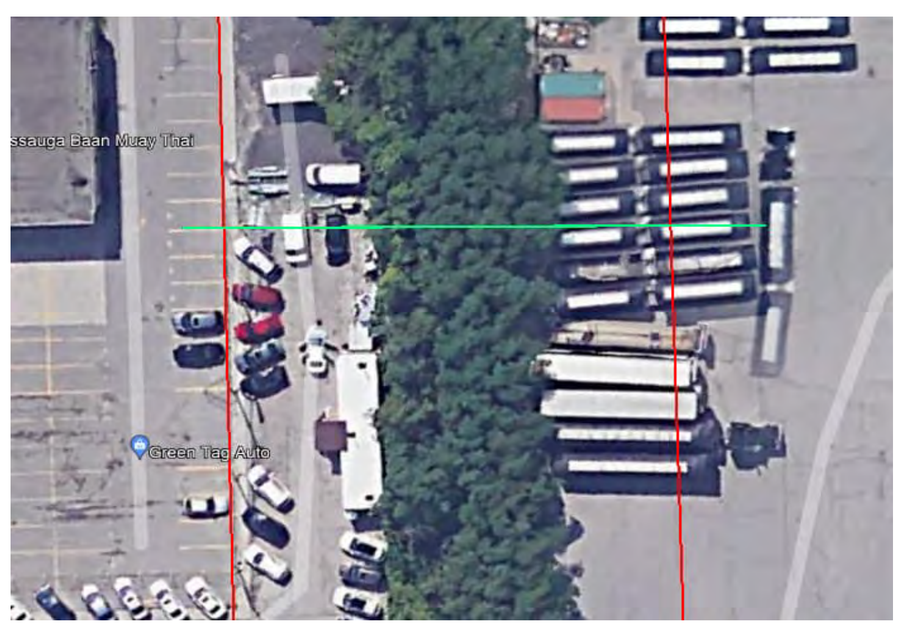
Survey-JD Surface	
Station	Elevation
0.0	138.550
2.7	138.500
4.1	138.520
5.3	138.470
6.7	138.510
8.1	138.500
8.8	138.520
9.5	138.570
10.2	138.560
10.9	138.590
12.2	138.590
13.0	138.650
14.5	138.660
15.2	138.700
16.6	138.750
18.0	138.860
18.7	138.700
19.4	138.420
20.8	137.700
20.8	137.683
22.2	136.900
22.9	136.780
23.6	136.700
23.7	136.710
24.4	136.860
25.0	137.060
26.4	137.667
27.2	138.020
29.4	138.980
30.0	139.160
30.6	139.240
30.9	139.190
31.4	139.000
32.1	138.800
32.3	138.730
32.8	138.590
33.4	138.600
34.3	138.760
34.7	138.840
35.0	138.850
36.1	138.690
36.6	138.660
37.8	138.640
38.5	138.530
39.5	138.470
40.9	138.510
43.8	138.530
45.6	138.590
47.3	138.600
48.4	138.660
49.1	138.640
49.8	138.670
50.5	138.650
51.2	138.700
51.9	138.670
52.6	138.710
53.9	138.670
55.0	138.690

Used in Final model Updates		
Station	Elevation	
0.0	138.550	
2.7	138.500	
4.1	138.520	
5.3	138.470	
6.7	138.510	
8.1	138.500	
8.8	138.520	
9.5	138.570	
10.2	138.560	
10.9	138.590	
12.2	138.590	
13.0	138.650	
14.5	138.660	
15.2	138.700	
16.6	138.750	
18.0	138.860	
18.7	138.700	
19.4	138.420	
20.8	137.700	
20.8	137.683	
22.2	136.900	
22.9	136.780	
23.6	136.700	
23.7	136.710	
24.4	136.860	
25.0	137.060	
26.4	137.667	
27.2	138.020	
29.4	138.980	
30.0	139.160	
30.6	139.240	
30.9	139.200	
31.4	139.070	
32.3	138.720	
32.8	138.550	
33.6	138.440	Changed to remove the stich effect
36.6	138.440	
42.7	138.530	
49.6	138.660	
55.0	138.690	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	138.550	0.025
5.3	138.440	
9.3	138.570	
13.0	138.650	
15.2	138.700	
16.5	138.750	
18.0	138.860	0.055
18.7	138.670	
19.4	138.340	
20.1	137.900	
20.8	137.540	0.035
21.5	137.240	
22.2	136.920	
22.9	136.770	
23.6	136.720	
24.4	136.830	
25.1	137.070	
26.4	137.490	0.055
27.2	137.900	
28.0	138.380	
28.6	138.650	
29.2	138.940	
30.0	139.140	
30.6	139.210	
30.9	139.200	
31.4	139.070	
32.3	138.720	
32.8	138.550	
33.6	138.440	0.025
36.6	138.440	
42.7	138.530	
49.6	138.660	
55.0	138.690	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	138.550	0.016
2.7	138.500	
4.1	138.520	
5.3	138.470	
6.7	138.510	
8.1	138.500	
8.8	138.520	
9.5	138.570	
10.2	138.560	
10.9	138.590	
12.2	138.590	
13.0	138.650	
14.5	138.660	
15.2	138.700	
16.6	138.750	
18.0	138.860	0.055
18.7	138.700	
19.4	138.420	
20.8	137.700	
20.8	137.683	0.035
22.2	136.900	
22.9	136.780	
23.6	136.700	
23.7	136.710	
24.4	136.860	
25.0	137.060	
26.4	137.667	0.055
27.2	138.020	
29.4	138.980	
30.0	139.160	
30.6	139.240	
30.9	139.200	
31.4	139.070	
32.3	138.720	
32.8	138.550	
33.6	138.440	0.016
36.6	138.440	
42.7	138.530	
49.6	138.660	
55.0	138.690	

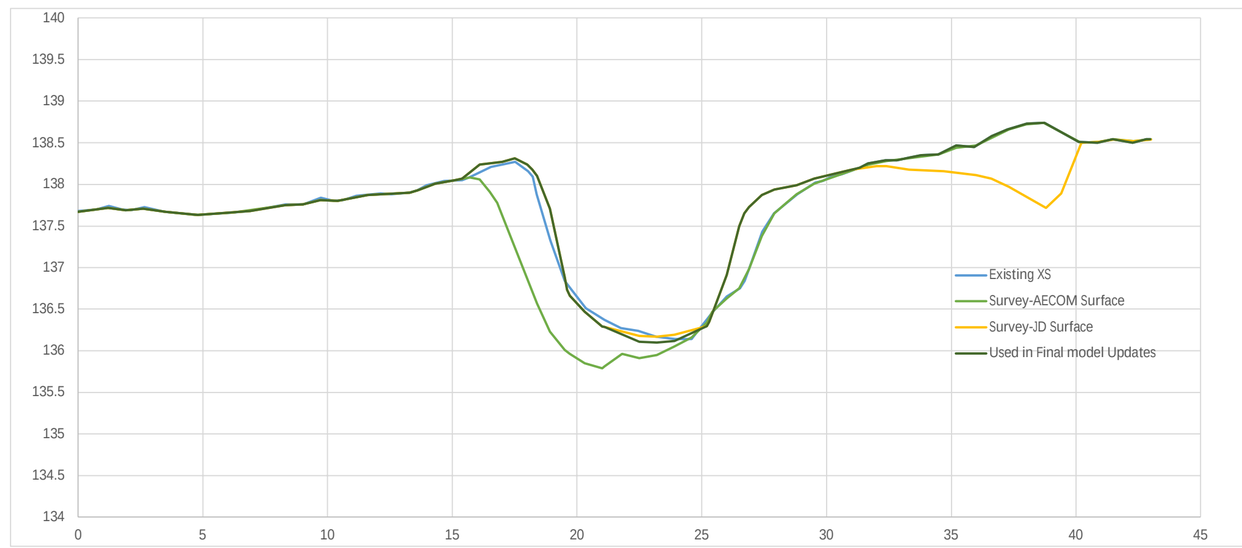


Existing XS	
Station	Elevation
0.0	137.680
0.7	137.700
1.2	137.740
1.8	137.700
2.1	137.690
2.7	137.730
3.5	137.670
4.8	137.630
6.2	137.660
6.9	137.680
8.3	137.760
9.0	137.760
9.7	137.840
10.2	137.800
10.6	137.810
11.1	137.860
12.1	137.890
12.6	137.880
13.3	137.900
13.6	137.930
14.0	137.990
14.7	138.040
15.4	138.050
15.7	138.080
16.6	138.210
17.5	138.270
18.0	138.160
18.2	138.090
18.4	137.880
18.9	137.330
19.5	136.840
19.8	136.740
20.3	136.510
21.1	136.370
21.8	136.270
22.4	136.240
23.2	136.170
23.9	136.140
24.6	136.140
25.4	136.460
26.0	136.650
26.5	136.750
26.7	136.840
26.9	136.980
27.4	137.430
27.9	137.650
28.8	137.880
29.5	138.020
29.9	138.040
30.3	138.100
30.6	138.120
31.3	138.200
31.7	138.250
32.4	138.290
32.8	138.290
33.3	138.320
33.8	138.350
34.5	138.360
35.2	138.470
35.9	138.450
36.6	138.580
37.3	138.660
38.0	138.730
38.7	138.740
40.1	138.510
40.9	138.500
41.5	138.540
42.3	138.500
42.8	138.540
43.0	138.540

Survey-AECOM Surface	
Station	Elevation
0.0	137.670
1.2	137.720
1.9	137.690
2.6	137.710
3.5	137.670
4.7	137.630
6.2	137.660
8.3	137.750
9.0	137.760
9.7	137.810
10.4	137.800
11.6	137.870
13.3	137.900
13.6	137.930
14.3	138.010
15.7	138.080
16.1	138.060
16.5	137.910
16.8	137.780
17.0	137.620
18.4	136.570
18.9	136.230
19.5	136.010
19.7	135.960
20.3	135.850
21.0	135.790
21.1	135.811
21.8	135.960
22.5	135.910
23.2	135.950
23.9	136.050
24.6	136.160
25.2	136.340
25.4	136.460
25.4	136.466
26.0	136.630
26.5	136.750
26.9	136.980
27.4	137.380
27.9	137.650
28.4	137.780
28.8	137.880
29.5	138.010
31.7	138.240
32.4	138.280
34.5	138.360
35.2	138.440
36.0	138.470
37.3	138.660
38.0	138.720
38.7	138.740
40.2	138.500
40.9	138.510
41.5	138.540
42.3	138.520
43.0	138.540

Survey-JD Surface	
Station	Elevation
0.0	137.670
1.2	137.720
1.9	137.690
2.6	137.710
3.5	137.670
4.8	137.630
6.9	137.680
8.3	137.750
9.0	137.760
9.7	137.810
10.4	137.800
11.6	137.870
13.3	137.900
13.6	137.930
14.3	138.010
15.1	138.050
15.4	138.070
16.1	138.240
17.0	138.270
17.5	138.310
18.0	138.240
18.2	138.180
18.4	138.100
18.9	137.710
19.5	136.880
19.6	136.730
19.7	136.660
20.3	136.470
21.0	136.290
21.1	136.283
22.5	136.180
23.2	136.170
23.9	136.190
25.2	136.300
25.3	136.350
25.4	136.446
26.0	136.910
26.5	137.500
26.7	137.650
26.9	137.730
27.4	137.870
27.9	137.940
28.8	137.990
29.5	138.070
31.0	138.180
32.0	138.220
32.4	138.220
33.3	138.180
34.7	138.160
36.0	138.110
36.6	138.070
37.3	137.970
38.8	137.720
39.4	137.890
40.2	138.490
40.2	138.500
40.9	138.510
41.5	138.540
42.3	138.520
43.0	138.540

Used in Final model Updates		
Station	Elevation	
0.0	137.670	
1.2	137.720	
1.9	137.690	
2.6	137.710	
3.5	137.670	
4.8	137.630	
6.9	137.680	
8.3	137.750	
9.0	137.760	
9.7	137.810	
10.4	137.800	
11.6	137.870	
13.3	137.900	
13.6	137.930	
14.3	138.010	
15.1	138.050	
15.4	138.070	
16.1	138.240	
17.0	138.270	
17.5	138.310	
18.0	138.240	
18.2	138.180	
18.4	138.100	
18.9	137.710	
19.5	136.880	
19.6	136.730	
19.7	136.660	
20.3	136.470	
21.0	136.290	
21.1	136.283	
22.5	136.110	
23.2	136.100	Modified based on AECOM surveyed TWG
23.9	136.120	
25.2	136.300	
25.3	136.350	
25.4	136.446	
26.0	136.910	
26.5	137.500	
26.7	137.650	
26.9	137.730	
27.4	137.870	
27.9	137.940	
28.8	137.990	
29.5	138.070	
31.3	138.200	
31.7	138.250	
32.4	138.290	
32.8	138.290	
33.3	138.320	
33.8	138.350	
34.5	138.360	
35.2	138.470	
35.9	138.450	
36.6	138.580	
37.3	138.660	
38.0	138.730	
38.7	138.740	
40.1	138.510	Changed to remove the stich effect
40.9	138.500	
41.5	138.540	
42.3	138.500	
42.8	138.540	
43.0	138.540	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	137.680	0.025
0.7	137.700	
1.2	137.740	
1.8	137.700	
2.1	137.690	
2.7	137.730	
3.5	137.670	
4.8	137.630	
6.2	137.660	
6.9	137.680	
8.3	137.760	
9.0	137.760	
9.7	137.840	
10.2	137.800	
10.6	137.810	
11.1	137.860	
12.1	137.890	
12.6	137.880	
13.3	137.900	
13.6	137.930	
14.0	137.990	
14.7	138.040	
15.4	138.050	
15.7	138.080	
16.6	138.210	0.08
17.5	138.270	
18.0	138.160	
18.2	138.090	
18.4	137.880	
18.9	137.330	
19.5	136.840	
19.8	136.740	
20.3	136.510	
21.1	136.370	0.035
21.8	136.270	
22.4	136.240	
23.2	136.170	
23.9	136.140	
24.6	136.140	
25.4	136.460	0.08
26.0	136.650	
26.5	136.750	
26.7	136.840	
26.9	136.980	
27.4	137.430	
27.9	137.650	
28.8	137.880	
29.5	138.020	0.025
29.9	138.040	
30.3	138.100	
30.6	138.120	
31.3	138.200	
31.7	138.250	
32.4	138.290	
32.8	138.290	
33.3	138.320	
33.8	138.350	
34.5	138.360	
35.2	138.470	
35.9	138.450	
36.6	138.580	
37.3	138.660	
38.0	138.730	
38.7	138.740	
40.1	138.510	
40.9	138.500	
41.5	138.540	
42.3	138.500	
42.8	138.540	
43.0	138.540	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0.0	137.670	0.016
1.2	137.720	
1.9	137.690	
2.6	137.710	
3.5	137.670	
4.8	137.630	
6.9	137.680	
8.3	137.750	
9.0	137.760	
9.7	137.810	
10.4	137.800	
11.6	137.870	
13.3	137.900	
13.6	137.930	
14.3	138.010	
15.1	138.050	
15.4	138.070	
16.1	138.240	0.08
17.0	138.270	
17.5	138.310	
18.0	138.240	
18.2	138.180	
18.4	138.100	
18.9	137.710	
19.5	136.880	
19.6	136.730	
19.7	136.660	
20.3	136.470	
21.0	136.290	
21.1	136.283	0.035
22.5	136.110	
23.2	136.100	
23.9	136.120	
25.2	136.300	
25.3	136.350	
25.4	136.446	0.08
26.0	136.910	
26.5	137.500	
26.7	137.650	
26.9	137.730	
27.4	137.870	
27.9	137.940	
28.8	137.990	
29.5	138.070	0.016
31.3	138.200	
31.7	138.250	
32.4	138.290	
32.8	138.290	
33.3	138.320	
33.8	138.350	
34.5	138.360	
35.2	138.470	
35.9	138.450	
36.6	138.580	
37.3	138.660	
38.0	138.730	
38.7	138.740	
40.1	138.510	
40.9	138.500	
41.5	138.540	
42.3	138.500	
42.8	138.540	
43.0	138.540	

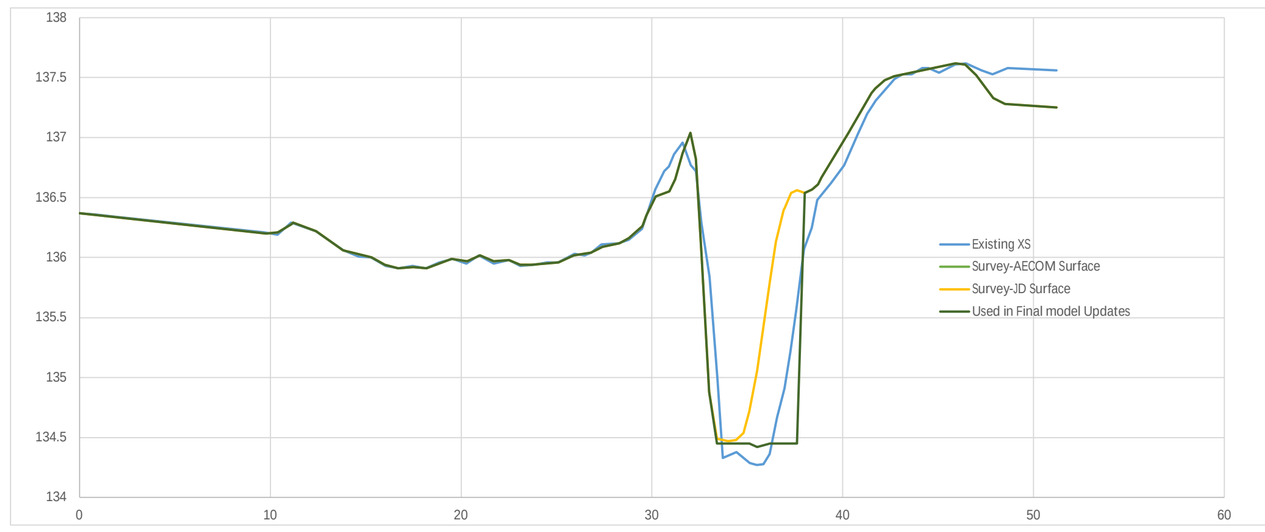
Existing XS	
Station	Elevation
0.0	136.370
0.8	136.360
1.9	136.340
9.7	136.210
10.4	136.190
11.1	136.290
12.4	136.220
13.8	136.060
14.6	136.010
15.3	136.000
16.0	135.930
16.7	135.910
17.5	135.930
18.2	135.910
18.9	135.960
19.6	135.990
20.3	135.950
20.9	136.020
21.7	135.950
22.5	135.980
23.1	135.930
23.8	135.940
24.5	135.960
25.1	135.960
25.9	136.030
26.5	136.020
26.8	136.040
27.4	136.110
28.3	136.120
28.8	136.150
29.5	136.240
30.2	136.570
30.6	136.720
30.9	136.760
31.2	136.860
31.6	136.960
32.0	136.770
32.3	136.720
32.6	136.290
33.0	135.840
33.4	135.000
33.7	134.330
34.4	134.380
35.1	134.290
35.5	134.270
35.8	134.280
36.2	134.360
36.6	134.670
36.9	134.910
37.3	135.210
37.6	135.560
38.0	136.070
38.4	136.250
38.7	136.480
39.4	136.620
40.1	136.770
40.8	137.030
41.3	137.200
41.7	137.310
42.7	137.490
43.1	137.530
43.6	137.530
44.2	137.580
44.5	137.580
45.0	137.540
45.9	137.610
46.5	137.620
47.3	137.560
47.9	137.530
48.7	137.580
51.2	137.560

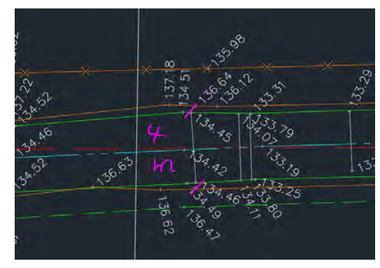
Survey-AECOM Surface	
Station	Elevation
NA	

Survey-JD Surface	
Station	Elevation
0.0	136.370
9.8	136.200
10.4	136.210
11.1	136.280
11.2	136.290
12.4	136.220
13.8	136.060
15.3	136.000
16.0	135.940
16.7	135.910
17.5	135.920
18.2	135.910
19.5	135.990
20.3	135.970
21.0	136.020
21.7	135.970
22.5	135.980
23.1	135.940
23.7	135.940
25.1	135.960
25.9	136.020
26.8	136.040
27.4	136.090
28.3	136.120
28.8	136.160
29.5	136.260
29.7	136.350
30.2	136.510
30.9	136.550
31.2	136.650
31.6	136.870
32.0	137.040
32.3	136.820
32.6	136.050
33.0	134.880
33.4	134.490
33.4	134.489
34.0	134.470
34.4	134.480
34.8	134.540
35.1	134.720
35.5	135.060
36.2	135.810
36.5	136.130
36.9	136.400
36.9	136.411
37.3	136.540
37.6	136.560
38.0	136.540
38.4	136.570
38.7	136.610
38.9	136.670
40.3	137.040
41.5	137.370
41.7	137.410
42.2	137.480
42.7	137.510
45.9	137.620
46.4	137.610
47.0	137.520
47.9	137.330
48.5	137.280
51.2	137.250

Used in Final model Updates	
Station	Elevation
0.0	136.370
9.8	136.200
10.4	136.210
11.1	136.280
11.2	136.290
12.4	136.220
13.8	136.060
15.3	136.000
16.0	135.940
16.7	135.910
17.5	135.920
18.2	135.910
19.5	135.990
20.3	135.970
21.0	136.020
21.7	135.970
22.5	135.980
23.1	135.940
23.7	135.940
25.1	135.960
25.9	136.020
26.8	136.040
27.4	136.090
28.3	136.120
28.8	136.160
29.5	136.260
29.7	136.350
30.2	136.510
30.9	136.550
31.2	136.650
31.6	136.870
32.0	137.040
32.3	136.820
32.6	136.050
33.0	134.880
33.4	134.450
33.4	134.450
34.0	134.450
34.4	134.450
34.8	134.450
35.1	134.450
35.5	134.420
36.2	134.450
36.5	134.450
36.9	134.450
36.9	134.450
37.3	134.450
37.6	134.450
38.0	136.540
38.4	136.570
38.7	136.610
38.9	136.670
40.3	137.040
41.5	137.370
41.7	137.410
42.2	137.480
42.7	137.510
45.9	137.620
46.4	137.610
47.0	137.520
47.9	137.330
48.5	137.280
51.2	137.250

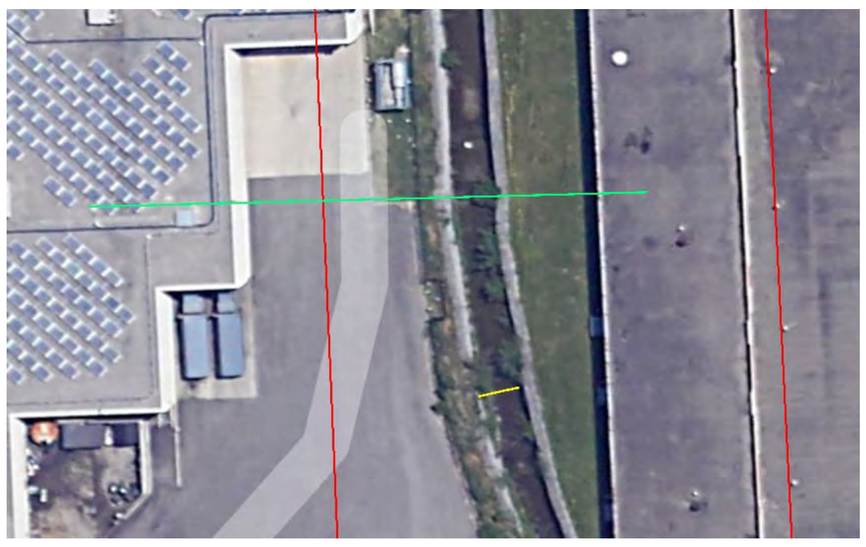
Modified to show the flat 4m channel





Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.025	0.025	0.045
Station	Elevation	n Value
0.0	136.370	
0.8	136.360	
1.9	136.340	
9.7	136.210	
10.4	136.190	
11.1	136.290	
12.4	136.220	
13.8	136.060	
14.6	136.010	
15.3	136.000	
16.0	135.930	
16.7	135.910	
17.5	135.930	
18.2	135.910	
18.9	135.960	
19.6	135.990	
20.3	135.950	
20.9	136.020	
21.7	135.950	
22.5	135.980	
23.1	135.930	
23.8	135.940	
24.5	135.960	
25.1	135.960	
25.9	136.030	
26.5	136.020	
26.8	136.040	
27.4	136.110	
28.3	136.120	
28.8	136.150	
29.5	136.240	
30.2	136.570	
30.6	136.720	
30.9	136.760	
31.2	136.860	
31.6	136.960	
32.0	136.770	
32.3	136.720	
32.6	136.290	
33.0	135.840	
33.4	135.000	
33.7	134.330	
34.4	134.380	
35.1	134.290	
35.5	134.270	
35.8	134.280	
36.2	134.360	
36.6	134.670	
36.9	134.910	
37.3	135.210	
37.6	135.560	
38.0	136.070	
38.4	136.250	
38.7	136.480	
39.4	136.620	
40.1	136.770	
40.8	137.030	
41.3	137.200	
41.7	137.310	
42.7	137.490	
43.1	137.530	
43.6	137.530	
44.2	137.580	
44.5	137.580	
45.0	137.540	
45.9	137.610	
46.5	137.620	
47.3	137.560	
47.9	137.530	
48.7	137.580	
51.2	137.560	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.055	0.025	0.055
Station	Elevation	n Value
0.0	136.370	
9.8	136.200	
10.4	136.210	
11.1	136.280	
11.2	136.290	
12.4	136.220	
13.8	136.060	
15.3	136.000	
16.0	135.940	
16.7	135.910	
17.5	135.920	
18.2	135.910	
19.5	135.990	
20.3	135.970	
21.0	136.020	
21.7	135.970	
22.5	135.980	
23.1	135.940	
23.7	135.940	
25.1	135.960	
25.9	136.020	
26.8	136.040	
27.4	136.090	
28.3	136.120	
28.8	136.160	
29.5	136.260	
29.7	136.350	
30.2	136.510	
30.9	136.550	
31.2	136.650	
31.6	136.870	
32.0	137.040	
32.3	136.820	
32.6	136.050	
33.0	134.880	
33.4	134.450	
33.4	134.450	
34.0	134.450	
34.4	134.450	
34.8	134.450	
35.1	134.450	
35.5	134.420	
36.2	134.450	
36.5	134.450	
36.9	134.450	
36.9	134.450	
37.3	134.450	
37.6	134.450	
38.0	136.540	
38.4	136.570	
38.7	136.610	
38.9	136.670	
40.3	137.040	
41.5	137.370	
41.7	137.410	
42.2	137.480	
42.7	137.510	
45.9	137.620	
46.4	137.610	
47.0	137.520	
47.9	137.330	
48.5	137.280	
51.2	137.250	

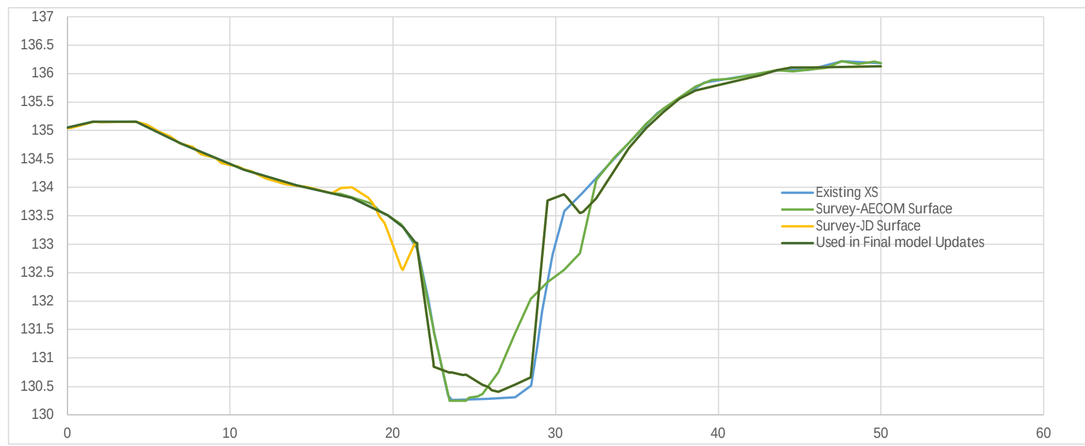


Existing XS	
Station	Elevation
0.0	135.050
1.6	135.160
4.2	135.160
7.0	134.770
10.9	134.310
14.1	134.040
17.5	133.820
19.7	133.510
20.6	133.300
21.5	132.910
22.2	132.020
22.5	131.460
23.4	130.350
23.6	130.260
25.9	130.280
27.5	130.310
28.5	130.520
28.9	131.220
29.2	131.820
29.8	132.820
30.3	133.300
30.5	133.580
31.7	133.900
34.4	134.750
36.3	135.310
39.1	135.840
42.5	136.000
43.8	136.060
45.6	136.070
47.6	136.220
50.0	136.180

Survey-AECOM Surface	
Station	Elevation
0.0	135.040
0.2	135.040
1.6	135.160
2.0	135.150
4.2	135.160
4.9	135.100
5.6	134.980
6.3	134.890
6.9	134.780
7.7	134.710
8.2	134.590
9.1	134.520
9.5	134.430
10.5	134.360
10.9	134.310
11.3	134.280
12.2	134.160
13.4	134.060
14.8	134.000
16.2	133.900
16.8	133.890
18.5	133.730
18.8	133.690
19.2	133.580
19.7	133.510
20.5	133.350
21.5	132.950
21.5	132.910
22.5	131.500
22.5	131.449
23.4	130.350
23.5	130.250
24.5	130.250
24.7	130.300
25.2	130.320
25.5	130.370
26.5	130.750
27.5	131.420
28.5	132.040
29.2	132.237
29.5	132.330
30.5	132.550
31.5	132.840
32.5	134.130
33.6	134.520
34.4	134.750
35.6	135.120
36.6	135.380
38.6	135.770
39.6	135.890
40.8	135.910
43.6	136.060
44.6	136.040
46.6	136.100
47.6	136.220
48.6	136.170
49.6	136.210
50.0	136.180

Survey-JD Surface	
Station	Elevation
0.0	135.040
0.2	135.040
1.6	135.160
2.0	135.150
4.2	135.160
4.9	135.100
5.6	134.980
6.3	134.890
6.9	134.780
7.7	134.710
8.2	134.590
9.1	134.520
9.5	134.430
10.5	134.360
10.9	134.310
11.3	134.280
12.2	134.160
13.4	134.060
14.8	134.000
16.2	133.900
16.3	133.910
16.8	133.990
17.5	134.000
18.5	133.820
18.8	133.710
19.2	133.480
19.5	133.380
19.7	133.220
20.5	132.590
20.6	132.550
21.4	133.030
21.5	133.020
21.5	132.940
22.1	131.730
22.5	130.900
22.5	130.850
22.5	130.846
23.5	130.740
23.6	130.750
24.3	130.700
24.5	130.710
25.5	130.530
25.9	130.490
26.1	130.440
26.5	130.410
27.5	130.530
28.5	130.660
29.2	132.775
29.5	133.770
30.5	133.880
30.7	133.830
31.5	133.550
31.7	133.570
32.5	133.810
34.5	134.690
35.6	135.040
36.6	135.320
37.6	135.560
38.6	135.700
42.6	135.970
43.6	136.060
44.5	136.110
45.8	136.110
50.0	136.130

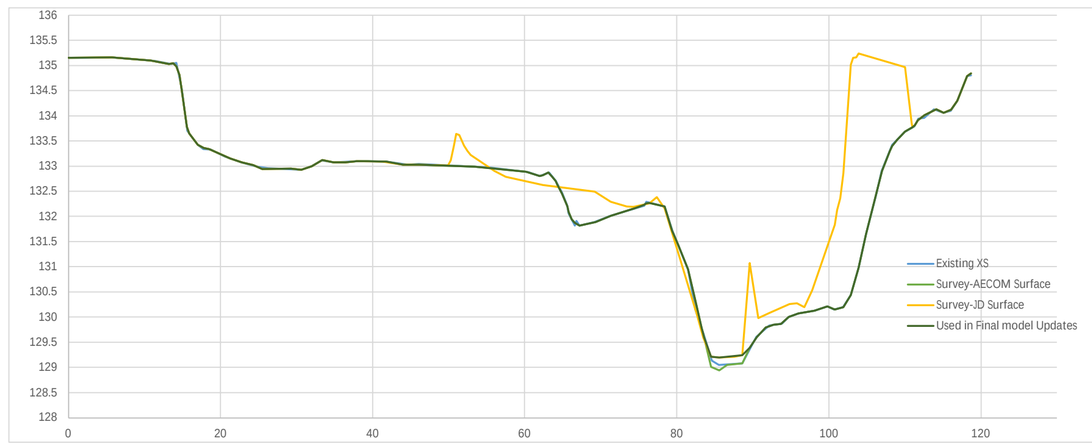
Used in Final model Updates		
Station	Elevation	
0.0	135.050	
1.6	135.160	
4.2	135.160	
7.0	134.770	
10.9	134.310	Changed to remove the stich effect
14.1	134.040	
17.5	133.820	
19.7	133.510	
20.6	133.300	
21.4	133.030	
21.5	133.020	
21.5	132.940	
22.1	131.730	
22.5	130.900	
22.5	130.850	
22.5	130.846	
23.5	130.740	
23.6	130.750	
24.3	130.700	
24.5	130.710	
25.5	130.530	
25.9	130.490	
26.1	130.440	
26.5	130.410	
27.5	130.530	
28.5	130.660	
29.2	132.775	
29.5	133.770	
30.5	133.880	
30.7	133.830	
31.5	133.550	
31.7	133.570	
32.5	133.810	
34.5	134.690	
35.6	135.040	
36.6	135.320	
37.6	135.560	
38.6	135.700	
42.6	135.970	
43.6	136.060	
44.5	136.110	
45.8	136.110	
50.0	136.130	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
	Manning's n	
LOB	Channel	ROB
0.055	0.025	0.055
Station	Elevation	n Value
0.0	135.050	
1.6	135.160	
4.2	135.160	
7.0	134.770	
10.9	134.310	
14.1	134.040	
17.5	133.820	
19.7	133.510	
20.6	133.300	
21.5	132.910	
22.2	132.020	
22.5	131.460	
23.4	130.350	
23.6	130.260	
25.9	130.280	
27.5	130.310	
28.5	130.520	
28.9	131.220	
29.2	131.820	
29.8	132.820	
30.3	133.300	
30.5	133.580	
31.7	133.900	
34.4	134.750	
36.3	135.310	
39.1	135.840	
42.5	136.000	
43.8	136.060	
45.6	136.070	
47.6	136.220	
50.0	136.180	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
	Manning's n	
LOB	Channel	ROB
0.055	0.025	0.055
Station	Elevation	n Value
0.0	135.050	
1.6	135.160	
4.2	135.160	
7.0	134.770	
10.9	134.310	
14.1	134.040	
17.5	133.820	
19.7	133.510	
20.6	133.300	
21.4	133.030	
21.5	133.020	
21.5	132.940	
22.1	131.730	
22.5	130.900	
22.5	130.850	
22.5	130.846	
23.5	130.740	
23.6	130.750	
24.3	130.700	
24.5	130.710	
25.5	130.530	
25.9	130.490	
26.1	130.440	
26.5	130.410	
27.5	130.530	
28.5	130.660	
29.2	132.775	
29.5	133.770	
30.5	133.880	
30.7	133.830	
31.5	133.550	
31.7	133.570	
32.5	133.810	
34.5	134.690	
35.6	135.040	
36.6	135.320	
37.6	135.560	
38.6	135.700	
42.6	135.970	
43.6	136.060	
44.5	136.110	
45.8	136.110	
50.0	136.130	

Existing XS		Survey-AECOM Surface		Survey-JD Surface		Used in Final model Updates	
Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation
0	135.15	0	135.15	0	135.15	0	135.15
2.17	135.15	5.7	135.16	5.7	135.16	5.7	135.16
5.71	135.16	10.8	135.1	10.8	135.1	10.8	135.1
11.38	135.09	13.2	135.03	13.2	135.03	13.2	135.03
13.5	135.03	13.8	135.04	13.8	135.04	13.8	135.04
14.21	135.05	14.2	134.98	14.2	134.98	14.2	134.98
14.92	134.53	14.6	134.81	14.6	134.81	14.6	134.81
15.63	133.7	14.9	134.5	14.9	134.5	14.9	134.5
17.04	133.42	15.6	133.78	15.6	133.78	15.6	133.78
17.75	133.34	15.9	133.65	15.9	133.65	15.9	133.65
18.69	133.33	17	133.42	17	133.42	17	133.42
20.58	133.19	17.8	133.36	17.8	133.36	17.8	133.36
22.71	133.07	18.5	133.34	18.5	133.34	18.5	133.34
24.83	132.99	21.3	133.15	21.3	133.15	21.3	133.15
26.25	132.96	22.8	133.07	22.8	133.07	22.8	133.07
30.62	132.93	24.3	133.02	24.3	133.02	24.3	133.02
31.96	133	25.5	132.94	25.5	132.94	25.5	132.94
33.3	133.11	29.3	132.95	29.3	132.95	29.3	132.95
34.88	133.07	30.6	132.93	30.6	132.93	30.6	132.93
37.89	133.1	32	133	32	133	32	133
41.83	133.09	33.4	133.12	33.4	133.12	33.4	133.12
44.67	133.03	34.9	133.07	34.9	133.07	34.9	133.07
46.08	133.04	36.4	133.07	36.4	133.07	36.4	133.07
55.29	132.97	37.9	133.1	37.9	133.1	37.9	133.1
60.47	132.88	39.4	133.1	41.3	133.09	39.4	133.1
61.97	132.8	41.8	133.09	44	133.03	41.8	133.09
63.22	132.87	44	133.03	46.1	133.03	44	133.03
64.07	132.71	46.1	133.03	49.9	133.01	46.1	133.03
64.92	132.48	53.4	132.99	50.3	133.11	53.4	132.99
65.55	132.23	60.2	132.89	50.7	133.4	60.2	132.89
65.77	132.06	62	132.8	51	133.64	62	132.8
66.62	131.82	62.4	132.82	51.4	133.62	62.4	132.82
66.82	131.91	63.1	132.87	52	133.41	63.1	132.87
67.21	131.82	63.6	132.79	52.5	133.3	63.6	132.79
69.18	131.89	64.1	132.7	52.9	133.22	64.1	132.7
71.29	132.01	64.3	132.63	56	132.9	64.3	132.63
75.71	132.21	64.9	132.45	57.5	132.79	64.9	132.45
75.99	132.29	65.6	132.2	62.4	132.62	65.6	132.2
78.42	132.2	65.8	132.09	69.2	132.49	65.8	132.09
79.44	131.72	66.2	131.94	71.3	132.29	66.2	131.94
81.48	130.95	66.6	131.87	73.4	132.2	66.6	131.87
82.47	130.14	67.2	131.82	74.3	132.19	67.2	131.82
83.52	129.66	69.3	131.89	76.4	132.26	69.3	131.89
84.6	129.13	71.3	132.01	77.4	132.38	71.3	132.01
85.56	129.05	74.4	132.16	78.4	132.16	74.4	132.16
88.62	129.08	75.7	132.23	80.5	131.12	75.7	132.23
90.46	129.61	76	132.26	82.47	130.1449	76	132.26
92.16	129.83	76.4	132.27	82.5	130.13	76.4	132.27
93.87	129.87	78.4	132.2	83.5	129.59	78.4	132.2
94.72	130	79.4	131.72	84.5	129.21	79.4	131.72
96.02	130.07	80.2	131.43	85.6	129.2	80.2	131.43
98.12	130.13	81.5	130.95	87.6	129.21	81.5	130.95
99.81	130.21	82.47	130.3195	88.6	129.24	82.47	130.3195
100.68	130.15	83.3	129.78	89.6	131.07	83.3	129.78
101.87	130.2	83.5	129.66	90.7	129.98	83.5	129.66
102.89	130.44	83.6	129.6	92.16	130.0797	83.6	129.6
103.91	130.98	84.5	129.01	94.8	130.26	84.5	129.21
104.91	131.65	85.6	128.94	95.8	130.27	85.6	129.2
106.18	132.4	86.6	129.05	96.8	130.2	86.6	129.21
106.96	132.9	88.6	129.08	97.8	130.53	88.6	129.24
108.34	133.42	89.6	129.39	100.8	131.83	89.6	129.39
109.99	133.68	90.5	129.6	101.1	132.13	90.5	129.6
111.26	133.79	91.7	129.79	101.5	132.36	91.7	129.79
111.75	133.94	92.16	129.8176	101.9	132.86	92.16	129.8176
112.53	133.96	92.7	129.85	102.4	133.99	92.7	129.85
113.8	134.13	93.7	129.86	102.9	135.01	93.7	129.86
115.07	134.06	94.7	130	103.2	135.15	94.7	130
116	134.1	96	130.07	103.6	135.16	96	130.07
116.85	134.28	98.1	130.13	103.9	135.24	98.1	130.13
118.18	134.79	99.8	130.21	110	134.97	99.8	130.21
118.69	134.8	100.8	130.15	110.9	133.85	100.8	130.15
		101.9	130.2	111	133.77	101.9	130.2
		102.9	130.44	111.3	133.81	102.9	130.44
		103.9	130.98	111.7	133.91	103.9	130.98
		104.9	131.65	112.6	134.01	104.9	131.65
		105.9	132.26	114.1	134.13	105.9	132.26
		107	132.9	115.1	134.06	107	132.9
		108	133.3	116.1	134.12	108	133.3
		108.3	133.4	116.9	134.3	108.3	133.4
		109	133.52	118.2	134.79	109	133.52
		110	133.69	118.7	134.84	110	133.69
		111	133.77			111	133.77
		111.3	133.81			111.3	133.81
		111.7	133.91			111.7	133.91
		112.6	134.01			112.6	134.01
		114.1	134.13			114.1	134.13
		115.1	134.06			115.1	134.06
		116.1	134.12			116.1	134.12
		116.9	134.3			116.9	134.3
		118.2	134.79			118.2	134.79
		118.7	134.84			118.7	134.84

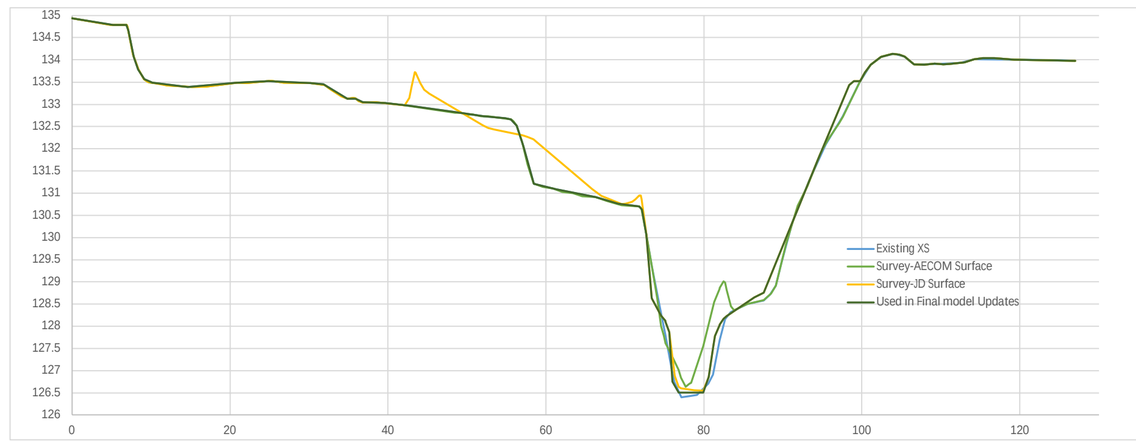


Updated based on JDB survey

Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0	135.15	0.025
2.17	135.15	
5.71	135.16	
11.38	135.09	
13.5	135.03	
14.21	135.05	
14.92	134.53	0.045
15.63	133.7	
17.04	133.42	0.025
17.75	133.34	
18.69	133.33	
20.58	133.19	
22.71	133.07	
24.83	132.99	
26.25	132.96	
30.62	132.93	
31.96	133	0.045
33.3	133.11	
34.88	133.07	
37.89	133.1	
41.83	133.09	
44.67	133.03	
46.08	133.04	
55.29	132.97	
60.47	132.88	
61.97	132.8	
63.22	132.87	0.045
64.07	132.71	
64.92	132.48	
65.55	132.23	
65.77	132.06	
66.62	131.82	0.025
66.82	131.91	
67.21	131.82	
69.18	131.89	
71.29	132.01	
75.71	132.21	
75.99	132.29	0.055
78.42	132.2	
79.44	131.72	
81.48	130.95	
82.47	130.14	0.025
83.52	129.66	
84.6	129.13	
85.56	129.05	
88.62	129.08	
90.46	129.61	
92.16	129.83	0.055
93.87	129.87	
94.72	130	
96.02	130.07	
98.12	130.13	
99.81	130.21	
100.68	130.15	
101.87	130.2	
102.89	130.44	
103.91	130.98	
104.91	131.65	
106.18	132.4	
106.96	132.9	
108.34	133.42	
109.99	133.68	
111.26	133.79	
111.75	133.94	
112.53	133.96	
113.8	134.13	
115.07	134.06	
116	134.1	
116.85	134.28	
118.18	134.79	
118.69	134.8	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0	135.15	0.016
5.7	135.16	
10.8	135.1	
13.2	135.03	
13.8	135.04	
14.2	134.98	
14.6	134.81	
14.9	134.5	0.045
15.6	133.78	
15.9	133.65	
17	133.42	
17.8	133.36	0.025
18.5	133.34	
21.3	133.15	
22.8	133.07	
24.3	133.02	
25.5	132.94	
29.3	132.95	
30.6	132.93	
32	133	0.045
33.4	133.12	
34.9	133.07	
36.4	133.07	
37.9	133.1	
39.4	133.1	
41.8	133.09	
44	133.03	
46.1	133.03	
53.4	132.99	
60.2	132.89	
62	132.8	
62.4	132.82	
63.1	132.87	0.045
63.6	132.79	
64.1	132.7	
64.3	132.63	
64.9	132.45	
65.6	132.2	
65.8	132.09	
66.2	131.94	
66.6	131.87	
67.2	131.82	
69.3	131.89	
71.3	132.01	
74.4	132.16	
75.7	132.23	
76	132.26	0.055
76.4	132.27	
78.4	132.2	
79.4	131.72	
80.2	131.43	
81.5	130.95	
82.47	130.3195	0.025
83.3	129.78	
83.5	129.66	
83.6	129.6	
84.5	129.21	
85.6	129.2	
86.6	129.21	
88.6	129.24	
89.6	129.39	
90.5	129.6	
91.7	129.79	
92.16	129.8176	0.055
92.7	129.85	
93.7	129.86	
94.7	130	
96	130.07	
98.1	130.13	
99.8	130.21	
100.8	130.15	
101.9	130.2	
102.9	130.44	
103.9	130.98	
104.9	131.65	
105.9	132.26	
107	132.9	
108	133.3	
108.3	133.4	
109	133.52	
110	133.69	
111	133.77	
111.3	133.81	
111.7	133.91	
112.6	134.01	
114.1	134.13	
115.1	134.06	
116.1	134.12	
116.9	134.3	
118.2	134.79	
118.7	134.84	

Existing XS		Survey-AECOM Surface		Survey-JD Surface		Used in Final model Updates	
Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation
0	134.94	0	134.94	0	134.94	0	134.94
5.2	134.78	4.9	134.78	4.9	134.78	5.2	134.78
6.87	134.78	6.9	134.78	6.9	134.78	6.87	134.78
7.1	134.66	7	134.74	7	134.74	7.1	134.66
7.83	134.06	7.7	134.11	7.7	134.11	7.83	134.06
8.36	133.79	8.4	133.79	8.4	133.79	8.36	133.79
9.14	133.57	9.1	133.57	9.1	133.57	9.14	133.57
10.2	133.49	9.6	133.51	9.6	133.51	10.2	133.49
14.61	133.39	9.9	133.49	12	133.43	14.61	133.39
20.86	133.49	11.3	133.46	15.2	133.39	20.86	133.49
24.86	133.52	12	133.43	17	133.4	24.86	133.52
30.18	133.48	15.2	133.39	20.9	133.49	30.18	133.48
31.84	133.45	17	133.4	22.1	133.48	31.84	133.45
34.86	133.13	20.9	133.49	25.2	133.53	34.86	133.13
35.87	133.13	22.1	133.48	26.8	133.49	35.87	133.13
36.84	133.05	25.2	133.53	30.2	133.48	36.84	133.05
39.62	133.03	26.8	133.49	32	133.44	39.62	133.03
42.71	132.97	30.2	133.48	32.7	133.34	42.71	132.97
49.14	132.81	32	133.44	34.1	133.18	49.14	132.81
52.13	132.73	32.7	133.34	34.9	133.13	52.13	132.73
54.85	132.69	34.1	133.18	35.6	133.15	54.85	132.69
55.57	132.66	34.9	133.13	35.9	133.14	55.57	132.66
56.28	132.52	35.6	133.15	36.3	133.08	56.28	132.52
57.13	132.06	35.9	133.14	36.8	133.04	57.13	132.06
58.48	131.21	36.3	133.08	38.5	133.05	58.48	131.21
61.28	131.09	36.8	133.04	42.1	132.98	61.28	131.09
66.28	130.91	38.5	133.05	42.7	133.15	66.28	130.91
69.14	130.76	41.8	132.99	43	133.41	69.14	130.76
71.8	130.7	48.5	132.81	43.4	133.73	71.8	130.7
72.14	130.63	49.1	132.81	43.5	133.72	72.14	130.63
72.71	130.08	50.2	132.77	44.1	133.48	72.71	130.08
73.39	129.36	50.6	132.78	44.6	133.33	73.4	128.63
74.64	128.25	51.8	132.73	45.2	133.24	73.5	128.6
75.13	127.81	52.7	132.73	52	132.53	74.6	128.24
75.89	127.04	55.6	132.66	52.7	132.47	75.1	128.12
76.28	126.74	55.9	132.62	53.5	132.43	75.13	128.105
77.14	126.4	56.3	132.52	57.1	132.3	75.6	127.87
78.19	126.43	56.8	132.26	57.7	132.27	76	126.75
79.14	126.45	57	132.15	58.4	132.21	76.8	126.5
80.55	126.71	57.7	131.64	65.9	131.09	77.1	126.5
81.16	126.91	58.4	131.23	67	130.94	78.8	126.5
81.97	127.68	58.5	131.21	69.6	130.75	79.9	126.5
82.68	128.16	59.6	131.14	70.1	130.76	80.6	126.86
83.39	128.32	60.9	131.11	70.9	130.81	81.2	127.56
85.52	128.5	62.1	131.03	71.3	130.86	81.4	127.78
87.57	128.58	63.4	131	71.8	130.95	81.97	128.027
88.36	128.71	64.6	130.93	72	130.95	82	128.04
89.09	128.92	66.3	130.91	72.1	130.87	82.5	128.17
89.78	129.42	67.7	130.82	72.7	130.09	82.9	128.23
91.19	130.33	69.6	130.73	73.4	128.63	86.4	128.65
93.32	131.27	71.8	130.7	73.5	128.6	87.6	128.76
95.44	132.1	72	130.67	74.6	128.24	94.4	131.74
97.57	132.72	72.1	130.63	75.1	128.12	98.4	133.44
99.69	133.49	72.7	130.08	75.13	128.105	99	133.52
101.11	133.89	73.4	129.37	75.6	127.87	99.8	133.52
102.44	134.06	74.1	128.63	76.3	126.88	100.4	133.72
104.09	134.13	74.6	128	76.8	126.64	101.1	133.89
105.38	134.07	74.9	127.79	77.1	126.6	102.4	134.06
106.62	133.9	75.1	127.63	78.8	126.56	103.9	134.13
109.64	133.91	75.13	127.6198	79.9	126.55	104.7	134.11
112.49	133.94	75.6	127.46	80.6	126.86	105.4	134.07
114.22	134.01	76.8	127.02	81.2	127.56	106.6	133.9
124.61	133.99	77.1	126.84	81.4	127.78	107.9	133.89
127	133.97	77.7	126.63	81.97	128.027	109.2	133.92
		78.2	126.71	82	128.04	110.3	133.9
		78.4	126.73	82.5	128.17	111.1	133.91
		79.9	127.55	82.9	128.23	113	133.95
		81.3	128.55	86.4	128.65	114.2	134.01
		81.97	128.8467	87.6	128.76	115.3	134.03
		82	128.86	94.4	131.74	116.8	134.03
		82.5	129.01	98.4	133.44	119.3	134
		82.7	128.99	99	133.52	127	133.97
		82.9	128.82	99.8	133.52		
		83.4	128.45	100.4	133.72		
		83.8	128.36	101.1	133.89		
		85.5	128.5	102.4	134.06		
		87.6	128.59	103.9	134.13		
		88.5	128.74	104.7	134.11		
		89.1	128.92	105.4	134.07		
		90.4	129.85	106.6	133.9		
		91.9	130.72	107.9	133.89		
		93.1	131.16	109.2	133.92		
		94.7	131.87	110.3	133.9		
		95.1	132.01	111.1	133.91		
		95.7	132.2	113	133.95		
		97.1	132.57	114.2	134.01		
		97.6	132.72	115.3	134.03		
		99.8	133.52	116.8	134.03		
		100.4	133.71	119.3	134		
		101.1	133.89	127	133.97		
		102.5	134.07				
		103.9	134.13				
		104.7	134.11				
		105.4	134.07				
		106.6	133.9				
		107.9	133.89				
		109.2	133.92				
		110.3	133.9				
		111.1	133.91				
		113	133.95				
		114.2	134.01				
		115.3	134.03				
		116.8	134.03				
		119.3	134				
		127	133.97				



Changed to remove the stich effect

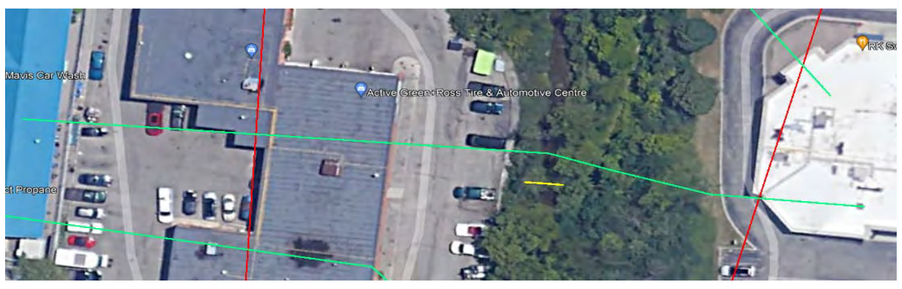
Modified to show the flat 4.5m wide channel

Original

Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.045	0.032	0.045
Station	Elevation	n Value
0	134.94	
5.2	134.78	
6.87	134.78	
7.1	134.66	
7.83	134.06	
8.36	133.79	
9.14	133.57	
10.2	133.49	
14.61	133.39	
20.86	133.49	
24.86	133.52	
30.18	133.48	
31.84	133.45	
34.86	133.13	
35.87	133.13	
36.84	133.05	
39.62	133.03	
42.71	132.97	
49.14	132.81	
52.13	132.73	
54.85	132.69	
55.57	132.66	
56.28	132.52	
57.13	132.06	
58.48	131.21	
61.28	131.09	
66.28	130.91	
69.14	130.76	
71.8	130.7	
72.14	130.63	
72.71	130.08	
73.39	129.36	
74.64	128.25	
75.13	127.81	
75.89	127.04	
76.28	126.74	
77.14	126.4	
78.19	126.43	
79.14	126.45	
80.55	126.71	
81.16	126.91	
81.97	127.68	
82.68	128.16	
83.39	128.32	
85.52	128.5	
87.57	128.58	
88.36	128.71	
89.09	128.92	
89.78	129.42	
91.19	130.33	
93.32	131.27	
95.44	132.1	
97.57	132.72	
99.69	133.49	
101.11	133.89	
102.44	134.06	
104.09	134.13	
105.38	134.07	
106.62	133.9	
109.64	133.91	
112.49	133.94	
114.22	134.01	
124.61	133.99	
127	133.97	

Updated Existing

Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Manning's n		
LOB	Channel	ROB
0.045	0.035	0.045
Station	Elevation	n Value
0	134.94	
5.2	134.78	
6.87	134.78	
7.1	134.66	
7.83	134.06	
8.36	133.79	
9.14	133.57	
10.2	133.49	
14.61	133.39	
20.86	133.49	
24.86	133.52	
30.18	133.48	
31.84	133.45	
34.86	133.13	
35.87	133.13	
36.84	133.05	
39.62	133.03	
42.71	132.97	
49.14	132.81	
52.13	132.73	
54.85	132.69	
55.57	132.66	
56.28	132.52	
57.13	132.06	
58.48	131.21	
61.28	131.09	
66.28	130.91	
69.14	130.76	
71.8	130.7	
72.14	130.63	
72.71	130.08	
73.4	128.63	
73.5	128.6	
74.6	128.24	
75.1	128.12	
75.13	128.105	
75.6	127.87	
76	126.75	
76.8	126.5	
77.1	126.5	
78.8	126.5	
79.9	126.5	
80.6	126.86	
81.2	127.56	
81.4	127.78	
81.97	128.027	
82	128.04	
82.5	128.17	
82.9	128.23	
86.4	128.65	
87.6	128.76	
94.4	131.74	
98.4	133.44	
99	133.52	
99.8	133.52	
100.4	133.72	
101.1	133.89	
102.4	134.06	
103.9	134.13	
104.7	134.11	
105.4	134.07	
106.6	133.9	
107.9	133.89	
109.2	133.92	
110.3	133.9	
111.1	133.91	
113	133.95	
114.2	134.01	
115.3	134.03	
116.8	134.03	
119.3	134	
127	133.97	



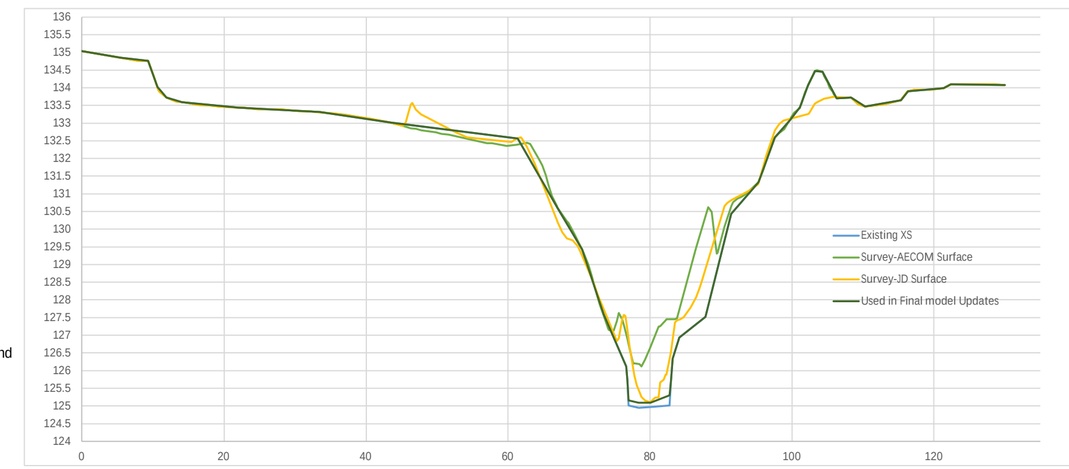
Existing XS	
Station	Elevation
0	135.04
5.46	134.85
9.29	134.76
10.59	134.02
11.87	133.72
14.08	133.59
22.08	133.44
33.49	133.31
43.44	133.02
61.35	132.57
66.97	130.6
70.4	129.43
73.43	127.6
76.66	126.12
76.78	125.736
76.98	125.01
78.37	124.95
80.03	124.97
82.73	125.01
82.95	125.754
83.18	126.34
84.11	126.94
87.8	127.52
91.4	130.43
95.26	131.33
97.59	132.6
99.61	133.06
101.1	133.45
102.28	134.08
103.25	134.47
104.27	134.45
106.28	133.7
108.29	133.72
110.3	133.47
115.33	133.65
116.33	133.9
121.36	133.99
122.37	134.1
130	134.08

Survey-AECOM Surface	
Station	Elevation
0	135.04
7.9	134.76
9.3	134.76
10	134.38
10.6	134.01
10.7	133.94
10.9	133.89
11.9	133.72
13.2	133.61
14.3	133.59
16.4	133.51
17.8	133.5
19.3	133.47
22.1	133.44
22.8	133.44
24.7	133.39
27.8	133.39
30.6	133.34
31.7	133.34
37	133.24
42.9	133.04
44.9	132.94
46.3	132.85
47	132.84
47.8	132.8
49.8	132.74
50.6	132.7
51.6	132.67
57	132.43
57.7	132.43
59.8	132.36
61.2	132.39
62.7	132.44
63.1	132.41
64.4	131.97
64.8	131.8
65.3	131.53
65.7	131.24
66.2	130.93
66.9	130.64
66.9	130.62
67	130.59
68.3	130.22
68.5	130.18
69.4	129.85
70.6	129.35
71.3	129
71.8	128.67
72.3	128.29
72.9	127.87
73.4	127.6
74.1	127.18
74.2	127.14
74.9	127.13
75.3	127.4
75.6	127.63
76.1	127.44
76.3	127.29
76.78	126.906
77.1	126.65
77.6	126.2
77.8	126.21
78.5	126.18
78.8	126.12
79.3	126.3
80	126.64
81.2	127.24
81.4	127.25
82.2	127.42
82.3	127.45
82.95	127.45
83.5	127.45
83.6	127.46
83.8	127.48
86.5	129.47
88.2	130.62
88.7	130.49
89.1	129.73
89.4	129.31
89.5	129.33
90.5	130.08
90.9	130.31
91.4	130.64
91.6	130.72
91.7	130.76
92.3	130.86
92.9	130.92
93.4	130.99
95.2	131.32
96	131.7
96.7	132.18
97.4	132.54
97.6	132.6
98.2	132.72
98.9	132.83
99.9	133.17
100.3	133.29
101.1	133.43
101.1	133.45
101.3	133.55
101.8	133.87
103.2	134.47
103.5	134.5
104.3	134.45
104.5	134.33
105	134.15
105.3	134
105.7	133.89
105.9	133.81
106.3	133.7
108.3	133.72
109.3	133.54
110.3	133.47
113.1	133.54
115.3	133.65
116.3	133.9
117.3	133.95
119.5	133.95
121.4	133.99
122.4	134.1
128.2	134.1
130	134.08

Survey-JD Surface	
Station	Elevation
0	135.04
7.9	134.76
9.3	134.76
10	134.38
10.6	134.01
10.7	133.94
10.9	133.89
11.9	133.72
13.2	133.61
14.3	133.59
16.4	133.51
17.8	133.5
19.3	133.47
22.1	133.44
22.8	133.44
24.7	133.39
27.8	133.39
30.6	133.34
31.7	133.34
35.6	133.27
40.6	133.13
43.4	133.02
45.2	132.92
45.6	133.02
46.1	133.41
46.3	133.52
46.5	133.57
47	133.38
47.7	133.25
52.5	132.75
54.2	132.6
60.5	132.46
61.2	132.57
61.8	132.6
61.9	132.58
62.7	132.32
63.7	131.87
67	130.18
67.6	129.92
68.3	129.74
69.1	129.68
69.4	129.62
69.8	129.52
70.4	129.25
72	128.49
72.7	128.12
73.4	127.77
75.3	126.83
75.6	126.91
76.1	127.48
76.3	127.58
76.5	127.54
76.78	127.1573
77.1	126.72
77.8	125.85
78.1	125.59
78.8	125.26
79.3	125.16
80	125.11
80.7	125.23
81.2	125.25
81.4	125.66
81.9	125.74
82.2	125.89
82.3	125.89
82.9	126.49
82.95	126.5633
83.5	127.37
83.6	127.39
83.8	127.42
84.3	127.45
84.7	127.51
85.7	127.78
86.5	128.07
87	128.34
87.2	128.47
90.5	130.66
90.9	130.74
91.4	130.82
94.1	131.11
95.2	131.27
96	131.8
96.4	132.09
97.6	132.8
98.2	132.97
98.8	133.07
102.3	133.26
102.5	133.3
103.2	133.55
103.5	133.59
104.5	133.69
105.9	133.75
107.3	133.72
108.3	133.72
109.3	133.54
110.3	133.47
113.1	133.54
115.3	133.65
116.3	133.9
117.3	133.95
119.5	133.95
121.4	133.99
122.4	134.1
128.2	134.1
130	134.08

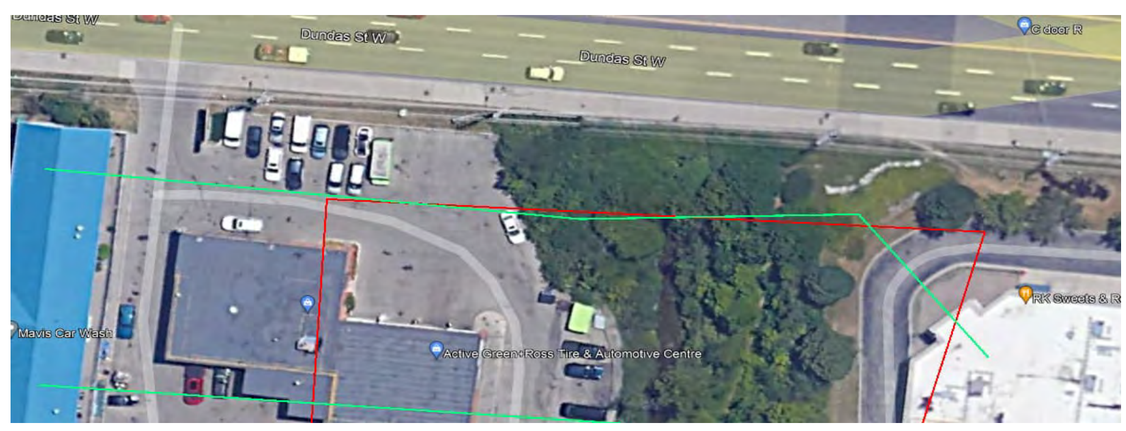
Used in Final model Updates	
Station	Elevation
0	135.04
5.46	134.85
9.29	134.76
10.59	134.02
11.87	133.72
14.08	133.59
22.08	133.44
33.49	133.31
43.44	133.02
61.35	132.57
66.97	130.6
70.4	129.43
73.43	127.6
76.66	126.12
76.78	125.736
76.98	125.16
78.37	125.1
80.03	125.1
82.73	125.3
82.95	125.754
83.18	126.34
84.11	126.94
87.8	127.52
91.4	130.43
95.26	131.33
97.59	132.6
99.61	133.06
101.1	133.45
102.28	134.08
103.25	134.47
104.27	134.45
106.28	133.7
108.29	133.72
110.3	133.47
115.33	133.65
116.33	133.9
121.36	133.99
122.37	134.1
130	134.08

Modified based on AECOM surveyed TWG and JDB Channel points



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0	135.04	0.045
5.46	134.85	
9.29	134.76	
10.59	134.02	0.025
11.87	133.72	
14.08	133.59	
22.08	133.44	
33.49	133.31	
43.44	133.02	
61.35	132.57	0.055
66.97	130.6	
70.4	129.43	
73.43	127.6	
76.66	126.12	
76.78	125.736	0.025
76.98	125.01	
78.37	124.95	
80.03	124.97	
82.73	125.01	
82.95	125.754	0.045
83.18	126.34	
84.11	126.94	
87.8	127.52	
91.4	130.43	
95.26	131.33	
97.59	132.6	
99.61	133.06	
101.1	133.45	
102.28	134.08	
103.25	134.47	
104.27	134.45	
106.28	133.7	
108.29	133.72	0.025
110.3	133.47	
115.33	133.65	
116.33	133.9	0.045
121.36	133.99	
122.37	134.1	
130	134.08	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M2	
Station	Elevation	n Value
0	135.04	0.045
5.46	134.85	
9.29	134.76	
10.59	134.02	0.016
11.87	133.72	
14.08	133.59	
22.08	133.44	
33.49	133.31	
43.44	133.02	
61.35	132.57	0.055
66.97	130.6	
70.4	129.43	
73.43	127.6	
76.66	126.12	
76.78	125.736	0.025
76.98	125.16	
78.37	125.1	
80.03	125.1	
82.73	125.3	
82.95	125.754	0.045
83.18	126.34	
84.11	126.94	
87.8	127.52	
91.4	130.43	
95.26	131.33	
97.59	132.6	
99.61	133.06	
101.1	133.45	
102.28	134.08	
103.25	134.47	
104.27	134.45	
106.28	133.7	
108.29	133.72	0.025
110.3	133.47	
115.33	133.65	
116.33	133.9	0.045
121.36	133.99	
122.37	134.1	
130	134.08	

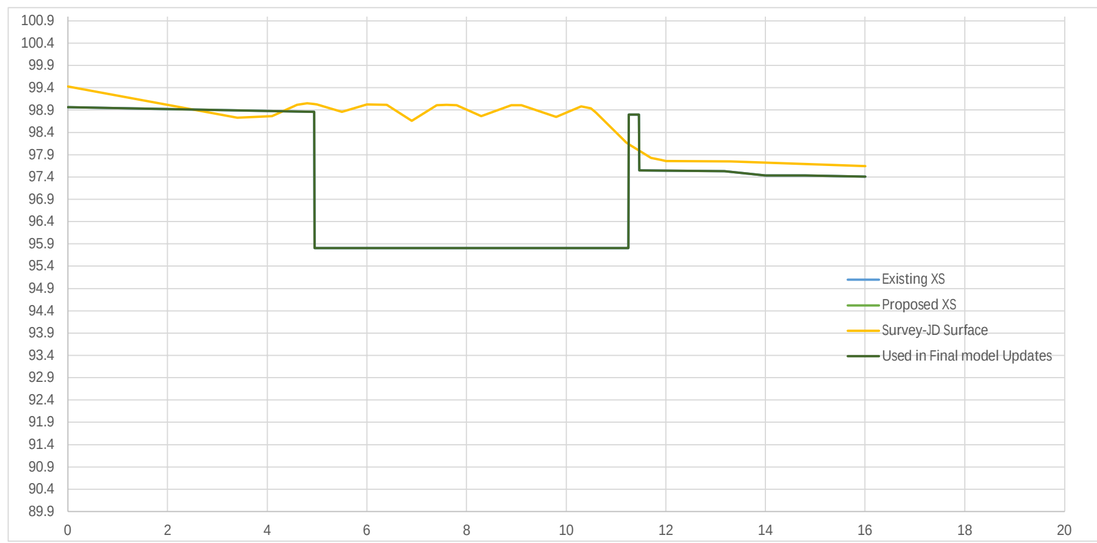


Existing XS	
Station	Elevation
0	98.97
4.94	98.86
4.95	95.81
11.25	95.81
11.26	98.8
11.46	98.8
11.47	97.55
13.18	97.53
14	97.43
14.8	97.43
16	97.41

Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	99.43
3.4	98.73
4.1	98.76
4.6	99.02
4.8	99.05
4.94	99.036
5	99.03
5.5	98.86
6	99.03
6.4	99.02
6.9	98.66
7.4	99.01
7.6	99.02
7.8	99.01
8.3	98.76
8.9	99.01
9.1	99.01
9.2	98.97
9.8	98.75
10.3	98.98
10.5	98.94
10.6	98.84
11.2	98.18
11.26	98.138
11.7	97.83
11.9	97.78
12	97.76
13.3	97.75
16	97.65

Used in Final model Updates	
Station	Elevation
0	98.97
4.94	98.86
4.95	95.81
11.25	95.81
11.26	98.8
11.46	98.8
11.47	97.55
13.18	97.53
14	97.43
14.8	97.43
16	97.41



Original

Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	98.97	
4.94	98.86	
4.95	95.81	
11.25	95.81	
11.26	98.8	
11.46	98.8	
11.47	97.55	
13.18	97.53	
14	97.43	
14.8	97.43	
16	97.41	

Updated Existing

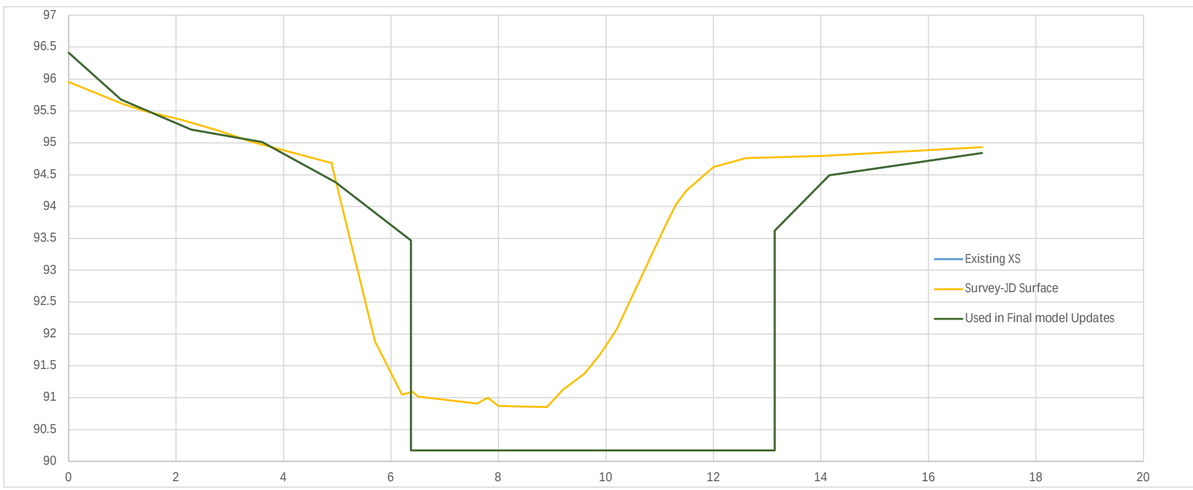
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	98.97	
4.94	98.86	
4.95	95.81	
11.25	95.81	
11.26	98.8	
11.46	98.8	
11.47	97.55	
13.18	97.53	
14	97.43	
14.8	97.43	
16	97.41	

Existing XS	
Station	Elevation
0	96.41
0.97	95.68
2.28	95.21
3.6	95.01
4.97	94.38
6.37	93.47
6.37	90.17
13.14	90.17
13.14	93.62
14.16	94.49
17	94.84

Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	95.95
1	95.61
1.4	95.5
2.1	95.36
2.8	95.19
3.4	95.02
4.9	94.68
4.9	94.64
5.7	91.88
6.2	91.05
6.37	91.084
6.4	91.09
6.5	91.02
7.6	90.91
7.8	91
8	90.87
8.9	90.85
9.2	91.13
9.6	91.38
9.9	91.69
10.2	92.07
11.1	93.69
11.3	94.03
11.5	94.25
12	94.62
12.6	94.76
13.14	94.7744
14.1	94.8
17	94.93

Used in Final model Updates	
Station	Elevation
0	96.41
0.97	95.68
2.28	95.21
3.6	95.01
4.97	94.38
6.37	93.47
6.37	90.17
13.14	90.17
13.14	93.62
14.16	94.49
17	94.84



Original

Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	96.41	
0.97	95.68	
2.28	95.21	
3.6	95.01	
4.97	94.38	
6.37	93.47	
6.37	90.17	
13.14	90.17	
13.14	93.62	
14.16	94.49	
17	94.84	

Updated Existing

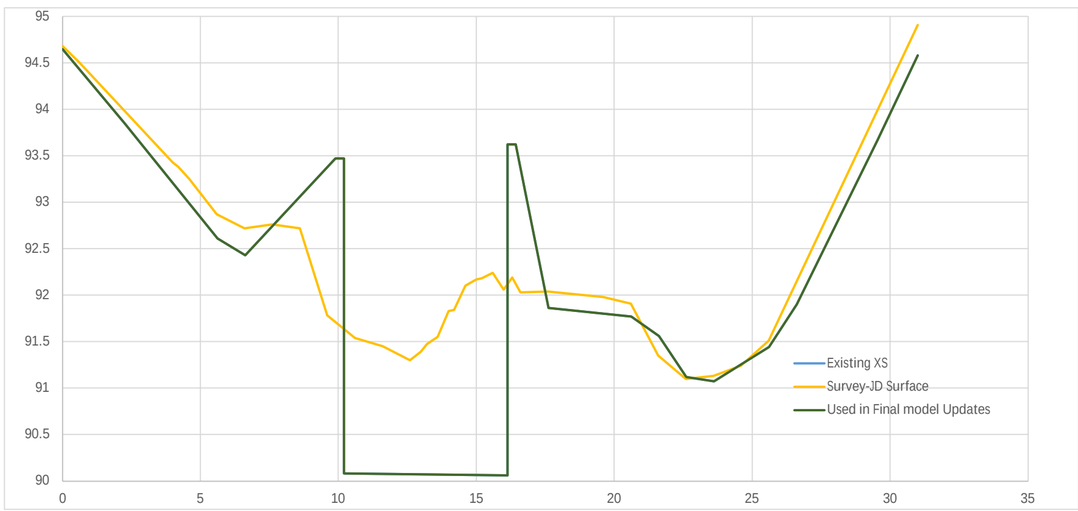
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	96.41	
0.97	95.68	
2.28	95.21	
3.6	95.01	
4.97	94.38	
6.37	93.47	
6.37	90.17	
13.14	90.17	
13.14	93.62	
14.16	94.49	
17	94.84	

Existing XS	
Station	Elevation
0	94.65
2.26	93.85
5.62	92.61
6.62	92.43
9.9	93.47
10.2	93.47
10.2	90.08
16.13	90.06
16.13	93.62
16.43	93.62
17.62	91.86
20.62	91.77
21.62	91.56
22.62	91.12
23.62	91.07
25.62	91.44
26.62	91.9
29.54	93.66
31	94.58

Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	94.68
0.6	94.51
4	93.43
4.2	93.38
4.6	93.25
5.6	92.87
6.6	92.72
7.6	92.76
8.6	92.72
9.6	91.78
10.2	91.636
10.6	91.54
11.6	91.45
12.6	91.3
13	91.39
13.2	91.47
13.6	91.55
14	91.83
14.2	91.84
14.6	92.1
15	92.17
15.2	92.18
15.6	92.24
16	92.06
16.13	92.11633
16.3	92.19
16.6	92.03
17.6	92.04
19.6	91.98
20.6	91.91
21.6	91.35
22.6	91.1
23.6	91.13
24.6	91.24
25.6	91.51
31	94.91

Used in Final model Updates	
Station	Elevation
0	94.65
2.26	93.85
5.62	92.61
6.62	92.43
9.9	93.47
10.2	93.47
10.2	90.08
16.13	90.06
16.13	93.62
16.43	93.62
17.62	91.86
20.62	91.77
21.62	91.56
22.62	91.12
23.62	91.07
25.62	91.44
26.62	91.9
29.54	93.66
31	94.58



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	94.65	
2.26	93.85	
5.62	92.61	
6.62	92.43	
9.9	93.47	
10.2	93.47	
10.2	90.08	
16.13	90.06	
16.13	93.62	
16.43	93.62	
17.62	91.86	
20.62	91.77	
21.62	91.56	
22.62	91.12	
23.62	91.07	
25.62	91.44	
26.62	91.9	
29.54	93.66	
31	94.58	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	94.65	
2.26	93.85	
5.62	92.61	
6.62	92.43	
9.9	93.47	
10.2	93.47	
10.2	90.08	
16.13	90.06	
16.13	93.62	
16.43	93.62	
17.62	91.86	
20.62	91.77	
21.62	91.56	
22.62	91.12	
23.62	91.07	
25.62	91.44	
26.62	91.9	
29.54	93.66	
31	94.58	

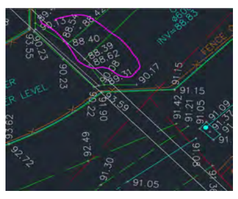
Existing XS	
Station	Elevation
0	94.44
2.64	93.45
3.64	93.05
4.64	92.48
5.64	92.15
6.64	92.05
8.11	90.73
9.71	89.33
12.32	88.25
13.93	88.27
16.37	89.17
17.64	91.06
18.64	91.57
20.37	91.61
21.64	91.54
22.64	91.18
23.64	91.05
24.83	91.22
25.64	91.39
26.79	91.87
28.54	93.02
31	94.43

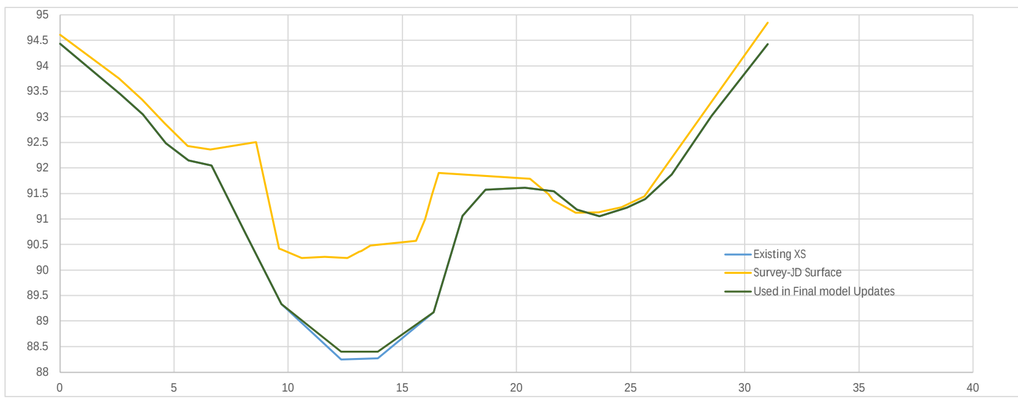
Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	94.61
2.6	93.75
3.6	93.34
4.6	92.87
5.6	92.43
6.6	92.36
8.6	92.51
9.6	90.42
9.71	90.4002
10.6	90.24
11.6	90.26
12.6	90.24
13.1	90.36
13.2	90.37
13.6	90.48
15.6	90.57
16	90.99
16.3	91.48
16.37	91.578
16.6	91.9
20.6	91.79
20.9	91.67
21.4	91.49
21.6	91.37
22.6	91.12
23.6	91.13
23.8	91.15
24.6	91.23
25.6	91.44
31	94.85

Used in Final model Updates	
Station	Elevation
0	94.44
2.64	93.45
3.64	93.05
4.64	92.48
5.64	92.15
6.64	92.05
8.11	90.73
9.71	89.33
12.32	88.4
13.93	88.4
16.37	89.17
17.64	91.06
18.64	91.57
20.37	91.61
21.64	91.54
22.64	91.18
23.64	91.05
24.83	91.22
25.64	91.39
26.79	91.87
28.54	93.02
31	94.43

Updated based on JDB survey





Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	94.44	
2.64	93.45	
3.64	93.05	
4.64	92.48	
5.64	92.15	
6.64	92.05	
8.11	90.73	
9.71	89.33	
12.32	88.25	
13.93	88.27	
16.37	89.17	
17.64	91.06	
18.64	91.57	
20.37	91.61	
21.64	91.54	
22.64	91.18	
23.64	91.05	
24.83	91.22	
25.64	91.39	
26.79	91.87	
28.54	93.02	
31	94.43	

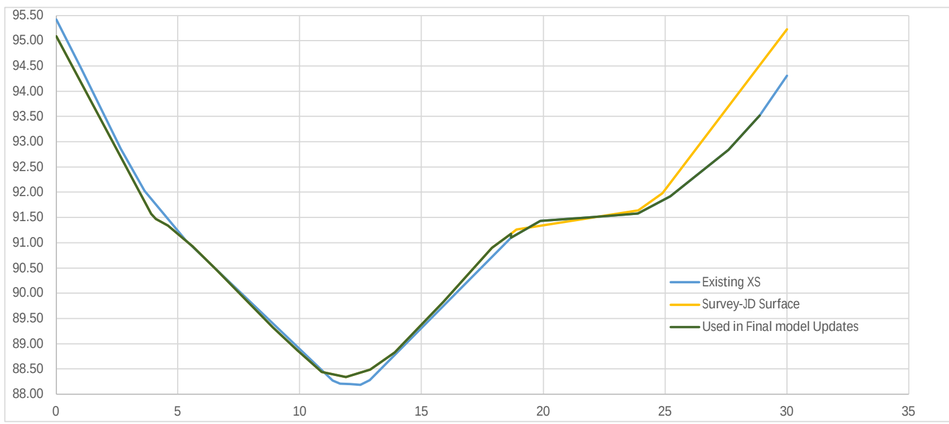
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	94.44	
2.64	93.45	
3.64	93.05	
4.64	92.48	
5.64	92.15	
6.64	92.05	
8.11	90.73	
9.71	89.33	
12.32	88.4	
13.93	88.4	
16.37	89.17	
17.64	91.06	
18.64	91.57	
20.37	91.61	
21.64	91.54	
22.64	91.18	
23.64	91.05	
24.83	91.22	
25.64	91.39	
26.79	91.87	
28.54	93.02	
31	94.43	

Existing XS	
Station	Elevation
0	95.42
1.05	94.43
2.66	92.86
3.64	92.03
5.32	91.05
11.36	88.27
11.66	88.21
12.08	88.20
12.49	88.19
12.88	88.28
18.67	91.10
19.88	91.43
21.88	91.50
23.88	91.58
25.21	91.92
27.6	92.84
28.88	93.52
30	94.31

Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	95.09
3.9	91.57
4.1	91.47
4.6	91.34
5.32	91.04
5.6	90.93
6.6	90.46
8.9	89.32
9.9	88.87
10.9	88.44
11.9	88.34
12.9	88.49
13.9	88.83
15.9	89.83
17.9	90.90
18.67	91.18
18.9	91.26
23.9	91.64
24.9	91.98
30	95.23

Used in Final model Updates		
Station	Elevation	
0	95.09	
3.9	91.57	
4.1	91.47	
4.6	91.34	
5.32	91.04	
5.6	90.93	
6.6	90.46	
8.9	89.32	
9.9	88.87	
10.9	88.44	
11.9	88.34	
12.9	88.49	
13.9	88.83	
15.9	89.83	
17.9	90.90	
18.67	91.18	
18.67	91.10	
19.88	91.43	
21.88	91.50	
23.88	91.58	
25.21	91.92	Changed to remove the stich effect
27.6	92.84	
28.88	93.52	
30	94.31	



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	95.42	
1.05	94.43	
2.66	92.86	
3.64	92.03	
5.32	91.05	
11.36	88.27	
11.66	88.21	
12.08	88.20	
12.49	88.19	
12.88	88.28	
18.67	91.10	
19.88	91.43	
21.88	91.50	
23.88	91.58	
25.21	91.92	
27.6	92.84	
28.88	93.52	
30	94.31	

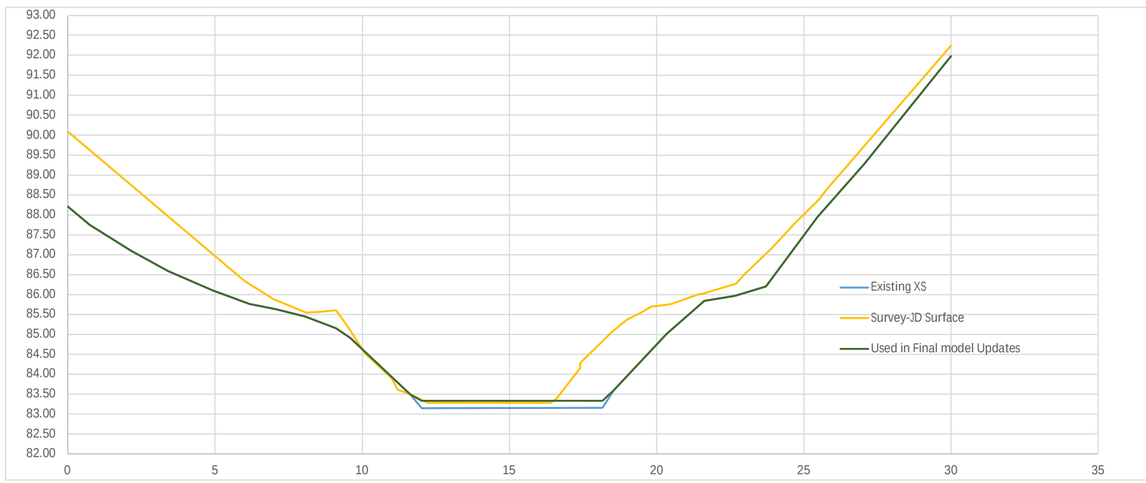
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	95.09	
3.9	91.57	
4.1	91.47	
4.6	91.34	
5.32	91.04	
5.6	90.93	
6.6	90.46	
8.9	89.32	
9.9	88.87	
10.9	88.44	
11.9	88.34	
12.9	88.49	
13.9	88.83	
15.9	89.83	
17.9	90.90	
18.67	91.18	
18.67	91.10	
19.88	91.43	
21.88	91.50	
23.88	91.58	
25.21	91.92	
27.6	92.84	
28.88	93.52	
30	94.31	

Existing XS	
Station	Elevation
0	88.21
0.74	87.75
2.16	87.10
3.42	86.59
4.92	86.11
6.18	85.76
7.05	85.64
8.05	85.45
9.1	85.16
9.59	84.91
11.63	83.50
12.02	83.15
18.16	83.16
18.54	83.60
20.34	85.01
21.62	85.84
22.67	85.97
23.71	86.21
25.46	87.95
27.06	89.28
30	91.98

Survey-AECOM Surface	
Station	Elevation
No AECOM TWG shot	

Survey-JD Surface	
Station	Elevation
0	90.09
6	86.34
7	85.88
8.1	85.55
8.6	85.57
9.1	85.61
9.4	85.31
9.59	85.10
10.1	84.52
10.4	84.32
11	83.90
11.2	83.62
11.8	83.44
12.2	83.29
13.4	83.28
16.4	83.29
16.6	83.39
17.4	84.16
17.4	84.29
18.5	85.08
19	85.37
19.5	85.56
19.8	85.70
20.34	85.75
20.5	85.76
21.4	86.00
21.6	86.03
22.7	86.27
23	86.52
23.7	87.02
23.9	87.16
24.7	87.79
25.5	88.38
25.8	88.65
30	92.24

Used in Final model Updates	
Station	Elevation
0	88.21
0.74	87.75
2.16	87.10
3.42	86.59
4.92	86.11
6.18	85.76
7.05	85.64
8.05	85.45
9.1	85.16
9.59	84.91
11.63	83.50
12.02	83.33
18.16	83.33
18.54	83.60
20.34	85.01
21.62	85.84
22.67	85.97
23.71	86.21
25.46	87.95
27.06	89.28
30	91.98



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	88.21	
0.74	87.75	
2.16	87.10	
3.42	86.59	
4.92	86.11	
6.18	85.76	
7.05	85.64	
8.05	85.45	
9.1	85.16	
9.59	84.91	
11.63	83.50	
12.02	83.15	
18.16	83.16	
18.54	83.60	
20.34	85.01	
21.62	85.84	
22.67	85.97	
23.71	86.21	
25.46	87.95	
27.06	89.28	
30	91.98	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	88.21	
0.74	87.75	
2.16	87.1	
3.42	86.59	
4.92	86.11	
6.18	85.76	
7.05	85.64	
8.05	85.45	
9.1	85.16	
9.59	84.91	
11.63	83.497	
12.02	83.33	
18.16	83.33	
18.54	83.598	
20.34	85.01	
21.62	85.84	
22.67	85.97	
23.71	86.21	
25.46	87.95	
27.06	89.28	
30	91.98	

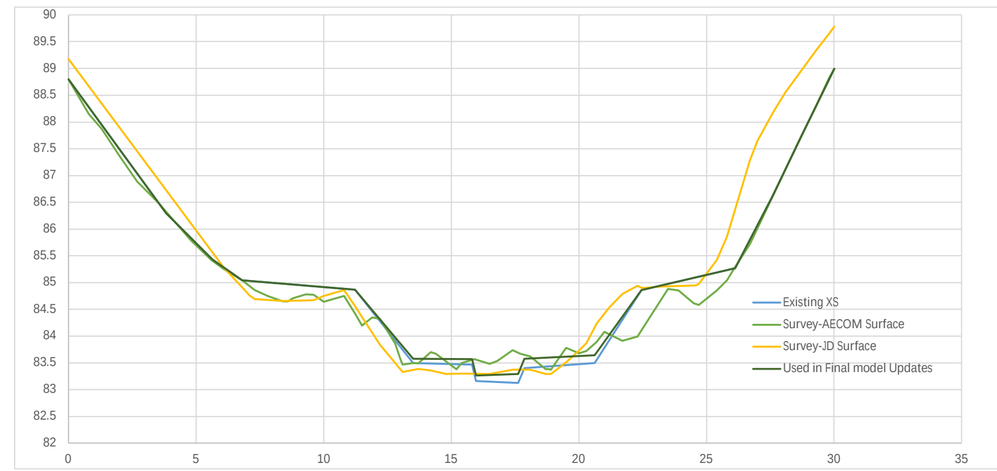
Existing XS	
Station	Elevation
0	88.79
3.82	86.3
5.65	85.43
6.8	85.04
11.22	84.87
13.51	83.5
15.81	83.47
15.97	83.16
17.62	83.12
17.86	83.4
20.61	83.5
22.46	84.86
26.13	85.27
27.59	86.62
28.69	87.71
30	88.99

Survey-AECOM Surface	
Station	Elevation
0	88.79
0.8	88.15
1.3	87.87
2	87.36
2.7	86.89
3.5	86.50
4.8	85.79
5.6	85.42
6.1	85.25
6.8	85.04
7.3	84.86
7.8	84.75
8.4	84.65
8.6	84.65
8.8	84.71
9.3	84.78
9.6	84.77
10	84.64
10.8	84.75
11.22	84.42
11.5	84.20
11.9	84.35
12.2	84.32
12.8	83.86
13	83.58
13.1	83.47
13.5	83.50
13.7	83.49
14.2	83.70
14.4	83.67
15.2	83.38
15.4	83.50
15.9	83.57
16.3	83.51
16.5	83.48
16.8	83.53
17.4	83.74
17.7	83.67
18.1	83.62
18.7	83.38
18.8	83.39
18.9	83.37
19	83.44
19.5	83.78
20	83.68
20.3	83.72
20.7	83.89
21	84.08
21.7	83.91
22.3	83.99
22.46	84.11
23.5	84.88
23.9	84.85
24.5	84.61
24.7	84.58
25.4	84.85
25.8	85.04
26.1	85.27
26.7	85.72
28.7	87.71
29.3	88.31
29.8	88.81
30	88.99

Survey-JD Surface	
Station	Elevation
0	89.17
6.1	85.27
6.8	84.91
7.1	84.76
7.3	84.69
8.4	84.66
9.6	84.67
10	84.75
10.8	84.86
11.22	84.56
11.5	84.36
12.2	83.84
12.8	83.50
13.1	83.33
13.7	83.39
14.2	83.36
14.8	83.29
15.4	83.30
16.5	83.29
17.4	83.37
18.1	83.37
18.7	83.29
18.9	83.29
19.5	83.51
20	83.73
20.3	83.87
20.7	84.23
21.2	84.54
21.7	84.79
22.3	84.94
22.46	84.91
22.5	84.90
23.2	84.93
24.6	84.95
24.7	84.98
25.4	85.42
25.8	85.86
26.7	87.29
27	87.65
27.6	88.18
28.1	88.56
29.3	89.34
29.8	89.64
30	89.78

Used in Final model Updates	
Station	Elevation
0	88.79
3.82	86.3
5.65	85.43
6.8	85.04
11.22	84.87
13.51	83.58
15.81	83.57
15.97	83.26
17.62	83.29
17.86	83.58
20.61	83.64
22.46	84.86
26.13	85.27
27.59	86.62
28.69	87.71
30	88.99

Updated based on JDB points



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	88.79	
3.82	86.3	
5.65	85.43	
6.8	85.04	
11.22	84.87	
13.51	83.5	
15.81	83.47	
15.97	83.16	
17.62	83.12	
17.86	83.4	
20.61	83.5	
22.46	84.86	
26.13	85.27	
27.59	86.62	
28.69	87.71	
30	88.99	

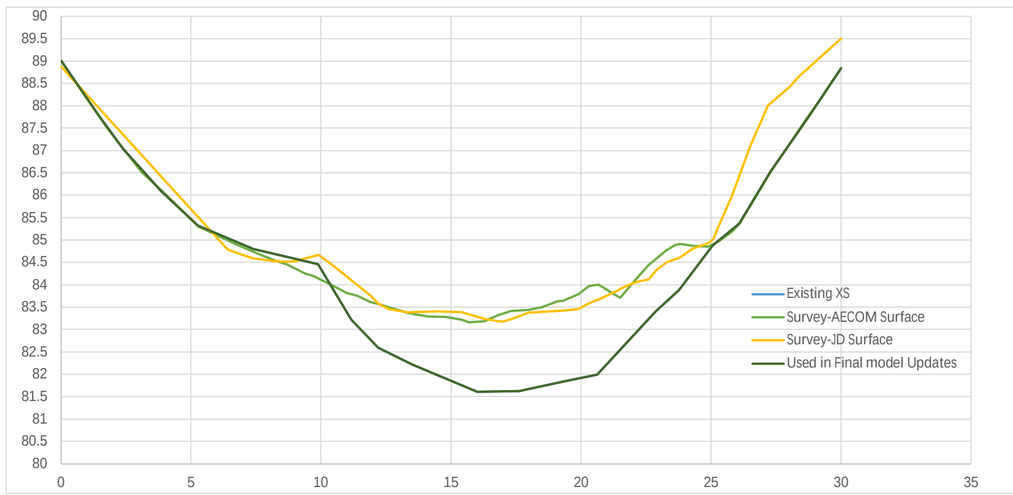
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.015	0.08
Station	Elevation	n Value
0	88.79	
3.82	86.3	
5.65	85.43	
6.8	85.04	
11.22	84.87	
13.51	83.58	
15.81	83.57	
15.97	83.26	
17.62	83.29	
17.86	83.58	
20.61	83.64	
22.46	84.86	
26.13	85.27	
27.59	86.62	
28.69	87.71	
30	88.99	

Existing XS	
Station	Elevation
0	89.01
1.42	87.81
2.39	87.04
3.85	86.09
5.26	85.32
7.39	84.8
9.89	84.46
11.17	83.22
12.2	82.59
13.51	82.22
16.01	81.61
17.63	81.62
19.3	81.83
20.62	81.99
22.87	83.4
23.77	83.88
25.06	84.88
26.08	85.37
27.29	86.53
28.72	87.73
30	88.84

Survey-AECOM Surface	
Station	Elevation
0	89.01
0.6	88.5
1.8	87.49
2.4	87.04
3.1	86.52
3.9	86.09
5.3	85.3
6.8	84.89
7.5	84.71
8.2	84.55
8.7	84.45
9.4	84.25
9.7	84.2
10.4	84
11	83.81
11.4	83.75
11.9	83.61
12.2	83.57
13.4	83.36
13.51	83.349
14.1	83.29
14.8	83.28
15.4	83.22
15.7	83.16
16.3	83.19
16.8	83.32
17.3	83.41
18	83.44
18.5	83.5
19.1	83.63
19.3	83.64
19.9	83.79
20.3	83.97
20.62	83.994
20.7	84
21.3	83.78
21.5	83.71
22.1	84.12
22.6	84.44
23.3	84.77
23.6	84.88
23.8	84.91
24.3	84.87
24.9	84.85
25.3	84.97
25.8	85.18
26.1	85.37
27.3	86.53
28.7	87.73
29.3	88.22
29.6	88.5
30	88.84

Survey-JD Surface	
Station	Elevation
0	88.87
6.4	84.79
6.8	84.7
7.4	84.59
8.2	84.53
8.7	84.51
9	84.53
9.7	84.63
9.9	84.67
10.4	84.46
11.9	83.76
12.2	83.58
12.6	83.46
13.4	83.38
13.51	83.382
14.5	83.4
15.4	83.39
16.3	83.24
16.8	83.19
17	83.18
17.3	83.23
18	83.38
19.3	83.42
19.9	83.46
20.3	83.59
20.62	83.654
20.7	83.67
21.3	83.84
21.4	83.87
21.5	83.91
22.1	84.06
22.6	84.12
22.9	84.33
23.3	84.5
23.8	84.61
24.3	84.81
24.9	84.93
25.1	85.03
25.3	85.32
25.8	85.98
26.5	87.09
27.2	88.01
28	88.41
28.4	88.66
30	89.51

Used in Final model Updates	
Station	Elevation
0	89.01
1.42	87.81
2.39	87.04
3.85	86.09
5.26	85.32
7.39	84.8
9.89	84.46
11.17	83.22
12.2	82.59
13.51	82.22
16.01	81.61
17.63	81.62
19.3	81.83
20.62	81.99
22.87	83.4
23.77	83.88
25.06	84.88
26.08	85.37
27.29	86.53
28.72	87.73
30	88.84



Original

Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M1

Manning's n

LOB	Channel	ROB
0.08	0.025	0.08

Station	Elevation	n Value
0	89.01	
1.42	87.81	
2.39	87.04	
3.85	86.09	
5.26	85.32	
7.39	84.8	
9.89	84.46	
11.17	83.22	
12.2	82.59	
13.51	82.22	
16.01	81.61	
17.63	81.62	
19.3	81.83	
20.62	81.99	
22.87	83.4	
23.77	83.88	
25.06	84.88	
26.08	85.37	
27.29	86.53	
28.72	87.73	
30	88.84	

Updated Existing

Project:	Wolfedale_FHM
River:	Wolfedale Creek
Reach:	941-M1

Manning's n

LOB	Channel	ROB
0.08	0.025	0.08

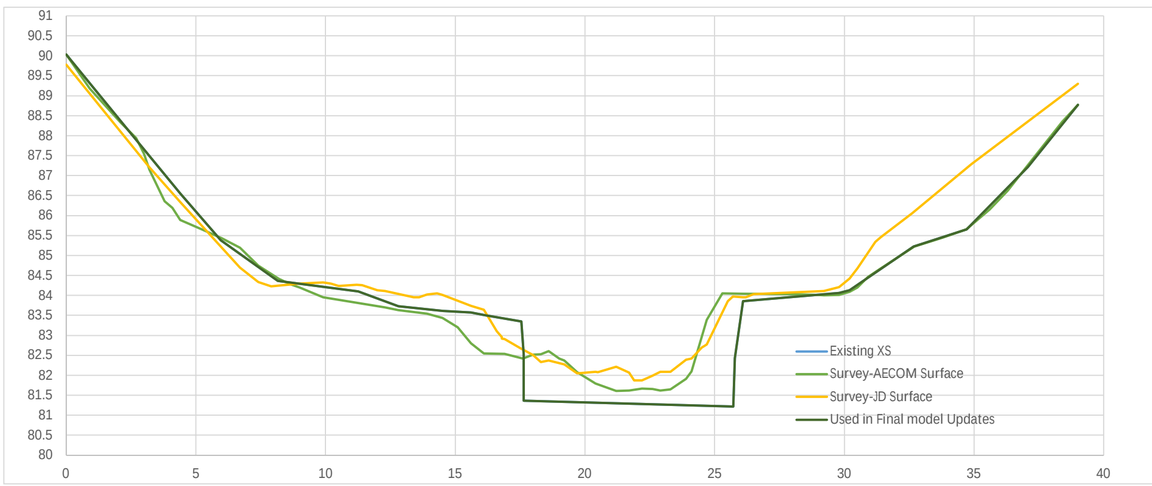
Station	Elevation	n Value
0	89.01	
1.42	87.81	
2.39	87.04	
3.85	86.09	
5.26	85.32	
7.39	84.8	
9.89	84.46	
11.17	83.22	
12.2	82.59	
13.51	82.22	
16.01	81.61	
17.63	81.62	
19.3	81.83	
20.62	81.99	
22.87	83.4	
23.77	83.88	
25.06	84.88	
26.08	85.37	
27.29	86.53	
28.72	87.73	
30	88.84	

Existing XS	
Station	Elevation
0	90.04
2.3	88.2
4.4	86.55
5.96	85.38
8.15	84.36
11.25	84.1
12.8	83.73
14.52	83.61
15.61	83.57
16.14	83.5
17.55	83.35
17.63	82.53
17.63	81.36
25.72	81.22
25.77	82.43
26.09	83.86
29.79	84.06
30.2	84.13
32.67	85.22
34.71	85.65
37.07	87.22
39	88.77

Survey-AECOM Surface	
Station	Elevation
0	90.04
0.9	89.18
2.1	88.33
2.7	87.94
3	87.55
3.2	87.15
3.8	86.36
4.1	86.19
4.4	85.89
5.2	85.66
6	85.43
6.7	85.19
7.4	84.74
8.2	84.41
8.7	84.27
9	84.20
9.9	83.95
12.3	83.70
12.8	83.63
13.9	83.54
14.5	83.44
15.1	83.20
15.6	82.80
16.1	82.55
16.9	82.54
17.55	82.43
17.6	82.42
18	82.52
18.3	82.53
18.6	82.60
19	82.42
19.2	82.37
19.7	82.08
20.4	81.79
21.2	81.61
21.7	81.62
22.2	81.67
22.6	81.66
22.9	81.62
23.3	81.65
23.9	81.91
24.1	82.10
24.5	82.96
24.7	83.39
25.3	84.05
26.09	84.04
27.8	84.03
29	84.01
29.2	84.00
29.8	84.01
30.2	84.09
30.5	84.20
30.9	84.46
31.4	84.68
32.7	85.22
33.8	85.45
34.7	85.65
34.9	85.76
35.6	86.15
36.3	86.62
37.2	87.36
38.4	88.35
39	88.77

Survey-JD Surface	
Station	Elevation
0	89.78
3.2	87.21
4.4	86.34
6.7	84.70
7.4	84.33
7.9	84.23
9	84.30
9.9	84.32
10.2	84.30
10.5	84.24
11.2	84.27
11.4	84.26
12	84.13
12.3	84.11
13.4	83.95
13.6	83.95
13.9	84.02
14.3	84.05
14.5	84.01
15.6	83.74
16.1	83.64
16.6	83.10
16.8	82.96
16.8	82.92
16.9	82.91
17.55	82.66
17.6	82.64
18	82.51
18.3	82.33
18.6	82.37
19.2	82.27
19.7	82.05
20.4	82.09
20.5	82.08
21.2	82.21
21.7	82.07
21.9	81.88
22.2	81.88
22.6	81.99
22.9	82.09
23.3	82.09
23.9	82.39
24.1	82.42
24.5	82.69
24.7	82.77
25.5	83.86
25.7	83.97
26.09	83.95
26.2	83.95
26.5	84.03
29.2	84.11
29.8	84.21
30.2	84.42
30.5	84.68
31.2	85.34
31.4	85.46
32.6	86.05
34.9	87.29
39	89.30

Used in Final model Updates	
Station	Elevation
0	90.04
2.3	88.20
4.4	86.55
5.96	85.38
8.15	84.36
11.25	84.10
12.8	83.73
14.52	83.61
15.61	83.57
16.14	83.50
17.55	83.35
17.63	82.53
17.63	81.36
25.72	81.22
25.77	82.43
26.09	83.86
29.79	84.06
30.2	84.13
32.67	85.22
34.71	85.65
37.07	87.22
39	88.77



Original

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M1
Manning's n

LOB	Channel	ROB
0.08	0.025	0.08

Station	Elevation	n Value
0	90.04	
2.3	88.2	
4.4	86.55	
5.96	85.38	
8.15	84.36	
11.25	84.1	
12.8	83.73	
14.52	83.61	
15.61	83.57	
16.14	83.5	
17.55	83.35	
17.63	82.53	
17.63	81.36	
25.72	81.22	
25.77	82.43	
26.09	83.86	
29.79	84.06	
30.2	84.13	
32.67	85.22	
34.71	85.65	
37.07	87.22	
39	88.77	

Updated Existing

Project: Wolfedale_FHM
River: Wolfedale Creek
Reach: 941-M1
Manning's n

LOB	Channel	ROB
0.08	0.025	0.08

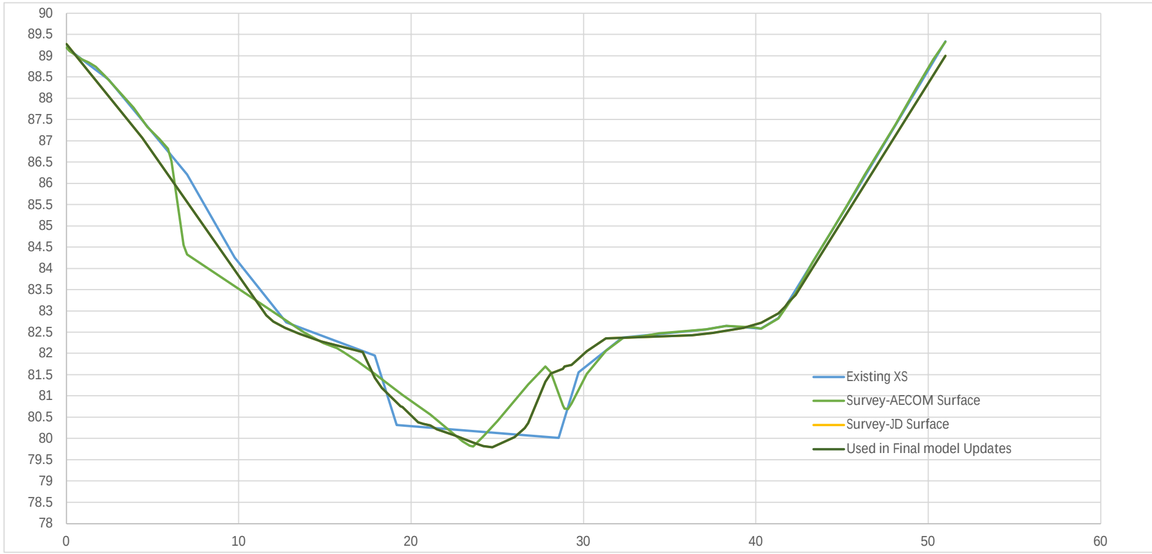
Station	Elevation	n Value
0	90.04	
2.3	88.2	
4.4	86.55	
5.96	85.38	
8.15	84.36	
11.25	84.1	
12.8	83.73	
14.52	83.61	
15.61	83.57	
16.14	83.5	
17.55	83.35	
17.63	82.53	
17.63	81.36	
25.72	81.22	
25.77	82.43	
26.09	83.86	
29.79	84.06	
30.2	84.13	
32.67	85.22	
34.71	85.65	
37.07	87.22	
39	88.77	

Existing XS	
Station	Elevation
0	89.19
2.45	88.44
7.01	86.21
9.78	84.25
12.75	82.73
17.9	81.95
19.17	80.32
28.55	80.02
29.71	81.55
32.26	82.37
37.12	82.56
38.28	82.65
40.29	82.58
41.3	82.83
45.25	85.44
48.12	87.38
51	89.34

Survey-AECOM Surface	
Station	Elevation
0	89.19
0.2	89.11
0.9	88.92
1.3	88.84
1.7	88.74
2.3	88.50
3.9	87.78
4.7	87.33
5.4	87.04
5.9	86.81
6.1	86.52
6.8	84.55
7	84.33
13.8	82.49
14.9	82.24
15.7	82.12
16.1	82.02
16.9	81.81
17.9	81.52
19.5	81.02
21.1	80.56
23	79.93
23.4	79.83
23.6	79.81
24.2	80.05
25	80.41
26.8	81.27
27.8	81.69
28.1	81.55
28.8	80.77
28.9	80.70
29.1	80.69
29.3	80.82
29.71	81.14
30.2	81.52
31.3	82.06
32.3	82.36
33.5	82.41
34.4	82.47
37.1	82.56
38.3	82.65
39.9	82.61
40.3	82.58
41.3	82.82
42.3	83.41
43.3	84.15
44.4	84.89
45.3	85.48
46.3	86.20
48.1	87.38
49.3	88.24
50.3	88.92
51	89.33

Survey-JD Surface	
Station	Elevation
0	89.28
4.4	87.07
11.6	82.89
12	82.75
12.7	82.60
13.5	82.46
14.8	82.28
17.2	82.03
17.9	81.43
18.3	81.19
19.4	80.76
19.5	80.74
20.4	80.38
20.7	80.34
21.1	80.31
21.5	80.21
22.5	80.08
23.6	79.90
24.2	79.82
24.7	79.80
26	80.03
26.6	80.24
26.8	80.36
27.8	81.33
28.1	81.53
28.8	81.64
28.9	81.69
29.3	81.73
29.71	81.88
30.2	82.05
31.3	82.35
36.3	82.43
37.5	82.48
39.3	82.60
40.3	82.72
41.3	82.94
41.7	83.10
41.9	83.21
42.3	83.37
51	89.00

Used in Final model Updates	
Station	Elevation
0	89.28
4.4	87.07
11.6	82.89
12	82.75
12.7	82.60
13.5	82.46
14.8	82.28
17.2	82.03
17.9	81.43
18.3	81.19
19.4	80.76
19.5	80.74
20.4	80.38
20.7	80.34
21.1	80.31
21.5	80.21
22.5	80.08
23.6	79.90
24.2	79.82
24.7	79.80
26	80.03
26.6	80.24
26.8	80.36
27.8	81.33
28.1	81.53
28.8	81.64
28.9	81.69
29.3	81.73
29.71	81.88
30.2	82.05
31.3	82.35
36.3	82.43
37.5	82.48
39.3	82.60
40.3	82.72
41.3	82.94
41.7	83.10
41.9	83.21
42.3	83.37
51	89.00



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	89.19	
2.45	88.44	
7.01	86.21	
9.78	84.25	
12.75	82.73	
17.9	81.95	
19.17	80.32	
28.55	80.02	
29.71	81.55	
32.26	82.37	
37.12	82.56	
38.28	82.65	
40.29	82.58	
41.3	82.83	
45.25	85.44	
48.12	87.38	
51	89.34	

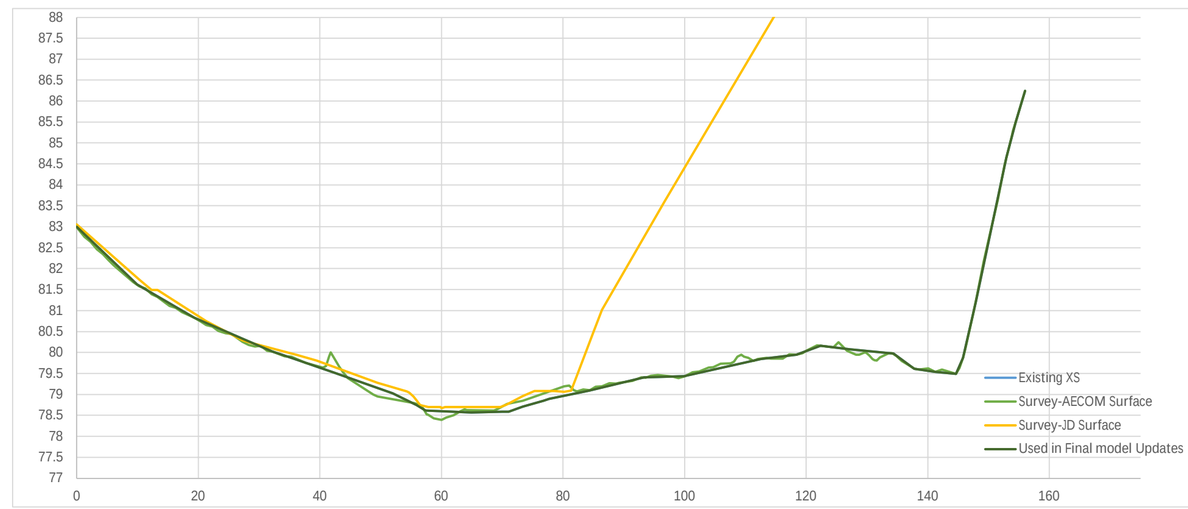
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	89.28	
4.4	87.07	
11.6	82.89	
12	82.75	
12.7	82.60	
13.5	82.46	
14.8	82.28	
17.2	82.03	
17.9	81.43	
18.3	81.19	
19.4	80.76	
19.5	80.74	
20.4	80.38	
20.7	80.34	
21.1	80.31	
21.5	80.21	
22.5	80.08	
23.6	79.90	
24.2	79.82	
24.7	79.80	
26	80.03	
26.6	80.24	
26.8	80.36	
27.8	81.33	
28.1	81.53	
28.8	81.64	
28.9	81.69	
29.3	81.73	
29.71	81.88	
30.2	82.05	
31.3	82.35	
36.3	82.43	
37.5	82.48	
39.3	82.60	
40.3	82.72	
41.3	82.94	
41.7	83.10	
41.9	83.21	
42.3	83.37	
51	89.00	

Existing XS	
Station	Elevation
0	83
9.93	81.62
19.33	80.83
27.26	80.33
32.21	80.02
35.5	79.86
42.37	79.52
51.97	79.02
55.88	78.74
57.38	78.61
64.92	78.57
70	78.59
71.06	78.59
73.36	78.71
76.76	78.85
77.76	78.89
84.26	79.09
93.31	79.41
99.9	79.43
112.53	79.84
118.4	79.95
122.32	80.16
127.12	80.08
134.36	79.97
137.78	79.61
141.21	79.54
144.63	79.49
145.77	79.87
147.88	81.21
150.27	82.84
152.93	84.65
154.43	85.5
156	86.25

Survey-AECOM Surface	
Station	Elevation
0	82.99
1.3	82.76
2.3	82.64
3.3	82.46
4.3	82.35
5.2	82.21
6.1	82.08
9.3	81.68
10.3	81.58
11.3	81.53
12.3	81.39
13.3	81.32
15.3	81.11
16.3	81.06
17.3	80.96
19.3	80.83
20.4	80.74
21.3	80.65
22.3	80.62
23.3	80.51
24.5	80.46
25.5	80.44
27.3	80.25
28.3	80.18
29.3	80.14
30.3	80.16
31.3	80.04
32.2	80.02
34.2	79.91
35.3	79.9
37.7	79.75
40.5	79.64
41	79.68
41.5	79.91
41.8	80
43.2	79.66
43.8	79.54
44.6	79.39
48.8	79
49.5	78.95
55.5	78.79
55.88	78.771
56.5	78.74
57	78.66
57.6	78.52
57.8	78.51
58.7	78.43
60	78.39
60.8	78.45
62	78.5
63.1	78.6
63.8	78.64
64.2	78.62
68.6	78.61
69.1	78.64
70.8	78.77
73.36	78.84877
73.4	78.85
80.2	79.19
81	79.21
81.8	79.1
82.3	79.07
83.3	79.12
84.4	79.1
85.4	79.18
86.4	79.19
87.6	79.27
88.7	79.26
89.2	79.28
91.4	79.32
92.9	79.41
93.6	79.4
94.4	79.44
95.6	79.46
98	79.42
99	79.39
100.1	79.43
101.3	79.53
102.4	79.55
103.9	79.64
104.7	79.65
105.9	79.73
107.6	79.74
108.1	79.78
108.7	79.9
109.3	79.95
109.8	79.9
110.5	79.87
111.3	79.8
112	79.84
113.5	79.87
114.2	79.85
116.1	79.85
117.2	79.96
118.4	79.95
119.4	79.98
120.1	80.05
121.8	80.17
124.5	80.12
125.3	80.24
126.7	80.04
128.2	79.95
128.7	79.95
129.5	79.99
129.8	80
130.4	79.93
130.9	79.84
131.2	79.82
131.6	79.81
132.1	79.88
133.6	79.98
134.1	79.98
134.8	79.92
135.7	79.8
137.8	79.61
138.5	79.59
140.1	79.62
141.2	79.54
142.3	79.59
144.6	79.49
145.2	79.63
145.8	79.87
146.1	80.05
147.4	80.88
148	81.32
149.2	82.17
150.3	82.87
151.5	83.63
152.6	84.45
153.8	85.16
154	85.29
154.7	85.62
155.5	86
156	86.25

Survey-JD Surface	
Station	Elevation
0	83.06
10.3	81.73
12.3	81.49
13.3	81.49
21.3	80.75
27.3	80.29
28.3	80.24
36.3	79.94
39.5	79.81
49.5	79.28
54.3	79.07
54.7	79.04
55.4	78.95
55.88	78.86
56.5	78.74
57.8	78.70
59.8	78.70
60	78.67
60.6	78.70
69.7	78.70
70.7	78.75
73.36	78.96
73.4	78.96
75.3	79.08
78.6	79.08
80.2	79.06
81.3	79.09
82.3	79.45
85.1	80.53
86.4	81.02
96.7	83.60
121.2	89.60
126.4	90.88
126.7	90.91
127.5	91.15
127.7	91.16
128.2	91.14
128.7	91.22
129.5	91.26
129.7	91.26
129.8	91.28
156	92.51

Used in Final model Updates	
Station	Elevation
0	83.00
9.93	81.62
19.33	80.83
27.26	80.33
32.21	80.02
35.5	79.86
42.37	79.52
51.97	79.02
55.88	78.74
57.38	78.61
64.92	78.57
70	78.59
71.06	78.59
73.36	78.71
76.76	78.85
77.76	78.89
84.26	79.09
93.31	79.41
99.9	79.43
112.53	79.84
118.4	79.95
122.32	80.16
127.12	80.08
134.36	79.97
137.78	79.61
141.21	79.54
144.63	79.49
145.77	79.87
147.88	81.21
150.27	82.84
152.93	84.65
154.43	85.50
156	86.25



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	83.00	
9.93	81.62	
19.33	80.83	
27.26	80.33	
32.21	80.02	
35.5	79.86	
42.37	79.52	
51.97	79.02	
55.88	78.74	
57.38	78.61	
64.92	78.57	
70	78.59	
71.06	78.59	
73.36	78.71	
76.76	78.85	
77.76	78.89	
84.26	79.09	
93.31	79.41	
99.9	79.43	
112.53	79.84	
118.4	79.95	
122.32	80.16	
127.12	80.08	
134.36	79.97	
137.78	79.61	
141.21	79.54	
144.63	79.49	
145.77	79.87	
147.88	81.21	
150.27	82.84	
152.93	84.65	
154.43	85.50	
156	86.25	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	83.00	
9.93	81.62	
19.33	80.83	
27.26	80.33	
32.21	80.02	
35.5	79.86	
42.37	79.52	
51.97	79.02	
55.88	78.74	
57.38	78.61	
64.92	78.57	
70	78.59	
71.06	78.59	
73.36	78.71	
76.76	78.85	
77.76	78.89	
84.26	79.09	
93.31	79.41	
99.9	79.43	
112.53	79.84	
118.4	79.95	
122.32	80.16	
127.12	80.08	
134.36	79.97	
137.78	79.61	
141.21	79.54	
144.63	79.49	
145.77	79.87	
147.88	81.21	
150.27	82.84	
152.93	84.65	
154.43	85.50	
156	86.25	

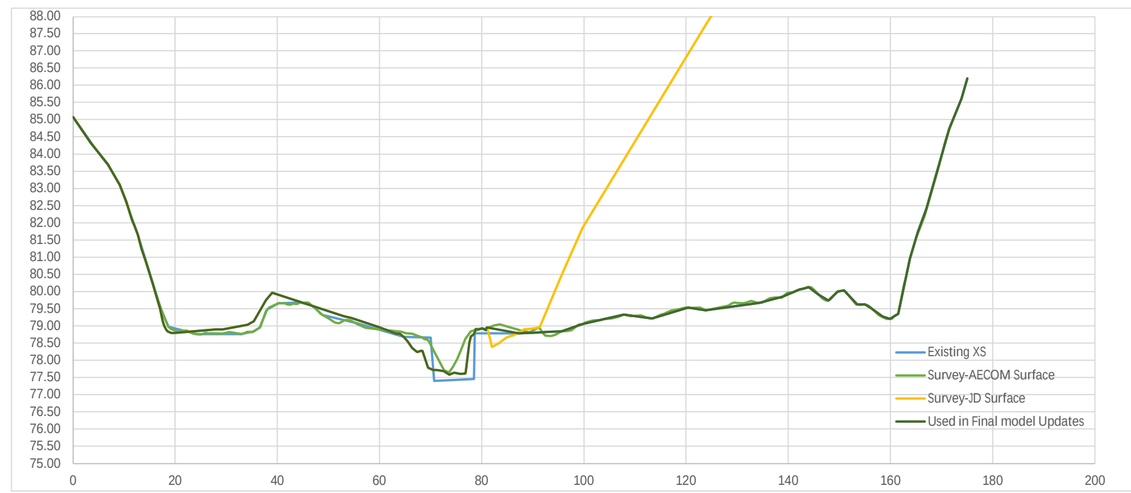
Existing XS	
Station	Elevation
0	85.07
4.05	84.22
6.94	83.66
9.17	83.10
12.69	81.64
17.06	79.56
18.71	78.98
24.29	78.76
32.86	78.76
35.41	78.84
36.52	78.95
38.02	79.48
40.19	79.66
44.52	79.68
46.69	79.60
48.86	79.32
55.55	79.08
64.7	78.68
69.99	78.66
70.66	77.41
78.51	77.46
78.62	78.79
87.27	78.79
90.88	78.81
93.38	78.83
95.63	78.84
99.82	79.06
107.82	79.33
113.35	79.22
120.39	79.54
123.82	79.46
134.35	79.67
138.92	79.85
142.1	80.06
144.03	80.13
145.96	79.91
147.82	79.74
149.64	80.00
150.88	80.03
153.53	79.62
155.01	79.63
156.26	79.51
158.47	79.27
159.94	79.20
161.53	79.35
163.81	80.96
165.34	81.72
167.03	82.41
171.54	84.74
173.92	85.61
175	86.20

Survey-AECOM Surface	
Station	Elevation
0	85.07
3.5	84.32
6.8	83.70
9.1	83.11
10.4	82.62
11.6	82.08
12	81.92
12.7	81.65
13.4	81.25
14.2	80.92
14.9	80.56
15.6	80.23
16.4	79.86
17.5	79.36
18.5	79.03
18.7	78.98
19.2	78.91
20.7	78.83
21.9	78.87
22.3	78.86
23.6	78.77
24.7	78.75
25	78.75
25.9	78.80
26.5	78.78
27.9	78.79
29.2	78.77
30.1	78.81
30.8	78.82
33	78.76
34.2	78.83
35.1	78.82
36.6	78.96
37.3	79.24
37.8	79.43
38.4	79.54
40.2	79.66
41.4	79.66
41.6	79.65
42	79.62
42.4	79.61
43.1	79.65
43.8	79.64
44.5	79.68
45.2	79.67
45.7	79.68
46.2	79.67
46.7	79.59
47.3	79.55
48.5	79.35
49.4	79.27
50.3	79.19
51.2	79.10
51.8	79.08
52.1	79.08
53.2	79.17
53.9	79.17
54.5	79.15
55.7	79.05
57.3	78.94
64.3	78.83
65.3	78.78
66.4	78.77
67.2	78.73
68.4	78.66
68.8	78.62
69.3	78.60
69.5	78.59
69.99	78.46
70.5	78.32
72.6	77.72
72.8	77.70
73.6	77.65
73.7	77.66
74.4	77.81
75.2	78.04
76	78.31
76.8	78.63
77.9	78.84
78.4	78.86
78.62	78.88
78.9	78.91
80.8	78.92
82.4	79.01
83.5	79.05
88.3	78.84
89.4	78.82
89.6	78.83
91.2	78.96
91.4	78.92
92	78.78
92.5	78.72
93.5	78.71
94.4	78.74
95.6	78.84
96.8	78.85
97.6	78.88
98.8	79.02
99.2	79.05
99.7	79.05
100.3	79.10
101.8	79.16
103.2	79.17
104	79.21
105.4	79.22
106.7	79.26
107.8	79.33
109.2	79.28
111.2	79.31
112.4	79.24
113.5	79.22
115.1	79.33
115.7	79.35
117	79.44
118.7	79.49
119.9	79.54
120.9	79.52
122.7	79.53
123.9	79.46
128.3	79.59
129	79.66
129.5	79.68
129.8	79.67
131.2	79.66
131.8	79.68
132.7	79.73
134.1	79.67
134.9	79.68
136.4	79.81
137.5	79.83
138.7	79.82
139.8	79.96
141	79.98
142.1	80.06
143	80.08
143.8	80.14
144.5	80.13
145.2	80.03
146.7	79.80
147.4	79.74
147.8	79.74
148.2	79.77
149.6	80.00
150.9	80.03
151.2	80.00
153.3	79.63
154.1	79.61
155	79.63
155.5	79.60
155.8	79.58
157.7	79.32
158.1	79.29
159.2	79.21
159.9	79.20
160.4	79.22
160.7	79.28
161.5	79.35
162.7	80.21
162.9	80.33
163.8	80.95
164.4	81.26
165	81.57
166.6	82.18
167.3	82.53
168.8	83.28
169.5	83.68
170.7	84.35
171	84.50
171.5	84.73
173.9	85.61
175	86.20

Survey-JD Surface	
Station	Elevation
0	85.07
3.5	84.32
6.8	83.70
9.1	83.11
10.4	82.62
11.6	82.08
12	81.92
12.7	81.65
13.4	81.25
14.2	80.92
14.9	80.56
15.6	80.23
16.3	79.87
17.1	79.49
17.5	79.16
17.8	79.01
18.2	78.90
18.5	78.84
19.2	78.80
19.9	78.80
27.9	78.90
29.3	78.90
34.2	79.03
35.4	79.14
37.8	79.75
39	79.97
53	79.28
54.6	79.23
60.1	78.96
63.3	78.77
64	78.77
64.8	78.67
65.6	78.54
66.4	78.35
67.2	78.26
67.4	78.24
68	78.27
68.4	78.27
69.5	77.80
69.6	77.78
69.99	77.75
70.5	77.72
71.2	77.72
72.6	77.68
73.7	77.59
74.4	77.63
74.7	77.64
75.8	77.61
76.8	77.62
76.8	77.63
76.9	77.67
77.6	78.50
77.9	78.69
78.4	78.75
78.62	78.82
78.9	78.91
79.2	78.89
80.1	78.93
80.8	78.88
81	78.95
81.6	78.64
82	78.39
83.5	78.51
84	78.57
84.8	78.66
85.6	78.71
86.2	78.73
88	78.88
88.3	78.90
90.4	78.93
91.2	78.96
91.4	78.98
95.6	80.46
99.7	81.85
124	87.80
125	88.03
125.4	88.10
126.1	88.30
126.8	88.38
127.2	88.48
128.3	88.56
128.4	88.58
175	90.82

Used in Final model Updates	
Station	Elevation
0	85.07
3.5	84.32
6.8	83.70
9.1	83.11
10.4	82.62
11.6	82.08
12	81.92
12.7	81.65
13.4	81.25
14.2	80.92
14.9	80.56
15.6	80.23
16.3	79.87
17.1	79.49
17.5	79.16
17.8	79.01
18.2	78.90
18.5	78.84
19.2	78.80
19.9	78.80
27.9	78.90
29.3	78.90
34.2	79.03
35.4	79.14
37.8	79.75
39	79.97
53	79.28
54.6	79.23
60.1	78.96
63.3	78.77
64	78.77
64.8	78.67
65.6	78.54
66.4	78.35
67.2	78.26
67.4	78.24
68	78.27
68.4	78.27
69.5	77.80
69.6	77.78
69.99	77.75
70.5	77.72
71.2	77.72
72.6	77.68
73.7	77.59
74.4	77.63
74.7	77.64
75.8	77.61
76.8	77.62
76.8	77.63
76.9	77.67
77.6	78.50
77.9	78.69
78.4	78.75
78.62	78.82
78.9	78.91
79.2	78.89
80.1	78.93
80.8	78.88
81	78.95
87.27	78.79
90.88	78.81
93.38	78.83
95.63	78.84
99.82	79.06
107.82	79.33
113.35	79.22
120.39	79.54
123.82	79.46
134.35	79.67
138.92	79.85
142.1	80.06
144.03	80.13
145.96	79.91
147.82	79.74
149.64	80.00
150.88	80.03
153.53	79.62
155.01	79.63
156.26	79.51
158.47	79.27
159.94	79.20
161.53	79.35
163.81	80.96
165.34	81.72
167.03	82.41
171.54	84.74
173.92	85.61
175	86.20

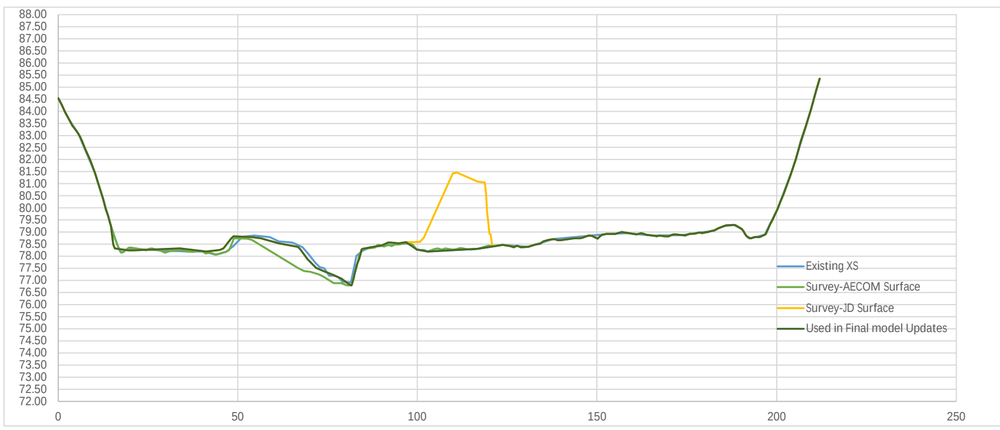
Changed to remove the stich effect



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	85.07	
4.05	84.22	
6.94	83.66	
9.17	83.10	
12.69	81.64	
17.06	79.56	
18.71	78.98	
24.29	78.76	
32.86	78.76	
35.41	78.84	
36.52	78.95	
38.02	79.48	
40.19	79.66	
44.52	79.68	
46.69	79.60	
48.86	79.32	
55.55	79.08	
64.7	78.68	
69.99	78.66	
70.66	77.41	
78.51	77.46	
78.62	78.79	
87.27	78.79	
90.88	78.81	
93.38	78.83	
95.63	78.84	
99.82	79.06	
107.82	79.33	
113.35	79.22	
120.39	79.54	
123.82	79.46	
134.35	79.67	
138.92	79.85	
142.1	80.06	
144.03	80.13	
145.96	79.91	
147.82	79.74	
149.64	80.00	
150.88	80.03	
153.53	79.62	
155.01	79.63	
156.26	79.51	
158.47	79.27	
159.94	79.20	
161.53	79.35	
163.81	80.96	
165.34	81.72	
167.03	82.41	
171.54	84.74	
173.92	85.61	
175	86.20	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	85.07	
3.5	84.32	
6.8	83.70	
9.1	83.11	
10.4	82.62	
11.6	82.08	
12	81.92	
12.7	81.65	
13.4	81.25	
14.2	80.92	
14.9	80.56	
15.6	80.23	
16.3	79.87	
17.1	79.49	
17.5	79.16	
17.8	79.01	
18.2	78.90	
18.5	78.84	
19.2	78.80	
19.9	78.80	
27.9	78.90	
29.3	78.90	
34.2	79.03	
35.4	79.14	
37.8	79.75	
39	79.97	
53	79.28	
54.6	79.23	
60.1	78.96	
63.3	78.77	
64	78.77	
64.8	78.67	
65.6	78.54	
66.4	78.35	
67.2	78.26	
67.4	78.24	
68	78.27	
68.4	78.27	
69.5	77.80	
69.6	77.78	
69.99	77.75	
70.5	77.72	
71.2	77.72	
72.6	77.68	
73.7	77.59	
74.4	77.63	
74.7	77.64	
75.8	77.61	
76.8	77.62	
76.8	77.63	
76.9	77.67	
77.6	78.50	
77.9	78.69	
78.4	78.75	
78.62	78.82	
78.9	78.91	
79.2	78.89	
80.1	78.93	
80.8	78.88	
81	78.95	
87.27	78.79	
90.88	78.81	
93.38	78.83	
95.63	78.84	
99.82	79.06	
107.82	79.33	
113.35	79.22	
120.39	79.54	
123.82	79.46	
134.35	79.67	
138.92	79.85	
142.1	80.06	
144.03	80.13	
145.96	79.91	
147.82	79.74	
149.64	80.00	
150.88	80.03	
153.53	79.62	
155.01	79.63	
156.26	79.51	
158.47	79.27	
159.94	79.20	
161.53	79.35	
163.81	80.96	
165.34	81.72	
167.03	82.41	
171.54	84.74	
173.92	85.61	
175	86.20	

Existing XS		Survey-AECOM Surface		Survey-JD Surface		Used in Final model Updates	
Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation
0	84.54	0	84.54	0	84.54	0	84.54
3.14	83.66	0.6	84.40	0.6	84.40	0.6	84.40
5.67	83.05	1.1	84.24	1.1	84.24	1.1	84.24
10.38	81.41	1.9	83.97	1.9	83.97	1.9	83.97
12.52	80.37	3.1	83.66	3.1	83.66	3.1	83.66
14.8	79.22	4	83.42	4	83.42	4	83.42
16.43	78.49	5	83.20	5	83.20	5	83.20
17.51	78.15	5.7	83.06	5.7	83.06	5.7	83.06
19.62	78.33	6.1	82.94	6.1	82.94	6.1	82.94
28.2	78.24	6.7	82.76	6.7	82.76	6.7	82.76
35.96	78.20	7.5	82.45	7.5	82.45	7.5	82.45
40.31	78.19	9	81.97	9	81.97	9	81.97
43.87	78.07	10.4	81.41	10.4	81.41	10.4	81.41
46.72	78.18	11.1	81.04	11.1	81.04	11.1	81.04
48.98	78.43	12.5	80.37	12.5	80.37	12.5	80.37
51.31	78.81	13.3	79.94	13.3	79.94	13.3	79.94
54.56	78.86	13.9	79.66	13.9	79.66	13.9	79.66
58.91	78.79	14.8	79.22	14.5	79.35	14.5	79.35
61.45	78.61	15.8	78.75	14.7	79.26	14.7	79.26
65.25	78.57	16.1	78.63	15.4	78.49	15.4	78.49
68.1	78.38	17.1	78.24	15.8	78.32	15.8	78.32
69.52	78.11	17.5	78.16	19.6	78.25	19.6	78.25
71.59	77.73	18.1	78.16	20.9	78.25	20.9	78.25
72.86	77.55	19.7	78.35	33.9	78.32	33.9	78.32
74.12	77.50	20.4	78.35	41.2	78.20	41.2	78.20
75.39	77.19	21.8	78.33	45	78.26	45	78.26
76.72	77.20	22.9	78.29	46	78.32	46	78.32
77.93	77.14	23.4	78.28	46.2	78.35	46.2	78.35
79.19	76.94	24.6	78.25	48.1	78.71	48.1	78.71
79.9	76.93	25.3	78.30	48.8	78.82	48.8	78.82
81.52	76.92	26.1	78.33	48.9	78.82	48.9	78.82
81.83	77.15	28.5	78.23	53.9	78.80	53.9	78.80
82.35	77.53	29.8	78.15	56.4	78.74	56.4	78.74
83	78.01	31.1	78.21	61.4	78.53	61.4	78.53
84.78	78.23	32.7	78.22	66.7	78.39	66.7	78.39
86.8	78.37	33.6	78.25	67.4	78.29	67.4	78.29
93.79	78.49	34.8	78.26	69.5	77.87	69.5	77.87
96.06	78.51	36	78.19	71.8	77.51	71.8	77.51
97.8	78.53	36.7	78.20	74.12	77.37	74.12	77.37
99.83	78.28	37.6	78.18	76.6	77.23	76.6	77.23
102.88	78.20	38.6	78.22	78.3	77.12	78.3	77.12
116.77	78.31	39.6	78.23	78.8	77.08	78.8	77.08
123.77	78.47	40.3	78.19	80.9	76.85	80.9	76.85
130.77	78.39	41	78.12	81.6	76.79	81.6	76.79
137.94	78.71	42.4	78.14	81.7	76.80	81.7	76.80
152.98	78.92	43.9	78.07	82.35	77.14	82.35	77.14
158.61	78.95	45.3	78.11	82.4	77.17	82.4	77.17
165.16	78.85	45.7	78.15	83.1	77.65	83.1	77.65
173.57	78.87	46.7	78.18	83.8	77.88	83.8	77.88
179.72	79.00	47.5	78.25	84.3	78.18	84.3	78.18
182.2	79.05	48.1	78.41	84.5	78.27	84.5	78.27
185.22	79.24	48.8	78.70	84.8	78.31	84.8	78.31
188.09	79.30	48.9	78.73	90.2	78.46	90.2	78.46
190.24	79.13	49	78.74	91.8	78.56	91.8	78.56
191.67	78.83	52.6	78.72	92.7	78.57	92.7	78.57
192.85	78.74	53.9	78.68	94.8	78.54	94.8	78.54
196.69	78.89	66.7	77.52	96.8	78.59	96.8	78.59
200.27	79.96	68.1	77.42	98.8	78.59	99.83	78.28
204.37	81.59	68.5	77.39	100.8	78.60	102.88	78.20
208.26	83.43	70.2	77.35	100.8	78.61	116.77	78.31
212	85.36	72.4	77.26	101.8	78.78	123.77	78.47
		73.4	77.19	109.8	81.40	123.8	78.47
		74.12	77.12	110	81.44	125.8	78.42
		76.7	76.89	110.5	81.44	126.8	78.38
		77.4	76.88	110.8	81.48	127.8	78.43
		78.8	76.89	116.8	81.09	128.8	78.37
		80.2	76.81	118.8	81.05	130.8	78.39
		80.9	76.80	119.1	80.60	132.9	78.49
		81.5	76.81	119.4	79.83	134.2	78.51
		81.7	76.84	120.1	78.92	135.1	78.61
		82.35	77.20	120.4	78.91	135.8	78.65
		82.4	77.23	120.8	78.42	136.6	78.68
		83.1	77.57	123.8	78.47	138.1	78.71
		83.8	78.03	125.8	78.42	139.1	78.67
		84.3	78.21	126.8	78.38	139.8	78.67
		84.8	78.27	127.8	78.43	143.7	78.74
		85.2	78.30	128.8	78.37	145.2	78.74
		88.1	78.36	130.8	78.39	145.8	78.76
		88.8	78.45	132.9	78.49	147.7	78.85
		89.3	78.47	134.2	78.51	148.7	78.84
		90.6	78.41	135.1	78.61	150.2	78.72
		90.9	78.41	135.8	78.65	150.8	78.82
		91.8	78.49	136.6	78.68	151.5	78.89
		92.8	78.42	138.1	78.71	152.6	78.92
		93.8	78.49	139.1	78.67	155.1	78.92
		94.8	78.49	139.8	78.67	156.9	79.01
		96.8	78.54	143.7	78.74	160.9	78.90
		97.8	78.53	145.2	78.74	161.6	78.92
		98.8	78.47	145.8	78.76	162.3	78.95
		99.8	78.28	147.7	78.85	163.7	78.89
		100.8	78.26	148.7	78.84	166.2	78.84
		101.8	78.26	150.2	78.72	166.6	78.83
		102.8	78.19	150.8	78.82	167.3	78.86
		104.6	78.29	151.5	78.89	168.9	78.82
		105.6	78.32	152.6	78.92	169.9	78.83
		106.8	78.27	155.1	78.92	170.9	78.89
		107.8	78.32	156.9	79.01	171.6	78.91
		109.8	78.28	160.9	78.90	173.8	78.88
		110.8	78.29	161.6	78.92	174.5	78.85
		111.8	78.34	162.3	78.95	175.7	78.92
		112.8	78.33	163.7	78.89	177.3	78.94
		113.8	78.29	166.2	78.84	178.1	78.97
		114.8	78.28	166.6	78.83	178.8	78.98
		116.8	78.31	167.3	78.86	179.2	78.96
		119.8	78.44	168.9	78.82	180.2	78.99
		120.8	78.42	169.9	78.83	180.9	79.00
		123.8	78.47	170.9	78.89	181.6	79.04
		125.8	78.42	171.6	78.91	182.6	79.06
		126.8	78.38	173.8	78.88	183.8	79.16
		127.8	78.37	174.5	78.85	185.9	79.28
		128.8	78.37	175.7	78.92	187.4	79.30
		130.8	78.39	177.3	78.94	188.4	79.29
		132.9	78.49	178.1	78.97	190.2	79.13
		134.2	78.51	178.8	78.98	190.8	79.04
		135.1	78.61	179.2	78.96	191.1	78.94
		135.8	78.65	180.2	78.99	191.7	78.82
		136.6	78.68	180.9	79.00	192.1	78.77
		138.1	78.71	181.6	79.04	192.4	78.75
		139.1	78.67	182.6	79.06	192.9	78.74
		139.8	78.67	183.8	79.16	193.8	78.80
		143.7	78.74	185.9	79.28	195.3	78.80
		145.2	78.74	187.4	79.30	196.7	78.89
		145.8	78.76	188.4	79.29	197	78.92
		147.7	78.85	190.2	79.13	197.4	79.07
		148.7	78.84	190.8	79.04	198.2	79.33
		150.2	78.72	191.1	78.94	198.8	79.51
		150.8	78.82	191.7	78.82	200.3	79.96
		151.5	78.89	192.1	78.77	201	80.25
		152.6	78.92	192.4	78.75	201.9	80.55
		155.1	78.92	192.9	78.74	203.1	81.03
		156.9	79.01	193.8	78.80	203.8	81.34
		160.9	78.90	195.3	78.80	205.3	82.02
		161.6	78.92	196.7	78.89	206.8	82.79
		162.3	78.95	197	78.92	208.1	83.37
		163.7	78.89	197.4	79.07	209.6	84.09
		166.2	78.84	198.2	79.33	211	84.87
		166.6	78.83	198.8	79.51	211.7	85.19
		167.3	78.86	200.3	79.96	212	85.36
		168.9	78.82	201	80.25		
		169.9	78.83	201.9	80.55		
		170.9	78.89	203.1	81.03		
		171.6	78.91	203.8	81.34		
		173.8	78.88	205.3	82.02		
		174.5	78.85	206.8	82.79		
		175.7	78.92	208.1	83.37		
		177.3	78.94	209.6	84.09		
		178.1	78.97	211	84.87		
		178.8	78.98	211.7	85.19		
		179.2	78.96	212	85.36		
		180.2	78.99				
		180.9	79.00				
		181.6	79.04				
		182.6	79.06				
		183.8	79.16				
		185.9	79.28				
		187.4	79.30				
		188.4	79.29				
		190.2	79.13				
		190.8	79.04				
		191.1	78.94				
		191.7	78.82				
		192.1	78.77				
		192.4	78.75				
		192.9	78.74				
		193.8	78.80				
		195.3	78.80				
		196.7	78.89				
		197	78.92				
		197.4	79.07				
		198.2	79.33				
		198.8	79.51				
		200.3	79.96				
		201	80.25				
		201.9	80.55				
		203.1	81.03				
		203.8	81.34				
		205.3	82.02				
		206.8	82.79				
		208.1	83.37				
		209.6	84.09				
		211	84.87				
		211.7	85.19				
		212	85.36				



Changed to remove the stich effect

Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	84.54	
3.14	83.66	
5.67	83.05	
10.38	81.41	
12.52	80.37	
14.8	79.22	
16.43	78.49	
17.51	78.15	
19.62	78.33	
28.2	78.24	
35.96	78.20	
40.31	78.19	
43.87	78.07	
46.72	78.18	
48.98	78.43	
51.31	78.81	
54.56	78.86	
58.91	78.79	
61.45	78.61	
65.25	78.57	
68.1	78.38	
69.52	78.11	
71.59	77.73	
72.86	77.55	
74.12	77.50	
75.39	77.19	
76.72	77.20	
77.93	77.14	
79.19	76.94	
79.9	76.93	
81.52	76.92	
81.83	77.15	
82.35	77.53	
83	78.01	
84.78	78.23	
86.8	78.37	
93.79	78.49	
96.06	78.51	
97.8	78.53	
99.83	78.28	
102.88	78.20	
116.77	78.31	
123.77	78.47	
130.77	78.39	
137.94	78.71	
152.98	78.92	
158.61	78.95	
165.16	78.85	
173.57	78.87	
179.72	79.00	
182.2	79.05	
185.22	79.24	
188.09	79.30	
190.24	79.13	
191.67	78.83	
192.85	78.74	
196.69	78.89	
200.27	79.96	
204.37	81.59	
208.26	83.43	
212	85.36	

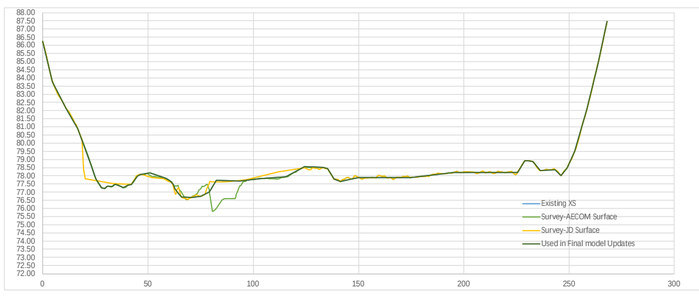
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	84.54	
0.6	84.4	
1.1	84.24	
1.9	83.97	
3.1	83.66	
4	83.42	
5	83.2	
5.7	83.06	
6.1	82.94	
6.7	82.76	
7.5	82.45	
9	81.97	
10.4	81.41	
11.1	81.04	
12.5	80.37	
13.3	79.94	
13.9	79.66	
14.5	79.35	
14.7	79.26	
15.4	78.49	
15.8	78.32	
19.6	78.25	
20.9	78.25	
33.9	78.32	
41.2	78.2	
45	78.26	
46	78.32	
46.2	78.35	
48.1	78.71	
48.8	78.82	
48.9	78.82	
53.9	78.8	
56.4	78.74	
61.4	78.53	
66.7	78.39	
67.4	78.29	
69.5	77.87	
71.8	77.51	
74.12	77.37467	
76.6	77.23	
78.3	77.12	
78.8	77.08	
80.9	76.85	
81.6	76.79	
81.7	76.8	
82.35	77.14357	
82.4	77.17	
83.1	77.65	
83.8	77.88	
84.3	78.18	
84.5	78.27	
84.8	78.31	
90.2	78.46	
91.8	78.56	
92.7	78.57	
94.8	78.54	
96.8	78.59	
99.83	78.28	
102.88	78.2	
116.77	78.31	
123.77	78.47	
123.8	78.47	
125.8	78.42	
126.8	78.38	
127.8	78.43	
128.8	78.37	
130.8	78.39	
132.9	78.49	
134.2	78.51	
135.1	78.61	
135.8	78.65	
136.6	78.68	
138.1	78.71	
139.1	78.67	
139.8	78.67	
143.7	78.74	
145.2	78.74	
145.8	78.76	
147.7	78.85	
148.7	78.84	
150.2	78.72	
150.8	78.82	
151.5	78.89	
152.6	78.92	
155.1	78.92	
156.9	79.01	
160.9	78.9	
161.6	78.92	
162.3	78.95	
163.7	78.89	
166.2	78.84	
166.6	78.83	
167.3	78.86	
168.9	78.82	
169.9	78.83	
170.9	78.89	
171.6	78.91	
173.8	78.88	
174.5	78.85	
175.7	78.92	
177.3	78.94	
178.1	78.97	
178.8	78.98	
179.2	78.96	
180.2	78.99	
180.9	79	
181.6	79.04	
182.6	79.06	
183.8	79.16	
185.9	79.28	
187.4	79.3	
188.4	79.29	
190.2	79.13	
190.8	79.04	
191.1	78.94	
191.7	78.82	
192.1	78.77	
192.4	78.75	
192.9	78.74	
193.8	78.8	
195.3	78.8	
196.7	78.89	
197	78.92	
197.4	79.07	
198.2	79.33	
198.8	79.51	
200.3	79.96	
201	80.25	
205.3	82.02	
206.8	82.79	
208.1	83.37	

Existing XS	
Station	Elevation
0	86.25
4.65	83.75
11.09	82.12
16.57	80.89
22.97	78.66
25.24	77.82
27.95	77.26
29.37	77.22
30.79	77.36
32.92	77.33
34.47	77.49
37.19	77.35
38.11	77.27
40.68	77.44
41.97	77.45
45.01	77.98
46.43	78.08
50.98	78.18
54.25	78.03
58.52	77.85
60.37	77.71
62.08	77.45
62.79	77.20
64.5	76.92
65.98	76.70
67.14	76.70
70.7	76.69
74.96	76.74
79.13	77.00
82.52	77.73
93.64	77.68
102.55	77.82
115.41	77.95
124.25	78.55
129.26	78.53
133.22	78.52
135.2	78.43
138.41	77.79
141.28	77.64
146.28	77.80
150.04	77.90
174.64	77.89
195.07	78.20
225.45	78.19
228.78	78.92
230.46	78.93
232.75	78.86
236.18	78.33
243.34	78.36
246.12	78.02
249.07	78.50
252.64	79.50
258.37	82.06
263.46	84.79
268	87.47

Survey-AECOM Surface	
Station	Elevation
0	86.25
1.1	85.72
1.6	85.42
2.7	84.76
4.3	83.92
4.5	83.81
4.7	83.75
5.2	83.59
6.6	83.15
7.2	82.99
8.7	82.70
9.5	82.51
10.2	82.36
11.1	82.13
12.4	81.94
14.4	81.46
15.1	81.25
15.9	81.11
16.2	81.01
17	80.74
18	80.44
18.6	80.21
19.4	79.96
20.1	79.68
21.4	79.25
22.7	78.76
23.3	78.55
24.4	78.09
24.9	77.91
25.8	77.68
27.8	77.28
28.1	77.24
29.4	77.22
29.7	77.24
30.1	77.32
30.4	77.35
31.3	77.37
32.2	77.32
32.9	77.33
33.6	77.44
34.2	77.49
35.5	77.46
38.1	77.28
38.6	77.26
39.4	77.30
40.7	77.45
42	77.45
42.4	77.50
43.3	77.64
44	77.83
44.5	77.94
45.8	78.06
47.1	78.09
48.6	78.08
49.3	78.14
49.7	78.15
50.7	78.04
51	78.04
52.1	77.94
53.5	77.96
54.3	77.92
55.1	77.94
55.7	77.89
56.4	77.86
56.7	77.88
57.8	77.81
58.7	77.79
59.9	77.70
61.3	77.63
61.4	77.61
61.5	77.55
62.1	77.39
62.6	77.37
63.1	77.39
63.5	77.36
64.2	77.41
64.5	77.30
64.9	77.15
65.6	77.06
66.2	76.93
67.1	76.74
67.8	76.58
68.5	76.53
69.2	76.57
69.4	76.63
70.3	76.68
70.6	76.67
71	76.73
72	76.79
73.5	76.94
74.1	77.12
74.9	77.18
75.8	77.36
76.3	77.35
77	77.38
77.4	77.44
78	77.48
78.4	77.42
79	77.12
79.13	77.02
79.3	76.88
80.6	75.83
81.3	75.85
82.5	75.99
84.3	76.36
85.3	76.53
86.3	76.59
91.3	76.61
91.7	76.72
91.9	76.86
92.7	77.08
92.9	77.22
93.3	77.32
93.6	77.38
93.9	77.38
94.3	77.44
94.6	77.55
94.9	77.55
95.3	77.66
96.3	77.66
97.3	77.76
98.3	77.76
99.3	77.81
100.3	77.77
103.5	77.85
104.3	77.85
105.3	77.81
106.3	77.86
107.3	77.83
109.5	77.83
111.3	77.80
112.3	77.83
113.3	77.89
114.1	77.90
115.3	77.95
116.3	77.93
119.2	78.20
120.3	78.22
121.2	78.35
123.2	78.47
124.3	78.55
125.3	78.51
126.3	78.52
127.3	78.48
128.3	78.52
129.3	78.46
130.2	78.46
131.3	78.40
132.2	78.47
133.3	78.52
134.2	78.45
135.3	78.43
136.2	78.22
137.3	78.02
138.3	77.80
140.3	77.78
141.3	77.63
141.4	77.64
142.1	77.74
143.3	77.79
144.3	77.89
145.3	77.89
146.3	77.80
147.3	77.84
148.3	78.01
150.3	77.89
151.3	77.80
153.3	77.87
154.6	77.86
156.6	77.88
158.3	77.87
159.3	78.03
160.3	78.02
161.3	77.97
162.3	77.98
163.3	77.89
163.7	77.87
164.3	77.86
165.3	77.88
166.3	77.78
168.3	77.91
170.3	77.90
171.3	77.96
172.3	77.94
173.3	77.98
174.2	77.90
174.6	77.89
175.4	77.92
177.5	77.92
178	77.91
178.9	77.96
181.7	77.97
182.5	77.99
183.2	77.96
184.2	78.04
184.7	78.05
185.4	78.10
186.1	78.09
186.7	78.10
187.5	78.16
189.7	78.13
191.6	78.13
192.9	78.17
194.1	78.16
196.6	78.27
197.1	78.25
197.8	78.20
198.8	78.19
200.5	78.26
201.1	78.26
201.8	78.23
202.5	78.24
203.3	78.22
204	78.23
204.7	78.22
205.6	78.16
206.5	78.14
209	78.29
210.2	78.18
211.4	78.23
212.6	78.24
214.1	78.14
215.2	78.18
216.1	78.28
218.3	78.23
219.2	78.20
220.1	78.19
220.4	78.20
221.2	78.26
221.9	78.25
222.6	78.27
224.3	78.08
224.7	78.08
225.1	78.12
225.4	78.19
226.2	78.39
226.9	78.50
227.7	78.70
228.8	78.92
229	78.93
229.7	78.91
230.5	78.93
231.3	78.92
232.7	78.86
233.7	78.74
234.8	78.50
235.5	78.40
236.1	78.33
236.2	78.33
237.8	78.31
239	78.40
239.8	78.37
241.2	78.38
241.9	78.36
242.4	78.42
242.6	78.42
242.9	78.41
243.3	78.36
243.6	78.35
244.6	78.25
245.5	78.08
246.1	78.02
246.9	78.14
247.6	78.30
248.6	78.41
249.1	78.50
249.8	78.74
251.1	79.01
252.6	79.50
253.1	79.67
254.8	80.37
256	80.98
256.5	81.23
257.3	81.60
258.5	82.12
260.5	83.16
261.2	83.61
261.9	83.98
262.7	84.38
263.4	84.75
264.1	85.08
264.7	85.40
265.5	85.95
267.2	87.01
267.7	87.30
268	87.47

Survey-JD Surface	
Station	Elevation
0	86.25
1.1	85.72
1.6	85.42
2.7	84.76
4.3	83.92
4.5	83.81
4.7	83.75
5.2	83.59
6.6	83.15
7.2	82.99
8.7	82.70
9.5	82.51
10.2	82.36
11.1	82.13
12.4	81.94
14.4	81.46
15.1	81.25
15.9	81.11
16.2	81.01
17	80.74
18	80.44
18.6	80.21
18.7	80.08
19.4	78.37
19.8	78.10
20.1	77.81
33	77.52
39.2	77.48
42	77.48
42.9	77.64
44	77.90
44.5	78.01
45	78.02
45.8	78.07
47.1	78.08
51.9	77.89
57.4	77.81
57.8	77.79
59.9	77.65
61.3	77.58
61.5	77.54
62.1	77.31
62.8	76.93
63.1	76.86
63.5	76.98
63.8	77.16
64.2	77.25
64.5	77.26
64.7	77.26
64.9	77.09
65.6	76.76
66.2	76.66
66.4	76.64
67.1	76.62
67.8	76.62
68.5	76.57
69	76.57
69.4	76.63
70.3	76.65
70.6	76.66
71	76.71
72	76.74
72.7	76.84
74.2	76.76
75.6	76.74
75.8	76.78
76.7	76.83
77	76.87
77.4	77.04
78	77.24
78.4	77.34
79	77.54
79.13	77.59
79.3	77.65
80.6	77.63
86.3	77.63
89.3	77.65
97.3	77.78
98.6	77.81
108.3	78.14
112.3	78.26
124.3	78.49
126.3	78.37
127.3	78.38
128.3	78.52
129.3	78.46
130.2	78.46
131.3	78.47
132.2	78.45
133.3	78.43
134.2	78.45
135.3	78.43
136.2	78.22
137.3	78.02
138.3	77.80
140.3	77.78
141.3	77.63
141.4	77.64
142.1	77.74
143.3	77.79
144.3	77.89
145.3	77.89
146.3	77.80
147.3	77.84
148.3	78.01
150.3	77.89
151.3	77.80
153.3	77.87
154.6	77.86
156.6	77.88
158.3	77.87
159.3	78.03
160.3	78.02
161.3	77.97
162.3	77.98
163.3	77.89
163.7	77.87
164.3	77.86
165.3	77.88
166.3	77.78
168.3	77.91
170.3	77.90
171.3	77.96
172.3	77.94
173.3	77.98
174.2	77.90
174.6	77.89
175.4	77.92
177.5	77.92
178	77.91
178.9	77.96
181.7	77.97
182.5	77.99
183.2	77.96
184.2	78.04
184.7	78.05
185.4	78.10
186.1	78.09
186.7	78.10
187.5	78.16
189.7	78.13
191.6	78.13
192.9	78.17
194.1	78.16
196.6	78.27
197.1	78.25
197.8	78.20
198.8	78.19
200.5	78.26
201.1	78.26
201.8	78.23
202.5	78.24
203.3	78.22
204	78.23
204.7	78.22
205.6	78.16
206.5	78.14
209	78.29
210.2	78.18
211.4	78.23
212.6	78.24
214.1	78.14
215.2	78.18
216.1	78.28
218.3	78.23
219.2	78.20
220.1	78.19
220.4	78.20
221.2	78.26
221.9	78.25
222.6	78.27
224.3	78.08
224.7	78.08
225.1	78.12
225.4	78.19
226.2	78.39
226.9	78.50
227.7	78.70
228.8	78.92
229	78.93
229.7	78.91
230.5	78.93
231.3	78.92
232.7	78.86
233.7	78.74
234.8	78.50
235.5	78.40
236.1	78.33
236.2	78.33
237.8	78.31
239	78.40
239.8	78.37
241.2	78.38
241.9	78.36
242.4	78.42
242.6	78.42
242.9	78.41
243.3	78.36
243.6	78.35
244.6	78.25
245.5	78.08
246.1	78.02
246.9	78.14
247.6	78.30
248.6	78.41
249.1	78.50
249.8	78.74
251.1	79.01
252.6	79.50
253.1	79.67
254.8	80.37
256	80.98
256.5	81.23
257.3	81.60
258.5	82.12
260.5	83.16
261.2	83.61
261.9	83.98
262.7	84.38
263.4	84.75
264.1	85.08
264.7	85.40
265.5	85.95
267.2	87.01
267.7	87.30
268	87.47

Used in Final model Updates	
Station	Elevation
0	86.25
4.65	83.75
11.09	82.12
16.57	80.89
22.97	78.66
25.24	77.82
27.95	77.26
29.37	77.22
30.79	77.36
32.92	77.33
34.47	77.49
37.19	77.35
38.11	77.27
40.68	77.44
41.97	77.45
45.01	77.98
46.43	78.08
50.98	78.18
54.25	78.03
58.52	77.85
60.37	77.71
62.08	77.45
62.79	77.20
64.5	76.92
65.98	76.70
67.14	76.70
70.7	76.69
74.96	76.74
79.13	77.00
82.52	77.73
93.64	77.68
102.55	77.82
115.41	77.95
124.25	78.55
129.26	78.53
133.22	78.52
135.2	78.43
138.41	77.79
141.28	77.64
146.28	77.80
150.04	77.90
174.64	77.89
195.07	78.20
225.45	78.19
228.78	78.92
230.46	78.93
232.75	78.86
236.18	78.33
243.34	78.36
246.12	78.02
249.07	78.50
252.64	79.50
258.37	82.06
263.46	84.79
268	87.47



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	86.25	
4.65	83.75	
11.09	82.12	
16.57	80.89	
22.97	78.66	
25.24	77.82	
27.95	77.26	
29.37	77.22	
30.79	77.36	
32.92	77.33	
34.47	77.49	
37.19	77.35	
38.11	77.27	
40.68	77.44	
41.97	77.45	
45.01	77.98	
46.43	78.08	
50.98	78.18	
54.25	78.03	
58.52	77.85	
60.37	77.71	
62.08	77.45	
62.79	77.20	
64.5	76.92	
65.98	76.70	
67.14	76.70	
70.7	76.69	
74.96	76.74	
79.13	77.00	
82.52	77.73	
93.64	77.68	
102.55	77.82	
115.41	77.95	
124.25	78.55	
129.26	78.53	
133.22	78.52	
135.2	78.43	
138.41	77.79	
141.28	77.64	
146.28	77.80	
150.04	77.90	
174.64	77.89	
195.07	78.20	
225.45	78.19	
228.78	78.92	
230.46	78.93	
232.75	78.86	
236.18	78.33	
243.34	78.36	
246.12	78.02	
249.07	78.50	
252.64	79.50	
258.37	82.06	
263.46	84.79	
268	87.47	

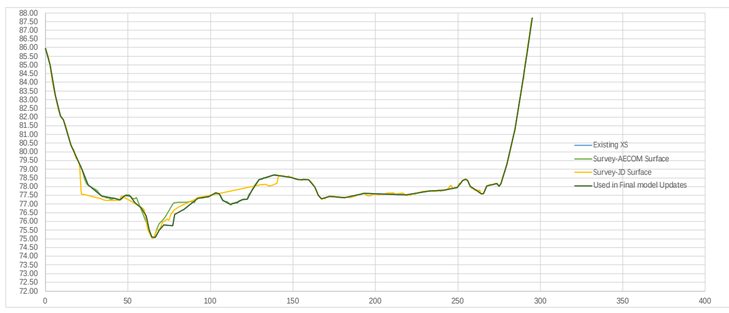
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.025	0.08
Station	Elevation	n Value
0	86.25	
4.65	83.75	
11.09	82.12	
16.57	80.89	
22.97	78.66	
25.24	77.82	
27.95	77.26	
29.37	77.22	
30.79	77.36	
32.92	77.33	
34.47	77.49	
37.19	77.35	
38.11	77.27	
40.68	77.44	
41.97	77.45	
45.01	77.98	
46.43	78.08	
50.98	78.18	
54.25	78.03	
58.52	77.85	
60.37	77.71	
62.08	77.45	
62.79	77.2	
64.5	76.917	
65.98	76.7	
67.14	76.7	
70.7	76.69	
74.96	76.74	
79.13	77	
82.52	77.73	
93.64	77.68	
102.55	77.82	
115.41	77.95	
124.25	78.55	
129.26	78.53	
133.22	78.52	
135.2	78.43	
138.41	77.79	
141.28	77.64	
146.28	77.8	
150.04	77.9	
174.64	77.89	
195.07	78.2	
225.45	78.19	
228.78	78.92	
230.46	78.93	
232.75	78.86	
236.18	78.33	
243.34	78.36	
246.12	78.02	
249.07	78.5	
252.64	79.5	
258.37	82.06	
263.46	84.79	
268	87.47	

Existing XS	
Station	Elevation
0	85.95
2.69	84.98
5.87	83.28
9.05	82.08
10.78	81.83
15.41	80.39
22.09	78.96
25.65	78.11
33.94	77.46
42.71	77.31
44.84	77.23
48.1	77.49
49.6	77.48
51.24	77.46
54.22	77.08
58	76.78
60.93	76.31
62.92	75.48
64.21	75.11
66.15	75.09
66.79	75.11
68.78	75.48
71.69	75.80
77.03	75.75
78.27	76.41
83.88	76.70
92.16	77.33
99.09	77.43
103.05	77.64
105.35	77.60
107.35	77.22
111.97	76.98
115.77	77.07
119.35	77.25
122.35	77.28
124.84	77.75
129.35	78.39
138.35	78.68
148.61	78.53
152.39	78.42
153.56	78.39
156.03	78.39
159.35	78.40
163.24	77.97
165.26	77.50
167.28	77.30
172.33	77.44
181.42	77.37
193.47	77.61
205.43	77.56
218.48	77.52
232.86	77.75
241.49	77.80
249.47	77.95
252.99	78.35
254.76	78.42
255.87	78.34
257.31	78.02
260.69	77.81
263.92	77.60
265.33	77.59
267.57	78.05
273.64	78.17
274.86	78.03
276	78.17
279.72	79.28
284.7	81.32
288.94	83.80
292.11	85.86
295	87.71

Survey-AECOM Surface	
Station	Elevation
0	85.95
1.1	85.61
1.5	85.48
1.8	85.39
2.2	85.22
2.7	84.98
3.1	84.78
3.6	84.47
4.3	84.01
5	83.65
6.9	82.85
7.5	82.55
7.9	82.36
8.6	82.21
9.3	82.03
9.5	81.99
10	81.94
10.8	81.83
11.4	81.70
12.1	81.54
15.4	80.39
15.7	80.32
15.9	80.27
17	80.14
17.2	80.09
17.8	79.90
18.5	79.66
19.2	79.57
20.2	79.36
21.1	79.22
21.4	79.16
21.8	79.06
22.4	78.88
23.6	78.44
24.9	78.18
26.2	78.04
27.5	78.00
29.2	77.89
30.1	77.87
30.6	77.82
31.4	77.78
32	77.68
34.2	77.44
35.2	77.44
37	77.35
37.8	77.36
38.4	77.35
39.2	77.28
40.4	77.28
41.3	77.34
43.4	77.28
44	77.28
44.8	77.23
45.5	77.24
46.8	77.34
48.1	77.49
48.8	77.53
50.5	77.53
52.7	77.33
53.2	77.32
53.5	77.30
54.1	77.30
54.5	77.35
54.8	77.37
55.1	77.36
60.93	75.97
64.8	75.04
65.5	75.06
66.2	75.16
67.4	75.55
68.7	75.87
71.2	76.10
72.6	76.28
77.4	77.04
77.6	77.06
78.27	77.08
78.3	77.08
80.3	77.10
85.3	77.11
87.5	77.15
88.5	77.14
90.1	77.08
90.3	77.10
91.3	77.29
93.1	77.40
95.3	77.35
96.1	77.36
97.3	77.40
98.3	77.39
99.3	77.44
100.3	77.53
101.3	77.52
102.3	77.62
103.3	77.65
104.3	77.57
104.7	77.57
105	77.60
105.3	77.60
106.3	77.46
107.3	77.22
108.3	77.17
110.3	77.12
111.7	77.01
112.3	76.95
113.3	77.05
114.3	77.03
115.3	77.09
116.3	77.05
117.3	77.18
118.9	77.23
120.3	77.29
122.3	77.28
123.3	77.55
124.3	77.65
125.3	77.85
126.3	78.02
127.9	78.22
129.3	78.39
130.3	78.43
131.3	78.42
132.3	78.52
133.3	78.50
134.3	78.54
135.3	78.55
136.3	78.60
137.3	78.62
138.3	78.68
140.3	78.66
141.3	78.63
143.7	78.63
146.3	78.56
147.3	78.60
148.3	78.53
149.3	78.53
150.6	78.49
151.1	78.45
151.6	78.44
152.1	78.45
153.3	78.39
154.5	78.41
155.2	78.38
155.5	78.38
156.2	78.42
156.5	78.43
159.3	78.40
160.2	78.36
161.5	78.19
162.2	78.11
163.2	77.97
164.4	77.70
165.4	77.48
166.4	77.40
167.4	77.29
168.4	77.32
169.4	77.30
170.4	77.39
171.4	77.43
173.4	77.46
174.3	77.43
175.4	77.43
176.4	77.40
177.3	77.41
178.3	77.37
179.4	77.36
180.4	77.38
181.3	77.37
183.3	77.39
184.4	77.38
188.4	77.47
189.4	77.53
190.4	77.53
192.2	77.62
193.5	77.61
194.7	77.50
195.5	77.48
196.2	77.49
197.1	77.49
198.4	77.58
199.1	77.57
199.8	77.55
200.8	77.57
202	77.53
202.7	77.56
203.4	77.56
204.4	77.55
205.6	77.56
206.8	77.61
208.4	77.63
209.1	77.62
209.9	77.64
210.7	77.63
212.5	77.55
213.5	77.60
216.6	77.62
217	77.60
217.8	77.55
219	77.49
219.9	77.54
221.3	77.50
222.1	77.58
222.6	77.59
223.8	77.56
225	77.61
228.7	77.72
229.9	77.71
230.7	77.74
231.4	77.73
232.1	77.76
232.9	77.76
233.6	77.77
234.8	77.73
236	77.74
237.1	77.72
237.9	77.78
238.4	77.79
238.9	77.76
239.6	77.74
240.7	77.78
240.8	77.77
242.1	77.82
242.4	77.80
242.9	77.82
244.5	77.92
245.1	78.01
245.7	78.07
246.9	77.89
248	77.92
248.1	77.94
249.3	77.93
250.1	78.05
250.6	78.14
250.8	78.17
251.8	78.18
253	78.35
253.7	78.41
254.2	78.42
255.1	78.41
255.4	78.39
255.9	78.34
257.3	78.02
257.9	77.95
259.5	77.86
260.2	77.80
261.5	77.80
261.6	77.79
261.8	77.78
262.3	77.77
263.1	77.79
263.6	77.70
263.9	77.60
264.5	77.58
265.3	77.59
265.9	77.71
267.1	77.99
267.4	78.03
267.6	78.05
270.2	78.13
271.2	78.11
272.4	78.18
273.1	78.17
273.6	78.17
274.6	78.05
274.9	78.03
275.3	78.08
276.1	78.18
277.3	78.60
278.2	78.83
279.7	79.28
281.8	80.11
283.9	81.03
284.3	81.16
284.6	81.27
284.6	81.28
284.7	81.32
286.1	82.11
286.5	82.39
287	82.74
288.2	83.33
288.9	83.80
289.4	84.07
289.7	84.21
290.6	84.96
291.1	85.21
291.7	85.61
292.5	86.15
293.1	86.55
293.5	86.89
294.3	87.38
294.7	87.57
295	87.71

Survey-JD Surface	
Station	Elevation
0	85.95
1.1	85.61
1.5	85.48
1.8	85.39
2.2	85.22
2.7	84.98
3.1	84.78
3.6	84.47
4.3	84.01
5	83.65
6.9	82.85
7.5	82.55
7.9	82.36
8.6	82.21
9.3	82.03
9.5	81.99
10	81.94
10.8	81.83
11.4	81.70
12.1	81.52
15.4	80.39
15.9	80.27
17	80.14
17.2	80.09
17.8	79.90
18.5	79.66
19.2	79.57
20.2	79.36
20.7	79.02
21.4	77.78
21.8	77.58
23.5	77.55
32.8	77.33
33.9	77.30
35.2	77.24
36.3	77.22
44.2	77.22
44.8	77.26
45.6	77.41
46.3	77.45
46.8	77.44
57.6	76.82
59.1	76.73
59.7	76.67
59.8	76.65
60.5	76.32
60.93	76.08
61.5	75.76
61.9	75.57
62.2	75.47
64.8	75.02
65.5	75.09
66.9	75.37
67.4	75.49
67.8	75.52
68.3	75.50
68.7	75.52
69	75.54
69.4	75.60
69.7	75.66
70.4	75.86
71	75.95
73.8	76.13
74	76.13
74.2	76.09
74.7	76.07
75.1	76.16
75.4	76.29
75.8	76.39
77.7	76.65
78.27	76.68
80.6	76.82
90.8	77.28
92.3	77.36
101.3	77.52
130.3	78.10
133.3	78.14
135.3	78.04
137.3	78.06
140.3	78.20
141.3	78.63
143.7	78.63
146.3	78.56
147.3	78.60
148.3	78.53
149.3	78.53
150.6	78.49
151.1	78.45
151.6	78.44
152.1	78.45
153.3	78.39
154.5	78.41
155.2	78.38
155.5	78.38
156.2	78.42
156.5	78.43
159.3	78.40
160.2	78.36
161.5	78.19
162.2	78.11
163.2	77.97
164.4	77.70
165.4	77.48
166.4	77.40
167.4	77.29
168.4	77.32
169.4	77.30
170.4	77.39
171.4	77.43
173.4	77.46
174.3	77.43
175.4	77.43
176.4	77.40
177.3	77.41
178.3	77.37
179.4	77.36
180.4	77.38
181.3	77.37
183.3	77.39
184.4	77.38
188.4	77.47
189.4	77.53
190.4	77.53
192.2	77.62
193.5	77.61
194.7	77.50
195.5	77.48
196.2	77.49
197.1	77.49
198.4	77.58
199.1	77.57
199.8	77.55
200.8	77.57
202	77.53
202.7	77.56
203.4	77.56
204.4	77.55
205.6	77.56
206.8	77.61
208.4	77.63
209.1	77.62
209.9	77.64
210.7	77.63
212.5	77.55
213.5	77.60
216.6	77.62
217	77.60
217.8	77.55
219	77.49
219.9	77.54
221.3	77.50
222.1	77.58
222.6	77.59
223.8	77.56
225	77.61
228.7	77.72
229.9	77.71
230.7	77.74
231.4	77.73
232.1	77.76
232.9	77.76
233.6	77.77
234.8	77.73
236	77.74
237.1	77.72
237.9	77.78
238.4	77.79
238.9	77.76
239.6	77.74
240.7	77.78
240.8	77.77
242.1	77.82
242.4	77.80
242.9	77.82
244.5	77.92
245.1	78.01
245.7	78.07
246.9	77.89
248	77.92
248.1	77.94
249.3	77.93
250.1	78.05
250.6	78.14
250.8	78.17
251.8	78.18
253	78.35
253.7	78.41
254.2	78.42
255.1	78.41
255.4	78.39
255.9	78.34
257.3	78.02
257.9	77.95
259.5	77.86
260.2	77.80
261.5	77.80
261.6	77.79
261.8	77.78
262.3	77.77
263.1	77.79
263.6	77.70
263.9	77.60
264.5	77.58
265.3	77.59
265.9	77.71
267.1	77.99
267.4	78.03
267.6	78.05
270.2	78.13
271.2	78.11
272.4	78.18
273.1	78.17
273.6	78.17
274.6	78.05
274.9	78.03
275.3	78.08
276.1	78.18
277.3	78.60
278.2	78.83
279.7	79.28
281.8	80.11
283.9	81.03
284.3	81.16
284.6	81.27
284.7	81.32
286.1	82.11
286.5	82.39
287	82.74
288.2	83.33
288.9	83.80
289.4	84.07
289.7	84.21
290.6	84.96
291.1	85.21
291.7	85.61
292.5	86.15
293.1	86.55
293.5	86.89
294.3	87.38
294.7	87.57
295	87.71

Used in Final model Updates	
Station	Elevation
0	85.95
2.69	84.98
5.87	83.28
9.05	82.08
10.78	81.83
15.41	80.39
22.09	78.96
25.65	78.11
33.94	77.46
42.71	77.31
44.84	77.23
48.1	77.49
49.6	77.48
51.24	77.46
54.22	77.08
58	76.78
60.93	76.31
62.92	75.48
64.21	75.11
66.15	75.09
66.79	75.11
68.78	75.48
71.69	75.80
77.03	75.75
78.27	76.41
83.88	76.70
92.16	77.33
99.09	77.43
103.05	77.64
105.35	77.60
107.35	77.22
111.97	76.98
115.77	77.07
119.35	77.25
122.35	77.28
124.84	77.75
129.35	78.39
138.35	78.68
148.61	78.53
152.39	78.42
153.56	78.39
156.03	78.39
159.35	78.40
163.24	77.97
165.26	77.50
167.28	77.30
172.33	77.44
181.42	77.37
193.47	77.61
205.43	77.56
218.48	77.52
232.86	77.75
241.49	77.80
249.47	77.95
252.99	78.35
254.76	78.42
255.87	78.34
257.31	78.02
260.69	77.81
263.92	77.60
265.33	77.59
267.57	78.05
273.64	78.17
274.86	78.03
276	78.17
279.72	79.28
284.7	81.32
288.94	83.80
292.11	85.86
295	87.71



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	85.95	
2.69	84.98	
5.87	83.28	
9.05	82.08	
10.78	81.83	
15.41	80.39	
22.09	78.96	
25.65	78.11	
33.94	77.46	
42.71	77.31	
44.84	77.23	
48.1	77.49	
49.6	77.48	
51.24	77.46	
54.22	77.08	
58	76.78	
60.93	76.31	
62.92	75.48	
64.21	75.11	
66.15	75.09	
66.79	75.11	
68.78	75.48	
71.69	75.80	
77.03	75.75	
78.27	76.41	
83.88	76.70	
92.16	77.33	
99.09	77.43	
103.05	77.64	
105.35	77.60	
107.35	77.22	
111.97	76.98	
115.77	77.07	
119.35	77.25	
122.35	77.28	
124.84	77.75	
129.35	78.39	
138.35	78.68	
148.61	78.53	
152.39	78.42	
153.56	78.39	
156.03	78.39	
159.35	78.40	
163.24	77.97	
165.26	77.50	
167.28	77.30	
172.33	77.44	
181.42	77.37	
193.47	77.61	
205.43	77.56	
218.48	77.52	
232.86	77.75	
241.49	77.80	
249.47	77.95	
252.99	78.35	
254.76	78.42	
255.87	78.34	
257.31	78.02	
260.69	77.81	
263.92	77.60	
265.33	77.59	
267.57	78.05	
273.64	78.17	
274.86	78.03	
276	78.17	
279.72	79.28	
284.7	81.32	
288.94	83.80	
292.11	85.86	
295	87.71	

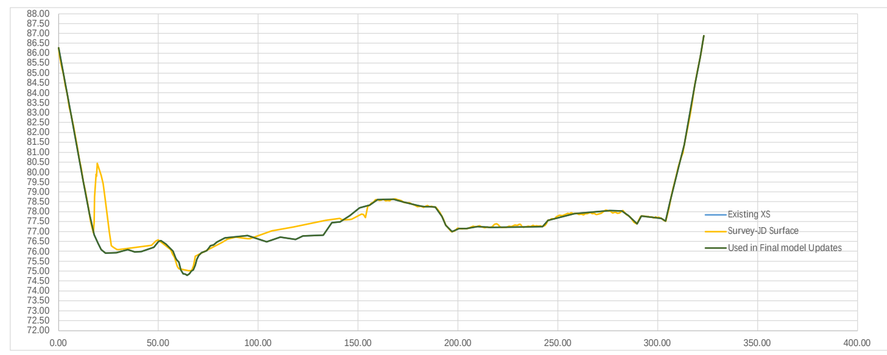
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	85.95	
2.69	84.98	
5.87	83.28	
9.05	82.08	
10.78	81.83	
15.41	80.39	
22.09	78.96	
25.65	78.11	
33.94	77.46	
42.71	77.31	
44.84	77.23	
48.1	77.49	
49.6	77.48	
51.24	77.46	
54.22	77.08	
58	76.78	
60.93	76.31	
62.92	75.48	
64.21	75.11	
66.15	75.09	
66.79	75.11	
68.78	75.48	
71.69	75.8	
77.03	75.75	
78.27	76.41	
83.88	76.7	
92.16	77.33	
99.09	77.43	
103.05	77.64	
105.35	77.6	
107.35	77.22	
111.97	76.98	
115.77	77.07	
119.35	77.25	
122.35	77.28	
124.84	77.75	
129.35	78.39	
138.35	78.68	
148.61	78.53	
152.39	78.42	
153.56	78.39	
156.03	78.39	
159.35	78.4	
163.24	77.97	
165.26	77.5	
167.28	77.3	
172.33	77.44	
181.42	77.37	
193.47	77.61	
205.43	77.56	
218.48	77.52	
232.86	77.75	
241.49	77.8	
249.47	77.95	
252.99	78.35	
254.76	78.42	
255.87	78.34	
257.31	78.02	
260.69	77.81	
263.92	77.6	
265.33	77.59	
267.57	78.05	
273.64	78.17	
274.86	78.03	
276	78.17	
279.72	79.28	
284.7	81.32	
288.94	83.8	
292.11	85.86	
295	87.71	

Existing XS	
Station	Elevation
0.00	86.28
6.47	82.89
12.54	79.54
15.54	77.87
17.87	76.83
19.92	76.40
21.54	76.09
23.54	75.91
29.13	75.92
34.83	76.09
38.34	75.96
41.62	75.98
47.88	76.21
50.21	76.49
51.43	76.53
53.87	76.36
57.36	76.01
58.79	75.65
59.29	75.55
60.38	75.46
61.36	75.06
62.40	74.86
63.63	74.84
64.51	74.79
65.51	74.86
66.54	75.00
67.58	75.06
68.51	75.30
69.33	75.59
70.23	75.78
71.66	75.92
74.15	76.03
75.16	76.14
76.17	76.28
77.79	76.33
79.19	76.46
83.35	76.67
89.26	76.74
94.79	76.79
104.21	76.48
111.16	76.71
118.79	76.60
122.49	76.78
132.56	76.82
136.98	77.45
140.95	77.48
145.92	77.79
150.88	78.20
155.85	78.33
159.82	78.61
167.76	78.63
172.73	78.48
179.96	78.31
181.79	78.27
183.49	78.26
185.79	78.25
188.79	78.23
191.99	77.76
194.00	77.31
197.02	77.00
200.53	77.14
204.31	77.14
209.76	77.24
216.23	77.21
233.51	77.22
242.48	77.24
245.21	77.57
258.21	77.90
275.98	78.05
282.06	78.03
285.34	77.80
289.62	77.38
291.81	77.78
301.89	77.67
304.05	77.53
306.21	78.46
310.53	80.31
313.41	81.38
318.67	84.41
321.33	85.81
323.00	86.90

Survey-AECOM Surface	
Station	Elevation
NA	

Survey-JD Surface	
Station	Elevation
0.00	86.28
0.60	85.90
1.50	85.37
2.60	84.88
3.50	84.36
4.50	83.94
5.50	83.28
6.50	82.89
7.50	82.34
8.50	81.77
9.50	81.24
10.50	80.64
11.50	80.19
12.50	79.54
13.50	79.10
15.30	78.03
15.80	77.71
16.20	77.49
16.50	77.33
17.50	76.94
17.90	77.50
18.20	78.74
18.90	79.89
19.20	79.79
19.50	80.44
21.50	79.82
22.50	79.42
23.50	78.67
25.50	76.95
26.50	76.29
27.50	76.21
29.10	76.11
29.50	76.09
30.20	76.08
46.60	76.31
46.80	76.32
48.90	76.52
50.00	76.58
56.20	76.09
57.20	75.85
58.20	75.69
59.30	75.30
59.60	75.24
60.30	75.11
60.38	75.11
65.30	75.03
66.50	75.03
66.90	75.07
67.40	75.20
67.60	75.24
67.70	75.31
68.50	75.72
68.60	75.75
69.33	75.79
81.80	76.43
84.80	76.61
88.80	76.71
94.80	76.63
95.80	76.63
106.80	77.03
117.80	77.23
133.80	77.56
140.80	77.67
141.80	77.61
142.80	77.59
145.90	77.61
146.80	77.63
151.80	77.88
152.80	77.85
153.80	77.70
154.80	78.28
155.80	78.33
156.70	78.42
157.70	78.47
158.80	78.60
159.80	78.61
160.80	78.57
161.80	78.58
162.80	78.63
163.80	78.54
164.80	78.57
165.80	78.55
166.80	78.63
168.80	78.65
169.70	78.61
170.80	78.59
171.80	78.54
172.80	78.47
173.80	78.45
175.90	78.45
176.70	78.39
178.80	78.32
179.80	78.26
181.70	78.27
182.80	78.21
183.80	78.28
184.80	78.31
185.80	78.25
186.90	78.28
187.60	78.24
188.80	78.23
189.80	78.12
191.00	77.95
192.80	77.62
193.80	77.34
196.80	77.00
198.00	77.02
198.80	77.07
199.80	77.16
202.10	77.12
202.50	77.14
205.00	77.14
207.60	77.27
208.30	77.24
209.00	77.24
209.80	77.25
210.50	77.29
211.00	77.28
211.90	77.23
213.50	77.19
214.70	77.22
215.50	77.21
217.00	77.22
217.70	77.28
218.30	77.36
219.10	77.38
219.50	77.38
219.80	77.36
220.30	77.33
220.70	77.27
221.30	77.22
221.90	77.21
224.20	77.21
225.60	77.27
226.80	77.25
228.50	77.32
229.90	77.31
230.40	77.35
231.00	77.36
231.40	77.34
232.10	77.25
232.80	77.20
235.20	77.27
236.40	77.24
237.60	77.30
237.80	77.30
238.50	77.26
239.30	77.28
240.70	77.27
241.30	77.29
242.10	77.24
242.50	77.24
242.90	77.28
243.40	77.29
243.70	77.32
244.30	77.41
245.00	77.57
246.10	77.59
247.00	77.64
248.50	77.65
249.30	77.73
250.50	77.80
250.90	77.81
252.30	77.79
255.10	77.91
255.80	77.88
256.50	77.93
257.00	77.94
257.70	77.90
259.40	77.91
260.60	77.86
261.80	77.87
263.00	77.83
263.70	77.89
264.80	77.89
265.20	77.91
265.50	77.94
266.50	77.96
267.30	77.90
268.30	77.91
269.10	77.86
269.50	77.85
271.70	77.91
273.80	78.07
274.50	78.07
275.30	78.04
276.30	78.04
277.20	77.95
277.40	77.94
277.60	77.93
278.80	77.97
280.00	77.91
281.00	77.93
282.40	78.05
282.50	78.05
282.60	78.05
284.30	77.85
286.10	77.74
287.20	77.60
288.20	77.46
289.60	77.38
290.40	77.56
291.40	77.76
292.10	77.78
292.50	77.77
293.30	77.78
294.70	77.73
295.40	77.76
296.10	77.72
296.90	77.74
298.10	77.68
299.00	77.73
299.70	77.69
300.50	77.71
301.90	77.67
303.30	77.55
303.90	77.52
304.10	77.53
304.20	77.56
304.80	77.80
305.70	78.20
306.90	78.82
307.40	79.08
307.60	79.17
307.80	79.24
309.20	79.79
310.50	80.31
312.00	80.80
312.70	81.00
312.80	81.05
313.80	81.60
314.80	82.08
316.30	82.89
317.00	83.35
317.50	83.61
318.40	84.28
318.70	84.42
319.90	85.14
321.30	85.81
321.70	86.02
323.00	86.90

Used in Final model Updates	
Station	Elevation
0.00	86.28
6.47	82.89
12.54	79.54
15.54	77.87
17.87	76.83
19.92	76.40
21.54	76.09
23.54	75.91
29.13	75.92
34.83	76.09
38.34	75.96
41.62	75.98
47.88	76.21
50.21	76.49
51.43	76.53
53.87	76.36
57.36	76.01
58.79	75.65
59.29	75.55
60.38	75.46
61.36	75.06
62.4	74.86
63.63	74.84
64.51	74.79
65.51	74.86
66.54	75.00
67.58	75.06
68.51	75.30
69.33	75.59
70.23	75.78
71.66	75.92
74.15	76.03
75.16	76.14
76.17	76.28
77.79	76.33
79.19	76.46
83.35	76.67
89.26	76.74
94.79	76.79
104.21	76.48
111.16	76.71
118.79	76.60
122.49	76.78
132.56	76.82
136.98	77.45
140.95	77.48
145.92	77.79
150.88	78.20
155.85	78.33
159.82	78.61
167.76	78.63
172.73	78.48
179.96	78.31
181.79	78.27
183.49	78.26
185.79	78.25
188.79	78.23
191.99	77.76
194.00	77.31
197.02	77.00
200.53	77.14
204.31	77.14
209.76	77.24
216.23	77.21
233.51	77.22
242.48	77.24
245.21	77.57
258.21	77.90
275.98	78.05
282.06	78.03
285.34	77.80
289.62	77.38
291.81	77.78
301.89	77.67
304.05	77.53
306.21	78.46
310.53	80.31
313.41	81.38
318.67	84.41
321.33	85.81
323.00	86.90



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	86.28	
6.47	82.89	
12.54	79.54	
15.54	77.87	
17.87	76.83	
19.92	76.4	
21.54	76.09	
23.54	75.91	
29.13	75.92	
34.83	76.09	
38.34	75.96	
41.62	75.98	
47.88	76.21	
50.21	76.49	
51.43	76.53	
53.87	76.36	
57.36	76.01	
58.79	75.65	
59.29	75.55	
60.38	75.46	
61.36	75.06	
62.4	74.86	
63.63	74.84	
64.51	74.79	
65.51	74.86	
66.54	75	
67.58	75.06	
68.51	75.3	
69.33	75.59	
70.23	75.78	
71.66	75.92	
74.15	76.03	
75.16	76.14	
76.17	76.28	
77.79	76.33	
79.19	76.46	
83.35	76.67	
89.26	76.74	
94.79	76.79	
104.21	76.48	
111.16	76.71	
118.79	76.6	
122.49	76.78	
132.56	76.82	
136.98	77.45	
140.95	77.48	
145.92	77.79	
150.88	78.2	
155.85	78.33	
159.82	78.61	
167.76	78.63	
172.73	78.48	
179.96	78.31	
181.79	78.27	
183.49	78.26	
185.79	78.25	
188.79	78.23	
191.99	77.76	
194	77.31	
197.02	77	
200.53	77.14	
204.31	77.14	
209.76	77.24	
216.23	77.21	
233.51	77.22	
242.48	77.24	
245.21	77.57	
258.21	77.9	
275.98	78.05	
282.06	78.03	
285.34	77.8	
289.62	77.38	
291.81	77.78	
301.89	77.67	
304.05	77.53	
306.21	78.46	
310.53	80.31	
313.41	81.38	
318.67	84.41	
321.33	85.81	
323	86.9	

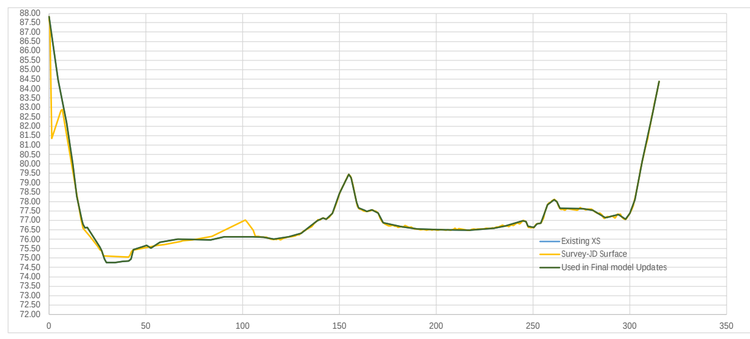
Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	86.28	
6.47	82.89	
12.54	79.54	
15.54	77.87	
17.87	76.83	
19.92	76.4	
21.54	76.09	
23.54	75.91	
29.13	75.92	
34.83	76.09	
38.34	75.96	
41.62	75.98	
47.88	76.21	
50.21	76.49	
51.43	76.53	
53.87	76.36	
57.36	76.01	
58.79	75.65	
59.29	75.55	
60.38	75.46	
61.36	75.06	
62.4	74.86	
63.63	74.84	
64.51	74.79	
65.51	74.86	
66.54	75	
67.58	75.06	
68.51	75.3	
69.33	75.59	
70.23	75.78	
71.66	75.92	
74.15	76.03	
75.16	76.14	
76.17	76.28	
77.79	76.33	
79.19	76.46	
83.35	76.67	
89.26	76.74	
94.79	76.79	
104.21	76.48	
111.16	76.71	
118.79	76.6	
122.49	76.78	
132.56	76.82	
136.98	77.45	
140.95	77.48	
145.92	77.79	
150.88	78.2	
155.85	78.33	
159.82	78.61	
167.76	78.63	
172.73	78.48	
179.96	78.31	
181.79	78.27	
183.49	78.26	
185.79	78.25	
188.79	78.23	
191.99	77.76	
194	77.31	
197.02	77	
200.53	77.14	
204.31	77.14	
209.76	77.24	
216.23	77.21	
233.51	77.22	
242.48	77.24	
245.21	77.57	
258.21	77.9	
275.98	78.05	
282.06	78.03	
285.34	77.8	
289.62	77.38	
291.81	77.78	
301.89	77.67	
304.05	77.53	
306.21	78.46	
310.53	80.31	
313.41	81.38	
318.67	84.41	
321.33	85.81	
323	86.9	

Existing XS	
Station	Elevation
0	87.82
2.69	85.93
4.81	84.47
9.13	82.17
12.35	79.96
14.49	78.29
17.06	77.01
17.71	76.79
18.73	76.61
19.85	76.62
26.29	75.59
27.27	75.38
28.81	74.94
29.8	74.77
30.96	74.77
34.22	74.77
38.1	74.81
41.3	74.84
42.37	74.95
43.63	75.44
48.14	75.59
50.46	75.68
52.77	75.52
57.34	75.83
66.69	76.00
83.6	75.95
90.61	76.12
105.33	76.13
110.74	76.11
116.16	76.00
123.88	76.13
130.32	76.32
138.57	76.98
141.66	77.12
143.14	77.06
146.4	77.37
150.14	78.43
152.84	79.03
154.8	79.44
156.06	79.26
158.9	77.96
159.87	77.65
162.86	77.53
164.08	77.48
166.78	77.55
170	77.39
172.58	76.88
181.85	76.66
190.31	76.54
203.24	76.50
217.41	76.48
229.78	76.59
235.96	76.70
244.79	76.97
246.39	76.94
247.5	76.68
250.48	76.62
251.97	76.82
254	76.85
256.12	77.42
257.54	77.82
260.89	78.10
262.38	78.00
263.87	77.63
275.77	77.62
280.9	77.53
287.27	77.14
288.62	77.17
290.81	77.22
294.11	77.31
297.72	77.05
300.01	77.36
302.54	78.09
306.38	80.16
311.22	82.45
315	84.37

Survey-AECOM Surface	
Station	Elevation
NA	

Survey-JD Surface	
Station	Elevation
0	87.82
0.2	87.68
0.5	87.42
1.6	81.35
5.9	82.74
6.4	82.84
7	82.89
16.6	77.04
17.2	76.77
17.7	76.58
21.1	76.16
25.2	75.60
26.3	75.44
27.27	75.37
27.3	75.37
28	75.18
28.4	75.12
41.3	75.06
42	75.17
42.7	75.33
43.4	75.43
43.6	75.43
43.63	75.43
55.9	75.66
59.5	75.71
68.1	75.88
69.2	75.91
74.1	75.97
84.2	76.14
101.4	77.01
102.4	76.90
105.6	76.48
106.7	76.13
107.3	76.15
108.4	76.15
109.9	76.10
111	76.11
112.3	76.10
114.6	76.00
116.2	75.99
116.4	76.01
116.9	76.01
117.4	75.99
118.5	76.02
119.6	75.97
121.1	76.05
123.9	76.13
125	76.12
127.1	76.17
128.2	76.22
129.3	76.23
131.6	76.43
132.4	76.46
133.2	76.53
135.7	76.66
136.8	76.78
137	76.83
138.6	76.98
138.9	77.03
140	77.02
141	77.10
141.7	77.12
142.4	77.11
143.2	77.06
144.8	77.16
145.5	77.24
146.3	77.35
147.1	77.51
148.6	77.94
149.4	78.20
149.6	78.29
150.7	78.58
151.9	78.83
152.5	78.93
153.3	79.14
153.9	79.23
154	79.29
154.3	79.37
154.8	79.44
155.4	79.37
155.6	79.37
156.1	79.26
157.1	78.86
157.9	78.42
158.7	78.04
159.4	77.74
159.9	77.65
160.3	77.59
161.4	77.57
162.5	77.49
164.6	77.48
166.4	77.52
166.8	77.55
167.2	77.55
167.9	77.49
168.9	77.49
170	77.39
170.3	77.34
171	77.12
172.1	76.93
173.4	76.81
175.4	76.71
176.5	76.71
177.5	76.74
178.6	76.69
179.5	76.69
179.9	76.67
180.3	76.62
181.1	76.64
182	76.67
182.9	76.65
183.9	76.72
186.1	76.63
187.2	76.64
188.8	76.55
190.4	76.54
191.9	76.50
193.6	76.51
195	76.48
196.8	76.53
197.9	76.47
199	76.53
200	76.48
201.1	76.47
202	76.49
203.5	76.50
205	76.48
205.8	76.50
207.5	76.48
208.9	76.53
209.7	76.58
210.5	76.51
210.8	76.50
211.8	76.57
216.1	76.48
217.4	76.48
218.3	76.53
219.3	76.54
220.5	76.51
221.5	76.54
224.4	76.54
225.9	76.58
227.9	76.57
229	76.60
229.8	76.59
231.1	76.64
232.1	76.64
234.3	76.75
235.4	76.68
236.5	76.71
237.6	76.67
238.6	76.74
239.1	76.75
239.7	76.72
240	76.73
241.6	76.85
242.3	76.86
243	76.82
243.4	76.83
244.5	76.95
245	77.00
245.5	76.97
246	76.96
246.4	76.94
247.7	76.63
248.3	76.63
249.1	76.60
249.7	76.62
250.5	76.61
251.2	76.75
251.8	76.82
254	76.86
254.5	76.91
254.9	77.00
255.4	77.13
255.8	77.30
256.1	77.43
256.8	77.63
257.5	77.82
257.9	77.88
258.2	77.92
259	77.95
259.7	78.03
261.1	78.11
262.4	78.00
262.6	77.95
263.2	77.76
263.9	77.62
264.6	77.58
265.4	77.59
266	77.55
266.6	77.54
267.4	77.61
268	77.62
272.8	77.54
273.4	77.58
274.3	77.67
274.5	77.68
275.2	77.62
276.1	77.62
277.3	77.55
277.4	77.55
278.1	77.60
278.8	77.59
280.2	77.60
280.9	77.53
283.2	77.38
284.2	77.38
284.4	77.39
284.7	77.38
285.6	77.29
286.2	77.18
286.6	77.12
286.9	77.11
287.7	77.17
288.3	77.20
289.6	77.19
291	77.22
292.3	77.13
292.9	77.21
293.6	77.32
293.6	77.33
293.7	77.33
294.3	77.30
295	77.33
295.1	77.32
295.8	77.19
296.6	77.09
297.2	77.06
297.7	77.05
297.9	77.06
298.1	77.07
300	77.36
301.1	77.57
301.8	77.79
302.5	78.09
302.8	78.24
303.6	78.65
304	78.87
304.3	78.96
305	79.39
305.5	79.70
306.4	80.15
307.2	80.50
307.8	80.79
308.5	81.04
309.2	81.35
309.9	81.72
310.6	82.11
311.3	82.53
311.5	82.58
312	82.85
312.8	83.21
313.9	83.76
315	84.37

Used in Final model Updates	
Station	Elevation
0	87.82
2.69	85.93
4.81	84.47
9.13	82.17
12.35	79.96
14.49	78.29
17.06	77.01
17.71	76.79
18.73	76.61
19.85	76.62
26.29	75.59
27.27	75.38
28.81	74.94
29.8	74.77
30.96	74.77
34.22	74.77
38.1	74.81
41.3	74.84
42.37	74.95
43.63	75.44
48.14	75.59
50.46	75.68
52.77	75.52
57.34	75.83
66.69	76.00
83.6	75.95
90.61	76.12
105.33	76.13
110.74	76.11
116.16	76.00
123.88	76.13
130.32	76.32
138.57	76.98
141.66	77.12
143.14	77.06
146.4	77.37
150.14	78.43
152.84	79.03
154.8	79.44
156.06	79.26
158.9	77.96
159.87	77.65
162.86	77.53
164.08	77.48
166.78	77.55
170	77.39
172.58	76.88
181.85	76.66
190.31	76.54
203.24	76.50
217.41	76.48
229.78	76.59
235.96	76.70
244.79	76.97
246.39	76.94
247.5	76.68
250.48	76.62
251.97	76.82
254	76.85
256.12	77.42
257.54	77.82
260.89	78.10
262.38	78.00
263.87	77.63
275.77	77.62
280.9	77.53
287.27	77.14
288.62	77.17
290.81	77.22
294.11	77.31
297.72	77.05
300.01	77.36
302.54	78.09
306.38	80.16
311.22	82.45
315	84.37



Original		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	87.82	
2.69	85.93	
4.81	84.47	
9.13	82.17	
12.35	79.96	
14.49	78.29	
17.06	77.01	
17.71	76.79	
18.73	76.61	
19.85	76.62	
26.29	75.59	
27.27	75.38	
28.81	74.94	
29.8	74.77	
30.96	74.77	
34.22	74.77	
38.1	74.81	
41.3	74.84	
42.37	74.95	
43.63	75.44	
48.14	75.59	
50.46	75.68	
52.77	75.52	
57.34	75.83	
66.69	76.00	
83.6	75.95	
90.61	76.12	
105.33	76.13	
110.74	76.11	
116.16	76.00	
123.88	76.13	
130.32	76.32	
138.57	76.98	
141.66	77.12	
143.14	77.06	
146.4	77.37	
150.14	78.43	
152.84	79.03	
154.8	79.44	
156.06	79.26	
158.9	77.96	
159.87	77.65	
162.86	77.53	
164.08	77.48	
166.78	77.55	
170	77.39	
172.58	76.88	
181.85	76.66	
190.31	76.54	
203.24	76.50	
217.41	76.48	
229.78	76.59	
235.96	76.70	
244.79	76.97	
246.39	76.94	
247.5	76.68	
250.48	76.62	
251.97	76.82	
254	76.85	
256.12	77.42	
257.54	77.82	
260.89	78.10	
262.38	78.00	
263.87	77.63	
275.77	77.62	
280.9	77.53	
287.27	77.14	
288.62	77.17	
290.81	77.22	
294.11	77.31	
297.72	77.05	
300.01	77.36	
302.54	78.09	
306.38	80.16	
311.22	82.45	
315	84.37	

Updated Existing		
Project:	Wolfedale_FHM	
River:	Wolfedale Creek	
Reach:	941-M1	
Manning's n		
LOB	Channel	ROB
0.08	0.035	0.08
Station	Elevation	n Value
0	87.82	
2.69	85.93	
4.81	84.47	
9.13	82.17	
12.35	79.96	
14.49	78.29	
17.06	77.01	
17.71	76.79	
18.73	76.61	
19.85	76.62	
26.29	75.59	
27.27	75.38	
28.81	74.94	
29.8	74.77	
30.96	74.77	
34.22	74.77	
38.1	74.81	
41.3	74.84	
42.37	74.95	
43.63	75.44	
48.14	75.59	
50.46	75.68	
52.77	75.52	
57.34	75.83	
66.69	76	
83.6	75.95	
90.61	76.12	
105.33	76.13	
110.74	76.11	
116.16	76	
123.88	76.13	
130.32	76.32	
138.57	76.98	
141.66	77.12	
143.14	77.06	
146.4	77.37	
150.14	78.43	
152.84	79.03	
154.8	79.44	
156.06	79.26	
158.9	77.96	
159.87	77.65	
162.86	77.53	
164.08	77.48	
166.78	77.55	
170	77.39	
172.58	76.88	
181.85	76.66	
190.31	76.54	
203.24	76.5	
217.41	76.48	
229.78	76.59	
235.96	76.7	
244.79	76.97	
246.39	76.94	
247.5	76.68	
250.48	76.62	
251.97	76.82	
254	76.85	
256.12	77.42	
257.54	77.82	
260.89	78.1	
262.38	78	
263.87	77.63	
275.77	77.62	
280.9	77.53	
287.27	77.14	
288.62	77.17	
290.81	77.22	
294.11	77.31	
297.72	77.05	
300.01	77.36	
302.54	78.09	
306.38	80.16	
311.22	82.45	
315	84.37	

AECOM

Appendix C

Hydraulic Model Results – Existing Conditions

Hydraulic Model-Updated Existing Condition-AECOM

Wolfedale Creek

HEC-RAS Plan: EXS_SEP2023

Reach	River Sta	Profile	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)	
941-M3	14069	2yr_Ex	2.20	153.47	153.97	153.89	154.07	0.014283	1.41	1.57	4.34	0.72
941-M3	14069	5yr_Ex	3.40	153.47	154.06	154.00	154.21	0.015804	1.72	2.02	4.73	0.79
941-M3	14069	10yr_Ex	4.70	153.47	154.16	154.10	154.35	0.016317	1.97	2.48	5.10	0.83
941-M3	14069	25yr_Ex	5.30	153.47	154.19	154.15	154.41	0.017402	2.11	2.64	5.22	0.86
941-M3	14069	50yr_Ex	5.80	153.47	154.22	154.18	154.46	0.017389	2.18	2.81	5.35	0.87
941-M3	14069	100yr_Ex	6.30	153.47	154.28	154.21	154.51	0.014967	2.15	3.13	5.59	0.82
941-M3	14069	Regional_Ex	4.60	153.47	154.13	154.09	154.34	0.019101	2.05	2.32	4.98	0.89
941-M3	14069	2yr_Fut	2.20	153.47	153.97	153.89	154.07	0.014283	1.41	1.57	4.34	0.72
941-M3	14069	5yr_Fut	3.40	153.47	154.06	154.00	154.21	0.015804	1.72	2.02	4.73	0.79
941-M3	14069	10yr_Fut	4.70	153.47	154.16	154.10	154.35	0.016317	1.97	2.48	5.10	0.83
941-M3	14069	25yr_Fut	5.30	153.47	154.19	154.15	154.41	0.017402	2.11	2.64	5.22	0.86
941-M3	14069	50yr_Fut	5.80	153.47	154.22	154.18	154.46	0.017389	2.18	2.81	5.35	0.87
941-M3	14069	100yr_Fut	6.30	153.47	154.28	154.21	154.51	0.014967	2.15	3.13	5.59	0.82
941-M3	14069	Regional_Fut	4.60	153.47	154.13	154.09	154.34	0.019093	2.05	2.32	4.98	0.89
941-M3	14019	2yr_Ex	2.20	152.71	153.39		153.47	0.009752	1.29	1.71	3.92	0.62
941-M3	14019	5yr_Ex	3.40	152.71	153.58		153.67	0.007402	1.37	2.51	4.61	0.56
941-M3	14019	10yr_Ex	4.70	152.71	153.74		153.85	0.006247	1.48	3.31	5.22	0.54
941-M3	14019	25yr_Ex	5.30	152.71	153.86		153.96	0.004807	1.42	3.95	5.66	0.48
941-M3	14019	50yr_Ex	5.80	152.71	153.98		154.07	0.003618	1.35	4.68	6.13	0.43
941-M3	14019	100yr_Ex	6.30	152.71	154.12		154.20	0.002687	1.27	5.56	6.65	0.38
941-M3	14019	Regional_Ex	4.60	152.71	153.99		154.04	0.002226	1.06	4.72	6.15	0.34
941-M3	14019	2yr_Fut	2.20	152.71	153.39		153.47	0.009752	1.29	1.71	3.92	0.62
941-M3	14019	5yr_Fut	3.40	152.71	153.58		153.67	0.007402	1.37	2.51	4.61	0.56
941-M3	14019	10yr_Fut	4.70	152.71	153.74		153.85	0.006247	1.48	3.31	5.22	0.54
941-M3	14019	25yr_Fut	5.30	152.71	153.86		153.96	0.004807	1.42	3.95	5.66	0.48
941-M3	14019	50yr_Fut	5.80	152.71	153.98		154.07	0.003618	1.35	4.68	6.13	0.43
941-M3	14019	100yr_Fut	6.30	152.71	154.12		154.20	0.002687	1.27	5.56	6.65	0.38
941-M3	14019	Regional_Fut	4.60	152.71	153.99		154.04	0.002225	1.06	4.72	6.15	0.34
942	20326	2yr_Ex	2.50	153.37	154.44	154.18	154.49	0.005456	0.99	2.54	5.92	0.46
942	20326	5yr_Ex	3.90	153.37	154.57	154.33	154.64	0.005617	1.18	3.39	6.90	0.49
942	20326	10yr_Ex	5.50	153.37	154.68	154.44	154.78	0.005991	1.37	4.21	7.42	0.52
942	20326	25yr_Ex	6.90	153.37	154.77	154.53	154.88	0.006159	1.51	4.89	7.82	0.54
942	20326	50yr_Ex	8.40	153.37	154.89	154.60	155.01	0.005501	1.56	5.84	8.37	0.52
942	20326	100yr_Ex	10.40	153.37	155.06	154.71	155.18	0.004436	1.57	7.34	9.15	0.48
942	20326	Regional_Ex	9.80	153.37	155.00	154.67	155.12	0.004929	1.59	6.78	8.86	0.50
942	20326	2yr_Fut	2.50	153.37	154.44	154.18	154.49	0.005456	0.99	2.54	5.92	0.46
942	20326	5yr_Fut	3.90	153.37	154.57	154.33	154.64	0.005617	1.18	3.39	6.90	0.49
942	20326	10yr_Fut	5.50	153.37	154.68	154.44	154.78	0.005991	1.37	4.21	7.42	0.52
942	20326	25yr_Fut	6.90	153.37	154.77	154.53	154.88	0.006159	1.51	4.89	7.82	0.54
942	20326	50yr_Fut	8.40	153.37	154.89	154.60	155.01	0.005501	1.56	5.84	8.37	0.52
942	20326	100yr_Fut	10.40	153.37	155.06	154.71	155.18	0.004436	1.57	7.34	9.15	0.48
942	20326	Regional_Fut	9.80	153.37	155.00	154.67	155.12	0.004929	1.59	6.78	8.86	0.50
942	20271	2yr_Ex	2.50	153.10	153.93		154.06	0.011451	1.55	1.62	4.24	0.78
942	20271	5yr_Ex	3.90	153.10	154.09		154.24	0.009326	1.73	2.33	5.29	0.75
942	20271	10yr_Ex	5.50	153.10	154.26		154.42	0.006767	1.78	3.39	6.49	0.67
942	20271	25yr_Ex	6.90	153.10	154.42		154.56	0.005232	1.78	4.44	7.35	0.61
942	20271	50yr_Ex	8.40	153.10	154.69		154.80	0.002700	1.53	6.67	8.86	0.46
942	20271	100yr_Ex	10.40	153.10	154.91		155.01	0.002045	1.50	8.79	10.16	0.41
942	20271	Regional_Ex	9.80	153.10	154.83		154.93	0.002363	1.54	7.93	9.65	0.43
942	20271	2yr_Fut	2.50	153.10	153.93		154.06	0.011451	1.55	1.62	4.24	0.78
942	20271	5yr_Fut	3.90	153.10	154.09		154.24	0.009326	1.73	2.33	5.29	0.75
942	20271	10yr_Fut	5.50	153.10	154.26		154.42	0.006767	1.78	3.39	6.49	0.67
942	20271	25yr_Fut	6.90	153.10	154.42		154.56	0.005232	1.78	4.44	7.35	0.61
942	20271	50yr_Fut	8.40	153.10	154.69		154.80	0.002700	1.53	6.67	8.86	0.46
942	20271	100yr_Fut	10.40	153.10	154.91		155.01	0.002045	1.50	8.79	10.16	0.41
942	20271	Regional_Fut	9.80	153.10	154.83		154.93	0.002363	1.54	7.93	9.65	0.43
942	20235	2yr_Ex	2.50	152.93	153.73	153.50	153.79	0.004218	1.11	2.25	4.36	0.49
942	20235	5yr_Ex	3.90	152.93	153.94	153.63	154.01	0.003272	1.23	3.28	5.76	0.46
942	20235	10yr_Ex	5.50	152.93	154.17	153.76	154.24	0.002399	1.26	4.80	7.14	0.41
942	20235	25yr_Ex	6.90	152.93	154.34	153.86	154.42	0.002008	1.29	6.09	7.69	0.39
942	20235	50yr_Ex	8.40	152.93	154.65	153.95	154.71	0.001159	1.15	8.62	8.66	0.31
942	20235	100yr_Ex	10.40	152.93	154.88	154.09	154.94	0.000990	1.18	10.57	9.38	0.29
942	20235	Regional_Ex	9.80	152.93	154.79	154.05	154.85	0.001101	1.20	9.79	9.09	0.30
942	20235	2yr_Fut	2.50	152.93	153.73	153.50	153.79	0.004218	1.11	2.25	4.36	0.49
942	20235	5yr_Fut	3.90	152.93	153.94	153.63	154.01	0.003272	1.23	3.28	5.76	0.46
942	20235	10yr_Fut	5.50	152.93	154.17	153.76	154.24	0.002399	1.26	4.80	7.14	0.41
942	20235	25yr_Fut	6.90	152.93	154.34	153.86	154.42	0.002008	1.29	6.09	7.69	0.39
942	20235	50yr_Fut	8.40	152.93	154.65	153.95	154.71	0.001159	1.15	8.62	8.66	0.31
942	20235	100yr_Fut	10.40	152.93	154.88	154.09	154.94	0.000990	1.18	10.57	9.38	0.29
942	20235	Regional_Fut	9.80	152.93	154.79	154.05	154.85	0.001101	1.20	9.79	9.09	0.30
942	20217 7-Wolfedale Rd		Bridge									
942	20198	2yr_Ex	2.50	152.59	153.58		153.63	0.002736	1.00	2.51	4.17	0.40
942	20198	5yr_Ex	3.90	152.59	153.77		153.84	0.002776	1.19	3.32	4.70	0.43
942	20198	10yr_Ex	5.50	152.59	153.94		154.04	0.002760	1.36	4.20	5.21	0.44
942	20198	25yr_Ex	6.90	152.59	154.08		154.19	0.002739	1.48	4.95	5.82	0.45
942	20198	50yr_Ex	8.40	152.59	154.21		154.33	0.002706	1.58	5.76	6.51	0.45
942	20198	100yr_Ex	10.40	152.59	154.37		154.51	0.002653	1.70	6.88	7.69	0.46
942	20198	Regional_Ex	9.80	152.59	154.31		154.45	0.002779	1.69	6.43	7.29	0.46
942	20198	2yr_Fut	2.50	152.59	153.58		153.63	0.002736	1.00	2.51	4.17	0.40
942	20198	5yr_Fut	3.90	152.59	153.77		153.84	0.002776	1.19	3.32	4.70	0.43
942	20198	10yr_Fut	5.50	152.59	153.94		154.04	0.002760	1.36	4.20	5.21	0.44

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
942	20198	25yr_Fut	6.90	152.59	154.08		154.19	0.002739	1.48	4.95	5.82	0.45
942	20198	50yr_Fut	8.40	152.59	154.21		154.33	0.002706	1.58	5.76	6.51	0.45
942	20198	100yr_Fut	10.40	152.59	154.37		154.51	0.002653	1.70	6.88	7.69	0.46
942	20198	Regional_Fut	9.80	152.59	154.31		154.45	0.002779	1.69	6.43	7.29	0.46
942	20164	2yr_Ex	2.50	152.43	153.50		153.53	0.002736	0.71	3.51	5.48	0.28
942	20164	5yr_Ex	3.90	152.43	153.69		153.73	0.002875	0.86	4.57	6.10	0.30
942	20164	10yr_Ex	5.50	152.43	153.87		153.92	0.002936	0.99	5.73	6.72	0.32
942	20164	25yr_Ex	6.90	152.43	154.01		154.07	0.002959	1.09	6.70	7.18	0.32
942	20164	50yr_Ex	8.40	152.43	154.14		154.21	0.002979	1.18	7.70	7.63	0.33
942	20164	100yr_Ex	10.40	152.43	154.30		154.38	0.003026	1.28	8.95	8.16	0.34
942	20164	Regional_Ex	9.80	152.43	154.24		154.32	0.003152	1.27	8.44	7.95	0.34
942	20164	2yr_Fut	2.50	152.43	153.50		153.53	0.002736	0.71	3.51	5.48	0.28
942	20164	5yr_Fut	3.90	152.43	153.69		153.73	0.002875	0.86	4.57	6.10	0.30
942	20164	10yr_Fut	5.50	152.43	153.87		153.92	0.002936	0.99	5.73	6.72	0.32
942	20164	25yr_Fut	6.90	152.43	154.01		154.07	0.002959	1.09	6.70	7.18	0.32
942	20164	50yr_Fut	8.40	152.43	154.14		154.21	0.002979	1.18	7.70	7.63	0.33
942	20164	100yr_Fut	10.40	152.43	154.30		154.38	0.003026	1.28	8.95	8.16	0.34
942	20164	Regional_Fut	9.80	152.43	154.24		154.32	0.003152	1.27	8.44	7.95	0.34
942	20089	2yr_Ex	2.50	152.38	153.23	152.96	153.28	0.004167	1.02	2.46	4.68	0.45
942	20089	5yr_Ex	3.90	152.38	153.41	153.09	153.48	0.003702	1.17	3.40	5.35	0.44
942	20089	10yr_Ex	5.50	152.38	153.59	153.22	153.68	0.003417	1.31	4.43	6.00	0.44
942	20089	25yr_Ex	6.90	152.38	153.73	153.30	153.83	0.003262	1.41	5.30	6.53	0.44
942	20089	50yr_Ex	8.40	152.38	153.87	153.39	153.98	0.003177	1.50	6.21	7.10	0.44
942	20089	100yr_Ex	10.40	152.38	154.02	153.50	154.15	0.003182	1.63	7.32	7.79	0.45
942	20089	Regional_Ex	9.80	152.38	153.92	153.47	154.06	0.003683	1.67	6.60	7.35	0.48
942	20089	2yr_Fut	2.50	152.38	153.23	152.96	153.28	0.004167	1.02	2.46	4.68	0.45
942	20089	5yr_Fut	3.90	152.38	153.41	153.09	153.48	0.003702	1.17	3.40	5.35	0.44
942	20089	10yr_Fut	5.50	152.38	153.59	153.22	153.68	0.003417	1.31	4.43	6.00	0.44
942	20089	25yr_Fut	6.90	152.38	153.73	153.30	153.83	0.003262	1.41	5.30	6.53	0.44
942	20089	50yr_Fut	8.40	152.38	153.87	153.39	153.98	0.003177	1.50	6.21	7.10	0.44
942	20089	100yr_Fut	10.40	152.38	154.02	153.50	154.15	0.003182	1.63	7.32	7.79	0.45
942	20089	Regional_Fut	9.80	152.38	153.92	153.47	154.06	0.003683	1.67	6.60	7.35	0.48
942	20033	2yr_Ex	2.50	152.08	153.04		153.08	0.003024	0.88	2.83	4.96	0.37
942	20033	5yr_Ex	3.90	152.08	153.26		153.31	0.002483	0.99	4.01	5.82	0.36
942	20033	10yr_Ex	5.50	152.08	153.45		153.51	0.002326	1.12	5.23	6.58	0.36
942	20033	25yr_Ex	6.90	152.08	153.60		153.67	0.002259	1.21	6.25	7.16	0.36
942	20033	50yr_Ex	8.40	152.08	153.74		153.82	0.002248	1.30	7.26	7.69	0.37
942	20033	100yr_Ex	10.40	152.08	153.89		153.98	0.002329	1.42	8.45	8.27	0.38
942	20033	Regional_Ex	9.80	152.08	153.76		153.87	0.002890	1.49	7.42	7.78	0.42
942	20033	2yr_Fut	2.50	152.08	153.04		153.08	0.003024	0.88	2.83	4.96	0.37
942	20033	5yr_Fut	3.90	152.08	153.26		153.31	0.002483	0.99	4.01	5.82	0.36
942	20033	10yr_Fut	5.50	152.08	153.45		153.51	0.002326	1.12	5.23	6.58	0.36
942	20033	25yr_Fut	6.90	152.08	153.60		153.67	0.002259	1.21	6.25	7.16	0.36
942	20033	50yr_Fut	8.40	152.08	153.74		153.82	0.002248	1.30	7.26	7.69	0.37
942	20033	100yr_Fut	10.40	152.08	153.89		153.98	0.002329	1.42	8.45	8.27	0.38
942	20033	Regional_Fut	9.80	152.08	153.76		153.87	0.002891	1.49	7.42	7.78	0.42
941-M2	13924	2yr_Ex	4.90	151.68	152.63	152.45	152.77	0.006590	1.63	3.02	4.86	0.65
941-M2	13924	5yr_Ex	7.60	151.68	152.84	152.64	153.02	0.006533	1.89	4.09	5.51	0.67
941-M2	13924	10yr_Ex	10.40	151.68	153.02	152.80	153.24	0.006297	2.11	5.11	6.06	0.68
941-M2	13924	25yr_Ex	12.70	151.68	153.15	152.91	153.41	0.006037	2.26	5.96	6.49	0.68
941-M2	13924	50yr_Ex	15.00	151.68	153.26	153.01	153.55	0.006170	2.42	6.67	6.83	0.70
941-M2	13924	100yr_Ex	17.70	151.68	153.37	153.13	153.71	0.006315	2.60	7.47	7.19	0.72
941-M2	13924	Regional_Ex	15.40	151.68	153.28	153.03	153.58	0.006189	2.45	6.79	6.88	0.70
941-M2	13924	2yr_Fut	4.90	151.68	152.63	152.45	152.77	0.006590	1.63	3.02	4.86	0.65
941-M2	13924	5yr_Fut	7.60	151.68	152.84	152.64	153.02	0.006533	1.89	4.09	5.51	0.67
941-M2	13924	10yr_Fut	10.40	151.68	153.02	152.80	153.24	0.006297	2.11	5.11	6.06	0.68
941-M2	13924	25yr_Fut	12.70	151.68	153.15	152.91	153.41	0.006037	2.26	5.96	6.49	0.68
941-M2	13924	50yr_Fut	15.00	151.68	153.26	153.01	153.55	0.006170	2.42	6.67	6.83	0.70
941-M2	13924	100yr_Fut	17.70	151.68	153.37	153.13	153.71	0.006315	2.60	7.47	7.19	0.72
941-M2	13924	Regional_Fut	15.40	151.68	153.28	153.03	153.58	0.006201	2.45	6.79	6.88	0.70
941-M2	13812	2yr_Ex	4.90	150.74	151.60	151.53	151.80	0.011620	1.96	2.50	4.53	0.84
941-M2	13812	5yr_Ex	7.60	150.74	151.77	151.72	152.04	0.011946	2.29	3.33	5.10	0.88
941-M2	13812	10yr_Ex	10.40	150.74	151.90	151.87	152.25	0.012737	2.64	3.99	5.51	0.94
941-M2	13812	25yr_Ex	12.70	150.74	151.98	151.98	152.41	0.013515	2.91	4.48	5.79	0.98
941-M2	13812	50yr_Ex	15.00	150.74	152.09	152.09	152.57	0.012864	3.06	5.12	6.14	0.98
941-M2	13812	100yr_Ex	17.70	150.74	152.21	152.21	152.73	0.012238	3.22	5.87	6.54	0.97
941-M2	13812	Regional_Ex	15.40	150.74	152.11	152.11	152.59	0.012758	3.09	5.23	6.20	0.98
941-M2	13812	2yr_Fut	4.90	150.74	151.60	151.53	151.80	0.011620	1.96	2.50	4.53	0.84
941-M2	13812	5yr_Fut	7.60	150.74	151.77	151.72	152.04	0.011946	2.29	3.33	5.10	0.88
941-M2	13812	10yr_Fut	10.40	150.74	151.90	151.87	152.25	0.012737	2.64	3.99	5.51	0.94
941-M2	13812	25yr_Fut	12.70	150.74	151.98	151.98	152.41	0.013515	2.91	4.48	5.79	0.98
941-M2	13812	50yr_Fut	15.00	150.74	152.09	152.09	152.57	0.012864	3.06	5.12	6.14	0.98
941-M2	13812	100yr_Fut	17.70	150.74	152.21	152.21	152.73	0.012238	3.22	5.87	6.54	0.97
941-M2	13812	Regional_Fut	15.40	150.74	152.11	152.11	152.59	0.012758	3.09	5.23	6.20	0.98
941-M2	13736	2yr_Ex	4.90	149.59	150.49	150.49	150.75	0.016698	2.23	2.20	4.31	1.00
941-M2	13736	5yr_Ex	7.60	149.59	150.68	150.68	150.99	0.016069	2.48	3.07	4.94	1.00
941-M2	13736	10yr_Ex	10.40	149.59	150.85	150.85	151.20	0.015275	2.64	3.93	5.49	1.00
941-M2	13736	25yr_Ex	12.70	149.59	151.00	150.96	151.36	0.012915	2.64	4.82	6.00	0.93
941-M2	13736	50yr_Ex	15.00	149.59	151.13	151.06	151.50	0.011279	2.67	5.65	6.44	0.89
941-M2	13736	100yr_Ex	17.70	149.59	151.26	151.17	151.65	0.010473	2.75	6.51	6.86	0.87
941-M2	13736	Regional_Ex	15.40	149.59	151.47	151.08	151.67	0.004260	1.98	8.00	7.66	0.57

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M2	13736	2yr_Fut	4.90	149.59	150.49	150.49	150.75	0.016698	2.23	2.20	4.31	1.00
941-M2	13736	5yr_Fut	7.60	149.59	150.68	150.68	150.99	0.016069	2.48	3.07	4.94	1.00
941-M2	13736	10yr_Fut	10.40	149.59	150.85	150.85	151.20	0.015275	2.64	3.93	5.49	1.00
941-M2	13736	25yr_Fut	12.70	149.59	151.00	150.96	151.36	0.012915	2.64	4.82	6.00	0.93
941-M2	13736	50yr_Fut	15.00	149.59	151.13	151.06	151.50	0.011279	2.67	5.65	6.44	0.89
941-M2	13736	100yr_Fut	17.70	149.59	151.26	151.17	151.65	0.010473	2.75	6.51	6.86	0.87
941-M2	13736	Regional_Fut	15.40	149.59	151.05	151.08	151.51	0.015863	3.01	5.12	6.16	1.04
941-M2	13684	2yr_Ex	4.90	149.17	150.28	149.88	150.35	0.002416	1.18	4.23	5.68	0.41
941-M2	13684	5yr_Ex	7.60	149.17	150.56	150.06	150.65	0.002189	1.36	5.93	6.53	0.41
941-M2	13684	10yr_Ex	10.40	149.17	150.78	150.21	150.90	0.002171	1.53	7.54	7.78	0.42
941-M2	13684	25yr_Ex	12.70	149.17	150.92	150.32	151.06	0.002273	1.68	8.70	54.89	0.44
941-M2	13684	50yr_Ex	15.00	149.17	151.05	150.43	151.21	0.002335	1.80	9.81	71.42	0.45
941-M2	13684	100yr_Ex	17.70	149.17	151.17	150.55	151.36	0.002497	1.95	10.88	77.27	0.47
941-M2	13684	Regional_Ex	15.40	149.17	151.44	150.45	151.54	0.001125	1.44	13.27	84.45	0.33
941-M2	13684	2yr_Fut	4.90	149.17	150.28	149.88	150.35	0.002416	1.18	4.23	5.68	0.41
941-M2	13684	5yr_Fut	7.60	149.17	150.56	150.06	150.65	0.002189	1.36	5.93	6.53	0.41
941-M2	13684	10yr_Fut	10.40	149.17	150.78	150.21	150.90	0.002171	1.53	7.54	7.78	0.42
941-M2	13684	25yr_Fut	12.70	149.17	150.92	150.32	151.06	0.002273	1.68	8.70	54.89	0.44
941-M2	13684	50yr_Fut	15.00	149.17	151.05	150.43	151.21	0.002335	1.80	9.81	71.42	0.45
941-M2	13684	100yr_Fut	17.70	149.17	151.17	150.55	151.36	0.002497	1.95	10.88	77.27	0.47
941-M2	13684	Regional_Fut	15.40	149.17	150.98	150.45	151.17	0.002892	1.94	9.21	62.87	0.50
941-M2	13643	2yr_Ex	7.20	148.67	149.71	149.71	150.06	0.017007	2.63	2.74	3.94	1.01
941-M2	13643	5yr_Ex	10.90	148.67	149.96	149.96	150.38	0.016097	2.88	3.78	4.46	1.00
941-M2	13643	10yr_Ex	14.40	148.67	150.15	150.15	150.63	0.015901	3.09	4.66	4.86	1.01
941-M2	13643	25yr_Ex	16.90	148.67	150.27	150.27	150.79	0.015367	3.21	5.27	5.12	1.00
941-M2	13643	50yr_Ex	19.40	148.67	150.38	150.38	150.94	0.014899	3.32	5.86	5.35	1.00
941-M2	13643	100yr_Ex	22.10	148.67	150.53	150.48	151.10	0.013211	3.35	6.66	5.66	0.95
941-M2	13643	Regional_Ex	25.20	148.67	151.04		151.40	0.005396	2.69	9.85	6.74	0.65
941-M2	13643	2yr_Fut	7.20	148.67	149.71	149.71	150.06	0.017007	2.63	2.74	3.94	1.01
941-M2	13643	5yr_Fut	10.90	148.67	149.96	149.96	150.38	0.016097	2.88	3.78	4.46	1.00
941-M2	13643	10yr_Fut	14.40	148.67	150.15	150.15	150.63	0.015901	3.09	4.66	4.86	1.01
941-M2	13643	25yr_Fut	16.90	148.67	150.27	150.27	150.79	0.015367	3.21	5.27	5.12	1.00
941-M2	13643	50yr_Fut	19.40	148.67	150.38	150.38	150.94	0.014899	3.32	5.86	5.35	1.00
941-M2	13643	100yr_Fut	22.10	148.67	150.53	150.48	151.10	0.013211	3.35	6.66	5.66	0.95
941-M2	13643	Regional_Fut	18.30	148.67	150.33	150.33	150.88	0.015076	3.27	5.60	5.25	1.00
941-M2	13606	2yr_Ex	7.20	148.16	149.19	148.96	149.32	0.005557	1.60	4.49	6.35	0.61
941-M2	13606	5yr_Ex	10.90	148.16	149.59	149.15	149.71	0.003341	1.50	7.28	7.57	0.49
941-M2	13606	10yr_Ex	14.40	148.16	149.94	149.30	150.04	0.002359	1.42	10.14	8.88	0.42
941-M2	13606	25yr_Ex	16.90	148.16	150.16	149.39	150.26	0.001859	1.39	12.21	9.53	0.38
941-M2	13606	50yr_Ex	19.40	148.16	150.37	149.49	150.47	0.001498	1.38	14.35	10.50	0.35
941-M2	13606	100yr_Ex	22.10	148.16	150.67	149.59	150.76	0.001079	1.31	17.67	11.86	0.31
941-M2	13606	Regional_Ex	25.20	148.16	151.13	149.70	151.20	0.000650	1.18	23.42	34.96	0.25
941-M2	13606	2yr_Fut	7.20	148.16	149.19	148.96	149.32	0.005557	1.60	4.49	6.35	0.61
941-M2	13606	5yr_Fut	10.90	148.16	149.59	149.15	149.71	0.003341	1.50	7.28	7.57	0.49
941-M2	13606	10yr_Fut	14.40	148.16	149.94	149.30	150.04	0.002359	1.42	10.14	8.88	0.42
941-M2	13606	25yr_Fut	16.90	148.16	150.16	149.39	150.26	0.001859	1.39	12.21	9.53	0.38
941-M2	13606	50yr_Fut	19.40	148.16	150.37	149.49	150.47	0.001498	1.38	14.35	10.50	0.35
941-M2	13606	100yr_Fut	22.10	148.16	150.67	149.59	150.76	0.001079	1.31	17.67	11.86	0.31
941-M2	13606	Regional_Fut	18.30	148.16	150.28	149.45	150.38	0.001637	1.38	13.40	10.08	0.36
941-M2	13556 5-Central Pkwy		Culvert									
941-M2	13526	2yr_Ex	7.20	147.57	148.88	148.47	148.96	0.002457	1.28	5.93	8.15	0.43
941-M2	13526	5yr_Ex	10.90	147.57	149.13	148.66	149.24	0.002395	1.49	8.16	9.40	0.44
941-M2	13526	10yr_Ex	14.40	147.57	149.34	148.80	149.47	0.002329	1.64	10.23	10.32	0.45
941-M2	13526	25yr_Ex	16.90	147.57	149.48	148.90	149.62	0.002294	1.73	11.66	10.85	0.45
941-M2	13526	50yr_Ex	19.40	147.57	149.60	148.99	149.76	0.002274	1.82	13.04	11.34	0.46
941-M2	13526	100yr_Ex	22.10	147.57	149.73	149.08	149.90	0.002251	1.90	14.50	11.81	0.46
941-M2	13526	Regional_Ex	25.20	147.57	149.87	149.19	150.05	0.002212	1.98	16.17	12.30	0.46
941-M2	13526	2yr_Fut	7.20	147.57	148.88	148.47	148.96	0.002457	1.28	5.93	8.15	0.43
941-M2	13526	5yr_Fut	10.90	147.57	149.13	148.66	149.24	0.002395	1.49	8.16	9.40	0.44
941-M2	13526	10yr_Fut	14.40	147.57	149.34	148.80	149.47	0.002329	1.64	10.23	10.32	0.45
941-M2	13526	25yr_Fut	16.90	147.57	149.48	148.90	149.62	0.002294	1.73	11.66	10.85	0.45
941-M2	13526	50yr_Fut	19.40	147.57	149.60	148.99	149.76	0.002274	1.82	13.04	11.34	0.46
941-M2	13526	100yr_Fut	22.10	147.57	149.73	149.08	149.90	0.002251	1.90	14.50	11.81	0.46
941-M2	13526	Regional_Fut	18.30	147.57	149.55	148.95	149.70	0.002283	1.78	12.43	11.13	0.45
941-M2	13499	2yr_Ex	7.20	147.42	148.46	148.46	148.76	0.016060	2.40	3.00	5.24	1.00
941-M2	13499	5yr_Ex	10.90	147.42	148.66	148.66	149.03	0.014332	2.70	4.12	6.07	0.99
941-M2	13499	10yr_Ex	14.40	147.42	148.82	148.82	149.25	0.013103	2.93	5.16	6.91	0.97
941-M2	13499	25yr_Ex	16.90	147.42	148.93	148.93	149.40	0.012394	3.06	5.93	7.48	0.96
941-M2	13499	50yr_Ex	19.40	147.42	149.03	149.03	149.53	0.011776	3.18	6.71	7.93	0.95
941-M2	13499	100yr_Ex	22.10	147.42	149.13	149.13	149.67	0.011310	3.30	7.54	8.34	0.95
941-M2	13499	Regional_Ex	25.20	147.42	149.24	149.24	149.82	0.010935	3.43	8.46	8.78	0.95
941-M2	13499	2yr_Fut	7.20	147.42	148.46	148.46	148.76	0.016060	2.40	3.00	5.24	1.00
941-M2	13499	5yr_Fut	10.90	147.42	148.66	148.66	149.03	0.014332	2.70	4.12	6.07	0.99
941-M2	13499	10yr_Fut	14.40	147.42	148.82	148.82	149.25	0.013103	2.93	5.16	6.91	0.97
941-M2	13499	25yr_Fut	16.90	147.42	148.93	148.93	149.40	0.012394	3.06	5.93	7.48	0.96
941-M2	13499	50yr_Fut	19.40	147.42	149.03	149.03	149.53	0.011776	3.18	6.71	7.93	0.95
941-M2	13499	100yr_Fut	22.10	147.42	149.13	149.13	149.67	0.011310	3.30	7.54	8.34	0.95
941-M2	13499	Regional_Fut	18.30	147.42	148.98	148.98	149.47	0.012001	3.13	6.37	7.76	0.96
941-M2	13371	2yr_Ex	7.20	145.91	147.27	146.85	147.35	0.002869	1.27	5.66	6.98	0.45
941-M2	13371	5yr_Ex	10.90	145.91	147.58	147.04	147.67	0.002399	1.38	8.01	8.13	0.43

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M2	13371	10yr_Ex	14.40	145.91	147.83	147.20	147.94	0.002105	1.45	10.20	9.06	0.41
941-M2	13371	25yr_Ex	16.90	145.91	147.95	147.30	148.07	0.002136	1.55	11.29	9.49	0.42
941-M2	13371	50yr_Ex	19.40	145.91	148.04	147.39	148.18	0.002250	1.66	12.18	9.83	0.44
941-M2	13371	100yr_Ex	22.10	145.91	148.14	147.47	148.30	0.002340	1.77	13.16	10.25	0.45
941-M2	13371	Regional_Ex	25.20	145.91	147.98	147.58	148.23	0.004458	2.26	11.53	9.58	0.61
941-M2	13371	2yr_Fut	7.20	145.91	147.27	146.85	147.35	0.002869	1.27	5.66	6.98	0.45
941-M2	13371	5yr_Fut	10.90	145.91	147.58	147.04	147.68	0.002364	1.37	8.06	8.15	0.42
941-M2	13371	10yr_Fut	14.40	145.91	147.84	147.20	147.94	0.002085	1.44	10.23	9.07	0.41
941-M2	13371	25yr_Fut	16.90	145.91	147.95	147.30	148.07	0.002136	1.55	11.29	9.49	0.42
941-M2	13371	50yr_Fut	19.40	145.91	148.04	147.39	148.18	0.002250	1.66	12.18	9.83	0.44
941-M2	13371	100yr_Fut	22.10	145.91	148.14	147.47	148.30	0.002340	1.77	13.16	10.25	0.45
941-M2	13371	Regional_Fut	18.30	145.91	147.94	147.35	148.08	0.002567	1.69	11.20	9.45	0.46
941-M2	13254	2yr_Ex	12.50	145.04	146.24	146.20	146.62	0.010694	2.78	5.08	6.72	0.91
941-M2	13254	5yr_Ex	18.60	145.04	146.47	146.47	146.99	0.011121	3.27	6.72	7.52	0.96
941-M2	13254	10yr_Ex	24.60	145.04	146.70	146.70	147.31	0.010524	3.57	8.50	8.31	0.96
941-M2	13254	25yr_Ex	27.60	145.04	146.81	146.81	147.45	0.010160	3.69	9.43	8.79	0.96
941-M2	13254	50yr_Ex	30.40	145.04	146.93	146.93	147.58	0.009354	3.72	10.51	9.34	0.93
941-M2	13254	100yr_Ex	33.20	145.04	147.02	147.02	147.69	0.009092	3.81	11.40	9.75	0.92
941-M2	13254	Regional_Ex	27.10	145.04	146.79	146.79	147.43	0.010167	3.67	9.29	8.72	0.96
941-M2	13254	2yr_Fut	12.50	145.04	146.24	146.20	146.62	0.010694	2.78	5.08	6.72	0.91
941-M2	13254	5yr_Fut	18.70	145.04	146.47	146.47	147.00	0.011202	3.29	6.73	7.53	0.96
941-M2	13254	10yr_Fut	24.70	145.04	146.70	146.70	147.31	0.010522	3.58	8.52	8.33	0.96
941-M2	13254	25yr_Fut	27.60	145.04	146.81	146.81	147.45	0.010160	3.69	9.43	8.79	0.96
941-M2	13254	50yr_Fut	30.40	145.04	146.93	146.93	147.58	0.009354	3.72	10.51	9.34	0.93
941-M2	13254	100yr_Fut	33.20	145.04	147.02	147.02	147.69	0.009092	3.81	11.40	9.75	0.92
941-M2	13254	Regional_Fut	27.00	145.04	146.78	146.78	147.42	0.010285	3.67	9.22	8.69	0.96
941-M2	13109	2yr_Ex	12.50	143.03	144.38	144.38	144.80	0.015006	2.88	4.39	5.59	1.00
941-M2	13109	5yr_Ex	18.60	143.03	145.04	144.65	145.30	0.004465	2.31	8.80	7.73	0.60
941-M2	13109	10yr_Ex	24.60	143.03	145.78	144.89	145.95	0.001848	1.93	15.47	13.28	0.41
941-M2	13109	25yr_Ex	27.60	143.03	146.20	144.99	146.32	0.001103	1.68	21.39	14.35	0.33
941-M2	13109	50yr_Ex	30.40	143.03	146.37	145.08	146.49	0.001035	1.69	23.98	17.28	0.32
941-M2	13109	100yr_Ex	33.20	143.03	146.43	145.17	146.57	0.001115	1.78	25.34	26.74	0.33
941-M2	13109	Regional_Ex	27.10	143.03	146.13	144.98	146.26	0.001197	1.71	20.35	14.14	0.34
941-M2	13109	2yr_Fut	12.50	143.03	144.38	144.38	144.80	0.015006	2.88	4.39	5.59	1.00
941-M2	13109	5yr_Fut	18.70	143.03	145.06	144.65	145.31	0.004359	2.29	8.91	7.77	0.59
941-M2	13109	10yr_Fut	24.70	143.03	145.79	144.89	145.96	0.001827	1.93	15.61	13.33	0.41
941-M2	13109	25yr_Fut	27.60	143.03	146.20	144.99	146.32	0.001103	1.68	21.39	14.35	0.33
941-M2	13109	50yr_Fut	30.40	143.03	146.37	145.08	146.49	0.001035	1.69	23.98	17.28	0.32
941-M2	13109	100yr_Fut	33.20	143.03	146.43	145.17	146.57	0.001115	1.78	25.34	26.74	0.33
941-M2	13109	Regional_Fut	27.00	143.03	146.11	144.97	146.25	0.001215	1.72	20.16	14.13	0.34
941-M2	13033	2yr_Ex	12.50	141.90	144.03	142.83	144.05	0.000265	0.71	23.27	41.05	0.16
941-M2	13033	5yr_Ex	18.60	141.90	145.14	143.00	145.15	0.000098	0.58	41.84	44.65	0.11
941-M2	13033	10yr_Ex	24.60	141.90	145.84	143.25	145.85	0.000077	0.59	54.56	49.45	0.10
941-M2	13033	25yr_Ex	27.60	141.90	146.24	143.30	146.26	0.000066	0.59	62.32	50.48	0.09
941-M2	13033	50yr_Ex	30.40	141.90	146.43	143.35	146.43	0.000013	0.27	164.66	50.96	0.04
941-M2	13033	100yr_Ex	33.20	141.90	146.50	143.40	146.50	0.000015	0.29	168.02	51.13	0.04
941-M2	13033	Regional_Ex	27.10	141.90	146.17	143.29	146.19	0.000068	0.59	60.93	50.30	0.09
941-M2	13033	2yr_Fut	12.50	141.90	144.03	142.83	144.05	0.000265	0.71	23.27	41.05	0.16
941-M2	13033	5yr_Fut	18.70	141.90	145.16	143.00	145.17	0.000097	0.58	42.07	45.13	0.11
941-M2	13033	10yr_Fut	24.70	141.90	145.85	143.25	145.86	0.000077	0.60	54.75	49.47	0.10
941-M2	13033	25yr_Fut	27.60	141.90	146.24	143.30	146.26	0.000066	0.59	62.32	50.48	0.09
941-M2	13033	50yr_Fut	30.40	141.90	146.43	143.35	146.43	0.000013	0.27	164.66	50.96	0.04
941-M2	13033	100yr_Fut	33.20	141.90	146.50	143.40	146.50	0.000015	0.29	168.02	51.13	0.04
941-M2	13033	Regional_Fut	27.00	141.90	146.16	143.29	146.17	0.000068	0.59	60.68	50.27	0.09
941-M2	13016 4-CPR		Culvert									
941-M2	13002	2yr_Ex	12.50	141.53	142.75	142.75	143.14	0.014594	2.78	4.53	5.97	0.99
941-M2	13002	5yr_Ex	18.60	141.53	143.61	143.01	143.77	0.002960	1.82	10.76	24.52	0.49
941-M2	13002	10yr_Ex	24.60	141.53	143.74	143.24	143.97	0.003733	2.17	12.40	41.09	0.55
941-M2	13002	25yr_Ex	27.60	141.53	143.78	143.33	144.05	0.004318	2.37	12.85	43.50	0.60
941-M2	13002	50yr_Ex	30.40	141.53	143.80	143.42	144.12	0.004951	2.56	13.16	44.65	0.64
941-M2	13002	100yr_Ex	33.20	141.53	143.83	143.50	144.19	0.005541	2.74	13.52	45.97	0.68
941-M2	13002	Regional_Ex	27.10	141.53	143.77	143.32	144.04	0.004248	2.34	12.74	43.07	0.59
941-M2	13002	2yr_Fut	12.50	141.53	142.75	142.75	143.14	0.014594	2.78	4.53	5.97	0.99
941-M2	13002	5yr_Fut	18.70	141.53	143.62	143.01	143.78	0.002951	1.82	10.82	25.42	0.48
941-M2	13002	10yr_Fut	24.70	141.53	143.74	143.24	143.97	0.003783	2.18	12.37	40.93	0.56
941-M2	13002	25yr_Fut	27.60	141.53	143.78	143.33	144.05	0.004318	2.37	12.85	43.50	0.60
941-M2	13002	50yr_Fut	30.40	141.53	143.80	143.42	144.12	0.004951	2.56	13.16	44.65	0.64
941-M2	13002	100yr_Fut	33.20	141.53	143.83	143.50	144.19	0.005541	2.74	13.52	45.97	0.68
941-M2	13002	Regional_Fut	27.00	141.53	143.77	143.31	144.04	0.004197	2.33	12.77	43.18	0.59
941-M2	12921	2yr_Ex	12.50	140.08	142.63	141.54	142.71	0.001420	1.24	10.07	8.70	0.31
941-M2	12921	5yr_Ex	18.60	140.08	143.62	141.85	143.65	0.000321	0.81	31.20	50.64	0.16
941-M2	12921	10yr_Ex	24.60	140.08	143.78	142.09	143.81	0.000336	0.86	40.22	63.08	0.17
941-M2	12921	25yr_Ex	27.60	140.08	143.83	142.20	143.86	0.000359	0.90	43.53	68.82	0.17
941-M2	12921	50yr_Ex	30.40	140.08	143.87	142.30	143.90	0.000382	0.94	46.31	72.81	0.18
941-M2	12921	100yr_Ex	33.20	140.08	143.91	142.39	143.94	0.000395	0.96	49.79	82.02	0.18
941-M2	12921	Regional_Ex	27.10	140.08	143.82	142.18	143.85	0.000359	0.90	42.76	68.00	0.17
941-M2	12921	2yr_Fut	12.50	140.08	142.63	141.54	142.71	0.001420	1.24	10.07	8.70	0.31
941-M2	12921	5yr_Fut	18.70	140.08	143.63	141.86	143.65	0.000318	0.81	31.51	50.97	0.16
941-M2	12921	10yr_Fut	24.70	140.08	143.78	142.09	143.80	0.000341	0.87	40.10	62.61	0.17
941-M2	12921	25yr_Fut	27.60	140.08	143.83	142.20	143.86	0.000359	0.90	43.53	68.82	0.17
941-M2	12921	50yr_Fut	30.40	140.08	143.87	142.30	143.90	0.000382	0.94	46.31	72.81	0.18

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Reach	River Sta	Profile	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)	
941-M2	12921	100yr_Fut	33.20	140.08	143.91	142.39	143.94	0.000395	0.96	49.79	82.02	0.18
941-M2	12921	Regional_Fut	27.00	140.08	143.82	142.18	143.85	0.000355	0.89	42.87	68.12	0.17
941-M2	12905 3-Spurline		Culvert									
941-M2	12892	2yr_Ex	12.50	139.92	142.08	141.37	142.18	0.001878	1.48	8.97	8.51	0.39
941-M2	12892	5yr_Ex	18.60	139.92	142.39	141.63	142.55	0.002169	1.81	11.01	10.64	0.43
941-M2	12892	10yr_Ex	24.60	139.92	142.64	141.86	142.85	0.002439	2.09	12.63	17.56	0.46
941-M2	12892	25yr_Ex	27.60	139.92	142.76	141.95	142.99	0.002539	2.21	13.40	23.73	0.48
941-M2	12892	50yr_Ex	30.40	139.92	142.84	142.04	143.11	0.002691	2.34	13.97	37.31	0.49
941-M2	12892	100yr_Ex	33.20	139.92	142.92	142.12	143.22	0.002852	2.46	14.49	52.05	0.51
941-M2	12892	Regional_Ex	27.10	139.92	142.74	141.94	142.97	0.002514	2.19	13.29	22.58	0.47
941-M2	12892	2yr_Fut	12.50	139.92	142.08	141.37	142.18	0.001878	1.48	8.97	8.51	0.39
941-M2	12892	5yr_Fut	18.70	139.92	142.39	141.64	142.56	0.002172	1.81	11.04	10.68	0.43
941-M2	12892	10yr_Fut	24.70	139.92	142.64	141.86	142.85	0.002453	2.10	12.64	17.64	0.46
941-M2	12892	25yr_Fut	27.60	139.92	142.76	141.95	142.99	0.002539	2.21	13.40	23.73	0.48
941-M2	12892	50yr_Fut	30.40	139.92	142.84	142.04	143.11	0.002691	2.34	13.97	37.31	0.49
941-M2	12892	100yr_Fut	33.20	139.92	142.92	142.12	143.22	0.002852	2.46	14.49	52.05	0.51
941-M2	12892	Regional_Fut	27.00	139.92	142.74	141.93	142.97	0.002509	2.19	13.27	22.42	0.47
941-M2	12861	2yr_Ex	12.50	140.56	141.61	141.61	141.98	0.011497	2.86	5.71	8.38	0.94
941-M2	12861	5yr_Ex	18.60	140.56	141.85	141.85	142.32	0.011129	3.27	7.83	9.42	0.96
941-M2	12861	10yr_Ex	24.60	140.56	142.06	142.06	142.61	0.010734	3.58	9.88	10.41	0.97
941-M2	12861	25yr_Ex	27.60	140.56	142.14	142.14	142.74	0.010884	3.75	10.77	10.98	0.99
941-M2	12861	50yr_Ex	30.40	140.56	142.24	142.24	142.86	0.010256	3.81	11.97	12.11	0.97
941-M2	12861	100yr_Ex	33.20	140.56	142.34	142.34	142.97	0.009829	3.87	13.16	13.12	0.96
941-M2	12861	Regional_Ex	27.10	140.56	142.12	142.12	142.72	0.011022	3.73	10.55	10.77	0.99
941-M2	12861	2yr_Fut	12.50	140.56	141.61	141.61	141.98	0.011497	2.86	5.71	8.38	0.94
941-M2	12861	5yr_Fut	18.70	140.56	141.85	141.85	142.33	0.011184	3.28	7.85	9.43	0.97
941-M2	12861	10yr_Fut	24.70	140.56	142.06	142.06	142.61	0.010594	3.57	9.96	10.44	0.97
941-M2	12861	25yr_Fut	27.60	140.56	142.14	142.14	142.74	0.010884	3.75	10.77	10.98	0.99
941-M2	12861	50yr_Fut	30.40	140.56	142.24	142.24	142.86	0.010256	3.81	11.97	12.11	0.97
941-M2	12861	100yr_Fut	33.20	140.56	142.34	142.34	142.97	0.009829	3.87	13.16	13.12	0.96
941-M2	12861	Regional_Fut	27.00	140.56	142.12	142.12	142.71	0.011045	3.73	10.51	10.73	0.99
941-M2	12763	2yr_Ex	12.50	139.58	140.81	140.62	141.03	0.007631	2.09	5.99	7.22	0.73
941-M2	12763	5yr_Ex	18.60	139.58	141.08	140.87	141.35	0.007336	2.30	8.09	8.18	0.74
941-M2	12763	10yr_Ex	24.60	139.58	141.30	141.07	141.62	0.006777	2.50	9.91	8.92	0.73
941-M2	12763	25yr_Ex	27.60	139.58	141.39	141.15	141.74	0.006564	2.59	10.80	9.54	0.73
941-M2	12763	50yr_Ex	30.40	139.58	141.49	141.22	141.85	0.006286	2.66	11.73	10.48	0.72
941-M2	12763	100yr_Ex	33.20	139.58	141.58	141.29	141.95	0.006064	2.72	12.69	11.37	0.71
941-M2	12763	Regional_Ex	27.10	139.58	141.38	141.14	141.72	0.006574	2.57	10.66	9.45	0.73
941-M2	12763	2yr_Fut	12.50	139.58	140.81	140.62	141.03	0.007631	2.09	5.99	7.22	0.73
941-M2	12763	5yr_Fut	18.70	139.58	141.09	140.87	141.36	0.007313	2.30	8.13	8.19	0.73
941-M2	12763	10yr_Fut	24.70	139.58	141.30	141.07	141.62	0.006793	2.51	9.93	8.93	0.73
941-M2	12763	25yr_Fut	27.60	139.58	141.39	141.15	141.74	0.006564	2.59	10.80	9.54	0.73
941-M2	12763	50yr_Fut	30.40	139.58	141.49	141.22	141.85	0.006286	2.66	11.73	10.48	0.72
941-M2	12763	100yr_Fut	33.20	139.58	141.58	141.29	141.95	0.006064	2.72	12.69	11.37	0.71
941-M2	12763	Regional_Fut	27.00	139.58	141.38	141.14	141.71	0.006581	2.57	10.63	9.43	0.73
941-M2	12692	2yr_Ex	12.50	138.54	139.85	139.85	140.25	0.014954	2.79	4.49	5.79	1.00
941-M2	12692	5yr_Ex	18.60	138.54	140.10	140.10	140.60	0.013197	3.14	6.02	6.47	0.98
941-M2	12692	10yr_Ex	24.60	138.54	140.32	140.32	140.91	0.012086	3.41	7.50	7.07	0.97
941-M2	12692	25yr_Ex	27.60	138.54	140.42	140.42	141.05	0.011567	3.52	8.25	7.35	0.96
941-M2	12692	50yr_Ex	30.40	138.54	140.51	140.51	141.17	0.011293	3.63	8.91	7.62	0.96
941-M2	12692	100yr_Ex	33.20	138.54	140.60	140.60	141.29	0.010927	3.71	9.61	7.91	0.95
941-M2	12692	Regional_Ex	27.10	138.54	140.41	140.41	141.03	0.011702	3.51	8.11	7.30	0.97
941-M2	12692	2yr_Fut	12.50	138.54	139.85	139.85	140.25	0.014954	2.79	4.49	5.79	1.00
941-M2	12692	5yr_Fut	18.70	138.54	140.11	140.11	140.61	0.013207	3.15	6.04	6.48	0.98
941-M2	12692	10yr_Fut	24.70	138.54	140.33	140.33	140.91	0.012017	3.41	7.54	7.08	0.97
941-M2	12692	25yr_Fut	27.60	138.54	140.42	140.42	141.05	0.011567	3.52	8.25	7.35	0.96
941-M2	12692	50yr_Fut	30.40	138.54	140.51	140.51	141.17	0.011293	3.63	8.91	7.62	0.96
941-M2	12692	100yr_Fut	33.20	138.54	140.60	140.60	141.29	0.010927	3.71	9.61	7.91	0.95
941-M2	12692	Regional_Fut	27.00	138.54	140.40	140.40	141.02	0.011719	3.51	8.09	7.29	0.97
941-M2	12558	2yr_Ex	12.50	137.32	138.88	138.61	139.08	0.004820	2.08	6.93	8.38	0.62
941-M2	12558	5yr_Ex	18.60	137.32	139.16	138.88	139.41	0.004689	2.37	9.46	9.71	0.63
941-M2	12558	10yr_Ex	24.60	137.32	139.38	139.09	139.68	0.004686	2.61	11.71	10.66	0.65
941-M2	12558	25yr_Ex	27.60	137.32	139.48	139.19	139.80	0.004679	2.71	12.80	11.09	0.65
941-M2	12558	50yr_Ex	30.40	137.32	139.56	139.27	139.90	0.004756	2.81	13.70	11.43	0.67
941-M2	12558	100yr_Ex	33.20	137.32	139.64	139.34	140.00	0.004729	2.89	14.69	11.80	0.67
941-M2	12558	Regional_Ex	27.10	137.32	139.46	139.17	139.78	0.004698	2.70	12.60	11.01	0.65
941-M2	12558	2yr_Fut	12.50	137.32	138.88	138.61	139.08	0.004820	2.08	6.93	8.38	0.62
941-M2	12558	5yr_Fut	18.70	137.32	139.16	138.88	139.42	0.004682	2.37	9.50	9.73	0.63
941-M2	12558	10yr_Fut	24.70	137.32	139.38	139.10	139.68	0.004715	2.61	11.72	10.66	0.65
941-M2	12558	25yr_Fut	27.60	137.32	139.48	139.19	139.80	0.004679	2.71	12.80	11.09	0.65
941-M2	12558	50yr_Fut	30.40	137.32	139.56	139.27	139.90	0.004756	2.81	13.70	11.43	0.67
941-M2	12558	100yr_Fut	33.20	137.32	139.64	139.34	140.00	0.004729	2.89	14.69	11.80	0.67
941-M2	12558	Regional_Fut	27.00	137.32	139.46	139.17	139.77	0.004687	2.69	12.57	11.00	0.65
941-M2	12448	2yr_Ex	12.50	136.70	137.91	137.88	138.27	0.012050	2.67	4.79	6.57	0.93
941-M2	12448	5yr_Ex	18.60	136.70	138.14	138.14	138.62	0.011770	3.09	6.38	7.52	0.96
941-M2	12448	10yr_Ex	24.60	136.70	138.35	138.35	138.90	0.010845	3.35	8.07	8.42	0.95
941-M2	12448	25yr_Ex	27.60	136.70	138.45	138.45	139.03	0.010450	3.45	8.93	8.86	0.94
941-M2	12448	50yr_Ex	30.40	136.70	138.55	138.54	139.15	0.009783	3.50	9.86	9.35	0.92
941-M2	12448	100yr_Ex	33.20	136.70	138.64	138.63	139.26	0.009569	3.59	10.65	9.75	0.92
941-M2	12448	Regional_Ex	27.10	136.70	138.44	138.44	139.01	0.010473	3.43	8.80	8.79	0.94

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M2	12448	2yr_Fut	12.50	136.70	137.91	137.88	138.27	0.012050	2.67	4.79	6.57	0.93
941-M2	12448	5yr_Fut	18.70	136.70	138.14	138.14	138.62	0.011783	3.09	6.40	7.54	0.96
941-M2	12448	10yr_Fut	24.70	136.70	138.36	138.36	138.91	0.010704	3.34	8.14	8.46	0.94
941-M2	12448	25yr_Fut	27.60	136.70	138.45	138.45	139.03	0.010450	3.45	8.93	8.86	0.94
941-M2	12448	50yr_Fut	30.40	136.70	138.55	138.54	139.15	0.009783	3.50	9.86	9.35	0.92
941-M2	12448	100yr_Fut	33.20	136.70	138.64	138.63	139.26	0.009569	3.59	10.65	9.75	0.92
941-M2	12448	Regional_Fut	27.00	136.70	138.43	138.43	139.01	0.010524	3.43	8.76	8.77	0.94
941-M2	12385	2yr_Ex	12.50	136.10	137.09	137.09	137.50	0.012441	2.95	5.13	6.80	0.99
941-M2	12385	5yr_Ex	18.60	136.10	137.34	137.34	137.87	0.011826	3.38	6.87	7.19	1.01
941-M2	12385	10yr_Ex	24.60	136.10	137.55	137.56	138.19	0.011476	3.73	8.45	7.55	1.02
941-M2	12385	25yr_Ex	27.60	136.10	137.65	137.66	138.34	0.011189	3.87	9.25	7.77	1.02
941-M2	12385	50yr_Ex	30.40	136.10	137.74	137.74	138.48	0.011054	4.01	9.97	8.10	1.02
941-M2	12385	100yr_Ex	33.20	136.10	137.85	137.85	138.61	0.010525	4.08	10.86	8.61	1.01
941-M2	12385	Regional_Ex	27.10	136.10	137.64	137.65	138.32	0.011265	3.85	9.11	7.73	1.02
941-M2	12385	2yr_Fut	12.50	136.10	137.09	137.09	137.50	0.012441	2.95	5.13	6.80	0.99
941-M2	12385	5yr_Fut	18.70	136.10	137.34	137.34	137.88	0.011800	3.39	6.91	7.20	1.01
941-M2	12385	10yr_Fut	24.70	136.10	137.55	137.56	138.20	0.011571	3.75	8.45	7.55	1.02
941-M2	12385	25yr_Fut	27.60	136.10	137.65	137.66	138.34	0.011189	3.87	9.25	7.77	1.02
941-M2	12385	50yr_Fut	30.40	136.10	137.74	137.74	138.48	0.011054	4.01	9.97	8.10	1.02
941-M2	12385	100yr_Fut	33.20	136.10	137.85	137.85	138.61	0.010525	4.08	10.86	8.61	1.01
941-M2	12385	Regional_Fut	27.00	136.10	137.63	137.65	138.31	0.011241	3.85	9.10	7.72	1.02
941-M2	12320	2yr_Ex	12.50	134.42	135.04	135.37	136.15	0.035933	4.66	2.68	4.77	1.99
941-M2	12320	5yr_Ex	18.60	134.42	135.23	135.64	136.59	0.032618	5.17	3.60	4.87	1.92
941-M2	12320	10yr_Ex	24.60	134.42	135.40	135.87	136.96	0.030380	5.52	4.45	4.96	1.86
941-M2	12320	25yr_Ex	27.60	134.42	135.48	135.98	137.14	0.029450	5.69	4.85	5.00	1.84
941-M2	12320	50yr_Ex	30.40	134.42	135.55	136.07	137.29	0.028200	5.84	5.21	5.04	1.83
941-M2	12320	100yr_Ex	33.20	134.42	135.62	136.17	137.46	0.027600	6.01	5.53	5.08	1.82
941-M2	12320	Regional_Ex	27.10	134.42	135.47	135.96	137.11	0.029628	5.66	4.79	5.00	1.85
941-M2	12320	2yr_Fut	12.50	134.42	135.04	135.37	136.15	0.035933	4.66	2.68	4.77	1.99
941-M2	12320	5yr_Fut	18.70	134.42	135.23	135.64	136.60	0.032608	5.17	3.61	4.87	1.92
941-M2	12320	10yr_Fut	24.70	134.42	135.41	135.87	136.96	0.030219	5.52	4.47	4.96	1.86
941-M2	12320	25yr_Fut	27.60	134.42	135.48	135.98	137.14	0.029450	5.69	4.85	5.00	1.84
941-M2	12320	50yr_Fut	30.40	134.42	135.55	136.07	137.29	0.028200	5.84	5.21	5.04	1.83
941-M2	12320	100yr_Fut	33.20	134.42	135.62	136.17	137.46	0.027600	6.01	5.53	5.08	1.82
941-M2	12320	Regional_Fut	27.00	134.42	135.47	135.95	137.10	0.029724	5.66	4.77	5.00	1.85
941-M2	12243	2yr_Ex	12.50	130.41	131.00	131.37	132.44	0.066842	5.32	2.36	6.16	2.73
941-M2	12243	5yr_Ex	18.60	130.41	131.11	131.60	133.06	0.066856	6.19	3.02	6.24	2.82
941-M2	12243	10yr_Ex	24.60	130.41	131.21	131.79	133.58	0.065344	6.83	3.63	6.32	2.85
941-M2	12243	25yr_Ex	27.60	130.41	131.25	131.89	133.82	0.064606	7.11	3.92	6.36	2.86
941-M2	12243	50yr_Ex	30.40	130.41	133.86	131.97	133.96	0.000365	1.42	24.94	15.51	0.26
941-M2	12243	100yr_Ex	33.20	130.41	133.93	132.05	134.04	0.000404	1.51	26.03	16.95	0.27
941-M2	12243	Regional_Ex	27.10	130.41	131.24	131.87	133.78	0.064643	7.06	3.88	6.35	2.86
941-M2	12243	2yr_Fut	12.50	130.41	131.00	131.37	132.44	0.066842	5.32	2.36	6.16	2.73
941-M2	12243	5yr_Fut	18.70	130.41	131.11	131.60	133.07	0.066806	6.20	3.03	6.25	2.82
941-M2	12243	10yr_Fut	24.70	130.41	131.21	131.80	133.59	0.065421	6.85	3.64	6.32	2.85
941-M2	12243	25yr_Fut	27.60	130.41	131.25	131.89	133.82	0.064606	7.11	3.92	6.36	2.86
941-M2	12243	50yr_Fut	30.40	130.41	133.87	131.97	133.97	0.000362	1.42	25.06	15.74	0.26
941-M2	12243	100yr_Fut	33.20	130.41	133.93	132.05	134.04	0.000403	1.51	26.08	16.99	0.27
941-M2	12243	Regional_Fut	27.00	130.41	131.24	131.87	133.77	0.064598	7.05	3.87	6.35	2.85
941-M2	12209	2yr_Ex	12.50	129.20	129.72	129.98	130.58	0.038262	4.10	3.05	7.89	2.10
941-M2	12209	5yr_Ex	18.60	129.20	129.82	130.18	130.99	0.044433	4.78	3.89	9.05	2.31
941-M2	12209	10yr_Ex	24.60	129.20	129.89	130.34	131.41	0.048860	5.47	4.57	10.80	2.47
941-M2	12209	25yr_Ex	27.60	129.20	132.79	130.40	132.81	0.000044	0.58	82.25	43.11	0.10
941-M2	12209	50yr_Ex	30.40	129.20	133.92	130.46	133.93	0.000016	0.43	133.06	65.96	0.06
941-M2	12209	100yr_Ex	33.20	129.20	134.00	130.50	134.01	0.000018	0.46	136.73	66.72	0.07
941-M2	12209	Regional_Ex	27.10	129.20	131.42	130.39	131.47	0.000327	1.11	35.34	24.32	0.25
941-M2	12209	2yr_Fut	12.50	129.20	129.72	129.98	130.58	0.038262	4.10	3.05	7.89	2.10
941-M2	12209	5yr_Fut	18.70	129.20	129.83	130.18	131.00	0.044517	4.79	3.90	9.07	2.31
941-M2	12209	10yr_Fut	24.70	129.20	129.89	130.34	131.42	0.048927	5.48	4.58	10.81	2.48
941-M2	12209	25yr_Fut	27.60	129.20	132.83	130.40	132.84	0.000042	0.57	83.86	43.17	0.10
941-M2	12209	50yr_Fut	30.40	129.20	133.93	130.46	133.94	0.000016	0.43	133.40	66.03	0.06
941-M2	12209	100yr_Fut	33.20	129.20	134.00	130.50	134.01	0.000018	0.46	136.84	66.74	0.07
941-M2	12209	Regional_Fut	27.00	129.20	131.42	130.39	131.47	0.000325	1.11	35.35	24.32	0.25
941-M2	12169	2yr_Ex	12.50	126.50	127.09	127.45	128.35	0.083300	4.97	2.52	4.91	2.22
941-M2	12169	5yr_Ex	18.60	126.50	128.68	127.72	128.78	0.001583	1.47	14.05	13.30	0.35
941-M2	12169	10yr_Ex	24.60	126.50	130.75	127.97	130.77	0.000117	0.67	49.34	22.72	0.11
941-M2	12169	25yr_Ex	27.60	126.50	132.80	128.08	132.80	0.000018	0.35	122.47	40.61	0.05
941-M2	12169	50yr_Ex	30.40	126.50	133.93	128.17	133.93	0.000009	0.28	170.45	75.51	0.03
941-M2	12169	100yr_Ex	33.20	126.50	134.00	128.26	134.01	0.000011	0.30	174.44	78.94	0.04
941-M2	12169	Regional_Ex	27.10	126.50	131.44	128.06	131.45	0.000067	0.57	70.45	35.60	0.08
941-M2	12169	2yr_Fut	12.50	126.50	127.09	127.45	128.35	0.083300	4.97	2.52	4.91	2.22
941-M2	12169	5yr_Fut	18.70	126.50	128.70	127.72	128.80	0.001519	1.45	14.37	13.57	0.35
941-M2	12169	10yr_Fut	24.70	126.50	130.79	127.97	130.80	0.000114	0.66	50.09	23.58	0.11
941-M2	12169	25yr_Fut	27.60	126.50	132.84	128.08	132.84	0.000017	0.34	123.98	40.70	0.05
941-M2	12169	50yr_Fut	30.40	126.50	133.93	128.17	133.94	0.000009	0.28	170.81	75.96	0.03
941-M2	12169	100yr_Fut	33.20	126.50	134.01	128.26	134.01	0.000011	0.30	174.56	79.02	0.04
941-M2	12169	Regional_Fut	27.00	126.50	131.44	128.06	131.45	0.000067	0.56	70.45	35.60	0.08
941-M2	12139	2yr_Ex	15.70	125.10	127.22	126.05	127.29	0.000403	1.20	15.13	11.62	0.27
941-M2	12139	5yr_Ex	23.40	125.10	128.72	126.32	128.75	0.000107	0.89	38.15	17.70	0.15
941-M2	12139	10yr_Ex	30.90	125.10	130.75	126.56	130.77	0.000031	0.65	81.44	26.25	0.09
941-M2	12139	25yr_Ex	36.90	125.10	132.79	126.74	132.80	0.000011	0.49	148.05	46.04	0.06

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M2	12139	50yr_Ex	42.50	125.10	133.92	126.89	133.93	0.000007	0.43	200.76	102.92	0.05
941-M2	12139	100yr_Ex	48.50	125.10	134.00	127.05	134.00	0.000009	0.48	204.97	107.32	0.05
941-M2	12139	Regional_Ex	33.00	125.10	131.44	126.62	131.45	0.000022	0.59	101.08	30.88	0.08
941-M2	12139	2yr_Fut	15.80	125.10	127.24	126.05	127.31	0.000396	1.20	15.33	11.77	0.27
941-M2	12139	5yr_Fut	23.50	125.10	128.74	126.32	128.78	0.000105	0.89	38.55	17.77	0.15
941-M2	12139	10yr_Fut	31.00	125.10	130.79	126.56	130.80	0.000030	0.65	82.30	26.49	0.09
941-M2	12139	25yr_Fut	37.00	125.10	132.83	126.74	132.84	0.000011	0.48	149.61	47.68	0.06
941-M2	12139	50yr_Fut	42.60	125.10	133.93	126.90	133.94	0.000007	0.43	201.16	103.37	0.05
941-M2	12139	100yr_Fut	48.70	125.10	134.00	127.06	134.01	0.000009	0.49	205.10	107.34	0.05
941-M2	12139	Regional_Fut	33.00	125.10	131.44	126.62	131.45	0.000022	0.59	101.08	30.88	0.08
941-M1	10647	2yr_Ex	19.60	95.81	96.08	96.81	102.83	0.190020	11.50	1.70	6.30	7.07
941-M1	10647	5yr_Ex	29.40	95.81	96.16	97.11	105.32	0.189979	13.41	2.19	6.30	7.26
941-M1	10647	10yr_Ex	38.80	95.81	96.22	97.38	107.50	0.189924	14.87	2.61	6.30	7.38
941-M1	10647	25yr_Ex	46.40	95.81	96.27	97.58	109.14	0.189899	15.88	2.92	6.30	7.45
941-M1	10647	50yr_Ex	54.20	95.81	96.32	97.77	110.73	0.189880	16.81	3.22	6.30	7.51
941-M1	10647	100yr_Ex	62.20	95.81	96.37	97.96	112.29	0.189869	17.67	3.52	6.30	7.55
941-M1	10647	Regional_Ex	43.70	95.81	96.26	97.51	108.56	0.189905	15.54	2.81	6.30	7.43
941-M1	10647	2yr_Fut	20.10	95.81	96.08	96.82	102.96	0.190014	11.61	1.73	6.30	7.08
941-M1	10647	5yr_Fut	30.10	95.81	96.16	97.13	105.49	0.189965	13.53	2.23	6.30	7.27
941-M1	10647	10yr_Fut	39.80	95.81	96.23	97.40	107.72	0.189929	15.01	2.65	6.30	7.39
941-M1	10647	25yr_Fut	47.60	95.81	96.28	97.61	109.39	0.189894	16.03	2.97	6.30	7.46
941-M1	10647	50yr_Fut	55.60	95.81	96.33	97.80	111.01	0.189873	16.97	3.28	6.30	7.52
941-M1	10647	100yr_Fut	63.70	95.81	96.38	97.99	112.58	0.189867	17.83	3.57	6.30	7.56
941-M1	10647	Regional_Fut	43.80	95.81	96.26	97.51	108.58	0.189897	15.55	2.82	6.30	7.43
941-M1	10638	2yr_Ex	19.60	90.17	91.41	91.12	91.69	0.001393	2.33	8.40	6.77	0.67
941-M1	10638	5yr_Ex	29.40	90.17	90.45	91.41	102.78	0.331547	15.55	1.89	6.77	9.40
941-M1	10638	10yr_Ex	38.80	90.17	90.51	91.66	105.02	0.306871	16.87	2.30	6.77	9.24
941-M1	10638	25yr_Ex	46.40	90.17	90.56	91.85	106.70	0.293511	17.79	2.61	6.77	9.16
941-M1	10638	50yr_Ex	54.20	90.17	90.60	92.04	108.33	0.283220	18.65	2.91	6.77	9.09
941-M1	10638	100yr_Ex	62.20	90.17	90.64	92.22	109.91	0.274987	19.44	3.20	6.77	9.03
941-M1	10638	Regional_Ex	43.70	90.17	90.54	91.78	106.11	0.297814	17.48	2.50	6.77	9.18
941-M1	10638	2yr_Fut	20.10	90.17	91.43	91.13	91.71	0.001389	2.35	8.55	6.77	0.67
941-M1	10638	5yr_Fut	30.10	90.17	90.45	91.43	102.96	0.329250	15.66	1.92	6.77	9.39
941-M1	10638	10yr_Fut	39.80	90.17	90.52	91.69	105.25	0.304929	17.00	2.34	6.77	9.23
941-M1	10638	25yr_Fut	47.60	90.17	90.56	91.88	106.96	0.291733	17.93	2.65	6.77	9.14
941-M1	10638	50yr_Fut	55.60	90.17	90.61	92.07	108.61	0.281628	18.79	2.96	6.77	9.08
941-M1	10638	100yr_Fut	63.70	90.17	90.65	92.25	110.20	0.273639	19.58	3.25	6.77	9.02
941-M1	10638	Regional_Fut	43.80	90.17	90.54	91.79	106.14	0.297639	17.49	2.50	6.77	9.18
941-M1	10619 W5-Weir 5	2yr_Ex	19.60	90.06	91.11	91.11	91.62	0.003261	3.19	6.14	5.93	1.00
941-M1	10619 W5-Weir 5	5yr_Ex	29.40	90.06	90.49	91.43	97.62	0.119640	11.83	2.49	5.93	5.83
941-M1	10619 W5-Weir 5	10yr_Ex	38.80	90.06	90.56	91.70	99.75	0.129618	13.43	2.89	5.93	6.14
941-M1	10619 W5-Weir 5	25yr_Ex	46.40	90.06	90.61	91.91	101.38	0.135606	14.54	3.19	5.93	6.33
941-M1	10619 W5-Weir 5	50yr_Ex	54.20	90.06	90.66	92.11	102.97	0.140414	15.54	3.49	5.93	6.47
941-M1	10619 W5-Weir 5	100yr_Ex	62.20	90.06	90.71	92.31	104.53	0.144324	16.47	3.78	5.93	6.59
941-M1	10619 W5-Weir 5	Regional_Ex	43.70	90.06	90.59	91.84	100.81	0.133657	14.16	3.09	5.93	6.27
941-M1	10619 W5-Weir 5	2yr_Fut	20.10	90.06	91.12	91.12	91.65	0.003255	3.22	6.25	5.93	1.00
941-M1	10619 W5-Weir 5	5yr_Fut	30.10	90.06	90.49	91.45	97.78	0.120511	11.96	2.52	5.93	5.86
941-M1	10619 W5-Weir 5	10yr_Fut	39.80	90.06	90.56	91.73	99.97	0.130508	13.58	2.93	5.93	6.17
941-M1	10619 W5-Weir 5	25yr_Fut	47.60	90.06	90.62	91.94	101.63	0.136415	14.70	3.24	5.93	6.35
941-M1	10619 W5-Weir 5	50yr_Fut	55.60	90.06	90.67	92.14	103.25	0.141157	15.71	3.54	5.93	6.49
941-M1	10619 W5-Weir 5	100yr_Fut	63.70	90.06	90.72	92.34	104.82	0.145002	16.63	3.83	5.93	6.61
941-M1	10619 W5-Weir 5	Regional_Fut	43.80	90.06	90.59	91.84	100.83	0.133729	14.17	3.09	5.93	6.27
941-M1	10618	2yr_Ex	19.60	88.40	89.16	89.69	91.44	0.028471	6.69	2.93	6.13	3.09
941-M1	10618	5yr_Ex	29.40	88.40	89.05	89.99	97.38	0.123189	12.78	2.30	5.48	6.30
941-M1	10618	10yr_Ex	38.80	88.40	89.12	90.23	99.50	0.136226	14.27	2.72	5.92	6.72
941-M1	10618	25yr_Ex	46.40	88.40	89.17	90.40	101.12	0.145108	15.31	3.03	6.22	7.00
941-M1	10618	50yr_Ex	54.20	88.40	89.22	90.56	102.71	0.150362	16.27	3.33	6.39	7.19
941-M1	10618	100yr_Ex	62.20	88.40	89.27	90.71	104.27	0.155053	17.15	3.63	6.55	7.36
941-M1	10618	Regional_Ex	43.70	88.40	89.16	90.35	100.55	0.142226	14.95	2.92	6.13	6.91
941-M1	10618	2yr_Fut	20.10	88.40	89.17	89.71	91.47	0.028221	6.72	2.99	6.19	3.09
941-M1	10618	5yr_Fut	30.10	88.40	89.05	90.01	97.54	0.124233	12.90	2.33	5.52	6.34
941-M1	10618	10yr_Fut	39.80	88.40	89.13	90.26	99.72	0.137510	14.41	2.76	5.97	6.76
941-M1	10618	25yr_Fut	47.60	88.40	89.18	90.43	101.37	0.145973	15.46	3.08	6.25	7.04
941-M1	10618	50yr_Fut	55.60	88.40	89.23	90.59	102.99	0.151230	16.43	3.38	6.42	7.22
941-M1	10618	100yr_Fut	63.70	88.40	89.27	90.75	104.55	0.155899	17.31	3.68	6.57	7.39
941-M1	10618	Regional_Fut	43.80	88.40	89.16	90.35	100.58	0.142344	14.97	2.93	6.13	6.92
941-M1	10607	2yr_Ex	19.60	88.34	90.48	89.77	90.59	0.000389	1.49	13.21	10.55	0.42
941-M1	10607	5yr_Ex	29.40	88.34	89.13	90.07	95.82	0.080904	11.45	2.57	5.18	5.20
941-M1	10607	10yr_Ex	38.80	88.34	89.21	90.31	97.75	0.091723	12.94	3.00	5.52	5.61
941-M1	10607	25yr_Ex	46.40	88.34	89.27	90.46	99.24	0.099311	13.99	3.32	5.76	5.88
941-M1	10607	50yr_Ex	54.20	88.34	89.32	90.61	100.73	0.106388	14.96	3.62	5.98	6.14
941-M1	10607	100yr_Ex	62.20	88.34	89.37	90.75	102.19	0.112613	15.86	3.92	6.18	6.35
941-M1	10607	Regional_Ex	43.70	88.34	89.25	90.41	98.72	0.096721	13.63	3.21	5.68	5.79
941-M1	10607	2yr_Fut	20.10	88.34	90.52	89.79	90.63	0.000370	1.48	13.64	10.71	0.41
941-M1	10607	5yr_Fut	30.10	88.34	89.14	90.09	95.97	0.081781	11.57	2.60	5.21	5.23
941-M1	10607	10yr_Fut	39.80	88.34	89.22	90.33	97.95	0.092788	13.09	3.04	5.55	5.65
941-M1	10607	25yr_Fut	47.60	88.34	89.28	90.49	99.47	0.100465	14.14	3.37	5.79	5.93
941-M1	10607	50yr_Fut	55.60	88.34	89.33	90.63	100.99	0.107534	15.12	3.68	6.01	6.18
941-M1	10607	100yr_Fut	63.70	88.34	89.38	90.77	102.46	0.113723	16.02	3.98	6.21	6.39
941-M1	10607	Regional_Fut	43.80	88.34	89.25	90.41	98.74	0.096818	13.64	3.21	5.68	5.79
941-M1	10562 1-Unnamed Clvt		Culvert									

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M1	10518	2yr_Ex	19.60	83.33	83.78	84.26	85.77	0.029738	6.25	3.14	7.56	3.10
941-M1	10518	5yr_Ex	29.40	83.33	83.93	84.52	86.38	0.026641	6.94	4.24	7.95	3.04
941-M1	10518	10yr_Ex	38.80	83.33	84.00	84.73	87.25	0.030577	7.98	4.86	8.16	3.30
941-M1	10518	25yr_Ex	46.40	83.33	84.03	84.87	88.27	0.038001	9.11	5.09	8.23	3.70
941-M1	10518	50yr_Ex	54.20	83.33	84.05	85.03	89.53	0.047916	10.37	5.23	8.28	4.17
941-M1	10518	100yr_Ex	62.20	83.33	84.06	85.17	90.96	0.058906	11.63	5.35	8.32	4.63
941-M1	10518	Regional_Ex	43.70	83.33	84.02	84.83	87.95	0.036168	8.79	4.97	8.20	3.60
941-M1	10518	2yr_Fut	20.10	83.33	83.79	84.27	85.79	0.029042	6.25	3.21	7.59	3.07
941-M1	10518	5yr_Fut	30.10	83.33	83.94	84.53	86.42	0.026487	6.98	4.31	7.97	3.03
941-M1	10518	10yr_Fut	39.80	83.33	84.00	84.75	87.50	0.033442	8.29	4.80	8.14	3.45
941-M1	10518	25yr_Fut	47.60	83.33	84.04	84.90	88.42	0.039074	9.28	5.13	8.25	3.76
941-M1	10518	50yr_Fut	55.60	83.33	84.05	85.04	89.75	0.049553	10.58	5.26	8.29	4.24
941-M1	10518	100yr_Fut	63.70	83.33	84.07	85.19	91.22	0.060770	11.85	5.38	8.33	4.71
941-M1	10518	Regional_Fut	43.80	83.33	84.02	84.83	87.97	0.036336	8.81	4.97	8.20	3.61
941-M1	10492 W4-Weir 4	2yr_Ex	19.60	83.26	84.10	84.38	85.03	0.010521	4.27	4.59	8.72	1.88
941-M1	10492 W4-Weir 4	5yr_Ex	29.40	83.26	84.22	84.62	85.60	0.012713	5.21	5.64	9.11	2.11
941-M1	10492 W4-Weir 4	10yr_Ex	38.80	83.26	84.27	84.82	86.31	0.017239	6.33	6.13	9.29	2.49
941-M1	10492 W4-Weir 4	25yr_Ex	46.40	83.26	84.29	84.98	87.08	0.023146	7.41	6.26	9.33	2.89
941-M1	10492 W4-Weir 4	50yr_Ex	54.20	83.26	84.29	85.14	88.03	0.030626	8.56	6.33	9.35	3.32
941-M1	10492 W4-Weir 4	100yr_Ex	62.20	83.26	84.30	85.30	89.11	0.038967	9.71	6.40	9.38	3.76
941-M1	10492 W4-Weir 4	Regional_Ex	43.70	83.26	84.28	84.91	86.83	0.021500	7.08	6.17	9.30	2.78
941-M1	10492 W4-Weir 4	2yr_Fut	20.10	83.26	84.11	84.40	85.05	0.010467	4.30	4.68	8.76	1.88
941-M1	10492 W4-Weir 4	5yr_Fut	30.10	83.26	84.23	84.63	85.64	0.012830	5.27	5.71	9.14	2.13
941-M1	10492 W4-Weir 4	10yr_Fut	39.80	83.26	84.26	84.84	86.48	0.019072	6.60	6.03	9.25	2.61
941-M1	10492 W4-Weir 4	25yr_Fut	47.60	83.26	84.29	85.00	87.21	0.024027	7.56	6.29	9.34	2.94
941-M1	10492 W4-Weir 4	50yr_Fut	55.60	83.26	84.30	85.17	88.20	0.031897	8.75	6.35	9.36	3.39
941-M1	10492 W4-Weir 4	100yr_Fut	63.70	83.26	84.30	85.32	89.31	0.040427	9.91	6.43	9.39	3.83
941-M1	10492 W4-Weir 4	Regional_Fut	43.80	83.26	84.28	84.92	86.85	0.021618	7.10	6.17	9.30	2.79
941-M1	10491	2yr_Ex	19.60	83.18	83.87	84.20	84.98	0.037120	4.67	4.28	9.75	2.16
941-M1	10491	5yr_Ex	29.40	83.18	84.00	84.44	85.55	0.038376	5.54	5.54	10.46	2.28
941-M1	10491	10yr_Ex	38.80	83.18	84.06	84.64	86.26	0.047267	6.59	6.24	10.87	2.57
941-M1	10491	25yr_Ex	46.40	83.18	84.08	84.82	87.02	0.060523	7.62	6.48	11.10	2.92
941-M1	10491	50yr_Ex	54.20	83.18	84.10	84.97	87.95	0.077741	8.74	6.62	11.23	3.32
941-M1	10491	100yr_Ex	62.20	83.18	84.11	85.11	89.01	0.096829	9.86	6.75	11.35	3.72
941-M1	10491	Regional_Ex	43.70	83.18	84.07	84.77	86.77	0.057028	7.31	6.35	10.97	2.83
941-M1	10491	2yr_Fut	20.10	83.18	83.88	84.21	85.01	0.036664	4.70	4.37	9.79	2.15
941-M1	10491	5yr_Fut	30.10	83.18	84.01	84.45	85.59	0.038435	5.60	5.63	10.51	2.28
941-M1	10491	10yr_Fut	39.80	83.18	84.05	84.66	86.42	0.051839	6.84	6.15	10.81	2.69
941-M1	10491	25yr_Fut	47.60	83.18	84.09	84.83	87.14	0.062465	7.77	6.53	11.14	2.97
941-M1	10491	50yr_Fut	55.60	83.18	84.10	85.00	88.12	0.080581	8.92	6.66	11.26	3.39
941-M1	10491	100yr_Fut	63.70	83.18	84.11	85.13	89.21	0.100125	10.05	6.79	11.39	3.79
941-M1	10491	Regional_Fut	43.80	83.18	84.07	84.77	86.78	0.057307	7.32	6.35	10.97	2.84
941-M1	10477 W3-Weir 3	2yr_Ex	19.60	82.58	83.08	83.44	84.37	0.049118	5.03	3.89	8.31	2.35
941-M1	10477 W3-Weir 3	5yr_Ex	29.40	82.58	83.22	83.72	84.94	0.048062	5.81	5.06	8.36	2.38
941-M1	10477 W3-Weir 3	10yr_Ex	38.80	82.58	83.31	83.94	85.55	0.052917	6.63	5.86	8.39	2.53
941-M1	10477 W3-Weir 3	25yr_Ex	46.40	82.58	83.37	84.10	86.12	0.059702	7.35	6.31	8.58	2.71
941-M1	10477 W3-Weir 3	50yr_Ex	54.20	82.58	83.41	84.26	86.79	0.068662	8.14	6.67	8.98	2.93
941-M1	10477 W3-Weir 3	100yr_Ex	62.20	82.58	83.44	84.44	87.55	0.079585	8.98	6.96	9.28	3.16
941-M1	10477 W3-Weir 3	Regional_Ex	43.70	82.58	83.35	84.06	85.93	0.058017	7.12	6.14	8.41	2.66
941-M1	10477 W3-Weir 3	2yr_Fut	20.10	82.58	83.09	83.45	84.40	0.048811	5.07	3.96	8.31	2.34
941-M1	10477 W3-Weir 3	5yr_Fut	30.10	82.58	83.23	83.74	84.98	0.048024	5.86	5.14	8.36	2.39
941-M1	10477 W3-Weir 3	10yr_Fut	39.80	82.58	83.31	83.97	85.67	0.055571	6.79	5.86	8.39	2.60
941-M1	10477 W3-Weir 3	25yr_Fut	47.60	82.58	83.38	84.12	86.21	0.060576	7.46	6.39	8.66	2.73
941-M1	10477 W3-Weir 3	50yr_Fut	55.60	82.58	83.42	84.29	86.91	0.070265	8.28	6.73	9.04	2.96
941-M1	10477 W3-Weir 3	100yr_Fut	63.70	82.58	83.45	84.46	87.70	0.081583	9.13	7.02	9.34	3.21
941-M1	10477 W3-Weir 3	Regional_Fut	43.80	82.58	83.35	84.06	85.94	0.058157	7.13	6.14	8.41	2.67
941-M1	10476	2yr_Ex	19.60	81.22	81.63	82.13	84.17	0.143687	7.05	2.78	8.11	3.84
941-M1	10476	5yr_Ex	29.40	81.22	81.76	82.39	84.74	0.114044	7.64	3.85	8.11	3.54
941-M1	10476	10yr_Ex	38.80	81.22	81.87	82.61	85.35	0.105598	8.27	4.69	8.12	3.47
941-M1	10476	25yr_Ex	46.40	81.22	81.94	82.79	85.92	0.106039	8.84	5.25	8.12	3.51
941-M1	10476	50yr_Ex	54.20	81.22	81.99	82.95	86.58	0.110773	9.49	5.71	8.12	3.61
941-M1	10476	100yr_Ex	62.20	81.22	82.04	83.11	87.34	0.118661	10.19	6.10	8.12	3.75
941-M1	10476	Regional_Ex	43.70	81.22	81.91	82.72	85.73	0.106337	8.66	5.05	8.12	3.51
941-M1	10476	2yr_Fut	20.10	81.22	81.64	82.14	84.19	0.141168	7.08	2.84	8.11	3.82
941-M1	10476	5yr_Fut	30.10	81.22	81.77	82.41	84.78	0.112662	7.68	3.92	8.11	3.53
941-M1	10476	10yr_Fut	39.80	81.22	81.88	82.64	85.47	0.107507	8.39	4.74	8.12	3.51
941-M1	10476	25yr_Fut	47.60	81.22	81.95	82.81	86.01	0.106125	8.93	5.33	8.12	3.52
941-M1	10476	50yr_Fut	55.60	81.22	82.00	82.98	86.70	0.111680	9.60	5.79	8.12	3.63
941-M1	10476	100yr_Fut	63.70	81.22	82.05	83.14	87.48	0.120173	10.32	6.17	8.12	3.78
941-M1	10476	Regional_Fut	43.80	81.22	81.91	82.73	85.74	0.106406	8.67	5.05	8.12	3.51
941-M1	10458	2yr_Ex	19.60	79.80	80.56	81.02	82.32	0.061157	5.86	3.34	7.07	2.72
941-M1	10458	5yr_Ex	29.40	79.80	80.70	81.27	83.05	0.063938	6.79	4.33	7.55	2.86
941-M1	10458	10yr_Ex	38.80	79.80	80.81	81.49	83.67	0.066838	7.50	5.17	7.98	2.97
941-M1	10458	25yr_Ex	46.40	79.80	80.88	81.65	84.18	0.069890	8.05	5.77	8.24	3.07
941-M1	10458	50yr_Ex	54.20	79.80	80.94	81.82	84.72	0.074069	8.61	6.29	8.47	3.19
941-M1	10458	100yr_Ex	62.20	79.80	81.00	81.97	85.31	0.079426	9.20	6.76	8.67	3.33
941-M1	10458	Regional_Ex	43.70	79.80	80.85	81.59	84.01	0.069011	7.87	5.55	8.15	3.04
941-M1	10458	2yr_Fut	20.10	79.80	80.57	81.03	82.36	0.061284	5.92	3.40	7.10	2.73
941-M1	10458	5yr_Fut	30.10	79.80	80.71	81.29	83.09	0.064048	6.84	4.40	7.58	2.87
941-M1	10458	10yr_Fut	39.80	79.80	80.82	81.51	83.76	0.067700	7.59	5.24	8.01	3.00
941-M1	10458	25yr_Fut	47.60	79.80	80.89	81.67	84.26	0.070352	8.13	5.85	8.28	3.09

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M1	10458	50yr_Fut	55.60	79.80	80.95	81.84	84.82	0.074844	8.71	6.38	8.51	3.21
941-M1	10458	100yr_Fut	63.70	79.80	81.01	81.99	85.42	0.080455	9.31	6.85	8.70	3.35
941-M1	10458	Regional_Fut	43.80	79.80	80.86	81.60	84.02	0.069076	7.88	5.56	8.15	3.04
941-M1	10363 W2-Weir 2	2yr_Ex	34.90	78.69	79.20	79.30	79.54	0.017110	2.58	13.51	38.93	1.40
941-M1	10363 W2-Weir 2	5yr_Ex	54.30	78.69	79.80	79.45	79.88	0.001239	1.25	50.06	84.31	0.44
941-M1	10363 W2-Weir 2	10yr_Ex	74.00	78.69	80.07	79.57	80.15	0.000860	1.25	75.71	107.71	0.38
941-M1	10363 W2-Weir 2	25yr_Ex	90.20	78.69	80.21	79.66	80.29	0.000839	1.34	91.19	117.09	0.38
941-M1	10363 W2-Weir 2	50yr_Ex	105.30	78.69	80.34	79.74	80.43	0.000793	1.39	106.34	119.34	0.38
941-M1	10363 W2-Weir 2	100yr_Ex	121.20	78.69	80.26	79.81	80.40	0.001304	1.71	97.19	117.99	0.48
941-M1	10363 W2-Weir 2	Regional_Ex	103.40	78.69	80.32	79.73	80.41	0.000797	1.38	104.52	119.07	0.38
941-M1	10363 W2-Weir 2	2yr_Fut	36.70	78.69	79.44	79.31	79.56	0.003701	1.51	24.40	56.43	0.69
941-M1	10363 W2-Weir 2	5yr_Fut	57.10	78.69	79.83	79.47	79.91	0.001233	1.27	52.24	85.93	0.44
941-M1	10363 W2-Weir 2	10yr_Fut	77.40	78.69	80.13	79.59	80.20	0.000783	1.24	82.12	113.34	0.37
941-M1	10363 W2-Weir 2	25yr_Fut	93.80	78.69	80.24	79.68	80.33	0.000826	1.35	94.89	117.65	0.38
941-M1	10363 W2-Weir 2	50yr_Fut	109.00	78.69	80.19	79.75	80.32	0.001300	1.65	88.89	116.75	0.48
941-M1	10363 W2-Weir 2	100yr_Fut	122.80	78.69	80.27	79.82	80.41	0.001297	1.72	98.48	118.18	0.48
941-M1	10363 W2-Weir 2	Regional_Fut	103.50	78.69	80.32	79.73	80.41	0.000797	1.38	104.61	119.09	0.38
941-M1	10362	2yr_Ex	34.90	78.11	79.44	79.02	79.50	0.001298	1.08	32.41	56.31	0.43
941-M1	10362	5yr_Ex	54.30	78.11	79.82		79.87	0.000666	1.04	59.53	85.31	0.33
941-M1	10362	10yr_Ex	74.00	78.11	80.08		80.14	0.000544	1.09	85.11	108.88	0.31
941-M1	10362	25yr_Ex	90.20	78.11	80.22		80.29	0.000559	1.19	100.68	117.29	0.32
941-M1	10362	50yr_Ex	105.30	78.11	80.35		80.42	0.000553	1.25	115.76	119.53	0.32
941-M1	10362	100yr_Ex	121.20	78.11	80.28		80.39	0.000868	1.52	107.56	118.32	0.40
941-M1	10362	Regional_Ex	103.40	78.11	80.33		80.41	0.000553	1.24	113.95	119.26	0.32
941-M1	10362	2yr_Fut	36.70	78.11	79.48		79.54	0.001192	1.07	34.78	58.37	0.41
941-M1	10362	5yr_Fut	57.10	78.11	79.84		79.90	0.000674	1.06	61.75	87.02	0.33
941-M1	10362	10yr_Fut	77.40	78.11	80.14		80.20	0.000508	1.09	91.47	114.36	0.30
941-M1	10362	25yr_Fut	93.80	78.11	80.25		80.32	0.000557	1.20	104.36	117.84	0.32
941-M1	10362	50yr_Fut	109.00	78.11	80.21		80.31	0.000844	1.45	99.23	117.08	0.39
941-M1	10362	100yr_Fut	122.80	78.11	80.29		80.40	0.000867	1.53	108.83	118.51	0.40
941-M1	10362	Regional_Fut	103.50	78.11	80.33		80.41	0.000553	1.24	114.03	119.28	0.32
941-M1	10353	2yr_Ex	34.90	77.59	79.05	79.05	79.45	0.004405	2.95	19.72	41.31	0.85
941-M1	10353	5yr_Ex	54.30	77.59	79.33	79.33	79.82	0.004487	3.41	33.70	63.65	0.88
941-M1	10353	10yr_Ex	74.00	77.59	79.54	79.54	80.08	0.004568	3.75	48.32	79.97	0.91
941-M1	10353	25yr_Ex	90.20	77.59	79.82	79.82	80.24	0.003268	3.50	73.04	95.98	0.79
941-M1	10353	50yr_Ex	105.30	77.59	79.94	79.94	80.37	0.003289	3.65	84.79	100.55	0.80
941-M1	10353	100yr_Ex	121.20	77.59	79.97	79.97	80.35	0.003157	3.62	109.15	124.63	0.79
941-M1	10353	Regional_Ex	103.40	77.59	79.92	79.92	80.36	0.003289	3.64	83.32	100.03	0.80
941-M1	10353	2yr_Fut	36.70	77.59	79.08	79.08	79.49	0.004329	2.98	21.25	43.00	0.84
941-M1	10353	5yr_Fut	57.10	77.59	79.46	79.46	79.85	0.003431	3.15	42.28	69.19	0.78
941-M1	10353	10yr_Fut	77.40	77.59	79.54	79.54	80.13	0.004998	3.92	48.32	79.97	0.95
941-M1	10353	25yr_Fut	93.80	77.59	79.85	79.85	80.28	0.003208	3.51	76.69	97.66	0.79
941-M1	10353	50yr_Fut	109.00	77.59	79.97	79.97	80.28	0.002554	3.25	109.14	124.63	0.71
941-M1	10353	100yr_Fut	122.80	77.59	79.97	79.97	80.36	0.003241	3.66	109.15	124.63	0.80
941-M1	10353	Regional_Fut	103.50	77.59	79.92	79.92	80.36	0.003284	3.63	83.46	100.08	0.80
941-M1	10322	2yr_Ex	34.90	76.79	77.91	78.27	79.11	0.020775	4.97	8.78	14.58	1.76
941-M1	10322	5yr_Ex	54.30	76.79	78.28	78.70	79.52	0.013642	5.15	14.50	17.08	1.52
941-M1	10322	10yr_Ex	74.00	76.79	78.94	78.94	79.22	0.002501	2.97	87.00	164.16	0.70
941-M1	10322	25yr_Ex	90.20	76.79	78.68	78.99	79.99	0.010935	5.62	38.58	80.48	1.43
941-M1	10322	50yr_Ex	105.30	76.79	78.79	79.14	80.12	0.010717	5.82	48.25	95.22	1.43
941-M1	10322	100yr_Ex	121.20	76.79	79.20	79.20	79.52	0.002873	3.49	132.59	178.29	0.77
941-M1	10322	Regional_Ex	103.40	76.79	78.78	79.13	80.10	0.010703	5.79	47.19	94.05	1.43
941-M1	10322	2yr_Fut	36.70	76.79	77.95	78.30	79.16	0.019999	5.00	9.26	14.80	1.74
941-M1	10322	5yr_Fut	57.10	76.79	78.33	78.70	79.58	0.013052	5.18	15.39	18.29	1.50
941-M1	10322	10yr_Fut	77.40	76.79	78.59	78.97	79.85	0.010853	5.38	31.58	74.96	1.41
941-M1	10322	25yr_Fut	93.80	76.79	78.71	79.09	80.02	0.010804	5.66	41.22	85.16	1.42
941-M1	10322	50yr_Fut	109.00	76.79	79.16	79.16	79.45	0.002707	3.33	124.04	176.73	0.74
941-M1	10322	100yr_Fut	122.80	76.79	79.21	79.21	79.53	0.002900	3.51	133.57	178.47	0.77
941-M1	10322	Regional_Fut	103.50	76.79	78.78	79.13	80.10	0.010703	5.79	47.25	94.12	1.43
941-M1	10275 W1-Weir 1	2yr_Ex	34.90	76.69	77.38	77.61	78.09	0.017046	3.78	10.57	27.82	1.54
941-M1	10275 W1-Weir 1	5yr_Ex	54.30	76.69	77.48	77.96	78.69	0.023910	4.96	13.76	34.56	1.87
941-M1	10275 W1-Weir 1	10yr_Ex	74.00	76.69	77.68	78.12	78.89	0.018126	5.08	21.08	41.07	1.69
941-M1	10275 W1-Weir 1	25yr_Ex	90.20	76.69	77.74	78.29	79.29	0.021516	5.77	24.13	60.36	1.86
941-M1	10275 W1-Weir 1	50yr_Ex	105.30	76.69	77.83	78.37	79.45	0.020542	5.98	30.17	72.83	1.85
941-M1	10275 W1-Weir 1	100yr_Ex	121.20	76.69	78.02	78.43	79.21	0.013066	5.33	50.90	129.35	1.52
941-M1	10275 W1-Weir 1	Regional_Ex	103.40	76.69	77.82	78.36	79.43	0.020640	5.95	29.40	71.11	1.85
941-M1	10275 W1-Weir 1	2yr_Fut	36.70	76.69	77.39	77.64	78.15	0.017676	3.90	10.90	28.46	1.57
941-M1	10275 W1-Weir 1	5yr_Fut	57.10	76.69	77.50	77.98	78.77	0.024641	5.10	14.26	35.10	1.90
941-M1	10275 W1-Weir 1	10yr_Fut	77.40	76.69	77.64	78.15	79.13	0.023385	5.60	19.51	38.23	1.91
941-M1	10275 W1-Weir 1	25yr_Fut	93.80	76.69	77.76	78.31	79.34	0.021339	5.83	25.47	63.35	1.86
941-M1	10275 W1-Weir 1	50yr_Fut	109.00	76.69	77.96	78.38	79.14	0.013520	5.24	42.85	121.42	1.53
941-M1	10275 W1-Weir 1	100yr_Fut	122.80	76.69	78.03	78.44	79.22	0.013012	5.34	51.94	130.36	1.51
941-M1	10275 W1-Weir 1	Regional_Fut	103.50	76.69	77.82	78.36	79.43	0.020634	5.95	29.44	71.19	1.85
941-M1	10274	2yr_Ex	34.90	75.54	76.31	76.76	77.88	0.044949	5.54	6.30	11.60	2.40
941-M1	10274	5yr_Ex	54.30	75.54	76.52	77.08	78.47	0.040131	6.18	8.79	12.54	2.36
941-M1	10274	10yr_Ex	74.00	75.54	76.77	77.36	78.70	0.029841	6.17	12.00	13.66	2.10
941-M1	10274	25yr_Ex	90.20	75.54	76.89	77.61	79.10	0.030198	6.58	13.70	14.21	2.14
941-M1	10274	50yr_Ex	105.30	75.54	77.04	77.85	79.27	0.026006	6.62	15.96	15.56	2.03
941-M1	10274	100yr_Ex	121.20	75.54	77.37	78.10	79.09	0.014125	5.82	22.13	27.22	1.56
941-M1	10274	Regional_Ex	103.40	75.54	77.02	77.83	79.25	0.026598	6.62	15.66	15.36	2.04
941-M1	10274	2yr_Fut	36.70	75.54	76.34	76.79	77.93	0.044020	5.59	6.56	11.70	2.39

HEC-RAS Plan: EXS_SEP2023 (Continued)

Reach	River Sta	Profile	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)	
941-M1	10274	5yr_Fut	57.10	75.54	76.55	77.11	78.55	0.039833	6.26	9.12	12.66	2.36
941-M1	10274	10yr_Fut	77.40	75.54	76.76	77.42	78.92	0.033618	6.51	11.88	13.62	2.23
941-M1	10274	25yr_Fut	93.80	75.54	76.92	77.66	79.15	0.029371	6.60	14.21	14.41	2.12
941-M1	10274	50yr_Fut	109.00	75.54	77.20	78.00	79.01	0.017435	5.95	18.64	17.29	1.70
941-M1	10274	100yr_Fut	122.80	75.54	77.39	78.12	79.10	0.013749	5.80	22.74	28.46	1.54
941-M1	10274	Regional_Fut	103.50	75.54	77.02	77.83	79.25	0.026564	6.62	15.68	15.37	2.04
941-M1	10260	2yr_Ex	34.90	75.09	76.01	76.34	77.14	0.077083	4.72	7.40	15.86	2.21
941-M1	10260	5yr_Ex	54.30	75.09	76.14	76.61	77.79	0.083781	5.68	9.55	16.43	2.38
941-M1	10260	10yr_Ex	74.00	75.09	76.29	76.86	78.23	0.077105	6.17	11.98	17.05	2.35
941-M1	10260	25yr_Ex	90.20	75.09	76.38	77.04	78.62	0.076207	6.62	13.64	17.74	2.38
941-M1	10260	50yr_Ex	105.30	75.09	76.49	77.20	78.85	0.068174	6.80	15.63	19.98	2.30
941-M1	10260	100yr_Ex	121.20	75.09	76.67	77.33	78.80	0.048614	6.49	19.61	24.55	2.00
941-M1	10260	Regional_Ex	103.40	75.09	78.32	77.18	78.37	0.000563	1.30	200.90	217.31	0.25
941-M1	10260	2yr_Fut	36.70	75.09	76.02	76.37	77.21	0.077808	4.82	7.62	15.92	2.22
941-M1	10260	5yr_Fut	57.10	75.09	76.16	76.65	77.87	0.084328	5.80	9.85	16.51	2.40
941-M1	10260	10yr_Fut	77.40	75.09	76.30	76.90	78.37	0.081358	6.38	12.13	17.09	2.42
941-M1	10260	25yr_Fut	93.80	75.09	76.41	77.09	78.68	0.074531	6.67	14.09	17.94	2.37
941-M1	10260	50yr_Fut	109.00	75.09	76.57	77.23	78.68	0.054343	6.44	17.35	22.07	2.08
941-M1	10260	100yr_Fut	122.80	75.09	76.68	77.33	78.81	0.047875	6.49	19.93	24.88	1.99
941-M1	10260	Regional_Fut	103.50	75.09	78.32	77.18	78.37	0.000564	1.30	200.89	217.31	0.25
941-M1	10213	2yr_Ex	34.90	74.79	76.42	76.27	76.62	0.003949	2.21	30.17	55.41	0.60
941-M1	10213	5yr_Ex	54.30	74.79	76.71	76.50	76.92	0.003649	2.42	50.64	92.49	0.59
941-M1	10213	10yr_Ex	74.00	74.79	76.79	76.73	77.10	0.005370	3.02	58.69	107.99	0.73
941-M1	10213	25yr_Ex	90.20	74.79	76.81	76.92	77.25	0.007614	3.62	60.36	111.89	0.86
941-M1	10213	50yr_Ex	105.30	74.79	77.02	77.00	77.33	0.005255	3.24	84.48	117.13	0.73
941-M1	10213	100yr_Ex	121.20	74.79	77.60	77.07	77.69	0.001471	2.03	174.20	184.83	0.40
941-M1	10213	Regional_Ex	103.40	74.79	78.33	76.99	78.35	0.000233	0.96	343.59	268.16	0.17
941-M1	10213	2yr_Fut	36.70	74.79	76.45	76.29	76.65	0.003919	2.24	31.93	56.61	0.60
941-M1	10213	5yr_Fut	57.10	74.79	76.74	76.58	76.95	0.003726	2.47	53.11	96.15	0.60
941-M1	10213	10yr_Fut	77.40	74.79	76.82	76.76	77.14	0.005442	3.07	61.45	114.37	0.73
941-M1	10213	25yr_Fut	93.80	74.79	76.82	76.94	77.28	0.007975	3.72	61.53	114.56	0.89
941-M1	10213	50yr_Fut	109.00	74.79	77.04	77.02	77.35	0.005266	3.27	87.03	118.10	0.73
941-M1	10213	100yr_Fut	122.80	74.79	77.60	77.08	77.69	0.001508	2.06	174.29	184.88	0.41
941-M1	10213	Regional_Fut	103.50	74.79	78.33	76.99	78.35	0.000234	0.96	343.59	268.16	0.17
941-M1	10117	2yr_Ex	34.90	74.77	75.69	75.67	76.02	0.010494	2.55	15.07	29.65	0.90
941-M1	10117	5yr_Ex	54.30	74.77	75.94	75.94	76.36	0.009896	2.95	23.15	39.03	0.91
941-M1	10117	10yr_Ex	74.00	74.77	76.28	76.28	76.59	0.005615	2.68	51.35	106.99	0.72
941-M1	10117	25yr_Ex	90.20	74.77	76.39	76.39	76.71	0.005638	2.82	63.38	109.92	0.73
941-M1	10117	50yr_Ex	105.30	74.77	76.47	76.47	76.81	0.005879	2.98	72.25	111.42	0.75
941-M1	10117	100yr_Ex	121.20	74.77	77.58	76.55	77.61	0.000410	1.12	295.56	249.03	0.22
941-M1	10117	Regional_Ex	103.40	74.77	78.33	76.46	78.34	0.000078	0.57	499.68	280.24	0.10
941-M1	10117	2yr_Fut	36.70	74.77	75.72	75.70	76.05	0.010489	2.60	15.77	30.14	0.90
941-M1	10117	5yr_Fut	57.10	74.77	75.99	75.99	76.40	0.009175	2.93	25.51	56.32	0.88
941-M1	10117	10yr_Fut	77.40	74.77	76.31	76.31	76.61	0.005596	2.70	54.13	108.03	0.72
941-M1	10117	25yr_Fut	93.80	74.77	76.41	76.41	76.73	0.005722	2.86	65.43	110.27	0.74
941-M1	10117	50yr_Fut	109.00	74.77	76.49	76.49	76.83	0.005875	3.00	74.67	122.12	0.75
941-M1	10117	100yr_Fut	122.80	74.77	77.58	76.56	77.61	0.000421	1.13	295.56	249.03	0.22
941-M1	10117	Regional_Fut	103.50	74.77	78.33	76.46	78.34	0.000078	0.57	499.68	280.24	0.10

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Appendix C

Geotechnical Investigation and Design Report

AECOM

Geotechnical Investigation and Design Report

Wolfedale Creek Erosion Control Study – Schedule B Municipal Class Environmental Assessment Study

City of Mississauga

60701082

December 2024

Delivering a better world

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Rev #	Revision Date	Revised By:	Revision Description
1	October 24,2023	WH	Initial Draft
2	November 9, 2023	WH	Revised Draft
3	August 16, 2024	WH	Final Report
4	December 11, 2024	WH	Final Report for PIC

Distribution List

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1. Introduction

AECOM was retained by the City of Mississauga to carry out a geotechnical as part of an Environmental Assessment (EA) relating to proposed creek improvements along Wolfedale Creek in the City of Mississauga. The creek is from Burnhamthorpe Road West to Dundas Street in addition to the tributary outlet to the Credit River south of Queensway and west of Stavebank Road (approximately 2,300 m in length). The site key plan is presented in **Figure 1** and **Figure 2**.

The geotechnical scope of work included a subsurface investigation and preliminary geotechnical engineering recommendations regarding existing site condition to support the EA submission.

The statement of Qualifications and Limitations forms an integral part of the report and must be considered in conjunction with this report.

Figure 1: Location from Burnhamthorpe Road West to Dundas Street, Mississauga

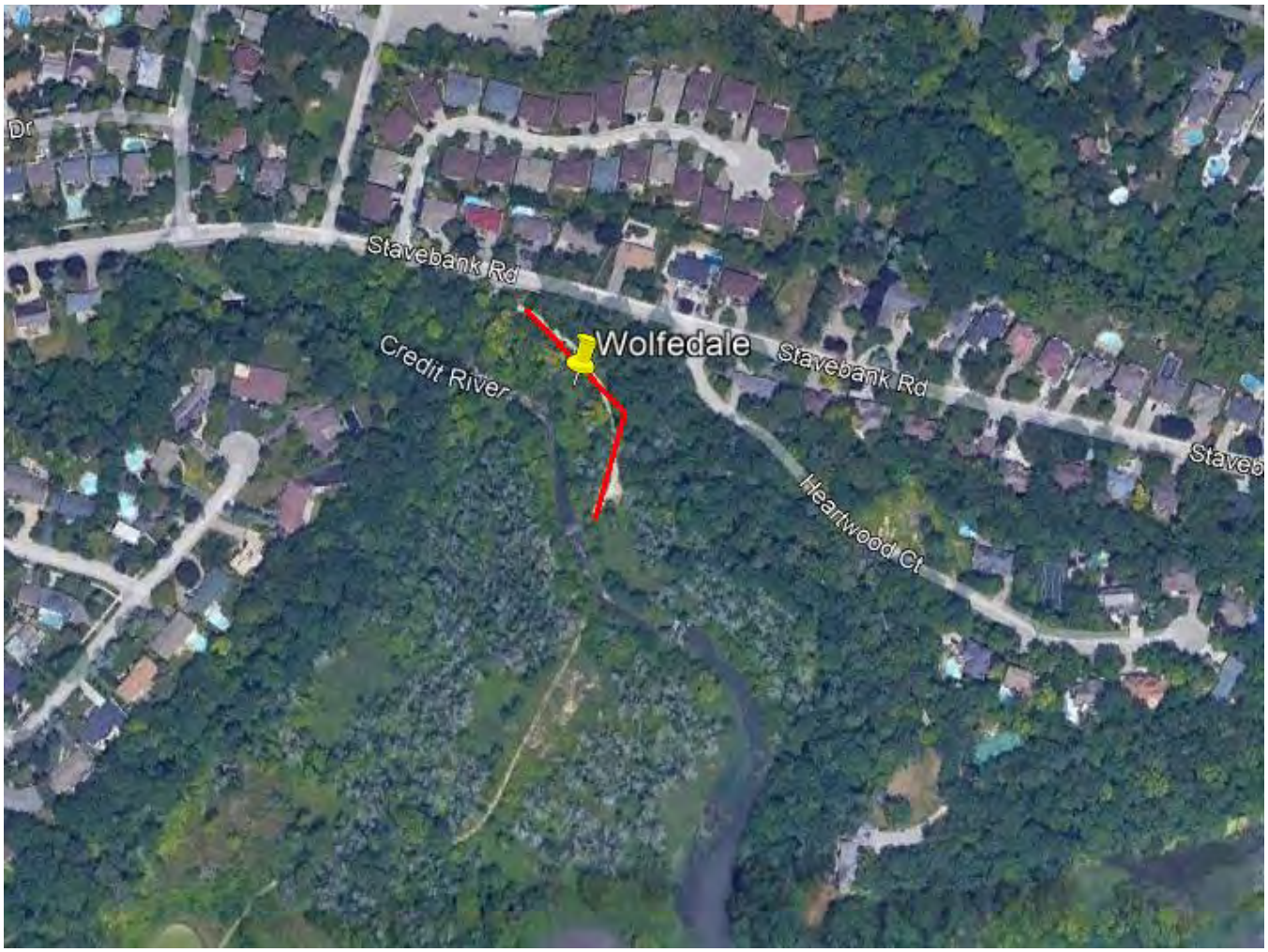

Figure 2: Location at West of Stavebank Road, Mississauga

2. Site Conditions and Regional Geological Setting

The Site is fed by storm runoff, with the outlet just south of Burnhamthorpe Road West, feeding into the confined engineered channel characterized predominantly by urban land uses. The northern section of study area is surrounded by industrial businesses and commercial use lots. The Canadian Pacific railline crosses the creek between Central Parkway West and Dundas Street. The southern area of study is surrounded by low-density residential areas, natural areas, and the Mississauga Golf and Country Club.

The physiographic region of the site is known as the ‘South Slope’ as delineated in The Physiography of Southern Ontario (Chapman and Putman, 1984). The South slope is known as such because it resides South of the Oak Ridges moraine; the predominant feature in the area. The South slope is smoothed, faintly drumlinized and scored at intervals by valleys tributary to the Humber and Credit River systems. The South slope can be classified as a ‘ground moraine’ with irregular knolls and hollows. As the South slope nears the lower elevation Lake Iroquois shorecliff, the moraine becomes planed and fluted. The flutings appear to be worn into the shale bedrock in places.

The South slope in the City of Mississauga overlies the grey shales of the Georgian Bay Formation. The soils are derived from the underlying rock and containing a variety of silts, sands, and clays. Significant rock inclusions are noted near to river valleys and outlets.

3. Site Investigation Procedures

The borehole locations were established on July 24th, 2023, by AECOM staffs during a meeting with the City. The public utility infrastructure owners were contracted through the Ontario One Call (ON1Call) system to request marking of publicly owned subsurface utilities in the investigation area. A private utility locating company, Altech Drilling & Investigative Services Ltd. located in Cambridge, Ontario, was subcontracted on August 11th, 2023, to carry out the private utility locating and borehole clearances for all existing buried underground infrastructure on Site impacting proposed borehole locations.

The geotechnical investigation program was carried out from September 5th to 8th 2023. Six (6) boreholes were drilled to a maximum depth of 7.7 mbgs. A monitoring well was installed in borehole BH-4 under full-time supervision of AECOM geotechnical field staff.

The geotechnical investigation program consisted of the sampled boreholes drilling and the installation of a monitoring well. To carry out the program, AECOM retained the drilling services of Altech Drilling & Investigative Services Ltd. located in Cambridge, Ontario, a Ministry of the Environment, Conservation, and Parks (MECP) licensed drilling contractor.

The boreholes were advanced using a track mounted mechanized drill rig Dietrich D-50 using both hollow and solid stem augers techniques. Upon completion of the drilling, a monitoring well was installed with stick-up protective casing and backfilled in accordance with Ontario Regulation (O.Reg.) 903, as amended. All borehole and monitoring well locations are presented in **Appendix A**.

In general, the geotechnical field testing and sampling was carried out according to ASTM standards modified based on site and encountered conditions. Standard Penetration Tests (SPT) were carried out at selected intervals to assess soil compactness/consistency to correlate its strength and to obtain samples for index (laboratory) testing purposes. SPTs were carried out in general accordance with ASTM D1586.

Table 1: Summary of Borehole Investigation

Borehole ID	Easting (m)	Northing (m)	Surface Elevation (mASL*)	Termination Depth (mbgs)	Monitoring Well
BH-1	4825725.038	608857.77	156.90	3.48	No
BH-2	4825661.458	608929.135	154.25	1.07	No
BH-3	4825443.339	609183.843	151.84	1.68	No
BH-4/MW	4825067.608	609619.02	147.63	3.20	Yes
BH-5	4823809.335	611796.324	79.39	5.18	No
BH-7	4823930.089	611744.253	101.49	7.72	No

4. Subsurface Conditions

The subsurface soil and groundwater conditions in the boreholes are summarized in the following sections. The stratigraphic layers were inferred from non-continuous sampling and observations of drilling and resistance and typically represent a transition from one soil type to another. These boundaries should not be interpreted to represent actual planes of geological change. The subsurface conditions have been confirmed at the borehole locations only, and they may vary between and beyond the borehole locations. Refer to **Appendix B** for the Record of Borehole Logs.

Generally, the subsurface profile consists of topsoil overlying varying thickness of fill. The native soils underlying the fill consist of a brown sand and gravel overlying sandy slit. The maximum explored depth was 7.72 mbgs in BH7.

4.1 Explored Soil Conditions

4.1.1 Topsoil

Topsoil was encountered at the ground surface in boreholes BH-1 and BH-3 drilled during the current investigation. The topsoil's explored thickness of 51mm was generally sandy silt based on appearance. Materials classified as topsoil were based on visual inspection only as no organic content testing was conducted.

4.1.2 Fill

Fill was encountered in all boreholes advanced during the current investigation. Fills encountered contained a variety of grain size composition and textures with varying amounts of organic inclusions. Fills are delineated by the majority of grain size inclusions – cohesionless (mainly sand and gravel) and cohesive (mainly silt and clay).

4.1.2.1 Cohesionless Fill

Cohesionless fill was encountered underlying the topsoil, or on ground surface in boreholes BH-1, BH-3, BH-4, and BH-7. The cohesionless fill consisted of a sand and gravel with varying levels of fines (silt and clay) and buried organics. Cohesionless fill was encountered underlying the topsoil or at ground surface: BH-1, BH-3, BH-4, and BH-7, during this investigation. The cohesionless fill layer extended from the ground surface to 0.0 and 1.5 m below ground surface (mbgs). Moisture contents ranged from 6.0% to 17.0%. SPT's carried out on this layer had N-values ranging from 8 to 20 blows per 0.3 m, indicating this layer was loose to compact in compactness. Grain size distribution analyses on the fill had gravel contents from 29% to 50%, sand contents from 33% to 38%, and fines (silt and clay) content from 17% to 55%. **Table 2** presents the results of the grain size analyses.

Table 2: Laboratory Test Result Summary - Cohesionless Fill

Borehole ID	Sample ID	Depth (m)	Moisture Content (%)	Grain Size Distribution		
				GR	SA	FINES
BH-1	SS-1	0.00	6.0	50	33	17
BH-4/MW	SS-1	0.00	17.0	30	38	32
BH-7	SS-1	0.00	13.0	29	36	35

4.1.2.2 Cohesive Fill

Cohesive fill was encountered in BH-2 and BH-6. The cohesive fill consisted of a clayey silt that had trace gravel to sandy in composition. Cohesive fill was encountered from 0.00 to 2.29 mbgs. SPT's carried out on this layer had N-values ranging from 5 to 27 blows per 0.3 m, indicating this layer was firm to very stiff. Moisture contents ranged from 10.0% to 21.0%. **Table 3** presents the results of the grain size analyses conducted on the fill. The raw laboratory analytical data are presented in **Appendix C.**

Table 3: Laboratory Test Result Summary - Cohesive Fill

Borehole ID	Sample ID	Depth (m)	Moisture Content (%)	Grain Size Distribution		
				GR	SA	FINES
BH-2	SS-1	0.00	18.0	4	25	71

4.1.3 Sandy Silt Till

The predominant soil type explored in all boreholes is a sandy silt till. The sandy silt till was brown to grey with trace gravel and clayey to some clay in composition. The sandy silt till was encountered from 0.3 to 1.8 mbgs and extended to the borehole termination depths ranging from 1.1 to 7.7 mbgs. SPTs carried out on this layer ranged from 4 to greater than 50 blows per 0.3 m, indicating a loose to very dense, but generally dense, soil. Moisture contents carried out on the sandy silt till ranged from 1.0% to 32%. Sieve and hydrometer analyses on the sandy silt till had gravel contents of 3%, sand contents ranging from 27% to 54%, silt contents ranging from 21% to 48%, and clay contents ranging from 16% to 27%. Atterberg limits testing conducted on the sandy silt till had plastic limits ranging from 14.4% to 20.5% and liquid limits ranging from 20% to 29%, indicating a low plasticity soil. **Table 4** presents the results of the sieve and hydrometer analyses and Atterberg limits analyses conducted on the sandy silt till. The raw laboratory analytical data are presented in **Appendix C**.

Table 4: Laboratory Test Result Summary – Sandy Silt Till

Borehole ID	Sample ID	Depth (m)	Moisture Content (%)	Sieve and Hydrometer				Atterberg Limits	
				GR	SA	SI	CL	Plastic Limit (%)	Liquid Limit (%)
BH-2	GS-4	0.98	14	3	27	48	22		
BH-3	SS-2	1.07	19	3	31	39	27	17.9	29
BH-4/MW	SS-4	2.29	24	3	54	21	22	18.8	22.1
BH-6	SS-7	4.9	17	3	40	41	16	14.4	20.0
BH-7	SS-5	3.1	17	3	42	38	17	20.5	25.7

4.1.4 Sand/Sand & Gravel

Thin layers of sand and gravel and sand were encountered in boreholes BH-4 and BH-7, respectively. The sand and sand and gravel was encountered at 1.1 to 1.5 mbgs and extended to 1.5 to 1.8 mbgs for explored thickness of 0.3 and 0.5 m, respectively. SPTs carried out on this layer had N values of 7 and 50, indicating a loose to dense soil. Moisture contents were 14% and 18%. The raw laboratory analytical data are presented in **Appendix C**.

4.2 Groundwater Conditions

One (1) monitoring well were installed as part of the geotechnical investigation for future groundwater monitoring assessment and analysis to aid in the detailed design and permitting phase of the construction works. The groundwater level monitoring data, as encountered when drilling, is presented in **Table 5**. It is anticipated that

seasonal fluctuations in groundwater levels will occur. It is recommended that additional groundwater level measurements and monitoring well development be completed to aid the detailed design process.

Table 5: Encountered Groundwater Condition

Monitoring Well ID	Ground Surface Elevation (mASL)	Encountered Groundwater Depth (mbgs)	Date of Encounter
BH-4/MW	147.63	Dry	September 6, 2023
BH-6	79.39	1.83	September 7, 2023

5. Preliminary Geotechnical Recommendations

As the design progresses, the geotechnical investigation and design report will evaluate five (5) critical cross-sections along the project length for long-term slope stability. **Appendix D** provides the locations of the evaluated cross-sections. The modelling results are provided in **Appendix E**.

5.1 Global Stability Analyses – Existing Conditions

A preliminary numerical analysis was carried out using SLOPE/W (from the GeoStudio software suite) to evaluate the global slope stability of five cross-sections on both banks of the creek where possible. The general procedure for the analyses began with modelling the selected cross-sections of the creek and estimating the material properties based on the geotechnical investigation. Critical slip surfaces which were 1m or less in thickness were assumed to be surficial failure and were not considered as part of this global slope stability analysis. The analysis was carried out based on the geometry obtained from the existing survey data. It is important to note that there may be substantial variations in geometry (e.g., elevation) or external factors beyond the surveyed area, which could potentially affect the preliminary assessment of global slope stability. Therefore, it is recommended to conduct further evaluations to account for these potential influences. **Table 6** provides the subsurface parameters and material models utilized in the global stability analyses.

Table 6: Subsurface Parameters – Global Stability Analyses

Soil/Structure Type	Material Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)
Fill	Mohr-Coulomb	19	2	30
Sandy Silt	Mohr-Coulomb	20	3	31
Gabion Basket	High Strength	22	-	-
Bedrock	Bedrock (Impenetrable)	-	-	-

5.1.1 Global Stability Results – Long Term Stability under Normal Conditions

Table 7: Summary of Factor of Safety for Long Term-Stability under Normal Conditions

Cross-section Location	Slope	Existing Conditions
G-101	East	1.5
G-102	East	1.3
	West	1.3
G-103	East	1.5
	West	1.5
G-104	East	1.2
	West	1.3
G-105	East (Gabion Baskets)	1.2
	East (Entire Slope)	1.2

Notes: Green font = Meets of exceeds target FS
Red font = Below target FS

5.2 Design Options

Based on the analysis results, it is noted that some of the existing conditions along the channel do not met the recommended FS (FS >1.3 and FS> 1.5) based on the CFEM for the short-term and long-term condition, respectively. Therefore, the following recommendations may be considered to increase the stability including above mentioned measures.

During the detailed design, the creek design options will be modelled and evaluated in Slope/W and the above provided FS values in **Table 7** will be updated to illustrate proposed conditions with improvements (i.e., flattened slope, increased elevation, hydro-fluvial alterations, etc.).

5.2.1 Improve Slope Drainage

Elevated groundwater levels and pore pressures can result in a loss of shear strength of the soil and an increase of slope instability. Promoting the drainage of the existing slopes will allow the groundwater level within the slope to be lowered and can prevent buildup of pore pressures. The slope drainage can be improved by a series of measures, including:

- Improving surface drainage:
  - diverting surface runoff at the top of the slope and along the slope face into solid pipes that discharge towards the toe of the slope;
  - Minimizing infiltration in the long term by increasing the amount of vegetation on the slope and near the crest of the slope;
- Installing sub-horizontal drains within the slope face at critical locations, considering:
  - A portion of the sub-horizontal drain should be non-perforated pipe towards the surface to reduce the risk of root intrusion;
  - The slope may be stabilized by installing fewer, longer drains which could limit disturbance to the existing slope and vegetation; and,
  - Sub-horizontal drains can be effective in limiting the effects of transient elevated groundwater levels, which is a common trigger of slope failures.

The drainage system may require occasional maintenance to ensure it remains functional. This may include periodic removal of siltation and bacterial growth within the horizontal drains by flushing using high-pressure water jets. However, the system may be constructed with materials that limit bacterial growth and with greater redundancy to reduce the amount of maintenance and flushing required. One of the disadvantages of this method is provided a limited level of improvement due to only controlling the groundwater table, therefore, this method should a combination of other mitigation measures. **Figure 3** presents the sub-horizontal drain installed on a slope.

5.2.2 Re-grading & Revegetation of Slopes

The next option is to simply regrade and revegetate the existing slopes. The existing slope should be stripped and regraded to the required stable slope gradient by backfilling with compacted engineered fill. The backfill material would need to be keyed into the existing slope and the final slope surface should be topsoiled and protected with an erosion control mat. As it is primarily short-term erosion that is of concern, while the vegetation establishes itself on the slopes, a degradable erosion control mat may be used. Consideration should be given to planting more mature trees on the final slope.

It is possible to regrade the slope by either flattening portions of the upper slope or by constructing a buttress from the base of the slope (or both). Flattening the upper slope effectively reduces the destabilizing forces within the slope while buttressing increases the stabilizing forces within the slope.

Figure 3: Example of Sub-Horizontal Drains during Construction

5.2.3 Additional Weight at the Toe

Increasing the weight distribution at the toe of the slope and the bottom of the creek provides the extra resistance against sliding and can lead to improved slope stability. The additional of rip-rap, or other fluvial improvement measures (i.e., armorstone) may be utilized in design.

5.2.4 Soil Nails or Anchors

Another option is to stabilize the slope with use of soil nails or anchors and a flexible facing. Soil anchoring can be done in areas with limited access to the creek or 'tight' property constraints.

For general earth slope, the soil nails can be installed into the existing slope without the need for significant excavation and a flexible facing constructed using a mesh-reinforced erosion control mat. A cellular confinement cell, such as GeoWeb, can also be installed over the erosion control mat to promote vegetation growth on relatively steep slopes (up to 70 degrees). On less steep slopes and where minimizing disturbance to the existing slope is desirable, a grillage system or tree rings (cut outs in the reinforced erosion control mat) can be adopted, where practicable, to allow for existing trees to be retained or to allow for new trees to be planted on the slope.

A soil nail solution is generally preferable when excavation of the existing slope is undesirable, such as when excavation would undermine existing structures and features. Given the access constraints, it is likely preferable to use a limited access rig that may be rappelled from the slope crest; however, a separate batch plant for grout would typically need to be established for this approach. Alternatively, soil nails can be installed from the top of the slope or the bottom of the slope (or both) using long reach excavators or high reach excavators respectively. An example of soil nail slope is shown in **Figure 4**.

Figure 4: Example of Soil Nail Wall during Construction

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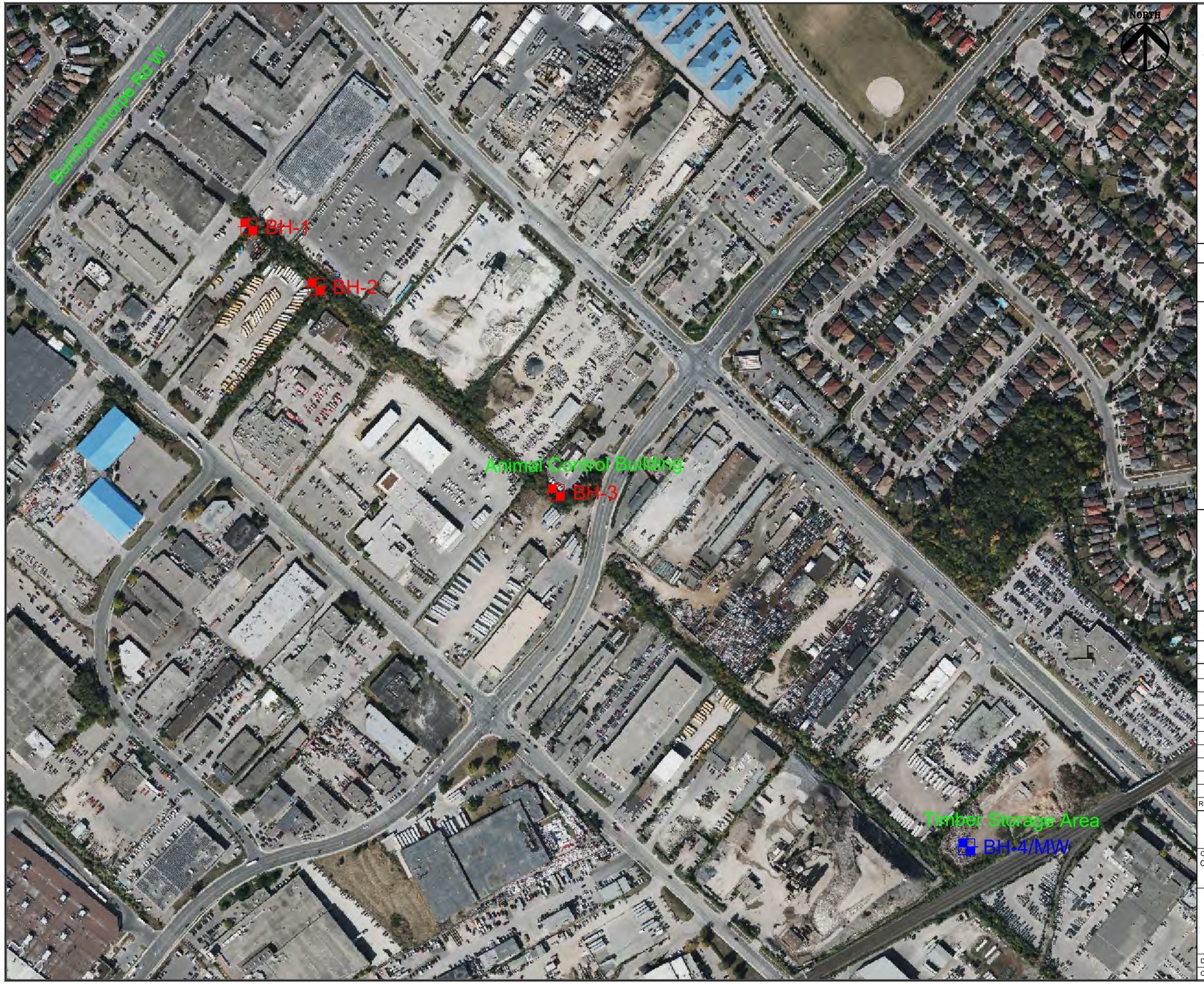
Appendix A

Borehole Location Plan



LEGEND

- AECOM - Geotechnical Boreholes
- AECOM - Geotechnical Boreholes with Monitoring Wells

SURVEY:

BOREHOLE ID	ELEVATION (MASL)	UTM COORDINATES (ZONE 17)	
		NORTHING	EASTING
BH-1	156.9	4825725.0	608857.8
BH-2	154.3	4825661.5	608929.1
BH-3	151.8	4825443.3	609183.8
BH-4/MW	147.6	4825067.6	609619.0
BH-6	79.4	4823809.3	611796.3
BH-7	101.5	4823930.1	611744.3

NOTES:

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REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
1	2023.09.25	Updated Borehole Plan	BK	TA
0	2023.07.24	Borehole Plan	BK	TA

AECOM

CLIENT NAME:
City of Mississauga

PROJECT LOCATION:
Wolfedale Creek

PROJECT NUMBER: 60701082

NORTH CHANNEL BOREHOLE LOCATION PLAN

DRAWN BY: BK	SCALE: 1:5000	DRAWING No. 1
CHECKED: TA	DATE: SEPT 2023	REVISION 0

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LEGEND

AECOM - Geotechnical Boreholes

SURVEY:

BOREHOLE ID	ELEVATION (MASL)	UTM COORDINATES (ZONE 17)	
		NORTHING	EASTING
BH-1	156.9	4825725.0	608857.8
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REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
1	2023.09.25	Updated Borehole Plan	BK	TA
0	2023.07.24	Borehole Plan	BK	TA

AECOM

CLIENT NAME:
City of Mississauga

PROJECT LOCATION:
Wolfedale Creek

PROJECT NUMBER: 60701082

SOUTH CHANNEL BOREHOLE LOCATION PLAN

DRAWN BY: BK	SCALE: 1:2000	DRAWING No. 2
CHECKED: TA	DATE: SEPT 2023	REVISION 0

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Appendix B

Record of Borehole Logs

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TERMINOLOGY USED IN BOREHOLE LOGS

Topsoil: Mixture of soil and humus capable of supporting good vegetative growth.

Peat: A mass of organic matter usually fibrous in texture in various stages of decomposition, generally dark brown to black in colour and of spongy consistency.

Fill: The term fill has been used to describe materials which have been placed by non-natural processes. Fills can often be heterogeneous in nature and those relying on this report should expect them to contain deleterious materials. Such materials can include wood, bricks, slag, porcelain, organics, and obstructions such as scrap metal, storage tanks, and abandoned concrete/steel structures.

Due to the uncertainty of the placement method of the material, the boring samples obtained for this report are not expected to represent other materials at any horizontal or vertical distance from where the sample was obtained.

Fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill site. Unless specifically stated, the fill on this site has not been tested for contaminants that can be considered toxic or hazardous. Testing to determine the toxicity of fill materials can be conducted, if requested.

Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Till must be considered heterogeneous in composition and containing pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) and boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the logs. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Due to the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone. Caution is essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

Residual: completed weathered sedimentary rock mixed with native soils.

All soil sample descriptions included in this report generally follow the Canadian Foundations Engineering Manual and the Unified Soil Classification System. These systems follow the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by AECOM follow the same system. Note that, with exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact gain sizing.

ISSMFE / USCS SOIL CLASSIFICATION

CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		

0.002 | 0.075 | 0.475 | 2.0 | 4.75 | 26.5 | 75 | 200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis. Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils.

The standard terminology to describe cohesionless soils includes the compactness condition as determined by the Standard Penetration Test 'N' value.

Cohesionless Soils		Cohesive Soils			Composition	
Compactness Condition	**SPT N-Index (blows per 0.3 m)**	**Consistency**	**Undrained Shear Strength (kPa)**	**SPT N-Index (blows per 0.3 m)**	**Term**	**Criteria**
Very loose	0 – 4	Very soft	< 12	< 2	Trace	1% - 10%
Loose	4 – 10	Soft	12 - 25	2 – 4	Some	10% - 20%
Compact	10 – 30	Firm	25 – 50	4 – 8	Adjective	20% - 35%
Dense	30 – 50	Stiff	50 – 100	8 – 15	And	> 35%
Very Dense	> 50	Very Stiff	100 - 200	15 – 30	Noun	> 35% & largest fraction
		Hard	> 200	> 30		

Standard Penetration Test (SPT):

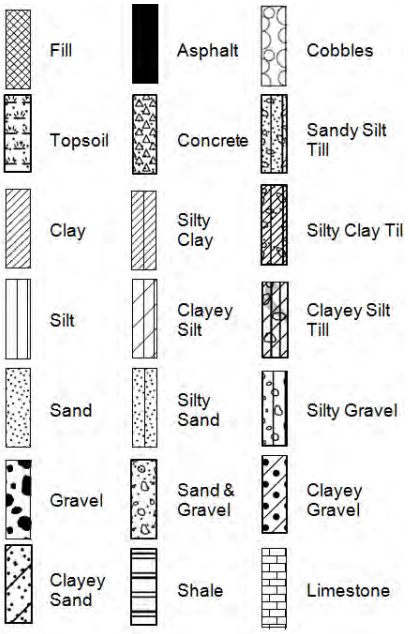
The number of blows required to drive a 50 mm (2 in.) open split spoon sampler from a depth of 150 mm (6 in.) to 450 mm (18 in.) in undisturbed soil. Each blow is driven by a 63.6 kg (140 lb.) hammer free falling a distance of 0.76 m (30 in.).

Sample & Soil Abbreviations	
CORE	Rock core sample
AS	Auger sample
FV	Field vane
PP	Pocket penetrometer
SG	Specific Gravity
GS	Grab sample
SS	Split spoon sample
DCPT	Dynamic cone penetration test
GR	Gravel
SA	Sand
SI	Silt
CL	Clay

Contaminant Abbreviations	
BNAE	base/neutral/acid extractables
BTEX	benzene, toluene, ethylbenzene, xylenes
OCP	organochlorine pesticides
MI	metals & inorganics
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PHC	CCME petroleum hydrocarbons (fractions 1 – 4)
VOC	volatile organic compounds (includes BTEX)

Plasticity Description	Liquid Limit (w_l)
Low	$w_l < 30$
Medium	$30 < w_l < 50$
High	$50 < w_l$

Strata/Graphic Plot



RECORD OF BOREHOLE: BH-1

PROJECT: Wolfedale Creek
LOCATION: 780 Burnhamthorpe Rd W #14, Mississauga, ON L5C 3X3
COORDINATES: N 4825725.0; E 608857.8
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: September 5, 2023
END DATE: September 5, 2023
BORING METHOD: 200 mm O.D. Hollow Stem Auger
CONTRACTOR: Altech Drilling and Investigative Services

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	N VALUE	HEADSPACE / GAS CONCENTRATION	SHEAR STRENGTH Cu, kPa (nat V. - + Q - ●; rem V. - ⊕ U - △) / WATER CONTENT PERCENT (Wp ⊢—○w—⊣ Wl)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		TOPSOIL		156.9						GR SA SI CL	
0	Power Auger Drilling; 200 mm O.D. Hollow Stem Auger	**TOPSOIL:** 51 mm thick		0.1							
		FILL: sand and gravel, some rootlets, some silt and clay, brown, moist, compact			1	SS	20		○	50 33 (17)	
				156.1							
1		**SILTY SAND:** broken rock pieces, trace gravel, brown, moist, very stiff to hard with buried cobbles and crushed rock **TILL**		0.8	2	SS	21		○		
		---------- hard			3	SS	50/152mm		○		
2					4	SS	50/152mm		○		
3					5	SS	50/13mm		○		
				153.4	6	SS	50/127mm		○		
		AUGER REFUSAL		3.5							
		END OF BOREHOLE									
4		Notes: 1. This log is to be read with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. No abnormal odour or staining was observed unless otherwise indicated. 4. No groundwater was observed at the depth of 3.48mbgs in the open hole.									
5											
6											
7											
8											
9											
10											

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

RECORD OF BOREHOLE: BH-2

PROJECT: Wolfedale Creek
LOCATION: 780 Burnhamthorpe Rd W #14, Mississauga, ON L5C 3X3
COORDINATES: N 4825661.5; E 608929.1
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: August 11, 2023
END DATE: August 11, 2023
BORING METHOD: Hand Auger Drilling
CONTRACTOR: Altech Drilling and Investigative Services

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	N VALUE	HEADSPACE ■ / GAS CONCENTRATION □ (20 40 60 80)	SHEAR STRENGTH Cu, kPa: nat V. - + Q - ● / rem V. - ⊕ U - △ (20 40 60 80); WATER CONTENT PERCENT Wp ⊢—○w—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		TOPSOIL		154.3						GR SA SI CL	
0	Hand Auger Drilling	**FILL:** clayey silt, some sand, trace gravel, brown, moist		0.0	1	GRAB			○	4 25 (71)	
		SILTY SAND: some clay, trace gravel, brown, moist		153.9 / 0.3	2	GRAB			○		
					3	GRAB			○		
1				153.2	4	GRAB			○	3 27 48 22	
		END OF BOREHOLE		1.1							
2											
3											
4											
5											
6											
7											
8											
9											
10											

Notes:
1. This log is to be read with the subject report and project number as presented above.
2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
3. No abnormal odour or staining was observed unless otherwise indicated.
4. No groundwater was observed at the depth of 1.07mbgs in the open hole.

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

RECORD OF BOREHOLE: BH-3

SHEET 1 OF 1

PROJECT: Wolfedale Creek
LOCATION: 735 Central Pkwy W, Mississauga, ON L5C 1T8
COORDINATES: N 4825443.3; E 609183.8
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: September 6, 2023
END DATE: September 6, 2023
BORING METHOD: 200 mm O.D. Hollow Stem Auger
CONTRACTOR: Altech Drilling and Investigative Services

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	N VALUE	HEADSPACE ■ / GAS CONCENTRATION □ (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. - + Q - ●; rem V. - ⊕ U - △) / WATER CONTENT PERCENT (Wp ⊢—○w—⊣ Wl) (20 40 60 80; 10 20 30 40)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		TOPSOIL		151.8						GR SA SI CL	
0	Power Auger Drilling, 200 mm O.D. Hollow Stem Auger	**TOPSOIL:** 51 mm thick		0.1							
		FILL: sand and gravel, some silt and clay, brown, moist, compact			1	SS	11		○		
				151.1							
1		**SANDY SILT:** clayey, trace gravel, brown, moist, stiff to hard, low plasticity **TILL**		0.8	2	SS	8		⊢—⊣	3 31 39 27	
		broken rock pieces, very dense		150.2	3	SS	50/13mm		○		
		AUGER REFUSAL **END OF BOREHOLE**		1.7							
2											
3											
4											
5											
6											
7											
8											
9											
10											

Notes:
1. This log is to be read with the subject report and project number as presented above.
2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
3. No abnormal odour or staining was observed unless otherwise indicated.
4. No groundwater was observed at the depth of 1.68mbgs in the open hole.

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

RECORD OF BOREHOLE: BH-4/MW

SHEET 1 OF 1

PROJECT: Wolfedale Creek
LOCATION: 3300 Mavis Rd Unit 2, Mississauga, ON L5C 1T8
COORDINATES: N 4825067.6; E 609619.0
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: September 6, 2023
END DATE: September 6, 2023
BORING METHOD: 200 mm O.D. Hollow Stem Auger
CONTRACTOR: Altech Drilling and Investigative Services

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	N VALUE	HEADSPACE / GAS CONCENTRATION	SHEAR STRENGTH Cu, kPa (nat V. - + Q - ●; rem V. - ⊕ U - △) / WATER CONTENT PERCENT (Wp ⊢—○w—⊣ Wl)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		GROUND SURFACE		147.6						GR SA SI CL	
0	Power Auger Drilling; 200 mm O.D. Hollow Stem Auger	**FILL:** sand and gravel, some silt, some clay, brown, moist, compact with buried organics/rootlets		0.0	1	SS	13			30 38 (32)	
1				146.5	2A	SS	21				
		SAND AND GRAVEL: grey to brown, moist, dense		1.1	2B	SS	50				
		SANDY SILT: trace gravel, clayey to some clay, grey to brown, moist, firm to hard **TILL**		146.1 1.5	3	SS	11				
2		moist to wet, firm (sand lens)			4	SS	7			3 54 21 22	
3		hard		144.4	5	SS	50/127mm				
		AUGER REFUSAL **END OF BOREHOLE**		3.2							

Notes:
1. This log is to be read with the subject report and project number as presented above.
2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
3. No abnormal odour or staining was observed unless otherwise indicated.
4. No groundwater was observed at the depth of 3.20mbgs in the open hole.

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

RECORD OF BOREHOLE: BH-6

SHEET 1 OF 1

PROJECT: Wolfedale Creek
LOCATION: South of 2143 Stavebank Rd
COORDINATES: N 4823809.3; E 611796.3
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: September 7, 2023
END DATE: September 7, 2023
BORING METHOD: 200 mm O.D. Hollow Stem Auger
CONTRACTOR: Altech Drilling and Investigative Services

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	N VALUE	HEADSPACE ■ / GAS CONCENTRATION □ (20 40 60 80)	SHEAR STRENGTH Cu, kPa nat V. - + Q - ● rem V. - ⊕ U - △ (20 40 60 80) / WATER CONTENT PERCENT Wp ⊢—○w—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		GROUND SURFACE		79.4						GR SA SI CL	
0	Power Auger Drilling, 200 mm O.D. Hollow Stem Auger	**FILL:** silty clay, sandy, trace gravel, brow, moist, very stiff to loose		0.0	1	SS	27		○		
1		firm			2	SS	10		○		
		loose			3	SS	5		○		▽ September 7, 2023
2				77.1							
		SANDY SILT: trace gravel, some clay, grey, wet, very stiff to firm		2.3	4	SS	9		○		
3		cobbles, very stiff			5	SS	17		○		
4		firm			6	SS	7		○		
5					7	SS	4		⊢○⊣	3 40 41 16	
				74.2							
		END OF BOREHOLE		5.2							
6											
7											
8											
9											
10											

Notes:
1. This log is to be read with the subject report and project number as presented above.
2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
3. No abnormal odour or staining was observed unless otherwise indicated.
4. Groundwater was observed at the depth of 1.83mbgs in the open hole.

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

RECORD OF BOREHOLE: BH-7

PROJECT: Wolfedale Creek
LOCATION: South of 2143 Stavebank Rd
COORDINATES: N 4823930.1; E 611744.3
DATUM: Geodetic
AECOM PROJECT #: 60710388
CLIENT: City of Mississauga

START DATE: September 7, 2023
END DATE: September 7, 2023
BORING METHOD: 200 mm O.D. Hollow Stem Auger
CONTRACTOR: Altech Drilling and Investigative Services

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	N VALUE	HEADSPACE ■ / GAS CONCENTRATION □ (20 40 60 80)	SHEAR STRENGTH Cu, kPa: nat V. - + Q - ● rem V. - ⊕ U - △ (20 40 60 80) / WATER CONTENT PERCENT Wp ⊢—○w—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		GROUND SURFACE		101.5						GR SA SI CL	
0	Power Auger Drilling; 200 mm O.D. Hollow Stem Auger	**FILL:** gravelly sand, some silt, some clay, brown, moist, stiff with buried organics/rootlets		0.0	1	SS	13		○	29 36 (35)	
1					2	SS	8		○		
				100.0							
		SAND: trace gravel, trace silt, brown, moist, loose		1.5 / 99.7	3A	SS	7		○		
2		**SANDY SILT:** trace gravel, some clay, brown, moist, firm to hard **TILL**		1.8	3B	SS	4		○		
		stiff			4	SS	12		○		
3					5	SS	8		○ ⊢⊣	3 42 38 17	
4											
		very stiff			6	SS	26		○		
5											
6					7	SS	20		○		
7											
		buried cobbles, hard		93.8 / 7.7	8	SS	50/102mm		○		
8		**END OF BOREHOLE**									
9											
10											

Notes:
1. This log is to be read with the subject report and project number as presented above.
2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
3. No abnormal odour or staining was observed unless otherwise indicated.
4. No groundwater was observed at the depth of 7.72mbgs in the open hole.

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE
1 : 50

MISSISSAUGA

AECOM

LOGGED: BK
CHECKED: TA

AECOM

Appendix C

Geotechnical Soil Laboratory Results

AECOM Canada Ltd.
1000-5090 Explorer Drive
Mississauga, ON L4W 4X6
Canada

T: 905 238 0007
www.aecom.com

To: William Hanson

Date: September 26, 2023
Project #: 60701082
From: Afshin Rabbani
Venkata Ramana Mullapudi

CC:

Memorandum

Subject: Wolfdale – Laboratory Test Results

Please find attached the following material test result(s) on sample(s) submitted to the Etobicoke Geotechnical Laboratory:

- Thirty-eight (36) Moisture Content Determination Tests.
- Four (4) Atterberg Limits (Minimum 3 Points) Tests.
- Five (5) Grain Size Distribution (Sieve and Hydrometer Method) Tests.
- Four (4) Sieve Analysis Tests.

If you have any questions, please contact the undersigned.

Prepared by:

Afshin Rabbani, B.Eng., C.E.T
Geotechnical Laboratory Supervisor

Reviewed by

Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Moisture Content (ASTM D2216-10)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

Project Name:	Wolfedale Cr	Supplier:	Not provided
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	Brian.K
Borehole ID:	Varies	Sample Date:	NA
Sample Number:	Varies	Lab Technician:	Sam E.
Sample Depth:	Varies	Date Tested:	September 12, 2023

Moisture Content Determination (ASTM D2216-10)

Borehole Name	Sample ID	Depth (feet)	Can ID	Observations			Formula		
				Wt of Empty Can (g) W_1	Wt of Wet Soil+Can (g) W_2	Wt of Dry Soil+Can (g) W_3	Wt of Water (g) $W_w = (W_2-W_3)$	Wt of Dry Soil (g) $W_s = (W_3-W_1)$	Moisture Content (%)
BH-1	SS1	0'-2'	151	13.30	65.10	62.00	3.10	48.70	6
	SS2	2.5'-4.5'	115	13.70	73.00	64.40	8.60	50.70	17
	SS3	5'-7'	42	13.90	72.70	67.50	5.20	53.60	10
	SS4	7.5'-9.5'	106	13.60	74.20	68.40	5.80	54.80	11
	SS5	10'-11'	138	13.90	67.40	66.60	0.80	52.70	2
	SS6	11'-11.4'	53	14.10	54.40	54.10	0.30	40.00	1
BH-2	AG1	0'-1'	21	13.80	58.20	51.40	6.80	37.60	18
	AG2	1'-2'	83	13.90	58.50	52.70	5.80	38.80	15
	AG3	2'-3'	166	13.00	53.10	46.90	6.20	33.90	18
	AG4	3'-3.5'	114	14.00	58.40	52.80	5.60	38.80	14
BH-3	SS1	0'-2'	102	13.90	69.80	65.10	4.70	51.20	9
	SS2	2.5'-4.5'	156	13.90	72.20	63.00	9.20	49.10	19
	SS3A	5'-5.5'	95	13.60	90.70	81.90	8.80	68.30	13
	SS3B	5'-5.5'	65	13.70	82.90	74.70	8.20	61.00	13
BH-4	SS1	0'-2'	155	13.70	70.10	61.80	8.30	48.10	17
	SS2A	2.5'-3.3'	122	14.00	64.80	55.60	9.20	41.60	22
	SS2B	3.3'-4.5'	166	13.90	63.00	56.90	6.10	43.00	14
	SS3	5'-7'	118	13.90	102.80	89.40	13.40	75.50	18
	SS4	7.5'-9.5'	135	14.10	70.70	59.60	11.10	45.50	24
	SS5	10'-10.5'	168	13.90	76.10	63.20	12.90	49.30	26

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Total Samples	20

Moisture Content (ASTM D2216-10)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

Project Name:	Wolfedale Cr	Supplier:	Not provided
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	Brian.K
Borehole ID:	Varies	Sample Date:	NA
Sample Number:	Varies	Lab Technician:	Sam E.
Sample Depth:	Varies	Date Tested:	September 12, 2023

Moisture Content Determination (ASTM D2216-10)

Borehole Name	Sample ID	Depth (feet)	Can ID	Observations			Formula		
				Wt of Empty Can (g) W_1	Wt of Wet Soil+Can (g) W_2	Wt of Dry Soil+Can (g) W_3	Wt of Water (g) $W_w = (W_2-W_3)$	Wt of Dry Soil (g) $W_s = (W_3-W_1)$	Moisture Content (%)
BH-6	SS1	0'-2'	135	14.10	79.30	73.50	5.80	59.40	10
	SS2	2.5'-4.5'	168	13.90	94.10	82.80	11.30	68.90	16
	SS3	5'-7'	81	13.40	66.70	57.30	9.40	43.90	21
	SS4	7.5'-9.5'	65	14.00	93.80	79.40	14.40	65.40	22
	SS5	10'-12'	155	13.50	75.60	63.80	11.80	50.30	23
	SS6	12.5'-14.5	172	14.20	70.20	56.70	13.50	42.50	32
	SS7	15'-17'	54	13.80	93.10	76.50	16.60	62.70	26
BH-7	SS1	0'-2'	99	13.70	95.10	85.70	9.40	72.00	13
	SS2	2.5'-4.5'	74	13.60	54.70	49.90	4.80	36.30	13
	SS3A	5'-6'	63	13.60	67.70	59.40	8.30	45.80	18
	SS3B	6'-7'	115	13.50	58.00	48.90	9.10	35.40	26
	SS4	7.5'-9.5'	192	13.70	83.60	73.30	10.30	59.60	17
	SS5	10'-12'	77	13.60	73.30	64.50	8.80	50.90	17
	SS6	15'-17'	180	13.90	116.60	104.60	12.00	90.70	13
	SS7	20'-22'	60	13.60	97.30	83.40	13.90	69.80	20
	SS8	25'-25.3'	84	14.00	53.40	49.10	4.30	35.10	12

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Total Samples	16

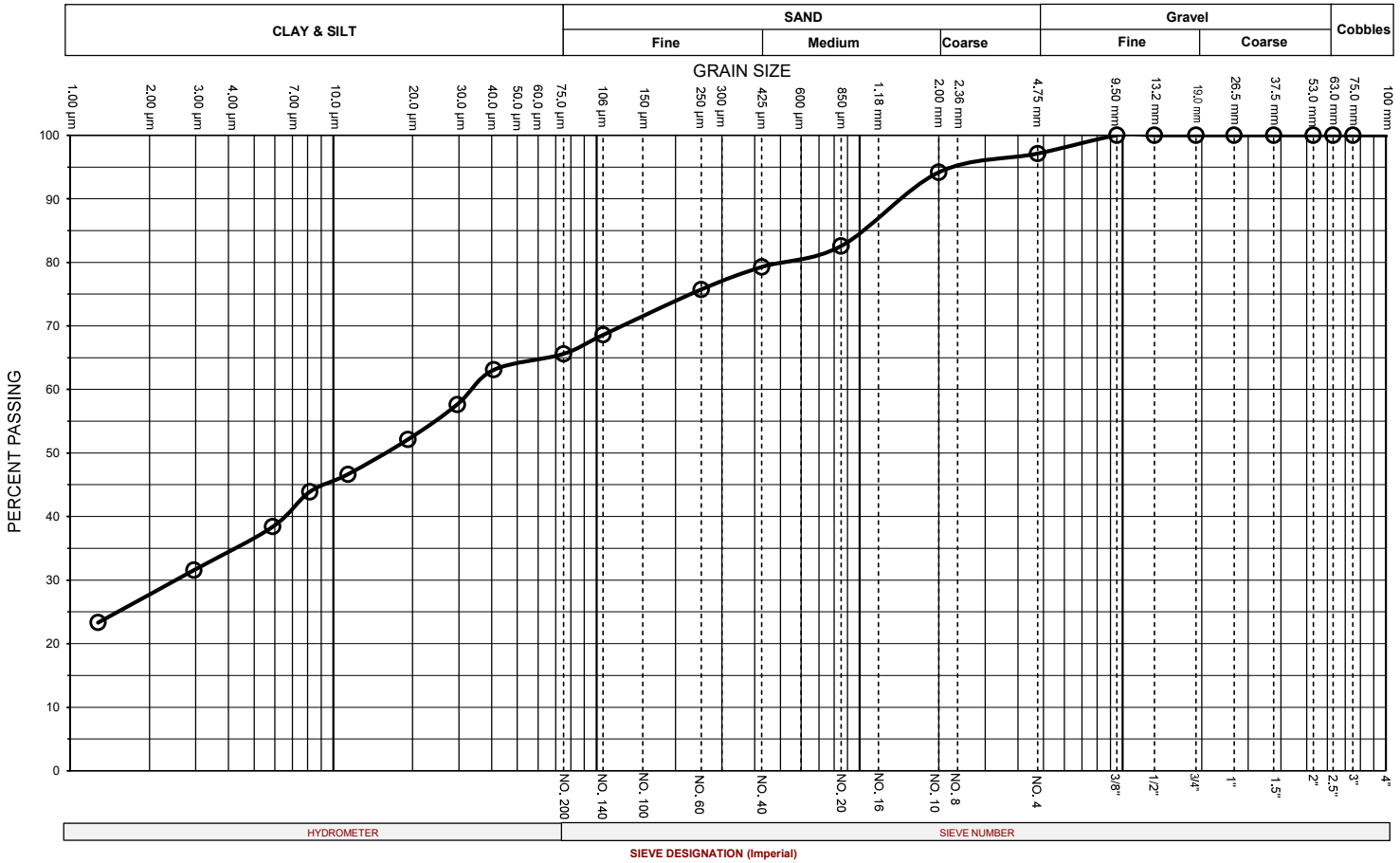
Grain Size Distribution (ASTM D422-63)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

Project Name:	Wolfdale Crk	Borehole No.:	BH-3	Date Tested:	15/8/2023
Project Number:	60701082	Sample No.:	SS2	Tested by:	AECOM
Client:	AECOM	Sample Depth:	2.5' to 4.5'		
Project Location:	Wolfdale Creek, Ontario	Date Sampled:	N/A		
		Sampled by:	H. Gillen		

GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)



Gravel (%)	3	**Silt (%)**	39
Sand (%)	31	**Clay (%)**	27

Soil Classification (USCS)			Sandy Lean Clay, trace gravel (CL)						
D10	N/A	**D30**	0.002	**D60**	-0.002	**Cu**	N/A	**Cc**	N/A

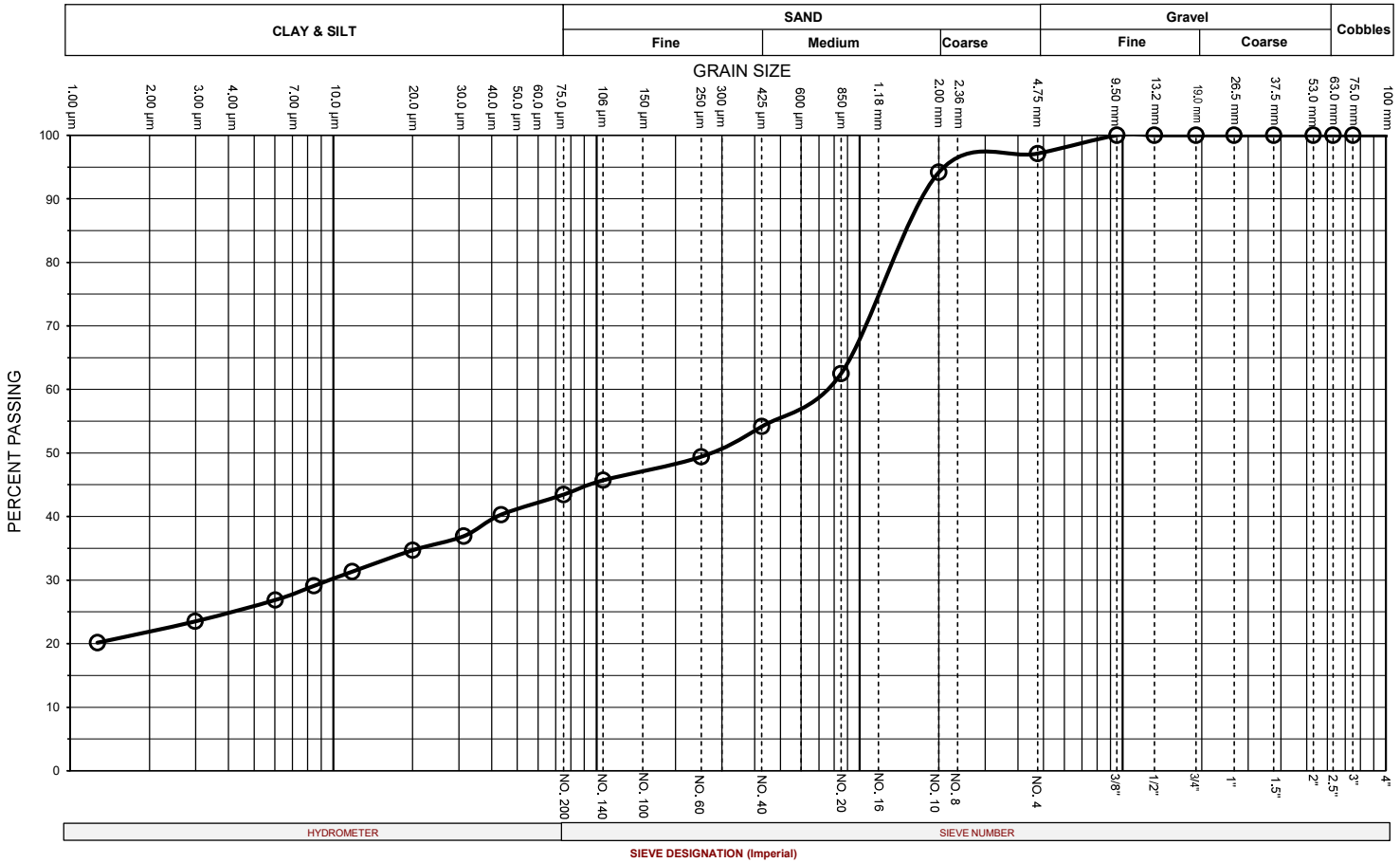
Grain Size Distribution (ASTM D422-63)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

Project Name:	Wolfdale Crk	Borehole No.:	BH-4	Date Tested:	15/8/2023
Project Number:	60701082	Sample No.:	SS4	Tested by:	AECOM
Client:	AECOM	Sample Depth:	7.5' to 9.5'		
Project Location:	Wolfdale Creek, Ontario	Date Sampled:	N/A		
		Sampled by:	H. Gillen		

GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)



Gravel (%)	3	**Silt (%)**	21
Sand (%)	54	**Clay (%)**	22

Soil Classification (USCS)			Clayey Silty Sand, trace gravel, some debris (Tile pices and recycled concrete) (SM)						
D10	N/A	**D30**	0.009	**D60**	0.759	**Cu**	N/A	**Cc**	N/A

Grain Size Distribution (ASTM D422-63)

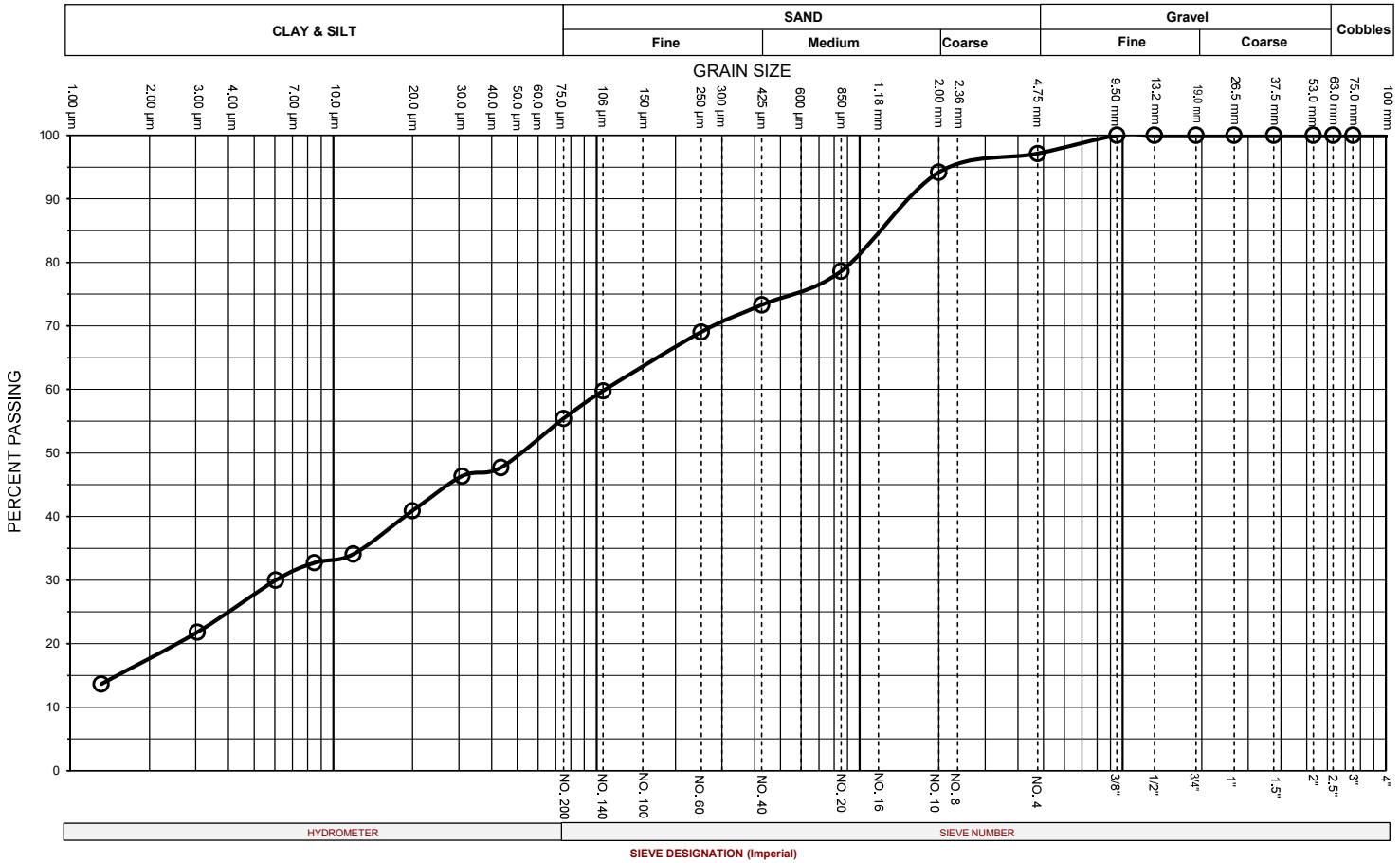
AECOM

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

Project Name:	Wolfdale Crk	Borehole No.:	BH-7	Date Tested:	15/8/2023
Project Number:	60701082	Sample No.:	SS5	Tested by:	AECOM
Client:	AECOM	Sample Depth:	10.0' to 12.0'		
Project Location:	Wolfdale Creek, Ontario	Date Sampled:	N/A		
		Sampled by:	H. Gillen		

GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)



Gravel (%)	3	**Silt (%)**	38
Sand (%)	42	**Clay (%)**	17

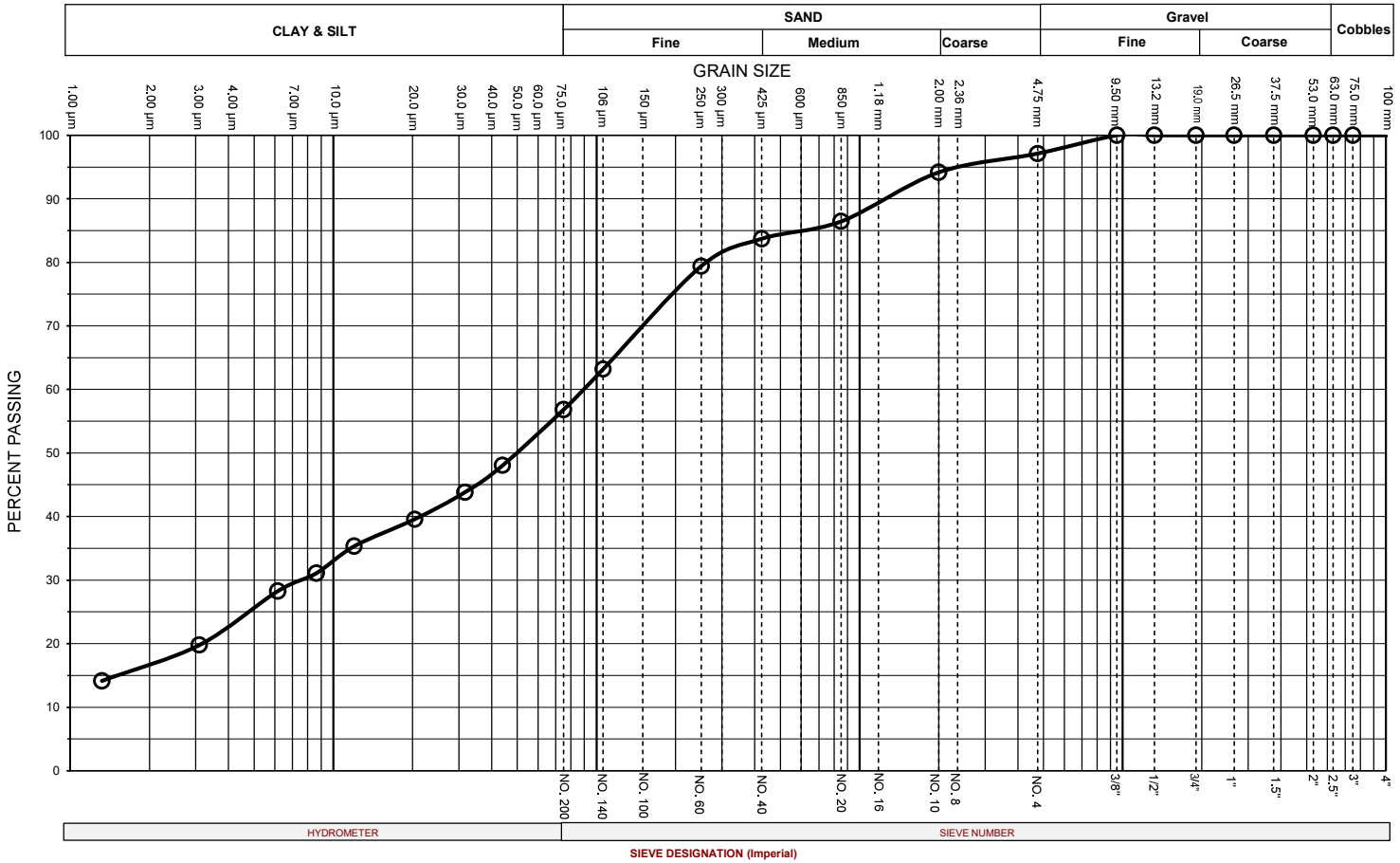
Soil Classification (USCS)			Sandy Silty Clay, trace gravel (CL-ML)						
D10	N/A	**D30**	0.002	**D60**	-0.120	**Cu**	N/A	**Cc**	N/A

Grain Size Distribution (ASTM D422-63)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

Project Name:	Wolfdale Crk	Borehole No.:	BH-6	Date Tested:	15/8/2023
Project Number:	60701082	Sample No.:	SS7	Tested by:	AECOM
Client:	AECOM	Sample Depth:	15.0' to 17.0'		
Project Location:	Wolfdale Creek, Ontario	Date Sampled:	N/A		
		Sampled by:	H. Gillen		

GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)



Gravel (%)	3	**Silt (%)**	41
Sand (%)	40	**Clay (%)**	16

Soil Classification (USCS)			Sandy Silty Clay, trace gravel (CL-ML)						
D10	N/A	**D30**	0.008	**D60**	0.078	**Cu**	N/A	**Cc**	N/A

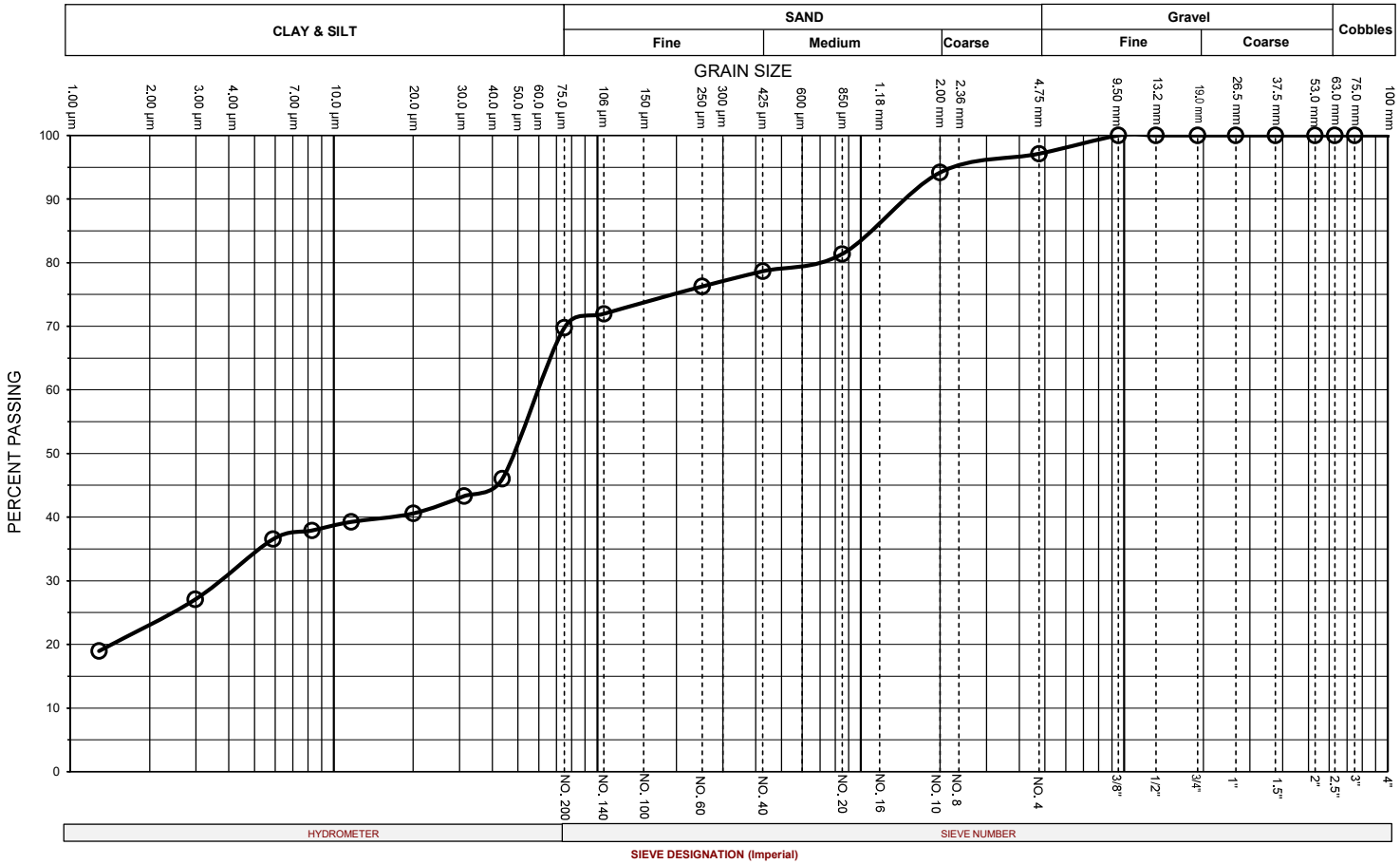
Grain Size Distribution (ASTM D422-63)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

Project Name:	Wolfdale Crk	Borehole No.:	BH-2	Date Tested:	15/8/2023
Project Number:	60701082	Sample No.:	AG4	Tested by:	AECOM
Client:	AECOM	Sample Depth:	3.0' to 3.5'		
Project Location:	Wolfdale Creek, Ontario	Date Sampled:	N/A		
		Sampled by:	H. Gillen		

GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)



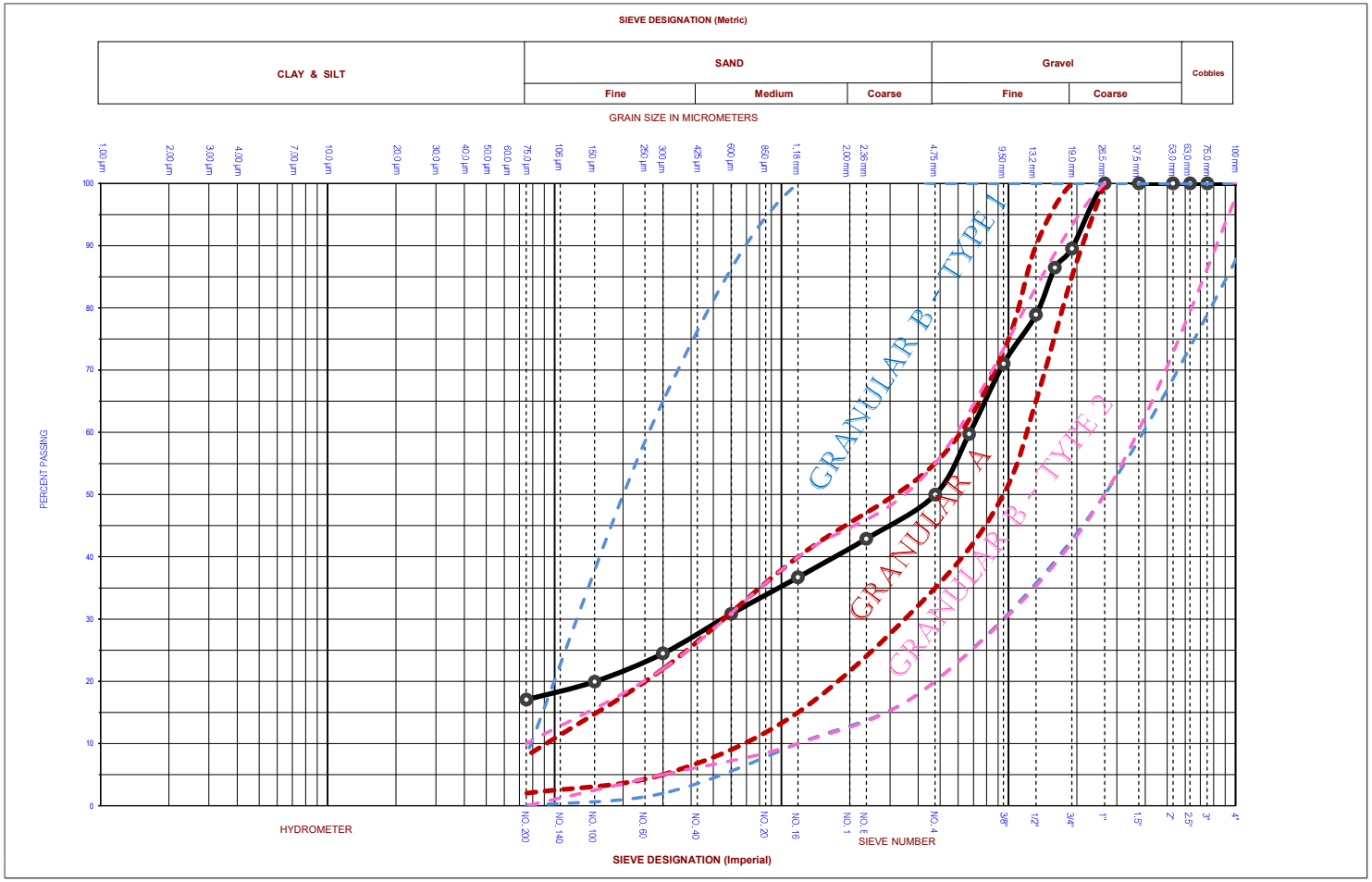
Gravel (%)	3	**Silt (%)**	48
Sand (%)	27	**Clay (%)**	22

Soil Classification (USCS)			Sandy Lean Clay, trace gravel (CL)						
D10	N/A	**D30**	-0.006	**D60**	-0.064	**Cu**	N/A	**Cc**	N/A

UNIFIED SOIL CLASSIFICATION SYSTEM

AECOM

CERTIFIED BY CCIL



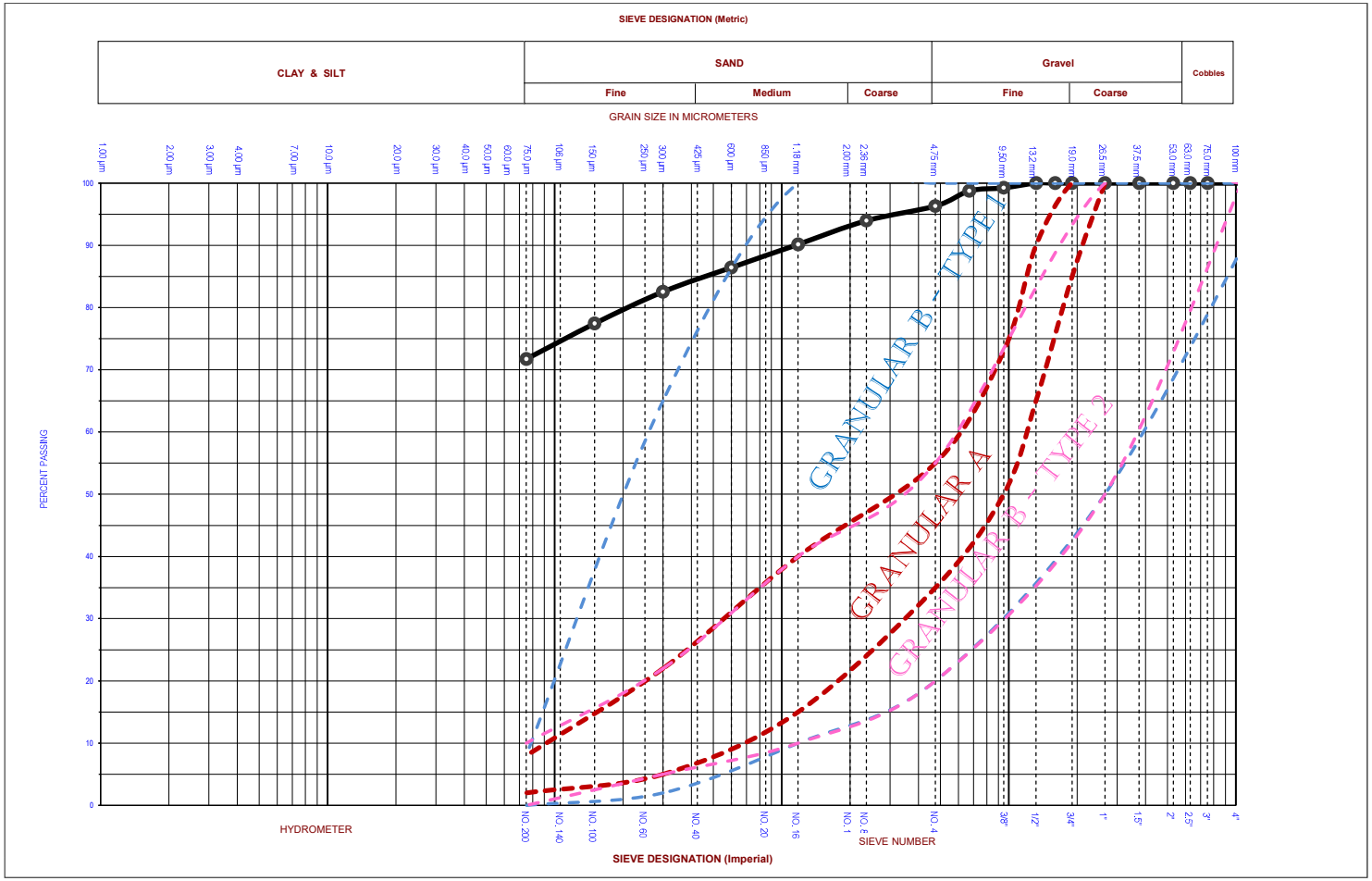
GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario			Client		AECOM			Date	September 13, 2023		Project Number		60701082	
			Borehole No / Sample Id		BH-1 SS1			Depth (feet)	0.0' to 2.0 '		Lab No		202309033	
			Project Name		Wolfedale Crk DD						Project Location		Along Wolfedale Creek	
			Soil Classification		Silty Gravel with Sand (GM)						Figure No:			
Gravel(%)	50	Sand(%)	33	Fines(%)	17	D_{60} (mm)	6.764	D_{30} (mm)	0.560	D_{10} (mm)	N/A	C_U	N/A	C_C	N/A

UNIFIED SOIL CLASSIFICATION SYSTEM

AECOM

CERTIFIED BY CCIL



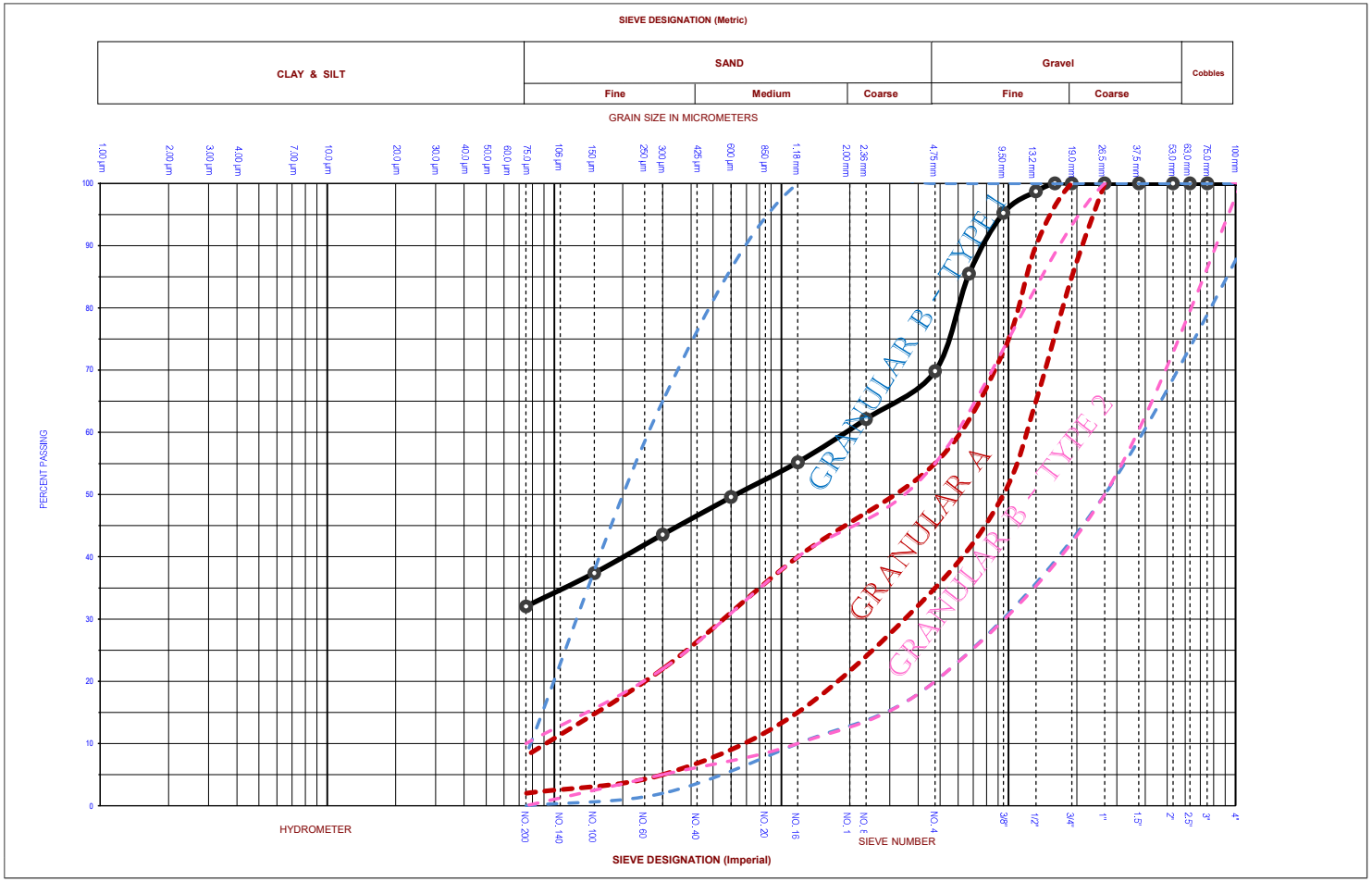
GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario			Client		AECOM			Date	September 13, 2023		Project Number		60701082		
			Borehole No / Sample Id		BH-2 AG1			Depth (feet)	0.0' to 1.0'		Lab No		202309034		
			Project Name		Wolfedale Crk DD						Project Location		Along Wolfedale Creek		
			Soil Classification		Lean Clay with Sand, trace gravel (CL)						Figure No:				
Gravel(%)	4	Sand(%)	25	Fines(%)	71	D_{60} (mm)	N/A	D_{30} (mm)	N/A	D_{10} (mm)	N/A	C_U	N/A	C_C	N/A

UNIFIED SOIL CLASSIFICATION SYSTEM

AECOM

CERTIFIED BY CCIL



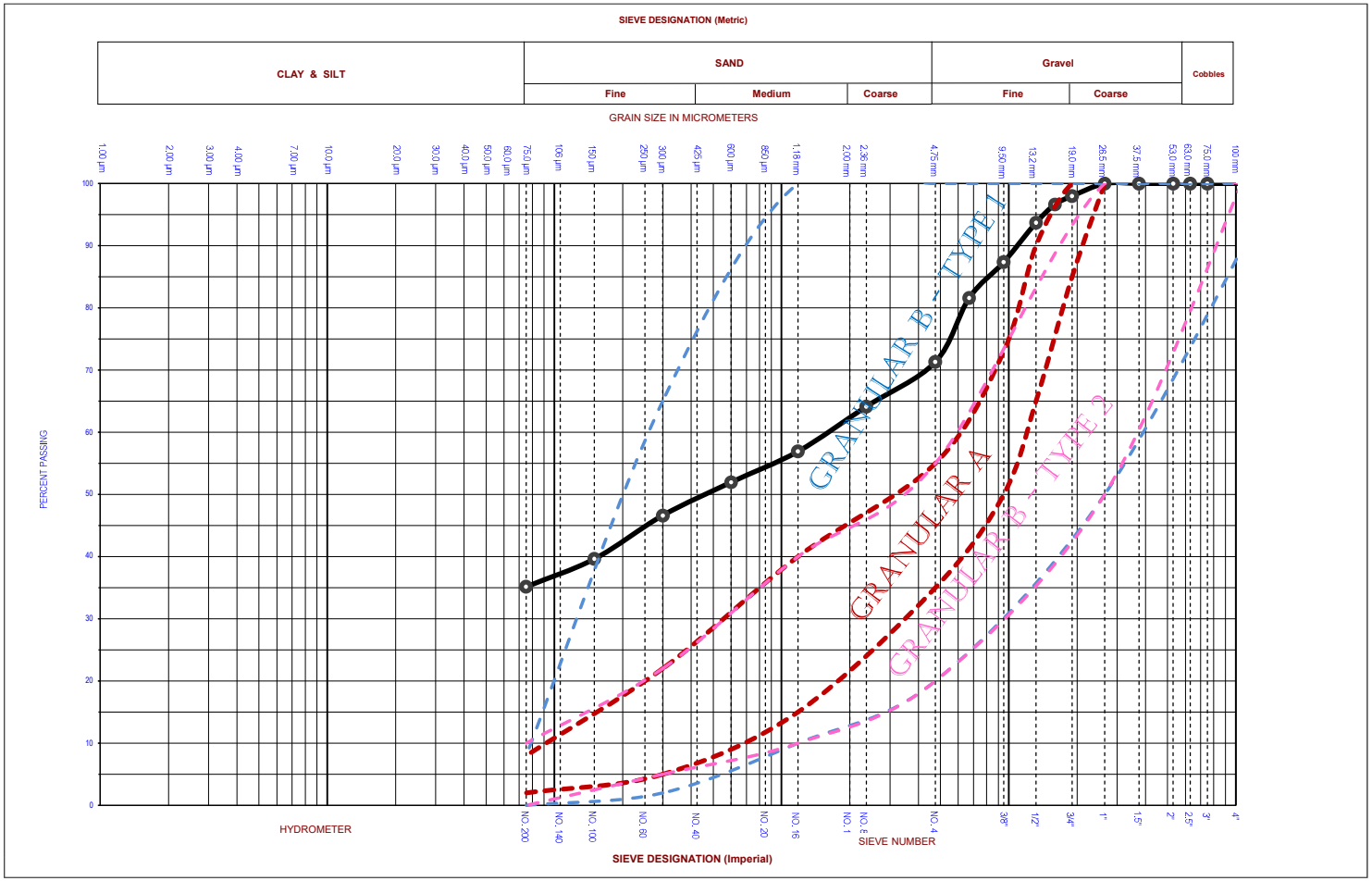
GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario			Client		AECOM			Date	September 13, 2023		Project Number		60701082		
			Borehole No / Sample Id		BH-4-MW SS1			Depth (feet)	0.0' to 2.0'		Lab No		202309037		
			Project Name		Wolfedale Crk DD						Project Location		Along Wolfedale Creek		
			Soil Classification		Silty Sand with Gravel (SM)						Figure No:				
Gravel(%)	30	Sand(%)	38	Fines(%)	32	D_{60} (mm)	1.997	D_{30} (mm)	N/A	D_{10} (mm)	N/A	C_U	N/A	C_C	N/A

UNIFIED SOIL CLASSIFICATION SYSTEM

AECOM

CERTIFIED BY CCIL



GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario			Client		AECOM			Date	September 13, 2023		Project Number		60701082		
			Borehole No / Sample Id		BH-7 SS1			Depth (feet)	0.0' to 2.0'		Lab No		202309040		
			Project Name		Wolfedale Crk DD						Project Location		Along Wolfedale Creek		
			Soil Classification		Silty Sand with Gravel (SM)						Figure No:				
Gravel(%)	29	Sand(%)	36	Fines(%)	35	D_{60} (mm)	1.681	D_{30} (mm)	N/A	D_{10} (mm)	N/A	C_U	N/A	C_C	N/A

Atterberg Limits (ASTM D4318)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

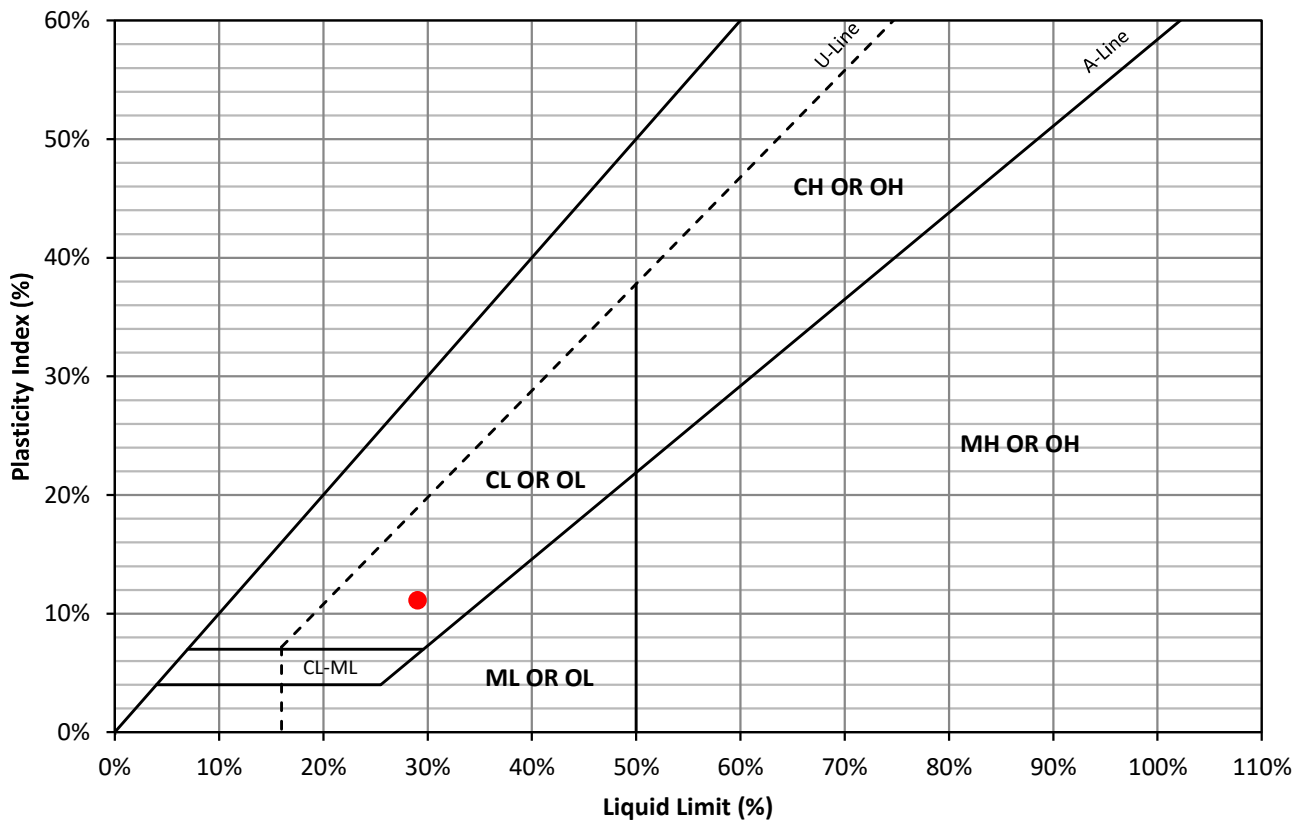
Project Name:	Wolfdale Crk	Supplier:	Not provided
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	Brian K
Sample Location:	BH-3	Sample Date:	NA
Sample Depth:	2.5'-4.5'	Lab Technician:	Ian Purchase
Sample Number:	SS2	Date Tested:	September 18, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit				
Blows	18	40	25	0
Wet Sample (g)	6.8	6.4	6.6	0.0
Dry Sample (g)	5.2	5.0	5.2	0.0
Water Content (%	30.0%	27.8%	28.7%	N/A

Plastic Limit			
Trial	1	2	3
Wet Sample (g)	5.2	7.0	4.6
Dry Sample (g)	4.4	5.9	3.9
Water Content (%)	18.0%	17.7%	17.9%



Liquid Limit (%):	29.0%	Plastic Limit (%):	17.9%	Plasticity Index (%):	11.1%

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Atterberg Limits (ASTM D4318)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

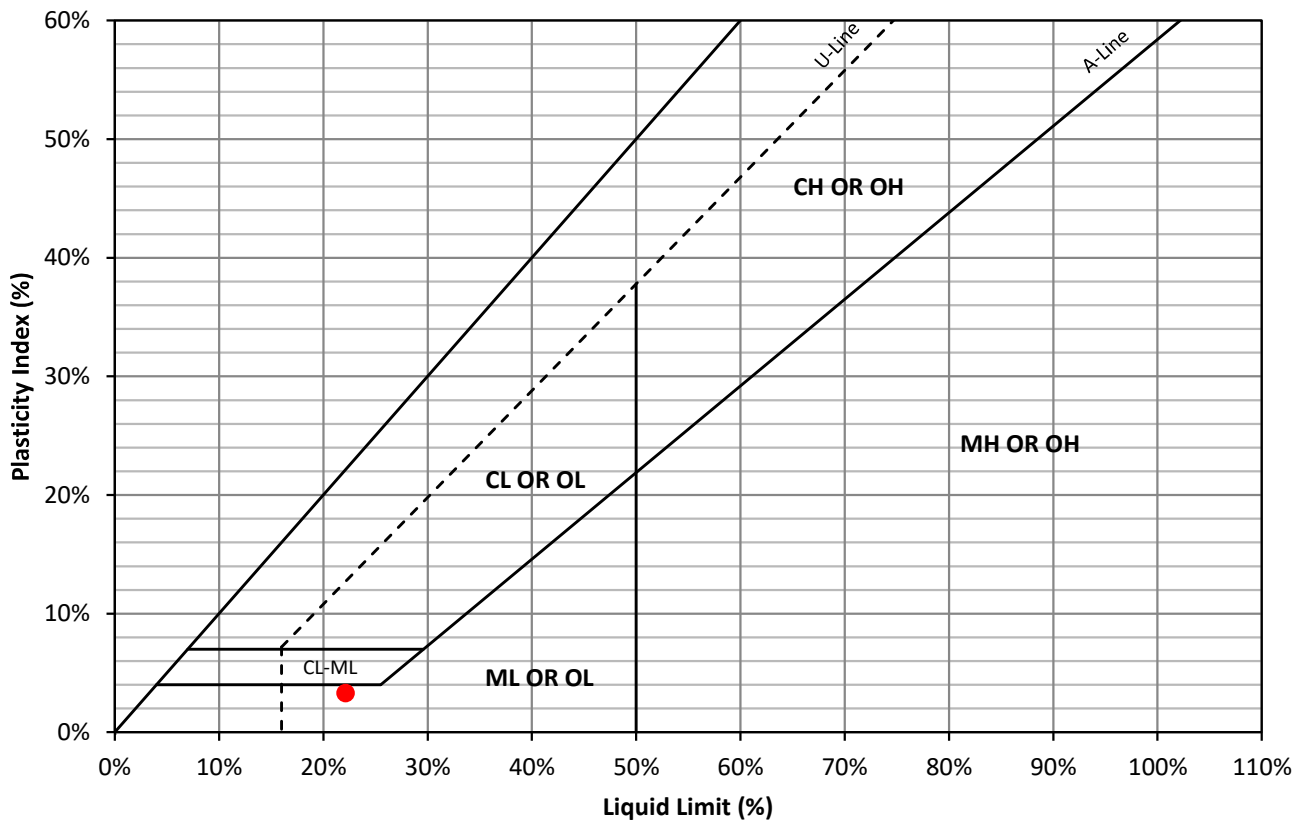
Project Name:	Wolfdale Crk	Supplier:	AECOM
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	
Sample Location:	BH-4	Sample Date:	NA
Sample Depth:	7.5'-9.5'	Lab Technician:	Ian Purchase
Sample Number:	SS4	Date Tested:	September 18, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit				
Blows	28	16	22	0
Wet Sample (g)	6.7	6.8	7.5	0.0
Dry Sample (g)	5.5	5.4	6.1	0.0
Water Content (%	20.4%	25.7%	24.1%	N/A

Plastic Limit			
Trial	1	2	3
Wet Sample (g)	0.7	1.2	0.8
Dry Sample (g)	0.6	1.0	0.7
Water Content (%)	19.0%	18.6%	18.8%



Liquid Limit (%):	22.1%	Plastic Limit (%):	18.8%	Plasticity Index (%):	3.3%

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Atterberg Limits (ASTM D4318)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

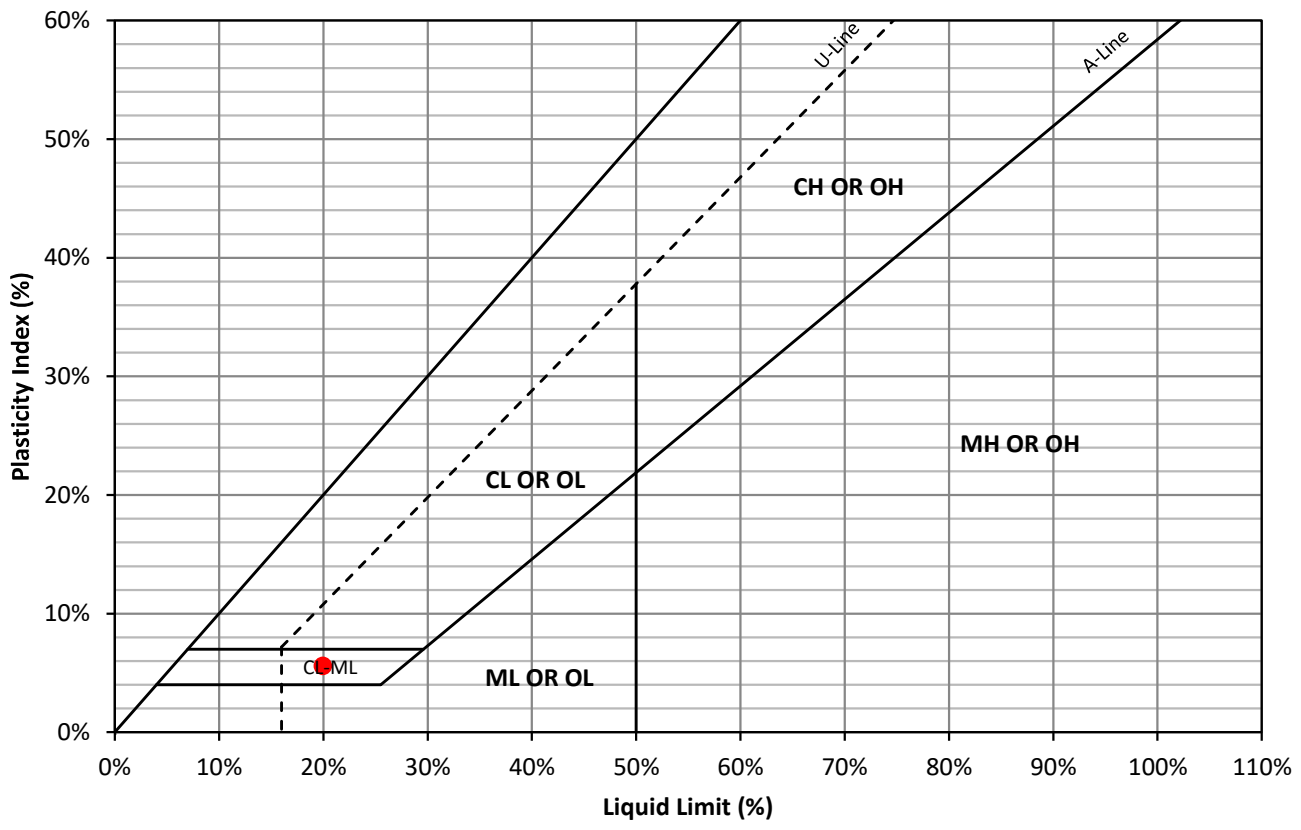
Project Name:	Wolfdale Crk	Supplier:	Not provided
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	Brian K
Sample Location:	BH-6	Sample Date:	NA
Sample Depth:	15'-17'	Lab Technician:	Ian Purchase
Sample Number:	SS7	Date Tested:	September 18, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit				
Blows	12	20	35	0
Wet Sample (g)	8.0	7.1	7.9	0.0
Dry Sample (g)	6.5	5.9	6.6	0.0
Water Content (%	22.5%	19.8%	19.1%	N/A

Plastic Limit			
Trial	1	2	3
Wet Sample (g)	1.4	1.5	1.1
Dry Sample (g)	1.2	1.3	0.9
Water Content (%)	14.4%	14.0%	14.7%



Liquid Limit (%):	20.0%	Plastic Limit (%):	14.4%	Plasticity Index (%):	5.6%

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Atterberg Limits (ASTM D4318)

AECOM Canada Ltd.
Etobicoke Geotechnical Laboratory
83 Galaxy Blvd, Unit 6, Etobicoke, ON, M9W 5X6
Phone: (437) 431-3841

CERTIFIED BY CCIL

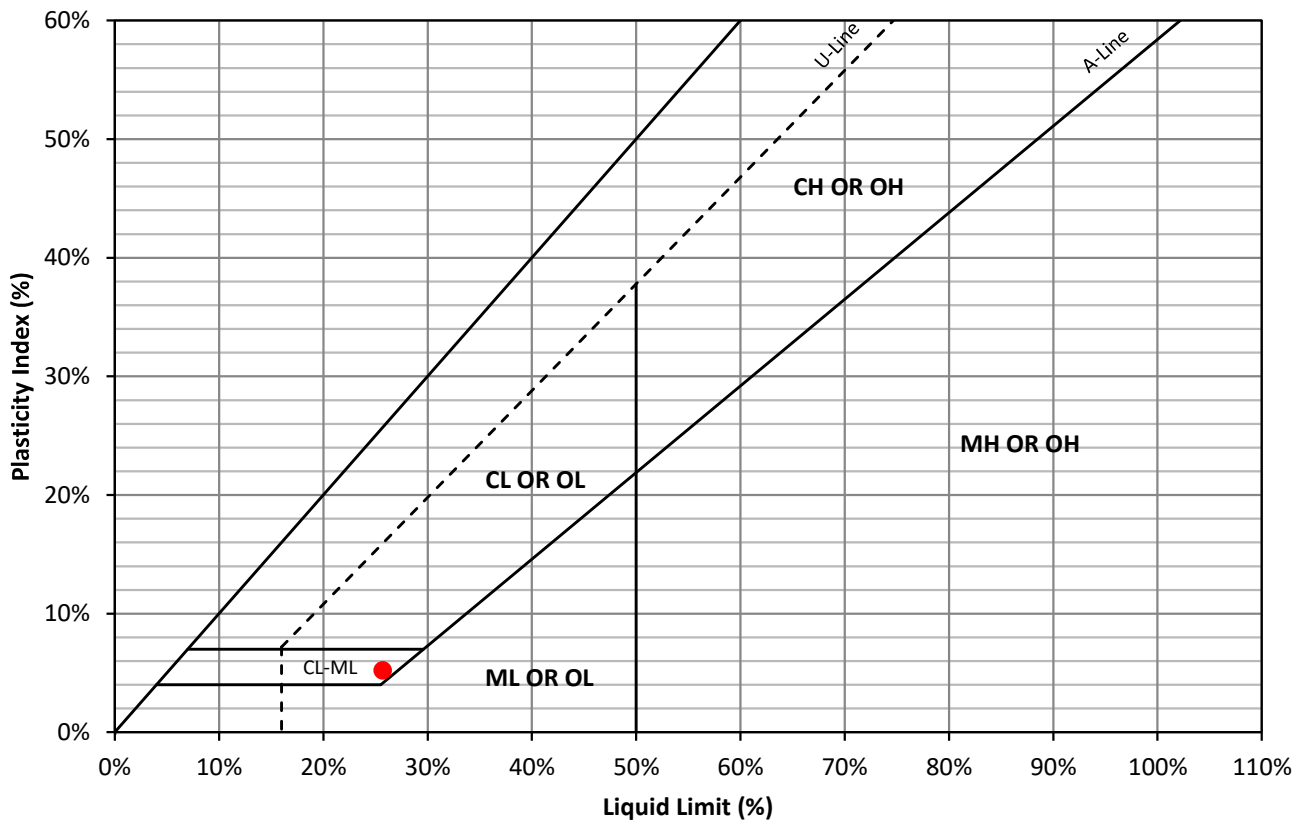
Project Name:	Wolfdale Crk	Supplier:	Not provided
Project Number:	60701082	Specification:	N/A
Client:	AECOM	Field Technician:	
Sample Location:	BH-7	Sample Date:	NA
Sample Depth:	10'-12'	Lab Technician:	Ian Purchase
Sample Number:	SS5	Date Tested:	September 18, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit				
Blows	43	25	30	12
Wet Sample (g)	6.3	6.2	6.3	6.6
Dry Sample (g)	5.0	4.9	5.0	5.2
Water Content (%	25.3%	25.5%	25.4%	26.0%

Plastic Limit			
Trial	1	2	3
Wet Sample (g)	2.7	3.3	3.2
Dry Sample (g)	2.3	2.7	2.7
Water Content (%)	19.7%	21.2%	20.6%



Liquid Limit (%):	25.7%	Plastic Limit (%):	20.5%	Plasticity Index (%):	5.2%

Reviewed and Approved by: Venkata Ramana Mullapudi, P.Eng., PMP
Senior Geotechnical Engineer

Lab No.																						
									Testing Required													
Hole No.	Sample No.	Depth (ft) from	Depth (ft) to	PHC's F1 through F4	Metals	SAR & EC	Other Testing	Sampling Method	Moisture	Special	UNIT WEIGHT	Waxed Sample	Atterberg	Proctor: Standard	Sieve Analysis	Sieve and Hydrometer	Consolidation Rebound	Consolidation w/o Rebound	Organic Content	Corrosivity	Specific Gravity	Soil Description
BH-1	SS-1	0.0	2.0						X						X							
	SS-2	2.5	4.5						X													
	SS-3	5.0	7.0						X													
	SS-4	7.5	9.5						X													
	SS-5	10.0	11.0						X													
	SS-6	11.0	11.4						X													
BH-2	AG-1	0.0	1.0						X						X							
	AG-2	1.0	2.0						X													
	AG-3	2.0	3.0						X													
	AG-4	3.0	3.5						X							X						
BH-3	SS-1	0.0	2.0						X													
	SS-2	2.5	4.5						X				X			X						
	SS-3	5.0	5.0042						X													
BH-4/MW	SS-1	0.0	2.0						X						X							
	SS-2A	2.5	3.3						X													
	SS-2B	3.3	4.5						X													
	SS-3	5.0	7.0						X													
	SS-4	7.5	9.5						X				X			X						
	SS-5	10.0	10.5						X													
BH-6	SS-1	0.0	2.0						X													
	SS-2	2.5	4.5						X													
	SS-3	5.0	7.0						X													
	SS-4	7.5	9.5						X													
	SS-5	10.0	12.0						X													
	SS-6	12.5	14.5						X													
	SS-7	15.0	17.0						X				X			X						
BH-7	SS-1	0.0	2.0						X						X							
	SS-2	2.5	4.5						X													
	SS-3A	5.0	6.0						X													
	SS-3B	6.0	7.0						X													
	SS-4	7.5	9.5						X													
	SS-5	10.0	12.0						X				X			X						
	SS-6	15.0	17.0						X													
	SS-7	20.0	22.0						X													
	SS-8	25.0	25.3						X													

AECOM

5080 Commerce Blvd, Mississauga, ON
T (905) 238-0007 **F** (905) 238-0038 www.aecom.com

60701082 Wolfedale Crk DD	Task Number: 2.03 GeoTech Invest
Location: Along Wolfedale Creek	
	Sheet 1 of 1

AECOM

Appendix D

Locations of Evaluated Cross-sections

TOPOGRAPHIC PLAN OF
PART OF WOLFEDALE CREEK AND ADJOINING PROPERTIES SOUTH SECTION
CITY OF MISSISSAUGA
REGIONAL MUNICIPALITY OF PEEL

SCALE 1 : 250

J.D. BARNES LIMITED
©COPYRIGHT

METRIC DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

CAUTION
THIS PLAN IS A PLAN OF SURVEY AND SHALL NOT BE USED FOR ANY USE OR PURPOSE INDICATED IN THE TITLE BLOCK

NOTES
BOUNDARY INFORMATION IS COMPILED FROM AVAILABLE PAPER RECORDS, UNLESS OTHERWISE SHOWN ON THIS PLAN AS A RESULT OF FIELD SURVEY

BEARINGS ARE UTM GRID, DERIVED FROM POLL TIME NETWORK GPSCO OBSERVATIONS, UTM ZONE 17, NAD83 (ORIGINAL) (2002.0)

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.9996704

ELEVATION NOTE
ELEVATIONS SHOWN ON THIS PLAN ARE RELATED TO GEODETIC DATUM AS THE ELEVATION FOR THE CITY OF MISSISSAUGA BENCHMARK "PL-27A(2002)"
PL-27A(2002)
ELEVATION=161.197m
PL-27A(1978)
ELEVATION=158.403m
PL-27A(1967)
ELEVATION=158.8m

LOCAL BENCHMARK #1
CUT CROSS SET ON CONCRETE SIDEWALK ON THE NORTHWEST SIDE OF CENTRAL PARKWAY WEST ADJACENT TO WOLFEDALE CREEK AND 1.8m EAST OF A FIRE HYDRANT, ELEVATED ON THE FIELD OF PLAN
ELEVATION=77.19m

LOCAL BENCHMARK #2
CUT CROSS SET IN CONCRETE CURB ON THE REAR OF CALE BOUTILIER ROAD, 32.7 0.3m NORTH EAST OF A FIRE HYDRANT AS ILLUSTRATED ON THE FIELD OF PLAN
ELEVATION=80.61m

LOCAL BENCHMARK #3
CUT CROSS SET IN CONCRETE SIDEWALK ON THE NORTHWEST SIDE OF DANDELI STREET WEST, 0.3m EAST OF A FIRE HYDRANT AS ILLUSTRATED ON THE FIELD OF PLAN
ELEVATION=77.73m

LOCAL BENCHMARK #4
BENCHMARK No. 8147
CUT CROSS SET IN CONCRETE ON THE TOP OF THE WEST FACE OF THE CITY OF MISSISSAUGA BENCHMARK PL 8147 - ON THE WEST FACE OF THE CONCRETE FOOTING OF THE SOUTH WEST CORNER OF THE CONCRETE STRUCTURE ON THE SOUTH SIDE OF STAVEBANK ROAD, OPPOSITE OF THE CREDIT RIVER
ELEVATION=74.98m

LEGEND
CSP (DENOTES CORRUGATED STEEL PIPE)
(DENOTES BENCH MARK)

BEFORE DIGGING, UNDERGROUND SERVICES SHOULD BE LOCATED ON SITE BY THE RESPECTIVE AGENCIES

IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THAT ALL UNDERGROUND SERVICES HAVE BEEN LOCATED AND MARKED AND THAT THE RELATIVE ELEVATIONS AGREE WITH THE INFORMATION SHOWN ON THIS PLAN.

DATED AT MISSISSAUGA THIS 4th DAY OF APRIL, 2022

THIS IS NOT AN ORIGINAL COPY UNLESS EMBOSSED WITH SEAL

J.D.BARNES LIMITED
ONTARIO LAND SURVEYORS
LAND INFORMATION SYSTEMS
2-4263 LAKESHORE BLVD. WEST, MISSISSAUGA, ONTARIO L5J 1E1
T: (905) 271-8772 F: (905) 271-8780 www.jdbarnes.com

DRAWN BY:	MC	CHECKED BY:	MC	REFERENCE:	20-30-027-00-A-S
SCALE: 1:250				DATE: 04/06/2022	

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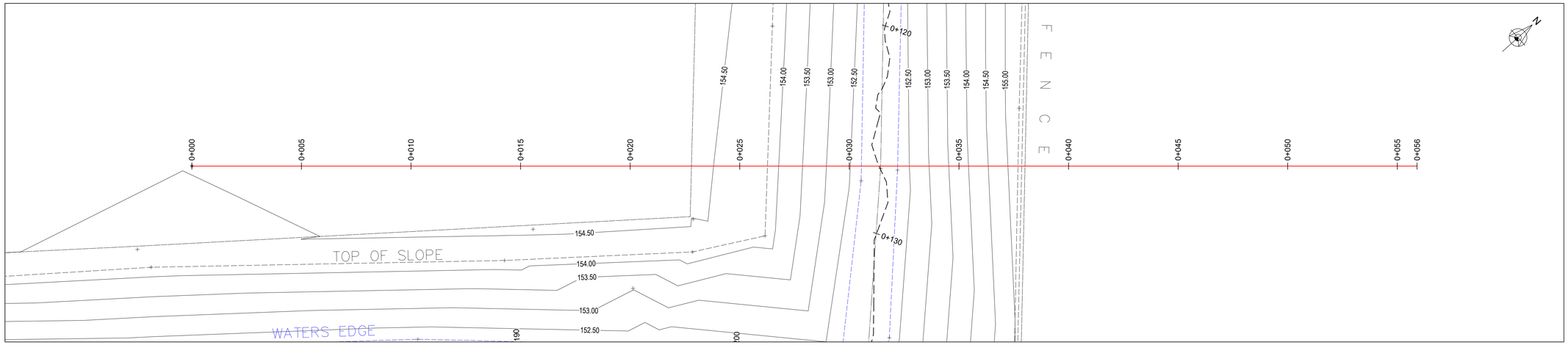
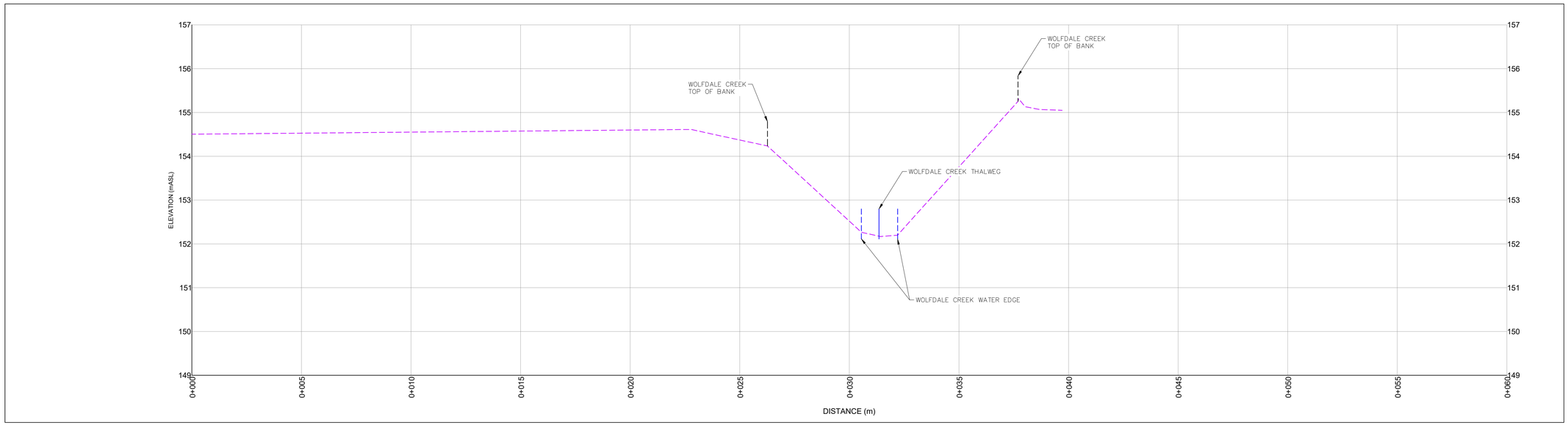


PLAN VIEW - GEO-1



PROFILE VIEW - 0+000 to 0+056

Ver: 2:1

LEGEND

CB	DENOTES CATCHBASIN
SICB	DENOTES SIDE INLET CATCHBASIN
HPED	DENOTES HYDRO PEDESTAL
GV	DENOTES GAS VALVE
HW	DENOTES HANDWELL
MH	DENOTES MANHOLE
SAN MH	DENOTES SANITARY MANHOLE
WMH	DENOTES WATER MANHOLE
BOL	DENOTES BOLLARD
HP	DENOTES HYDRO POLE
LS	DENOTES LIGHT STANDARD
H	DENOTES FIRE HYDRANT
WV	DENOTES WATER VALVE
FP	DENOTES FENCE POST
CSP	DENOTES CORRUGATED STEEL PIPE
PVC	DENOTES POLYVINYL CHLORIDE PIPE
TC	DENOTES TELEPHONE CHAMBER
	DENOTES BENCH MARK
MW	DENOTES MONITORING WELL
OC	DENOTES OVERHEAD CABLE
	EXISTING WOLFDALE CREEK THALWEG
	EXISTING MAJOR CONTOUR (1m INTERVAL)
	EXISTING MINOR CONTOUR (0.5m INTERVAL)
	PROFILE GROUND SURVEY (JD BARNES)

AECOM

PROJECT

Wolfdale Creek North Rehabilitation
Mississauga, Ontario

CLIENT

City of Mississauga
Mississauga, Ontario

CONSULTANT

AECOM Canada Ltd.
50 Sportsworld Crossing Road, Suite 290
Kitchener, Ontario, N2P 0A4
519 650 5313 tel 519 650 3424 fax
www.aecom.com

NOTE:

IT IS THE RESPONSIBILITY OF THE CONTRACTORS TO INFORM THEMSELVES OF THE EXACT LOCATION OF, AND ASSUME ALL LIABILITY FOR DAMAGE TO ALL UTILITIES, SERVICES AND STRUCTURES WHETHER ABOVE GROUND OR BELOW GRADE BEFORE COMMENCING THE WORK. SUCH INFORMATION IS NOT NECESSARILY SHOWN ON THE DRAWING, AND WHERE SHOWN, THE ACCURACY CANNOT BE GUARANTEED.

WITH THE SOLE EXCEPTION OF THE BENCHMARK(S) SPECIFICALLY DESCRIBED FOR THIS PROJECT, NO ELEVATION INDICATED OR ASSUMED HEREON IS TO BE USED AS A REFERENCE ELEVATION FOR ANY PURPOSE.

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60701082

SHEET TITLE

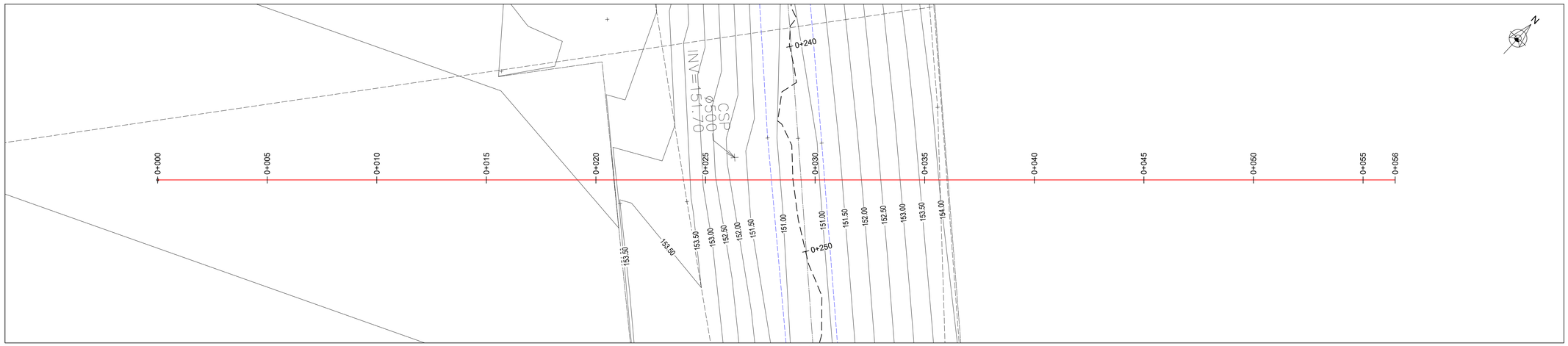
GEOTECH CROSS-SECTION GEO-1
WOLFDALE CREEK NORTH
0+000 to 0+056

SHEET NUMBER

G-101

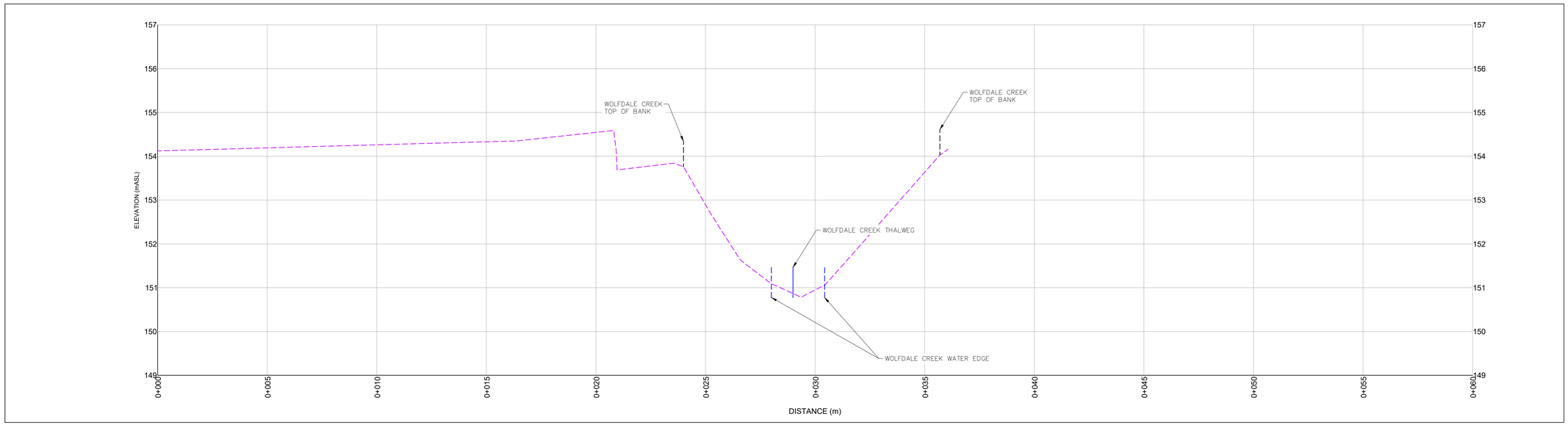
Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI D 864mm x 559mm
Last saved by: LEVESQUEI(2023-10-16) Last Plotted: 2023-10-16
Filename: \\CABRETFP002\GIS_DATA\PROJECTS\60701082\910-CAD\05-MODELS\GI\GEOTECH CROSS-SECTIONS\60701082_WOLFDALE RD - GEO - CROSS-SECTIONS.DWG

Printed on ____% Post-Consumer Recycled Content Paper



PLAN VIEW - GEO-2

1 : 100



PROFILE VIEW - 0+000 to 0+056

Ver: 2:1

1 : 100

LEGEND

CB	DENOTES CATCHBASIN
SICB	DENOTES SIDE INLET CATCHBASIN
HPED	DENOTES HYDRO PEDESTAL
GV	DENOTES GAS VALVE
HW	DENOTES HANDWELL
MH	DENOTES MANHOLE
SAN MH	DENOTES SANITARY MANHOLE
WMH	DENOTES WATER MANHOLE
BOL	DENOTES BOLLARD
HP	DENOTES HYDRO POLE
LS	DENOTES LIGHT STANDARD
H	DENOTES FIRE HYDRANT
WV	DENOTES WATER VALVE
FP	DENOTES FENCE POST
CSP	DENOTES CORRUGATED STEEL PIPE
PVC	DENOTES POLYVINYL CHLORIDE PIPE
TC	DENOTES TELEPHONE CHAMBER
	DENOTES BENCH MARK
MW	DENOTES MONITORING WELL
OC	DENOTES OVERHEAD CABLE
	EXISTING WOLFDALE CREEK THALWEG
	EXISTING MAJOR CONTOUR (1m INTERVAL)
	EXISTING MINOR CONTOUR (0.5m INTERVAL)
	PROFILE GROUND SURVEY (JD BARNES)

AECOM

PROJECT

Wolfdale Creek North
Rehabilitation
Mississauga, Ontario

CLIENT

City of Mississauga
Mississauga, Ontario

CONSULTANT

AECOM Canada Ltd.
50 Sportsworld Crossing Road, Suite 290
Kitchener, Ontario, N2P 0A4
519 650 5313 tel 519 650 3424 fax
www.aecom.com

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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60701082

SHEET TITLE

GEOTECH CROSS-SECTION GEO-2
WOLFDALE CREEK NORTH
0+000 to 0+056

SHEET NUMBER

G-102

Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI D 864mm x 559mm

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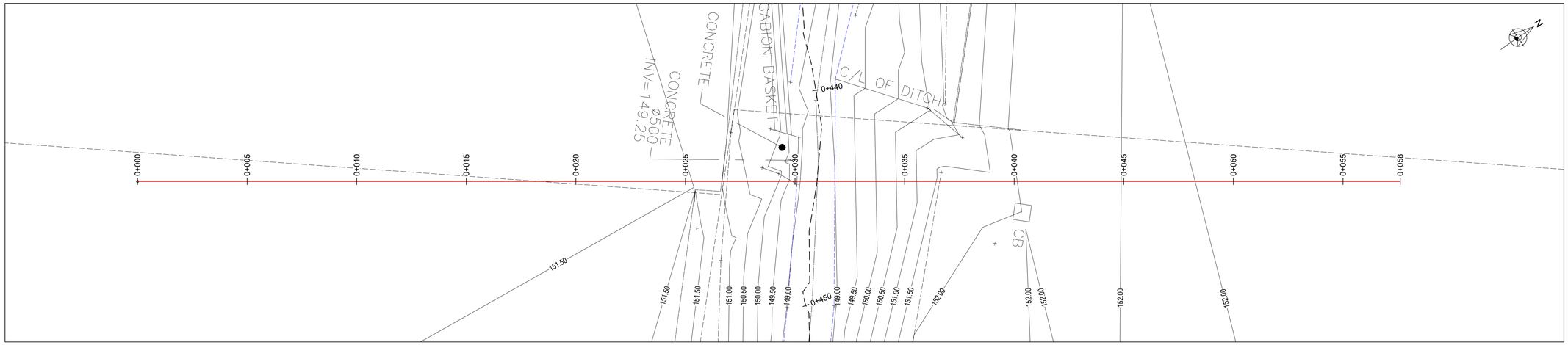
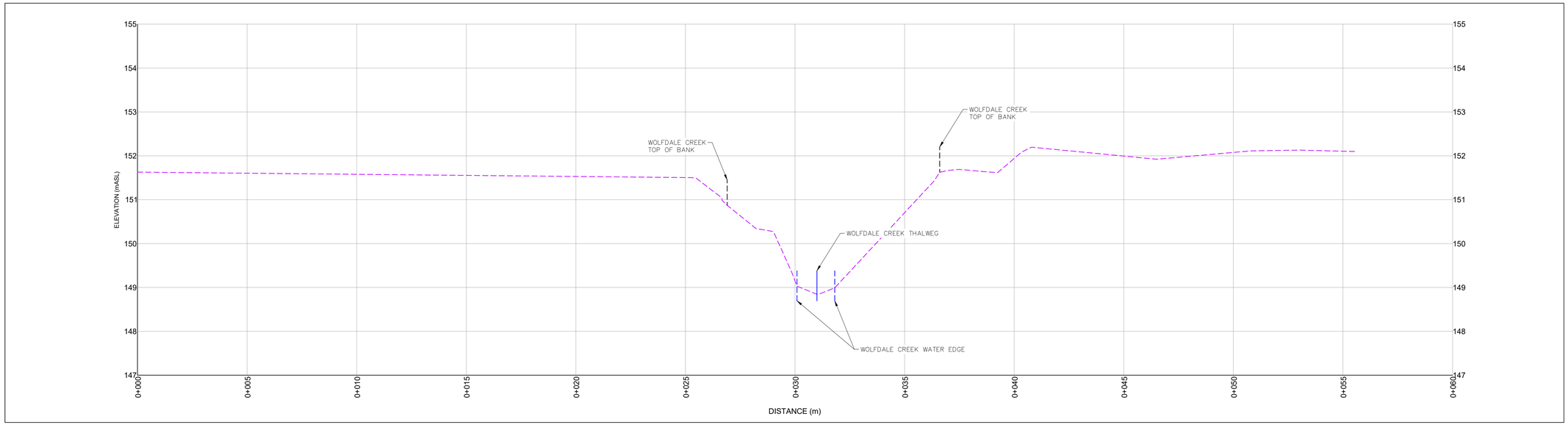


PLAN VIEW - GEO-3

1 : 100



PROFILE VIEW - 0+000 to 0+056

Ver: 2:1

1 : 100

LEGEND

CB	DENOTES CATCHBASIN
SICB	DENOTES SIDE INLET CATCHBASIN
HPED	DENOTES HYDRO PEDESTAL
GV	DENOTES GAS VALVE
HW	DENOTES HANDWELL
MH	DENOTES MANHOLE
SAN MH	DENOTES SANITARY MANHOLE
WMH	DENOTES WATER MANHOLE
BOL	DENOTES BOLLARD
HP	DENOTES HYDRO POLE
LS	DENOTES LIGHT STANDARD
H	DENOTES FIRE HYDRANT
WV	DENOTES WATER VALVE
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KEY PLAN

PROJECT NUMBER

60701082

SHEET TITLE

GEOTECH CROSS-SECTION GEO-3
WOLFDALE CREEK NORTH
0+000 to 0+056

SHEET NUMBER

G-103

Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI D 864mm x 559mm

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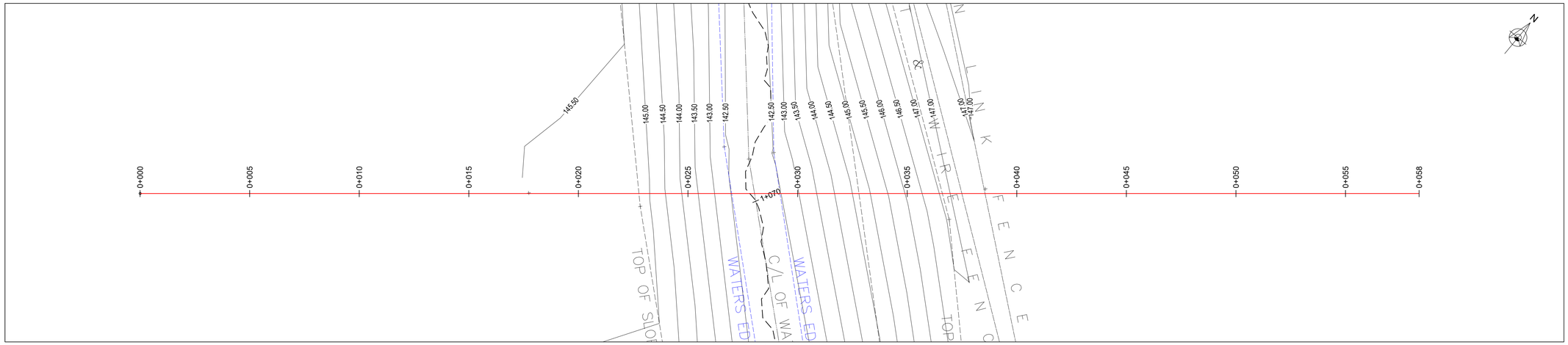
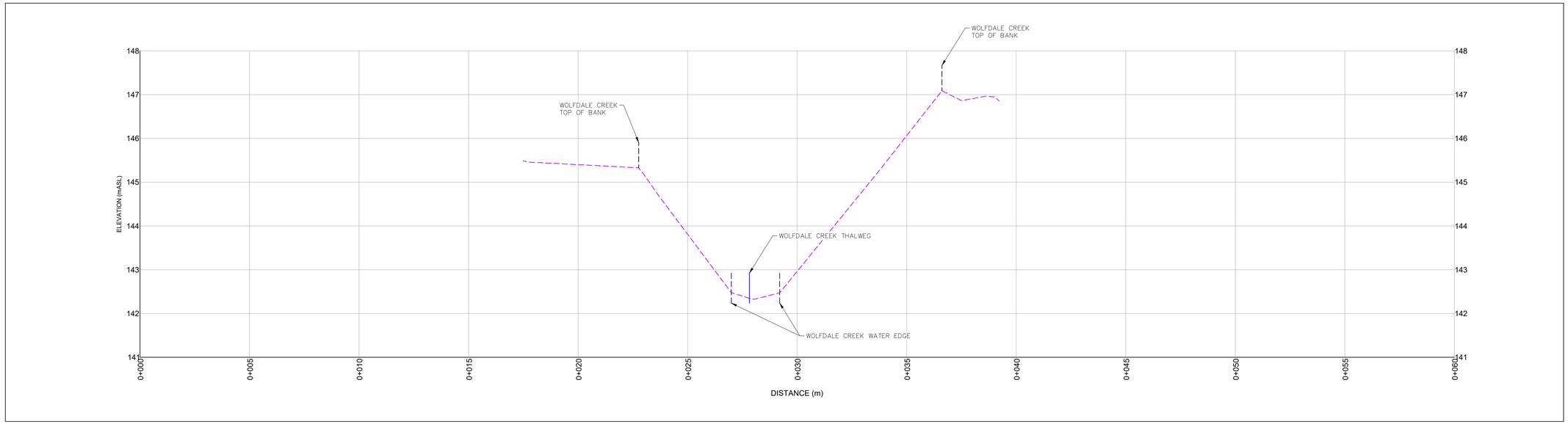


PLAN VIEW - GEO-4

1 : 100



PROFILE VIEW - 0+000 to 0+056

Ver: 2:1

1 : 100

LEGEND

	CB	DENOTES CATCHBASIN
	SICB	DENOTES SIDE INLET CATCHBASIN
	HPED	DENOTES HYDRO PEDESTAL
	GV	DENOTES GAS VALVE
	HW	DENOTES HANDWELL
	MH	DENOTES MANHOLE
	SAN MH	DENOTES SANITARY MANHOLE
	WMH	DENOTES WATER MANHOLE
	BOL	DENOTES BOLLARD
	HP	DENOTES HYDRO POLE
	LS	DENOTES LIGHT STANDARD
	H	DENOTES FIRE HYDRANT
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I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60701082

SHEET TITLE

GEOTECH CROSS-SECTION GEO-4
WOLFDALE CREEK NORTH
0+000 to 0+058

SHEET NUMBER

G-104

Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI D 864mm x 559mm

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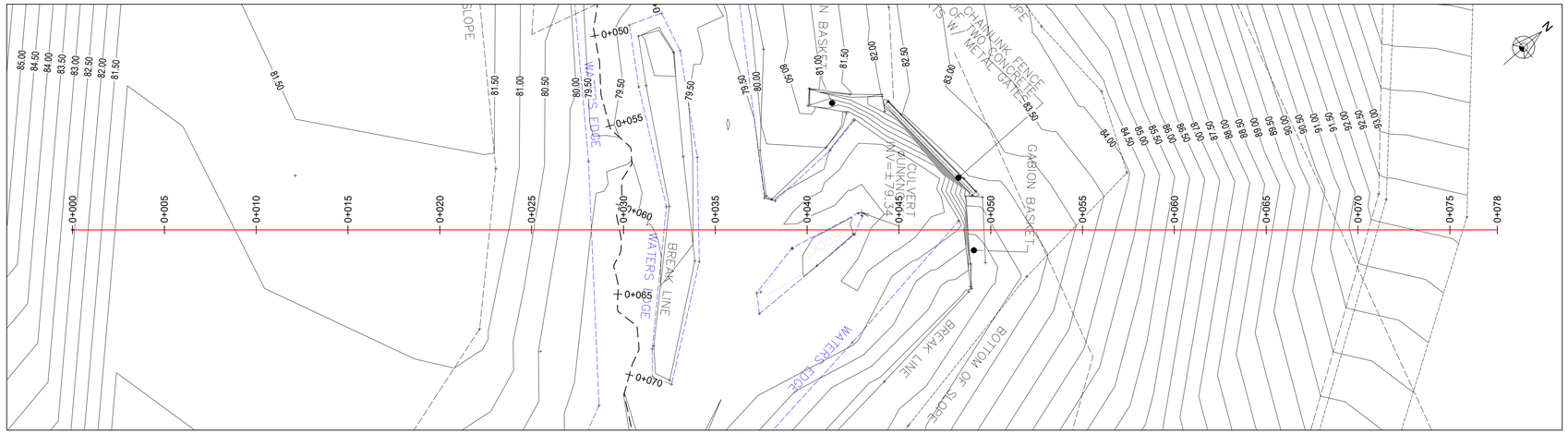
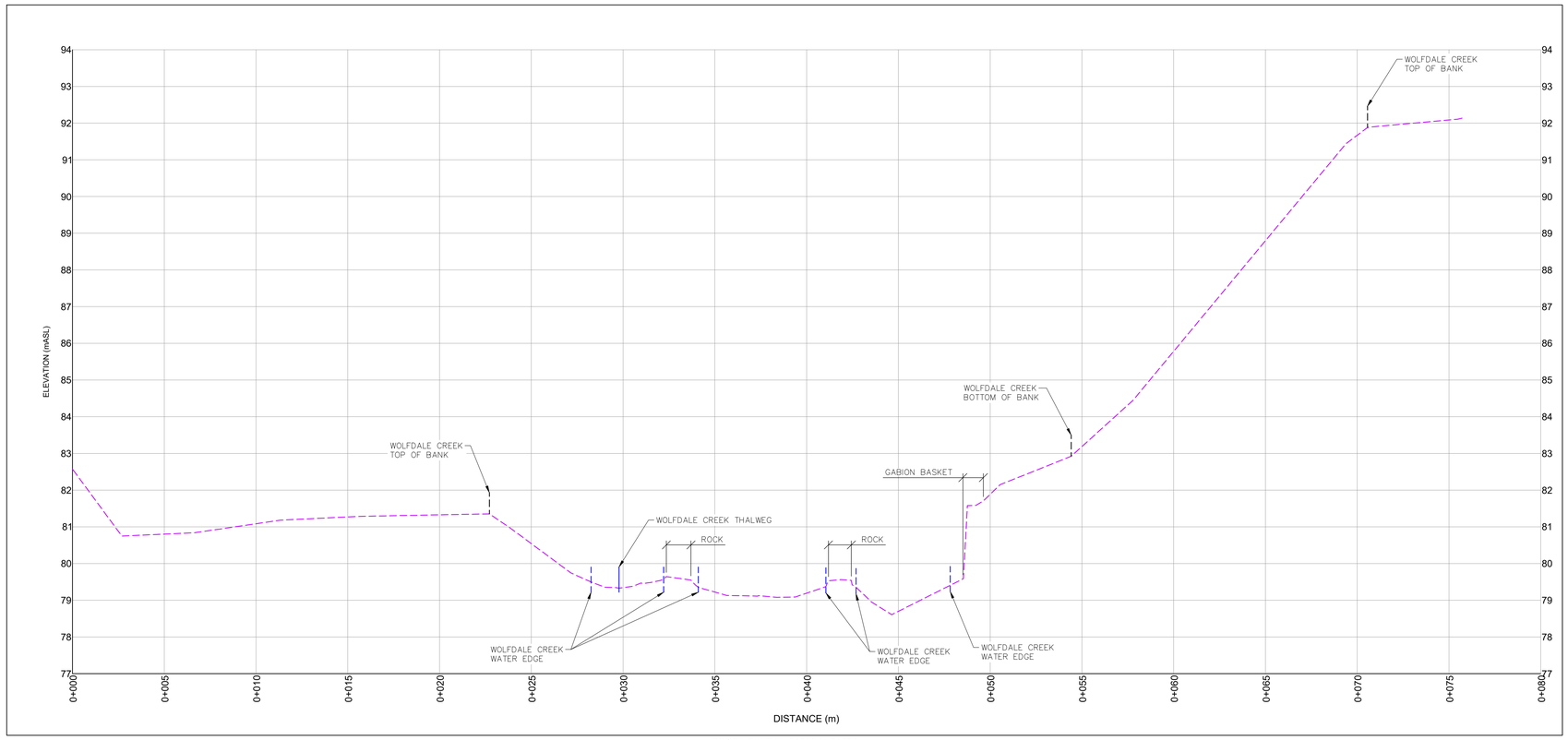


PLAN VIEW - GEO-5

1 : 150



PROFILE VIEW - 0+000 to 0+078

Ver: 2:1

1 : 150

LEGEND

CB	DENOTES CATCHBASIN
SICB	DENOTES SIDE INLET CATCHBASIN
HPED	DENOTES HYDRO PEDESTAL
GV	DENOTES GAS VALVE
HW	DENOTES HANDWELL
MH	DENOTES MANHOLE
SAN MH	DENOTES SANITARY MANHOLE
WMH	DENOTES WATER MANHOLE
BOL	DENOTES BOLLARD
HP	DENOTES HYDRO POLE
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ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60701082

SHEET TITLE

GEOTECH CROSS-SECTION GEO-5
WOLFDALE CREEK NORTH
0+000 to 0+078

SHEET NUMBER

G-105

Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI D 864mm x 559mm

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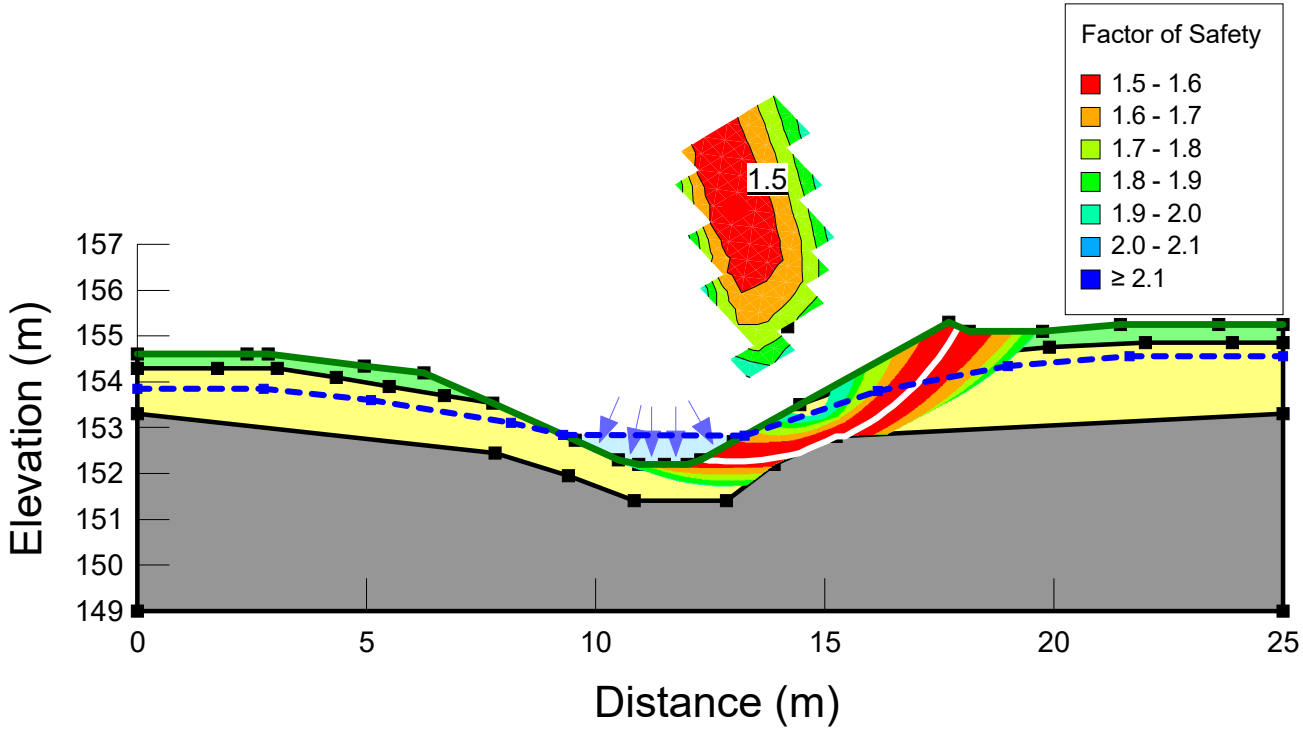
Appendix E

Slope/W Output Results

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31

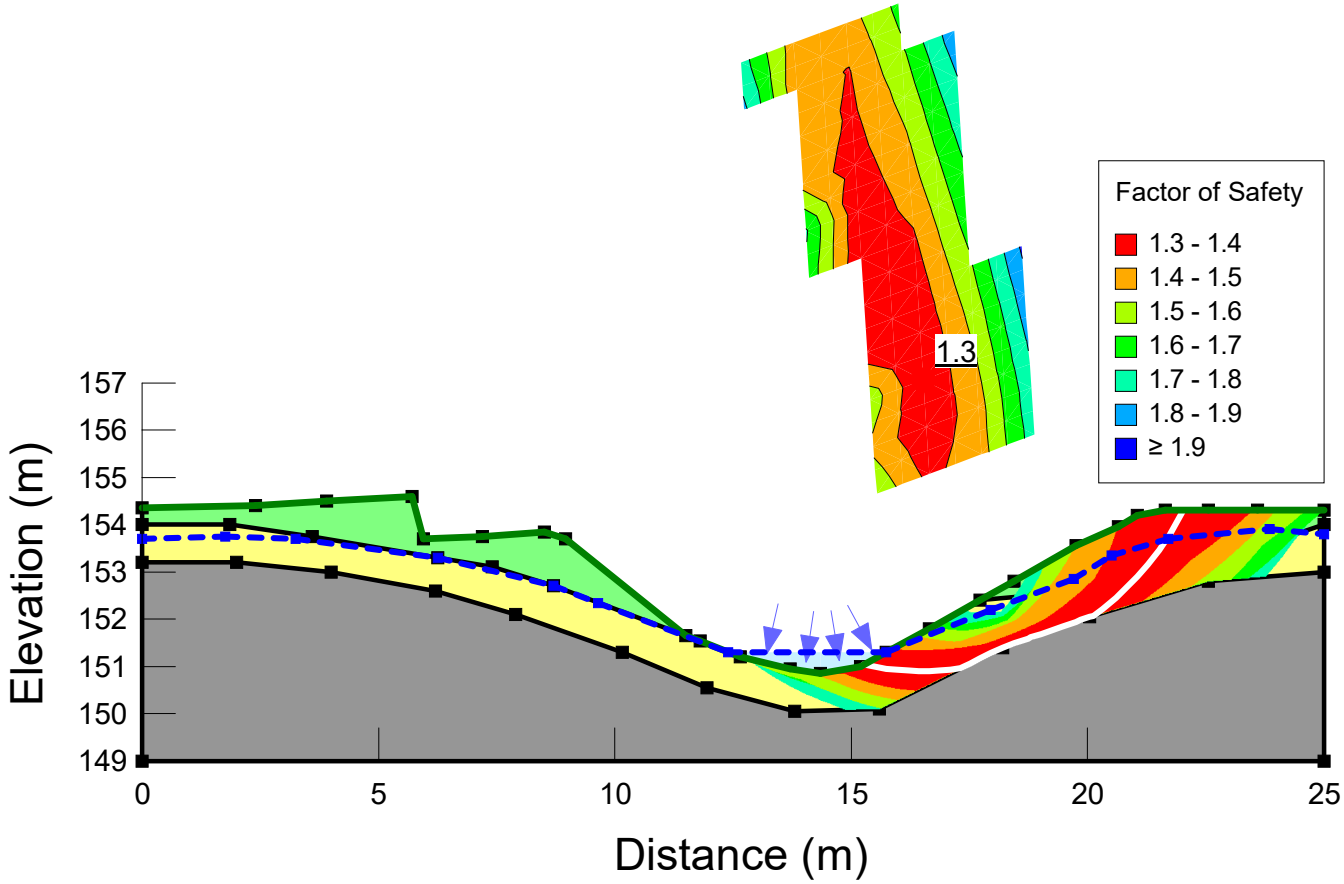


North G-101 Section_East

60701082 Wolfdale Creek Slope Stability Analysis.gsz

10/23/2023 1:165

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31

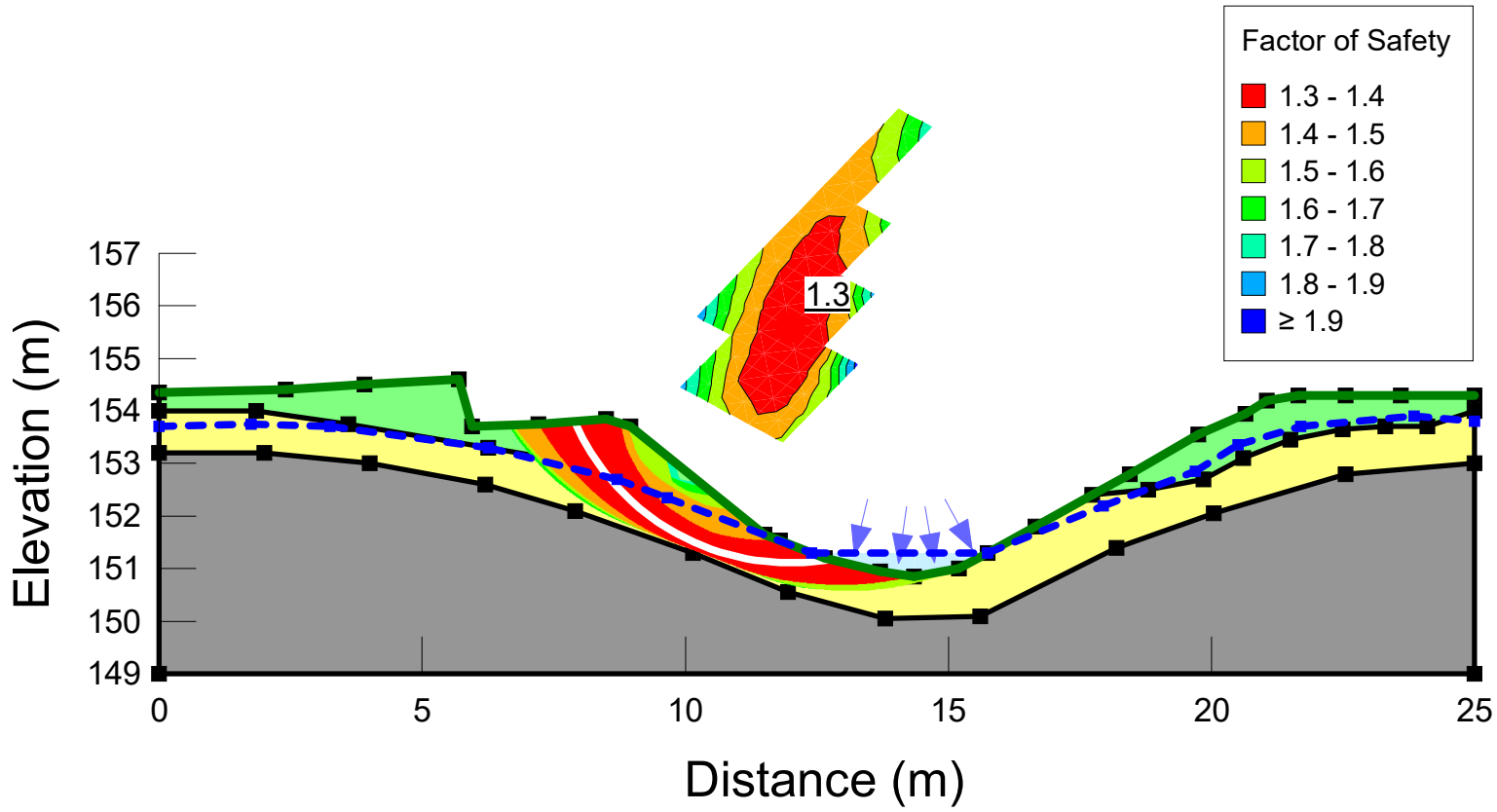


North G-102 Section_East

60701082 Wolfdale Creek Slope Stability Analysis.gsz

10/23/2023 1:160

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31



North G-102 Section_West	
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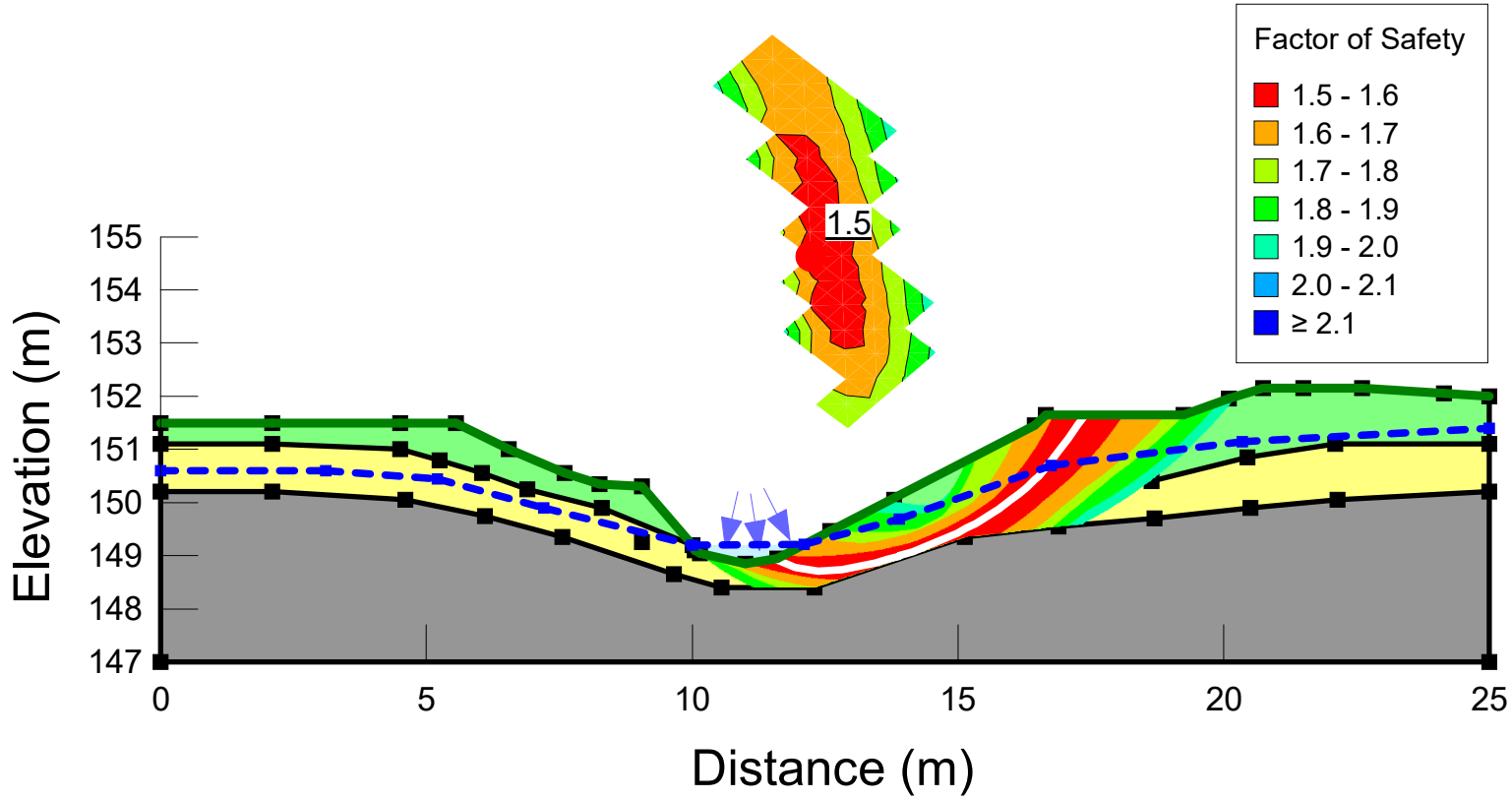
Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31



North G-103 Section_East

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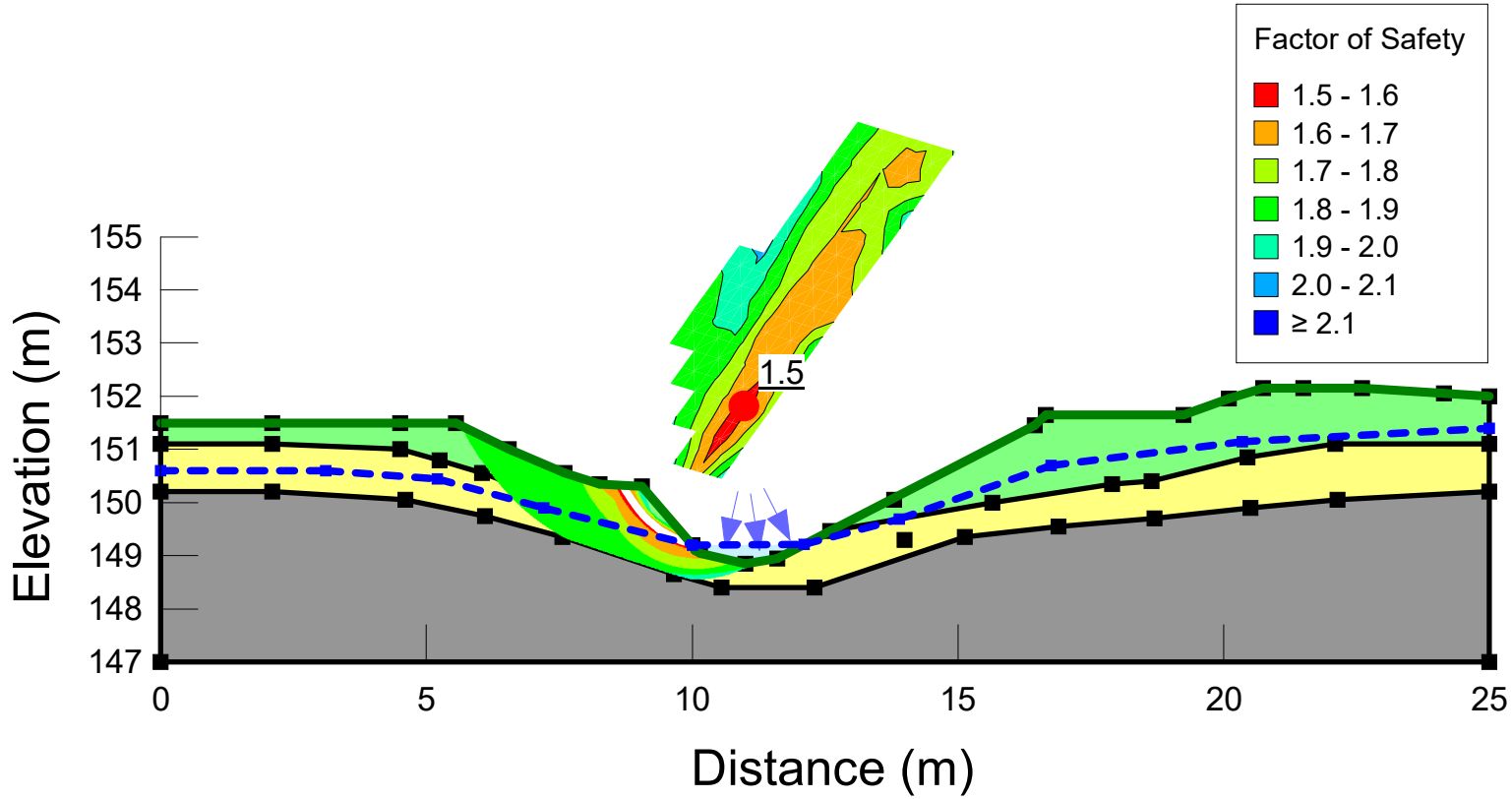
10/23/2023 1:140

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31

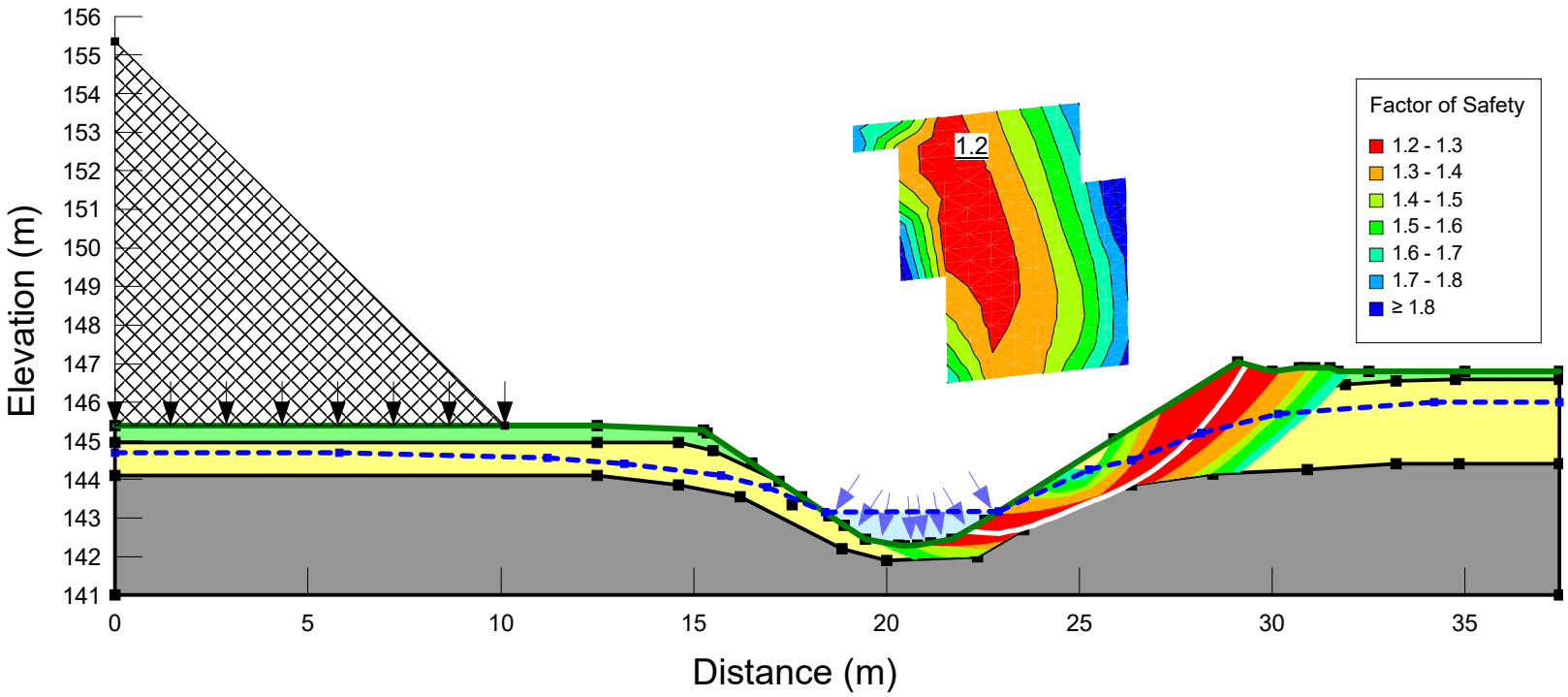


North G-103 Section_West

60701082 Wolfdale Creek Slope Stability Analysis.gsz

10/23/2023 1:140

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31

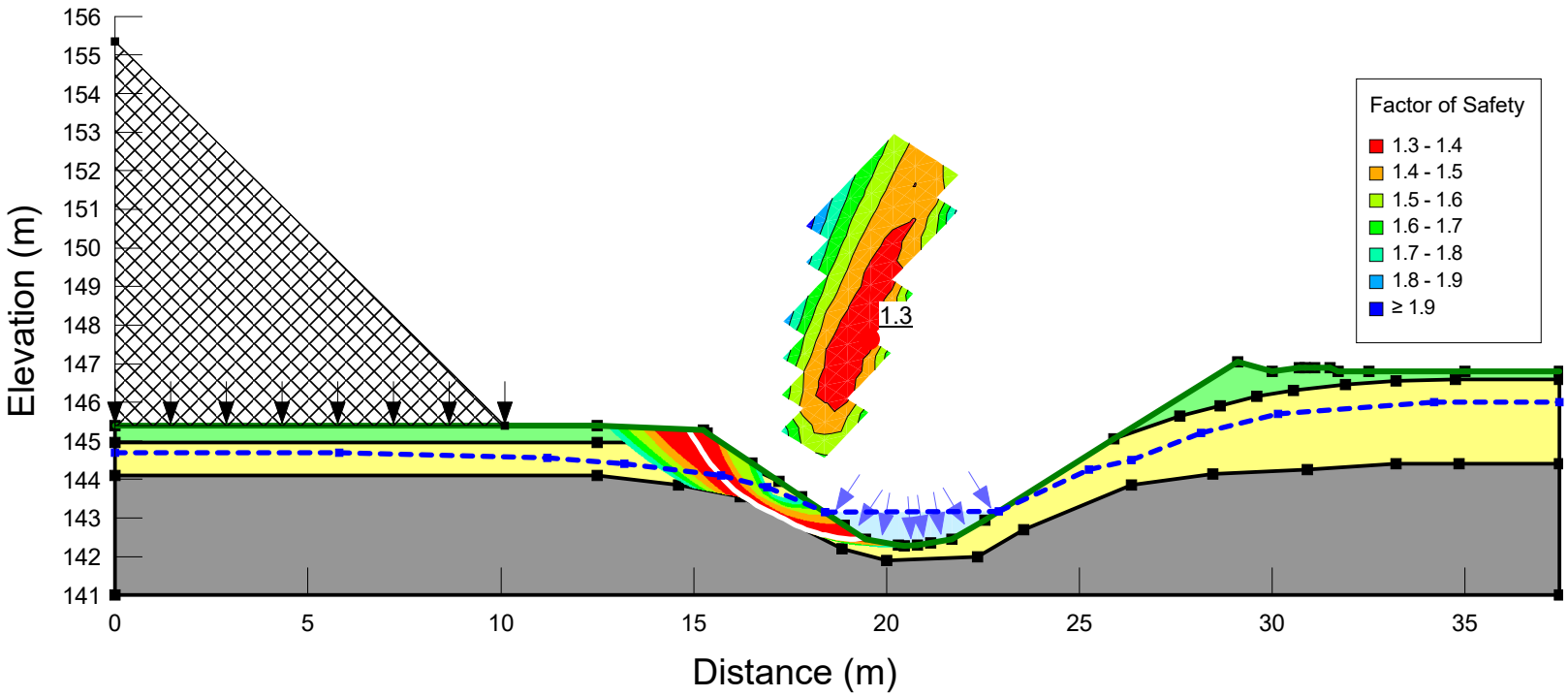


North G-104 Section_East

60701082 Wolfdale Creek Slope Stability Analysis.gsz

10/23/2023 1:190

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Sandy Silt	Mohr-Coulomb	20	3	31

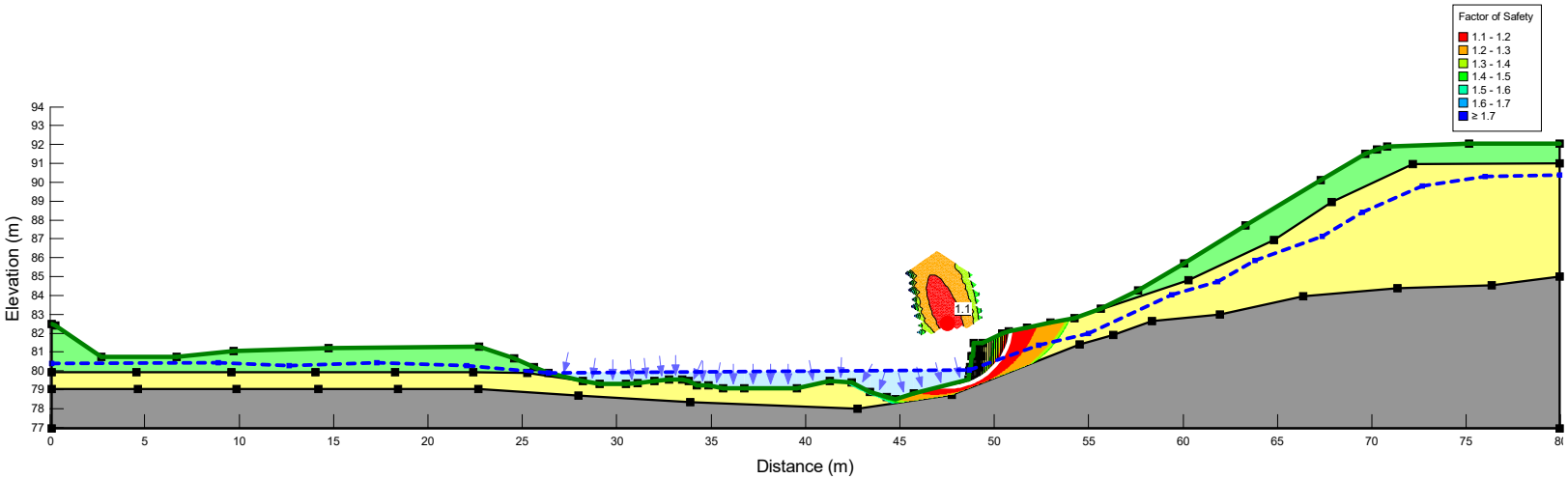


North G-104 Section_West

60701082 Wolfdale Creek Slope Stability Analysis.gsz

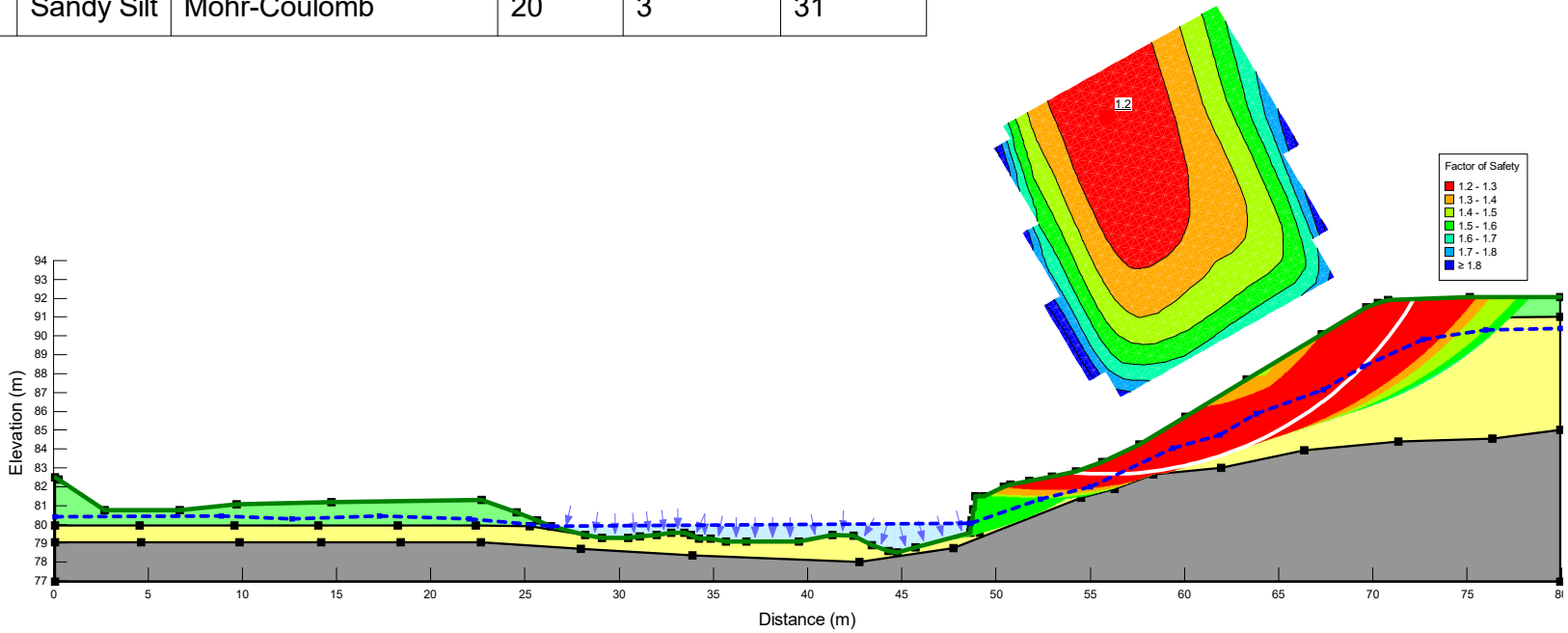
10/23/2023 1:190

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Gabion Basket	High Strength	22		
	Sandy Silt	Mohr-Coulomb	20	3	31



South G-105 Section_East	
60701082 Wolfdale Creek Slope Stability Analysis.gsz	
10/23/2023	1:387

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Fill	Mohr-Coulomb	19	2	30
	Gabion Basket	High Strength	22		
	Sandy Silt	Mohr-Coulomb	20	3	31



South G-105 Section_East	
60701082 Wolfdale Creek Slope Stability Analysis.gsz	
10/23/2023	1:387

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AECOM

Appendix D

Natural Environment Report

AECOM

Natural Environment Report

Wolfedale Creek Erosion Control Study – Schedule B Municipal Class Environmental Assessment Study

The City of Mississauga

60701082

December 2024

Delivering a better world

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and,
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

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Quality Information

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Prepared by

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Senior Terrestrial Ecologist

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Katie Easterling, B.Sc. (Hons)
Senior Aquatic Ecologist

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Executive Summary

AECOM Canada Ltd. (AECOM) has been retained by The City of Mississauga (the City) to undertake a Schedule 'B' Municipal Class Environmental Assessment (MCEA) study and to prepare detailed engineering design and associated construction drawings for the Wolfedale Creek Erosion Control Project (the Project).

This Natural Environment Report provides background and context for the Project; describes the existing environmental conditions (based on information collected through background information review and ecological field investigations); evaluates and identifies significant natural heritage features; describes the proposed work and identifies potential impacts associated with the Project. The Study Areas include the following segments:

- **Study Area 1**: Wolfedale Creek from Burnhamthorpe Road West to Dundas Street West, including the tributary channel between 3577 and 3599 Wolfedale Road.
- **Study Area 2:** Tributary outlet to the Credit River, south of Queensway West and west of Stavebank Road.

Existing aquatic and terrestrial conditions were identified through a background review of secondary sources and field investigations. A Species at Risk (SAR) and Significant Wildlife Habitat (SWH) screening were completed based on the existing conditions data and species records identified. The following significant features were identified within each Study Area:

- **Study Area 1**
  - Credit Valley Conservation (CVC) Authority Regulated Area;
  - The City of Mississauga Public Tree Protection By-law 0020-2022;
  - Candidate SWH for Bat Maternity Colonies, Amphibian Movement Corridors and habitat for Barn Swallow (*Hirundo rustica*), Snapping Turtle (*Chelydra serpentina*) and Common Nighthawk (*Chordeiles minor*);
  - Candidate SAR habitat for Chimney Swift (*Chaetura pelagica*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Bat SAR including Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tri-coloured Bat (*Perimyotis subflavus*), butternut (*Juglans cinerea*) and black ash (*Fraxinus nigra*); and,
  - Fish habitat.

- **Study Area 2**
  - CVC Authority Regulated Area;
  - The City of Mississauga Public Tree Protection By-law 0020-2022;
  - Region of Peel Greenlands System;
  - City of Mississauga Natural Heritage System;
  - Credit River Coastal Marsh Provincially Significant Wetland Complex;
  - Credit River Marshes Regional Area of Natural and Scientific Interest;
  - Valleylands;
  - Stavebank Oak Woods Environmentally Significant Area;
  - Fish Habitat;
  - Candidate SWH for Bat Maternity Colonies, Turtle Wintering Areas, Amphibian Breeding Habitat (Woodland), Amphibian Movement Corridors and habitat for Eastern Wood-pewee), Wood Thrush (Hylocichla mustelina), Snapping Turtle and Western-chorus Frog (*Pseudacris triseriata*); and,

  - Candidate SAR habitat for Chimney Swift (*Chaetura pelagica*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Bat SAR including Eastern Small-footed Myotis, Little Brown Myotis, Northern Myotis, and Tri-coloured Bat , butternut, and black ash .

A preliminary impact assessment was completed based on the preferred solution. Potential impacts from the Project may include damage and disturbance to natural heritage features, disturbance to terrestrial wildlife, including potential SAR and Species of Conservation Concern (SOCC), increased sedimentation and erosion potential, and disturbance to aquatic species and their habitat. Avoidance measures such as work limit restrictions designed for the Project, compliance with restriction of construction activities to outside of sensitive periods for local or significant wildlife species should be adhered to. In addition to avoidance measures, incorporation of mitigation measures such as installation of tree protection fencing, wildlife exclusion measures, erosion and sediment control measures, machinery and equipment best practices, and invasive species control strategies can aid in addressing potential impacts to natural heritage features and wildlife.

Recommended additional studies and next steps to be completed during detailed design include:

- Depending on the site of proposed works, species-specific surveys targeting SAR presence/absence may be required following MECP approved protocols and guidelines.
- Updated Impact Assessment during detailed design.
- Recommended additional studies to be completed during detailed design that should be considered include:
  - **Study Area 1**
    - Bat and Woodpecker leaf-off cavity tree and acoustic surveys;
    - Bird nest searches under affected structures (e.g., bridges, culverts);
    - Tree inventory; and,
    - Updated SAR and SWH habitat screenings.
  - **Study Area 2**
    - Breeding bird surveys;
    - Nocturnal amphibian call surveys;
    - Bat and Woodpecker leaf-off cavity tree and acoustic surveys;
    - Bird nest searches under affected structures (e.g., bridges, culverts);
    - Tree inventory;
    - Wetland delineation and rare plant inventory; and,
    - Updated SAR and SWH habitat screenings.
- An Arborist Report should be completed to identify the recommended action (i.e., remove, retain, protect) for individual trees, provide compensation requirements for tree removals and identify required permits for tree removals and injuries.

The anticipated permits and approvals required may include a Request for Review submission to Department of Fisheries and Oceans Canada (DFO) for Project review under the *Fisheries Act, 1985* and *Species at Risk Act*, 2002, a License to Collect Fish for Scientific Purposes, a Wildlife Scientific Collector's Authorization under the *Fish and Wildlife Conservation Act, 1997* for wildlife relocation and salvages, and a Section 28 Permit under *Ontario Regulation 41/24* for work in CVC's regulated area. Impacts to SAR and SAR habitat should be re-assessed during the early phases of detailed design to determine the need for additional surveys and potential permits or authorizations under the *Endangered Species Act, 2007*. An Arborist Report should also be completed to detail permits that may be required for tree removals and injuries.

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1. Introduction

AECOM Canada Ltd. (AECOM) has been retained by The City of Mississauga (the City) to undertake a Schedule 'B' Municipal Class Environmental Assessment (MCEA) study and to prepare detailed engineering design and associated construction drawings for the Wolfedale Creek Erosion Control Project (the Project). The Project is in the south-central part of the City and includes segments of Wolfedale Creek extending from Burnhamthorpe Road West to the Credit River for a total creek length of approximately 2,300 m. The following Natural Environment Report was completed in support of the MCEA study.

This Natural Environment Report provides background and context for the Project; describes the existing environmental conditions (based on information collected through background information review and ecological field investigations); evaluates and identifies significant natural heritage features; describes the proposed work and identifies potential impacts associated with the Project. There are two Study Areas for the Project, which include the following segments:

- **Study Area 1**: Wolfedale Creek from Burnhamthorpe Road West to Dundas Street, including the tributary channel between 3577 and 3599 Wolfedale Road.
- **Study Area 2:** Tributary outlet to the Credit River, south of Queensway West and west of Stavebank Road.

The Study Areas include an additional 120 m area around each segment to allow for the identification of natural heritage features on adjacent lands as defined by the Natural Heritage Reference Manual (MNRF, 2010). **Figure 1** shows the extent of the Study Areas.

Where information from this report has been incorporated into other reports, documents, drawings or applications, this report should be referenced in its entirety to provide context and to facilitate the comprehensive implementation of recommendations.

1.1 Project Background

The City has identified the need for erosion control and engineering design within Wolfedale Creek between Burnhamthorpe Road West to the Credit River. Wolfedale Creek originates at a storm sewer outlet south of Burnhamthorpe Road West and transitions into an open engineered channel which flows south until Dundas Street West where it is conveyed into a storm sewer. A short side tributary of the creek located between 3577 and 3599 Wolfedale Road joins the main branch near the upstream end of the creek. Wolfedale Creek reappears south of Queensway West and between Stavebank Road and Sir Richards Road and outlets into the Credit River.

The Study Area 1 study reach consists of a channelized creek with existing stabilization measures that include gabion baskets (stacked and single layered), rock rip-rap, concrete drop structures and armourstones. The majority of the channel was originally constructed approximately 40 to 50 years ago with rehabilitation completed over the years for certain segments. The Study Area 2 study reach consists of a large outfall structure, a couple of weirs, check dams, and the Wolfedale Creek natural channel.

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

- Study Area
- Boundary Limits (300 m)
- Flood Lines
- Credit Valley Conservation Authority Regulated Area (2013)
- City of Mississauga Natural Heritage System (2021)

General Features

- Main Railway
- Spur Railway
- Contour Line (5m interval)

Aerial Imagery: 2021

Wolfedale Creek

Natural Heritage Features

0 50 100 200 300 400 500 M

NAD 1983 UTM Zone 17N

Data Sources:
Contains Information licensed under the Open Government License Ontario. City of Mississauga and Credit Valley Conservation

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Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

- Boundary Limits (300 m)
- Study Area
- Flood Lines
- Credit River Marshes Provincially Significant Wetland Complex
- Credit River Marshes Regional Areas of Natural and Scientific Interest
- Credit Valley Conservation Authority Regulated Area (2013)
- City of Mississauga Natural Heritage System (2021)

General Features

- Primary or 400 Series Highway
- District, County, or Regional Road
- Watercourse
- Intermittent Watercourse
- Contour Line (5m interval)

Aerial Imagery: 2021

Map Extents

Wolfedale Creek

Natural Heritage Features

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

Data Sources:
Contains Information licensed under the Open Government License Ontario. City of Mississauga and Credit Valley Conservation

Jul, 2023

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AECOM

Figure: 1-2

Project Location: U:\Projects\60701082\Wolfedale\WolfedaleCreek\Design\1_Reports\ECO\1.0\SYECO_60701082_Wolfedale.aprx Layout: 01-Study Area - Base Map
Date Saved: 6/14/2023 4:32 PM User: MarinoS

Through its ongoing erosion monitoring program, the City has identified Wolfedale Creek as a high priority site in need of rehabilitation. Based on the continued erosion and risk to property and infrastructure, the City now wishes to proceed with the design and construction of stabilization works within the subject reaches. Some of the issues within the Study Areas include but are not limited to the following:

- Failed gabion basket and armourstone walls that are slumping and outflanked.
- Storm outfalls which have accumulated sediment and/or are damaged.
- Accumulation of debris and sediment within the creek.
- Entrenched channel with bank instability and erosion.

A key element of this study will be to identify and evaluate the existing conditions of the watercourse, identifying constraints and opportunities to minimize further ravine incision and potential threats to the surrounding infrastructure, in addition to adjacent properties, and even in some cases structures. The creek is located almost entirely within City lands; however, at various locations the creek corridor encroaches into private property, some with existing city easements.

The current investigation aims at providing long term erosion protection that is compatible with the natural tendencies of the creek and protects adjacent properties and infrastructure while maintaining or improving the morphological form and function; hydraulic capacity; and providing environmental enhancements to improve fish habitat and passage within the watercourse. The MCEA study will determine an effective erosion control and restoration strategy for Wolfedale Creek that is environmentally sound and acceptable to key review agencies, stakeholders and Indigenous communities.

2. Legislative and Policy Context

The Project triggers requirements under, and consideration for, legislation at municipal, provincial and federal jurisdictions. The requirements and considerations for each level of government are outlined in **Table 2-1**.

Table 2-1: Relevant Legislation and Policies

Level of Government	Legislation	Governing Authority	Relevant Information
Federal	■ Fisheries Act, 1985 (amended 2019)	■ Fisheries and Oceans Canada (DFO)	■ On August 28, 2019, the new Fish and Fish Habitat Protection Provisions of the Amended Fisheries Act came into force. Changes to the Act include a return to the policies that were enforced prior to the 2012 amendments, focusing on the following key concepts: – Protecting all fish and fish habitat (i.e., the focus is no longer on only protecting Commercial, Recreational and Aboriginal fisheries) – Restoring the previous prohibition against 'harmful alteration, disruption or destruction of fish habitat – Restoring a prohibition against causing 'the death of a fish by any other means than fishing'. ■ The Fish and Fish Habitat Protection Program ensures compliance with relevant provisions under the Fisheries Act and Species at Risk Act. If project proponents are unable to reduce the risk of a harmful alteration, disruption, or destruction to fish habitat or death of fish through the implementation of Fisheries and Oceans Canada Measures to Protect Fish and Fish Habitat, including the use of applicable Standards and Codes of Practice, or if a project does not fall under the exclusion criteria presented on the Fisheries and Oceans Canada Projects Near Water website, those projects may be subject to a Request for Review by Fisheries and Oceans Canada. ■ If death of a fish, or harmful alteration, disruption, or destruction is likely to result from a project, the proponent will be required to obtain Authorization from DFO. An Authorization includes terms and conditions the proponent must follow to avoid, mitigate, offset, and monitor the impacts to fish and fish habitat resulting from the Project.
Federal	■ *Migratory Birds Convention Act, 1994 (MBCA)* ■ *Migratory Bird Regulations, 2022*	■ Environment and Climate Change Canada (ECCC)	■ The MBCA is intended to protect migratory birds, their eggs, and their active nests. The Act includes protections for more than 700 species of birds. The *Migratory Birds Regulations, 2022* prohibits the possession, destruction, and harm of migratory birds and/or their nests while there is a live bird or a viable egg in it for most migratory birds except for 18 species listed in Schedule 1 of the MBCA that have site fidelity, reuse their nests from year to year and therefore, receive year-round nest protection whether there are eggs or live birds in there or not.
Federal	■ *Species At Risk Act, 2002 (SARA)*	■ Environment and Climate Change Canada - Canadian Wildlife Services (ECCC – CWS), DFO	■ The SARA and its associated regulations afford protection to terrestrial species listed in Schedule 1 of the Act when they occur on federal land, land subject to federal approvals, or are also regulated under the Migratory Birds Convention Act, 1994 (MBCA). ■ The federal government has the authority to regulate in relation to fisheries, shipping, and navigation, and jurisdiction over these subject areas applies to all parts of the oceans, lakes, rivers, and streams within the Canadian provinces and territories. As such, SARA regulates any activity that affects a SARA-protected aquatic species, such as fish, shellfish, crustaceans, marine animals, or marine plants. ■ The SARA contains several prohibitions to species listed on Schedule 1 as Endangered or Threatened, including prohibitions on harming an individual Species at Risk (SAR), their residence, or the Critical Habitat of the listed aquatic species and MBCA-protected migratory birds.
Provincial	■ *Endangered Species Act, 2007 (ESA)*	■ Ontario Ministry of Environment, Conservation, and Parks (MECP)	■ Under the ESA, species are listed as Extirpated, Endangered, Threatened, and Special Concern. – The ESA prohibits the killing, harming, or harassment of Endangered or Threatened species and the damage or destruction of their habitat. ■ MECP may grant a permit or other authorization for activities that would otherwise not be allowable under the ESA. – For the purposes of this report, Special Concern species are considered Species of Conservation Concern (SOCC).
Provincial	■ *Fish and Wildlife Conservation Act, 1997 (FWCA)*	■ Ontario Ministry of Natural Resources and Forestry (MNRF)	■ The FWCA affords protection for some species of birds, amphibians, reptiles, and mammals in Ontario. Some bird species which are not afforded protection under the MBCA are afforded protection under the FWCA, such as raptors. Nests of these bird species can only be removed if a permit is obtained from the MNRF.
Provincial	■ *Planning Act, 1990 and Provincial Policy Statement (PPS; 2020)*	■ Ministry of Municipal Affairs and Housing (MMAH)	■ The PPS, 2020 identifies seven types of natural heritage features to be protected: – Significant habitat of Endangered or Threatened species – Significant wetlands. – Coastal wetlands. – Significant woodlands in Ecoregions 6E and 7E. – Significant valley lands in Ecoregions 6E and 7E. – Significant Wildlife Habitat (SWH), including habitat of SOCC. – Significant Areas of Natural and Scientific Interest (ANSI). ■ Policies in the PPS are used to guide decision-making in land use planning. Under the PPS, development and site alteration are prohibited in significant wetlands in Ecoregion 6E and 7E. In addition, development and site alteration are not permitted in or within the remaining natural heritage features unless it can be shown that there will be no negative impact or permits or approvals are obtained under other regulations and legislations as appropriate.
Provincial	■ *Conservation Authorities Act, 1990b*	■ MNRF	■ *Ontario Regulation (O. Reg.) 41/24: Prohibited Activities, Exemptions, and Permits* came into effect on April 1, 2024, following amendments to the *Conservation Authorities Act, 1990*. The new O. Reg 41/24 establishes guidelines for the mapping of regulated areas within conservation authorities' jurisdictions where development could be subject to flooding, erosion, or dynamic beaches, or where interference with wetlands and alterations to shorelines and watercourses might have an adverse effect on those environmental features. This regulation identifies the processes to be followed to obtain exemptions and permits to allow for prohibited activities to occur within these regulated areas. The Study Area falls within the Credit Valley Conservation (CVC) regulation limit.
Municipal	■ *Regional Official Plan, consolidated* (2022)	■ Region of Peel	■ The Region of Peel established the Greenlands System which outlines policies for natural heritage areas within the region. The Greenlands System in Peel is divided into three categories of natural heritage areas, as follows: **1) Core Areas:** – Woodlands ≥ 30 ha. – Habitats of threatened or endangered species. – Provincially Significant Wetlands (PSWs). – Environmentally Significant Areas. – Provincially significant life science ANSIs. – Valley and stream corridors outlined in Table 2 of the Regional Official Plan.

Level of Government	Legislation	Governing Authority	Relevant Information
			2) Natural Areas and Corridors (NAC) – Woodlands between 3 ha and 30 ha. – Evaluated non-provincially significant wetlands. – Significant Wildlife Habitat (SWH) outlined in Figure 5 of the Regional Official Plan. – Fish habitat. – Regionally significant life science ANSIs. – Provincially significant earth science ANSIs. – Escarpment Protection Areas of the Niagara Escarpment Plan; – Any valley and stream corridor that have not been defined as Core Areas. – Headwater source and discharge areas and any other natural features. – Functional areas interpreted as part of the Greenlands System Natural Areas and Corridors by the individual area municipalities. **3) Potential Natural Areas and Corridors (PNAC)** – Unevaluated wetlands. – Cultural woodlands and cultural savannahs within the Urban System and Rural Service Centres meeting one or more of the criteria in Table 1 of the Regional Official Plan. – Any other woodlands greater than 0.5 ha. – Regionally significant earth science ANSI's. – Sensitive groundwater recharge areas. – Portions of Historic shorelines. – Open space portions of the Parkway Belt West Plan Area. – Potential ESA's identified as such by the conservation authorities. Any other natural features and functional areas interpreted as part of the Greenlands System PNAC, by the individual area municipalities in consultation with the conservation authorities. ■ Development and site alteration is prohibited within features of the Greenlands System. According to Section 2.14.15 essential infrastructure exempted, pre-approved or authorized under an environmental assessment process are permitted within features of the Greenlands System.
Municipal	■ *Mississauga Official Plan (2023)*	■ City of Mississauga	■ The City of Mississauga's Natural Heritage System includes Significant Natural Areas, Natural Green Spaces, Special Management Areas, Residential Woodlands and Linkages as identified on Schedule 3 of the Mississauga Official Plan (2023). Development and site alteration will not be permitted within or adjacent to the Natural Heritage System unless it has been demonstrated that there will be no negative impact to the natural heritage features and their ecological functions and opportunities for their protection, restoration, enhancement and expansion have been identified. This will be demonstrated through a study in accordance with the requirements of the *Environmental Assessment Act*. When not subject to the *Environmental Assessment Act*, an Environmental Impact Study will be required. For the purposes of this Project, an EIS is not required as this Project is following the MCEA process.
Municipal	■ The City of Mississauga Public Tree Protection By-law 0020-2022 ■ The City of Mississauga Private Tree Protection By-law 0021-2022	■ City of Mississauga	■ The City's Tree Protection by-laws outline the permitting requirements for obtaining a Permit if a tree or trees within private or public property are to be injured or destroyed.

3. Methodologies

3.1 Background Information Review

A background information review was completed prior to field investigations to obtain information on known natural heritage features and species records, including rare species (i.e., SAR and SOCC) within the Study Areas. Background information was obtained from the following sources:

- MNRF's Natural Heritage Information Centre (NHIC): Make-a-map feature (2023a) and MNRF's Land Information Ontario (LIO) GeoHub base (2023b) for:
  - Natural Heritage Features (e.g., ANSIs, wooded areas, PSWs /Locally Significant Wetlands (LSWs) / unevaluated wetlands, provincial parks).
  - Aquatic Resource Areas.
  - Dam Inventory.
  - Watershed mapping.
  - Wildlife habitats.
  - Aerial Photography.
  - NHIC provincially tracked species.
- Wildlife Atlases and other online databases:
  - Ontario Breeding Bird Atlas (OBBA; Bird Studies Canada [BSC] et al., 2006).
  - Important Bird Areas (BSC, 2023).
  - Ontario Reptile and Amphibian Atlas (ORAA; Ontario Nature, 2019).
  - Ontario Butterfly Atlas (OBA; Toronto Entomologists' Association [TEA], 2023).
  - Bat Conservation International (BCI) Species Profile and Range Maps (2023).
  - DFO SAR map (DFO, 2023).
  - eBird (2023).
  - iNaturalist (2023).
  - Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Ag Maps (OMAFRA, 2023).
  - MNRF Fish ONLine (MNRF, 2023c).
  - City of Mississauga Open Data – Natural Area Surveys (2021a).
  - CVC's Open Data – Ecological Land Classification and Land Use (2022).
- Planning Documents and Guidelines:
  - *Natural Heritage Reference Manual* (MNRF, 2010).
  - Species at Risk Public Registry (ECCC, 2021).
  - Species at Risk in Ontario (SARO) List (MECP, 2018).
  - *Significant Wildlife Habitat Technical Guide* (MNRF, 2000).
  - *Significant Wildlife Habitat Criteria Schedules For Ecoregion* 7E (MNRF, 2015).
  - *Region of Peel Official Plan* (Region of Peel, 2022).
  - *City of Mississauga Official Plan (*City of Mississauga, 2022).
- Reports:
  - *Preliminary Design Recommendations for Mississauga Structures* (Aquafor Beech Ltd., 2015);
  - *Wolfedale Creek Erosion Control and Rehabilitation – From Burnhamthorpe Road West to the Credit River* (AECOM, 2023).
  - *Credit River Watershed Natural Heritage System Final Technical Report* (CVC, 2015).
  - *Natural Areas Study Fact Sheet CRR8* (City of Mississauga, 2021b).
  - *Natural Areas Study Fact Sheet ER6* (City of Mississauga, 2021c).
  - *Natural Areas Study Fact Sheet FV1* (City of Mississauga, 2021d).
- Aerial photographic Imagery (City of Mississauga 2021).

3.2 Field Investigations

Field investigations were conducted to supplement available background information as described in **Section 3.1** above. Representative terrestrial and aquatic photographic logs are provided in **Appendix A1** and **A2,** respectively. The following sections document the detailed methods of these investigations.

3.2.1 Fish and Fish Habitat Investigations

Fish habitat investigations within the Study Areas were completed on April 19 and 20, 2023. Site reconnaissance was undertaken by AECOM Ecologists to confirm the location and boundaries of aquatic features, and potential fish habitat to capture any additional potential aquatic features not identified initially through the background information review or aerial imagery.

A detailed assessment of aquatic habitat in Wolfedale Creek was completed within the Study Areas.
The reaches of Wolfedale Creek that fall within the Study Areas were assessed in their entirety. At multiple points in the Study Areas where, for example, a change in habitat condition was observed, a break in stream reach, etc., details were collected using ArcGIS Field Maps at transects in representative areas to characterize the habitat conditions of that reach. These include:

- Substrate, recorded by percent composition of substrate type:
  - Bedrock – continuous rock that may be only partly exposed.
  - Boulders – separate, often embedded, over 250 mm diameter.
  - Cobble – 65 mm to 250 mm in diameter.
  - Gravel – 2 mm to 65 mm in diameter.
  - Sand – 0.06 mm to 2 mm in diameter, gritty.
  - Silt – <0.06 mm in diameter, floury.
  - Clay – <0.002 mm in diameter, silky.
  - Muck – mix of detritus and silt, sand and/or clay.
  - Detritus – organic matter.
- Visual observations of water clarity, water colour, and sources of pollution.
- Riparian conditions, vegetation, and surrounding land use.
- Aquatic vegetation composition and abundance. described by type (floating, emergent, or submergent), and the abundance of each type was described as the percent of surface area coverage in each section.
- In-water cover and structure for fish, based on the presence and distribution through the water column of material for fish to seek refuge provided by woody debris, boulders (>250 mm diameter), cobble (65-250 mm diameter), aquatic vegetation, other material (i.e., man-made structures) and/or undercut banks.
- Overhead canopy cover, which is based on shade and cover provided by the presence and distribution of material hanging over the water (i.e., trees, shrubs, grasses, herbaceous, man-made structures or other) was estimated and classified as: closed 90%-100%, high 61-90%; moderate 31-60%; low 1-30% or none. The vegetation (e.g., woody, herbaceous, grasses, etc.) of the riparian zone were described.
- Channel dimensions:
  - Wetted depth.
  - Wetted width.
  - Bankfull width
  - Bankfull depth.

- Morphology:
  - Runs – typically deep, fast-flowing water with little to no surface turbulence.
  - Riffles – shallow, fast-flowing water typically running over rocks where the surface turbulence aerates the water.
  - Flats – slow-flowing water with a smooth un-agitated surface.
  - Pools – deeper pockets and depositional areas of slow-moving water of compounded water, or side pools along the bank outside of the main flow.
- General notes of habitat conditions, and photographs.

In addition to the general aquatic habitat conditions that were documented, any specialized habitat and other notable features and functions, such as suitable spawning habitat for game fish (i.e., typically targeted by recreational anglers) species known to occur in the watershed, evidence of erosion, sources of pollution, fish passage impediment, and incidental fish observations were delineated using ArcGIS Field Maps.

Due to the availability of existing recent records in the area, an assessment of the fish community was not completed for this work.

3.2.2 Terrestrial Field Investigations

3.2.2.1 Confirmatory Ecological Land Classification

AECOM conducted Ecological Land Classification (ELC) assessments and a floral inventory of sites within the Study Areas on May 19, 2023. Vegetation communities within the Study Areas were classified using the *Southern Ontario Ecological Land Classification (ELC) System* (ELC Protocol; Lee *et al.*, 1998), which provides a standard for comparing similar vegetation communities across Ontario. This protocol classifies vegetation communities by completing a multilayer (canopy, sub-canopy, ground cover) vegetation inventory.

The CVC has mapped vegetation communities within both Study Areas to the Community Series level using colour orthoimagery as well as vegetation community mapping from applicable studies, where available (CVC, 2022). The Community Series level is the lowest level of ELC that can be identified without a site visit. Vegetation communities at the Community Series level are distinguished based on the type of vegetation cover or the plant form that characterizes the community. Generally, they are identified based on whether the community has open, shrub, or treed vegetation cover, as well as whether the plant form is deciduous, coniferous, or mixed (MNRF, 2000). The City's Natural Areas Survey (2022) highlighted vegetation communities to Vegetation Type within Study Area 2 and communities near Study Area 1. The Vegetation Type level is the finest level of resolution in the ELC hierarchy and is identified by the plant species assemblages found during site visits.

AECOM completed confirmatory ELC surveys to confirm and refine vegetation communities identified by both the City's Natural Areas Survey (2022) and CVC's ELC mapping (2022). Where vegetation community data was missing and accessibility was limited during field investigations, aerial imagery was used to classify vegetation to the Community Series level in accordance with MNRF's ELC protocol (Lee et al., 1998).

3.2.2.1.1 Community Sensitivity

Vegetation community sensitivity was based on the calculation of the Mean Coefficient of Conservatism (CC), the Floristic Quality Index (FQI), and the Wetness index for all vegetation communities present in the Study Area. These parameters are intended to be used together to assign an ecological community's sensitivity ranking based on plant species composition. The ranking is not intended to measure the overall value of a community, but rather reflects the community's sensitivity to disturbance based on the grouping of plants present within the community.

Co-efficient of Conservation (CC)

- These values range from 0 (low) to 10 (high) and are based on species' tolerance of disturbance and fidelity to a specific habitat. Vegetation species and community sensitivity were assessed through the application of CC values, assigned to each native species in southern Ontario (Oldham *et al.* 1995). The occurrence of species with a Co-efficient of Conservatism of 9 or 10 can be indicators of undisturbed habitats such as mature forests, fens or bogs. General habitat values associated with the Co-efficient of Conservatism values are:
  - 0-3: species found in a wide variety of communities, including disturbed sites.
  - 4-6: species associated with a specific community, but tolerate moderate disturbance.
  - 7-8: species associated with a community in an advanced successional stage, tolerant of minor disturbances.
  - 9-10: species with a high degree of fidelity to a narrow range of synecological parameters.

Floristic Quality Index (FQI)

- The FQI of an area is reflected in the mean value of CC. For example, an old field or grazed woodlot would tend to have a low mean CC; these habitats are dominated by opportunistic species that occur in a wide range of site conditions and are tolerant of disturbance. A bog, prairie or intact forest would have a higher value, reflecting the specific habitat requirements of many of the species and the general absence of disturbance. A community with an FQI between 1-19 would be considered to be of low vegetative quality; communities with an FQI between 20-35 would be considered to have a high vegetative quality and communities with an FQI above 35 will be considered of "Natural Area" Quality.

Co-efficient of Wetness (CW)

- All plants in southern Ontario have been assigned a wetland category, based on the designations developed for use by the United States Fish and Wildlife Service. Each wetland category has been assigned a numerical value to facilitate the quantification of the wetness index. Plants are designated into the following categories:
  - Obligate Wetland: occurs almost always in wetlands under natural conditions (estimated >99% probability).
  - Facultative Wetland: usually occurs in wetlands, but occasionally found in non-wetlands (estimated 67-99% probability).
  - Facultative: equally likely to occur in wetlands or non-wetlands (estimated 34-66% probability).
  - Facultative Upland: occasionally occurs in wetlands, but usually occurs in non-wetlands (estimated 1-33% probability).
  - Upland: occurs seldom in wetlands under natural conditions (estimated <1% probability).

3.3 Significant Wildlife Habitat Screening

The *Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E* (MNRF, 2015) contains information and criteria for identifying SWH. SWH are defined as areas that have important ecological features and functions and that support sustainable populations of plants, wildlife and other organisms within this Ecoregion. The MNRF generally categorizes SWH into the following five categories:

- Seasonal Concentration Areas.
- Rare Vegetation Communities.
- Specialized Habitats for Wildlife.
- Habitats of SOCC.
- Animal Movement Corridors.

The presence of an SWH was determined by comparing general habitat conditions and characteristics to the habitat criteria identified in the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E* (MNRF, 2015).

For the purpose of this report, as defined in the *Natural Heritage Reference Manual* (MNRF, 2010), SOCC are those species that are listed as Special Concern under the ESA, assessed as Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that are not considered SAR under the ESA, or have a sub-national (S-Rank) of S1 – S3. Although SOCC do not receive legal protection under the ESA, they may be afforded protection under the PPS, the MBCA, FWCA, and other planning documents. A screening for SOCC was completed as outlined in **Section 3.4** below.

3.4 Species at Risk Habitat Screening

Special consideration was given to identifying any SOCC or SAR within the Study Areas. SAR includes species that are listed as Extirpated, Endangered or Threatened on the SARO list and receives both individual and habitat protection under the ESA. Desktop SOCC and SAR habitat screenings were conducted using the sources listed in **Section 3.1** within the Study Areas. SAR and SOCC with recent occurrence records or with ranges overlapping within the subject Study Area were identified and then screened by comparing their habitat requirements to the habitat conditions present on-site as determined through the background information review (**Section 3.1**) and field investigations (**Section 3.2**). The potential for the species to occur within the Study Areas was determined through a probability of occurrence whereby the following rankings were applied:

- **Low Probability**: no suitable habitat for the species and no occurrence of the species incidentally observed through field reconnaissance within the Study Areas but there is a known species record in the general area.
- **Medium Probability**: potentially suitable SAR habitat identified within the Study Areas, but no occurrence of the species incidentally observed through field reconnaissance although there is a known species record in the general area.
- **High Probability**: good quality SAR habitat identified within the Study Areas and known species record in the Study Areas (either through current field assessment or background information).

4. Existing Conditions

4.1 Natural Heritage Features

Natural features and areas identified for protection in the PPS and other legislation are collectively referred to as "natural heritage features". Natural heritage features include Valleylands, Environmentally Significant Areas, PSWs, ANSIs, Significant Woodlands and SWH. Brief descriptions of the different types of natural heritage features are as follows:

- Valleylands refer to a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year (MNRF, 2010). Significance is determined based on a variety of criteria including, but not limited to, hydrological, geomorphological and ecological function (MNRF, 2010).
- Provincially Significant Wetlands (PSWs) and Locally Significant Wetlands (LSWs) are wetlands that are seasonally or permanently flooded by shallow water, or areas where the water table is close to the surface, enabling the development of hydric soil, which supports primarily hydrophytic or water-tolerant plants (MNRF, 2014). MNRF evaluates the significance of wetlands through the Ontario Wetland Evaluation System. Based on the resulting score of an evaluation, an evaluated wetland can fall into one of two classes: PSWs or LSWs (MNRF, 2014). Until such a time, that an Ontario Wetland Evaluation System evaluation is completed and evaluated by MNRF, unevaluated wetlands should be considered as significant for the purpose of assessing impacts.
- ANSIs include land and/or water containing natural landscapes or features that have been scientifically identified by MNRF as having life science or earth science values related to protection, scientific study or education (MNRF, 2010). ANSIs are designated as earth science (geological) or life science (biological) depending on the features present (MNRF, 2010). "Candidate ANSIs" are those provincial-level ANSI that MNRF has identified and recommended for protection but that have not been formally confirmed through a confirmation procedure (MNRF, 2010). For the purpose of the PPS, an ANSI is not considered provincially significant until it has been confirmed.
- Significant Woodlands are woodlots that are identified as significant in a municipal official plan or woodlots that have been investigated and meet the criteria of significance as identified in the Natural Heritage Reference Manual (MNRF, 2010) or municipal official plan.
- SWH are areas that have important ecological features and functions which support sustainable populations of plants, wildlife and other organisms. SWH are further described in **Section 4.7**.

According to the sources listed in **Section 3.1**, there were no natural heritage features within Study Area 1; however, Study Area 2 contained valleylands, the Credit River Coastal Marsh PSW complex and the Credit River Marshes Regional ANSI. The City's Natural Area Survey (2022) also identified Stavebank Oak Woods Environmentally Significant Area which shares similar boundaries to the ANSI.

Furthermore, Vegetation communities associated with the Stavebank Oak Woods Environmentally Significant Area meet the criteria for Significant Woodlands as outlined in the City's Official Plan (2022). According to Section 6.1.12 of the City's Official Plan (2022), Significant Woodlands are those that meet one or more of the following criteria:

- Woodlands, excluding cultural savannahs, greater than or equal to four ha.
- Woodlands, excluding cultural woodlands and cultural savannahs, greater than or equal to two ha and less than four ha.

- Any woodland greater than 0.5 ha that:
  - Supports old growth trees (greater than or equal to 100 years old).
  - Supports a significant linkage function as determined through an EIS by the City in consultation with the appropriate conservation authority.
  - Is located within 100 m of another Significant Natural Area supporting a significant ecological relationship between the two features.
  - Is located within 30 m of a watercourse or significant wetland.
  - Supports significant species or communities.

Vegetation communities associated with Stavebank Oak Woods were confirmed as Significant Woodlands as the area was greater than four ha, located adjacent to the Credit River Coastal Marsh PSW complex, supports old growth trees (City of Mississauga, 2021b), as well as supports significant species and SWH (refer to **Section 4.4**).

Natural heritage features are shown on **Figure 1**.

4.2 Planning Policy Areas

Planning Policy Areas include land use planning designations from provincial plans, upper and lower-tier municipal official plans, and conservation authorities as described in **Section 2.** A summary of Planning Policy Areas related to the protection of the natural environment that are applicable to the Project is provided below:

- Credit Valley Conservation Authority Regulated Area in both Study Areas.
- The City of Mississauga Public Tree Protection By-law 0020-2022 in both Study Areas.
- Region of Peel Greenlands System in Study Area 2.
- City of Mississauga Natural Heritage System in Study Area 2.

Planning Policy Areas are shown on **Figure 1**.

4.3 Site Physiographical, Geological and Hydrogeological Setting

The *Wolfedale Creek Erosion Control and Rehabilitation – From Burnhamthorpe Road West to the Credit River* (AECOM, 2023) used background reports to provide a general understanding of the natural and historical conditions that influence the channel morphology and watercourse stability in the Study Areas. The following subsections provide a summary the findings from the background review.

4.3.1 Watershed Characteristics

The Study Areas are located within the larger Credit River watershed which contains approximately 1,500 km of tributaries within an area of 1,000 km^2. Wolfedale Creek is part of the smaller Norval to Port Credit subwatershed, comprising an approximate area of 72.8 km^2.

4.3.2 Physiography and Surficial Geology

North of the Canadian Pacific Railway (CPR) the Study Area is located within the physiographic region of the Drumlinized Till Plains physiographic landform within the South Slope physiographic region. South of the CPR, the Study Area is located within the Shale Plains physiographic landform, within the Iroquois Plain region. The South Slope and Iroquois Plains gently slope to the south and consist of shallow shale and till plains (Chapman & Putnam, 2007).

The Ontario Geological Survey (2010) surficial geology map indicates that the surficial geology of the area is dominated by Paleozoic bedrock (specifically the Georgian Bay Formation) from southeast of Central Parkway West to the confluence with the Credit River, where the dominant surficial geology is modern alluvial deposits of clay, silt, sand, gravel, and organics. The bedrock of the Georgian Formation is characterized by blue-grey shales with interbeds of siltstone, sandstone, limestone and dolostone (CVC, 2011). North of Central Parkway West and beyond Burnhamthorpe Road West, the surficial geology is characterized by glaciolacustrine till deposits of clay and silt.

Sections of the investigated area along Wolfedale Creek flow over bedrock. Bedrock is a geologic constraint on rivers, and affects their shape, pattern, and susceptibility to erosion. The erosion rate of bedrock varies greatly, with hard bedrock (e.g., granite) being the most resistant to erosion, and soft bedrock (i.e., limestone) being less resistant to erosion. Soft shale is the most susceptible rock type to erosion, and several factors including slope and orientation of individual rock layers will impact its long-term stability (MNRF, 2002). Bedrock is relatively impermeable compared to other unconsolidated sediment types. The impermeable surface results in high runoff during spring melt and during periods of rainfall. High runoff leads to larger discharge quantities and faster flow velocities. This can in turn impact the overall long-term stability of the bedrock channel.

4.3.3 Topography

The longitudinal profile identifies channel bed forms and local bed gradients and is an important geomorphological consideration as the bed gradient is a primary control of tractive forces within a reach and is therefore a major determinant of morphological form and function. The steeper the longitudinal profile the greater the ability for the channel to entrain and transport sediment along its boundaries. The topography can also constrain channel migration with flat topographic areas supporting a meandering system and steep valley walls confining channel migration.

The topography ranges from approximately 154 mASL at the northern end of the Study Area 1 to approximately 125 mASL at Dundas Street West, over approximately 2030 m, for an average slope of 1.40%. In Study Area 2 the elevation is steeper and ranges from approximately 83 m to 76 m, over approximately 267 m for an average slope of approximately 2.8%. The topographic map indicates that in Study Area 1 the channel is largely confined by steep valley walls, while in Study Area 2 the topography consists of an undulating floodplain between steep valley walls that widen towards the Credit River (City of Mississauga, 2021b).

4.3.4 Land Use

The land around Study Area 1 is heavily urbanized, with many industrial and commercial establishments as well as numerous residential subdivisions surrounding the watercourse. The urbanized nature of the surrounding land contributes to increased stormwater runoff during stormwater events due to the higher percentage of impervious surfaces. This increased runoff has the potential to cause significant erosion issues for watercourses downstream of the urbanized area.

In Study Area 2 the watercourse is surrounded by residential development on both sides of the river, and by forested lands/ a large golf course in the south. The watercourse discharges into the Credit River. Forest cover tends to slow runoff and increase infiltration of water into the ground.

4.4 Ecological Land Classification and Plant Inventory

All the vegetation communities in Study Area 1 were disturbed as a result of anthropogenic activities and were largely limited to narrow vegetation strips along Wolfedale Creek which were surrounded by heavily developed commercial and industrial areas. Study Area 2 consisted of more naturalized communities that were apart of the

Credit River Marshes Wetland PSW Complex and ANSI, which were surrounded by residential development and a golf course. Surveys confirmed that there were no provincially significant vegetation communities identified in either Study Area.

Most of the vegetation communities documented in the City's Natural Area Surveys (2022) and CVC's ELC mapping were confirmed during field investigations conducted by AECOM. The community located in southeast end of Study Area 1 was mapped as a Cultural Savannah (CUS) by the CVC (2022) through orthoimagery interpretation to the Community Series level. During the field investigations by AECOM, the site was assessed to the Vegetation Type level and found to be more characteristic of a Fresh-Moist Ash Lowland Deciduous Forest (FOD7-2).

AECOM's Vegetation Surveys indicated the presence of three ELC vegetation communities in Study Area 1 with generally low vegetation quality as the FQI values were below 19. The three vegetation communities in Study Area 2 had higher FQI values than in Study Area 1, however, were still below an FQI of 19. Although Study Area 2 contained more naturalized communities, the area had an overall abundance of non-native species that were established including, but not limited to: Norway maple (*Acer platanoides*), Manitoba maple (*Acer* negundo), common buckthorn (*Rhamnus cathartica*) and garlic mustard (*Alliaria petiolata*). The abundance of non-native species was likely the result of previous and ongoing disturbances from urbanization within and around the Study Areas (residential/ commercial developments, litter, trail systems etc.). Descriptions of vegetation communities, community sensitivity and floristic assessments are summarized in **Table 4-1** and mapped in **Figure 2**.

A total of 96 plant species were recorded within the Study Area, of which 57 (59%) were native and 39 (41%) were introduced. Additionally, 25 (25%) out of the total 96 plant species were also identified as invasive. No plant SAR were identified in the Study Areas. Honey Locust was the only plant SOCC identified, where planted individuals were observed in the east end of Study Area 1. There were no naturally occurring plant SOCC identified in the Study Areas.

A list of vascular plant species identified is provided in **Appendix B**.

Table 4-1: Vegetation Communities within Study Areas

ELC Code and Location	Dominant Species					
	Vegetation or Ecosite Name	Inclusion	Tree Canopy	Shrub Layer	Ground Layer	Floristic Assessments
Forest Communities						
FOD7-2 ■ **Located in the east end of Study Area 1, immediately west of Dundas Street West.**	■ Fresh – Moist Ash Lowland Deciduous Forest Ecosite.	■ None.	■ The tree canopy consisted of green ash (*Fraxinus pennsylvanica*), Manitoba maple (*Acer negundo*), Norway Maple (*Acer plantanoides*) and American Elm (*Ulmus americana*).	■ The shrub layer was dominated by common buckthorn (*Rhamnus cathartica*) and Tartarian honeysuckle *(Lonicera tatarica*) followed by some hawthorn species (*Cretaegus sp*), green ash and chokecherry (*Prunus virginiana*).	■ This ground layer was vegetated with garlic mustard (*Alliaria petiolata*), yellow avens (*Geum aleppicum*), Canada's enchanter's nightshade (*Circaea lutetiana*) and common buckthorn seedlings.	■ Average CC: 3.45 ■ Average CW: 1.5 ■ Non-native species (%):33 ■ FQI:15.43 ■ No SAR, SOCC or locally rare plants observed.
FOD7-3 ■ **Located throughout the central portion of Study Area 2**	■ Fresh-Moist Willow Lowland Deciduous Forest.	■ MAM3-2: Reed-canary Meadow Marsh was located in the east end of Study Area 2, adjacent to Wolfedale Creek. The inclusion was dominated by reed canary grass (*Phalarus arundinacea*) and also contained a small patch of common reed (*Phragmites australis*).	■ The tree canopy was dominated by Manitoba maple, Freeman's maple (*Acer freemanii*), Norway maple and willow species (*Salix sp.*).	■ The shrub layer consisted of Manitoba maple, green ash, Freeman's maple and American elm.	■ The ground layer consisted of spotted jewelweed (*Impatiens capensis*), garlic mustard, bittersweet nightshade (*Solanum dulcamara*) and reed canary grass.	■ Average CC: 3.12 ■ Average CW: 0.43 ■ Non-native species (%):44 ■ FQI:15.6 ■ No SAR, SOCC or locally rare plants observed.
FOD5-3 ■ **Located in the east and west ends of Study Area 2.**	■ Dry-Fresh Sugar Maple Deciduous Forest.	■ None.	■ The canopy and subcanopy was dominated by sugar maple (*Acer saccharum*), red oak (*Quercus rubrum*), white oak (*Quercus alba*), white pine (*Pinus strobus*) and American elm.	■ The shrub layer contained young sugar maple, black cherry, hop hornbeam (*Ostrya virginiana),* green ash and common buckthorn.	■ The ground layer consisted of garlic mustard, aster species (*Symphyotrichum sp.*), Canada's enchanter's nightshade and wild grape.	■ Average CC: 3.24 ■ Average CW: 1.85 ■ Non-native species (%):26 ■ FQI:17.46 ■ No SAR, SOCC or locally rare plants observed.
Cultural Communities						
CUW1 ■ **Community present in Study Area 1 as a narrow strip along Wolfedale Creek between Central Parkway West and approximately 200 m west of Dundas Street West.**	■ Mineral Cultural Woodland Ecosite.	■ None.	■ Tree canopy consisted of mostly of Manitoba maple and Norway maple. The subcanopy contained Manitoba maple, green ash, Norway maple and bur oak (*Quercus macrocarpa*).	■ The shrub layer consisted of common buckthorn, Tartarian honeysuckle, red-osier dogwood (*Cornus sericea*) and Manitoba maple.	■ Common groundcover species included garlic mustard, common buckthorn seedlings, cow vetch (*Vicia cracca*) and Kentucky bluegrass (*Poa pratensis*).	■ Average CC: 3.26 ■ Average CW: 1.54 ■ Non-native species (%):47 ■ FQI:15.29 ■ No SAR, SOCC or locally rare plants observed.
CUT1 ■ **Community present in Study Area 1 as a narrow strip along Wolfedale Creek between Burnhamthorpe Road West and Central Parkway West.**	■ Mineral Cultural Thicket Ecosite.	■ None.	■ No tree canopy layer identified in this community.	■ The dense shrub layer consisted of Manitoba maple. American elm, green ash, common buckthorn, Tartarian honeysuckle and choke cherry (*Prunis virginiana).*	■ Ground layer species included garlic mustard, large-leaved aster (*Eurybia macrophylla*), common buckthorn seedlings, thicket creeper (*Parthenocissus quinquefolia*) and common dandelion (*Taraxacum officinale*).	■ Average CC: 2.44 ■ Average CW: 1.48 ■ Non-native species (%): 46 ■ FQI:9.44 ■ No SAR, SOCC or locally rare plants observed.
Marsh Communities						
MAS2-1 ■ **Located in the east end of Study Area 2**	■ Cattail Mineral Shallow Marsh.	■ None.	■ No tree canopy layer identified in this community.	■ No shrub layer identified in this community.	■ This community consisted mostly of Broad-leaved Cattail (*Tyhpa latifolia*). Other species observed included common reed, purple loosestrife (*Lythrum salicaria*), field horsetail (Equisetum arvense) and spotted jewelweed.	■ Average CC: 1 ■ Average CW:-3.17 ■ Non-native species (%): 0.33 ■ FQI:2 No SAR, SOCC or locally rare plants observed.

Tea Garden Cir
Grand Park Dr
Gandhi Way
Summer Park Cres
Fairview Rd W
Pilcom Cres
Pilcom Crt
Claymeadow Ave
Cottagers Green Dr
Cottage Clay Rd
Wheatstone Ave
Wildgrass Rd
Elmcreek Rd
Shoreline Dr
Neighbourhood Cir
Crystalbr
Trident Ave
Palisander Ave
Kingsberry Cres
Galloway Cres
Chicory Crt
Mavis Rd
Hillcrest Ave
Dundas St W
CUW1
CUT1
CUW1
FOD7-2
Pollard Crt
Morrison Ave
Chisholm Ave
Pollard Dr
Messenger
Meadow Dr
Burnhamthorpe Rd W
Wolfedale Rd
Central Pky W
Teakwood Dr
Hawkestone Rd
Westlock Rd
Eaglemount Cres
Strabane Dr
Consort Cres
Forestwood Dr
Perivale Rd
Whispering Wood Dr
Semenyk Crt
Icbride Ave
Blairholm Ave
Stainton Dr
Hemus

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

- Boundary Limits (300 m)
- Study Area
- ELC

General Features

- Main Railway
- Spur Railway

ELC Code/Description

CUT1: Mineral Cultural Thicket Ecosite
FOD7-2: Fresh-Moist Ash Lowland Deciduous Forest
CUW1: Mineral Cultural Woodland Ecosite
FOD7-3: Fresh-Moist Willow Lowland Deciduous Forest
MAS2-1: Cattail Mineral Shallow Marsh
FOD5-3: Dry-Fresh Sugar Maple Deciduous Forest

Aerial Imagery: 2021

Wolfedale Creek

ELC

0 50 100 200 300 400 500 M
NAD 1983 UTM Zone 17N

Data Sources:
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Figure: 2-1

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

- Boundary Limits (300 m)
- Study Area
- ELC

General Features

- Primary or 400 Series Highway
- District, County, or Regional Road
- Watercourse
- Intermittent Watercourse

ELC Code/Description

CUT1: Mineral Cultural Thicket Ecosite
FOD7-2: Fresh-Moist Ash Lowland Deciduous Forest
CUW1: Mineral Cultural Woodland Ecosite
FOD7-3: Fresh-Moist Willow Lowland Deciduous Forest
MAS2-1: Cattail Mineral Shallow Marsh
FOD5-3: Dry-Fresh Sugar Maple Deciduous Forest

Aerial Imagery: 2021

Map Extents

Wolfedale Creek

ELC

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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Figure: 2-2

4.5 Fish and Fish Habitat

Wolfedale Creek is situated within the Mary Fix Creek – Credit River quaternary watershed, the northern extent of which is just north of Mayfield Road in Brampton. The southerly extent is the Credit River outlet to Lake Ontario in Port Credit and extends easterly from Ninth Line to Hurontario Street at the watershed's widest part, covering an area that is roughly 226 km^2 (MNRF, 2023a) (**Figure 3**).

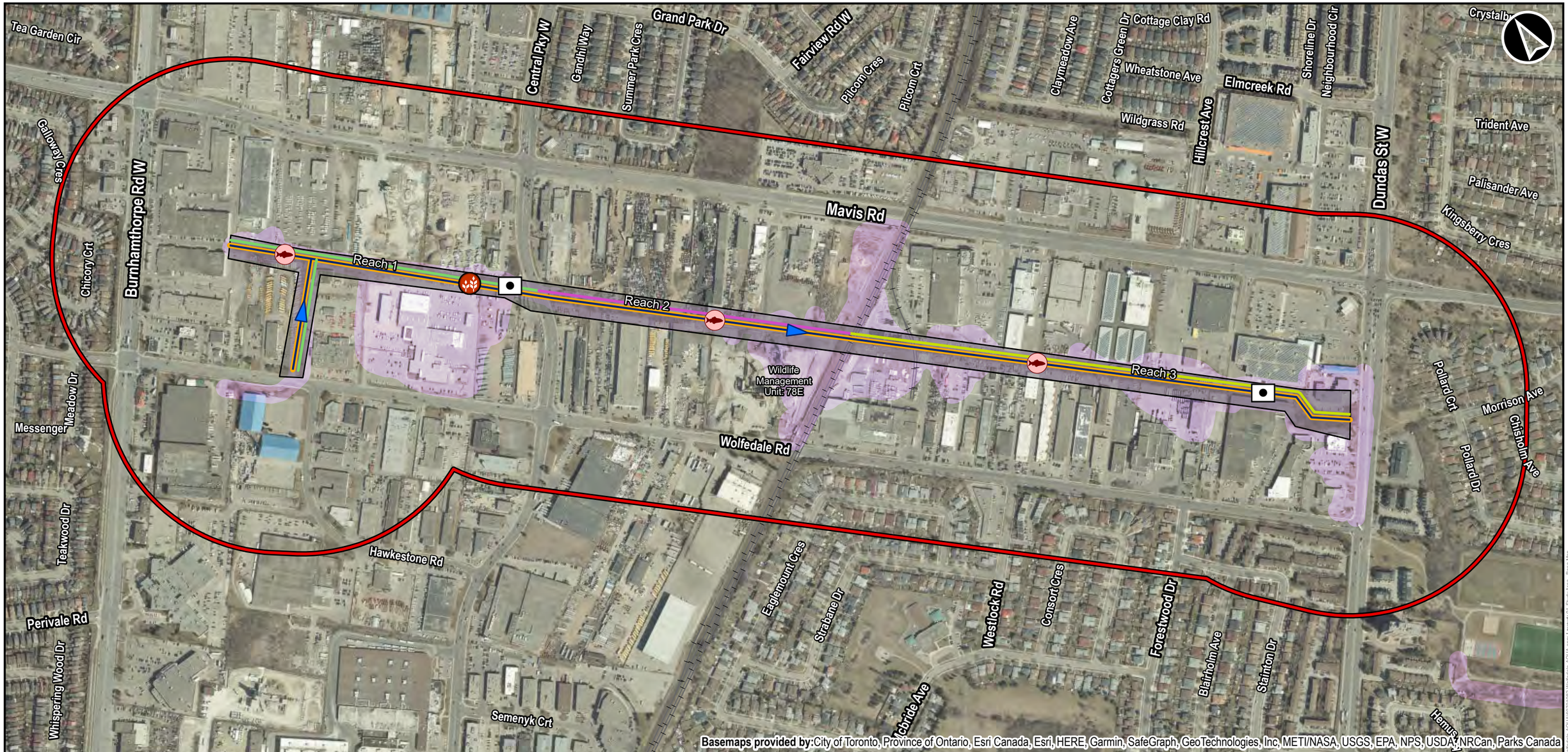
The Project Study Area for this project, which is entirely within the City of Mississauga, has been broken into two Study Areas. As previously stated, Wolfedale Creek flows to Study Area 1 from a storm sewer outlet from Burnhamthorpe Road West to Dundas Street West. From there it enters another storm sewer pipe, and the flows are conveyed underground for approximately 1.5 km before outletting just West of Stavebank Road into the second Study Area, which outlets to the Credit River. Wolfedale Creek is a channelized, permanent watercourse and has been identified as having a warmwater thermal regime (MNRF, 2023a). For the purposes of this report, since it is unlikely that fish will migrate from Study Area 2 to Study Area 1 due to the upstream migration impediments and stormwater pipes, we have referred to fish that are potentially trapped in Study Area 1 as the resident fish population.

Based on the results from the background review, Study Areas 1 and 2 have been identified as direct fish habitat for a community that consists of warmwater and a few coolwater species (MNRF, 2023a). A review of DFO aquatic SAR mapping did not identify any aquatic SAR within Wolfedale Creek (DFO 2023). Records of American eel (*Anguilla rostrata*), and Lake Sturgeon – Great Lakes Upper St. Lawrence population (*Acipenser fulvescens)* were identified in NHIC records, and Redside Dace was identified on the LIO records as potentially occurring in the vicinity of the Study Area MNRF, 2023a; MNRF 2023b). Although as there were no records of Redside Dace on the DFO aquatic SAR mapping nor NHIC, it is believed that the record of Redside Dace on the LIO database is historical. This shall be confirmed with the regulatory agencies. The background fish community data for this watercourse is summarized in **Table 4-2.**

Table 4-2: Fish Community Data within Wolfedale Creek

Common Name	Scientific Name	ESA Status	COSEWIC Status	SARA Status
American eel	*Anguilla rostrata*	**END**	**THR**	**NAR***
Blacknose Dace	*Rhinichthys obtusus*	NAR	NAR	NAR
Bluntnose Minnow	*Pimephales notatus*	NAR	NAR	NAR
Central Mudminnow	*Umbra limi*	NAR	NAR	NAR
Coho Salmon	*Oncorhynchus kisutch*	NAR	NAR	NAR
Common Shiner	*Luxilus cornutus*	NAR	NAR	NAR
Creek Chub	*Semotilus atromaculatus*	NAR	NAR	NAR
Fathead Minnow	*Pimephales promelas*	NAR	NAR	NAR
Goldfish	*Carassius auratus*	NAR	NAR	NAR
Greater Redhorse	*Moxostoma valenciennesi*	NAR	NAR	NAR
Lake Sturgeon (Great Lakes population.)	*Acipenser fulvescens*	**END**	**THR**	**NAR***
Longnose Dace	*Rhinichthys cataractae*	NAR	NAR	NAR
Mimic Shiner	*Notropis volucellus*	NAR	NAR	NAR
Pumpkinseed	*Lepomis gibbosus*	NAR	NAR	NAR
Rock Bass	*Ambloplites rupestris*	NAR	NAR	NAR
Stonecat	*Noturus flavus*	NAR	NAR	NAR
White Sucker	*Catostomus commersonii*	NAR	NAR	NAR

Sources: MNRF, 2023a; NHIC, 2022.
*Note: * Under consideration for a status change*



Legend

- Boundary Limits (300 m)
- Study Area
- Invasive Phragmites
- Impediment to Fish Passage

Reaches

- Reach 1
- Reach 2
- Reach 3

Thermal Regime

- Warm

Fish Habitat

- Resident

Flow Permanency

- Permanent
- Dirrection of Flow

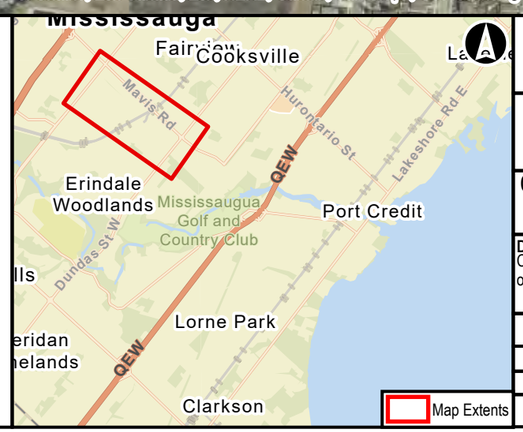
Environmentally Significant Areas

- Credit Valley Conservation Authority Regulated Area (2013)

General Features

- Ontario Railway Network (ORWN) Track

Aerial Imagery: 2021



Wolfedale Creek

Wolfedale Creek Fish and Fish Habitat-Study Area 1

0 50 100 200 300 400 500 M

NAD 1983 UTM Zone 17N

Data Sources:
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Project Location: J:\projects\60701082\Wolfedale\WolfedaleCreek\Design\01_Reports\AquaticEC\60701082-Wolfedale-AQUA-001.aprx Layout: 01-Study Area - Base Map
Date Saved: 8/16/2023 5:11 PM User: MarinoS

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

- Boundary Limits (300 m)
- Study Area
- Invasive Phragmites
- Impediment to Fish Passage

Thermal Regime

- Warm

Fish Habitat

- Direct

Flow Permanency

- Intermittent
- Permanent
- Dirrection of Flow

Environmentally Significant Areas

- Environmentally Sensitive Area
- Credit River Marshes Regional Areas of Natural and Scientific Interest
- Credit Valley Conservation Authority Regulated Area (2013)
- Credit River Marshes Provincially Significant Wetland Complex

General Features

- Primary or 400 Series Highway
- District, County, or Regional Road

Aerial Imagery: 2021

Map Extents

Wolfedale Creek

Wolfedale Creek Fish and Fish Habitat-StudyArea 2

0 50 100 200 300 M

NAD 1983 UTM Zone 17N

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AECOM

Figure: 3-2

Project Location: 13.29 kpc60701082\Workspace\Wolfedale Creek\Design\1_Reports\AquaticTC\60701082-Wolfedale-AQUA\60701082-Wolfedale-AQUA.aprx Layout: 01-Study Area - Base Map
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4.5.1 Study Area 1: Wolfedale Creek from Burnhamthorpe Road West to Dundas Street

This section of Wolfedale Creek is a channelized, presumably warmwater system that begins from a storm sewer outlet at Burnhamthorpe Road West and flows southerly for approximately 1.95 km before entering what is presumed to be another storm sewer pipe under Dundas Street West. It is probable that Study Area 1 provides habitat for resident fish. However, the likelihood of upstream migration between Study Area 2 and Study Area 1 is low. This is mainly attributed to the piped section that exists between the two study areas. The piped section creates a barrier that likely hinders the ability of fish to effectively migrate upstream, thus effectively separating the two Study Areas. Flow was low during the site visit in April 2023 and presumed to be permanent. Review of multi-season satellite imagery supports this characterization. Surrounding lands were comprised of commercial lands and municipal roads. Study Area 1 was divided into the following reaches:

- Reach 1: Burnhamthorpe Road West – Central Parkway West.
- Reach 2: Central Parkway West – Canadian Pacific Rail.
- Reach 3: Canadian Pacific Rail – Dundas Street West.

These reaches were identified based on differing natural habitat elements and differ from the reaches identified in the Fluvial Geomorphological Assessment, which were based on localized changes in geomorphological form and function. The details of the fluvial geomorphological assessment are discussed in the Fluvial Geomorphology Assessment Report (AECOM, 2023).

4.5.1.1 Reach 1: Burnhamthorpe Road West to Central Parkway West

Within the assessed reach, Wolfedale Creek is representative of a channelized system. At the time of assessment, the wetted width ranged from 1.5 to 2.0 m and the wetted depth ranged from 0.03 to 0.15 m. The average bankfull width was 3.54 m while the average bankfull depth was 0.48 m. Leaf litter and other debris were noted approximately 0.8 m above the water line at the time of inspection, indicating that the channel likely experiences high flows during storm events/ spring freshet etc. The substrates were mainly comprised of bedrock, gravel, cobble, sand, debris, and silt in order of dominance. The bedrock was exposed in numerous places along the banks and had fallen into the channel in many places. Anthropogenic debris / garbage was found throughout the reach and there were multiple instances where anthropogenic stabilization methods had failed, or partially failed and were impeding flow in the channel.

4.5.1.2 Reach 2: Central Parkway West to Canadian Pacific Rail

Within the assessed reach, Wolfedale Creek is representative of a channelized system. At the time of assessment, the wetted width ranged from 1.2 to 3.5 m and the wetted depth ranged from 0.05 to 0.15 m. The average bankfull width was 5.22 m while the average bankfull depth was 0.67 m. A few pools were present in this section, the larger of which was approximately 3.0 m long, 2.0 m wide, and roughly 1.0 m deep. The substrates were mainly comprised of bedrock, silt, sand cobble, and gravel in order of dominance. Canopy cover was approximately 30% during inspection as it was still relatively early in the year, during the summer months canopy cover is likely closer to 80% due to deciduous trees in the area. The only in-water vegetation observed was algae on some of the cobble within the watercourse. Anthropogenic debris / garbage was found throughout the reach and there were multiple debris jams within this reach. A sheen was present by the right bank approximately 70 m downstream from Central Parkway West. This sheen on the water's surface was presumed to be hydrocarbon as there was an excavator present at the top of the right bank at the time of inspection.

4.5.1.3 Reach 3: Canadian Pacific Rail to Dundas Street West

Within the assessed reach, Wolfedale Creek is representative of a channelized system. At the time of assessment, the wetted width ranged from 1.0 to 1.3 m and the wetted depth ranged from 0.1 to 0.3 m. The average bankfull width was 6.2 m while the average bankfull depth was 1.14 m. The substrates were mainly comprised of riprap, sand, cobbles, gravel, and silt in order of dominance for approximately 575 m downstream of the CP rail crossing. From approximately 575 m downstream of the CPR crossing to Dundas Street West the channel bottom was comprised of interlocking concrete blocks and the banks were entirely comprised of vertical gabion baskets that were roughly 3.0 m high. Towards Dundas Street West, sections were present where trees were growing through the gabion baskets on both banks and there were sections where it looked like the bottom gabion basket was unstable or some corrosion was present at the toe of the gabion basket with some displaced concrete blocks.

4.5.2 Study Area 2: Tributary Outlet to the Credit River South of Queensway and West of Stavebank Road

This section of Wolfedale Creek appeared more naturalized and consists of a warmwater system that outlets from a storm sewer at Stavebank Road and flows southerly for approximately 475 m before its confluence with the Credit River. Flow was moderate during the site visit in April 2023 and presumed to be permanent. Review of multi-season satellite imagery supports this characterization. Surrounding lands were comprised of residential lands, a wood lot, and municipal roads.

At the time of assessment, Study Area 2 had a run, riffle, pool morphology. The average bankfull width of the study area was 10.62 m while the average bankfull depth of the Study Area was 0.75 m. The wetted width of the run ranged from approximately 5.0 to 6.0 m and the wetted depth along the right bank was approximately 0.6 m before it dropped to an un-wadable depth, this was the deepest portion of the reach. The wetted width at the pools throughout the Study Area ranged from 1.0 to >2.5 m and the average wetted depth was 0.75 m. The wetted depth at the riffle sections ranged from 0.1 to 0.5 m. The substrates were mainly comprised of riprap/boulder, sand, silt, cobbles, gravel, and muck in order of dominance. Other than the common reed present at the downstream limits of the Study Area and some algae on the rocks throughout the reach, no aquatic vegetation was observed at the time of inspection, limiting in-stream cover to overhanging herbaceous vegetation, under cut banks, cobbles/boulders, and some overhanging woody vegetation. Approximately 50 m downstream from the Stavebank Road outlet, the gabion baskets that are protecting the outlet have begun to fail. Some of the gabion baskets have fallen over entirely while others had some signs of corrosion. Approximately 150 m downstream of the Stavebank Road outlet, angular stone debris was present throughout the channel and the channel banks had some under cutting and other minor signs of erosion. Approximately 300 m downstream from the Stavebank Road outlet, the right bank was nearly vertical and had obvious signs of erosion. Three fish passage impediments were observed between the outlet under Stavebank Road and the confluence with the Credit River. These were concrete weirs and armourstone flow dams that would likely limit fish movement upstream during low flows; however, small-bodied fish were observed throughout Study Area 2 during the field investigation.

4.6 Wildlife and Wildlife Habitat

Incidental wildlife observations and the identification of preferred wildlife habitat were documented during the confirmatory ELC field investigations. Most species observed were considered common and tolerant of urban disturbance (refer to **Table 4-3**). Chimney Swift (*Chaetura pelagica*) was the only SAR observed during field investigations in Study Area 1. Two individuals were observed foraging in the east end of Study Area 1. Additionally, Eastern Wood-pewee (*Contopus virens*) was the only SOCC recorded, which was observed singing in suitable breeding habitat in Study Area 2. SOCC and SAR are discussed further in **Sections 0** and **4.8**, respectively.

Table 4-3: Incidental Wildlife Observations

Taxon	Common Name	Scientific Name	S-Rank	COSEWIC Status	SARA Status	ESA Status	Protected under MBCA (Yes/No)	Observed in Study Area 1	Observed in Study Area 2
Amphibian	Green Frog	*Lithobates clamitans*	S5	-	-	-	No	No	Yes
Bird	American Crow	*Corvus brachyrhynchos*	S5B	-	-	-	No	Yes	Yes
Bird	American Goldfinch	*Spinus tristis*	S5B	-	-	-	Yes	Yes	Yes
Bird	American Red-start	*Setophaga ruticilla*	S5B	-	-	-	Yes	No	Yes
Bird	American Robin	*Turdus migratorius*	S5B	-	-	-	Yes	Yes	Yes
Bird	Baltimore Oriole	*Icterus galbula*	S4B	-	-	-	Yes	No	Yes
Bird	Black-capped Chickadee	*Poecile atricapillus*	S5	-	-	-	Yes	No	Yes
Bird	Blue Jay	*Cyanocitta cristata*	S5	-	-	-	No	Yes	Yes
Bird	Chimney Swift	*Chaetura pelagica*	S4B,S4N	THR	THR	THR	Yes	Yes	No
Bird	Common Grackle	*Quiscalus quiscula*	S5B	-	-	-	No	Yes	Yes
Bird	Common Yellowthroat	*Geothlypis trichas*	S5B	-	-	-	Yes	No	Yes
Bird	Cooper's Hawk	*Accipiter cooperii*	S4	NAR	-	NAR	No	No	Yes
Bird	Downy Woodpecker	*Picoides pubescens*	S5	-	-	-	Yes	No	Yes
Bird	Eastern-Wood Pewee	*Contopus virens*	S4B	SC	SC	SC	Yes	No	Yes
Bird	House Sparrow	*Passer domesticus*	SNA	-	-	-	No	Yes	No
Bird	Killdeer	*Charadrius vociferus*	S5B,S5N	-	-	-	Yes	Yes	No
Bird	Mallard	*Anas platyrhynchos*	S5	-	-	-	Yes	No	Yes
Bird	Mourning Dove	*Zenaida macroura*	S5	-	-	-	Yes	Yes	Yes
Bird	Northern Cardinal	*Cardinalis*	S5	-	-	-	Yes	Yes	Yes
Bird	Northern Flicker	*Colaptes auratus*	S4B	-	-	-	Yes	No	Yes
Bird	Red-bellied Woodpecker	*Melanerpes carolinus*	S4	-	-	-	Yes	No	Yes
Bird	Red-eyed Vireo	*Vireo olivaceus*	S5B	-	-	-	Yes	No	Yes
Bird	Red-tailed Hawk	*Buteo jamaicensis*	S5	NAR	-	NAR	No	No	Yes
Bird	Red-winged Blackbird	*Agelaius phoeniceus*	S4	-	-	-	No	Yes	Yes
Bird	Ring-billed Gull	*Larus delawarensis*	S5B,S4N	-	-	-	No	Yes	No
Bird	Rock Pigeon	*Columba livia*	SNA	-	-	-	No	Yes	No
Bird	Song Sparrow	*Melospiza melodia*	S5B	-	-	-	Yes	Yes	Yes
Bird	Yellow Warbler	*Setophaga petechia*	S5B	-	-	-	Yes	Yes	Yes
Reptile	Eastern Garter Snake	*Thamnophis sirtalis*	S5	-	-	-	No	No	Yes

Notes: 1. S4 – Apparently Secure, S5 – Secure
2. NAR: Not at Risk, SC: Special Concern, THR: Threatened

A total of 18 bird species observed were protected under the MBCA as indicated in **Table 4-3**. Although Study Area 1 has been anthropogenically disturbed and fragmented, existing vegetation still provided potential nesting opportunities for migratory birds. Isolated trees, shrubs, vegetation communities and anthropogenic structures (e.g., buildings and culverts) can provide nesting habitat for migratory birds protected under the MBCA. Study Area 2 contained more naturalized communities associated with the PSW and ANSI that likely provide habitat for many urban-tolerant species, including MBCA protected birds. Large, forested habitat within Study Area 2 was noted to contain potentially suitable nest habitat for Pileated Woodpecker *(Dryocopus pileatus*) which receives protection under Schedule 1 of the MBCA.

Study Area 2 also possessed dead and decaying trees for foraging along the creek within the Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3). As evidence of Pileated Woodpecker (i.e., foraging cavities) was not found, the entirety of the Study Area 2 was not searched. Furthermore, while evidence of Pileated Woodpecker was not identified, the potential for future nesting is present within forested communities in Study Area 2. Study Area 1 lacked suitable habitat for Pileated Woodpecker as treed habitats were highly disturbed and limited to small, fragmented strips of vegetation situated between commercial and industrial businesses. Study Area 1 also lacked dead and decaying trees for foraging. While Pileated Woodpeckers may forage in a variety of habitats, the species typically nests and roosts in mature forests that have an abundance of large trees and high crown canopies (Government of Canada, 2015; Bull & Jackson, 2011). The canopy cover[1] was between 35-60% within the Mineral Cultural Woodland (CUW1) communities in Study Area 1. Majority of trees within the CUW1 communities were relatively between 10-24 cm Diameter at Breast Height (DBH)[2]. Trees between 25-50 cm DBH were occasionally observed within CUW1 communities. Trees larger than 50 cm DBH were rare within the CUW1 communities.

The Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3) within Study Area 1 had a canopy coverage of greater than 60% and contained more trees between 25-50 cm DBH. However, trees larger than 50 cm DBH were also rare in the FOD7-3. No Pileated Woodpecker nests or foraging cavities were found within Study Area 1. Given the lack of suitable habitat in Study Area 1, it is unlikely that forested and woodland communities in Study Area 1 support nest habitat for Pileated Woodpecker.

According to the City's Natural Area Survey, the communities in Study Area 2 were some of the most extensive in the City and contained habitat for 65 species of birds, 10 species of mammals and 7 species of reptiles and amphibians (City of Mississauga, 2021b).

4.7 Significant Wildlife Habitat

SWH within Study Area 1 was limited due to the presence of anthropogenic influences (i.e., industrial and commercial properties). As mentioned in **Section 4.4**, Study Area 1 consisted of narrow cultural communities that have been continuously disturbed as evidenced by litter throughout the Study Area and high amounts of invasive species including Manitoba maple, garlic mustard and common buckthorn. Study Area 2 has also been disturbed from anthropogenic influences (i.e., residential properties, recreational activities). However, Study Area 2 contained naturalized communities comparatively to the greater urbanized landscape. A detailed SWH screening is provided in **Appendix C**. The following provides a summary of SWH identified within the Study Areas:

Study Area 1

- Seasonal concentration areas:
  - Candidate Bat Maternity Colonies within the Fresh – Moist Ash Lowland Deciduous Forest Ecosite (FOD7-2) and Mineral Cultural Woodland Ecosite (CUW1).

1. *Canopy Cover: A proportion of ground area, expressed as a percent, covered by a particular plant species, vegetation layer or plant form (Lee et al. 1998)*
2. *Diameter at Breast Height (DBH): Is a standard method of expressing the diameter of the trunk of a standing tree.*

- Habitats for the following SOCC were identified (refer to **Appendix D** for a detailed SOCC Habitat Screening):
  - Candidate habitat for Barn Swallow) on buildings.
  - Candidate habitat for Common Nighthawk on flat-topped buildings.
  - Candidate habitat for Snapping Turtle in Wolfedale Creek.
- Animal Movement Corridors
  - Amphibian Movement Corridor may be present along Wolfedale Creek watercourse and vegetation communities associated with the creek.

Study Area 2

- Seasonal concentration areas:
  - Candidate Bat Maternity Colonies within the Fresh – Moist Willow Lowland Deciduous Forest Ecosite (FOD7-3) and Dry-Fresh Sugar Maple Deciduous Forest (FOD5-3) and,
  - Candidate Turtle Wintering Areas within Wolfedale Creek and Credit River.
- Specialized Habitats of Wildlife:
  - Candidate Amphibian Breeding Habitat (Woodland) within Moist Willow Lowland Deciduous Forest Ecosite (FOD7-3).
- Habitats for the following SOCC were identified (refer to **Appendix D** for a detailed SOCC Habitat Screening):
  - Confirmed habitat for Eastern Wood-pewee within forested communities.
  - Candidate habitat for Wood Thrush within forested communities.
  - Candidate habitat for Western-chorus Frog within the Cattail Mineral Shallow Marsh (MAS2-1) and Fresh – Moist Willow Lowland Deciduous Forest Ecosite (FOD7-3).
  - Candidate habitat for Snapping Turtle and Northern Map Turtle
  - (*Graptemys geographica*) in Wolfedale Creek and Credit River.
- Animal Movement Corridors
  - Amphibian Movement Corridor may be present along Wolfedale Creek watercourse and vegetation communities associated with the creek.

4.8 Species at Risk Habitat Screening

The SAR habitat assessment and screening exercise are presented in **Appendix D**. Several candidate habitats for SAR were identified within the Study Areas. Of the 22 SAR records identified through the background review, one SAR designated as Threatened was determined to have a high potential to occur in the Study Areas. The SAR habitat assessment also determined that seven SAR designated as Endangered have medium potential to occur in the Study Areas. The remaining SAR outlined in **Appendix D** were determined to have a low potential to occur within the Study Areas due to a lack of suitable habitat.

The following SAR were determined to have a high potential to occur within the Study Areas:

- **Chimney Swift (*Chaetura pelagica*)**
  Chimney Swift is designated as Threatened under the ESA. Two individuals were observed foraging in the east end of Study Area 1. Buildings within Study Area 1 may contain suitable chimneys for breeding.
- **American eel (*Anguilla rostrata*)**
  American eel is designated as Endangered under the ESA. Records of American eel were returned for the lower section of Wolfedale Creek, by the confluence with the Credit River in Study Area 2 (MNRF, 2023a).

The following SAR were determined to have a medium potential to occur within the vegetation communities found in the Study Areas:

- **Red-headed Woodpecker (*Melanerpes erythrocephalus*)**
  Red-headed Woodpecker is designated as Endangered under the ESA. The woodland and edge of forested communities in both Study Areas may contain suitable cavity trees for nesting.
- **Bat SAR including Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tri-coloured Bat (*Perimyotis subflavus*)**
  Bat SAR are designated as Endangered under the Endangered Species Act. Candidate habitat for bat SAR was identified within the forested and woodland communities in both Study Areas. These communities may contain suitable cavity trees for bat roosting.
- **Butternut (*Juglans cinerea*) and Black ash (*Fraxinus nigra*)**
  As no individuals were identified during field investigations, the entirety of the Study Areas was not searched.

5. Proposed Project Works

The following alternative solutions were considered for the Wolfedale Creek Erosion Control Project from Burnhamthorpe Road West to the Credit River:

1. Do Nothing will be used as a base case comparison to other more viable alternatives or strategies.
2. Full replacement of failed bank protection with structural bank protection options to maintain long term erosion protection, such as reinforced soil slope walls, cast-in-place re-enforced concrete walls, or steel sheet pile. Structural grade control could include concrete weir structures. Incorporation of a natural channel design will be included to improve fish habitat and passage.
3. Full replacement of failed bank protection with non-structural bank protection options to maintain long term erosion protection, such as rock, armourstone walls, green gabion, or geogrid retaining walls. Non-structural grade control could include rock weir structures. Incorporation of a natural channel design will be included to improve fish habitat and passage.
4. A combination of both structural and non-structural bank protection and grade control structures to maintain long term erosion protection. Incorporation of a natural channel design will be included to improve fish habitat and passage.
5. Enclose the watercourse in storm sewer and landscape a trail over top.

The existing conditions as described in **Section 4** were used to evaluate the potential constraints of the proposed alternatives for the Project on the natural environment. The Natural Environment criterion used to assess the alternative solutions is as follows:

- Potential effects on terrestrial habitat and species.
- Potential effects on aquatic habitat and species.
- Potential effects on channel morphology.
- Potential effects on hydraulics and flooding impacts.
- Erosion mitigation.
- Potential effects on SAR and SAR habitat.
- Potential effects on surface water and groundwater.
- Anticipated environmental permitting and approval considerations.

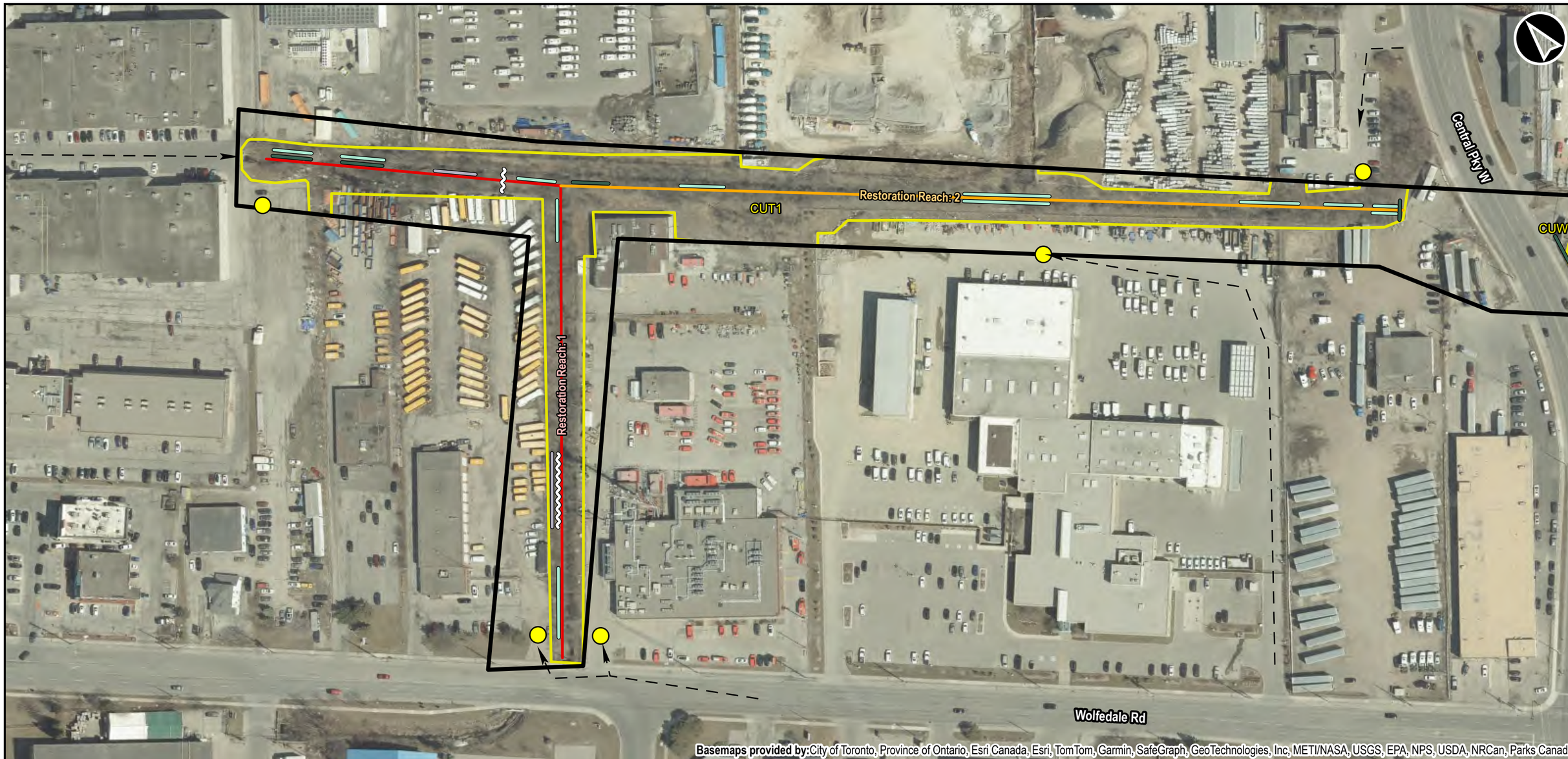
Alternative 4 (combination of both structural and non- structural bank protection) was identified as the preferred erosion control and restoration strategy. Alternative 4 was selected as there were lower impacts given the limited removal of generally low-quality riparian vegetation and wildlife habitat. Additionally, opportunities for removing non-native and invasive vegetation and re-planting the area with native species could provide an overall benefit to the natural environment.

Improvements recommended as part of the preliminary preferred solution as shown in **Figure 4** are primarily non-structural as the channel bed is degrading for the majority of the creek and armourstone could potentially lose its base support over time. The majority of erosional issues along the creek overbanks could also be addressed with non-structural measures, though in select areas co-operation with the adjacent landowners would be required to address erosional issues to address deficiencies to existing structures (for example, small section of retaining wall failing) along the property limits. As such, localized small-scale structural measures, such as retaining wall repair or

replacement, would then be implemented as required in select areas. The following construction tasks are anticipated to accommodate the proposed work:

- Establishing an access route.
- Vegetation removal.
- Isolation of the work area, and set up of a by-pass pump to maintain flows.
- Removal of existing bank protection.
- Installation of new structural or non-structural bank protection.
- Incorporate natural channel design.
- Replace the removed vegetation.
- Re-establish flows within the channel.

At the time of writing, the Project is in early stages and the extent of the proposed construction tasks are unknown. Furthermore, additional construction tasks may be proposed as the Project moves into the design stage.



Legend

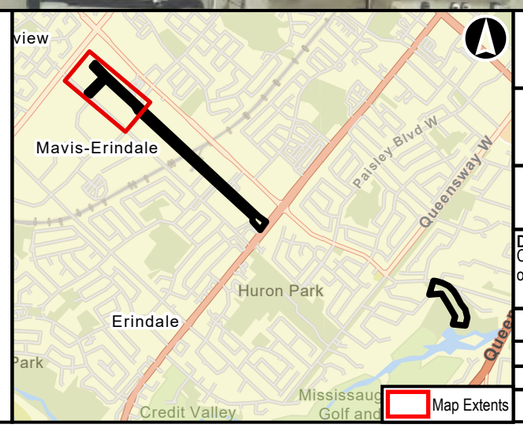
- Study Area
- ELC

ELC Code/Description

- **CUT1:** Mineral Cultural Thicket Ecosite
- **FOD7-2:** Fresh-Moist Ash Lowland Deciduous Forest
- **CUW1:** Mineral Cultural Woodland Ecosite
- **FOD7-3:** Fresh-Moist Willow Lowland Deciduous Forest
- **MAS2-1:** Cattail Mineral Shallow Marsh
- **FOD5-3:** Dry-Fresh Sugar Maple Deciduous Forest

- Potential Access Location
- Potential Access
- Potential Debris Jam Removal*
- Potential Repair Culvert / Storm Water Outlet*
- Potential Structural and /or Non-structural Bank Protection Measures*
- Potential Structural and /or Non-structural Grade Control Measures*
- Restoration Reach 1
- Restoration Reach 2
- Restoration Reach 3

Aerial Imagery: 2021



Wolfedale Creek - Natural Environment Report

Preferred Solutions

0 50 100 M

NAD 1983 UTM Zone 17N

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Figure: 4-1

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Legend

- Study Area
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- Potential Access Location
- Potential Access
- Potential Debris Jam Removal*
- Potential Repair Culvert / Storm Water Outlet*
- Potential Structural and /or Non-structural Bank Protection Measures*
- Potential Structural and /or Non-structural Grade Control Measures*
- Restoration Reach 3
- Restoration Reach 4

General Features

- Main Railway
- Spur Railway

Aerial Imagery: 2021

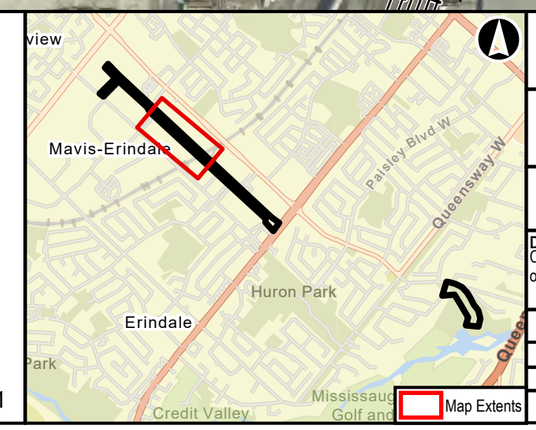

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Figure: 4-2

Legend

- Study Area
- ELC

ELC Code/Description

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- Potential Access Location
- Potential Access
- Potential Debris Jam Removal*
- Potential Repair Culvert / Storm Water Outlet*
- Potential Structural and /or Non-structural Bank Protection Measures*
- Potential Structural and /or Non-structural Grade Control Measures*
- Restoration Reach 4
- Restoration Reach 5
- Restoration Reach 6

General Features

- Spur Railway

Aerial Imagery: 2021

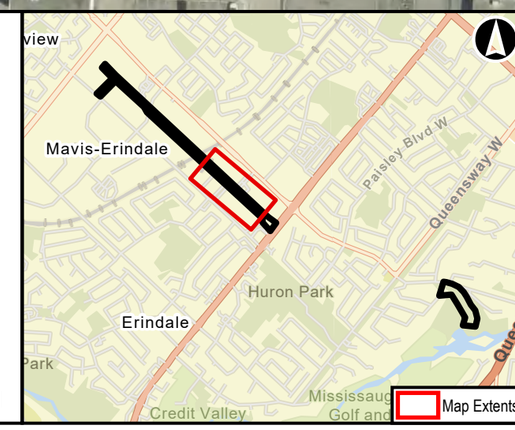

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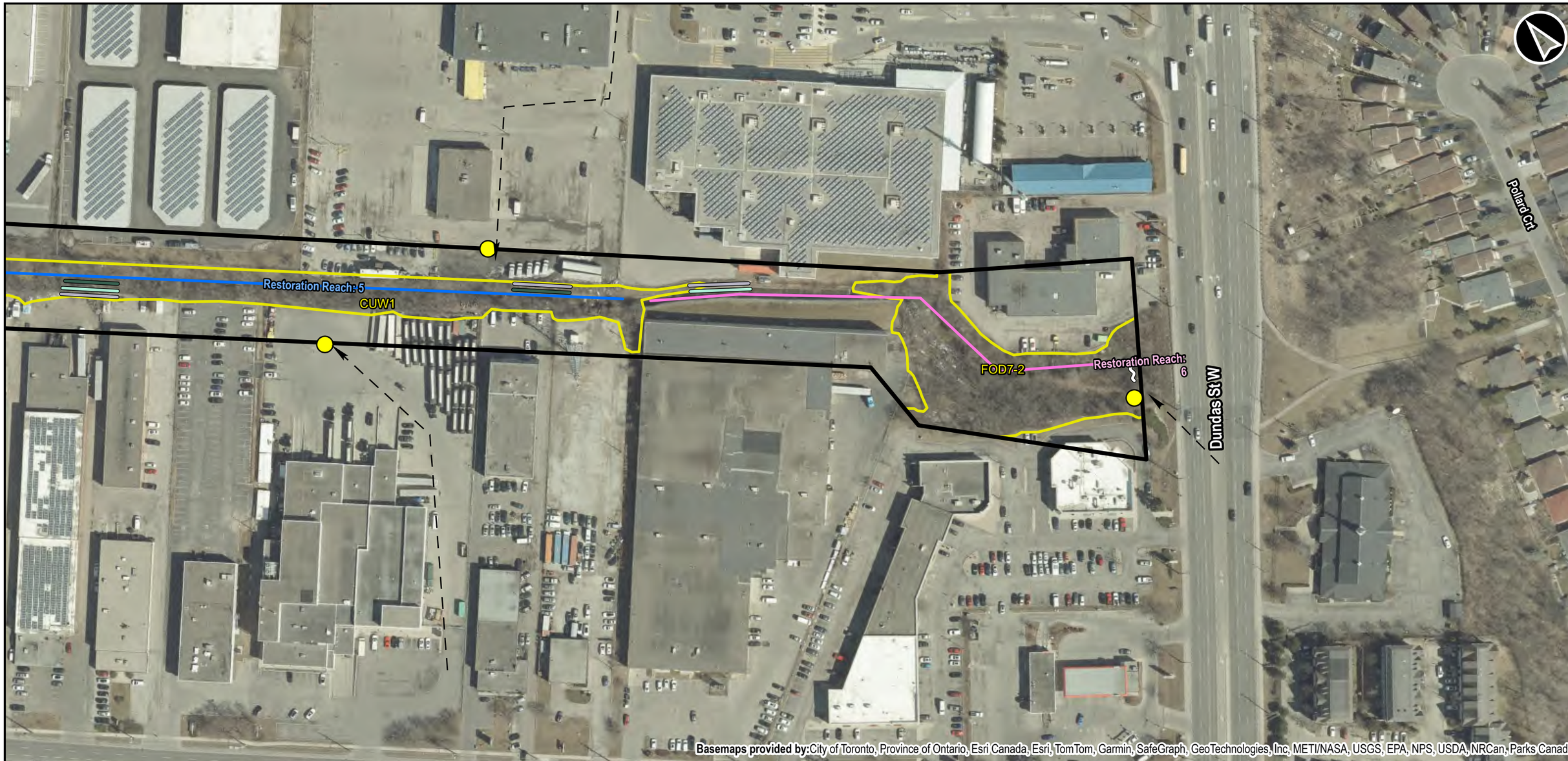
Figure: 4-3



Legend

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- ELC

ELC Code/Description

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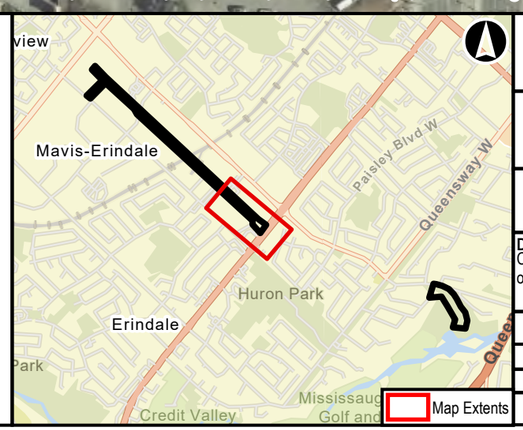
- Potential Access Location
- Potential Access
- Potential Debris Jam Removal*
- Potential Repair Culvert / Storm Water Outlet*
- Potential Structural and /or Non-structural Bank Protection Measures*
- Potential Structural and /or Non-structural Grade Control Measures*
- Restoration Reach 5
- Restoration Reach 6

Aerial Imagery: 2021



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Preferred Solutions

0 50 100 M

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Figure: 4-4

Isabella Ave
Medhat Dr
Stavebank Rd
Wolfedale Creek
Sir Richards Rd
Courrier Lane
Heartwood Crt
FOD5-3
FOD7-3
FOD5-3
MAS2-1
Restoration Reach 7
Credit River

Basemaps provided by: City of Toronto, Province of Ontario, Esri Canada, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada

Legend

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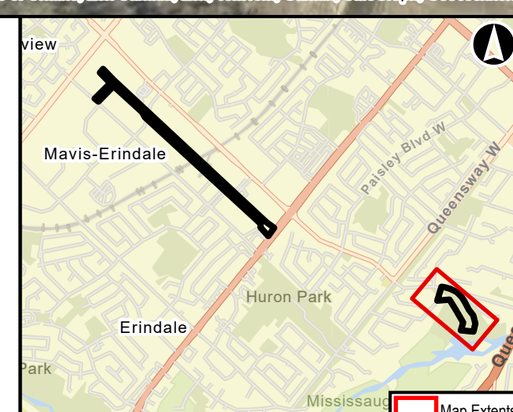
- **FOD5-3:** Dry-Fresh Sugar Maple Deciduous Forest

- Potential Access Location
- Potential Access
- Potential Structural and /or Non-structural Bank Protection Measures*
- Potential Structural and /or Non-structural Grade Control Measures*
- Restoration Reach 7

General Features

- Watercourse

Aerial Imagery: 2021



Wolfedale Creek - Natural Environment Report

Preferred Solutions

0 50 100 M
NAD 1983 UTM Zone 17N

Data Sources:
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Aug, 2024
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Rev:00

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Figure: 4-5

6. Assessment of Potential Impacts

In order to reduce any damages or disturbances to existing natural heritage features caused by the Project, potential environmental impacts from construction processes were identified. Potential impacts were identified based on the preferred solution shown in **Figure 4**. At this stage of the Project, the location of construction activities and design are unknown. The potential impacts outlined below are commonly encountered with construction. An updated impact assessment should be completed when the extent of planned activities for the Project are known during the detailed design phase.

6.1 Existing Impacts

The Study Areas contained vegetation communities within an urbanized landscape largely impacted by anthropogenic disturbances. In order to assess the potential impacts of the Project, it is necessary to consider existing impacts that are present within the Study Areas prior to the initiation of the work. Existing impacts should be documented to determine whether, following site alteration, impacts are a result of the work or a result of previous activities or events on the lands. Based on AECOM's site investigations, the following existing impacts were identified within the Study Areas:

- **Fragmentation of Vegetation and Habitat**
  Natural heritage features within the Study Area 1 and surrounding landscape have been fragmented and influenced by the construction of adjacent anthropogenic structures such as the existing railway, industrial/commercial/residential properties and major roads. Despite this, delineated vegetation communities within Study Area 1 can still provide marginal habitat and movement corridors for urban wildlife. Study Area 2 is surrounded by residential properties; however, larger naturalized vegetation communities are present and still intact with continuous naturalized habitat along the Credit River.
- **Introduction of Horticultural and Invasive Plants**
  Vegetation communities adjacent to urban areas are subject to the gradual invasion of weedy and horticultural species introduced from residential gardens, vehicle traffic and by natural dispersal. A heavy presence of non-native and invasive vegetation species such as Manitoba Maple, Norway Maple, Garlic Mustard and Common Buckthorn were recorded in the Study Areas.
- **Noise Disturbance**
  Traffic noise levels from existing transportation infrastructure are evident throughout Study Area 1 especially. This noise may cause a reduction in the species abundance or richness of birds and other wildlife inhabiting natural areas. Some species may have acclimated to the noises generated by human activities.
- **Soil and Water Contamination**
  Vegetation communities in Study Area 1 were present as narrow, disturbed strips surrounded by a railway, major roads, commercial/industrial properties and parking lots. Vegetation communities in Study Area 2 were adjacent to residential properties and roads. Road salt, oil and gas, and other deleterious substances from the railway may enter surrounding vegetation communities via runoff in the Study Areas.
- **Recreational Uses**
  Both Study Areas contained trails systems through vegetation communities. Increased foot traffic may cause disturbances to wildlife as some species may be deterred from the area, which may affect their critical behaviours such as foraging, reproduction and communication. Increased foot traffic and recreational uses may also degrade the quality of vegetation communities through the compaction of soils and the inadvertent transportation and deposition of seeds from non-native species. An accumulation of litter throughout Study Area 1 was also noted.

- **Erosion and Sedimentation**
  In many areas where the Wolfedale Creek banks were not protected by concrete, or the existing erosion protections were failing, the banks were steep and eroding. Increases in sediment input to watercourses can negatively impact aquatic habitat and water quality. Impairments to either habitat or water quality may impact the overall health of aquatic organisms and systems.
- **Barriers to Fish Passage**
  Impediments to fish passage were identified in both Study Areas. In Study Area 1, organic and woody debris, and the failing bank protection could impede fish passage. In Study Area 2 there were three impediments caused by failed bank stabilization measures or weirs structures. Under high-flow conditions it is possible that these impediments may be submerged. The largest barrier to fish passage is the approximately 1.5 km section of Wolfedale Creek that is piped from Dundas Street West to South of Queensway West and just West of Stavebank Road (**Figure 3**).

6.2 Potential Impacts of the Proposed Works

The potential environmental impacts associated with the Project were based on the project components described in **Section 5**. Potential activities associated with the Project may result in vegetation and wildlife habitat removal as well as alteration to natural heritage features such as Wolfedale Creek.

6.2.1 Long Term Impacts

Direct long-term environmental effects are defined as those impacts that result in the immediate loss of features or functions due to the implementation of the proposed Project works and that have an impact over a long period of time. An example of a direct impact would be the removal of trees or other vegetation in order to clear land for a development. However, the objective of the Project is to ensure stability of the creek and to protect and enhance natural areas impacted by the proposed works the direct impacts of the project are generally expected to be positive in nature. The potential long-term impacts associated with the undertaking are outlined below for each Study Area:

Study Area 1

- **Loss and Damage of Vegetation and Ecological Land Classification Communities, including within Policy Areas:**
  - Vegetation removal is anticipated within ELC communities that are also within CVC Regulated Areas for the access route, staging areas, installation and restoration of structural and non-structural bank protection and grade controls. The exact amount of vegetation removal is not known at this phase of the Project; however, vegetation communities were disturbed and limited to narrow strips surrounded by existing infrastructure. Impacts to connectivity between vegetation communities is not anticipated as the proposed work will occur along the Wolfedale Creek corridor and disturbed areas should be restored with native vegetation.
- **Alteration of Channel Morphology and Drainage:**
  - Replacement of failed bank protection and installation of new structural and non-structural protection can affect channel morphology and drainage. This can alter flow hydraulics impacting sediment entrainment and transport and could increase erosion potential due to loss of vegetation along channel banks.
- **Loss of Candidate SWH:**
  - Vegetation removal within the Fresh – Moist Ash Lowland Deciduous Forest Ecosite (FOD7-2) and Mineral Cultural Woodland Ecosite (CUW1) may result in loss of candidate Bat Maternity Colonies.

- Loss of candidate habitat for Barn Swallow if culverts are replaced or altered.
- Removal of old bank protection and installation of new bank protection in the Wolfedale Creek corridor may result in loss of candidate SWH for Snapping Turtle. Removal of old bank protection and installation of new bank protection in the Wolfedale Creek corridor as well as vegetation removal in ELC communities along the creek may result in loss of Amphibian Movement Corridors.

- **Loss of Candidate SAR Habitat:**
  - Vegetation removal in woodland communities and edges of forest communities may result in loss of candidate Red-headed Woodpecker habitat.
  - Vegetation removal in woodland and forest communities may result in loss of candidate habitat for bat SAR, Butternut and Black ash.

- **Loss of nests belonging to MBCA Protected Birds including MBCA Schedule 1 Protected Birds**
  - Although no nests were identified on, under or in structures likely affected by construction activities, there is potential for them to occur in the future between when field investigations were conducted and start of construction. Vegetation within the Study Area may also provide nesting habitat for protected birds. The proposed works may therefore result in the destruction of active nests if vegetation removal or culvert replacements or repairs occur during the bird nesting period of **April 1 to August 31**.

- **Loss and Damage of Public and Private Trees:**
  - Removal or injury of trees are anticipated for this Project. A separate arborist report should be produced during later stages of the Project to identify all trees that require removal, injury or preservation. The report should also identify required permitting and provide tree protection, mitigation, and compensation measures will also be described in detail in accordance with the City's Tree Protection By-laws.

- **Enhanced Habitat for Terrestrial Wildlife:**
  - Study Area 1 contained significant populations of non-native and invasive species such as common buckthorn, Norway maple and Manitoba maple. The restoration along the Wolfedale Creek corridor in Study Area 1 with native plantings is anticipated to result in an overall increase in habitat quality and diversity.

- **Enhanced Habitat for Aquatic Wildlife:**
  - The use of bank protection measures and incorporation of a natural channel design is anticipated to improve fish habitat by addressing impediments to fish passage and erosional issues along the banks.

Study Area 2

- **Loss and Damage of Vegetation and Ecological Land Classification Communities, including within Policy Areas and Designated Natural Areas**
  - Vegetation removal is anticipated within ELC communities that are also part of CVC Regulated Areas, the City's Natural Heritage System, Credit River Coastal Marsh PSW complex, Credit River Marshes Regional ANSI, Stavebank Oak Woods Environmentally Significant Area and Significant Woodlands. Impacts to connectivity between vegetation communities is not anticipated as the proposed work will occur along the Wolfedale Creek corridor and disturbed areas should be restored with native vegetation. Vegetation removal in the PSW in Study Area 2 is not anticipated for the proposed work. If vegetation removal is required adjacent to the PSW, further assessment during detailed design will be required to ensure there are no adverse effects on the PSW and its function will be retained.

- **Alteration of Channel Morphology and Drainage:**
  - Replacement of failed bank protection and installation of new structural and non-structural protection can affect channel morphology and drainage. This can alter flow hydraulics impacting sediment entrainment and transport and could increase erosion potential due to loss of vegetation along channel banks. Candidate SWH for turtle wintering and habitat for Snapping Turtle and Northern Map Turtle was identified along Wolfedale Creek in Study Area 2. SAR habitat for American eel was also identified in the lower section of Wolfedale Creek in Study Area 2.

- **Loss of Candidate SWH**
  - Vegetation removal within forested communities including the Fresh – Moist Willow Lowland Deciduous Forest Ecosite (FOD7-3) and Dry-Fresh Sugar Maple Deciduous Forest (FOD5-3) may result in loss of candidate Bat Maternity Colonies, Amphibian Breeding Habitat (Woodland), Eastern Wood-pewee, Wood Thrush and Western Chorus Frog.
  - Vegetation removal within the Cattail Mineral Shallow Marsh (MAS2-1) may result in a loss of candidate habitat for Western-chorus Frog, Snapping Turtle and Northern Map Turtle.
  - Removal of old bank protection and installation of new bank protection in the Wolfedale Creek corridor may result in in loss of candidate Turtle Wintering Areas and habitat for Snapping Turtle and Northern Map Turtle.
  - Removal of old bank protection and installation of new bank protection in the Wolfedale Creek corridor as well as vegetation removal in ELC communities along the creek may result in a loss of Amphibian Movement Corridors.

- **Loss of Confirmed SWH**
  - Vegetation removal in forested communities may result in a loss of confirmed SOCC habitat for Eastern Wood-pewee.

- **Loss of Candidate SAR Habitat**
  - Vegetation removal in woodland communities and edge of forest communities may result in a loss of candidate Red-headed Woodpecker habitat.
  - Vegetation removal in woodland and forest communities may result in loss of candidate habitat for bat SAR, Butternut and Black ash.
  - Removal of old bank protection and installation of new bank protection in the lower section of Wolfedale Creek, by the confluence with the Credit River in Study Area 2 may result in loss of American eel habitat.

- **Loss of nests belonging to MBCA Protected Birds including MBCA Schedule 1 Protected Birds**
  - Although no nests were identified on, under or in structures likely affected by construction activities, there is potential for them to occur in the future between when field investigations were conducted and start of construction. Vegetation within the Study Area may also provide nesting habitat for protected birds. The proposed works may therefore result in the destruction of active nests if vegetation removal or culvert replacements or repairs occur during the bird nesting period of **April 1 to August 31**.
  - Vegetation removal within forested communities may result in the loss of nests belonging to species listed under Schedule 1 of the MBCA (i.e., Pileated Woodpecker), which receive year-round protection.

- **Loss and Damage of Public and Private Trees:**
  - Removal or injury of trees are anticipated for this Project. A separate arborist report should be produced during later stages of the Project to identify all trees that require removal, injury or preservation. The report should also identify required permitting and provide tree protection, mitigation, and compensation measures will also be described in detail in accordance with the City's Tree Protection By-laws.

- **Enhanced Habitat for Terrestrial Wildlife:**
  - While Study Area 2 was more naturalized along the creek, significant populations of non-native and invasive species such as common reed and reed canary grass were still present. The restoration along the Wolfedale Creek corridor in Study Area 2 with native plantings is anticipated to result in an overall increase in habitat quality and diversity.
- **Enhanced Habitat for Aquatic Wildlife:**
  - The use of bank protection measures and incorporation of a natural channel design is anticipated to improve fish habitat by addressing impediments to fish passage and erosional issues along the banks.

6.2.2 Short Term Impacts

Many of the potential short-term impacts are commonly encountered with the construction phase and therefore, have associated standard mitigation measures available to minimize or avoid potential impacts. The potential short-term effects generally include the following for both Study Areas:

- **Indirect Loss and/or Damage to Vegetation Communities:**
  The possibility of incidental intrusion into the adjacent vegetation communities surrounding the vegetation removal areas may occur during construction. This may result in damage (e.g., broken limbs and damage to trunks) to trees and shrubs within adjacent natural heritage features which provide candidate habitat SWH and potential SAR habitat. Additionally, machinery use adjacent to natural heritage features can result in soil compaction and trampling of herbaceous vegetation. These impacts can limit a plant's ability to grow and absorb nutrients and water. These impacts can typically be mitigated for with the installation of tree protection fencing along the limits of work to exclude machinery and construction personnel.
- **Temporary Loss of Available Fish Habitat**
  Activities below the high-water mark in the creek will require isolation from the waterbody in order to complete the in-water work and to avoid significant negative impacts to the aquatic environment. Installation of a cofferdam and flow-bypass, and the dewatering of this isolated work area will leave the habitat, structure and cover in this isolated area inaccessible and unavailable for fish for the duration of the in-water work. General direct fish habitat was identified within the channel. In-water work will adhere to the in-water work timing window (i.e., no work between **March 15 – July 14**), which will prevent disturbance to fish during spawning, migration, and early development periods. Therefore, it will avoid such sensitive periods and will not interrupt the ability for fish to complete their life processes, including the nursery function of the habitat. However, the temporary loss of access to the habitat for feeding, refuge, cover, etc. in this area will remain.
- **Temporary Loss of Riparian and Aquatic Vegetation**
  The isolated work area below the high-water mark will be dewatered and temporarily disturbed for the duration of the in-water work. Vegetation within this area will be cut and/or compacted to facilitate construction activities. Where feasible the vegetation will be cut, but root systems will be left in place to maintain soil stability. Any aquatic vegetation present in the dewatered work area will not survive extended periods of dry conditions. However, excavation/dredging of substrate and root systems within areas of temporary disturbance should not occur and will therefore promote regrowth. There will therefore be a period of time between the removal of the isolation measures, and restoration and regrowth where there will be a reduction in riparian/overhanging vegetation and aquatic vegetation. Riparian, overhanging and aquatic vegetation provide substrate stability, overhanging cover and shade, and food, nutrient and oxygen inputs. Alterations to vegetation can also affect the amount of light penetration, water temperature, and buffering ability of riparian areas.

- **Temporary Release of Sediment**
  A cofferdam is to be used to isolate in-water work areas to prevent significant releases of sediment (among other negative impacts) to the watercourse. However, installation of the measures themselves will result in a brief release of sediment resulting from the disturbance to the fine substrate on the creek bed. Considering the substrate disturbance will be localized to the cofferdam installation area only and limited to the duration of the installation and removal, the net effects are negligible to none.

- **Sediment and Erosion**
  Clearing and grading the land for construction will require vegetation removal. This will likely result in the disturbance and exposure of soils which can result in sediment runoff discharging into nearby aquatic and terrestrial communities and an increase in dust. Deposition of sediment and dust can bury roots and herbaceous vegetation, resulting in reduced health of the trees. It can also enter the watercourse and suffocate fish and their eggs. In order to mitigate these impacts, sediment and erosion control measures including silt fencing and dust suppressants, should be implemented and maintained through construction to prevent indirect impacts on adjacent vegetation as well as the Credit River Coastal Marsh PSW complex.

- **Introduction or Spread of Invasive Species**
  As mentioned in **Section 4.4**, present vegetation communities have already been anthropogenically influenced. The Study Areas both had an abundance of non-native species, including highly invasive species such as garlic mustard, common buckthorn and Manitoba maple. Impacts are minimal given that many invasive species are already present. Vegetation clearing and grubbing or grading and movement of construction equipment may perpetuate the establishment of invasive species in new areas and further spread in already established areas if control measures are not implemented.

- **Soil and Water Contamination**
  The use of machinery and vehicles on site could result in spills or leaks of oil, gasoline, and other fluids that could enter the surrounding natural communities. These impacts can be limited and even avoided with proper machinery inspections and maintenance, as well as by establishing areas away from natural features that are dedicated to re-fuelling and storing machinery. It is recommended that the refuelling of any machinery is completed at least 30 m away from a watercourse or wetland to help prevent deleterious substances from entering the watercourse.

- **Disturbance to Wildlife, including SOCC**
  Construction activities can potentially disturb wildlife (e.g., birds, snakes, and turtles) within adjacent natural heritage features. Construction within the active season may result in wildlife collisions with construction equipment or disruption of life cycle processes (e.g., nesting, hibernating, etc.). During construction, nesting Snapping Turtles may be attracted to recently disturbed soils and exposed stockpiles to lay their eggs. Without exclusion fencing or proper stockpile management, this can lead to Snapping Turtle adult and egg mortality. Noise and vibrations from construction activities are anticipated to be temporary and are not anticipated to substantially increase from daily existing road and railway use. A certain degree of disturbance can be avoided by restricting construction activities to certain times of the day and outside of breeding periods for any bird species identified within the Study Area.

- **Disturbance or Displacement of MBCA-protected Birds, SOCC Birds and SAR Birds as well as Destruction of Their Nests**
  Vegetation communities provide breeding habitat and movement corridors for a variety of wildlife, including SAR, SOCC and/or migratory birds protected under the MBCA. Furthermore, migratory and/or SAR birds may use manmade structures (e.g., bridges and buildings) for nesting. Vegetation (i.e., trees, shrubs and ground cover) removal or structure demolition/rehabilitation has the potential to destroy migratory bird nests and eggs, which are protected under the MBCA, if conducted during the overall bird nesting period of **April 1 to August 31**.

6.3 Compensation, Restoration and Enhancement Opportunities

Compensation for the loss of vegetation and wildlife habitat or the restoration of degraded areas can provide a net benefit to the natural features and functions that contribute to an overall natural heritage system. The proposed restoration of the creek will result in vegetation removal. As previously mentioned, natural heritage features have experienced numerous impacts due to historic land uses within and adjacent to the Study Areas, including the introduction of many invasive plant species. The Project allows for the restoration of natural habitats within disturbed area, providing higher quality habitat for resident wildlife, including potential SAR and SOCC.

Fish Habitat Restoration – The proposed work is expected to improve habitat for fish. The incorporation of a natural channel design (where feasible) will improve fish habitat by allowing for a more naturally sinuous and morphologically diverse channel in the Study Areas. Particularly in Study Area 2, the improved morphology will help manage sediment in the creek as well as downstream into the Credit River. Additionally, the natural channel will provide habitat for many fish species and benthic invertebrates while also removing several impediments to upstream fish passage. The channel design should consider incorporating a riffle, pool, run morphology, a low flow channel to ensure fish passage during lower flow conditions, and habitat features such as root wads, lunkers, and keystones which can provide hydraulic diversity (micro resting areas for fish), cover, and refuge habitat for aquatic wildlife.

Ecological Restoration – Where vegetation removal is required, compensation plantings should be implemented to enhance and create higher quality habitat to the extent possible following CVC's *Plant Selection Guidelines* (2018). Furthermore, removal of invasive species and replacement with native plants as compensation can improve habitat quality within the Significant Woodlands and Environmentally Significant Area in Study Area 2. It is recommended that an Invasive Plant Control and Monitoring Plan should be developed during detailed design. The spatial extent of invasive plants such as purple loosestrife, common buckthorn and common reed within the Study Areas should be inventoried in the field. The plan should include control measures for invasive plant species, if feasible, and restoration with native wetland plants suitable to soil conditions in order to increase plant biodiversity and wildlife habitat.

Enhancement features should be considered to improve habitat quality and provide specialized habitat to support critical behaviours and life stages of a number of taxa. If bat SAR are determined to be present through future surveys, the design should also consider incorporating rocket boxes to provide suitable roosting habitat during the early successional stage of restoration as well as planting native host plants, including night-blooming flowers that will attract pollinators in the night to increase bat prey populations. Proposed tree plantings may also include species that are known to provide suitable roosting habitat for bat SAR (i.e., oak and maple species). Eco-passage opportunities should be considered where feasible. It is recommended that wildlife eco-passage design is incorporated to facilitate wildlife movement, such as an installation of a dry bench placed over the water mark integrated in the tunnel that has access to dry ground at both entrances of a culvert (MNRF, 2016).

Tree Compensation – Compensation requirements for tree removal should be discussed with the City and/or City tree by-laws as appropriate. CVC's *Ecosystem Offsetting Guidelines* (2020) should be used to determine appropriate tree replacement ratios to offset functional loss of the features in CVC's regulated areas.

7. Mitigation

At this early stage of the Project, the location and extent of planned Project activities are unknown. Mitigation measures are dependent on the extent of the planned Project activities (i.e., amount of tree/vegetation clearing). The below generally outlines standard mitigation measures. A detailed impact assessment and the provision of detailed recommendations for mitigation and compensation should be provided at the Detailed Design stage of the proposed works.

Vegetation Removal

- Avoid vegetation and tree removal to the extent possible, especially within natural heritage features and candidate SWH and SAR habitat. Natural heritage features within the Study Area include the Credit River Coastal Marsh PSW complex, the Credit River Marshes Regional ANSI and Stavebank Oak Woods Environmentally Significant Area. The design should avoid encroachment within these natural heritage features to the greatest extent possible. If work is required within 30 m of the PSW, an Environmental Impact Study, may be required to demonstrate that there will be no adverse effects on the wetland function as result of the proposed restoration works.
- Construction vehicle access should be limited to existing roadways and construction paths, where feasible.
- Construction fencing and silt fencing, where appropriate, should be installed and maintained to clearly define the construction footprint, prevent accidental damage or intrusion to adjacent vegetation communities and natural heritage features.
- Temporarily disturbed areas should be re-vegetated using non-invasive, native plantings and / or seed mix appropriate to the site conditions and adjacent vegetation communities using CVC's *Plant Selection Guideline* (2018) and *CVC's Guidelines for Designing Enhancement Plans within Setbacks and Buffers* (2023).
- If applicable, removal of ash trees, or portions of ash trees, will be carried out in compliance with the Canada Food and Inspection Agency Directive 'D-03-08: Phytosanitary Requirements to Prevent the Introduction into and Spread within Canada of the emerald ash borer, *Agrilus planipennis (Fairmaire)*. To comply with this Directive, all Ash trees requiring removal, including any wood, bark or chips, will be restricted from being transported outside of the emerald ash borer regulated areas of Canada.
- A tree inventory and an Arborist Report may be required. The tree protection measures described in the Arborist Plan should be adhered to.

Wildlife and Wildlife Habitat, including Species at Risk

- Vegetation removal timing window: Vegetation removal activities should be limited to outside of the breeding bird nesting period (**April 1 to August 31**) in all types of vegetation communities and bat active season (**April 1 to September 30**) in treed or forested communities of any given year. Other wildlife sensitive periods may need to be considered as well based on the results of field investigations to be completed during future study stages as applicable.
- If constructions activities are required during the active bird nesting period, exclusionary netting should be installed on culverts in advance of the active season in accordance with the *Best Management Practices for Excluding Barn Swallows and Chimney Swifts from Buildings and Structures* (MNRF, 2017). Additional wildlife exclusionary measures including fencing should also be implemented to prevent wildlife encounters with turtles during construction. Exclusion fencing should be installed around the work areas prior to the turtle active season (**April 1 – October 30**) to avoid turtles entering the work area. A Preclearance survey should be completed prior to the installation of exclusionary measures to ensure that turtles are not present within the area of construction, if this cannot be accommodated. Exclusion fencing type and installation should follow the *Best Management Practices for Mitigation the Effects of Roads on Amphibian and Reptile Species at Risk in Ontario* (MNRF 2016).

- Candidate SWH was identified for Bat Maternity Colonies, Amphibian Movement Corridor, Turtle Wintering Areas, Amphibian Breeding Habitat and habitat for Barn Swallow, Wood Thrush, Western Chorus Frog and Snapping Turtle. Confirmed SWH included habitat for Eastern Wood-pewee. Wildlife-specific mitigation measures to minimize effects on affected SWH may include avoiding vegetation removal within SWH, avoiding construction during the breeding bird season (**April 1 – August 31**), avoiding in-water work during the turtle brumation period (**October 31 - April 1**) and use of exclusionary measures outlined above.
- Work on watercourse banks or in Wolfedale Creek shall be carried out during the appropriate in-water work timing window of **July 15 – March 14** (i.e., no in-water work is permitted between **March 15 – July 14**).
- All stockpiled materials of soil, overburden or similar materials are to be maintained at 70 degrees or less by sloping off stockpiles to create a slot angle that will not support nesting breeding birds during the breeding bird season (**April 1 to August 31**).
- Construction personnel will be trained in ways to prevent a wildlife encounter from occurring, including the following:
  i. No personnel shall approach, feed or harass wildlife;
  ii. Food waste will be properly stored and disposed of; and
  iii. Vehicles will yield to wildlife.
- If wildlife is encountered, measures will be implemented to avoid destruction, injury, or interference with the species, and / or its habitat. For example, construction activities will cease or be reduced, and wildlife will be encouraged to move off-site and away from the construction area on its own. A qualified Biologist will be contacted to define the appropriate buffer required from wildlife or to move the wildlife to a nearby suitable habitat outside of the construction site if necessary.

Sediment and Erosion Control Fencing

- Mitigation measures should be implemented for erosion and sediment control to prevent sediment from entering neighbouring properties and natural areas during construction. The primary principles and practices associated with erosion prevention and management of sediment are to:
  - Minimize the duration of soil exposure.
  - Retain existing vegetation, where feasible.
  - Encourage re-vegetation.
  - Divert runoff away from exposed soils.
  - Keep runoff velocities low.
  - Trap sediment as close to the source as possible.
- Details of the type and placement of sediment and erosion control to be used will be outlined in an *Erosion and Sediment Control Plan* to be drafted prior to construction.

Construction Vehicle Re-fuelling Stations

- Re-fuelling stations should be located at least 30 m away from wetlands, watercourses, waterbodies, or other site drainage features.
- Re-fuelling stations should be located within a centralized location on-site.
- Re-fuelling stations should be constructed in a manner to prevent soil and/or surface and groundwater contamination from any leaks or spills.
- An emergency response kit should be made available at each re-fuelling station in case of a spill.
- All on-site crew members operating construction vehicles should be appropriately trained in handling a potential spill and have Workplace Hazardous Materials Information System (WHMIS) training.
- All chemical transfer/maintenance should be conducted within the refuelling station areas.

Soil and Water Contamination

- A Spill Prevention and Contingency Plan will be developed and adhered to. Spills will be immediately contained and cleaned up in accordance with provincial regulatory requirements and the contingency plan.
- All machinery, construction equipment and vehicles arriving on-site should be in clean condition (e.g., free of fluid leaks, soils containing seeds of plant material from invasive species) and be inspected and washed in accordance with the Clean Equipment Protocol for Industry (Halloran et al., 2013) prior to arriving and leaving the construction site in order to prevent the spread of invasive species between locations.

Monitoring during Construction

- On-site inspection will be undertaken to confirm the implementation of the mitigation measures and identify corrective actions if required. Corrective actions may include additional site maintenance and alteration of activities to minimize impacts.
- All erosion and sediment control measures should be inspected weekly, after every rainfall and significant snow melt event, and daily during periods of extended rain or snow melt.
- All damaged erosion and sediment control measures will be repaired and/or replaced within 48 hours of the inspection.

8. Anticipated Permits and Approvals

Based on the known background information and proposed works at this time, the permits and approvals that are anticipated for this project are summarized in **Table 8-1**.

Table 8-1: Anticipated Permits and Approvals

Level of Legislation	Federal Legislation	Anticipated Permit and Approval Requirements
Federal	*Fisheries Act, 1985*	A Request for Review will be required based on the in-water works associated with the proposed bank stabilization and channel rehabilitation works. DFO will determine if an Authorization is required based on their review of the Request for Review.
Federal	*Migratory Birds Convention Act, 1994*	Contravention of the MBCA is not anticipated provided vegetation removal occurs outside of the breeding bird season (**April 1** to **August 31**). While no nests belonging to species listed under Schedule 1 of the MBCA (i.e., Pileated Woodpecker) were identified, potential for Pileated Woodpecker nests may appear from year to year and could be proposed for removal. Unoccupied nests of these migratory birds, whose nests are commonly re-used from one year to the next, cannot be removed without a permit unless reported though the Abandoned Nest Registry and nest remains unoccupied for the corresponding period of time (i.e., 36 months for Pileated Woodpecker).
Provincial	*Provincial Policy Statement, 2020*	Permits to be obtained under the PPS are not anticipated; however, mitigation measures and best management practices should prevent negative impacts to SWH and the PSW. If work is proposed within 30 m of the PSW, an Environmental Impact Study may be required to ensure no adverse effects to the PSW occur as result of the proposed alternative solution.
Provincial	*Endangered Species Act, 2007*	Impacts to SAR and SAR habitat should be re-assessed during the early phases of detailed design to determine the need for additional surveys and permits. Correspondence with MECP will be required to confirm if approvals are needed under the *ESA* in relation to the records of American eel in Study Area 2.
Provincial	*Fish and Wildlife Conservation Act, 1997*	A Fish Collection Licence will be required if there is in-water works that require fish or wildlife salvage to prevent impacts to fish. A Wildlife Scientific Collector's Authorization (WSCA) for relocation of herpetofauna (amphibians and reptiles) during fish and wildlife salvages for any in-water works will be required.
Provincial	*Ontario Regulation 41/24*	Required as it relates to natural hazards in the CVC's regulated area.
Municipal	■ *The City of Mississauga Public Tree Protection By-law 0020-2022* ■ *The City of Mississauga Private Tree Protection By-law 0021-2022*	An Arborist Report should be completed and detail permits that may be required for tree removals and injuries.

9. Future Opportunities and Next Steps

The following outlines potential opportunities, constraints, and other considerations that should be assessed during future works once the selection of the preferred solution is confirmed as part of the MCEA process:

General:

- Due to the records of provincially and federally listed SAR within the Study Areas it is recommended that desktop review screening for SAR continues to be conducted during future study stages of this project since species can be added to or removed from the scheduled list of protected species under the ESA or SARA on a periodic basis.
- Regulatory agencies should also be consulted at the time of the SAR screening to confirm the potential of new SAR and the requirement for permits under the provincial ESA and/or the federal SARA.

Aquatic Environment:

- Fisheries in-water timing window: Given the warmwater classification of Wolfedale Creek, a warmwater fisheries timing window is anticipated for any in-water work. The warmwater timing window permits in-water work from **July 15 – March 14** of any given year; however, this should be confirmed with the MNRF in advance of the detailed design.
- Aquatic Habitat Assessments during future study stages should be conducted, as applicable to Project sites, to characterize and confirm existing aquatic conditions.
- Rehabilitation work will likely require review by DFO under the *Fisheries Act*, and a Request for Review should be submitted once the project moves into detailed design, prior to construction.
- Additionally, due to the presence of American eel in the Credit River, correspondence will be required with MECP to confirm approvals required under the ESA, if required.

Terrestrial Environment:

- Depending on the site of proposed works, species-specific surveys targeting SAR presence/absence may be required following MECP approved protocols and guidelines. Impacts and prescribed avoidance and mitigation measures will need to be re-assed details on the proposed access route and construction disturbance areas are identified during the detailed design phase.
- A scoped Environmental Impact Study may be required if there is work proposed within 30 m of the Credit River Coastal Marsh PSW complex and should be confirmed with the City of Mississauga.
- Recommended additional studies to be completed during detailed design that should be considered include:
  - **Study Area 1**
    - Bat and Woodpecker leaf-off cavity tree and acoustic surveys.
    - Bird nest searches under affected structures (e.g., bridges, culverts).
    - Tree inventory.
    - Updated SAR and SWH habitat screenings.
  - **Study Area 2**
    - Breeding bird surveys.
    - Nocturnal amphibian call surveys.
    - Bat and Woodpecker leaf-off cavity tree and acoustic surveys.
    - Bird nest searches under affected structures (e.g., bridges, culverts).
    - Tree inventory.

  - Wetland delineation and rare plant inventory if restoration activities are planned to occur within 30 m of the PSW.
  - Updated SAR and SWH habitat screenings.

- An Arborist Report should be completed to identify the recommended action (i.e., remove, retain, protect) for individual trees, provide compensation requirements for tree removals and identify required permits for tree removals and injuries.

10. Conclusion

This Natural Environment Report provides background and context for the Project; describes the existing environmental conditions (based on information collected through background information review and ecological field investigations); evaluates and identifies significant natural heritage features; describes the proposed work and identifies potential impacts associated with the Project.

Existing aquatic and terrestrial conditions were identified through a background review of secondary sources and field investigations for both Study Areas. The following significant features were identified within each Study Area:

- **Study Area 1**
  - CVC Authority Regulated Area.
  - The City of Mississauga Public Tree Protection By-law 0020-2022.
  - Candidate SWH for Bat Maternity Colonies, Amphibian Movement Corridors and habitat for Barn Swallow (*Hirundo rustica*) and Common Nighthawk (*Chordeiles minor*).
  - Candidate SAR habitat for Chimney Swift (*Chaetura pelagica*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Bat SAR including Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tri-coloured Bat (*Perimyotis subflavus*).
  - Butternut (*Juglans cinerea*) and black ash (*Fraxinus nigra*).
  - Fish habitat.

- **Study Area 2**
  - CVC Authority Regulated Area.
  - The City of Mississauga Public Tree Protection By-law 0020-2022.
  - Region of Peel Greenlands System.
  - City of Mississauga Natural Heritage System.
  - Credit River Coastal Marsh Provincially Significant Wetland Complex.
  - Credit Riser Marshes Regional Area of Natural and Scientific Interest.
  - Valleylands.
  - Stavebank Oak Woods Environmentally Significant Area.
  - Candidate SWH for Bat Maternity Colonies, Turtle Wintering Areas, Amphibian Breeding Habitat (Woodland), Amphibian Movement Corridors and habitat for Eastern Wood-pewee (*Contopus virens*), Wood Thrush (Hylocichla mustelina), Snapping Turtle (*Chelydra serpentina*) and Western-chorus Frog (*Pseudacris triseriata*).
  - Candidate SAR habitat for Chimney Swift (*Chaetura pelagica*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Bat SAR including Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tri-coloured Bat (*Perimyotis subflavus*), butternut (*Juglans cinerea*) and black ash (*Fraxinus nigra*).
  - Fish habitat.

The preferred solution (Alternative 4) was used for the preliminary impact assessment and recommendations for avoidance, mitigation and enhancement measures. The impact assessment should be updated during detailed design. Potential impacts from the Project may include damage and disturbance to natural heritage features, disturbance to terrestrial wildlife, including potential SAR and SOCC, increased sedimentation and erosion potential, and disturbance to aquatic species and their habitat. A preliminary impact assessment was completed based on the preferred solution. Potential impacts from the Project may include damage and disturbance to natural

heritage features, disturbance to terrestrial wildlife, including potential SAR and SOCC, increased sedimentation and erosion potential, and disturbance to aquatic species and their habitat.
Avoidance measures such as work limit restrictions designed for the Project, compliance with restriction of construction activities to outside of sensitive periods for local or significant wildlife species should be adhered to. In addition to avoidance measures, incorporation of mitigation measures such as installation of tree protection fencing, wildlife exclusion measures, erosion and sediment control measures, machinery and equipment practices, and invasive species control strategies can aid in addressing potential impacts to natural heritage features and wildlife.

Overall, the Project is anticipated to result in a benefit to the natural environment given the opportunities to remove invasive species, replant the area with native vegetation, stabilize shoreline and banks, and incorporate a natural channel design to improve fish habitat and passage.

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Appendix A

Photologs

Appendix A1. Terrestrial Photolog

Appendix A2. Aquatic Photolog

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Appendix A1. Terrestrial Photolog

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Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfdale Creek Erosion Control Study Natural Environment Report	60701082

Photo No.	Date
1	May 19, 2023

Direction Photo Taken

West

Description

FOD7-2: Fresh – Moist Ash Lowland Deciduous Forest Ecosite in Study Area 1.

Photo No.	Date
2	May 19, 2023

Direction Photo Taken

Northeast

Description

CUW1: Mineral Cultural Woodland Ecosite in Study Area 1.

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfdale Creek Erosion Control Study Natural Environment Report	60701082

Photo No.	Date
3	May 19, 2023

Direction Photo Taken

North

Description

CUT1: Mineral Cultural Thicket Ecosite in Study Area 1.

Photo No.	Date
4	May 19, 2023

Direction Photo Taken

West

Description

FOD7-3: Fresh-Moist Willow Lowland Deciduous Forest in Study Area 2.

AECOM

Photographic Log

Client Name:	Report Name	Project No.
City of Mississauga	Wolfdale Creek Erosion Control Study Natural Environment Report	60701082

Photo No.	Date
5	May 19, 2023

Direction Photo Taken

North

Description

MAS2-1: Cattail Mineral Shallow Marsh in Study Area 2.

Photo No.	Date
6	May 19, 2023

Direction Photo Taken

Northeast

Description

FOD5-3: Dry-Fresh Sugar Maple Deciduous Forest in Study Area 2

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Appendix A2. Aquatic Photolog

Photographic Log

Client Name:	Report Name	Project No.
The City of Mississauga	Wolfdale Creek Erosion Control Study	60701082

Photo 1
Study Area 1. Looking south at erosion on left bank.

Photo 2
Study Area 1. Cattail marsh surrounding culvert.

Photo 3
Study Area 1. Bedrock and failed concrete bank armouring.

Photo 4
Study Area 1. Bedrock shelf and failed concrete bank armouring. The change in elevation could cause an impediment to fish passage.

Photo 5
Study Area 1. Anthropogenically altered portion of the creek. Vertical gabion basket and concrete lattice channel bottom.

Photo 6
Study Area 1. Gabion basket weir present in the anthropogenically altered section of channel. Weir is likely an impediment to fish passage.

Photo 7 ↑
Study Area 2. Looking downstream towards from the southern extent of the Study Area towards the confluence with the Credit River.

Photo 8 ↑
Study Area 2. Evidence of recent beaver activity.

Photo 9 ↑
Study Area 2. Looking south and bank erosion on the left bank.

Photo 10 ↑
Study Area 2. Debris at top of rock weir and erosion present on the left upstream bank.

Photo 11 ↑
Study Area 2. Failing Gabion basket at the inlet from the Stavebank Rd stormwater pipe.

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Appendix B

Vascular Plant List

Appendix B: Vascular Plant List

AECOM

Botanical Name			Plant Species Information										Local Rank		Plant Form		Climate Change Vulnerability Index (CCVI)		ELC ID#:	1	2	3	4	5	6
Common Name	Scientific Name	Family	CC	CW	Native Status	Invasive (Y/N)	Tall-grass Species (Y/N)	SRANK	NRANK	GRank	COSEWIC	SARO	CVC/Peel Status (2002)	7E4	Type	Flowering Season	CCVI	CCVI Confidence	ELC Code:	FOD7-2	CUW1	CUT1	FOD7-3	MAS2-1	FOD5-3
Manitoba Maple	Acer negundo	Aceraceae	0	0	N	Y		S5	N5	G5				IC	TR					x	x	x	x		x
Norway Maple	Acer platanoides	Aceraceae		5	I	Y		SE5	NNA	GNR				IC	TR					x	x		x		x
Red Maple	Acer rubrum	Aceraceae	4	0	N	N		S5	N5	G5				C	TR										x
Sugar Maple	Acer saccharum	Aceraceae	4	3	N	N		S5	N5	G5				C	TR		LV	VH							x
(Acer rubrum X Acer saccharinum)	Acer x freemanii	Aceraceae	6	-5	N	N		SNA	NNA	GNA				hyb	TR						x		x		
Garlic Mustard	Alliaria petiolata	Brassicaceae		0	I	Y		SE5	NNA	GNR				IC	FO	Spr-Aut				x	x	x	x		x
European Black Alder	Alnus glutinosa	Betulaceae		-3	I	Y		SE4	NNA	GNR				IC	SH						x				
Canada Anemone	Anemonastrum canadense	Ranunculaceae	3	-3	N	N	Y	S5	N5	G5				C	FO	Sum							x		x
Angelica	Angelica sylvestris	Apiaceae		0	I	N		SE1	NNA	G5?				IR	FO								x		
Common Burdock	Arctium minus	Asteraceae		3	I	N		SE5	NNA	GNR				IC	FO					x					x
Jack-in-the-pulpit	Arisaema triphyllum	Araceae	5	-3	N	N		S5	N5	G5				C	FO	Spr							x		x
Canada Wild-ginger	Asarum canadense	Aristolochiaceae	6	5	N	N		S5	N5	G5				C	FO	Spr									x
Paper Birch	Betula papyrifera	Betulaceae	2	3	N	N		S5	N5	G5				C	TR										x
Smooth Brome	Bromus inermis	Poaceae		5	I	Y		SE5	NNA	G5				IC	GR						x				
Yellow Marsh Marigold	Caltha palustris	Ranunculaceae	5	-5	N	N		S5	N5	G5				C	FO	Spr							x		
Narrow-leaved Bittercress	Cardamine impatiens	Brassicaceae		0	I	Y		SE1	NNA	GNR				IR	FO								x		
Blue Cohosh	Caulophyllum thalictroides	Berberidaceae	5	5	N	N		S5	N5	G5				U	FO	Spr									x
Wild Chicory	Cichorium intybus	Asteraceae		5	I	N		SE5	NNA	GNR				IC	FO	Sum					x				
Spotted Water-hemlock	Cicuta maculata	Apiaceae	6	-5	N	N		S5	N5	G5				0	FO	Sum							x		
Broad-leaved Enchanter's Nightshade	Circaea canadensis	Onagraceae	2	3	N	N		S5	N5	G5				C	FO	Sum									x
Canada Enchanter's Nightshade	Circaea canadensis ssp. cai	Onagraceae	2	3	N	N		S5	N5	G5T5				C	FO	Sum				x					
Canada Thistle	Cirsium arvense	Asteraceae		3	I	Y		SE5	NNA	G5				IC	FO	Sum							x		
Silky Dogwood	Cornus obliqua	Cornaceae	2	-3	N	N		S5	N5	G5			rare	R	SH							x			
Grey Dogwood	Cornus racemosa	Cornaceae	2	0	N	N		S5	N5	G5				C	SH						x				
Dogwood	Cornus sericea	Cornaceae	2	-3	N	N		S5	N5	G5				C	SH	Spr				x	x	x	x		x
English Hawthorn	Crataegus monogyna	Rosaceae		3	I	Y		SE4	NNA	G5				IC	SH						x				
Orchard Grass	Dactylis glomerata	Poaceae		3	I	N		SE5	NNA	GNR				IC	GR						x		x		
Wild Carrot	Daucus carota	Apiaceae		5	I	N		SE5	NNA	GNR				IC	FO	Sum-Aut						x			
Common Teasel	Dipsacus fullonum	Dipsacaceae		3	I	Y		SE5	NNA	GNR				IC	FO	Sum				x			x		x
Hairy Willowherb	Epilobium hirsutum	Onagraceae		-3	I	Y		SE5	NNA	GNR				IC	FO										x
Field Horsetail	Equisetum arvense	Equisetaceae	0	0	N	N		S5	N5	G5				C	FE	Spr							x	x	
Yellow Trout-lily	Erythronium americanum	Liliaceae	5	5	N	N		S5	N5	G5				C	FO	Spr									x
Common Boneset	Eupatorium perfoliatum	Asteraceae	2	-3	N	N		S5	N5	G5				C	FO	Aut							x		
Large-leaved Aster	Eurybia macrophylla	Asteraceae	5	5	N	N		S5	N5	G5				C	FO	Sum-Aut				x	x	x			
American Beech	Fagus grandifolia	Fagaceae	6	3	N	N		S4	N5	G5				C	TR										x
Woodland Strawberry	Fragaria vesca	Rosaceae	4	3	N	N		S5	N5	G5				0	FO	Spr				x	x	x			x
White Ash	Fraxinus americana	Oleaceae	4	3	N	N		S4	N5	G5				C	TR										x
Red Ash	Fraxinus pennsylvanica	Oleaceae	3	-3	N	N		S4	N5	G5				C	TR					x	x	x			x
Smooth Bedstraw	Galium mollugo	Rubiaceae		5	I	Y		SE5	NNA	GNR				IU	FO							x			x
Spotted Geranium	Geranium maculatum	Geraniaceae	6	3	N	N		S5	N5	G5				C	FO	Spr							x		
Herb-Robert	Geranium robertianum	Geraniaceae	2	3	N	N		S5	N5	G5				C	FO	Spr-Aut							x		x
Yellow Avens	Geum aleppicum	Rosaceae	2	0	N	N		S5	N5	G5				X	FO	Sum				x	x				
Avens	Geum macrophyllum	Rosaceae	9	-3	N	N		S5	N5	G5				0	FO					x					
Honey Locust	Gleditsia triacanthos	Fabaceae	8	0	N	N	Y	S2?	N2?	G5				IR	TR					x	x				
Virginia Waterleaf	Hydrophyllum virginianum	Hydrophyllaceae	6	0	N	N		S5	N5	G5				C	FO	Spr							x		
Spotted Jewelweed	Impatiens capensis	Balsaminaceae	4	-3	N	N		S5	N5	G5				C	FO	Sum							x	x	
Black Walnut	Juglans nigra	Juglandaceae	5	3	N	N		S4?	N4?	G5				C	TR					x	x				
European Privet	Ligustrum vulgare	Oleaceae		3	I	Y		SE5	NNA	GNR				IU	SH					x					
Tatarian Honeysuckle	Lonicera tatarica	Caprifoliaceae		3	I	Y		SE5	NNA	GNR				IC	SH					x	x	x	x		x
Garden Bird's-foot Trefoil	Lotus corniculatus	Fabaceae		3	I	Y		SE5	NNA	GNR				IC	FO	Sum					x				
Purple Loosestrife	Lythrum salicaria	Lythraceae		-5	I	Y		SE5	NNA	G5				IC	FO	Sum							x	x	

Appendix B: Vascular Plant List

AECOM

Common Name	Scientific Name	Family	CC	CW	Native Status	Invasive (Y/N)	Tall-grass Species (Y/N)	SRANK	NRANK	GRank	COSEWIC	SARO	CVC/Peel Status (2002)	7E4	Type	Flowering Season	CCVI	CCVI Confidence	ELC Code:	FOD7-2	CUW1	CUT1	FOD7-3	MAS2-1	FOD5-3
Large False Solomon's Seal	Maianthemum racemosum	Liliaceae	4	3	N	N		S5	N5	G5				C	FO	Spr-Sum							x		
Common Apple	Malus pumila	Rosaceae		5	I	N		SE4	NNA	G5				IC	SH						x	x			
Catnip	Nepeta cataria	Lamiaceae		3	I	N		SE5	NNA	GNR				IC	FO	Sum					x				
Sensitive Fern	Onoclea sensibilis	Dryopteridaceae	4	-3	N	N		S5	N5	G5				C	FE								x		
Virginia Creeper	Parthenocissus quinquefolia	Vitaceae	6	3	N	N		S4?	N4?	G5				R	VW	Sum				x	x	x	x		x
Reed Canarygrass	Phalaris arundinacea	Poaceae	0	-3	N	Y		S5	N5	G5				C	GR					x	x	x	x	x	x
Common Timothy	Phleum pratense	Poaceae		3	I	N		SE5	NNA	GNR				IC	GR								x		
Common Reed	Phragmites australis	Poaceae	0	-3	I	Y		S4?	N5	G5				0	GR	Sum					x	x	x	x	
Eastern White Pine	Pinus strobus	Pinaceae	4	3	N	N		S5	N5	G5				C	TR		LV	VH							x
Common Plantain	Plantago major	Plantaginaceae		3	I	N		SE5	NNA	G5				IC	FO								x		
Kentucky Bluegrass	Poa pratensis	Poaceae	0	3	N	N		S5	N5	G5				0	GR					x	x	x			
Eastern Cottonwood	Populus deltoides	Salicaceae	4	0	N	N		S5	N5	G5				0	TR						x	x			
Trembling Aspen	Populus tremuloides	Salicaceae	2	0	N	N		S5	N5	G5				C	TR							x			
Shagbark Hickory	Carya ovata	Juglandaceae	6	3	N	N		S5	N5	G5				U	TR					x					
Black Cherry	Prunus serotina	Rosaceae	3	3	N	N		S5	N5	G5				C	TR										x
Chokecherry	Prunus virginiana	Rosaceae	2	3	N	N		S5	N5	G5				C	TR	Spr				x	x		x		x
Bur Oak	Quercus macrocarpa	Fagaceae	5	3	N	N		S5	N5	G5				C	TR					x	x	x	x		
Northern Red Oak	Quercus rubra	Fagaceae	6	3	N	N		S5	N5	G5				C	TR					x	x				x
Common Buttercup	Ranunculus acris	Ranunculaceae		0	I	N		SE5	NNA	G5				IC	FO								x		
Japanese Knotweed	Reynoutria japonica	Polygonaceae		3	I	Y		SE5	NNA	GNR				IC	FO	Sum				x					
European Buckthorn	Rhamnus cathartica	Rhamnaceae		0	I	Y		SE5	NNA	GNR				IC	SH	Sum				x	x	x	x		x
Staghorn Sumac	Rhus typhina	Anacardiaceae	1	3	N	N		S5	N5	G5				C	SH					x		x			
European Red Currant	Ribes rubrum	Grossulariaceae		5	I	N		SE5	NNA	G4G5				IC	SH						x				
Multiflora Rose	Rosa multiflora	Rosaceae		3	I	Y		SE5	NNA	GNR				IC	SH						x	x			
Red Raspberry	Rubus idaeus	Rosaceae	2	3	N	N		S5	N5	G5				0	SH						x	x	x		x
Curled Dock	Rumex crispus	Polygonaceae		0	I	N		SE5	NNA	GNR				IC	FO					x					
(Salix alba X Salix euxina)	Salix x fragilis	Salicaceae			I	N		SNA	NNA	GNA				hyb	TR						x	x	x		
vetch	Securigera varia	Fabaceae		5	I	Y		SE5	NNA	GNR				IC	FO								x		
Bittersweet Nightshade	Solanum dulcamara	Solanaceae		0	I	Y		SE5	NNA	GNR				IC	VW								x		
Tall Goldenrod	Solidago altissima	Asteraceae	1	3	N	N		S5	N5	G5				0	FO	Sum-Aut									x
Canada Goldenrod	Solidago canadensis	Asteraceae	1	3	N	N		S5	N5	G5				0	FO	Sum-Aut							x		x
Field Sow-thistle	Sonchus arvensis	Asteraceae		3	I	N		SE5	NNA	GNR				IC	FO						x	x			
Dandelion	Taraxacum officinale	Asteraceae		3	I	N		SE5	N5	G5				IC	FO	Spr-Aut					x	x			x
Eastern White Cedar	Thuja occidentalis	Cupressaceae	4	-3	N	N		S5	N5	G5				C	TR						x				
Basswood	Tilia americana	Tiliaceae	4	3	N	N		S5	N5	G5				C	TR						x		x		x
Poison Ivy	Toxicodendron radicans	Anacardiaceae	2	0	N	N		S5	N5	G5				0	VW	Spr					x				
White Trillium	Trillium grandiflorum	Liliaceae	5	3	N	N		S5	N5	G5				C	FO	Spr									x
Coltsfoot	Tussilago farfara	Asteraceae		3	I	Y		SE5	NNA	GNR				IC	FO	Spr					x		x		
Broad-leaved Cattail	Typha latifolia	Typhaceae	1	-5	N	N		S5	N5	G5				C	FO	Sum								x	
White Elm	Ulmus americana	Ulmaceae	3	-3	N	N		S5	N5	G4				C	TR					x	x	x	x		x
Siberian Elm	Ulmus pumila	Ulmaceae		3	I	Y		SE3	NNA	GNR				IC	TR							x	x		
Stinging Nettle	Urtica dioica	Urticaceae		0	N	N		S5	N5	G5				0	FO	Sum							x		
Common Mullein	Verbascum thapsus	Scrophulariaceae		5	I	N		SE5	NNA	GNR				IC	FO	Sum						x			
Tufted Vetch	Vicia cracca	Fabaceae		5	I	Y		SE5	NNA	GNR				IC	VI					x	x		x		x
Riverbank Grape	Vitis riparia	Vitaceae	0	0	N	N		S5	N5	G5				C	VW					x			x		x

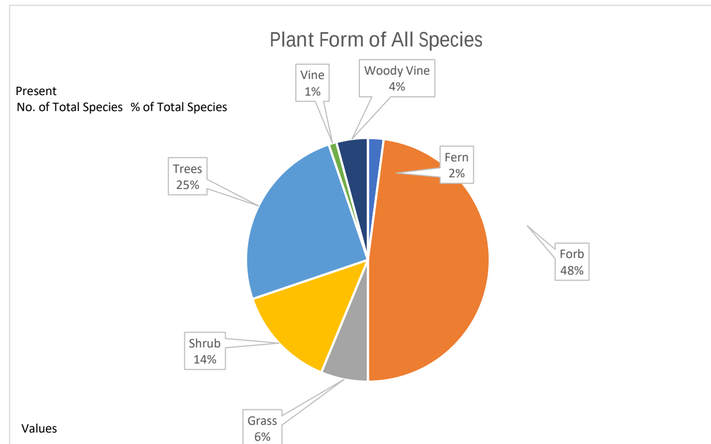
AECOM

Summary and Analysis for Entire Study Area		
Summary		
Total Species:	96	N/A
Native Species:	57	59%
Introduced Species:	39	41%
Invasive Species:	25	26%
ESA Status		
END	0	0%
THR	0	0%
SC	0	0%
COSEWIC Status		
END	0	0%
THR	0	0%
SC	0	0%
Provincially Rare (S-rank of S1-S3)		
S1	0	0%
S1?	0	0%
S1S2	0	0%
S1S3	0	0%
S2	0	0%
S2?	1	1%
S2S3	0	0%
S2S4	0	0%
S3	0	0%
S3?	0	0%
S3S4	0	0%
Total S1-S3:	**1**	**1%**
Local Rank		
None		

Co-efficient of Conservatism and Floral Quality Index			
Co-efficient of Conservatism (CC) (average):	**3.46**		
CC 0 to 3	lowest sensitivity	27	47%
CC 4 to 6	moderate sensitivity	28	49%
CC 7 to 8	high sensitivity	1	2%
CC 9 to 10	highest sensitivity	1	2%
Floral Quality Index (FQI)			
FQI:	**26.09**		
Presence of Wetland Species			
Wetness Value (CW) (average):	**1.326315789**		
upland	5	14	15%
facultative upland	2 to 4	42	44%
facultative	1 to -1	19	20%
facultative wetland	-2 to -4	15	16%
obligate wetland	-5	5	5%

Physiognomy

Plant Form	No. of Total Species	% of Total Species
Fern	2	2%
Forb	46	48%
Grass	6	6%
Shrub	13	14%
Trees	24	25%
Vine	1	1%
Woody Vine	4	4%
Grand Total	**96**	**100%**



Floristic Summary and Analysis Per ELC						
Summary						
Total Species:	30	42	28	45	6	39
Native Species:	20	22	15	25	4	29
Introduced Species:	10	20	13	20	2	10
Invasive Species:	10	14	9	16	3	10
ESA Status						
END	0	0	0	0	0	0
THR	0	0	0	0	0	0
SC	0	0	0	0	0	0
COSEWIC Status						
END	0	0	0	0	0	0
THR	0	0	0	0	0	0
SC	0	0	0	0	0	0
Provincially Rare (S-rank of S1-S3)						
S1	0	0	0	0	0	0
S1?	0	0	0	0	0	0
S1S2	0	0	0	0	0	0
S1S3	0	0	0	0	0	0
S2	0	0	0	0	0	0
S2?	1	1	0	0	0	0
S2S3	0	0	0	0	0	0
S2S4	0	0	0	0	0	0
S3	0	0	0	0	0	0
S3?	0	0	0	0	0	0
S3S4	0	0	0	0	0	0
Total S1-S3:	**1**	**1**	**0**	**0**	**0**	**0**
Local Rank						
None						

Co-efficient of Conservatism and Floral Quality Index						
Co-efficient of Conservatism (CC) (average):	**3.45**	**3.26**	**2.44**	**3.12**	**1.00**	**3.24**
CC 0 to 3	11	12	11	13	4	15
CC 4 to 6	7	10	5	12	1	14
CC 7 to 8	1	1	0	0	0	0
CC 9 to 10	1	0	0	0	0	0
Floral Quality Index (FQI)						
FQI:	**15.43**	**15.29**	**9.44**	**15.60**	**2.00**	**17.46**
Presence of Wetland Species						
Wetness Value (CW) (average):	**1.50**	**1.54**	**1.48**	**0.43**	**-3.17**	**1.85**
upland	3	7	5	3	0	6
facultative upland	15	18	11	17	0	21
facultative	7	8	5	11	1	5
facultative wetland	5	7	6	9	3	7
obligate wetland	0	1	0	4	2	0

AECOM

Appendix C

Significant Wildlife Habitat Screening

SWH Ecoregion 7E Criterion Schedule

Table 1.1 Seasonal Concentration Areas of Animals

Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Found Within the Study Area	Conclusions/ Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Waterfowl Stopover and Staging Areas (Terrestrial) **Rationale;** Habitat important to migrating waterfowl.	American Black Duck Northern Pintail Gadwall Blue-winged Teal Green-winged Teal American Wigeon Northern Shoveler Tundra Swan	• CUM1 • CUT1 • Plus evidence of annual spring flooding from melt water or run-off within these Ecosites. • Fields with waste grain in the Long Point, Rondeau, Lk. St. Clair, Grand Bend and Pt. Pelee areas may be important to Tundra Swans.	• Fields with sheet water during Spring (mid- March to May). • Fields flooding during spring melt and run-off provide important invertebrate foraging habitat for migrating waterfowl. • Agricultural fields with waste grains are commonly used by waterfowl, these are not considered SWH unless they have spring sheet water available. Information Sources • Anecdotal information from the landowner, adjacent landowners or local naturalist clubs may be good information in determining occurrence. • Reports and other information available from Conservation Authorities (CAs) • Sites documented through waterfowl planning processes (eg. EHJV implementation plan) • Field Naturalist Clubs • Ducks Unlimited Canada • Natural Heritage Information Centre (NHIC) Waterfowl Concentration Area	• Studies carried out and verified presence of an annual concentration of any listed species, evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • Any mixed species aggregations of 100Ⓔ or more individuals required. • The area of the flooded field ecosite habitat plus a 100-300m radius buffer dependant on local site conditions and adjacent land use is the significant wildlife habitat [cxlviii]. • Annual use of habitat is documented from information sources or field studies (annual use can be based on studies or determined by past surveys with species numbers and dates). • SWHMIST[cxlix] Index #7 provides development effects and mitigation measures.	**No**; • Although Cultural Thicket (CUT1) was present within the Study Area 1, the habitat is not large enough to support large numbers of waterfowl.	**No**; • Suitable habitat was not identified within the Study Areas.	• No further considerations are required.
Waterfowl Stopover and Staging Areas (Aquatic) **Rationale;** Important for local and migrant waterfowl populations during the spring or fall migration or both periods combined. Sites identified are usually only one of a few in the eco-district.	Northern Shoveler American Wigeon Gadwall Green-winged Teal Blue-winged Teal Hooded Merganser Common Merganser Lesser Scaup Greater Scaup Long-tailed Duck Surf Scoter White-winged Scoter Black Scoter Ring-necked duck Common Goldeneye Bufflehead Redhead Ruddy Duck Red-breasted Merganser Brant Canvasback Ruddy Duck	• MAS1 • MAS2 • MAS3 • SAS1 • SAM1 • SAF1 • SWD1 • SWD2 • SWD3 • SWD4 • SWD5 • SWD6 • SWD7	Information Sources • Environment Canada • Naturalist clubs often are aware of staging/stopover areas. • OMNRF Wetland Evaluations indicate presence of locally and regionally significant waterfowl staging. • Sites documented through waterfowl planning processes (eg. EHJV implementation plan) • Ducks Unlimited projects • Element occurrence specification by Nature Serve: http://www.natureserve.org • Natural Heritage Information Centre (NHIC) Waterfowl Concentration Area	• Studies carried out and verified presence of: - Aggregations of 100 Ⓔ or more of listed species for 7 daysⒺ, results in > 700 waterfowl use days. - Areas with annual staging of ruddy ducks, canvasbacks, and redheads are SWH [cxlix] - The combined area of the ELC ecosites and a 100m radius area is the SWH [cxlviii] - Wetland area and shorelines associated with sites identified within the SWHTG [cxlviii] Appendix K [cxlix] are significant wildlife habitat. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - Annual Use of Habitat is Documented from Information Sources or Field Studies (Annual can be based on completed studies or determined from past surveys with species numbers and dates recorded). - SWH MIST[cxlix] Index #7 provides development effects and mitigation measures.	**No**; • Shallow Marsh (MAS) were identified within the Study Area. Area is not large enough to support large aggregations of waterfowl.	**No**; • Suitable habitat was not identified within the Study Areas.	• No further considerations are required.

Appendix C: Significant Wildlife Habitat Screening

Natural Environmental Report – Wolfedale Creek Erosion Control Study – Schedule B Municipal Class Environmental Assessment Study

Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Found Within the Study Area	Conclusions/ Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Shorebird Migratory Stopover Area **<u>Rationale;</u>** High quality shorebird stopover habitat is extremely rare and typically has a long history of use.	Greater Yellowlegs Lesser Yellowlegs Marbled Godwit Hudsonian Godwit Black-bellied Plover American Golden-Plover Semipalmated Plover Solitary Sandpiper Spotted Sandpiper Semipalmated Sandpiper Pectoral Sandpiper White-rumped Sandpiper Baird's Sandpiper Least Sandpiper Purple Sandpiper Stilt Sandpiper Short-billed Dowitcher Red-necked Phalarope Whimbrel Ruddy Turnstone Sanderling Dunlin	• BBO1 • BBO2 • BBS1 • BBS2 • BBT1 • BBT2 • SDO1 • SDS2 • SDT1 • MAM1 • MAM2 • MAM3 • MAM4 • MAM5	• Shorelines of lakes, rivers and wetlands, including beach areas, bars and seasonally flooded, muddy and un-vegetated shoreline habitats. • Great Lakes coastal shorelines, including groynes and other forms of armour rock lakeshores, are extremely important for migratory shorebirds in May to mid-June and early July to October. Sewage treatment ponds and storm water ponds do not qualify as a SWH, <u>Information Sources</u> • Western hemisphere shorebird reserve network. • Canadian Wildlife Service (CWS) Ontario Shorebird Survey. • Bird Studies Canada • Ontario Nature • Local birders and naturalist clubs • NHIC Shorebird Migratory Concentration Area	• Studies confirming: - Presence of 3 or more of listed species and > 1000Í shorebird use days during spring or fall migration period. (shorebird use days are the accumulated number of shorebirds counted per day over the course of the fall or spring migration period) - Whimbrel stop briefly (<24hrs) during spring migration, any site with >100Í Whimbrel used for 3 years or more is significant. - The area of significant shorebird habitat includes the mapped ELC shoreline ecosites plus a 100m radius area [cxlviii] - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST[cxlix] Index #8 provides development effects and mitigation measures.	**No**; • Candidate habitat was not identified within the Study Areas.	**No**; • Suitable habitat is not present within the Study Areas.	• No further considerations are required.
Raptor Wintering Area **<u>Rationale;</u>** Sites used by multiple species, a high number of individuals and used annually are most significant	Rough-legged Hawk Red-tailed Hawk Northern Harrier American Kestrel Snowy Owl **<u>Special Concern:</u>** Short-eared Owl Bald Eagle	**<u>Hawks/Owls</u>** • Combination of ELC Community Series; need to have present one Community Series from each land class; • Forest: - FOD, FOM, FOC. • Upland: - CUM; CUT; CUS; CUW. **<u>Bald Eagle:</u>** • Forest community Series: FOD, FOM, FOC, SWD, SWM or SWC on shoreline areas adjacent to large rivers or lakes with open water (hunting areas).	• The habitat provides a combination of fields and woodlands that provide roosting, foraging and resting habitats for wintering raptors. • Raptor wintering(hawk/owl) sites need to be > 20 ha [cxlviii, cxlix] with a combination of forest and upland.[xvi, xvii, xviii, xix, xx, xxi]. • Least disturbed sites, idle/fallow or lightly grazed field/meadow (>15ha) with adjacent woodlands [cxlix] • Field area of the habitat is to be wind swept with limited snow depth or accumulation. • Eagle sites have open water and large trees and snags available for roosting. <u>Information Sources</u>: • OMNR Ecologist or Biologist • Naturalist club • Natural Heritage Information Center (NHIC) Raptor Winter Concentration Area • Data from Bird Studies Canada, most notably for Short-eared Owls. • Results of Christmas Bird Counts. • Reports and other information available from Conservation Authorities.	• Studies confirm the use of these habitats by: - One or more Short-eared Owls or; One of more Bald Eagles or; At least 10 individuals and two of listed hawk/owl species Ⓔ. - To be significant a site must be used regularly (3 in 5 years) [cxlix] for a minimum of 20 days by the above number of birdsⒺ. - The habitat area for an Eagle winter site is the shoreline forest ecosites directly adjacent to the prime hunting area Ⓔ. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST[cxlix] Index #10 and #11 provides development effects and mitigation measures.	**No**; • Forest communities greater than 20 hectares were present within Study Area 2. However, the forest is not adjacent to suitable upland habitat.	**No**; • Candidate habitat was not present within the Study Areas.	• No further considerations are required.
Bat Hibernacula **<u>Rationale;</u>** Bat hibernacula are rare habitats in all Ontario landscapes.	Big Brown Bat Tri-colored Bat	• Bat Hibernacula may be found in these ecosites: - CCR1 - CCR2 - CCA1 - CCA2 (Note: buildings are not considered to be SWH)	• Hibernacula may be found in caves, mine shafts, underground foundations and Karsts. • Active mine sites should not be considered as SWH. • The locations of bat hibernacula are relatively poorly known. <u>Information Sources</u> • OMNR for possible locations and contact for local experts • Natural Heritage Information Center (NHIC) Bat Hibernaculum • Ministry of Northern Development and Mines for location of mine shafts. • Clubs that explore caves (eg. Sierra Club) • University Biology Departments with bat experts.	• All sites with confirmed hibernating bats are SWH Ⓔ. • The area includes 200m radius around the entrance of the hibernaculum [cxlviii, ccvii, Ⓔ] for most development types and 1000m for wind farms. • Studies are to be conducted during the peak swarming period (Aug. – Sept.). Surveys should be conducted following methods outlined in the "Guideline for Wind Power Projects Potential Impacts to Bats and Bat Habitats"[ccv]. • SWH MIST[cxlix] Index #1 provides development effects and mitigation measures.	**No**; • There were no caves, mine shafts or underground foundations and karsts identified within the Study Areas.	**No**; • Candidate habitat was not present within the Study Areas.	• No further considerations are required.

Appendix C: Significant Wildlife Habitat Screening

Natural Environmental Report – Wolfedale Creek Erosion Control Study – Schedule B Municipal Class Environmental Assessment Study

Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Found Within the Study Area	Conclusions/ Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Bat Maternity Colonies **<u>Rationale;</u>** Known locations of forested bat maternity colonies is extremely rare in all Ontario landscapes.	Big Brown Bat Silver-haired Bat	• Maternity colonies considered SWH are found in forested Ecosites. • All ELC Ecosites in ELC Community Series: - FOD - FOM - SWD - SWM	• Maternity colonies can be found in tree cavities, vegetation and often in buildlings[xxii, xxv, xxvi, xxvii, xxxi] (buildings are not considered to be SWH). Maternity roosts are not found in caves and mines in Ontario[xxii]. • Maternity colonies located in Mature deciduous or mixed forest stands[ccix, ccx] with >10/ha large diameter (>25cm dbh) wildlife trees[ccvii] • Female Bats prefer wildlife tree (snags) in early stages of decay, class 1-3 [ccxiv] or class 1 or 2 [ccxii]. • Silver-haired Bats prefer older mixed or deciduous forest and form maternity colonies in tree cavities and small hollows. Older forest areas with at least 21 snags/ha are preferred[ccx] <u>Information Sources</u> • OMNR for possible locations and contact for local experts • University Biology Departments with bat experts.	• Maternity Colonies with confirmed use by; - >10 Big Brown BatsÍ - >5 Adult Female Silver-haired BatsÍ • The area of the habitat includes the entire woodland or the forest stand ELC Ecosite containing the maternity coloniesÍ. • Evaluation methods for maternity colonies should be conducted following methods outlined in the "Bats and Bat Habitats: Guidelines for Wind Power Projects""[ccv]. • SWH MIST[cxlix] Index #12 provides development effects and mitigation measures.	**Yes;** • Forested communities may support bat maternity colonies.	**Candidate;** • Forested and swamp communities may support bat maternity colonies.	• If tree removal is required in forested habitat, targeted bat surveys should be conducted to confirm presence of SWH or SAR habitat.
Turtle Wintering Areas **<u>Rationale;</u>** Generally sites are the only known sites in the area. Sites with the highest number of individuals are most significant.	Midland Painted Turtle **<u>Special Concern:</u>** Northern Map Turtle Snapping Turtle	• Snapping and Midland Painted turtles; ELC Community Classes; SW, MA, OA and SA. ELC Community Series; FEO and BOO • Northern Map Turtle - Open Water areas such as deeper rivers or streams and lakes with current can also be used as over-wintering habitat.	• For most turtles, wintering areas are in the same general area as their core habitat. Water has to be deep enough not to freeze and have soft mud substrates. • Over-wintering sites are permanent water bodies, large wetlands, and bogs or fens with adequate Dissolved Oxygen. cix, cx, cxi, cxviii • Man-made ponds such as sewage lagoons or storm water ponds should not be considered SWH. <u>Information Sources</u> • EIS studies carried out by Conservation Authorities. • Field Naturalist Clubs • OMNRF Ecologist or Biologist • Natural Heritage Information Center (NHIC)	• Presence of 5 over-wintering Midland Painted Turtles is significant. • One or more Northern Map Turtle or Snapping Turtle over-wintering within a wetland is significant. • The mapped ELC ecosite area with the over wintering turtles is the SWH. If the hibernation site is within a stream or river, the deep-water pool where the turtles are over wintering is the SWH. • Over wintering areas may be identified by searching for congregations (Basking Areas) of turtles on warm, sunny days during the fall (Sept. – Oct.) or spring (Mar. – May) [cvii]. Congregation of turtles is more common where wintering areas are limited and therefore significant [cix, cx, cxi, cxii]. • SWH MIST[cxlix] Index #28 provides development effects and mitigation measures for turtle wintering habitat.	**Yes;** • Wolfdale creek may provide overwintering habitat.	**Candidate;** • Wolfdale Creek is deep enough to support overwintering habitat in Study Area 2.	• Appropriate exclusionary fencing should be installed to prevent turtles from entering the area of construction. A Preclearance survey should be completed prior to the installation of exclusionary measures to ensure that turtles are not present within the area of construction.
Reptile Hibernaculum **<u>Rationale;</u>** Generally sites are the only known sites in the area. Sites with the highest number of individuals are most significant.	**<u>Snakes:</u>** Eastern Gartersnake Northern Watersnake Northern Red-bellied Snake Northern Brownsnake Smooth Green Snake Northern Ring-necked Snake **<u>Special Concern:</u>** Milksnake Eastern Ribbonsnake	• For all snakes, habitat may be found in any ecosite other than very wet ones. Talus, Rock Barren, Crevice and Cave, and Alvar sites may be directly related to these habitats. • Observations of congregations of snakes on sunny warm days in the spring or fall is a good indicator.	• For snakes, hibernation takes place in sites located below frost lines in burrows, rock crevices and other natural or naturalized locations. The existence of features that go below frost line; such as rock piles or slopes, old stone fences, and abandoned crumbling foundations assist in identifying candidate SWH. • Areas of broken and fissured rock are particularly valuable since they provide access to subterranean sites below the frost line[xliv, l, li, iii, cxii] . Wetlands can also be important over-wintering habitat in conifer or shrub swamps and swales, poor fens, or depressions in bedrock terrain with sparse trees or shrubs with sphagnum moss or sedge hummock ground cover. <u>Information Sources</u> • In spring, local residents or landowners may have observed the emergence of snakes on their property (e.g.old dug wells). • Reports and other information available from Conservation Authorities. • Field Naturalist Clubs • University herpetologists. • Natural Heritage Information Center (NHIC)	• Studies confirming: - Presence of snake hibernacula used by a minimum of five individuals of a snake sp. <u>or</u>; individuals of two or more snake spp. - Congregations of a minimum of five individuals of a snake sp. <u>or</u>; individuals of two or more snake spp. near potential hibernacula (eg. foundation or rocky slope) on sunny warm days in Spring (Apr/May) and Fall (Sept/Oct)Í . - <u>Note</u>: If there are Special Concern Species present, then site is SWH - <u>Note</u>: Sites for hibernation possess specific habitat parameters (e.g. temperature, humidity, etc.) and consequently are used annually, often by many of the same individuals of a local population [i.e. strong hibernation site fidelity.]. Other critical life processes (e.g. mating) often take place in close proximity to hibernacula. The feature in which the hibernacula is located plus a 30 m buffer is the SWHⒺ - SWH MIST[cxlix] Index #13 provides development effects and mitigation measures for snake hibernacula.	**Yes;** • Suitable ecosites exist within the Study Areas that may provide candidate reptile hibernacula.	**No**; • There was no habitat for Reptile Hibernaculum observed within the Study Areas.	• No further considerations are required. .

Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Found Within the Study Area	Conclusions/ Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Colonially -Nesting Bird Breeding Habitat (Bank and Cliff) **<u>Rationale;</u>** Historical use and number of nests in a colony make this habitat significant. An identified colony can be very important to local populations. All swallow population are declining in Ontario.	Cliff Swallow Northern Rough-winged Swallow (this species is not colonial but can be found in Cliff Swallow colonies).	• Eroding banks, sandy hills, borrow pits, steep slopes, and sand piles, cliff faces, bridge abutments, silos, barns (Cliff Swallows). • Habitat found in the following ecosites: - CUM1 CUT1 - CUS1 BLO1 - BLS1 BLT1 - CLO1 CLS1 - CLT1	• Any site or areas with exposed soil banks, undisturbed or naturally eroding that is not a licensed/permitted aggregate area. • Does not include man-made structures (bridges or buildings) or recently (2 years) disturbed soil areas, such as berms, embankments, soil or aggregate stockpiles. • Does not include a licensed/permitted Mineral Aggregate Operation. <u>Information Sources</u> • Reports and other information available from Conservation Authorities • Ontario Breeding Bird Atlas [ccv]. • Bird Studies Canada; *NatureCounts* http://www.birdscanada.org/birdmon/ • Field Naturalist Clubs.	• Studies confirming: - Presence of 1 or more nesting sites with 8[cxlvix] or more cliff swallow pairs and/or rough-winged swallow pairs during the breeding season. - A colony identified as SWH will include a 50m radius habitat area from the peripheral nests[ccvii] - Field surveys to observe and count swallow nests are to be completed during the breeding season (May-June). Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST[cxlix] Index #4 provides development effects and mitigation measures	**Yes**; • Eroded or undisturbed exposed soil banks may be present within the Study Areas along Wolfdale Creek.	**No**; • There were suitable eroded banks present within the Study Areas.	• No further considerations are required.
Colonially -Nesting Bird Breeding Habitat (Tree/Shrubs) **<u>Rationale;</u>** Large colonies are important to local bird population, typically sites are only known colony in area and are used annually.	Great Blue Heron Black-crowned Night-Heron Great Egret Green Heron	• SWM2 • SWM3 • SWM5 • SWM6 • SWD1 • SWD2 • SWD3 • SWD4 • SWD5 • SWD6 • SWD7 • FET1	• Nests in live or dead standing trees in wetlands, lakes, islands, and peninsulas. Shrubs and occasionally emergent vegetation may also be used. • Most nests in trees are 11 to 15 m from ground, near the top of the tree. <u>Information Sources</u> • Ontario Breeding Bird Atlas [ccv], colonial nest records. • Ontario Heronry Inventory 1991 available from Bird Studies Canada or NHIC (OMNRF). • Natural Heritage Information Center (NHIC) Mixed Wader Nesting Colony • Aerial photographs can help identify large heronries. • Reports and other information available from Conservation Authorities • MNRF District Offices. • Local naturalist clubs.	• Studies confirming: - Presence of 2Ⓔ or more active nests of Great Blue Heron or other listed species.. - The habitat extends from the edge of the colony and a minimum 300 m radius or extend of the Forest Ecosite containing the colony or any island <15.0ha with a colony is the SWH [cc, ccvii] - Confirmation of active heronries are to be achieved through site visits conducted during the nesting season (April to August) or by evidence such as the presence of fresh guano, dead young and/or eggshells - SWH MIST[cxlix] Index #5 provides development effects and mitigation measures.	**Yes**; • Swamp communities may be present within the Study Area.	**No**; • There were no nests of indicator species observed.	• No further considerations are required.
Colonially -Nesting Bird Breeding Habitat (Ground) **<u>Rationale;</u>** Colonies are important to local bird population, typically sites are only known colony in area and are used annually.	Herring Gull Great Black-backed Gull Little Gull Ring-billed Gull Common Tern Caspian Tern Brewer's Blackbird	• Any rocky island or peninsula (natural or artificial) within a lake or large river (two-lined on a 1;50,000 NTS map). • Close proximity to watercourses in open fields or pastures with scattered trees or shrubs (Brewer's Blackbird) • MAM1 – 6; • MAS1 – 3; • CUM CUT • CUS	• Nesting colonies of gulls and terns are on islands or peninsulas associated with open water or in marshy areas. • Brewers Blackbird colonies are found loosely on the ground in or in low bushes in close proximity to streams and irrigation ditches within farmlands. <u>Information Sources</u> • Ontario Breeding Bird Atlas [ccv], rare/colonial species records. • Canadian Wildlife Service • Reports and other information available from Conservation Authorities • Natural Heritage Information Center (NHIC) Colonial Waterbird Nesting Area • MNRF District Offices. • Field Naturalist Clubs.	• Studies confirming: - Presence of > 25 active nests for Herring Gulls or Ring-billed Gulls, >5 active nests for Common Tern or >2 active nests for Caspian TernⒺ. - Presence of 5 or more pairs for Brewer's BlackbirdⒺ - Any active nesting colony of one or more Little Gull, and Great Black-backed Gull is significantⒺ. - The edge of the colony and a minimum 150m radius area of habitat, or the extent of the ELC ecosites containing the colony or any island <3.0ha with a colony is the SWH [cc, ccvii] - Studies would be done during May/June when actively nesting. Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST[cxlix] Index #6 provides development effects and mitigation measures.	**No;** • There were no islands or peninsulas within the Study Areas.	**No;** • Candidate habitat is not present within the Study Areas.	• No further considerations are required.

Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Found Within the Study Area	Conclusions/ Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Migratory Butterfly Stopover Areas **<u>Rationale:</u>** Butterfly stopover areas are extremely rare habitats and are biologically important for butterfly species that migrate south for the winter.	Painted Lady Red Admiral <u>Special Concern</u> Monarch	• Combination of ELC Community Series; need to have present one Community Series from each landclass: <u>Field</u>: - CUM - CUT - CUS <u>Forest</u>: - FOC - FOD - FOM - CUP • Anecdotally, a candidate sight for butterfly stopover will have a history of butterflies being observed.	• A butterfly stopover area will be a minimum of 10 ha in size with a combination of field and forest habitat present, and will be located within 5 km of Lake Erie and Ontario cxlix. • The habitat is typically a combination of field and forest, and provides the butterflies with a location to rest prior to their long migration south xxxii, xxxiii, xxxiv, xxxv, xxxvi. • The habitat should not be disturbed, fields/meadows with an abundance of preferred nectar plants and woodland edge providing shelter are requirements for this habitat [cxlviii, cxlix]. • Stopover areas usually provide protection from the elements and are often spits of land or areas with the shortest distance to cross the Great Lakes xxxvii, xxxviii, xxxix, xl, xli. <u>Information Sources</u> • MNRF district Offices • Natural Heritage Information Center (NHIC) • Agriculture Canada in Ottawa may have list of butterfly experts. • Field Naturalist Clubs • Toronto Entomologists Association • Conservation Authorities	• Studies confirm: - The presence of Monarch Use Days (MUD) during fall migration (Aug/Oct)xliii. MUD is based on the number of days a site is used by Monarchs, multiplied by the number of individuals using the site. Numbers of butterflies can range from 100-500/dayxxxvii, significant variation can occur between years and multiple years of sampling should occur xl, xlii. - Observational studies are to be completed and need to be done frequently during the migration period to estimate MUD - MUD of >5000 **or** >3000 with the presence of Painted Ladies or Red Admiral's is to be considered significant.Ⓔ - SWH MIST cxlix Index #16 provides development effects and mitigation measures.	**No;** • Suitable forest and field ecosites are greater than 5 km from Lake Erie and Lake Ontario.	**No;** • Candidate habitat is not present within the Study Areas.	• No further considerations area required.
Landbird Migratory Stopover Areas **<u>Rationale:</u>** Sites with a high diversity of species as well as high numbers are most significant.	All migratory songbirds. Canadian Wildlife Service Ontario website: http://www.ec.gc.ca/nature/default.asp?lang=En&n=421B7A9D-1 All migrant raptors species: Ontario Ministry of Natural Resources: Fish and Wildlife Conservation Act, 1997. Schedule 7: Specially Protected Birds (Raptors)	• All Ecosites associated with these ELC Community Series: - FOC - FOM - FOD - SWC - SWM - SWD	• Woodlots need to be >5 haⒺ in size and within 5 km iv, v, vi, vii, viii, ix, x, xi, xii, xiii, xiv, xv of Lake Ontario and Erie. If woodlands are rare in an area of shoreline, woodland fragments 2-5ha can be considered for this habitat. Ⓔ • If multiple woodlands are located along the shoreline those Woodlands <2km from Lake Erie and Lake Ontario are more significant [cxlix] • Sites have a variety of habitats; forest, grassland and wetland complexes [cxlix]. • The largest sites are more significant [cxlix] • Woodlots and forest fragments are important habitats to migrating birds[ccxviii], these features located along the shore and located within 5km of Lake Erie and Lake Ontario are Candidate SWH cxlviii. <u>Information Sources</u> • Bird Studies Canada • Ontario Nature • Local birders and naturalist club • Ontario Important Bird Areas (IBA) Program	• Studies confirm: - Use of the woodlot by >200 birds/day and with >35 spp with at least 10 bird spp. recorded on at least 5 different survey datesⒺ. This abundance and diversity of migrant bird species is considered above average and significant. - Studies should be completed during spring (March to May) and fall (Aug to Oct) migration using standardized assessment techniques. Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST [cxlix] Index #9 provides development effects and mitigation measures.	**No;** • Suitable deciduous forest ecosites are present within the Study Areas but are greater than 5 km from Lake Ontario.	**No;** • Candidate habitat is not present within the Study Area.	• No further considerations required.
Deer Winter Congregation Areas **<u>Rationale:</u>** Deer movement during winter in the southern areas of Ecoregion 7E are not constrained by snow depth, however deer will annually congregate in large numbers in suitable woodlands to reduce or avoid the impacts of winter conditions [cxlviii].	White-tailed Deer	• All Forested Ecosites with these ELC Community Series; - FOC - FOM - FOD - SWC - SWM - SWD • Conifer plantations much smaller than 50 ha may also be used.	• Woodlots >100 ha in size or if large woodlots are rare in a planning area woodlots>50ha Ⓔ. • Deer movement during winter in the southern areas Ecoregion 7E are not constrained by snow depth, however deer will annually congregate in large numbers in suitable woodlands [cxlviii]. • Large woodlots > 100ha and up to 1500 ha are known to be used annually by densities of deer that range from 0.1-1.5 deer/ha [ccxxiv]. • Woodlots with high densities of deer due to artificial feeding are not significantⒺ. <u>Information Sources</u> • MNRF District Offices. • LIO/NRVIS	• Studies confirm: - Deer management is an MNRF responsibility, deer winter congregation areas considered significant will be mapped by MNRF [cxlviii]. - Use of the woodlot by white-tailed deer will be determined by MNRF, all woodlots exceeding the area criteria are significant, unless determined not to be significant by MNRFⒺ - Studies should be completed during winter (Jan/Feb) when >20cm of snow is on the ground using aerial survey techniques[ccxxiv] , ground or road surveys, or a pellet count deer density survey[ccxxv]. - SWH MIST [cxlix] Index #2 provides development effects and mitigation measures.	**No;** • No Deer Winter Congregation Areas were mapped by MNRF in the Study Areass.	**No;** • Candidate habitat is not present within the Study Areas.	• No further considerations required.

Table 1.2.1 Rare Vegetation Communities

Rare Vegetation Community	CANDIDATE SWH			CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
	ELC Ecosite Code	Habitat Description	Detailed Information and Sources	Defining Criteria			
Cliffs and Talus Slopes **Rationale;** Cliffs and Talus Slopes are extremely rare habitats in Ontario.	Any ELC Ecosite within Community Series: TAO CLO TAS CLS TAT CLT	• A Cliff is vertical to near vertical bedrock >3m in height. • A Talus Slope is rock rubble at the base of a cliff made up of coarse rocky debris	• Most cliff and talus slopes occur along the Niagara Escarpment. Information Sources • The Niagara Escarpment Commission has detailed information on location of these habitats. • OMNRF Districts • Natural Heritage Information Center (NHIC) has location information available their website • Field Naturalist Clubs • Conservation Authorities	• Confirm any ELC Vegetation Type for Cliffs or Talus Slopes [lxxviii] • SWH MIST[cxlix] Index #21 provides development effects and mitigation measures.	**No;** • Cliff or talus slope ecosites are not anticipated to be present within the Study Areas.	**No;** • Cliffs and talus slope ecosites were not observed within the Study Areas during field investigations.	• No further considerations required.
Sand Barren **Rationale;** Sand barrens are rare in Ontario and support rare species. Most Sand Barrens have been lost due to cottage development and forestry	ELC Ecosites: SBO1 SBS1 SBT1 Vegetation cover varies from patchy and barren to continuous meadow (SBO1), thicket-like (SBS1), or more closed and treed (SBT1). Tree cover always ≤ 60%.	• Sand Barrens typically are exposed sand, generally sparsely vegetated and caused by lack of moisture, periodic fires and erosion. Usually located within other types of natural habitat such as forest or savannah. Vegetation can vary from patchy and barren to tree covered but less than 60%.	• A sand barren area >0.5ha in size Ⓔ. Information Sources • OMNRF Destricts. • Natural Heritage Information Center (NHIC) has location information available on their website • Field Naturalist Clubs • Conservation Authorities	• Confirm any ELC Vegetation Type for Sand Barrens [lxxviii] • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics) Ⓔ. • SWHMIST[cxlix] Index #20 provides development effects and mitigation measures.	**No;** • Sand barren ecosites are not anticipated to be present within the Study Areas.	**No;** • Sand barren ecosites were not observed within the Study Areas during field investigations.	• No further considerations required.
Alvar **Rationale;** Alvars are extremely rare habitats in Ecoregion 7E.	ALO1 ALS1 ALT1 FOC1 FOC2 CUM2 CUS2 CUT2-1 CUW2 **Five Alvar Indicator Species:** 1)*Carex crawei* 2)*Panicum philadelphicum* 3)*Elocharis compressa* 4)*Scutellaria parvula* 5)*Trichostema brachiatum* These indicator species are very specific to Alvars within Ecoregion 7EⒺ.	• An alvar is typically a level, mostly unfractured calcareous bedrock feature with a mosaic of rock pavements and bedrock overlain by a thin veneer of soil. The hydrology of alvars is complex, with alternating periods of inundation and drought. Vegetation cover varies from sparse lichen-moss associations to grasslands and shrublands and comprising a number of characteristic or indicator plant. Undisturbed alvars can be phyto- and zoogeographically diverse, supporting many uncommon or are relict plant and animals species. Vegetation cover varies from patchy to barren with a less than 60% tree cover [lxxviii].	• An Alvar site > 0.5 ha in size [lxxv]. • Alvar is particularly rare in Ecoregion 7E where the only known sites are found in the western islands of Lake Erie.[cxcix] Information Sources • Alvars of Ontario (2000), Federation of Ontario Naturalists [lxxvi]. • Ontario Nature – Conserving Great Lakes Alvars[ccviii]. • Natural Heritage Information Center (NHIC) has location information available on their website • OMNRF Staff. • Field Naturalist Clubs. • Conservation Authorities.	• Field studies identify four of the five Ⓔ **Alvar Indicator Species** [lxxv] at a Candidate Alvar site is Significant. • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • The alvar must be in excellent condition and fit in with surrounding landscape with few conflicting land uses [lxxv]. • SWH MIST[cxlix] Index #17 provides development effects and mitigation measures.	**No;** • Alvar ecosites are not anticipated to be present within the Study Areas.	**No;** • Alvar ecosites were not observed within the Study Areas during field investigations.	• No further considerations required.

Rare Vegetation Community	CANDIDATE SWH			CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
	ELC Ecosite Code	Habitat Description	Detailed Information and Sources	Defining Criteria			
Old Growth Forest **Rationale;** Due to historic logging practices and land clearance for agriculture, old growth forest is rare in Ecoregion 7E.	Forest Community Series: FOD FOC FOM SWD SWC SWM	• Old-growth forests are characterized by heavy mortality or turnover of over-storey trees resulting in mosaic of gaps that encourage development of multi-layered canopy and an abundance of snags and downed woody debris.	• Woodland area is >0.5 ha Ⓔ. Information Sources • OMNRF Forest Resource Inventory mapping • OMNRF Districts. • Field Naturalist Clubs • Conservation Authorities • Sustainable Forestry Licence (SFL) companies will possibly know locations through field operations. • Municipal forestry departments	• Field Studies will determine: - If dominant trees species of the ecosite are >140 years old, then area containing these trees is Significant Wildlife Habitat [cxlviii]. - The forested area containing the old growth characteristics will have experienced no recognizable forestry activities (cut steps will not be present) - The area of forest ecosites combined or an eco-element within an ecosite that contain the old growth characteristics is the SWH. - Determine ELC vegetation types for the forest area containing the old growth characteristics[lxxviii]. - SWH MIST[cxlix] Index #23 provides development effects and mitigation measures.	**Yes;** • Suitable forested ecosites may be present within the Study Areas.	**No;** • Forested communities are present (e.g., FOD; FOC; SWD) within the Study Areas; however, dominate trees species were not >140 years.	• No further considerations required.
Savannah **Rationale:** Savannahs are extremely rare habitats in Ontario.	TPS1 TPS2 TPW1 TPW2 CUS2	• A Savannah is a tallgrass prairie habitat that has tree cover between 25 – 60%. • In ecoregion 7E, known Tallgrass Prairie and savannah remnants are scattered between Lake Huron and Lake Erie, near Lake St. Clair, north of and along the Lake Erie shoreline, in Brantford and in the Toronto area (north of Lake Ontario).	• No minimum size to site Ⓔ • Site must be restored or a natural site. Remnant sites such as railway right of ways are not considered to be SWH. Information Sources • Natural Heritage Information Center (NHIC) has location data available on their website. • OMNRF Districts. • Field Naturalists Clubs. • Conservation Authorities.	• Field studies confirm one or more of the Savannah indicator species listed in [lxxv] Appendix N should be present Ⓔ. Note: Savannah plant spp. list from Ecoregion 7E should be used • Area of the ELC Ecosite is the SWH· • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • SWH MIST[cxlix] Index #18 provides development effects and mitigation measures.	**No;** • Savannah ecosites are not anticipated to be present within the Study Areas.	**No;** • Savannah ecosites were not observed within the Study Areas during field investigations.	• No further considerations required.
Tallgrass Prairie **Rationale:** Tallgrass Prairies are extremely rare habitats in Ontario.	TPO1 TPO2	• A Tallgrass Prairie has ground cover dominated by prairie grasses. An open Tallgrass Prairie habitat has < 25% tree cover. • In ecoregion 7E, known Tallgrass Prairie and savannah remnants are scattered between Lake Huron and Lake Erie, near Lake St. Clair, north of and along the Lake Erie shoreline, in Brantford and in the Toronto area (north of Lake Ontario). [cc]	• No minimum size to site Ⓔ. Site must be restored or a natural site. Remnant sites such as railway right of ways are not considered to be SWH. Information Sources • OMNRF Districts. • Natural Heritage Information Center (NHIC) has location data available on their website. • Field Naturalists Clubs. • Conservation Authorities	• Field studies confirm one or more of the Prairie indicator species listed in [lxxv] Appendix N should be present Ⓔ. Note: Prairie plant spp. list from Ecoregion 7E should be used • Area of the ELC Ecosite is the SWH • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • SWH MIST[cxlix] Index #19 provides development effects and mitigation measures.	**No;** • Tallgrass prairie ecosites are not anticipated to be present within the Study Areas.	**No;** • Tallgrass prairie ecosites were not observed within the Study Areas during field investigations.	• No further considerations required.
Other Rare Vegetation Communities **Rationale:** Plant communities that often contain rare species which depend on the habitat for survival.	Provincially Rare S1, S2 and S3 vegetation communities are listed in Appendix M of the SWHTG[cxlviii] . Any ELC Ecosite Code that has a possible ELC Vegetation Type that is Provincially Rare is Candidate SWH.	• Rare Vegetation Communities may include beaches, fens, forest, marsh, barrens, dunes and swamps.	• ELC Ecosite codes that have the potential to be a rare ELC Vegetation Type as outlined in appendix M [cxlviii] • The OMNRF/NHIC will have up to date listing for rare vegetation communities. Information Sources • OMNRF Districts. • Natural Heritage Information Center (NHIC) has location data available on their website. • Field Naturalists Clubs. • Conservation Authorities	• Field studies should confirm if an ELC Vegetation Type is a rare vegetation community based on listing within Appendix M of SWHTG[cxlviii] . • Area of the ELC Vegetation Type polygon is the SWH. • SWH MIST [cxlix] Index #37 provides development effects and mitigation measures.	**Yes**; • Rare vegetation communities may be present.	**No**; • No Rare Vegetation Communities were identified.	• No further considerations required.

Table 1.2.2 Specialized Habitats of Wildlife considered SWH

Specialized Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Waterfowl Nesting Area **<u>Rationale;</u>** Important to local waterfowl populations, sites with greatest number of species and highest number of individuals are significant.	American Black Duck Northern Pintail Northern Shoveler Gadwall Blue-winged Teal Green-winged Teal Wood Duck Hooded Merganser Mallard	• All upland habitats located adjacent to these wetland ELC Ecosites are Candidate SWH: - MAS1 MAS2 - MAS3 SAS1 - SAM1 SAF1 - MAM1 MAM2 - MAM3 MAM4 - MAM5 MAM6 - SWT1 SWT2 - SWD1 SWD2 - SWD3 SWD4 **Note: includes adjacency to Provincially Significant Wetlands**	• A waterfowl nesting area extends 120 m [cxlix] from a wetland (> 0.5 ha) or a wetland (>0.5 ha) with small wetlands (<0.5ha) within 120m or a cluster of 3 or more small (<0.5 ha) wetlands within 120 m of each individual wetland where waterfowl nesting is known to occur [cxlix]. • Upland areas should be at least 120m wide so that predators such as racoons, skunks, and foxes have difficulty finding nests. • Wood Ducks and Hooded Mergansers utilize large diameter trees (>40cm dbh) in woodlands for cavity nest sites. <u>Information Sources</u> • Ducks Unlimited staff may know the locations of particularly productive nesting sites. • OMNRF Wetland Evaluations for indication of significant waterfowl nesting habitat. • Reports and other information available from Conservation Authorities	• Studies confirmed: - Presence of 3 or more nesting pairs for listed species excluding Mallards Ⓔ , or; - Presence of 10 or more nesting pairs for listed species including Mallards Ⓔ - Any active nesting site of an American Black Duck is considered significant. - Nesting studies should be completed during the spring breeding season (April - June). Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - A field study confirming waterfowl nesting habitat will determine the boundary of the waterfowl nesting habitat for the SWH, this may be greater or less than 120 m [cxlviii] from the wetland and will provide enough habitat for waterfowl to successfully nest. - SWH MIST[cxlix] Index #25 provides development effects and mitigation measures.	**No**; • Suitable upland habitat adjacent to wetland habitat was not present in the Study Areas.	**No**; • Suitable candidate habitat was not identified within the Study Area. Size of wetland and distance of upland habitat does not meet criteria.	• No further considerations required.
Bald Eagle and Osprey Nesting, Foraging and Perching Habitat **<u>Rationale;</u>** Nest sites are fairly uncommon in Ecoregion 7E and are used annually by these species. Many suitable nesting locations may be lost due to increasing shoreline development pressures and scarcity of habitat.	Osprey **Special Concern** Bald Eagle	• ELC Forest Community Series: FOD, FOM, FOC, SWD, SWM and SWC directly adjacent to riparian areas – rivers, lakes, ponds and wetlands	• Nests are associated with lakes, ponds, rivers or wetlands along forested shorelines, islands, or on structures over water. • Osprey nests are usually at the top a tree whereas Bald Eagle nests are typically in super canopy trees in a notch within the tree's canopy. • Nests located on man-made objects are not to be included as SWH (e.g. telephone poles and constructed nesting platforms). <u>Information Sources</u> • Natural Heritage Information Center (NHIC) compiles all known nesting sites for Bald Eagles in Ontario. • MNRF values information (LIO/NRVIS) will list known nesting locations, Note: data from NRVIS is provided as a point and does not represent all the habitat. • Nature Counts, Ontario Nest Records Scheme data. • OMNRF Districts. • Check the Ontario Breeding Bird Atlas [ccv] or Rare Breeding Birds in Ontario for species documented • Reports and other information available from Conservation Authorities • Field naturalist Clubs	• Studies confirm the use of these nests by: - One or more active Osprey or Bald Eagle nests in an area[cxlviii] . - Some species have more than one nest in a given area and priority is given to the primary nest with alternate nests included within the area of the SWH. - For an Osprey, the active nest and a 300 m radius around the nest or the contiguous woodland stand is the SWH [ccvii], maintaining undisturbed shorelines with large trees within this area is important[cxlviii]. - For a Bald Eagle the active nest and a 400-800 m radius around the nest is the SWH. [cvi, ccvii] Area of the habitat from 400-800m is dependant on site lines from the nest to the development and inclusion of perching and foraging habitat [cvi] - To be significant a site must be used annually. When found inactive, the site must be known to be inactive for <u>></u> 3 years or suspected of not being used for >5 years before being considered not significant. [ccvii] - Observational studies to determine nest site use, perching sites and foraging areas need to be done from mid March to mid August. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST[cxlix] Index #26 provides development effects and mitigation measures	**Candidate**; • Forested communities adjacent to Wolfdale Creek in Study Area 2 may provide suitable habitat.	**No**; • No nests or indicator species were not observed during site investigations.	• No further considerations required.

Appendix C: Significant Wildlife Habitat Screening

Natural Environmental Report – Wolfedale Creek Erosion Control Study – Schedule B Municipal Class Environmental Assessment Study

Specialized Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Woodland Raptor Nesting Habitat **<u>Rationale:</u>** Nests sites for these species are rarely identified; these area sensitive habitats are often used annually by these species.	Northern Goshawk Cooper's Hawk Sharp-shinned Hawk Red-shouldered Hawk Barred Owl Broad-winged Hawk	• May be found in all forested ELC Ecosites. • May also be found in SWC, SWM, SWD and CUP3	• All natural or conifer plantation woodland/forest stands combined >30ha or with >4 ha of interior habitat [lxxxviiii, lxxxix, xc, xci, xciii, xciv, xcv,xcvi, cxxxiii]. Interior habitat determined with a 200m buffer[cxlviii] • Stick nests found in a variety of intermediate-aged to mature conifer, deciduous or mixed forests within tops or crotches of trees. Species such as Coopers hawk nest along forest edges sometimes on peninsulas or small off-shore islands. • In disturbed sites, nests may be used again, or a new nest will be in close proximity to old nest. <u>Information Sources</u> • OMNRF Districts. • Check the Ontario Breeding Bird Atlas [ccv] or Rare Breeding Birds in Ontario for species documented. • Check data from Bird Studies Canada. • Reports and other information available from Conservation Authorities	• Studies confirm: - Presence of 1 or more active nests from species list is considered significant[cxlviii]. - Red-shouldered Hawk and Northern Goshawk – A 400m radius around the nest or 28 ha habitat area would be applied where optimal habitat is irregularly shaped around the nest) [ccvii]. - Barred Owl – A 200m radius around the nest is the SWH [ccvii]. - Broad-winged Hawk and Coopers Hawk,– A 100m radius around the nest is the SWH[ccvii]. - Sharp-Shinned Hawk – A 50m radius around the nest is the SWH[ccvii]. - Conduct field investigations from mid-March to end of May. The use of call broadcasts can help in locating territorial (courting/ nesting) raptors and facilitate the discovery of nests by narrowing down the search area. - SWH MIST[cxlix] Index #27 provides development effects and mitigation measures.	**No;** • Forest communities do not meet size criteria.	**No;** Forest communities do does not meet size criteria.	• None required
Turtle Nesting Areas **<u>Rationale;</u>** These habitats are rare and when identified will often be the only breeding site for local populations of turtles.	Midland Painted Turtle <u>Special Concern Species</u> Northern Map Turtle Snapping Turtle	• Exposed mineral soil (sand or gravel) areas adjacent (<100m) [cxlviii] or within the following ELC Ecosites: - MAS1 - MAS2 - MAS3 - SAS1 - SAM1 - SAF1 - BOO1 - FEO1	• Best nesting habitat for turtles are close to water and away from roads and sites less prone to loss of eggs by predation from skunks, raccoons or other animals. • For an area to function as a turtle-nesting area, it must provide sand and gravel that turtles are able to dig in and are located in open, sunny areas. Nesting areas on the sides of municipal or provincial road embankments and shoulders are not SWH. • Sand and gravel beaches adjacent to undisturbed shallow weedy areas of marshes, lakes, and rivers are most frequently used. <u>Information Sources</u> • Use Ontario Soil Survey reports and maps to help find suitable substrate for nesting turtles (well-drained sands and fine gravels). • Check the Ontario Herpetofaunal Atlas records (or other similar atlases) for uncommon turtles; location information may help to find potential nesting habitat for them. • Natural Heritage Information Center (NHIC) • Field Naturalist Clubs	• Studies confirm: - Presence of 5 or more nesting Midland Painted Turtles Ⓔ - One or more Northern Map Turtle or Snapping Turtle nesting is a SWH Ⓔ. - The area or collection of sites within an area of exposed mineral soils where the turtles nest, plus a radius of 30-100m around the nesting area dependant on slope, riparian vegetation and adjacent land use is the SWH.[cxlviii] - Travel routes from wetland to nesting area are to be considered within the SWH as a part of the 30-100m area of habitat. [cxlix] - Field investigations should be conducted in prime nesting season typically late spring to early summer. Observational studies observing the turtles nesting is a recommended method. - SWH MIST [cxlix] Index #28 provides development effects and mitigation measures for turtle nesting habitat.	**Yes**; • Suitable gravelly and sandy substrate may be present to support nesting habitat.	**No;** • No suitable nesting habitat identified.	• No further considerations required.
Seeps and Springs **<u>Rationale;</u>** Seeps/Springs are typical of headwater areas and are often at the source of coldwater streams.	Wild Turkey Ruffed Grouse Spruce Grouse White-tailed Deer Salamander spp.	• Seeps/Springs are areas where ground water comes to the surface. Often they are found within headwater areas within forested habitats. Any forested Ecosite within the headwater areas of a stream could have seeps/springs.	• Any forested area (with <25% meadow/field/pasture) within the headwaters of a stream or river system [cxvii, cxlix]. • Seeps and springs are important feeding and drinking areas especially in the winter will typically support a variety of plant and animal species [cxix, cxx, cxxi, cxxii, cxiii, cxiv]. <u>Information Sources</u> • Topographical Map. • Thermography. • Hydrological surveys conducted by Conservation Authorities and MOE. • Field Naturalists Clubs and landowners. • Municipalities and Conservation Authorities may have drainage maps and headwater areas mapped.	• Field Studies confirm: - Presence of a site with 2 or more Ⓔ seeps/springs should be considered SWH. - The area of a ELC forest ecosite or ecoelement within ecosite containing the seeps/springs is the SWH. The protection of the recharge area considering the slope, vegetation, height of trees and groundwater condition need to be considered in delineation the habitat [cxlviii]. - SWH MIST [cxlix] Index #30 provides development effects and mitigation measures	**Yes**; • Forest habitats within the Study Areas may contain seeps and springs.	**No**; • SWH was not identified.	• No further considerations required.

Specialized Wildlife Habitat	Wildlife Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
		ELC Ecosite Codes	Habitat Criteria and Information Sources	Defining Criteria			
Amphibian Breeding Habitat (Woodland). **<u>Rationale:</u>** These habitats are extremely important to amphibian biodiversity within a landscape and often represent the only breeding habitat for local amphibian populations	Eastern Newt Blue-spotted Salamander Spotted Salamander Gray Treefrog Spring Peeper Western Chorus Frog Wood Frog	• All Ecosites associated with these ELC Community Series; - FOC - FOM - FOD - SWC - SWM - SWD • Breeding pools within the woodland or the shortest distance from forest habitat are more significant because they are more likely to be used due to reduced risk to migrating amphibians	• Presence of a wetland, pond or woodland pool(including vernal pools) >500m^2 within or adjacent (within 120m) to a woodland (no minimum size).[clxxxii, lxiii, lxv, lxvi, lxvii, lxviii, lxix, lxx]. Some small wetlands may not be mapped and may be important breeding pools for amphibians. • Woodlands with permanent ponds or those containing water in most years until mid-July are more likely to be used as breeding habitat [cxlviii] <u>Information Sources</u> • Ontario Herpetofaunal Summary Atlas (or other similar atlases) for records • Local landowners may also provide assistance as they may hear spring-time choruses of amphibians on their property. • OMNRF Districts and wetland evaluations • Field Naturalist Clubs • Canadian Wildlife Service Amphibian Road Call Survey • Ontario Vernal Pool Association: http://www.ontariovernalpools.org	• Studies confirm; - Presence of breeding population of 1 or more of the listed salamander species or 2 or more of the listed frog species with at least 20 individuals (adults, juveniles, eggs/larval masses) [lxxi] or 2 or more of the listed frog species wioth Call Level Codes of 3 Ⓔ. - A combination of observation study and call count survey will be required during the sping (March-June) when amphibians are concentrated around suitable breeding habitat within or near the woodland/wetlands. - The habitat is the wetland area plus a 230m radius of area. If a wetland area is adjacent to a woodland, a travel corridor connecting the wetland to the woodland is to be included in the habitat. - SWH MIST [cxlix] Index #14 provides development effects and mitigation measures.	**Yes**; • Forested communities present within the Study Area.	**Candidate**; • Study Area 2 contains vernal pools within forest communities and a marsh community adjacent to forest.	• Surveys to confirm SWH may be required.
Amphibian Breeding Habitat (Wetlands) **<u>Rationale;</u>** Wetlands supporting breeding for these amphibian species are extremely important and fairly rare within Central Ontario landscapes.	Eastern Newt American Toad Spotted Salamander Four-toed Salamander Blue-spotted Salamander Gray Treefrog Western Chorus Frog Northern Leopard Frog Pickerel Frog Green Frog Mink Frog Bullfrog	• ELC Community Classes SW, MA, FE, BO, OA and SA. • Typically these wetland ecosites will be isolated (>120m) from woodland ecosites, however larger wetlands containing predominantly aquatic species (e.g. Bull Frog) may be adjacent to woodlands.	• Wetlands>500m2 (about 25m diameter)) [ccvii] ,supporting high species diversity are significant; some small or ephemeral habitats may not be identified on MNRF mapping and could be important amphibian breeding habitats [clxxxii] . • Presence of shrubs and logs increase significance of pond for some amphibian species because of available structure for calling, foraging, escape and concealment from predators. • Bullfrogs require permanent water bodies with abundant emergent vegetation. <u>Information Sources</u> • Ontario Herpetofaunal Summary Atlas (or other similar atlases) • Canadian Wildlife Service Amphibian Road Surveys and Backyard Amphibian Call Count. • OMNRF Districts and wetland evaluations. • Reports and other information available from Conservation Authorities.	• Studies confirm: - Presence of breeding population of 1 or more of the listed newt/salamander species or 2 or more of the listed frog/toad species with at least 20 individuals (adults or eggs masses) [lxxi] or 2 or more of the listed frog/toad species with Call Level Codes of 3Ⓔ. or; Wetland with confirmed breeding Bullfrogs are significantⒺ. - The ELC ecosite wetland area and the shoreline are the SWH. - A combination of observational study and call count surveys cviii will be required during the spring (March-June) when amphibians are concentrated around suitable breeding habitat within or near the wetlands. - If a SWH is determined for Amphibian Breeding Habitat (Wetlands) then Movement Corridors are to be considered as outlined in Table 1.4.1 of this Schedule. - SWH MIST cxlix Index #15 provides development effects and mitigation measures.	**No**; • All wetland communities present within the Study Areas are <120m from woodland habitat.	**No**; • Candidate habitat was not identified.	• No further considerations required.

Table 1.3. Habitats of Species of Conservation Concern considered SWH.

Wildlife	Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
		ELC Ecosite	Habitat Criteria and Information Sources	Defining Criteria			
Woodland Area-Sensitive Bird Breeding Habitat **Rationale:** Large, natural blocks of mature woodland habitat within the settled areas of Southern Ontario are important habitats for area sensitive interior forest song birds.	Yellow-bellied Sapsucker Red-breasted Nuthatch Veery Blue-headed Vireo Northern Parula Black-throated Green Warbler Blackburnian Warbler Black-throated Blue Warbler Ovenbird Scarlet Tanager Winter Wren Pileated Woodpecker Special Concern: Cerulean Warbler Canada Warbler	• All Ecosites associated with these ELC Community Series; - FOC - FOM - FOD - SWC - SWM - SWD	• Habitats where interior forest breeding birds are breeding, typically large mature (>60 yrs old) forest stands or woodlots >30 ha. [cv, cxxxi, cxxxii, cxxxiii, cxxxiv, cxxxv, cxxxvi, cxxxvii, cxxxviii, cxxxix, cxl, cxli, cxlii, cxliii, cxliv, cxlv, cxlvi, cl, cli, clii, cliii, cliv, clv, clvi, clvii, clviii, clix] • Interior forest habitat is at least 200 m from forest edge habitat. [clxiv] Information Sources • Local birder clubs. • Canadian Wildlife Service (CWS) for the location of forest bird monitoring . • Bird Studies Canada conducted a 3-year study of 287 woodlands to determine the effects of forest fragmentation on forest birds and to determine what forests were of greatest value to interior species • Reports and other information available from Conservation Authorities	• Studies confirm: - Presence of nesting or breeding pairs of 3 or more of the listed wildlife species. Ⓔ - Note: any site with breeding Cerulean Warblers or Canada Warbler is to be considered SWH.Ⓔ - Conduct field investigations in spring and early summer when birds are singing and defending their territories. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] - SWH MIST [cxlix] Index #34 provides development effects and mitigation measures.	**No**; • Forested communities were very fragmented across the Study Areas and greater landscape.	**No**; • There were no large naturalized blocks or forest communities for breeding interior forest birds. Forested communities were very fragmented across the Study Areas and greater landscape.	• No further considerations required.
Marsh Breeding Bird Habitat **Rationale:** Wetlands for these bird species are typically productive and fairly rare in Southern Ontario landscapes.	American Bittern Virginia Rail Sora Common Moorhen American Coot Pied-billed Grebe Marsh Wren Sedge Wren Common Loon Green Heron Trumpeter Swan **Special Concern:** Black Tern Yellow Rail	• MAM1 • MAM2 • MAM3 • MAM4 • MAM5 • MAM6 • SAS1 • SAM1 • SAF1 • FEO1 • BOO1 • For Green Heron: All SW, MA and CUM1 sites.	• Nesting occurs in wetlands. • All wetland habitat is to be considered as long as there is shallow water with emergent aquatic vegetation present [cxxiv]. • For Green Heron, habitat is at the edge of water such as sluggish streams, ponds and marshes sheltered by shrubs and trees. Less frequently, it may be found in upland shrubs or forest a considerable distance from water. Information Sources • OMNRF District and wetland evaluations. • Field Naturalist clubs • Natural Heritage Information Centre (NHIC) Records. • Reports and other information available from Conservation Authorities. • Ontario Breeding Bird Atlas.	• Studies confirm: - Presence of 5 or more nesting pairs of Sedge Wren or Marsh Wren **or** breeding by any combination of 4 or more of the listed species Ⓔ . - Note: any wetland with breeding of 1 or more Black Terns, Trumpeter Swan, Green Heron or Yellow Rail is SWH Ⓔ. - Area of the ELC ecosite is the SWH. - Breeding surveys should be done in May/June when these species are actively nesting in wetland habitats. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects" - SWH MIST Index #35 provides development effects and mitigation measures	**Yes**; • Candidate habitat may be present in Study Area 2.	**No**; • Suitable habitat was not identified during field investigations.	• No further considerations required.
Open Country Bird Breeding Habitat **Rationale;** This wildlife habitat is declining throughout Ontario and North America. Species such as the Upland Sandpiper have declined significantly the past 40 years based on CWS (2004) trend records.	Upland Sandpiper Grasshopper Sparrow Vesper Sparrow Northern Harrier Savannah Sparrow **Special Concern** Short-eared Owl	• CUM1 • CUM2	• Large grassland areas (includes natural and cultural fields and meadows) >30 ha [clx, clxi, clxii, clxiii, clxiv, clxv, clxvi, clxvii, clxviii, clxix]. • Grasslands not Class 1 or 2 agricultural lands, and not being actively used for farming (i.e. no row cropping or intensive hay or livestock pasturing in the last 5 years) Ⓔ. • Grassland sites considered significant should have a history of longevity, either abandoned fields, mature hayfields and pasturelands that are at least 5 years or older. • The Indicator bird species are area sensitive requiring larger grassland areas than the common grassland species. Information Sources • Agricultural land classification maps, Ministry of Agriculture. • Local bird clubs. • Ontario Breeding Bird Atlas • EIS Reports and other information available from Conservation Authorities.	• Field Studies confirm: - Presence of nesting or breeding of 2 or more of the listed species. Ⓔ - A field with 1 or more breeding Short-eared Owls is to be considered SWH. - The area of SWH is the contiguous ELC ecosite field areas. - Conduct field investigations of the most likely areas in spring and early summer when birds are singing and defending their territories. - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"ccxi - SWH MIST cxlix Index #32 provides development effects and mitigation measures	**No**; • No open communities >30 ha were identified.	**No**; • Suitable habitat was not identified.	• No further considerations required.

Wildlife	Species	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat within the Study Area	Confirmed Habitat within the Study Area	Conclusions/Recommendations
		ELC Ecosite	Habitat Criteria and Information Sources	Defining Criteria			
Shrub/Early Successional Bird Breeding Habitat **Rationale:** This wildlife habitat is declining throughout Ontario and North America. The Brown Thrasher has declined significantly over the past 40 years based on CWS (2004) trend records [cxcix].	Indicator Spp: Brown Thrasher Clay-coloured Sparrow Common Spp. Field Sparrow Black-billed Cuckoo Eastern Towhee Willow Flycatcher **Special Concern:** Yellow-breasted Chat Golden-winged Warbler	• CUT1 • CUT2 • CUS1 • CUS2 • CUW1 • CUW2 • Patches of shrub ecosites can be complexed into a larger habitat for some bird species	• Large field areas succeeding to shrub and thicket habitats >10ha[clxiv] in size. • Shrub land or early successional fields, not class 1 or 2 agricultural lands, not being actively used for farming (i.e. no row-cropping, haying or live-stock pasturing in the last 5 years) Ⓔ. • Shrub thicket habitats (>10 ha) are most likely to support and sustain a diversity of these species clxxiii. • Shrub and thicket habitat sites considered significant should have a history of longevity, either abandoned fields or pasturelands. Information Sources • Agricultural land classification maps, Ministry of Agriculture. • Local bird clubs. • Ontario Breeding Bird Atlas • Reports and other information available from Conservation Authorities.	• Field Studies confirm: - Presence of nesting or breeding of 1 of the indicator species and at least 2 of the common species. Ⓔ - A habitat with breeding Yellow-breasted Chat or Golden-winged Warbler is to be considered as Significant Wildlife Habitat. Ⓔ - The area of the SWH is the contiguous ELC ecosite field/thicket area. - Conduct field investigations of the most likely areas in spring and early summer when birds are singing and defending their territories - Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"ccxi - SWH MIST [cxlix] Index #33 provides development effects and mitigation measures.	**No**; • Cultural Woodland and Cultural Thicket are present within the Study Areas. However, communities were not large enough to meet criteria for candidate habitat.	**No**; • Candidate habitat was not identified within the Study Areas.	• No further considerations required.
Terrestrial Crayfish; **Rationale:** Terrestrial Crayfish are only found within SW Ontario in Canada and their habitats are very rare. [ccii]	Chimney or Digger Crayfish; (*Fallicambarus fodiens*) Devil Crawfish or Meadow Crayfish; (*Cambarus Diogenes*)	• MAM1 • MAM2 • MAM3 • MAM4 • MAM5 • MAM6 • MAS1 • MAS2 • MAS3 • SWD • SWT • SWM	• Wet meadow and edges of shallow marshes (no minimum size) should be surveyed for terrestrial crayfish. • Constructs burrows in marshes, mudflats, meadows, the ground can't found far from water. • Both species are a semi-terrestrial burrower which spends most of its life within burrows consisting of a network of tunnels. Usually the soil is not too moist so that the tunnel is well formed. Information Sources • Information sources from "Conservation Status of Freshwater Crayfishes" by Dr. Premek Hamr for the WWF and CNF March 1998	• Studies Confirm: - Presence of 1 or more individuals of species listed or their chimneys (burrows) in suitable meadow marsh, swamp or moist terrestrial sites cci - Area of ELC ecosite or an Habitat ecoelement area of meadow marsh or swamp within the larger ecosite area is the SWH. - Surveys should be done April to August in temporary or permanent water. Note the presence of burrows or chimneys are often the only indicator of presence, observance or collection of individuals is very difficult cci - SWH MIST cxlix Index #36 provides development effects and mitigation measures.	**Yes**; • Suitable wetland communities were present within Study Area 2.	**No**; • Evidence of terrestrial crayfish was not observed within the shallow marsh community.	• No further considerations required.
Special Concern and Rare Wildlife Species **Rationale:** These species are quite rare or have experienced significant population declines in Ontario.	All Special Concern and Provincially Rare (S1-S3, SH) plant and animal species. Lists of these species are tracked by the Natural Heritage Information Centre (NHIC).	• All plant and animal element occurrences (EO) within a 1 or 10km grid. • Older element occurrences were recorded prior to GPS being available, therefore location information may lack accuracy	• When an element occurrence is identified within a 1 or 10 km grid for a Special Concern or provincially Rare species; linking candidate habitat on the site needs to be completed to ELC Ecosites lxxviii Information Sources • Natural Heritage Information Centre (NHIC) will have Special Concern and Provincially Rare (S1-S3, SH) species lists with element occurrences data. • NHIC Website "Get Information" : http://nhic.mnr.gov.on.ca • Ontario Breeding Bird Atlas• • Expert advice should be sought as many of the rare spp. have little information available about their requirements.	• Studies Confirm: - Assessment/inventory of the site for the identified special concern or rare species needs to be completed during the time of year when the species is present or easily identifiable. - The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH, this must be delineated through detailed field studies. The habitat needs be easily mapped and cover an important life stage component for a species e.g. specific nesting habitat or foraging habitat. - SWH MIST Index #37 provides development effects and mitigation measures.	**Yes**; • Suitable habitat is anticipated within the Study Area for Special Concern or Rare Wildlife Species.	**Confirmed**; • Eastern Wood-pewee (*Contopus virens*) was observed singing in the forested communities in Study Area 2. **Candidate;** • Snapping Turtle (*Chelydra* serpentina) within Wolfedale Creek and PSW in Study Area 1 and 2. • Wood Thrush (*Hylocichla mustelina*) within forested communities in Study Area 2. • Barn Swallow (*Hirundo rustica*) on buildings within Study Area 1; • Common Nighthawk (Chordeiles *minor*) on flat-topped buildings in Study Area 1	• Surveys may be required to confirm SWH.

Table 1.4 Animal Movement Corridors

Habitat	SPECIES	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Present within the Study Area	Conclusions/Recommendations
		ELC Eco-sites	Habitat Criteria and Information Sources	Defining Criteria			
Amphibian Movement Corridors **Rationale;** Movement corridors for amphibians moving from their terrestrial habitat to breeding habitat can be extremely important for local populations.	Eastern Newt American Toad Spotted Salamander Four-toed Salamander Blue-spotted Salamander Gray Treefrog Western Chorus Frog Northern Leopard Frog Pickerel Frog Green Frog Mink Frog Bullfrog	• Corridors may be found in all ecosites associated with water. • Corridors will be determined based on identifying the significant breeding habitat for these species in Table 1.1	• Movement corridors between breeding habitat and summer habitat [clxxiv, clxxv, clxxvi, clxxvii, clxxviii, clxxix, clxxx, clxxxi]. • Movement corridors must be determined when Amphibian breeding habitat is confirmed as SWH from Table 1.2.2 • (Amphibian Breeding Habitat –Wetland) of this Schedule Ⓔ. Information Sources • MNRF District Office. • Natural Heritage Information Centre (NHIC). • Reports and other information available from Conservation Authorities. • Field Naturalist Clubs.	• Field Studies must be conducted at the time of year when species are expected to be migrating or entering breeding sites. • Corridors should consist of native vegetation, with several layers of vegetation. Corridors unbroken by roads, waterways or bodies, and undeveloped areas are most significant cxlix • Corridors should have at least 15m of vegetation on both sides of waterway cxlix or be up to 200m wide cxlix of woodland habitat and with gaps <20m cxlix . • Shorter corridors are more significant than longer corridors, however amphibians must be able to get to and from their summer and breeding habitat cxlix. • SWH MIST cxlix Index #40 provides development effects and mitigation measures	**Yes**; • Suitable breeding and summer habitat may be present within Study Area 2.	**Candidate**; • Suitable breeding habitat for Amphibian Breeding Habitat (Woodland) was identified in Study Area 2. Adjacent communities associated with the PSW and ANSI may provide opportunities for amphibian movement between breeding and summer habitat.	• Surveys to confirm SWH may be required.

Table 1.5 Significant Wildlife Habitat Exceptions for Ecodistricts within Eco-Region 7E

Habitat	SPECIES	CANDIDATE SWH		CONFIRMED SWH	Candidate Habitat Present Within the Study Area	Confirmed Habitat Present within the Study Area	Conclusions/Recommendations
		ELC Eco-sites	Habitat Criteria and Information Sources	Defining Criteria			
7E-2	**Bat Migratory Stopover Area** Rationale: Stopover areas for long distance migrant bats are important during fall migration. Hoary Bat Eastern Red Bat Silver-haired Bat	• No specific ELC types.	• Long distance migratory bats typically migrate during late summer and early fall from summer breeding habitats throughout Ontario to southern wintering areas. Their annual fall migration may concentrate these species of bats at stopover areas. • This is the only known bat migratory stopover habitats based on current information. Information Sources • OMNRF for possible locations and contact for local experts • University of Waterloo, Biology Department	• Long Point (42°35'N, 80°30'E, to 42°33'N, 80°03'E) has been identified as a significant stop-over habitat for fall migrating Silver-haired Bats, due to significant increases in abundance, activity and feeding that was documented during fall migration ccxv. • The confirmation criteria and habitat areas for this SWH are still being determined. • SWH MIST cxlix Index #38 provides development effects and itigation measures	**No**; • Study Areas are not located within Long Point.	**No**; • Study Areas are not located within Long Point.	• No further considerations are required.

AECOM

Appendix D

Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Amphibians	Jefferson Salamander *Ambystoma jeffersonianum*	END	END Schedule 1	END	Adults live in moist, loose soil, under logs or in leaf litter. Your best chance of spotting a Jefferson Salamander is in early spring when they travel to woodland ponds to breed. They lay their eggs in clumps attached to underwater vegetation. By midsummer, the larvae lose their gills and leave the pond and head into the surrounding forest. Once in the forest, Jefferson Salamanders spend much of their time underground in rodent burrows, and under rocks and stumps. They feed primarily on insects and worms. Adult Jefferson Salamanders, throughout their range, are found within deciduous or mixed upland forests containing, or adjacent to, suitable breeding ponds. Breeding ponds are normally ephemeral, or vernal, woodland pools that dry in late summer. Terrestrial habitat is in mature woodlands that have small mammal burrows or rock fissures that enable adults to over-winter underground below the frost line.	**FOD** where permanent or temporary ponds or pools are present.	In Canada, the species is found only in isolated populations that are mostly associated with the Niagara Escarpment and Carolinian forest regions in Ontario.	iNaturalist	Low Forested communities in Study Area 2 are surrounded by urban developments and fragmented.
Amphibians	Unisexual Ambystoma (Jefferson Salamander dependent population) *Ambystoma laterale-(2) jeffersonianum*	END	No Status	END	Unisexual Ambystoma salamanders live in leaf litter, under logs, and in underground cavities in deciduous and mixed forests, typically within close proximity to breeding habitats. Adults breed in vernal pools (temporary woodland ponds) or fish-free permanent wetlands. They lay their eggs in clumps attached to underwater vegetation in shallow water. The eggs hatch into aquatic larvae after about one month, and the larvae transform into juveniles by the end of summer. The juveniles leave the pond and head into the surrounding forest. Unisexual Ambystoma salamanders spend the winter underground where they can get below the frost line and avoid freezing temperatures, such as in mammal burrows, rock crevices, or other underground cavities. Although these salamanders spend much of the year underground or under cover, they can often be observed in early spring when they travel to breeding sites. Unisexual salamanders have the same habitat requirements as their respective sperm-donating species. They are normally found within deciduous or mixed forests containing, or adjacent to, suitable breeding ponds. Breeding ponds are normally ephemeral, or vernal, pools that dry in late summer. Terrestrial habitat is in moist woodlands, where the salamanders find shelter from predators and desiccation under fallen trees or rocks, as well as in mammal burrows. Adults forage during humid conditions at night on the forest floor within ~1 km of the breeding pond. These salamanders also require terrestrial overwintering sites below the frost line.		In Canada, the Unisexual Ambystoma (Jefferson Salamander dependent population) salamanders are restricted to southern Ontario, mainly along the Niagara Escarpment. Unisexual salamanders are found in association with appropriate bisexual species whose males serve as sperm donors. The geographic range of unisexual salamanders in the genus *Ambystoma* roughly coincides with deciduous and mixed-wood forests in northeastern North America from Nova Scotia and the New England States to Indiana. Their northern limits are in Minnesota, north-central Ontario, and southern Quebec, and they range south to Kentucky. In Canada, unisexual salamanders are found in association with the Jefferson Salamander in Ontario. In Canada, unisexual populations of salamanders occur in all known Jefferson Salamander populations.	iNaturalist	Low Forested communities in Study Area 2 are surrounded by urban developments and fragmented.
Amphibians	Western Chorus Frog (Great Lakes / St. Lawrence - Canadian Shield population) *Pseudacris triseriata*	No Status	THR Schedule 1	THR	The Western Chorus Frog is primarily a lowland terrestrial species. In marshes or wooded wetland areas, it is found on the ground or in low shrubs and grass. It is a poor climber. Like all other frogs, the Western Chorus Frog requires both terrestrial and aquatic habitats in close proximity. For breeding and tadpole development, it requires seasonally dry temporary ponds devoid of predators, particularly fish. The Western Chorus Frog is very rarely found in permanent ponds. Although it uses aquatic habitat during the breeding season, the Western Chorus Frog is a poor swimmer. The species hibernates in its terrestrial habitat, under rocks, dead trees, or leaves, or in loose soil or animal burrows, even though these sites are sometimes flooded.		In Canada, the Western Chorus Frog is found in southern Ontario and southwestern Quebec. In southern Ontario, its range is bounded by the United States border in the south, Georgian Bay in the northwest, and south of Algonquin Park and up the Ottawa River valley to the vicinity of Eganville in the east. There are approximately 100 locations, divided into two distinct populations: the Carolinian population (southwestern Ontario) and the Great Lakes/St. Lawrence–Canadian Shield population (other regions of Ontario and Quebec).	ORAA	Medium Vernal pooling in Study Area 2 may provide breeding habitat which is located in close proximity to suitable terrestrial habitat.
Birds	Acadian Flycatcher *Empidonax virescens*	END	END Schedule 1	END	It is typically found in mature, shady forests with ravines, or in forested swamps with lots of maple and beech trees. The nest is placed near the tip of a lower limb on a tree, and is loosely woven, with strands of plant material hanging down. In Canada, the Acadian Flycatcher nests only in southwestern Ontario, mostly in large forests and forested ravines near the shore of Lake Erie. The Acadian Flycatcher requires large areas of mature undisturbed forest. Most individuals occur in forests more than 40 hectares in size. The species is also considered to be a forest interior species, meaning that it avoids forest edges and build their nests in areas that are more than 100 meters from the forest edge. The bird lives in the understory of woods with a closed canopy. It is often found in well-wooded swamps and ravines. Acadian Flycatchers also occupy dry woods but they usually prefer to hang their nests over water. Prior to the 1800's, the Carolinian area of Ontario would have had abundant suitable habitat for this species. Currently, very little of the forest remains and the remnants are highly fragmented. Throughout the Carolinian Forest region of Ontario, most of the remaining forest patches are very small (less than three hectares) and only an extremely small percentage of them is large enough to meet the species' requirements.	**SWD, FOD** communities that are mature, have a closed canopy, and are of sufficient size.	In Ontario, the Acadian Flycatcher primarily lives in the warmer climate of southern Ontario's Carolinian forests. It needs large, undisturbed forests, often more than 40 hectares in size. It has also been known to nest at a few sites in the Greater Toronto Area but this is unusual. In Canada, the Acadian Flycatcher occurs in very low numbers in the Carolinian area of southern Ontario. The species is thought to have been more widespread and numerous in Canada prior to the clearing of forests in the early 1800s. Today, there is relatively little habitat remaining that is suitable for the species.	OBBA	Low No suitable habitat observed within Study Areas.
Birds	Bald Eagle *Haliaeetus leucocephalus*	SC	No Status	Not at Risk	Bald Eagles nest in a variety of habitats and forest types, almost always near a major lake or river where they do most of their hunting. While fish are their main source of food, Bald Eagles can easily catch prey up to the size of ducks, and frequently feed on dead animals, including White-tailed Deer. They usually nest in large trees such as pine and poplar. During the winter, Bald Eagles sometimes congregate near open water such as the St. Lawrence River, or in places with a high deer population where carcasses might be found.	**FOC, FOM, FOD, SWC, SWM** and **SWD**. Nests typically located near major bodies of water.	In Ontario, they nest throughout the north, with the highest density in the northwest near Lake of the Woods. Historically they were also relatively common in southern Ontario, especially along the shore of Lake Erie, but this population was all but wiped out 50 years ago. After an intensive re-introduction program and environmental clean-up efforts, the species has rebounded and can once again be seen in much of its former southern Ontario range.	eBird	Low While suitable habitat is present, no nests were observed in the Study Areas.

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Birds	Bank Swallow *Riparia riparia*	THR	THR Schedule 1	THR	Bank Swallows nest in burrows in natural and human-made settings where there are vertical faces in silt and sand deposits. Many nests are on banks of rivers and lakes, but they are also found in active sand and gravel pits or former ones where the banks remain suitable. The birds breed in colonies ranging from several to a few thousand pairs. The Bank Swallow breeds in a wide variety of natural and artificial sites with vertical banks, including riverbanks, lake and ocean bluffs, aggregate pits, road cuts, and stock piles of soil. Sand-silt substrates are preferred for excavating nest burrows. Breeding sites tend to be somewhat ephemeral due to the dynamic nature of bank erosion. Breeding sites are often situated near open terrestrial habitat used for aerial foraging (e.g., grasslands, meadows, pastures, and agricultural cropland). Large wetlands are used as communal nocturnal roost sites during post-breeding, migration, and wintering periods.		The Bank Swallow is found all across southern Ontario, with sparser populations scattered across northern Ontario. The largest populations are found along the Lake Erie and Lake Ontario shorelines, and the Saugeen River (which flows into Lake Huron). In North America, it breeds widely across the northern two-thirds of the U.S., north to the treeline. It breeds in all Canadian provinces and territories, except perhaps Nunavut.	eBird	Low No suitable eroding banks within Study Areas.
Birds	Barn Swallow *Hirundo rustica*	SC	THR Schedule 1	THR	Barn Swallows often live in close association with humans, building their cup-shaped mud nests almost exclusively on human-made structures such as open barns, under bridges, and in culverts. The species is attracted to open structures that include ledges where they can build their nests, which are often re-used from year to year. They prefer unpainted, rough-cut wood, since the mud does not adhere as well to smooth surfaces. Before European colonization, Barn Swallows nested mostly in caves, holes, crevices, and ledges in cliff faces. Following European settlement, they shifted largely to nesting in and on artificial structures, including barns and other outbuildings, garages, houses, bridges, and road culverts. Barn Swallows prefer various types of open habitats for foraging, including grassy fields, pastures, various kinds of agricultural crops, lake and river shorelines, cleared rights-of-way, cottage areas and farmyards, islands, wetlands, and subarctic tundra.	**TPO, CUM1, MAM, MAS, OAO, SAS1, SAM1, SAF1**; containing or adjacent structures that are suitable for nesting.	The Barn Swallow may be found throughout southern Ontario and can range as far north as Hudson Bay, wherever suitable locations for nests exist. The Barn Swallow has become closely associated with human rural settlements. It breeds across much of North America south of the treeline, south to central Mexico. In Canada, it is known to breed in all provinces and territories.	eBird	Medum Buildings in Study Area 1 may provide nesting habitat.
Birds	Black Tern *Chlidonias niger*	SC	No Status	Not at Risk	Black Terns build floating nests in loose colonies in shallow marshes, especially in cattails.	**MAS2-1** and **OAO**. These two communities must be present immediately adjacent each other and with sufficient water to	The Black Tern breeds in the temperate regions of Europe, and in North America where it ranges from northern British Columbia and Alberta south to Arizona and Kansas and east to New Brunswick. In Ontario, Black Terns are found scattered throughout the province, but breed mainly in the marshes along the edges of the Great Lakes.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Bobolink *Dolichonyx oryzivorus*	THR	THR Schedule 1	THR	Historically, Bobolinks lived in North American tallgrass prairie and other open meadows. With the clearing of native prairies, Bobolinks moved to living in hayfields. Bobolinks often build their small nests on the ground in dense grasses. Both parents usually tend to their young, sometimes with a third Bobolink helping. Most of this prairie was converted to agricultural land over a century ago, and at the same time the forests of eastern North America were cleared to hayfields and meadows that provided habitat for the birds. Since the conversion of the prairie to cropland and the clearing of the eastern forests, the Bobolink has nested in forage crops (e.g., hayfields and pastures dominated by a variety of species, such as clover, Timothy, Kentucky Bluegrass, and broadleaved plants). The Bobolink also occurs in various grassland habitats including wet prairie, graminoid peatlands, and abandoned fields dominated by tall grasses, remnants of uncultivated virgin prairie (tall-grass prairie), no-till cropland, small-grain fields, restored surface mining sites, and irrigated fields in arid regions. It is generally not abundant in short-grass prairie, Alfalfa fields, or in row crop monocultures (e.g., corn, soybean, wheat), although its use of Alfalfa may vary with region.	**TPO, TPS, CUM1** and **MAM2**.	The Bobolink breeds across North America. In Ontario, it is widely distributed throughout most of the province south of the boreal forest, although it may be found in the north where suitable habitat exists. The breeding range of the Bobolink in North America includes the southern part of all Canadian provinces from British Columbia to Newfoundland and Labrador and south to the northwestern, north-central and northeastern U.S.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Canada Warbler *Cardellina canadensis*	SC	THR Schedule 1	THR	The Canada Warbler breeds in a range of deciduous and coniferous, usually wet forest types, all with a well-developed, dense shrub layer. Dense shrub and understory vegetation help conceal Canada Warbler nests that are usually located on or near the ground on mossy logs or roots, along stream banks or on hummocks. It is also found in riparian shrub forests on slopes and in ravines and in old-growth forests with canopy openings and a high density of shrubs, as well as in stands regenerating after natural disturbances, such as forest fires, or anthropogenic disturbances, such as logging. Canada Warbler habitat is believed to be in decline, especially in South America, where the Canada Warbler overwinters. Habitat loss has also been observed in the eastern part of its breeding range, where wet forests have been drained for urban development or farming.	**FOC3, FOC4, FOM6, FOM7, FOM8, FOD6, FOD7, FOD8, FOD9, SWC, SWM** and **SWD** with a well-developed shrub layer.	The Canada Warbler only breeds in North America and 80% of its known breeding range is in Canada. Its primary breeding range is in the Boreal Shield, extending north into the Hudson Plains and south into the Mixedwood Plains. Although the Canada Warbler breeds at low densities across its range, in Ontario it is most abundant along the Southern Shield. The Canada Warbler breeds primarily across much of southeastern Canada, the northeastern United States, the Great Lakes region. In Canada, it breeds in all provinces and territories except Nunavut and Newfoundland and Labrador.	eBird	Low No suitable habitat observed within Study Areas.

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Birds	Cerulean Warbler *Setophaga cerulea*	THR	END Schedule 1	END	Cerulean Warblers spend their summers (breeding seasons) in mature, deciduous forests with large, tall trees and an open understorey. They are found in both wet bottomland forests and upland areas. At a finer spatial scale, canopy configuration (e.g., foliage stratification, gap distribution, tree species distribution) are predictors of habitat suitability.	**FOD** and **SWD** that are mature and contain an open understory.	The Cerulean Warbler's breeding range extends from extreme southwestern Quebec and southern Ontario west to Minnesota and Nebraska and south to Texas and other Gulf states across to North Carolina. In southern Ontario, populations appear to be separated into two distinct bands: one from southern Lake Huron to western Lake Ontario, and further north, the other from the Bruce Peninsula and Georgian Bay area to the Ottawa River. This species breeds in the deciduous forests of eastern North America but has a patchy distribution. The Canadian breeding range consists of two main geographic clusters in southwestern and southeastern Ontario, plus a small number of breeding individuals in southwestern Quebec.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Chimney Swift *Chaetura pelagica*	THR	THR Schedule 1	THR	Before European settlement, Chimney Swifts mainly nested on cave walls and in hollow trees or tree cavities in old growth forests. However, due to the land clearing associated with colonization, hollow trees became increasingly rare, which led Chimney Swifts to move into house chimneys. Today, they are more likely to be found in and around urban settlements where they nest and roost (rest or sleep) in chimneys and other manmade structures. It is likely that a small portion of the population continues to use hollow trees. They also tend to stay close to water as this is where the flying insects they eat congregate. The Chimney Swift spends the major part of the day in flight feeding on insects. In the northern part of the breeding range, the Chimney Swift favours sites where the ambient temperature is relatively stable.	**TPO, CUM1, MAM, MAS, OAO, SAS1, SAM1, SAF1** containing or adjacent structures with suitable nesting habitat (i.e. chimneys).	The Chimney Swift breeds in eastern North America, possibly as far north as southern Newfoundland. In Ontario, it is most widely distributed in the Carolinian zone in the south and southwest of the province, but has been detected throughout most of the province south of the 49th parallel. The Chimney Swift breeds mainly in eastern North America, from southern Canada down to Texas and Florida. The species breeds in east central Saskatchewan, southern Manitoba, southern Ontario, southern Quebec, New Brunswick, Nova Scotia, and possibly in Prince Edward Island and southwestern Newfoundland.	eBird	High Buildings with suitable chimneys may be present in the Study Areas. Species observed foraging in the east end of Study Area 1.
Birds	Common Nighthawk *Chordeiles minor*	SC	THR Schedule 1	SC	Traditional Common Nighthawk habitat consists of open areas with little to no ground vegetation, such as logged or burned-over areas, forest clearings, rock barrens, peat bogs, lakeshores, and mine tailings. Although the species also nests in cultivated fields, orchards, urban parks, mine tailings, and along gravel roads and railways, they tend to occupy natural sites. The Common Nighthawk nests in a wide range of open, vegetation-free habitats, including dunes, beaches, recently harvested forests, rocky outcrops, grasslands, pastures, marshes, and river banks. This species also inhabits mixed and coniferous forests. The Common Nighthawk probably benefited from the newly-opened habitats created by the massive deforestation associated with the arrival of European settlers in eastern Canada and United States. The appearance of gravel roofs contributed to the expansion of the Common Nighthawk's habitat in North America.	**SD, BB, RB, CUM, BO, FOM, FOC** and **FOD** with openings with little vegetation.	The range of the Common Nighthawk spans most of North and Central America. In Canada, the species is found in all provinces and territories except Nunavut. In Ontario, the Common Nighthawk occurs throughout the province except for the coastal regions of James Bay and Hudson Bay.	eBird	Medium Flat topped buildings in Study Area 1 may be suitable for nesting.
Birds	Eastern Meadowlark *Sturnella magna*	THR	THR Schedule 1	THR	Eastern Meadowlarks breed primarily in moderately tall grasslands, such as pastures and hayfields, but are also found in alfalfa fields, weedy borders of croplands, roadsides, orchards, airports, shrubby overgrown fields, or other open areas. Small trees, shrubs, or fence posts are used as elevated song perches. Eastern Meadowlarks prefer grassland habitats, including native prairies and savannahs, as well as non-native pastures, hayfields, weedy meadows, herbaceous fencerows, and airfields.	**TPO, TPS, CUM1, CUS**, and **MAM2** with elevated song perches.	In Ontario, the Eastern Meadowlark is primarily found south of the Canadian Shield but it also inhabits the Lake Nipissing, Timiskaming, and Lake of the Woods areas. Including all subspecies, the Eastern Meadowlark's global breeding range extends from central and eastern North America, south through parts of South America. However, there is only one subspecies in Canada and the neighbouring northeastern U.S. In Canada, the bulk of the population breeds in southern Ontario.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Eastern Whip-poor-will *Antrostomus vociferus*	THR	THR Schedule 1	THR	The Eastern Whip-poor-will is usually found in areas with a mix of open and forested areas, such as savannahs, open woodlands, or openings in more mature deciduous, coniferous, and mixed forests. It forages in these open areas and uses forested areas for roosting (resting and sleeping) and nesting. It lays its eggs directly on the forest floor, where its colouring means it will easily remain undetected by visual predators. Whip-poor-will breeding habitat is not dependent upon species composition, but rather on forest structure, although common tree associations in both summer and winter are pine and oak. The species shuns both wide-open spaces and dense forest. It prefers to nest in semi-open forests or patchy forests with clearings, such as barrens or forests that are regenerating following major disturbances. Other necessary breeding habitat elements are thought to involve ground-level vegetation and woodland size. Individuals will often feed in nearby shrubby pastures or wetlands with perches. Areas with decreased light levels where forest canopies are closed are generally not occupied, perhaps because of reduced forage success for this aerial-feeding insectivore.	**TPS, TPW, CUW, FOD, FOC** and **FOM** where open areas are present.	The Eastern Whip-poor-will's breeding range includes two widely separate areas. It breeds throughout much of eastern North America, reaching as far north as southern Canada. In Ontario they breed as far north as the shore of Lake Superior. Although Eastern Whip-poor-wills were once widespread throughout the central Great Lakes region of Ontario, their distribution in this area is now fragmented.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Eastern Wood-pewee *Contopus virens*	SC	SC Schedule 1	SC	The Eastern Wood-pewee lives in the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in intermediate-age mature forest stands with little understory vegetation. During migration, a variety of habitats are used, including forest edges and early successional clearings.	**FOC, FOM, FOD, SWD, SWM** and **CUW**.	The Eastern Wood-pewee is found across most of southern and central Ontario, and in northern Ontario as far north as Red Lake, Lake Nipigon, and Timmins. The breeding range of the Eastern Wood-pewee covers much of south-central and eastern North America.	eBird	High One individual heard singing in Study Area 2.

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Birds	Evening Grosbeak *Coccothraustes vespertinus*	SC	SC Schedule 1	SC	During the breeding season, the Evening Grosbeak is generally found in open, mature mixed-wood forests dominated by fir species, White Spruce, and/or Trembling Aspen. Its abundance is strongly linked to the cycle of its primary prey, the Spruce Budworm. Outside the breeding season, the species depends mostly on seed crops from tree species in the boreal forest, such as firs and spruces. It is also attracted to ornamental trees that have seeds or fruit, and may visit bird feeders.	**FOC** and **FOM**	The Evening Grosbeak is found in all Canadian provinces and territories except Nunavut. In Ontario, it breeds in coniferous forests across northern Ontario, as far south as southern Georgian Bay. Evening Grosbeak breeds in Canada, the United States, and Mexico. In winter, it is nomadic and can range widely, depending on the quantity of seeds produced in the boreal forest. Historically, this species was restricted to western North America, but expanded eastward in the late 19th and early 20th centuries.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Golden-winged Warbler *Vermivora chrysoptera*	SC	THR Schedule 1	THR	Golden-winged Warblers prefer to nest in areas with young shrubs surrounded by mature forest – locations that have recently been disturbed, such as field edges, hydro or utility right-of-ways, or logged areas. In their breeding areas, Golden-winged Warblers seem to be fond of regeneration zones where young shrubs grow, surrounded by mature forest, and characterized by plant succession of 10 to 30 years. The warblers frequent clusters of herbaceous plants and low bushes (where they place their nests, which are built on the ground). They favour environments where the trees are spread out, as well as the forest edge, and use this setting for perching, singing, and looking for food. Golden-winged Warblers are found in dry uplands, swamp forests, and marshes. This warbler shows a preference for beaver ponds and burned-out or intermittently cultivated areas.		The Golden-winged Warbler is found in southern Saskatchewan, Manitoba, Ontario, and Quebec, as well as the north-eastern United States. In Ontario, these birds breed in central-eastern Ontario, as far south as Lake Ontario and the St. Lawrence River, and as far north as the northern edge of Georgian Bay. Golden-winged Warblers have also been found in the Lake of the Woods area near the Manitoba border, and around Long Point on Lake Erie. Golden-winged Warblers nest primarily in the northeastern United States, southeastern Saskatchewan, southwestern Manitoba, southwestern Ontario and far southwestern Quebec. In Ontario, they breed from the far southwest of the province north as far as the centre of the Nipissing region, the southern part of the Sudbury and Algoma districts, and the southwest part of the Rainy River district, near Lake of the Woods.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Grasshopper Sparrow *Ammodramus savannarum* Grasshopper Sparrow (pratensis subspecies; Eastern Grasshopper Sparrow) *Ammodramus savannarum pratensis*	SC	SC Schedule 1	SC	It lives in open grassland areas with well-drained, sandy soil. It will also nest in hayfields and pasture, as well as alvars, prairies, and occasionally grain crops such as barley. It prefers areas that are sparsely vegetated. Its nests are well-hidden in the field and woven from grasses in a small cup-like shape. The Grasshopper Sparrow is a short-distance migrant and leaves Ontario in the fall to migrate to the southestern United States and Central America for the winter. In Canada, the Eastern Grasshopper Sparrow typically breeds in large human-created grasslands (5 ha or greater), such as pastures and hayfields, and natural prairies, such as alvars, characterized by well-drained, often poor soil dominated by relatively low, sparse perennial herbaceous vegetation.		The Grasshopper Sparrow can be found throughout southern Ontario, but only occasionally on the Canadian Shield. It is most common where grasslands, hay, or pasture dominate the landscape. In Canada, the breeding range of the Eastern Grasshopper Sparrow includes extreme southern Québec and southern Ontario, with the vast majority of birds occurring in Ontario.	eBird	Low No suitable habitat observed within Study Areas.
Birds	King Rail *Rallus elegans*	END	END Schedule 1	END	King Rails are found in densely vegetated freshwater marshes with open shallow water that merges with shrubby areas. They are sometimes found in smaller isolated marshes but most seem to prefer larger, coastal wetlands. Its nest is a dinner plate-sized platform made of plant material, placed just above the water in shrubs or clumps of other marsh plants. King Rails are found in a variety of freshwater marshes and marsh-shrub swamp habitats. The species occurs in areas where wild rice grows, but also in sedge and cattail marshes. Most importantly, the species requires large marshes with open shallow water that merges with shrubby areas. In fact, birds only return in successive years to large marshes that are not overgrown with cattails. Originally, the best habitat for King Rails was in southwestern Ontario, but most of these wetlands have since been eliminated. Only 10% of the original pre-European settlement marshes remain in the one area of Ontario where the largest component of the species occurs. The quality of the remaining habitat is also deteriorating.	**MAS, SWT,** and **MAM**.	King Rails reach their northern limit in southern Ontario, where they are quite rare. Recent province-wide surveys suggest there are only about 30 pairs left, the majority of which are in the large wetlands bordering Lake St. Clair. Most of the remainder are found in several key coastal marshes along Lakes Erie and Ontario. In Canada, the species breeds only in the extreme southern part of Ontario. It is thought that the King Rail was quite common in some southern Ontario marshes, although there is no early information on population numbers and the area occupied.	eBird	Low No suitable habitat observed within Study Areas.

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Birds	Kirtland's Warbler *Setophaga kirtlandii*	END	END Schedule 1	END	Kirtland's Warblers have very specific habitat requirements, typically nesting in well-drained sandy soils covered in large forests of young Jack Pine, a habitat often created by fire. They lay their nests on the ground, hidden away under low living branches of young Jack Pines with a thick cover of understory plants, such as grasses, Sweet-fern, and blueberry. Mature pines that no longer have branches near the ground do not provide sufficient cover. During the breeding season, Kirtland's Warbler is restricted to young Jack Pine growing in dense stands with small openings. It prefers young Jack Pine to mature pines, which do not have branches near the ground. These stands may have regenerated after wildfire or timber harvest. Today, however, most Kirtland's Warblers breed in Jack Pine plantations specifically managed for this bird species. The species is typically found in tracts of forest larger than 30 ha, and the percentage of nests with fledglings (i.e., breeding success) is highest in stands that are larger than 80 ha. Kirtland's Warblers nest on the ground on well-drained, sandy soils where blueberries typically grow. It is difficult to determine habitat trends for Kirtland's Warbler because, unless specific management is undertaken, preferred habitat is constantly changing as stands mature. However, it appears likely that suitable habitat is not limited in Canada.		A few are seen annually at Point Pelee National Park and other migration hotspots in southwestern Ontario, and they have long been suspected of occasional nesting in Ontario, in pockets of suitable habitat. To date, breeding evidence has been acquired at only two sites, the most recent being in 2007 at Canadian Forces Base Petawawa. Kirtland's Warbler breeds in Michigan, Wisconsin, Ontario and possibly Quebec. The species has been reported from Minaki, Ontario, in the west, to Kazabazua, Quebec, in the east. The earliest records of Kirtland's Warbler in Canada date back to 1900. Singing males in suitable breeding habitat have been recorded sporadically since the early 1900's, particularly in the Petawawa area. There are two confirmed breeding locations in Ontario, Canada. One is from 1945 near Barrie, Ontario, and then a small population has been successfully breeding at Garrison Petawawa from 2007 through 2015.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Least Bittern *Ixobrychus exilis*	THR	THR Schedule 1	THR	In Ontario, the Least Bittern is found in a variety of wetland habitats, but strongly prefers cattail marshes with a mix of open pools and channels. This bird builds its nest above the marsh water in stands of dense vegetation, hidden among the cattails. The nests are almost always built near open water, which is needed for foraging. This species eats mostly frogs, small fish, and aquatic insects. The Least Bittern breeds strictly in marshes dominated by emergent vegetation surrounded by areas of open water. Most breeding grounds in Canada are dominated by cattails, but breeding also occurs in areas with other robust emergent plants and in shrubby swamps. The presence of stands of dense vegetation is essential for nesting because the nests of Least Bittern sit on platforms of stiff stems. The nests are almost always within 10 m of open water. Open water is also needed for foraging, because Least Bitterns forage by ambushing their prey in shallow water near marsh edges, often from platforms that they construct out of bent vegetation. Access to clear water is essential for the birds to see their prey. This small heron prefers large marshes that have relatively stable water levels throughout the nesting period. Adults can raise nests somewhat to deal with rising waters, but persistent or sudden increases will flood nests. Conversely, drops in water level can reduce foraging opportunities and increase the species' exposure to predators. Needs for wintering habitat are less specific, and appear to be met by a wide variety of wetlands—not only emergent marshes like those used for breeding, but also brackish and saline swamps. Habitat use during migration is poorly known, but presumably is similar to breeding and wintering habitat.	**MAS2-1, MAS3-1, SA** and **OAO**.	In Ontario, the Least Bittern is mostly found south of the Canadian Shield, especially in the central and eastern part of the province. Small numbers also breed occasionally in northwest Ontario. This species has disappeared from much of its former range, especially in southwestern Ontario, where wetland loss has been most severe. The Least Bittern breeds from southern Canada to South America. In Canada, the Least Bittern has been observed in every province, but most individuals occur in Ontario. The species breeds primarily in southern Ontario.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Peregrine Falcon *Falco peregrinus* Peregrine Falcon (anatum/tundrius) *Falco peregrinus anatum/tundrius*	SC	SC Schedule 1	Not At Risk	Peregrine Falcons usually nest on tall, steep cliff ledges close to large bodies of water. Although most people associate Peregrine Falcons with rugged wilderness, some of these birds have adapted well to city life. Urban peregrines raise their young on ledges of tall buildings, even in busy downtown areas. Cities offer peregrines a good year-round supply of pigeons and starlings to feed on. The Peregrine Falcon is found in various types of habitats, from Arctic tundra to coastal areas and from prairies to urban centres. It usually nests alone on cliff ledges or crevices, preferably 50 to 200 m in height, but sometimes on the ledges of tall buildings or bridges, always near good foraging areas. Suitable nesting sites are usually dispersed, but can be common locally in some areas. The natural nesting habitat has not changed significantly since the population crash and is still largely available. In addition, structures built by humans in both rural and urban areas provide the Peregrine Falcon with other potential nesting sites. And though urbanization and other land uses have had a significant impact on some areas where they feed, Peregrine Falcons can usually modify their diet based on the prey species present in a given area.	**CLO**	The historic North American distribution of the eastern subspecies is east of the Rocky Mountains and south of the tree line. Although Peregrine Falcons now nest in and around Toronto and several other southern Ontario cities, the majority of Ontario's breeding population is found around Lake Superior in northwestern Ontario. The anatum Peregrine Falcon breeds in the interior of Alaska and throughout northern Canada up to southern Greenland, and across continental North America up to northern Mexico. In Canada it is found in all territories and provinces except Prince Edward Island, Nunavut, and the Island of Newfoundland. The tundrius Peregrine Falcon breeds in Alaska and throughout northern Canada up to Greenland. In Canada, it breeds from northern Yukon, the low Arctic islands, northern Northwest Territories, and northern Nunavut up to Baffin Island, Hudson Bay, Ungava, and northern Labrador.	eBird	Low No suitable habitat observed within Study Areas.

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Associated ELC Communities	Known Species Range[1, 2]	Source Identifying Species Record	Species/Habitat Observed
Birds	Piping Plover *Charadrius melodus* Piping Plover (circumcinctus subspecies) *Charadrius melodus circumcinctus*	END	END Schedule 1	END	Piping Plovers nest exclusively on dry sandy or gravelly beaches just above the reach of high water and waves. When not migrating, this bird spends virtually all of its time between the water's edge and the back of the beach. It pecks the sand and searches small pools of water for food - mostly insects and small crustaceans.	**BBO**	In North America, the Piping Plover primarily breeds along the Atlantic coast, the western Great Lakes, and along wetlands, rivers, and lakes in the northern Great Plains. In Ontario, although never common, they breed along the shores of the Great Lakes, and at Lake of the Woods in northwestern Ontario. The circumcinctus subspecies of the Piping Plover is a North American bird that breeds on the American shores of the Great Lakes (Michigan) and throughout the Great Plains from the southern Canadian prairies to Nebraska. In Canada, the circumcinctus subspecies breeds in central Alberta, southern Saskatchewan, southern Manitoba, and used to breed in southern Ontario. The numbers of Piping Plovers have been decreasing everywhere. However, the most dramatic declines have occurred in the Great Lakes region. The last known nesting of Piping Plovers on the Canadian Great Lakes occurred at Long Point in 1977.	eBird	Low No suitable habitat observed within Study Areas.
Birds	Red-headed Woodpecker *Melanerpes erythrocephalus*	END	THR Schedule 1	END	The Red-headed Woodpecker lives in open woodland and woodland edges, and is often found in parks, golf courses, and cemeteries. These areas typically have many dead trees, which the bird uses for nesting and perching. A few of these birds will stay the winter in woodlands in southern Ontario if there are adequate supplies of nuts. The Red-headed Woodpecker is found in a variety of habitats, including oak and beech forests, grasslands, forest edges, orchards, pastures, riparian forests, roadsides, beaver ponds, and burns.	**TPS, TPW, CUW, FOD1, FOD2, FOD4-1, FOD6, FOD7**, and **FOD9** that are open and have an abundance of dead trees.	The Red-headed Woodpecker is found across southern Ontario, where it is widespread but rare. In Canada, its range includes southern Saskatchewan, Manitoba, Ontario, and Quebec.	eBird	Medium Cavity trees within woodlands or forest egdes may provide nesting habitat.
Birds	Wood Thrush *Hylocichla mustelina*	SC	THR Schedule 1	THR	The Wood Thrush lives in mature deciduous and mixed (conifer-deciduous) forests. They seek moist stands of trees with well-developed undergrowth and tall trees for singing perches. These birds prefer large forests, but will also use smaller stands of trees. They build their nests in living saplings, trees, or shrubs, usually in Sugar Maple or American Beech. In Canada, the Wood Thrush nests mainly in second-growth and mature deciduous and mixed forests, with saplings and well-developed understory layers. This species prefers large forest mosaics, but may also nest in small forest fragments.	**FOD** and **FOM** that are greater than 1 ha in size.	The Wood Thrush is found all across southern Ontario. It is also found, but less common, along the north shore of Lake Huron, as far west as the southeastern tip of Lake Superior. There is a very small population near Lake of the Woods in northwestern Ontario, and there have been scattered sightings in the mixed forest of northern Ontario. The Wood Thrush breeds in southeastern Canada from southern Ontario east to Nova Scotia.	eBird	Medium Study Area 2 contains suitable habitat however, species not observed during site visit.
Fish	American Eel *Anguilla rostrata*	END	No Status	THR	Over the course of its life, the American Eel can be found in both salt and fresh water. In fact, some scientists consider the American Eel to have the broadest diversity of habitats of any fish species in the world. In Canada, it is found in all fresh water, estuaries, and coastal marine waters that are accessible to the Atlantic Ocean, from Niagara Falls in the Great Lakes up to the mid- Labrador coast. American Eel can be declining in certain locations and be stable elsewhere.		In Canada, it is found in fresh water and salt water areas that are accessible from the Atlantic Ocean. This area extends from Niagara Falls in the Great Lakes up to the mid-Labrador coast. In Ontario, American Eels can be found as far inland as Algonquin Park. Once the eels mature (10-25 years) they return to the Sargasso Sea to spawn.	NHIC	Medium Study Area 2 contains suitable habitat, however species was
Fish	Shortnose Cisco *Coregonus reighardi*	END	END Schedule 1	END	In Ontario, the Shortnose Cisco lives in the deep, cold water of the Great Lakes, usually at depths between 22 to 110 metres. It has been found at depths reaching 144 metres. This species eats mostly freshwater shrimp.		The Shortnose Cisco is found only in the Great Lakes of North America. It was last seen in Lake Ontario in 1964 and in Lake Huron in 1985.	DFO	Low No suitable habitat observed within Study Areas.

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Insects	Monarch *Danaus plexippus*	SC	SC Schedule 1	END	Throughout their life cycle, Monarchs use three different types of habitat. Only the caterpillars feed on milkweed plants and are confined to meadows and open areas where milkweed grows. Adult butterflies can be found in more diverse habitats where they feed on nectar from a variety of wildflowers. Milkweeds (numerous species) are the sole food plant for Monarch caterpillars. These plants grow predominantly in open and periodically disturbed habitats such as roadsides, fields, wetlands, prairies, and open forests. Milkweeds are often planted outside their native range, and sometimes wayward Monarchs are observed at these patches. Monarchs require staging areas which are used to rest, feed, and avoid inclement weather during migration. In Canada, they are found along the north shores of the Great Lakes where Monarchs roost in trees before crossing large areas of open water.	**AI, TP,** and **CUM** where milkweed plants are present.	The Monarch's range extends from Central America to southern Canada. In Canada, Monarchs are most abundant in southern Ontario and Quebec where milkweed plants and breeding habitat are widespread. During late summer and fall, Monarchs from Ontario migrate to central Mexico where they spend the winter months. During migration, groups of Monarchs numbering in the thousands can be seen along the north shores of Lake Ontario and Lake Erie. The overall native range of the Monarch occurs from Central America northward through the continental United States to southern Canada, and from the Atlantic Coast westward to the Pacific Coast. The Canadian range of occurrence includes portions of all ten provinces and the Northwest Territories. Monarchs are loosely divided into eastern and western subgroups based on their migratory routes and overwintering sites. Eastern Monarchs breed from Alberta east to Nova Scotia and migrate south to overwinter in the mountains of Central Mexico. The breeding range in Canada is south of the 50° latitude in Ontario, Quebec, and the Maritimes. Each fall hundreds of thousands of Monarchs migrate through Long Point in southern Ontario but it's unknown what proportion of the Canadian population these individuals represent.	OBA	Low No meadow communitues with milkweed species observed.
Mammals	Eastern Small-footed Myotis (Eastern Small-footed Bat) *Myotis leibii*	END	N/A	N/A	In the spring and summer, Eastern Small-footed Bats will roost in a variety of habitats, including in or under rocks, in rock outcrops, in buildings, under bridges, or in caves, mines, or hollow trees. These bats often change their roosting locations every day. At night, they hunt for insects to eat, including beetles, mosquitos, moths, and flies. In the winter, these bats hibernate, most often in caves and abandoned mines. They seem to choose colder and drier sites than similar bats and will return to the same spot each year.		The Eastern Small-footed Bat has been found from south of Georgian Bay to Lake Erie and east to the Pembroke area. There are also records from the Bruce Peninsula, the Espanola area, and Lake Superior Provincial Park. Most documented sightings are of bats in their winter hibernation sites.	BCI	Medium Suitable habitat may be present within forested communities in Study Area 2 and woodlands in Study Area 1.
Mammals	Little Brown Myotis (Little Brown Bat) *Myotis lucifugus*	END	END Schedule 1	END	Bats are nocturnal. During the day they roost in trees and buildings. They often select attics, abandoned buildings, and barns for summer colonies where they can raise their young. Bats can squeeze through very tiny spaces (as small as six millimetres across) and this is how they access many roosting areas. Little Brown Bats hibernate from October or November to March or April, most often in caves or abandoned mines that are humid and remain above freezing. Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies, often in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.		The Little Brown Bat is widespread in southern Ontario and found as far north as Moose Factory and Favourable Lake. In Canada, *Myotis lucifugus* occurs from Newfoundland to British Columbia, and northward to near the treeline in Labrador, Northwest Territories and Yukon.	BCI	Medium Suitable habitat may be present within forested communities in Study Area 2 and woodlands in Study Area 1.
Mammals	Northern Myotis (Northern Long-eared Bat) *Myotis septentrionalis*	END	END Schedule 1	END	Northern Long-eared Bats are associated with boreal forests, choosing to roost under loose bark and in the cavities of trees. These bats hibernate from October or November to March or April. The Northern Long-eared Bat overwinters in cold and humid hibernacula (caves/mines). Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies in buildings or large-diameter trees. Foraging occurs along waterways, forest edges, and in gaps in the forest. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.	**FOC, FOM, FOD, SWC, SWM,** and **SWD** where suitable roosting (i.e. cavity trees and trees with loose bark) habitat is available.	The Northern Long-eared Bat is found throughout forested areas in southern Ontario, to the north shore of Lake Superior and occasionally as far north as Moosonee, and west to Lake Nipigon. In Canada, *Myotis septentrionalis* occurs from Newfoundland to British Columbia, and northward to near the treeline in Labrador, Northwest Territories, and Yukon.	BCI	Medium Suitable habitat may be present within forested communities in Study Area 2 and woodlands in Study Area 1.

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Mammals	Tri-colored Bat *Perimyotis subflavus*	END	END Schedule 1	END	During the summer, the Tri-colored Bat is found in a variety of forested habitats. It forms day roosts and maternity colonies in older forest and occasionally in barns or other structures. They forage over water and along streams in the forest. Tri-colored Bats eat flying insects and spiders gleaned from webs. At the end of the summer they travel to a location where they swarm; it is generally near the cave or underground location where they will overwinter. They overwinter in caves where they typically roost by themselves rather than part of a group. The Tri-colored Bat overwinters in cold and humid hibernacula (caves/mines). Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.		This bat is found in southern Ontario and as far north as Espanola near Sudbury. Because it is very rare, it has a scattered distribution. It is also found from eastern North America down to Central America. In Canada, *Perimyotis subflavus* occurs in Nova Scotia, New Brunswick, Quebec, and Ontario.	BCI	Medium Suitable habitat may be present within forested communities in Study Area 2 and woodlands in Study Area 1.
Plants	Butternut *Juglans cinerea*	END	END Schedule 1	END	In Ontario, Butternut usually grows alone or in small groups in deciduous forests. It prefers moist, well-drained soil and is often found along streams. It is also found on well-drained gravel sites and rarely on dry, rocky soil. This species does not do well in the shade, and often grows in sunny openings and near forest edges. Butternut occurs primarily in neutral to calcareous soils of pH 5.5 to 8, often in regions with underlying limestone, and is generally absent from acidic regions. It tends to reach greatest abundance in rich well-drained mesic loams in floodplains, streambanks, terraces, and ravine slopes, but can occur in a wide range of other situations. In closed-canopy stands, it must be in the overstory to thrive. Seedling establishment, growth, and survival to maturity are most frequent in stand openings, riparian zones, and forest edges.	**FOD** and mature hedgerows; Soil: dry rocky or moist (4, 5, 6) to fresh (2, 3).	Butternut can be found throughout central and eastern North America. In Ontario, this species is found throughout the southwest, north to the Bruce Peninsula, and south of the Canadian Shield. Butternut's native Canadian range is restricted to southern Ontario and Quebec (primarily south of the area bounded by Georgian Bay, the Ottawa Valley, and the Quebec City region), and western and southern portions of New Brunswick.	iNaturalist	Medium No individuals observed however, the entirety of Study Area 1 could not be searched due to access limitations.
Plants	Black Ash *Fraxinus nigra*	END	N/A	THR	Black Ash is a medium-sized, shade-intolerant hardwood tree species that occurs on moist to wet sites such as swamps, bogs, and riparian areas. Like other Ash (Fraxinus) species, black ash has wind-dispersed pollen and seeds and regenerates readily from seed and via stump sprouting	SWD, SWM, SWC	Black Ash occurs from western Newfoundland to southeastern Manitoba and North Dakota, ranging southward to Iowa, Illinois, Virginia and Delaware. Black Ash's range extends farther north than any other ash and approximately 51% of the species' global range is within Canada. Black Ash occurs throughout most of Ontario, except the Far North, ranging from southern Ontario east to the Quebec border, west to the Manitoba border and north to approximately 51° latitude.	iNaturalist	Medium No individuals observed however, the entirety of Study Area 1 could not be searched due to access limitations.
Reptiles	Blanding's Turtle (Great Lakes / St. Lawrence population) *Emydoidea blandingii*	THR	THR Schedule 1	END	Blanding's Turtles live in shallow water, usually in large wetlands and shallow lakes with lots of water plants. It is not unusual, though, to find them hundreds of metres from the nearest water body, especially while they are searching for a mate or traveling to a nesting site. Blanding's Turtles hibernate in the mud at the bottom of permanent water bodies from late October until the end of April. In the Great Lakes/St. Lawrence population, Blanding's Turtles are often observed using clear water, eutrophic wetlands. Blanding's Turtles have strong site fidelity but may use several connected water bodies throughout the active season. Females nest in a variety of substrates including sand, organic soil, gravel, cobblestone, and soil-filled crevices of rock outcrops. Adults and juveniles overwinter in a variety of water bodies that maintain pools averaging about 1 m in depth; however, hatchling turtles have been observed hibernating terrestrially during their first winter. Reported mean home ranges generally fall between 10-60 ha (maximum 382 ha) or 1000-2500 m (maximum 7000 m); however, most studies likely underestimate Blanding's Turtle home range size because few have utilized GPS loggers to track daily movements throughout one or more entire active seasons.	**SWT2, SWT3, SWD, SWM, MAS2, SAS1, SAM1**, where open water is present.	The Blanding's Turtle is found in and around the Great Lakes Basin, with isolated populations elsewhere in the United States and Canada. In Canada, the Blanding's Turtle is separated into the Great Lakes-St. Lawrence population and the Nova Scotia population. Blanding's Turtles can be found throughout southern, central, and eastern Ontario. In its Canadian range, the Great Lakes/St. Lawrence population of the Blanding's Turtle occurs primarily in southern Ontario (with isolated reports as far north as Timmins) and southern Québec (with isolated reports occurring as far north as the Abitibi-Témiscamingue region and as far east as the Capitale-Nationale region in Québec). Across the North American range, Blanding's Turtles mainly occur in small, isolated subpopulations that maintain a few dozen to approximately 100 turtles.	ORAA	Low Large wetlands or large shallow lakes were not present.
Reptiles	Northern Map Turtle *Graptemys geographica*	SC	SC Schedule 1	SC	The Northern Map Turtle inhabits rivers and lakeshores where it basks on emergent rocks and fallen trees throughout the spring and summer. In winter, the turtles hibernate on the bottom of deep, slow-moving sections of river. They require high-quality water that supports the female's mollusc prey. Their habitat must contain suitable basking sites, such as rocks and deadheads, with an unobstructed view from which a turtle can drop immediately into the water if startled. The Northern Map Turtle inhabits both lakes and rivers, showing a preference for slow moving currents, muddy bottoms, and abundant aquatic vegetation. These turtles need suitable basking sites (such as rocks and logs) and exposure to the sun for at least part of the day.	**OAO, SA** with emergent rocks and fallen trees suitable habitat for prey.	The Northern Map Turtle's range extends from the Great Lakes region west to Oklahoma and Kansas, south to Louisiana, and east to the Adirondack and Appalachian mountain barrier. In Canada, it is found in southwestern Quebec and southern Ontario. In southern Ontario, it lives primarily on the shores of Georgian Bay, Lake St. Clair, Lake Erie, and Lake Ontario, and along larger rivers including the Thames, Grand, and Ottawa. It reaches its northern limit in southern Ontario and southwestern Quebec, where it is associated with the Great Lakes Basin and the St. Lawrence River.	ORAA	Medium Wolfdale Creek and Credit River in Study Area 2 may provide habitat.

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Reptiles	Snapping Turtle *Chelydra serpentina*	SC	SC Schedule 1	SC	Snapping Turtles spend most of their lives in water. They prefer shallow waters so they can hide under the soft mud and leaf litter, with only their noses exposed to the surface to breathe. During the nesting season, from early to mid summer, females travel overland in search of a suitable nesting site, usually gravelly or sandy areas along streams. Snapping Turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams, and aggregate pits. Although Snapping Turtles have been observed in shallow water in almost every kind of freshwater habitat, the preferred habitat of the species is characterized by slow-moving water with a soft mud bottom and dense aquatic vegetation. Established populations are most often located in ponds, sloughs, shallow bays or river edges, and slow streams, or areas combining several of these wetland habitats. Individual turtles will persist in urbanized water bodies, such as golf course ponds and irrigation canals, but it is unlikely that a population could become established in such habitats. The Snapping Turtle can occur in highly polluted waterways, but environmental contamination is known to reduce the already low reproductive output of this species. Basking on offshore logs and protruding rocks can be common in Snapping Turtles, depending on environmental temperature. Females generally nest on sand or gravel banks along waterways. Upon emergence from the nest in early fall, hatchling Snapping Turtles usually move to water, after which they bury themselves under leaf litter or debris. Snapping Turtles overwinter underwater, buried beneath logs, sticks or overhanging banks in small streams that flow continuously throughout the winter. They can also hibernate buried in deep mud in marshy areas or beneath floating mats of vegetation. Snapping Turtle habitat is diminishing in both quantity and quality in Canada, with losses primarily due to conversion of wetlands to agriculture and urban development.	**OAO, SA** near gravelly or sandy areas.	The Snapping Turtle's range extends from Ecuador to Canada. The Snapping Turtle's range is contracting. In Canada, the species is widespread from Nova Scotia to southeastern Saskatchewan, though it is absent from northwestern Ontario, where summers are likely too cool for Snapping Turtle embryos to complete development successfully. The Snapping Turtle is therefore present in mainland Nova Scotia, southern New Brunswick, southern and central Quebec, southern and central Ontario, southern Manitoba, and southeastern Saskatchewan, primarily in the Qu'Appelle watershed.	ORAA	Medium Wolfdale Creek and Credit River in Study Area 2 may provide habitat.

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