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Report To: Municipality of West Grey Council

From: Matt Armstrong, Manager of Environmental Planning and Regulations, Saugeen Valley Conservation Authority

Date: March 18th, 2025

Subject: Durham Creek Floodplain Mapping Project

Purpose: To provide West Grey Council with an overview of the 2023-2024 Durham Creek floodplain mapping project

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Background

In January 2022, Natural Resources Canada launched the Flood Hazard Identification and Mapping Program (FHIMP) to make flood hazard information more accessible. Though this program, 165 million dollars was invested by the government of Canada to increase the resiliency of Canadians in the face of the rising frequency and costs of flood events and other climate-related disasters. Flood hazard maps inform decision-making in support of land use planning, flood mitigation, climate change adaptation, resilience building and protection of lives and properties.

Opportunity to partner with Saugeen Valley Conservation Authority (SVCA) was presented to all 15 municipalities in the Saugeen watershed. Up to 50% matched federal funding to provinces and territories was made available for eligible flood mapping projects. The Municipality of West Grey, the Town of Saugeen Shores, and the Township of Huron-Kinloss decided to proceed with mapping for the desired areas within their municipalities. SVCA was the program applicant and acted as project coordinator. Engineering companies were contracted through the Request for Proposal (RFP) process to complete all necessary modelling and mapping required to generate flood hazard maps, as well as for independent peer review.

In September 2022, West Grey Council approved a matching funding contribution of $25,000 towards floodplain mapping for Durham Creek, which was identified as a priority area by and for the Municipality of West Grey.

Through the RFP process, DM Wills Associates Ltd. was awarded the project, which included the creation of hydrologic and hydraulic models, two public consultation sessions, and the creation of a floodplain report and mapping (see attached). Due to the influence that the Saugeen River has on the Durham Creek Floodplain, modelling was also carried out for the Saugeen River.

All mapping results underwent extensive third-party review by an independent engineering consultant procured through the RFP process, and members of the provincial and federal government administering the grant program. Through this review process, all models and maps were thoroughly scrutinized with respect to the data collected, hypotheses made, and regulatory standards/guidelines. Extensive modelling calibration and a sensitivity analysis were completed to ensure that the hypotheses (where applicable) were valid and appropriate for the model being produced.

The project was completed in 2024, and Saugeen Conservation's floodplain hazard information has been updated to incorporate the floodplain mapping produced by DM Wills (page 252 and 253 of the DM Wills report). Similar to the rest of Durham, the Durham Creek floodplain is managed in accordance with Two-Zone policy. This policy divides the floodplain into two areas: the flood way, where flood depths and velocities are greatest and development is generally not permitted, and the flood fringe, where development may be permissible subject to conditions. These areas are shown in blue and red respectively on the DM Wills maps.

The DM Wills report included the following recommendations:

1. SVCA and the Municipality of West Grey should update the floodplain mapping for the Saugeen River and then consider updates to their Two-Zone floodplain planning policies and development approvals processes for both Durham Creek and the Saugeen River in alignment with the revised mapping.
2. Given the potential significant impacts of a failure of the dike at the Durham Upper Dam, the SVCA and Municipality of West Grey should consider the development of an Emergency Preparedness and Response Plan (EPRP) for the structure.

Prepared by:
[Original signed by:]
Matt Armstrong
Manager of Environmental Planning and Regulations

Approved by:
[Original signed by:]
Erik Downing
General Manager / Secretary-Treasurer

Flood Hazard Mapping Report

Durham Creek Flood Hazard Mapping Project

Municipality of West Grey, Ontario

D.M. Wills Project Number 23-5591

D.M. Wills Associates Limited
Partners in Engineering
Peterborough

March 2024

Prepared for:
Saugeen Valley
Conservation Authority

WILLS

Summary of Revisions

Revision	Revision Title	Date of Release	Summary of Revisions
1	Hydrology Report	December 18, 2023	Issued for Client Review
2	Draft FHM Report	February 26, 2024	Issued for Client Review
3	Final FHM Report	March 1, 2024	Issued as Final

This report / proposal has been formatted considering the requirements of the Accessibility for Ontarians with Disabilities Act.

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1.0 Introduction

1.1 Background

The Saugeen Valley Conservation Authority (SVCA), in partnership with the Municipality of West Grey, has recognized the need to develop hydrologic and hydraulic modelling and regulatory flood hazard mapping for Durham Creek in the Town of Durham, Municipality of West Grey, Ontario. There is no existing flood hazard mapping for Durham Creek. Funding for this project is provided, in part, through the Flood Hazard Identification Mapping Program (FHIMP), which, in Ontario, is administered by the Ministry of Natural Resources and Forestry (MNRF).

1.2 Objective

The objective of this project is to provide regulatory flood hazard and flood risk mapping for Durham Creek. In addition to this work, this report covers the development of hydrologic and hydraulic models for the Saugeen River through Durham, Ontario, in order to assess the spill from the Saugeen River into Durham Creek at the Durham Upper Dam. Durham Creek extends approximately 1.3 km northeast from its confluence with the Saugeen River, which is located approximately 50 m west of the intersection of Countess Street South and South Street West. The drainage area for the Durham Creek watershed upstream of the confluence with the Saugeen River was calculated to be 0.87 km^2. The drainage area for Saugeen River upstream of the Durham Upper Dam was calculated to be 347.3 km^2.

1.3 Study Process and Report Organization

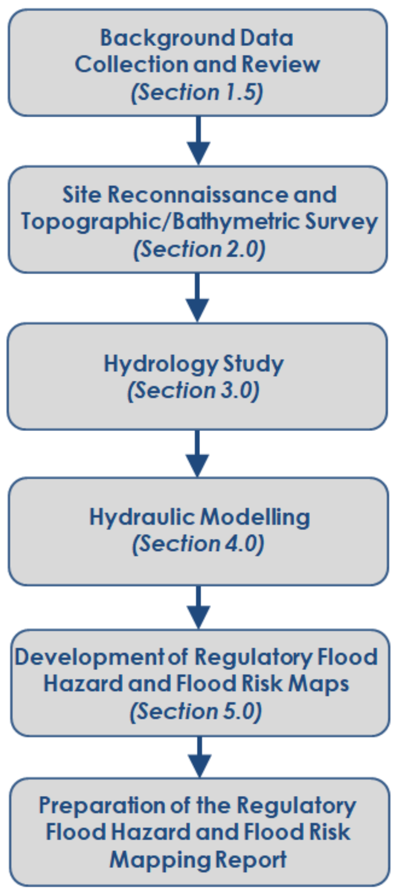
The regulatory floodplain and flood risk mapping study process is documented in Figure 1 and generally involves the following key phases:

- Background Data Collection and Review – The background data collection and review involved the collection and review of available background information from the SVCA and Municipality of West Grey. The available information is summarized in Section 1.5.
- Site Reconnaissance and Topographic/Bathymetric Survey – The site reconnaissance and topographic/bathymetric survey involved field work to survey and photograph existing bridge/culvert structures and collect in-water creek cross sections to supplement the LiDAR data. The outputs from the site reconnaissance are used as inputs into the hydraulic modelling. The site reconnaissance and topographic/bathymetric survey is described in Section 2.0.
- Hydrology Study – The hydrology study included the delineation of the Durham Creek watershed, delineation of the applicable Saugeen River watershed and sub-watersheds, characterization of the sub-watersheds, development of a HEC-HMS (Version 4.11) model, and calibration/validation of the HEC-HMS model. The outputs from the hydrology study are the Regional Storm (Hurricane Hazel), and Annual Exceedance Probability peak flow rates, which are used as inputs into

the hydraulic modelling. The hydrology study is described in Section 3.0 of this report.

- Hydraulic Modelling – The hydraulic modelling will include the preparation of the base topographic data and the development of a two-dimensional (2D) unsteady-state HEC-RAS model. The model will be created using HEC-RAS (Version 6.4.1). The development of the hydraulic model is described in Section 4.0.
- Development of Regulatory Flood Hazard and Flood Risk Maps – The development of regulatory flood hazard and flood risk maps involves using the outputs from the hydraulic modelling to create the final mapping products in ArcGIS. The outputs from this phase of the project include both paper/pdf maps as well as digital flood lines. The development of the regulatory flood hazard and flood risk maps is described in Section 5.0.
- Preparation of the Regulatory Flood Hazard and Flood Risk Mapping Report – This report documents the inputs and results of all analyses associated with the project as well as the final results.

Figure 1 – Study Process



1.4 Study Area

The primary focus of this study is on Durham Creek and the section of the Saugeen River flowing through the Town of Durham, in the Municipality of West Grey, Ontario. Durham Creek extends approximately 1.3 km northeast from its confluence with the Saugeen River. The Saugeen River study area starts just north of the Grey County Road 4 bridge crossing and extends upstream approximately 8.5 km through the Town of Durham, ending before the Concession Road 2 bridge crossing. The full extent of the study area is shown in Figure 2.

There are four bridges and three dams along the Saugeen River and there are 23 culverts and foot bridges along Durham Creek. Each bridge, culvert, and dam, as well as the upstream and downstream bathymetry (where possible), was surveyed as part of the study. Additional discussion on the site reconnaissance and topographic and bathymetric survey is provided in Section 2.0.

While the hydraulic modelling and flood hazard mapping are limited to the extents described above for Durham Creek, the hydrology study included the full extent of the Saugeen River watershed upstream of the Grey County Road 4 bridge crossing. Additional discussion on the hydrology study, including the catchment and sub-catchment area plans, is provided in Section 3.0.

1.5 Available Information

There have been several projects addressing the hydrology and flooding of the Saugeen River and Durham Creek, dating as far back as 1966. Table 1 shows a list of the background studies and previous maps provided by SVCA as background for this project.

Table 1 – Background Information Provided

Report / Model	Description	Date
Historical Flood Records	Multiple documents reviewed for background information review.	Multiple
Durham Upper Dam Drawings	Durham Upper Dam Repair Drawings	1966
Durham Upper Dam Drawings	Plan, Sections, and drawings for the Durham Upper Dam and Dike.	1976
Durham Upper Dam Site Report	Site Investigation for the Durham Upper Dam	1976
Durham Lower Dam Drawings	Engineered Drawing for the Durham Lower Dam	1978/1982
Floodline Mapping Study	Floodplain mapping report for the Town of Durham completed by Latham Group	1983

Report / Model	Description	Date
Durham Upper Dam Hydraulic Assessment	Hydraulic Assessment of the Durham Upper Dam for the purposes of Dam Safety completed by WESA.	2009
LiDAR Mapping	Ontario Elevation Mapping Program.	2023
Existing GIS Data	Existing GIS data files of existing floodlines, floodplain data and aerial imagery.	Unknown
Stream Gauge Data	Stream gauge data for multiple gauges in the area of the site.	Data up to 2023
West Grey Official Plan	Official Plan for the Municipality of West Grey.	2012
Grey County Official Plan	Official Plan for Grey County, including Appendices A to E, Schedules A, B and C, and Secondary Schedules.	2019

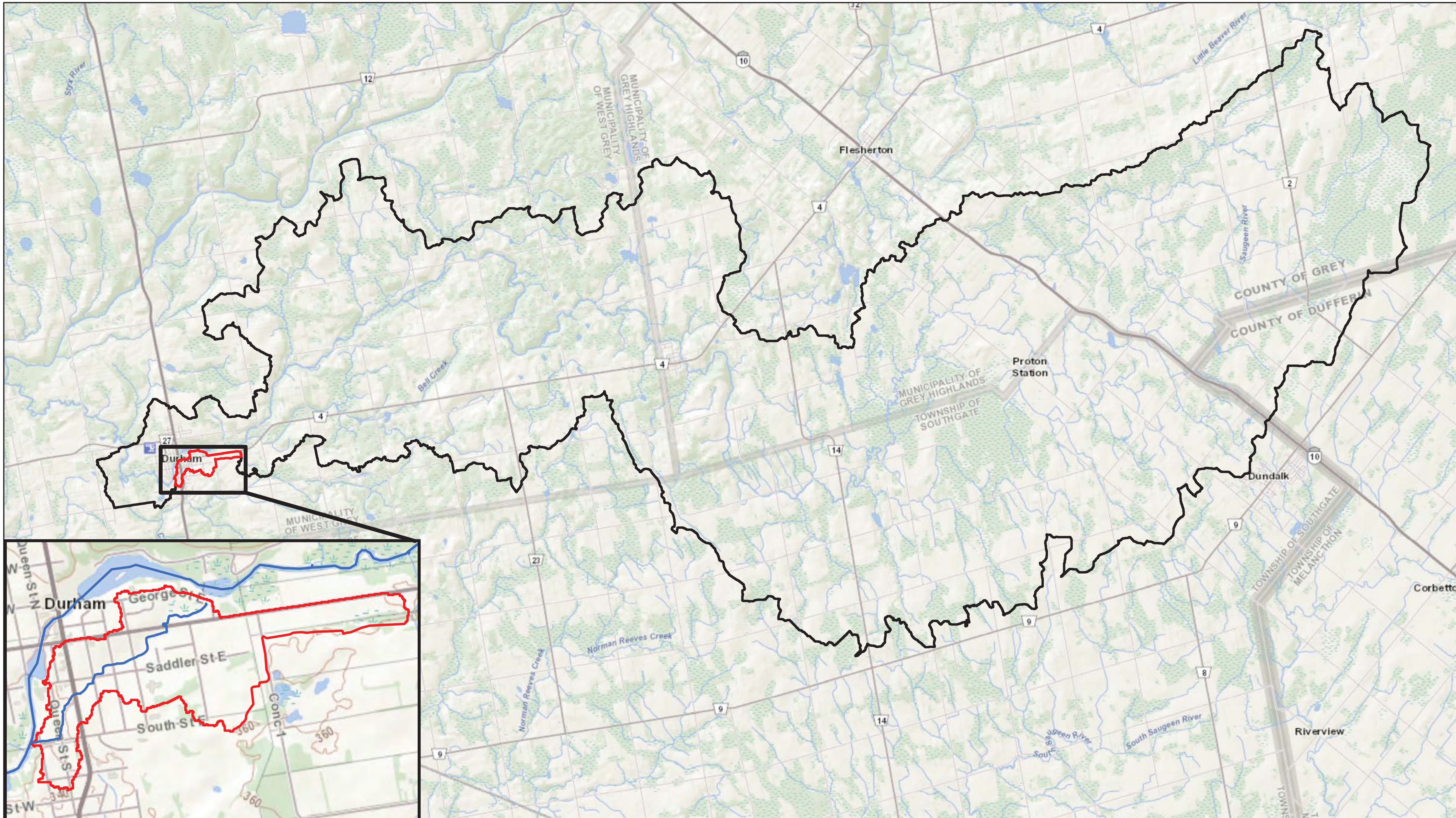


Figure 2
Saugeen and Durham
Creek Watersheds

Legend

- Subwatershed Boundary
- Durham Creek Watershed Boundary

Data Sources:
Soil Survey Complex, GEOHUB 2023
SCOOP 2010, GEOHUB 2023

NAD 1983 UTM Zone 17N
1:110,000
Meters
0 2,500 5,000

N

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2.0 Site Reconnaissance and Topographic/Bathymetric Survey

2.1 Overview

The development of the hydraulic model and regulatory flood hazard and flood risk maps requires the use of topographic and bathymetric survey data. The primary source of topographic data for this project was the LiDAR Digital Terrain Model (DTM) that was provided by the Ministry of Natural Resources and Forestry (MNRF). The LiDAR DTM was supplemented with topographic survey of bridges, culverts, dams, and bathymetric survey of representative channel cross-sections. Wills' survey was completed in July 2023.

2.2 LiDAR Digital Elevation Model

The primary source of topographic data for this project was the LiDAR-derived Ontario Digital Terrain Model (DTM) that was provided by the MNRF through Ontario GeoHub. The DTM represents the bare earth surface and was generated from the classified LiDAR point cloud data. The User Guide, Digital Terrain Model (Lidar Derived) (MNRF, 2023), identifies the coordinate reference systems used as:

> The horizontal datum of the products is the North American Datum of 1983 Canadian Spatial Reference System epoch 2010 (NAD83 (CSRS)). The horizontal unit of measure (coordinate system axis units) for all raster grid cells is metres (m).
>
> The vertical coordinate system of the products is based on the Canadian Geodetic Vertical Datum 2013 (CGVD 2013) of the Geodetic Survey Division and is measured in metres (m).

The User Guide, Digital Terrain Model (Lidar Derived) (MNRF, 2023) indicated that the DEDSFM Huron-Georgian Bay LiDAR data that was utilized as part of the Durham Creek flood hazard mapping project has a non-vegetated vertical accuracy of 8.5 cm at a 95% confidence level (MNRF, 2023), and a vegetated accuracy of 10.06 cm. Further information regarding the accuracy and quality of the DTM can be found in the User Guide, Ontario Digital Terrain Model (LiDAR-Derived) (MNRF, 2023).

A comparison of the topographic survey and LiDAR DTM to determine whether the LiDAR DTM and topographic survey data points were generally within the expected margin of error of the survey equipment (+/- 0.10 m) was completed as part of the hydraulic report.

The DTM was used to create the overbank portions of cross sections for input into the hydraulic model. The DTM was also used as the base dataset to create the regulatory flood hazard and flood risk maps. All coordinates used throughout this study are expressed using NAD83 (CSRS) horizontal datum and CGVD2013 vertical datum. All future development proposals within the regulated area of Durham Creek will need to be presented on the same coordinate system to ensure a direct comparison, including referencing a control monument of appropriate accuracy.

2.3 Topographic and Bathymetric Survey

The LiDAR DTM does not include the channel surface below the water level and does not define the hydraulic conveyance characteristics of the bridges, culverts, or dams, therefore, topographic and bathymetric survey was required. Wills undertook the topographic and bathymetric survey in July 2023 using a survey grade GPS rover and total station survey equipment. The horizontal datum used in the survey was NAD83 (CSRS), and the vertical datum used in the survey was CGVD 2013 to be consistent with the LiDAR data.

As part of the topographic survey, Wills surveyed each bridge, culvert and dam crossing of Durham Creek and the Saugeen River. This survey included 30 bridges, culverts, and dams. The survey of these structures was performed with the intention of gathering the information required for the development of the hydraulic model. The bridge surveys collected elevations related to the top of deck, soffit, abutments, flow obstructions (such as barrier walls) and the overflow surface (weir flow). The culvert surveys collected elevations related to inverts, obverts, dimensions, flow obstructions (such as barrier walls) and the overflow surface (weir flow).

Bathymetric cross-sections were surveyed upstream and downstream of each bridge, culvert, and dam structure, where possible. Full creek and river cross-sections were surveyed when possible; however, there were some locations that could not be safely accessed due to water level and flow conditions in the Saugeen River. Where possible, additional cross-sections were surveyed upstream and downstream of the bridge, culvert, or dam to assist with defining the overall slope for each reach of the creek and define the bathymetry of the channel between structures.

The results of the survey, along with numerous other field measurements, were used to define the structures and channel bathymetry within the hydraulic model.

3.0 Hydrology Study

3.1 Overview

The purpose of the hydrology study is to determine the peak flows at key locations along Durham Creek and the Saugeen River for the 1% Annual Exceedance Probability (AEP) return period as well as the Regional Storm (Hurricane Hazel). The results of the hydrology study are the key inputs into the hydraulic model. The regulatory flood event for the SVCA is the flood produced by the Hurricane Hazel storm or the 1% AEP flood, whichever is greater.

The hydrology study involved the development, calibration, and validation of a new hydrologic model using HEC-HMS (Version 4.11). The hydrologic model development included the following tasks:

- Delineation of the Durham Creek and Saugeen River catchments and sub-catchments.
- Characterization of the Durham Creek and Saugeen River catchments and sub-catchments.
- Characterization of channel routing elements.
- Development of return period storms and the Hurricane Hazel hyetographs.

Traditional calibration was possible as there is a flow gauge in the Saugeen River Watershed. Wills validated the results of the of the HEC-HMS model by comparing the hydrologic modeling results to measured flows from Water Survey of Canada Station 02FC016 (Saugeen River Above Durham).

The following sections describe the background information used in the analyses, presents the results of the hydrology study, and identify the peak flows to be used in the hydraulic model.

3.2 Available Data

3.2.1 Precipitation Data and Design Storms

3.2.1.1 Annual Exceedance Probability Storm Event and Distribution

The 1% Annual Exceedance Probability (AEP) total rainfall volume for Durham Creek is based on the Intensity-Duration-Frequency (IDF) parameters in Durham in the Municipality of West Grey and come from the MTO IDF Curve Lookup Tool. The IDF parameters and additional information regarding MTO IDF Curve Lookup Tool data sources and development are provided in Appendix B1.

The 1% AEP total rainfall volume for the Saugeen River was calculated using a single station frequency analysis. The single station frequency analysis utilized one Water Survey of Canada station that is located within the Saugeen River watershed on the Saugeen River, just upstream of the Town of Durham. Further information regarding the single station frequency analysis can be found in Section 3.5.2.

The total rainfall volumes were distributed based on various synthetic storm distributions for use within the hydrologic model. The most common synthetic storm distributions for the purposes of flood hazard mapping are the 12-hour AES storm distribution, and the 6-hour, 12-hour, and 24-hour SCS Type II storm distributions. The 6-hour SCS Type II storm was used in the hydrologic model to estimate the peak flows for Durham Creek. Rationale for choosing the 6-hour duration is discussed in Section 3.3.10.

3.2.1.2 Regional (Hurricane Hazel) Storm

The Regional Storm is considered the worst storm on record to have hit a particular region. As per the Technical Guide - River and Stream Systems: Flood Hazard Limit (MNR, 2002), Figure B-1, the Durham Creek and Saugeen River watersheds are within Zone 1, meaning that the Regional Storm is the Hurricane Hazel Storm.

Hurricane Hazel was adopted by the Ministry of Natural Resources as the storm for watersheds located within Zone 1. The 48-hour storm was developed from rainfall gauge data located at Snelgrove, just north of Brampton. The full storm is to be applied to watersheds with areas less than 25 km^2, with an areal reduction factor applied for larger drainage areas. The rainfall distribution for the Hazel Storm is based on the Technical Guide - River and Stream Systems: Flood Hazard Limit (MNR, 2002); the rainfall hyetograph is included in Appendix B1.

3.2.1.3 Climate Change

Wills completed a climate change scenario for the Hurricane Hazel storm based on the methodology provided by the project team for incorporating climate change in the FHIMP where the Regulatory Storm Event is Hazel. The suggested method for incorporating climate change for flood hazard modelling under FHIMP is based on recommendations by Environment and Climate Change Canada (ECCC) and can be found on the climate data portal. The method described by ECCC is outlined as follows:

1. Obtain the hyetograph for the regulatory storm to obtain the hourly rainfall intensity.
2. Obtain the mean annual temperature change (ΔT) for the specified location from the federal climate data portal. The MNRF recommends obtaining this value for the 50th percentile of the mean annual temperature change for the RCP 4.5 scenario (using CMIP 5) for time horizon 2050. The mean annual temperature change for the RCP 4.5 was 2.94 °C for Durham Creek.
3. Calculate the future estimated rainfall intensity, R_P, using the equation below, where R_C is the historic estimate rainfall intensity and ΔT is the long term (30-year mean) annual mean temperature change.

$$R_p = R_c x 1.07^{\Delta T}$$

4. Apply the future estimated rainfall (R_P)to a hydrologic model to produce estimated flood flows.

The results of applying the estimated future intensity for the Hurricane Hazel storm for climate change scenario RCP 4.5 in the year 2051 for Durham, Ontario can be found in Table 2.

Table 2 – Estimated Future Intensity of Hurricane Hazel Storm

Time (hrs)	Historic Estimated Intensity Hazel (mm/hr)	% of the Last 12 Hours	Future Estimated **Intensity ΔT=2.94**	% Increase in Intensity
First 36 hours	2.0	-	0.0	22.0%
37.0	6.0	3.0	7.3	22.0%
38.0	4.0	2.0	4.9	22.0%
39.0	6.0	3.0	7.3	22.0%

Time (hrs)	Historic Estimated Intensity Hazel (mm/hr)	% of the Last 12 Hours	Future Estimated **Intensity ΔT=2.94**	% Increase in Intensity
40.0	13.0	6.0	15.9	22.0%
41.0	17.0	8.0	20.7	22.0%
42.0	13.0	6.0	15.9	22.0%
43.0	23.0	11.0	28.1	22.0%
44.0	13.0	6.0	15.9	22.0%
45.0	13.0	6.0	15.9	22.0%
46.0	53.0	25.0	64.7	22.0%
47.0	38.0	18.0	46.4	22.0%
48.0	13.0	6.0	15.9	22.0%
Total	285.0	100.0	347.7	22.0%

Application of this climate change scenario resulted in a total of 347.7 mm representing a 22.0% increase in rainfall volume and intensity over the historic storm. The same methodology was applied to the 4%, 2%, 1% AEP storm durations and can be found in Appendix B.

3.2.2 Land Cover and Soils Data

Soils data was obtained from the Soil Survey Complex GIS Data available on GeoHub for southern Ontario. In 2015, the Ontario Ministry of Agriculture, Food and Rural Affairs and Agriculture (OMAFRA) and Agri-Food Canada, in cooperation with the Ministry of Natural Resources, compiled a geo-spatial soils database for southern Ontario. The database consolidated the existing digital soil data, mapped on a county basis, into a digitally stitched and standardized product. The GIS data indicate that the Saugeen River watershed soils consists of mostly loam in the lower basin, and organic and silty loam in the upper basin. The GIS data also indicates that most of the Durham Creek Watershed is unavailable but has sandy loam in the middle basin, and Loam in the upper basin. For the purposes of this study the lower two basins were assumed to be sandy loam and the upper basin was assumed to be loam. The soils map is included in Figure 3.

The data used to define the land cover within the Saugeen River and Durham Creek watersheds were the Southern Ontario Land Resource Information System V3.0 (SOLRIS). The data was downloaded from the MNRF's GeoHub database. SOLRIS is a landscape level inventory of natural, rural, and urban areas for the Province of Ontario with a 15 m resolution (MNRF, 2019). There are 32 landcover types in SOLRIS and these were consolidated by Wills to 7 land cover types with similar hydrologic parameters for the purposes of this study. For example swamp and thicket swamp were grouped as "wetland", and deciduous forest and coniferous forest were grouped as "forest" (MNRF, 2019). The Saugeen River Watershed is primarily comprised of agricultural land, wetlands, and forest, while the Durham Creek Watershed is primarily built-up area and agricultural land. The land cover map is included in Figure 4.

3.2.3 Ontario Base Map Data

Ontario Base Map (OBM) data were downloaded from the MNRF's GeoHub database. The data used in this study included watercourses, wetlands, woods, and roads.

3.2.4 LiDAR Digital Terrain Model and Catchment Delineation

The primary source of topographic data for the hydrology study was the LiDAR DTM that was provided through the MNRF's GeoHub. The LiDAR for this project was collected as part of the DEDSFM Huron-Georgian Bay Project in 2022-23. The DTM represents the bare earth surface and was generated from the classified LiDAR point cloud data. Published vertical accuracy for the DEDSFM Huron-Georgian Bay Project is 8.5 cm in non-vegetated conditions and 10.06 cm in vegetated conditions (MNRF, 2023). Native Resolution of the DTM was 50 cm and was used for determining characteristics cross sections and slope data. This DTM was resampled to a 5 m resolution and was used to delineate the Saugeen River and Durham Creek basins and subbasins and longest flow paths with HEC-HMS. A map of the subbasins can be found in Figure 5.

3.2.5 Recorded Hydrometric Data

The maximum annual instantaneous discharge data and maximum annual daily discharge data were downloaded from the Water Survey of Canada website for the stream gauge station shown in Table 3. There is no discharge data available for Durham Creek.

Table 3 – Recorded Hydrometric Data

River	Station ID	Co-ordinates	Subasin Area (km^2)	Period of Record (years)
Saugeen River Above Durham	02FC016	44°11'07" N 80°47'14" W	329.0	39

The annual instantaneous peak flow data were used to complete a Single Station Frequency Analysis for the stream gauging station, the results of which were used to assist with the development and calibration of the hydrologic model.

3.2.6 Municipal Layers

Wills received Official Plans and a geodatabase for the Municipality of West Grey and Grey County. Based on the review of the Official Plan and Zoning, no areas of significant future development were identified. It is anticipated that any future land use conditions in the Town of Durham or within the Saugeen River Watershed as a whole will be similar to the current conditions. A map of the future land use conditions can be found in Appendix B4.

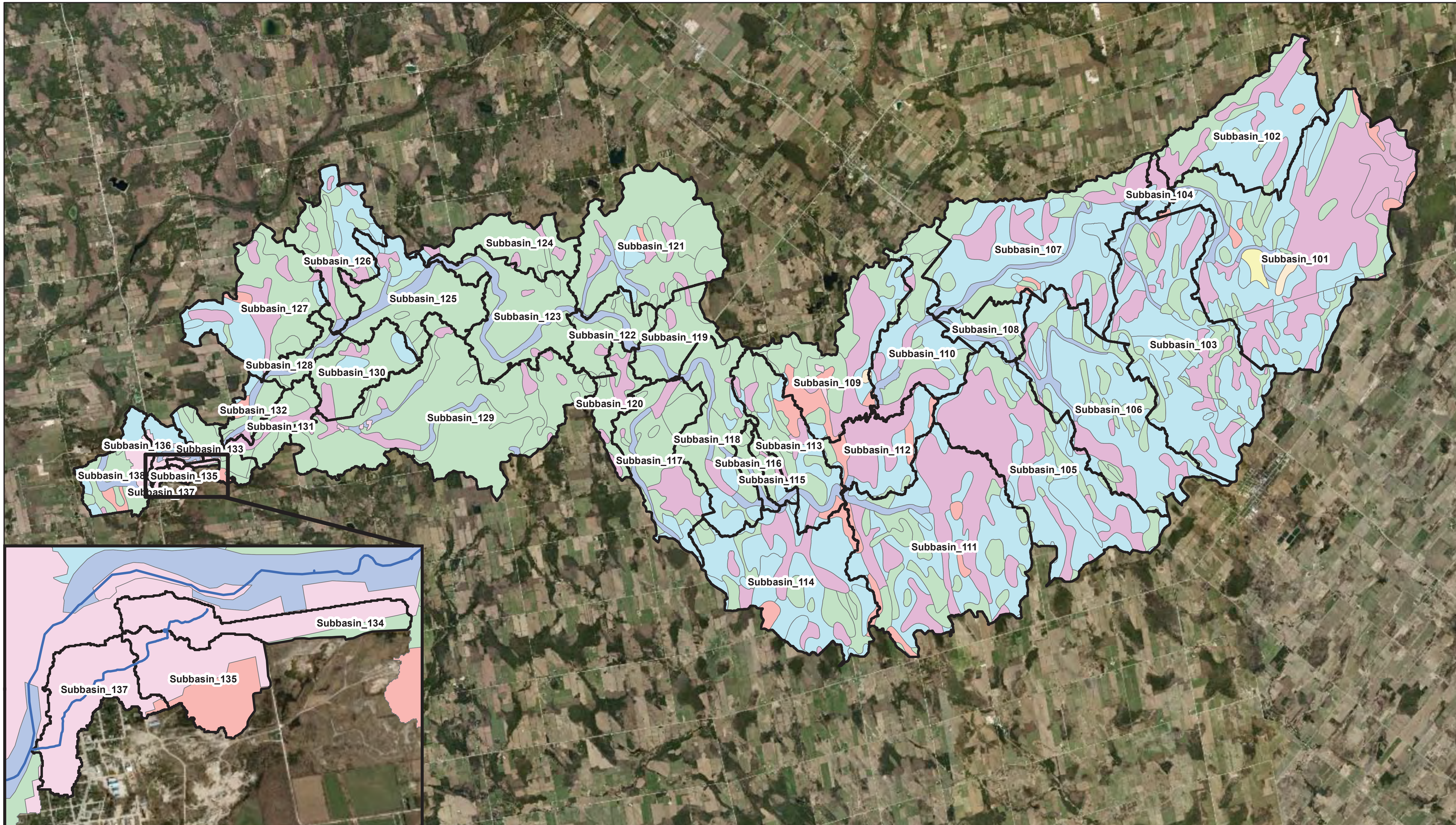

Figure 3
Soil Textures for
Durham Creek

Legend

- Watercourse
- Subwatershed Boundary

Soil Texture

- Clay Loam
- Loam
- Not Available
- Organic
- Sand
- Silty Loam
- Sandy Loam
- Variable

Data Sources:
Soil Survey Complex, GEOHUB 2023
SCOOP 2010, GEOHUB 2023

NAD 1983 UTM Zone 17N
1:110,000
Meters
0 2,500 5,000

N

Drawn By:	SO
Checked By:	MC/DG
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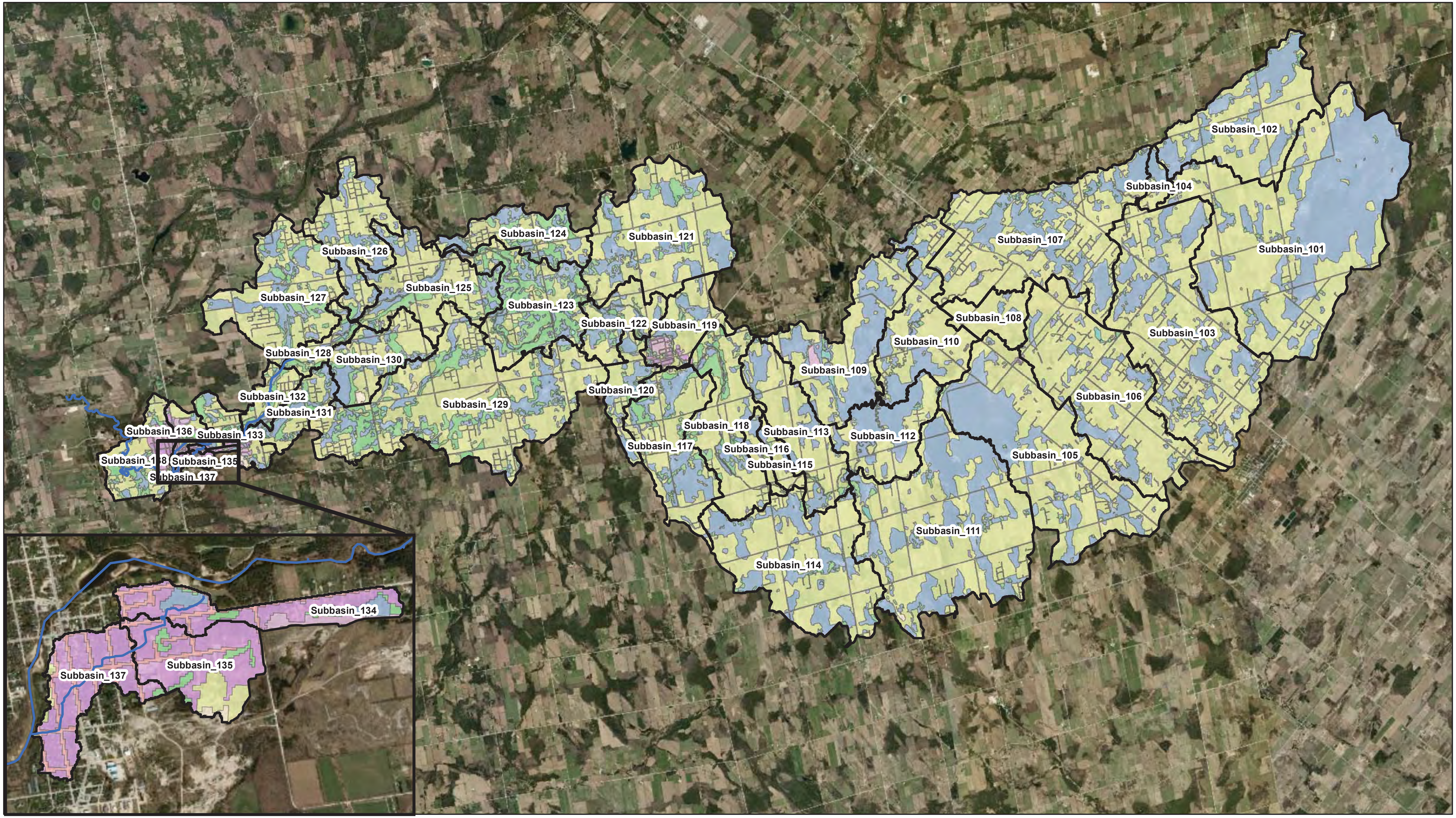

Figure 4
Land Cover for
Durham Creek

Legend

Subwatershed Boundary

Watercourse

Land Cover

- Agriculture
- Built -Up Area – Impervious
- Built -Up Area – Pervious
- Extraction – Aggregate
- Forest
- Open Water
- Transportation
- Wetland

Data Sources:
Soil Survey Complex, GEOHUB 2023
SCOOP 2010, GEOHUB 2023

NAD 1983 UTM Zone 17N
1:110,000
Meters
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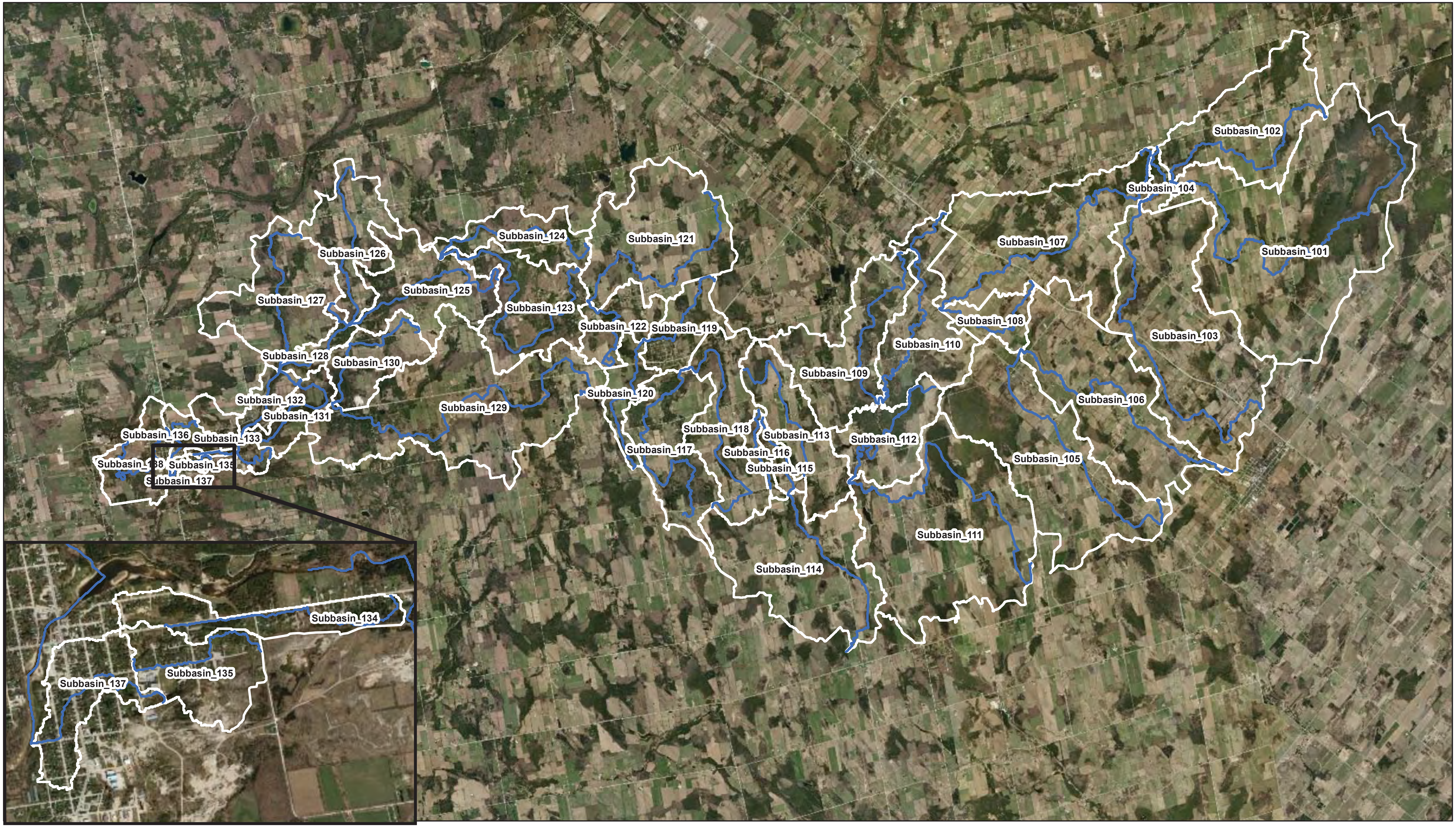

Figure 5
Subwatershed Boundary and Longest Flow Paths for the Saugeen River

Legend

Longest_Flowpath

Subwatershed Boundary

Data Sources:
Soil Survey Complex, GEOHUB 2023
SCOOP 2010, GEOHUB 2023

NAD 1983 UTM Zone 17N
1:110,000
Meters
0 2,500 5,000

N

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3.3 Hydrologic Model Development

3.3.1 Model Selection

The HEC-HMS (Version 4.11) hydrologic model was selected by the project team and the SVCA as the preferred hydrologic model to be used for this project. HEC-HMS is a free hydrologic modeling software developed and maintained by the U.S Army Corps of Engineer's (USACE) Hydrologic Engineering Centre (HEC) with a long history of use in Canada and internationally. The software can simulate the complete hydrologic process of watersheds including rainfall, snowmelt, evapotranspiration, and soil moisture accounting in lumped, semi-lumped or gridded models. HEC-HMS is capable of single event or continuous modeling simulations and allows the user significant control of modeling approaches for each hydrologic process. Built in analysis tools to HEC-HMS include GIS, model optimization, forecasting streamflow, assessing model uncertainty, erosion and sediment transport, and water quality. HEC-HMS is well integrated with other HEC software products. The software is suitable for many applications including watershed studies, flood hazard mapping, dam safety reviews, hydraulic structure design, and flood forecasting exercises.

The following information is required to calculate the input parameters for HEC-HMS to compute hydrographs, peak flows, and routing information:

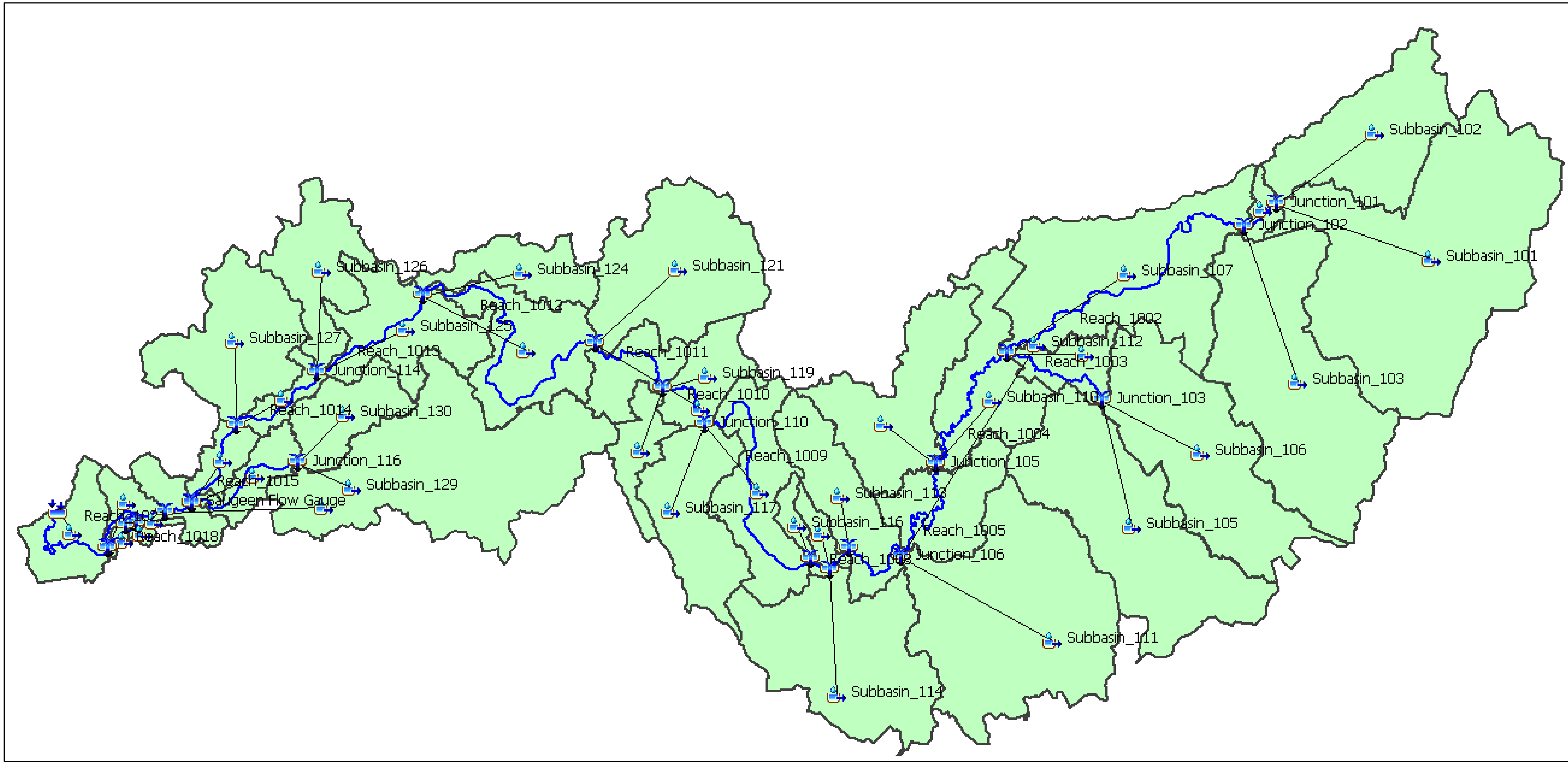
- Physical characteristics of subbasins to compute infiltration and runoff, which includes topographic information, soil drainage features, and land cover.
- Physical characteristics of the watercourses for reach routing, which includes slope, length, geometry, and reach roughness.
- Meteorological information such as rainfall, and when modeling snowmelt, temperature and snow water equivalent, to calculate hydrographs and peak flows at points of interests.

A single event, semi lumped modeling approach was chosen for computing peak flows and hydrographs for this study based on the available data and modeling objectives.

3.3.2 Subbasin Delineation and Hydrologic Elements

The Saugeen River and Durham Creek catchment areas were subdivided into 38 sub-basins, 21 routing reaches, and 21 junctions based on the various tributaries and the anticipated flow change locations in the hydraulic model. The subbasins were delineated using the 5 m resolution LiDAR DTM and enforcing hydrology in HEC-HMS. The sub-catchment boundaries can be found in Figure 5. Subbasin drainage areas ranged from 0.27 km^2 to 36.12 km^2. The routing reach lengths ranged from 335 m to 11,293 m. The model layout and schematic can be found in Figure 6.

Figure 6 – HEC-HMS Model Schematic



3.3.3 Catchment Characterization

The Saugeen River generally flows in a southwesterly direction through the Town of Durham. The headwaters originate just east of County Road 2 near the Town of Maxwell. The landcover is mixed rural and low to medium density residential with some commercial within the Town of Durham.

The Saugeen River catchment area was delineated using the LiDAR DTM and HEC-HMS. The Saugeen River has a total drainage area of 347.3 km^2 and is approximately 81.3 km by longest flowpath (not including all tributaries). Its topography can be described as rolling hills with a significant change in grade in the central watershed. The total basin relief of the watershed is 194.2 m with an average slope of 3.2%.

The hydrologic characterization parameters for each sub-catchments are provided in Table 4. These hydrologic parameters were used as the initial parameters or used to calculate other parameters in the model.

Table 4 – Subbasin Characteristics

Catchment ID	Area (km^2)	Basin Slope (m/m)	Basin Relief (m)	Longest Flow Path (km)	Longest Flow Path Slope (m/m)	10-85 Flowpath Length (km)	10-85 Flowpath Slope (m/m)	Elongation Ratio
Subbasin_101	36.12	0.026	46.6	18.67	0.002	14.00	0.002	0.363
Subbasin_102	12.72	0.039	46.3	9.97	0.005	7.48	0.004	0.404
Subbasin_103	24.35	0.032	39.9	14.72	0.003	11.04	0.002	0.378
Subbasin_104	1.18	0.038	16.6	3.45	0.005	2.59	0.002	0.355
Subbasin_105	21.00	0.027	38.8	11.06	0.004	8.30	0.003	0.467
Subbasin_106	18.32	0.032	42.8	11.75	0.004	8.81	0.004	0.411
Subbasin_107	20.67	0.037	36.3	13.75	0.002	10.32	0.002	0.373
Subbasin_108	3.34	0.030	25.5	5.67	0.004	4.25	0.003	0.364
Subbasin_109	11.36	0.037	32.5	7.87	0.002	5.90	0.001	0.483
Subbasin_110	9.48	0.036	36.3	11.60	0.003	8.70	0.002	0.300
Subbasin_111	25.59	0.030	32.8	14.00	0.002	10.50	0.002	0.408
Subbasin_112	6.81	0.033	27.2	8.10	0.002	6.08	0.001	0.363
Subbasin_113	7.99	0.037	40.0	6.55	0.004	4.91	0.004	0.487
Subbasin_114	17.00	0.035	40.8	7.86	0.003	5.89	0.003	0.592
Subbasin_115	1.37	0.033	23.4	3.27	0.007	2.46	0.006	0.404
Subbasin_116	1.27	0.042	25.0	3.23	0.007	2.42	0.006	0.393
Subbasin_117	9.51	0.063	53.5	10.89	0.003	8.17	0.003	0.319

Catchment ID	Area (km^2)	Basin Slope (m/m)	Basin Relief (m)	Longest Flow Path (km)	Longest Flow Path Slope (m/m)	10-85 Flowpath Length (km)	10-85 Flowpath Slope (m/m)	Elongation Ratio
Subbasin_118	9.23	0.070	54.6	9.27	0.004	6.95	0.002	0.370
Subbasin_119	4.46	0.072	48.0	4.60	0.008	3.45	0.007	0.517
Subbasin_120	3.29	0.053	36.0	6.03	0.005	4.52	0.003	0.340
Subbasin_121	14.99	0.053	65.2	10.14	0.006	7.60	0.005	0.431
Subbasin_122	4.22	0.067	44.0	4.56	0.007	3.42	0.008	0.508
Subbasin_123	9.55	0.108	90.8	12.40	0.006	9.30	0.004	0.281
Subbasin_124	5.42	0.087	88.2	7.73	0.010	5.80	0.010	0.340
Subbasin_125	9.03	0.072	76.4	8.02	0.009	6.02	0.008	0.423
Subbasin_126	7.72	0.047	45.0	7.00	0.006	5.25	0.004	0.448
Subbasin_127	11.40	0.064	51.4	7.29	0.005	5.47	0.003	0.523
Subbasin_128	1.85	0.081	50.5	4.56	0.009	3.42	0.008	0.336
Subbasin_129	24.81	0.084	110.3	15.69	0.007	11.77	0.006	0.358
Subbasin_130	5.45	0.073	66.3	6.05	0.010	4.54	0.007	0.435
Subbasin_131	3.11	0.070	50.2	5.70	0.008	4.28	0.005	0.349
Subbasin_132	2.19	0.078	47.8	3.95	0.012	2.96	0.012	0.422
Subbasin_133	2.57	0.068	43.8	3.50	0.009	2.62	0.006	0.517
Subbasin_134	0.27	0.063	22.9	1.70	0.011	1.27	0.008	0.345
Subbasin_135	0.32	0.081	20.2	1.12	0.015	0.84	0.011	0.568
Subbasin_136	1.71	0.075	60.4	3.34	0.017	2.51	0.020	0.441
Subbasin_137	0.28	0.062	26.0	1.28	0.020	0.96	0.012	0.469
Subbasin_138	4.88	0.068	55.5	6.10	0.008	4.57	0.004	0.409

3.3.4 Initial Abstractions

At the initial stage of rainfall, a certain amount of water is intercepted by vegetation before it can reach the ground and infiltrate. When water does it make through the vegetation it must fill depressions in the landscape before it can produce runoff. These collectively are called initial abstractions. HEC-HMS requires the user to define initial canopy storage, canopy storage, initial depression storage, and depression storage to account for initial abstractions. Initial abstractions were calculated for each catchment based on an area weighted average of typical values for land cover types in each catchment using GIS in accordance with EWRG, 2017. It was assumed that all canopy and depression storage in the subbasin were available for each event modeled. The input parameters for initial abstractions can be found in Table 5. Calculations are provided in Appendix B.

Table 5 – Canopy and Depression Storage

Catchment ID	Initial Canopy Storage	Max Canopy Storage (mm)	Initial Depression Storage	Max Depression Storage (mm)	Total Abstraction (mm)
Subbasin_101	0.0	2.0	0.0	10.1	12.0
Subbasin_102	0.0	1.8	0.0	9.0	10.8
Subbasin_103	0.0	1.6	0.0	8.3	9.9
Subbasin_104	0.0	1.9	0.0	9.4	11.3
Subbasin_105	0.0	1.7	0.0	8.9	10.7
Subbasin_106	0.0	1.4	0.0	7.3	8.7
Subbasin_107	0.0	1.8	0.0	8.7	10.5
Subbasin_108	0.0	1.2	0.0	6.7	7.9
Subbasin_109	0.0	2.0	0.0	9.8	11.8
Subbasin_110	0.0	1.7	0.0	8.5	10.2
Subbasin_111	0.0	1.8	0.0	9.2	11.0
Subbasin_112	0.0	1.9	0.0	9.8	11.8
Subbasin_113	0.0	1.6	0.0	8.0	9.6
Subbasin_114	0.0	1.7	0.0	8.4	10.1
Subbasin_115	0.0	1.5	0.0	7.6	9.1
Subbasin_116	0.0	1.7	0.0	8.3	10.0
Subbasin_117	0.0	2.1	0.0	8.4	10.6
Subbasin_118	0.0	1.8	0.0	6.8	8.6
Subbasin_119	0.0	1.6	0.0	6.6	8.2
Subbasin_120	0.0	2.2	0.0	9.2	11.4
Subbasin_121	0.0	1.8	0.0	8.0	9.8
Subbasin_122	0.0	2.0	0.0	7.8	9.8
Subbasin_123	0.0	3.1	0.0	7.2	10.3
Subbasin_124	0.0	2.7	0.0	8.5	11.2
Subbasin_125	0.0	2.1	0.0	7.8	9.9
Subbasin_126	0.0	1.9	0.0	8.4	10.3
Subbasin_127	0.0	2.1	0.0	7.9	9.9
Subbasin_128	0.0	2.2	0.0	7.1	9.3

Catchment ID	Initial Canopy Storage	Max Canopy Storage (mm)	Initial Depression Storage	Max Depression Storage (mm)	Total Abstraction (mm)
Subbasin_129	0.0	2.0	0.0	7.2	9.2
Subbasin_130	0.0	2.2	0.0	7.9	10.1
Subbasin_131	0.0	2.5	0.0	8.2	10.8
Subbasin_132	0.0	2.2	0.0	6.5	8.7
Subbasin_133	0.0	2.1	0.0	7.0	9.1
Subbasin_134	0.0	1.6	0.0	3.6	5.2
Subbasin_135	0.0	1.3	0.0	2.1	3.4
Subbasin_136	0.0	1.6	0.0	4.6	6.2
Subbasin_137	0.0	1.0	0.0	1.2	2.2
Subbasin_138	0.0	2.0	0.0	6.1	8.0

3.3.5 Infiltration Loss Method

Green and Ampt method was chosen as the loss method in the model to account for infiltration and compute rainfall excess. The Green and Ampt Model was chosen as it has a long history of use for floodplain mapping in Southern Ontario, is physically based, and parameter estimation can be done with soil texture information or measured in the field. The Green and Ampt is based on Darcy's Law and is a simplification of the Richard's equation. As water content at the soil surface increases, it is pulled through the soil column by suction at the wetting front in a piston like displacement. The parameters required in HEC-HMS for the Green and Ampt model are saturated hydraulic conductivity, initial water content, porosity, suction head at the wetting front, and percent impervious.

Saturated hydraulic conductivity, field capacity, wilting point, porosity, and suction head at the wetting front were calculated for each catchment based on an area weighted average of typical values from soil textures in each catchment using GIS. Typical values were taken from Rawl et al. (1983), and Schroeter & Associates (2006) for sandy loam, silty clay loam, loam, and organic soil textures. The initial water content for each modeling scenario was assumed to be at field capacity for all events modeled in this study. The percent impervious was calculated from land cover for each catchment. It was assumed that land cover designated as transportation to be 100% impervious and built up – impervious to be 45% impervious. The Green and Ampt parameters used in the model can found in Table 6. Calculations are provided in Appendix B.

Table 6 – Loss Method - Green and Ampt

Catchment ID	Effective Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Suction at the Wetting Front (Average) (mm)	Saturated Hydraulic Conductivity (mm/h)	% Impervious
Subbasin_101	0.500	0.350	0.188	191.2	4.6	1.8
Subbasin_102	0.490	0.310	0.163	189.7	4.4	2.2
Subbasin_103	0.490	0.310	0.160	187.3	4.7	2.1
Subbasin_104	0.510	0.360	0.194	189.0	3.8	1.5
Subbasin_105	0.510	0.350	0.186	189.1	3.7	2.7
Subbasin_106	0.480	0.300	0.152	188.7	5.0	2.5
Subbasin_107	0.490	0.310	0.160	190.0	4.7	2.5
Subbasin_108	0.450	0.260	0.134	207.9	4.2	1.7
Subbasin_109	0.470	0.300	0.156	200.1	4.8	3.5
Subbasin_110	0.470	0.300	0.154	200.4	4.1	3.3
Subbasin_111	0.500	0.330	0.176	193.3	3.8	1.8
Subbasin_112	0.510	0.350	0.189	189.1	4.1	2.8
Subbasin_113	0.460	0.270	0.141	203.5	4.4	3.3
Subbasin_114	0.490	0.300	0.153	185.9	5.2	2.2
Subbasin_115	0.460	0.280	0.150	213.7	3.1	3.3
Subbasin_116	0.440	0.260	0.142	231.6	2.6	3.4
Subbasin_117	0.460	0.290	0.155	214.4	2.7	2.5
Subbasin_118	0.450	0.270	0.139	213.6	3.5	3.5
Subbasin_119	0.440	0.250	0.132	222.2	2.7	10.1
Subbasin_120	0.470	0.300	0.159	214.1	2.2	1.7
Subbasin_121	0.450	0.260	0.132	216.7	3.0	2.2
Subbasin_122	0.440	0.250	0.134	224.9	2.7	3.5
Subbasin_123	0.440	0.250	0.134	227.2	2.6	5.1
Subbasin_124	0.450	0.250	0.131	216.5	2.8	2.6
Subbasin_125	0.450	0.260	0.137	216.8	3.3	3.1
Subbasin_126	0.470	0.280	0.146	199.9	4.0	1.5
Subbasin_127	0.470	0.290	0.151	201.4	3.7	1.6
Subbasin_128	0.430	0.260	0.138	231.6	2.5	5.4
Subbasin_129	0.440	0.250	0.129	220.0	2.8	2.7
Subbasin_130	0.460	0.270	0.138	209.2	3.3	2.3

Catchment ID	Effective Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Suction at the Wetting Front (Average) (mm)	Saturated Hydraulic Conductivity (mm/h)	% Impervious
Subbasin_131	0.460	0.290	0.153	215.8	2.3	3.2
Subbasin_132	0.440	0.270	0.140	217.4	3.9	5.0
Subbasin_133	0.440	0.240	0.121	215.5	3.8	6.3
Subbasin_134	0.430	0.230	0.116	218.9	3.0	39.9
Subbasin_135	0.410	0.190	0.085	179.6	11.0	39.0
Subbasin_136	0.470	0.290	0.148	189.1	5.8	23.0
Subbasin_137	0.410	0.190	0.085	179.6	10.9	56.6
Subbasin_138	0.450	0.260	0.134	203.0	4.8	12.4

3.3.6 Runoff Transform – Unit Hydrograph

The SCS Unit Hydrograph method was used in the model to convert excess rainfall to runoff. The SCS Unit Hydrograph method is based upon an average of unit hydrographs derived from gauged rainfall and runoff for a large number of small agricultural watersheds in the United States (USACE, 2023). This method uses a dimensionless, curvilinear unit hydrograph to route excess rainfall to the subbasin outlet. HEC-HMS requires the Peaking Rate Factor and lag time as input parameters for each subbasin.

The peaking rate factor controls the volume of water on the rising and recession limbs (NOAA, 2005). Choosing a peaking rate factor is based on land cover and topography. Hydrograph peaking factors based on general description and their associated limb ratio can be found in Table 7.

Table 7 – Hydrograph Peaking Factors & Recession Limb Ratios (Wanielista, et al 1997)

General Description	Peaking Factor	Limb Ratio (Recession to Rising)
Urban areas; steep slopes	575	1.25
Typical SCS	484	1.67
Mixed urban/rural	400	2.25
Rural, rolling hills	300	3.33
Rural, slight slopes	200	5.50
Rural, very flat	100	12.00

The peaking rate factors for the subbasins in the model were chosen based on topography, land cover, and engineering judgement.

Lag is the time from the centre of mass of excess rainfall to the time to peak of a unit hydrograph (NRCS, 2007). Lag Time can be related to most watersheds with time of concentration, T_c, using the following equation (NRCS, 2007):

$$t_p = 0.6 * T_C$$

The time of concentration is used to estimate the peak discharge from a watershed, and it depends on slope, watershed characteristics and the flow path length. Time of concentration is the longest time required for runoff from the most distant point in the watershed to travel to the outlet. Many empirical equations are available to estimate the time of concentration. In this study, the TR-55 method has been used to calculate the time of concentration. The TR-55 Method computes travel times for sheet flow, shallow concentrated flow, and channel flow along the longest flow path to calculate the time of concentration. The equation can be found below.

$$T_c = t_{sheet} + t_{shallow\ contrated} + t_{channel}$$

The detailed time of concentration calculations and equations for each component can be found in Appendix B1. The resulting peaking rate factor, time of concentration, and lag time for each catchment are presented in Table 8.

Table 8 – Runoff Transform – Unit Hydrograph

Catchment ID	Peaking Rate Factor	Time of Concentration (hrs)	Lag Time (Hrs)	Time of Concentration (mins)	Lag Time (min)
Subbasin_101	484	35.9	21.6	2155.4	1293.2
Subbasin_102	484	6.9	4.1	411.5	246.9
Subbasin_103	484	8.5	5.1	510.9	306.5
Subbasin_104	484	4.5	2.7	272.8	163.7
Subbasin_105	484	7.2	4.3	429.3	257.6
Subbasin_106	484	10.5	6.3	632.1	379.3
Subbasin_107	484	7.5	4.5	449.7	269.8
Subbasin_108	484	2.9	1.7	174.3	104.6
Subbasin_109	484	10.4	6.2	623.4	374.0
Subbasin_110	484	7.6	4.6	456.4	273.8
Subbasin_111	484	16.8	10.1	1010.6	606.3
Subbasin_112	484	15.6	9.4	936.8	562.1
Subbasin_113	484	6.6	4.0	398.5	239.1
Subbasin_114	484	8.6	5.2	515.6	309.3
Subbasin_115	484	3.3	2.0	199.8	119.9
Subbasin_116	484	2.4	1.4	142.8	85.7

Catchment ID	Peaking Rate Factor	Time of Concentration (hrs)	Lag Time (Hrs)	Time of Concentration (mins)	Lag Time (min)
Subbasin_117	484	9.1	5.5	546.4	327.8
Subbasin_118	484	3.4	2.0	201.3	120.8
Subbasin_119	484	2.2	1.3	129.4	77.6
Subbasin_120	484	2.7	1.6	160.2	96.1
Subbasin_121	484	8.1	4.9	487.3	292.4
Subbasin_122	484	3.6	2.2	217.0	130.2
Subbasin_123	484	3.2	1.9	193.4	116.0
Subbasin_124	484	4.8	2.9	289.4	173.6
Subbasin_125	484	3.7	2.2	221.7	133.0
Subbasin_126	484	4.2	2.5	252.3	151.4
Subbasin_127	484	6.6	4.0	395.5	237.3
Subbasin_128	484	1.9	1.1	114.6	68.7
Subbasin_129	484	8.3	5.0	496.1	297.7
Subbasin_130	484	5.7	3.4	340.4	204.3
Subbasin_131	484	1.5	0.9	90.3	54.2
Subbasin_132	484	1.5	0.9	90.5	54.3
Subbasin_133	484	2.3	1.4	135.7	81.4
Subbasin_134	484	2.9	1.7	172.7	103.6
Subbasin_135	484	1.1	0.7	67.1	40.3
Subbasin_136	484	1.7	1.0	101.8	61.1
Subbasin_137	484	0.9	0.6	55.6	33.3
Subbasin_138	484	3.6	2.2	217.5	130.5

3.3.7 Recession

In large rural watersheds interflow generally makes up a large proportion of the total volume on the receding limb of a hydrograph. Wills used the recession baseflow method within the HEC-HMS model to account for this phenomenon. This method uses a recession constant that controls the rate that flow recedes and a Ratio to Peak to trigger when this exponential decay becomes active in the hydrograph. The recession and ratio to peak values used for each subbasin can be found in Table 9. A recession baseflow method was not used for the Durham Creek watershed given its drainage area and time of concentration.

Table 9 – Recession Method Parameters

Hydrologic Element	Recession Constant	Ratio to Peak
Subbasin_101	0.8	0.35
Subbasin_102	0.8	0.35
Subbasin_103	0.8	0.35
Subbasin_104	0.8	0.35
Subbasin_105	0.8	0.35
Subbasin_106	0.8	0.35
Subbasin_107	0.8	0.35
Subbasin_108	0.8	0.35
Subbasin_109	0.8	0.35
Subbasin_110	0.8	0.35
Subbasin_111	0.8	0.35
Subbasin_112	0.8	0.35
Subbasin_113	0.8	0.35
Subbasin_114	0.8	0.35
Subbasin_115	0.8	0.35
Subbasin_116	0.8	0.35
Subbasin_117	0.8	0.35
Subbasin_118	0.8	0.35
Subbasin_119	0.8	0.35
Subbasin_120	0.8	0.35
Subbasin_121	0.8	0.35
Subbasin_122	0.8	0.35
Subbasin_123	0.8	0.35
Subbasin_124	0.8	0.35
Subbasin_125	0.8	0.35
Subbasin_126	0.8	0.35
Subbasin_127	0.8	0.35
Subbasin_128	0.8	0.35
Subbasin_129	0.8	0.35
Subbasin_130	0.8	0.35
Subbasin_132	0.8	0.35
Subbasin_133	0.8	0.35
Subbasin_138	0.8	0.35

3.3.8 Reach Routing

The Muskingum-Cunge method was chosen as the channel routing method in the model. The Muskingum-Cunge method is based on the solution of the continuity and momentum equation. This method was chosen as it has a long history of use in flood mapping projects in Southern Ontario and has measurable physically based parameters. The Muskingum-Cunge method in HEC-HMS requires reach length, slope of the energy grade line (estimated as channel bed slope), wave celerity, characteristic cross section, and manning roughness.

The reach length, slope, cross section, and invert were calculated using the LiDAR DTM in HEC-RAS and HEC-HMS. The manning's roughness in the channel and left and right overbank were chosen based on typical values of the land cover at the characteristic cross section. A main channel manning's roughness of 0.035 was used which is typical for Ontario (EWRG, 2017). The overbank manning roughness was chosen to be 0.055 for agricultural land, and 0.08 for forested land (EWRG, 2017). Wave Celerity was estimated to be 1.5 m/s and for most applications is adequate (USACE, 2023). The reach routing parameters used in the model can be found in Table 10.

Table 10 – Reach Routing Parameters

Reach	Length (m)	Slope (m/m)	Mannings n	Index Method	Shape	Left Overbank Mannings Roughness	Right Overbank Mannings Roughness	Invert
Reach_1001	1784	0.001	0.035	Celerity	8 Point	0.080	0.080	493.0
Reach_1002	11293	0.002	0.035	Celerity	8 Point	0.055	0.080	483.5
Reach_1003	4028	0.001	0.035	Celerity	8 Point	0.055	0.055	476.5
Reach_1004	6964	0.000	0.035	Celerity	8 Point	0.080	0.080	471.0
Reach_1005	5954	0.000	0.035	Celerity	8 Point	0.080	0.080	469.2
Reach_1006	3060	0.000	0.035	Celerity	8 Point	0.080	0.055	468.0
Reach_1007	853	0.000	0.035	Celerity	8 Point	0.055	0.055	467.3
Reach_1008	672	0.002	0.035	Celerity	8 Point	0.080	0.080	467.0
Reach_1009	7973	0.001	0.035	Celerity	8 Point	0.055	0.080	464.3
Reach_1010	2213	0.002	0.035	Celerity	8 Point	0.080	0.080	455.0
Reach_1011	3351	0.003	0.035	Celerity	8 Point	0.080	0.080	449.0
Reach_1012	11129	0.005	0.035	Celerity	8 Point	0.080	0.080	420.0
Reach_1013	4339	0.004	0.035	Celerity	8 Point	0.080	0.080	388.7
Reach_1014	3399	0.004	0.035	Celerity	8 Point	0.080	0.080	370.0
Reach_1015	2903	0.003	0.035	Celerity	8 Point	0.080	0.080	358.0
Reach_1016	4202	0.005	0.035	Celerity	8 Point	0.080	0.080	369.0
Reach_1017	967	0.003	0.035	Celerity	8 Point	0.080	0.080	351.0

Reach	Length (m)	Slope (m/m)	Mannings n	Index Method	Shape	Left Overbank Mannings Roughness	Right Overbank Mannings Roughness	Invert
Reach_1018	2488	0.007	0.035	Celerity	8 Point	0.045	0.045	350.0
Reach_1019	335	0.001	0.035	Celerity	8 Point	0.080	0.080	351.0
Reach_1020	929	0.009	0.035	Celerity	8 Point	0.045	0.045	350.0
Reach_1021	4540	0.001	0.035	Celerity	8 Point	0.080	0.080	332.0

3.3.9 Baseflow

Field surveys indicated that base flow in the context of large magnitude flood events was insignificant for Durham Creek. Therefore, baseflow has been assumed to be zero in the hydrologic model.

Wills reviewed the base flow for the Saugeen River at Durham flow gauge and found it was typically on the order of 4 m^3/s. Baseflow was not included for the Saugeen River portion of the hydrology model as determining the regional flow was the main objective of the model and in this context only represented 1.4% of the total flow during this event.

3.3.10 Design Storm Distribution and Duration

The primary objective of the hydrology model is determining the AEP flood events for Durham Creek and the Regional Flood event for both Durham Creek and the Saugeen River. Durham Creek does not have a flow gauge, and therefore the AEP flood events were calculated from the SCS synthetic storms. The Saugeen River does have a flow gauge, and therefore the AEP flood events could be calculated statistically. Details regarding the statistical analysis for the Saugeen River gauge can be found in Section 3.5.2.

Typically, synthetic design storms for floodplain mapping in Ontario are represented by rain on snow (spring) events or intense thunderstorms (summer) (EWRG, 2017). Choosing a design storm approach is dependent on watershed characteristics such as land cover, time of concentration, watershed size, and seasonality of when most annual maximum peak flow rates occur (EWRG, 2017). Durham Creek has a relatively small drainage area and a short time of concentration and therefore an intense thunderstorm event is likely to govern. Therefore, Wills selected the SCS Type-2 storm distribution which has a long history of use in Ontario to simulate intense thunderstorm events for floodplain mapping.

The SCS Type-2 storm is typically developed for the 6-hour, 12-hour, or 24-hour durations. The MNRF recommends that storm duration for floodplain mapping should be approximately equal to the time of concentration of the watershed for synthetic design storms (MNRF, 2002). The time of concentration for Durham Creek was calculated to be less than 6 hours. Therefore, Wills selected the 6-hour duration to be used in the model for calculating the AEP peak flows for Durham Creek. The 1% AEP 6-hour SCS total rainfall volume for the town of Durham is 88.2 mm with 29.6 mm falling during the most intense 15 minutes of the event. The SCS 6-hour design storm for all AEP flows and the regional storms run in the model have been provided in Appendix B1.

3.3.11 Rainfall and Computation Time Step

The computation time step and rainfall time step were considered based on watershed characteristics. The rainfall time step for modeling should be less than the minimum time of concentration of any catchment (EWRG, 2017). Subbasin 137 has shortest time of concentration of 55.6 minutes within the catchments and therefore 15 min rainfall time steps were considered appropriate for the purposes of this study. Computation time steps for small urban watersheds may require computational time steps between 5 and 10 minutes, but further reductions below these can result in unrealistic flows (MNRF, 2022). Therefore, a computation time step of 5 minutes was used for the purposes of this study.

3.3.12 Areal Reduction Factor

The equivalent circle diameter method was used to assess the need for application of areal reduction factors to the design storms. The first point of interest for hydraulic modeling, the Durham Upper Dam, is approximately 39.5 km as the “crow flies” from the most remote portion of the watershed which resulted in an equivalent circle diameter of 1,225.4 km^2. The second point of interest for hydraulic modeling (the upstream end of Durham Creek) is approximately 1.14 km as the “crow flies” from the most remote portion of the watershed which resulted in an equivalent diameter of 1.02 km^2. Generally, studies in Ontario do not use areal reduction factors for circular areas under 25 km^2 (MNRF, 2002). Therefore, areal reduction factors was applied to the Saugeen River watershed, but were not applied to the Durham Creek watershed during this study.

3.3.13 Future Development

In accordance with the Technical Guide – River and Stream Systems: Flooding Hazard Limit (MNR, 2002), the potential for future development must be considered in the hydrologic assessment for floodplain mapping. The Official Plans and Zoning for the Municipality of West Grey and Grey County were reviewed. Based on the review of the Official plan and Zoning, no areas of significant future development were identified. The Municipality of West Grey indicated plans to construct a large retirement home in Subbasin 135 during the start up meeting. However, given its relative size to the watershed area it was determined by Wills to have negligible affects on impervious area. It is anticipated that any future land use conditions will be similar to the current conditions.

3.3.14 Model Calibration and Verification

It is important to calibrate and verify a hydrologic model if there is available observed streamflow and rainfall available to improve model performance. Wills performed a calibration exercise using the Saugeen River Above Durham rainfall and flow gauge data provided by SVCA, as well as the Grand River Near Dundalk rainfall gauge data provided by Grand River Conservation Authority (GRCA). The Dundalk gauge is not in the Saugeen River watershed, however, it is closer in distance to roughly 70% of the drainage area contributing to the streamflow gauge. The name, location, and period of record relevant for each gauge has been provided in Table 11. The location of the gauges can be found on Figure 7.

Table 11 - Recorded Rainfall and Streamflow Data

Location	Station ID	Co-ordinates	Period of Record Streamflow (years)	Period of Record Rainfall (years)
Saugeen River Above Durham	02FC016	44°11'07" N 80°47'14" W	48	39
Grand River Near Dundalk	02GA041	44°08'24" N 80°21'45" W	N/A	16

Wills used stream flow and rainfall data from a September 1986 storm to calibrate the model and a storm from September 2008 storm to verify the model. A rainfall only events was chosen by Wills for the purposes of calibration/verification because the modeling objective is to calculate peak discharge for the Hurricane Hazel event which is a rainfall only event.

The September 1986 storm had a recorded rainfall volume of 155.0 mm at the Saugeen River Above Durham over the course of approximately 40 hours. The most intense hour of the 1986 storm recorded 20.5 mm of rain. The peak discharge recorded at Saugeen River Above Durham gauge was 77.7 m^3/s for this event. An additional 57.1 mm of rainfall occurred over the next week as the Saugeen River was receding for a total of 212.1 mm. The Grand River Near Dundalk rainfall gauge’s period of record did not extend to 1986 and therefore was not used for this event.

The original model parameters discussed above were modified by Wills until the modeled results reasonably fit the observed results at the Saugeen River Above Durham Gauge for the 1986 event. The observed and modeled hydrographs and the hyetograph from the calibrated model can be found in Figure 8. The modeled results match the observed hydrograph well for peak flow, and general shape. The model did a reasonable job at estimating total runoff value but appears to underestimate total volume in the first two thirds of the hydrograph and overestimate it in the last one third. The timing of the modeled peak discharge is a little earlier than the observed.

The September 2008 storm had a recorded rainfall volume of 89.6 mm at the Saugeen River Above Durham gauge and 90.8 mm at the Grand River Near Dundalk over the course of approximately 36 hours. The most intense hour of the 2008 storm recorded 27.8 mm of rain at the Saugeen River Above Durham Gauge and 18.8 mm of rain at the Grand River Near Dundalk. The peak discharge recorded at the Saugeen River Above Durham gauge was 37.9 m^3/s. An additional 6.1 mm of rain was recorded in the preceding 5 days at the Saugeen River Above Durham gauge for a total of 95.7 mm.

An additional 12.9 mm of rain was recorded in the preceding 5 days at the Grand River Near Dundalk gauge for a total of 103.7 mm.

Wills used the September 2008 event to verify that the calibrated model would produce satisfactory results without additional parameter changes. Wills initially applied the Saugeen River Above Durham Gauge rainfall to the lower half of the watershed, and the Grand River Near Dundalk gauge to the upper half of the watershed. After review of the modeled vs observed results the general shape appeared to have a significant double peak that was not present in the observed hydrograph. Wills then applied just the Grand River Near Dundalk to all subbasins and found the shape, volume, and peak flow performed well in this scenario, although the double peak is still present to a lesser degree. Given that the Dundalk gauge is closer to larger proportion of watershed area, it may have been more representative of the temporal and spatial variability of the actual rainfall. Therefore, Wills deemed it acceptable for the purposes of this study to rely on this gauge for verification. The observed and modeled hydrographs and the hyetograph from the verification exercise can be found in Figure 9. The modeled results match the observed hydrograph reasonably well for peak flow, general shape, and total runoff value, but appears to slightly underestimate total volume in the first two thirds of the hydrograph and overestimate it in the last one third. The timing of the modeled peak discharge is a little earlier than the observed for the initial peak and very well for the second peak. Statistical performance metrics typically used in hydrologic modeling for measuring model performance are percent difference in peak flow, Nash-Sutcliffe, Percent Bias, and Root Mean Square Error. Wills calculated or used HEC-HMS to calculate these statistical performance metrics and they have been provided in Table 12.

Table 12 – Calibration/Verification Performance Metrics

Start	End	Total Rainfall (mm)	Peak Discharge Observed (m^3/s)	Peak Discharge Modeled (m^3/s)	Percent Difference in Peak Flow	Nash Sutcliffe	Percent Bias	Root Mean Square Error
05Sep1986 00:00	25Sep1986 00:00	212.1	77.70	76.90	1.03%	0.867	-18.50%	0.40
09Sep2008 00:00	24Sep2008 00:00	103.7	37.90	42.73	-12.74%	0.843	13.00%	0.36

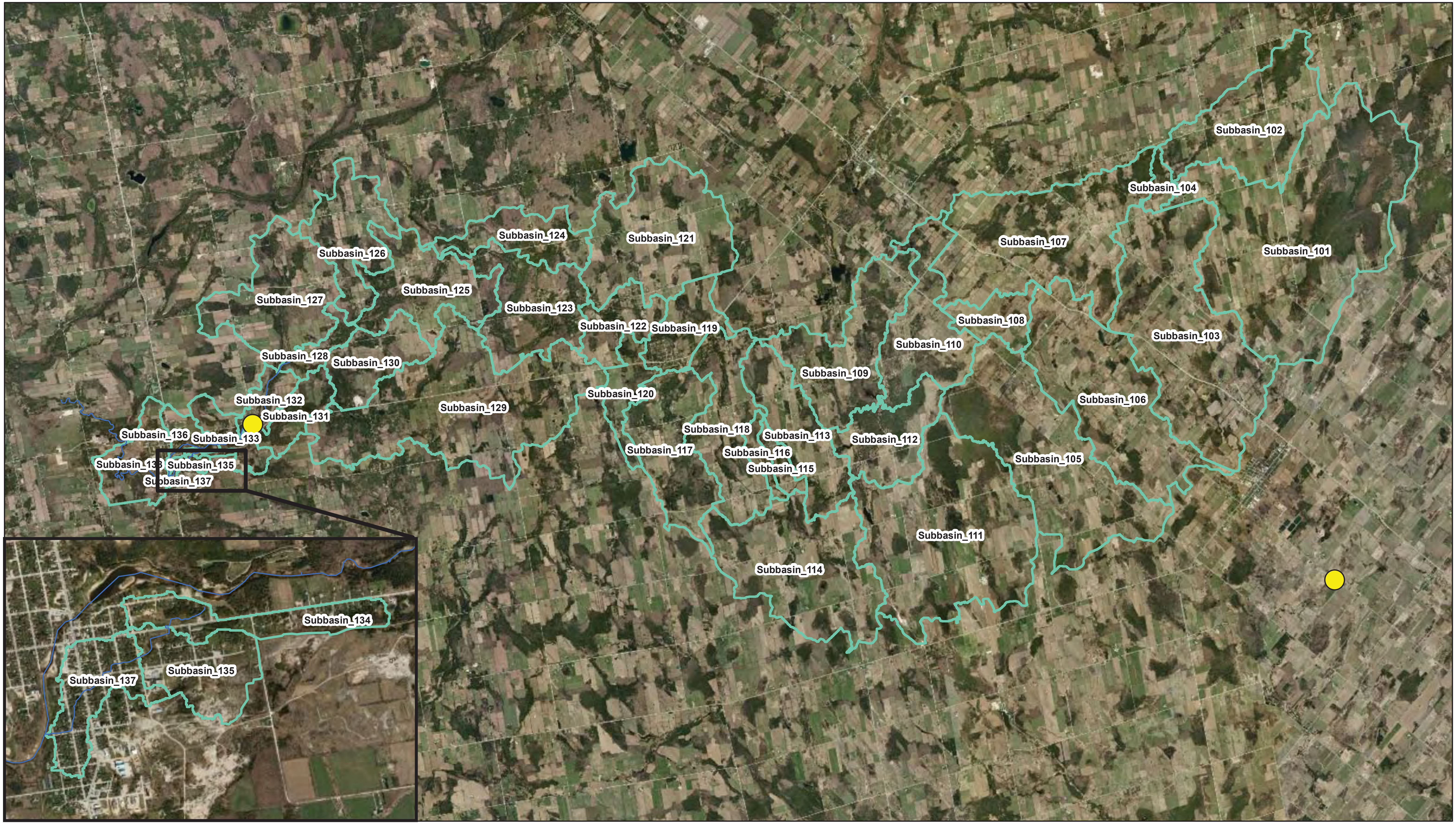


Figure 7
Rain Gauge Locations for
Durham Creek

Legend

- Rain Gauge
- Watercourse
- Subwatershed Boundary

Data Sources:
Soil Survey Complex, GEOHUB 2023
SCOOP 2010, GEOHUB 2023

NAD 1983 UTM Zone 17N
1:110,000
Meters
0 2,500 5,000

N

Drawn By:	SO
Checked By:	MC/DG
Map Date:	2/29/24
Project Number:	5591
Map File Number	23-5591

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Figure 8 – September 1986 Calibration Event

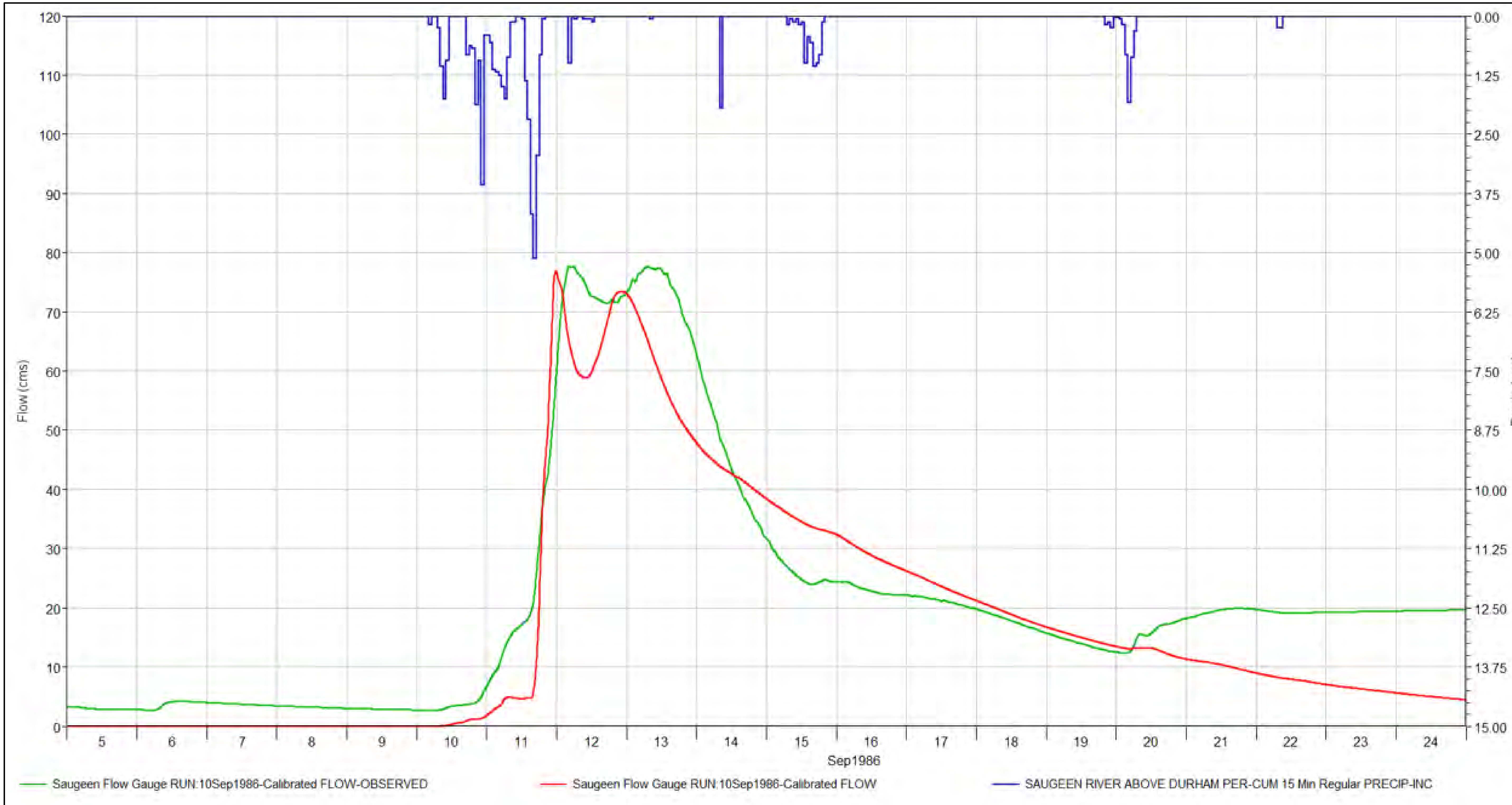
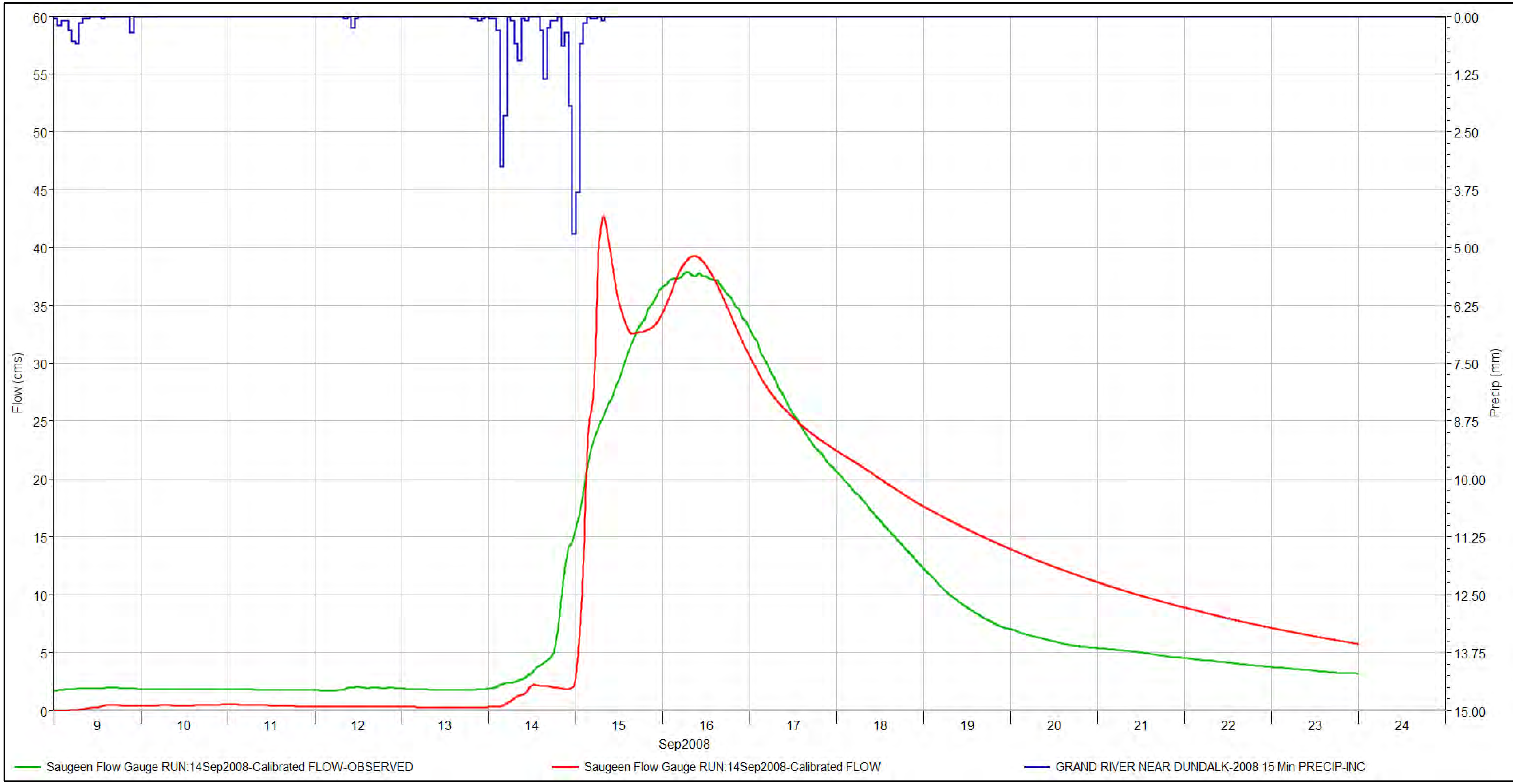


Figure 9 – September 2008 Verivication Event



Wills found the model to produce satisfactory results estimating the observed discharge at the Saugeen River Near Durham gauge during the calibration and verification exercise. Therefore, the model has been accepted for the purposes of calculating flood flows for this study. The calibrated hydrologic characterization parameters for each sub-catchment are provided in Tables 13-16 These hydrologic parameters were used to produce the results shown in Section 3.4.

Table 13 – Subbasin Characteristics – Calibrated

Catchment ID	Area (km^2)	Basin Slope (m/m)	Basin Relief (m)	Longest Flow Path (km)	Longest Flow Path Slope (m/m)	10-85 Flowpath Length (km)	10-85 Flowpath Slope (m/m)	Elongation Ratio
Subbasin_101	36.12	0.026	46.6	18.67	0.002	14.00	0.002	0.363
Subbasin_102	12.72	0.039	46.3	9.97	0.005	7.48	0.004	0.404
Subbasin_103	24.35	0.032	39.9	14.72	0.003	11.04	0.002	0.378
Subbasin_104	1.18	0.038	16.6	3.45	0.005	2.59	0.002	0.355
Subbasin_105	21.00	0.027	38.8	11.06	0.004	8.30	0.003	0.467
Subbasin_106	18.32	0.032	42.8	11.75	0.004	8.81	0.004	0.411
Subbasin_107	20.67	0.037	36.3	13.75	0.002	10.32	0.002	0.373
Subbasin_108	3.34	0.030	25.5	5.67	0.004	4.25	0.003	0.364
Subbasin_109	11.36	0.037	32.5	7.87	0.002	5.90	0.001	0.483
Subbasin_110	9.48	0.036	36.3	11.60	0.003	8.70	0.002	0.300
Subbasin_111	25.59	0.030	32.8	14.00	0.002	10.50	0.002	0.408
Subbasin_112	6.81	0.033	27.2	8.10	0.002	6.08	0.001	0.363
Subbasin_113	7.99	0.037	40.0	6.55	0.004	4.91	0.004	0.487
Subbasin_114	17.00	0.035	40.8	7.86	0.003	5.89	0.003	0.592
Subbasin_115	1.37	0.033	23.4	3.27	0.007	2.46	0.006	0.404
Subbasin_116	1.27	0.042	25.0	3.23	0.007	2.42	0.006	0.393
Subbasin_117	9.51	0.063	53.5	10.89	0.003	8.17	0.003	0.319
Subbasin_118	9.23	0.070	54.6	9.27	0.004	6.95	0.002	0.370
Subbasin_119	4.46	0.072	48.0	4.60	0.008	3.45	0.007	0.517
Subbasin_120	3.29	0.053	36.0	6.03	0.005	4.52	0.003	0.340
Subbasin_121	14.99	0.053	65.2	10.14	0.006	7.60	0.005	0.431
Subbasin_122	4.22	0.067	44.0	4.56	0.007	3.42	0.008	0.508
Subbasin_123	9.55	0.108	90.8	12.40	0.006	9.30	0.004	0.281
Subbasin_124	5.42	0.087	88.2	7.73	0.010	5.80	0.010	0.340
Subbasin_125	9.03	0.072	76.4	8.02	0.009	6.02	0.008	0.423

Catchment ID	Area (km^2)	Basin Slope (m/m)	Basin Relief (m)	Longest Flow Path (km)	Longest Flow Path Slope (m/m)	10-85 Flowpath Length (km)	10-85 Flowpath Slope (m/m)	Elongation Ratio
Subbasin_126	7.72	0.047	45.0	7.00	0.006	5.25	0.004	0.448
Subbasin_127	11.40	0.064	51.4	7.29	0.005	5.47	0.003	0.523
Subbasin_128	1.85	0.081	50.5	4.56	0.009	3.42	0.008	0.336
Subbasin_129	24.81	0.084	110.3	15.69	0.007	11.77	0.006	0.358
Subbasin_130	5.45	0.073	66.3	6.05	0.010	4.54	0.007	0.435
Subbasin_131	3.11	0.070	50.2	5.70	0.008	4.28	0.005	0.349
Subbasin_132	2.19	0.078	47.8	3.95	0.012	2.96	0.012	0.422
Subbasin_133	2.57	0.068	43.8	3.50	0.009	2.62	0.006	0.517
Subbasin_134	0.27	0.063	22.9	1.70	0.011	1.27	0.008	0.345
Subbasin_135	0.32	0.081	20.2	1.12	0.015	0.84	0.011	0.568
Subbasin_136	1.71	0.075	60.4	3.34	0.017	2.51	0.020	0.441
Subbasin_137	0.28	0.062	26.0	1.28	0.020	0.96	0.012	0.469
Subbasin_138	4.88	0.068	55.5	6.10	0.008	4.57	0.004	0.409

Table 14 – Loss Method – Green and Ampt – Calibrated

Catchment ID	Effective Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Suction at the Wetting Front (Average) (mm)	Saturated Hydraulic Conductivity (mm/h)	% Impervious
Subbasin_101	0.500	0.350	0.188	191.2	4.6	1.8
Subbasin_102	0.490	0.310	0.163	189.7	4.4	2.2
Subbasin_103	0.490	0.310	0.160	187.3	4.7	2.1
Subbasin_104	0.510	0.360	0.194	189.0	3.8	1.5
Subbasin_105	0.510	0.350	0.186	189.1	3.7	2.7
Subbasin_106	0.480	0.300	0.152	188.7	5.0	2.5
Subbasin_107	0.490	0.310	0.160	190.0	4.7	2.5
Subbasin_108	0.450	0.260	0.134	207.9	4.2	1.7
Subbasin_109	0.470	0.300	0.156	200.1	4.8	3.5
Subbasin_110	0.470	0.300	0.154	200.4	4.1	3.3
Subbasin_111	0.500	0.330	0.176	193.3	3.8	1.8
Subbasin_112	0.510	0.350	0.189	189.1	4.1	2.8
Subbasin_113	0.460	0.270	0.141	203.5	4.4	3.3

Catchment ID	Effective Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Suction at the Wetting Front (Average) (mm)	Saturated Hydraulic Conductivity (mm/h)	% Impervious
Subbasin_114	0.490	0.300	0.153	185.9	5.2	2.2
Subbasin_115	0.460	0.280	0.150	213.7	3.1	3.3
Subbasin_116	0.440	0.260	0.142	231.6	2.6	3.4
Subbasin_117	0.460	0.290	0.155	214.4	2.7	2.5
Subbasin_118	0.450	0.270	0.139	213.6	3.5	3.5
Subbasin_119	0.440	0.250	0.132	222.2	2.7	10.1
Subbasin_120	0.470	0.300	0.159	214.1	2.2	1.7
Subbasin_121	0.450	0.260	0.132	216.7	3.0	2.2
Subbasin_122	0.440	0.250	0.134	224.9	2.7	3.5
Subbasin_123	0.440	0.250	0.134	227.2	2.6	5.1
Subbasin_124	0.450	0.250	0.131	216.5	2.8	2.6
Subbasin_125	0.450	0.260	0.137	216.8	3.3	3.1
Subbasin_126	0.470	0.280	0.146	199.9	4.0	1.5
Subbasin_127	0.470	0.290	0.151	201.4	3.7	1.6
Subbasin_128	0.430	0.260	0.138	231.6	2.5	5.4
Subbasin_129	0.440	0.250	0.129	220.0	2.8	2.7
Subbasin_130	0.460	0.270	0.138	209.2	3.3	2.3
Subbasin_131	0.460	0.290	0.153	215.8	2.3	3.2
Subbasin_132	0.440	0.270	0.140	217.4	3.9	5.0
Subbasin_133	0.440	0.240	0.121	215.5	3.8	6.3
Subbasin_134	0.430	0.230	0.116	218.9	3.0	39.9
Subbasin_135	0.410	0.190	0.085	179.6	11.0	39.0
Subbasin_136	0.470	0.290	0.148	189.1	5.8	23.0
Subbasin_137	0.410	0.190	0.085	179.6	10.9	56.6
Subbasin_138	0.450	0.260	0.134	203.0	4.8	12.4

Table 15 – Canopy and Depression Storage - Calibrated

Catchment ID	Initial Canopy Storage	Max Canopy Storage (mm)	Initial Depression Storage	Max Depression Storage (mm)	Total Abstraction (mm)
Subbasin_101	0.0	2.0	0.0	10.1	12.0
Subbasin_102	0.0	1.8	0.0	9.0	10.8
Subbasin_103	0.0	1.6	0.0	8.3	9.9
Subbasin_104	0.0	1.9	0.0	9.4	11.3
Subbasin_105	0.0	1.7	0.0	8.9	10.7
Subbasin_106	0.0	1.4	0.0	7.3	8.7
Subbasin_107	0.0	1.8	0.0	8.7	10.5
Subbasin_108	0.0	1.2	0.0	6.7	7.9
Subbasin_109	0.0	2.0	0.0	9.8	11.8
Subbasin_110	0.0	1.7	0.0	8.5	10.2
Subbasin_111	0.0	1.8	0.0	9.2	11.0
Subbasin_112	0.0	1.9	0.0	9.8	11.8
Subbasin_113	0.0	1.6	0.0	8.0	9.6
Subbasin_114	0.0	1.7	0.0	8.4	10.1
Subbasin_115	0.0	1.5	0.0	7.6	9.1
Subbasin_116	0.0	1.7	0.0	8.3	10.0
Subbasin_117	0.0	2.1	0.0	8.4	10.6
Subbasin_118	0.0	1.8	0.0	6.8	8.6
Subbasin_119	0.0	1.6	0.0	6.6	8.2
Subbasin_120	0.0	2.2	0.0	9.2	11.4
Subbasin_121	0.0	1.8	0.0	8.0	9.8
Subbasin_122	0.0	2.0	0.0	7.8	9.8
Subbasin_123	0.0	3.1	0.0	7.2	10.3
Subbasin_124	0.0	2.7	0.0	8.5	11.2
Subbasin_125	0.0	2.1	0.0	7.8	9.9
Subbasin_126	0.0	1.9	0.0	8.4	10.3
Subbasin_127	0.0	2.1	0.0	7.9	9.9
Subbasin_128	0.0	2.2	0.0	7.1	9.3
Subbasin_129	0.0	2.0	0.0	7.2	9.2

Catchment ID	Initial Canopy Storage	Max Canopy Storage (mm)	Initial Depression Storage	Max Depression Storage (mm)	Total Abstraction (mm)
Subbasin_130	0.0	2.2	0.0	7.9	10.1
Subbasin_131	0.0	2.5	0.0	8.2	10.8
Subbasin_132	0.0	2.2	0.0	6.5	8.7
Subbasin_133	0.0	2.1	0.0	7.0	9.1
Subbasin_134	0.0	1.6	0.0	3.6	5.2
Subbasin_135	0.0	1.3	0.0	2.1	3.4
Subbasin_136	0.0	1.6	0.0	4.6	6.2
Subbasin_137	0.0	1.0	0.0	1.2	2.2
Subbasin_138	0.0	2.0	0.0	6.1	8.0

Table 16 – Runoff Transform – Unit Hydrograph - Calibrated

Catchment ID	Peaking Rate Factor	Lag Time (min)
Subbasin_101	200	1551.9
Subbasin_102	200	296.3
Subbasin_103	200	367.8
Subbasin_104	200	196.4
Subbasin_105	200	309.1
Subbasin_106	200	455.1
Subbasin_107	200	323.8
Subbasin_108	200	125.5
Subbasin_109	200	448.8
Subbasin_110	200	328.6
Subbasin_111	200	727.6
Subbasin_112	200	674.5
Subbasin_113	200	286.9
Subbasin_114	200	371.2
Subbasin_115	200	143.8
Subbasin_116	200	102.8
Subbasin_117	200	393.4
Subbasin_118	200	144.9

Catchment ID	Peaking Rate Factor	Lag Time (min)
Subbasin_119	200	93.2
Subbasin_120	200	115.3
Subbasin_121	200	350.8
Subbasin_122	200	156.2
Subbasin_123	200	139.2
Subbasin_124	200	208.3
Subbasin_125	200	159.6
Subbasin_126	200	181.7
Subbasin_127	200	284.8
Subbasin_128	200	82.5
Subbasin_129	200	357.2
Subbasin_130	200	245.1
Subbasin_131	200	65.0
Subbasin_132	200	65.1
Subbasin_133	200	97.7
Subbasin_134	484	124.3
Subbasin_135	484	48.3
Subbasin_136	200	73.3
Subbasin_137	484	40.0
Subbasin_138	484	156.6

3.4 Hydrologic Model Results

3.4.1 Existing Condition Modeling Results

The HEC-HMS model was run for the 50% AEP, 20% AEP, 10% AEP, 4% AEP, 2% AEP, and 1% AEP SCS 6-hour storms, and the Regional storm event using the existing condition parameter set as described in Section 3.3. The peak flows for the 4%, 2%, 1% AEP, and regional storm for each hydrologic element in Durham Creek, as well as the regional flow upstream of the Upper Dam (Junction_118) are provided in Table 17. The results for all AEP storms can be found in Appendix B2.

Table 17 – Existing Condition Peak Flows

Hydrologic Element	Drainage Area (km^2)	4% AEP Peak Discharge (m^3/s)	2% AEP Peak Discharge (m^3/s)	1% AEP Peak Discharge (m^3/s)	Hazel Peak Discharge (m^3/s)
Subbasin_134	0.3	1.1	1.3	1.4	2.3
Junction_119	0.3	1.1	1.3	1.4	2.3
Reach_1019	0.3	1.1	1.2	1.4	2.3
Subbasin_135	0.3	2.3	2.6	3.0	3.2
Junction_120	0.6	2.6	3.0	3.4	4.6
Reach_1020	0.6	2.6	3.0	3.4	4.6
Subbasin_137	0.3	2.7	3.0	3.4	3.2
OutflowDurham	0.9	4.8	5.6	6.3	7.4
Junction_118	347.3	N/A[1]	N/A[1]	N/A[1]	276.4

1. 6-hour AEP storms were run for the Saugeen River, but they are not appropriate for the purposes of this study and are therefore not reported in this table. However, the results from these model runs can be found in Appendix B2.

The Regional Storm produced larger peak flows than the 1% AEP at the junctions, reaches, and most subbasins. The 1% AEP event produced larger peak flows than the Hurricane Hazel Storm at Subbasin 137. Subbasin 137 is characterized as having lower lag time and/or higher percent imperviousness.

3.4.2 Future Conditions Modeling Results

As described in Section 3.3.12, based on the review of the Official Plan and the Zoning, significant future development is not anticipated for the Town of Durham or within the Saugeen River Watershed; therefore, no future conditions were modelled as part of the hydrology study.

3.4.3 Sensitivity Analysis

A sensitivity analysis was performed on several parameters to assess their relative impact on peak flows and runoff volume. The typical range for sensitivity analysis for floodplain mapping is 75% to 125% of the estimated parameter values (EWRG, 2017). A summary of the results for peak can be found in Table 18. The full results of the analysis can be found in Appendix B2.

Table 18 – Summary of Sensitivity Analysis

Parameter	75% of Estimated Value		125% of Estimated Value	
	Maximum Net Change in Peak Flow (m^3/s)	Maximum Percent Change in Peak Flow	Maximum Net Change in Peak Flow (m^3/s)	Maximum Percent Change in Peak Flow
Hydraulic Conductivity	28.9	17.5%	-26.9	-17.3%
Suction at the Wetting Front	8.7	4.7%	-8.3	-4.5%
Initial Water Content	-12.0	-7.6%	13.2	8.2%
Percent Impervious	-2.2	-4.7%	2.1	4.7%
Lag Time	61.2	33.1%	-39.9	-19.8%
Slope	-19.9	-13.3%	9.6	4.7%
Canopy Storage	0.2	0.2%	-0.2	-0.2%
Depression Storage	4.7	2.8%	-4.7	-2.7%

The results from the analyses show that hydraulic conductivity and lag time were the most sensitive parameters in the model. Canopy and Depression storage were found to be the least sensitive parameters. Channel slope, Suction at the Wetting Front, Initial Water Content and Percent Impervious were found to be moderately sensitive.

3.5 Hydrologic Model Validation

3.5.1 Overview

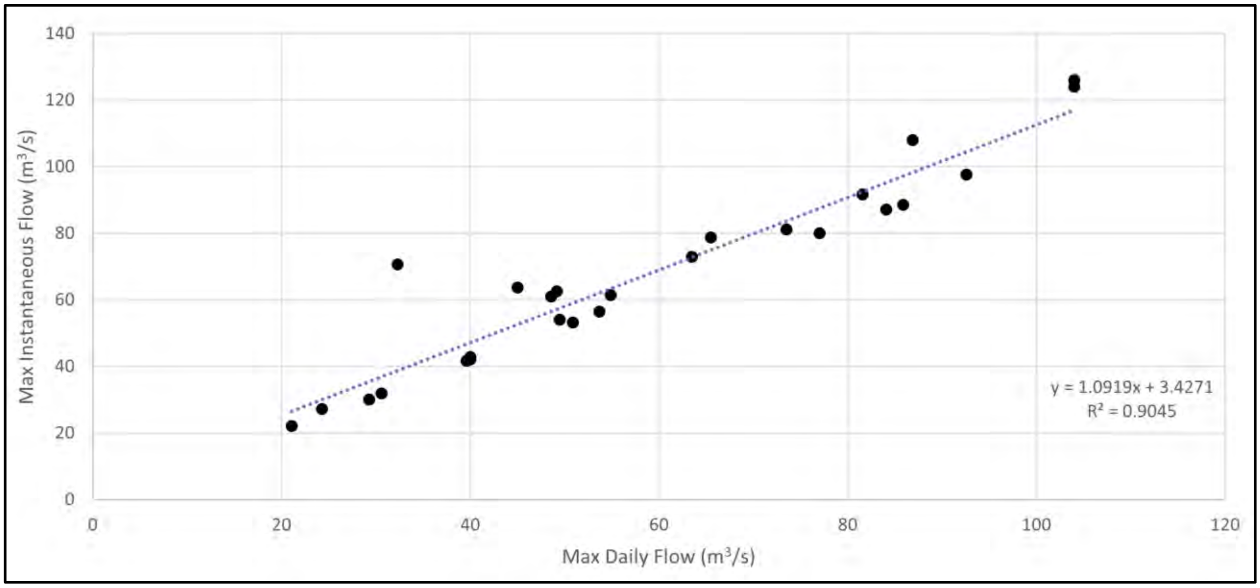
This section describes several methods used to calculate peak flows for the purpose of validating the hydrologic model and single station frequency results. While there are no regional frequency methods that were appropriate for the small drainage area associated with Durham Creek, the parameters in the model were globally changed during the calibration exercise for the Saugeen River and, therefore, Wills has assumed that the results from the calibrated model are representative of Durham Creek as well.

3.5.2 Single Station Frequency Analysis

The Saugeen River Above Durham Water Survey of Canada Gauging Station (02FC016) was used for the Single Station Frequency Analysis (SSFA). Wills downloaded the maximum annual instantaneous flow (MAIF) and the maximum annual daily flow (MADF) data from Water Survey of Canada. There were 29 years of data available for the MAIF and 37 years of MADF. In general, the MADF flow data is always more complete than then the MAIF data as WSC QA/QC process removes MAIF when flow is under the influence by ice or some other factor. These missing events can often be significant flood events that are important to the gauge record and can result in underestimated AEP flows generated from a SSFA. Additionally, general guidelines suggest that 30 years at minimum is required and 50 years preferred to confidently generate a 1% AEP event from a SSFA (Watt et al.). Therefore, it is often desirable to extend the data record if possible.

Wills used 26 events where MAIF and MADF data were both available and occurred within the same time frame (+/- 1 day) to produce a relationship using linear regression between the two data sets. The results of this analysis can be found in Figure 10.

Figure 10 – Max. Instantaneous Vs. Max. Daily Flow for Saugeen River Above Durham



The results of the linear regression analysis showed there was a good correlation between MADF and MAIF with a coefficient of determination of 0.9045. Wills then used the linear regression formula of y=1.0919x+3.471 where x is MADF and y is MAIF to estimate the missing data from MAIF where MADF was present. Wills used this method to extend the MAIF data record to 36 years which is sufficient period of record to confidently produce a 1% AEP flood event using SSFA.

Wills input the MAIF data into the statistical software package HEC-SSP. HEC-SSP is used to complete a statistical analysis of the data to determine Annual Exceedance Probability peak flows. The Log Normal 3 Parameter (LN3) and Log Pearson 3 (LP3) distributions using method of moments were evaluated. Wills found that both methods reasonably represented the data and therefore selected LN3 on the basis of that LN3 is a common distribution used in Ontario. The results from the Single Station Frequency Analysis can be found in Table 19 and the statistical plot can be Figure 11.

The drainage area to the Saugeen River gauge represents 89% of the drainage area to the Durham Upper Dam. The transposition of the data can be calculated using the following formula:

$$Q2 = Q1\left(\frac{A2}{A1}\right)^{0.75}$$

Where Q2 is the transposed flows, Q1 is the calculated AEP flows, A1 is the drainage area at the gauge, and A2 is the drainage area at the Durham Upper Dam. The results from the flow transposition can be found in Table 19.

Figure 11 – Single Station Frequency Analysis Statistical Plot – LN3

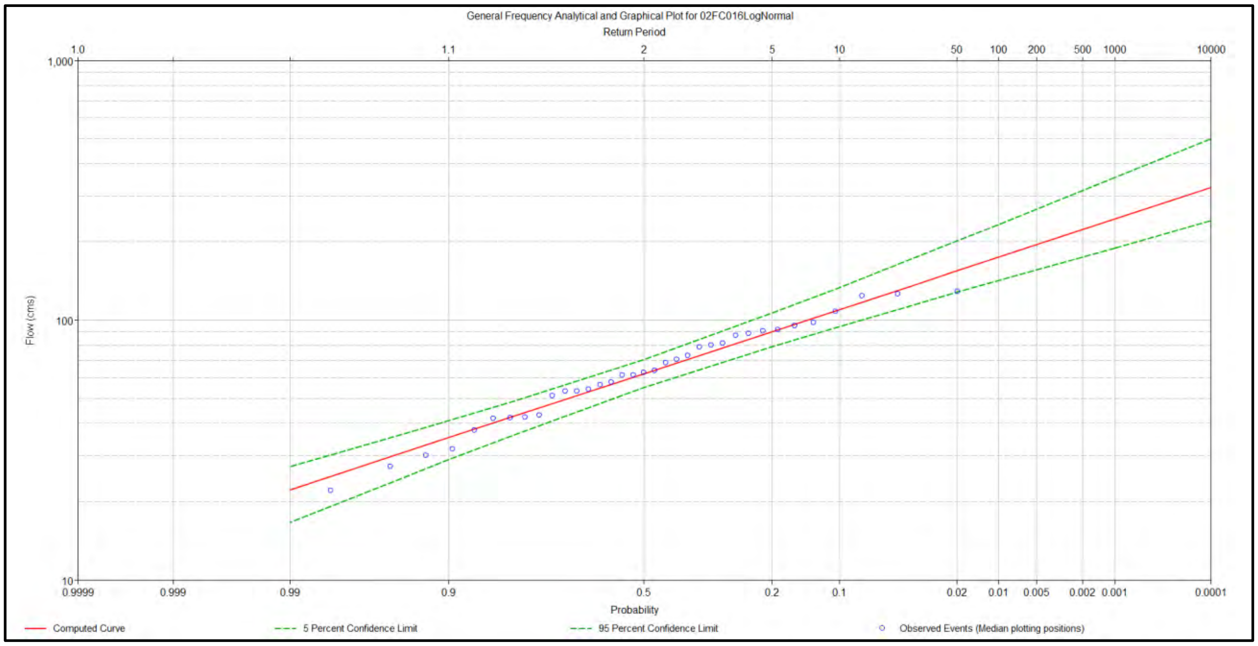


Table 19 – Single Station Frequency Analysis Results

Return Period (years)	Probability	Annual Exceedance Probability Percent	Flow at Gauge (m^3/s)	Transposed Flow (m^3/s)
1000	0.001	0.1	244.7	265.6
100	0.01	1	174.4	189.3
50	0.02	2	154.6	167.8
25	0.04	4	135.1	146.6
10	0.1	10	109.8	119.2
5	0.2	20	90.3	98.0
2	0.5	50	62.2	67.5
1.25	0.8	80	42.8	46.4
1.11	0.9	90	35.3	38.3
1.05	0.95	95	30.0	32.6
1.01	0.99	99	22.2	24.1

3.5.3 MNR Index Flow Method

The MNRF Index Flood Method (IFM) was developed by the MNRF to provide flow rates in catchments where a limited number of years of data were available. 238 gauging stations were analyzed to determine homogeneous regions with common hydrologic characteristics. 12 regions were identified, and a frequency curve was developed for each. Within this applicable region (Region 3), this method is recommended for watersheds between 86 km^2 and 3,960 km^2; therefore, this method is applicable to the Saugeen River watershed, but not the Durham Creek watershed. In Region 3, which contains the Saugeen River watershed, the index flood is calculated as:

$$Q2 = 0.20(Drainage\ Area)^{0.957}$$

Where, Q2 is the 50% AEP period index flood in m^3/s and drainage area is in km^2.

The remaining return period flows (20% AEP through 1% AEP) are calculated as ratios of the Index Flood. The applicable ratios for Region 3 are as follows:

Index	Q2	Q5	Q10	Q25	Q50	Q100
Ratio	1.00	1.35	1.60	1.90	2.20	2.50

A comparison of the modelled flows with the MNRF Index Flow Method is provided in Table 20.

3.5.4 Flood Flow Comparison Results

The results from the SSFA completed by Wills was compared to the computed results of the MNR Index flood, and the results from other flood studies completed historically for the Saugeen River. A summary table of the flood flows for the 1% AEP event can be found in Table 20.

Table 20 – Flood Flow Comparison for 1% AEP Event

Subbasin	Peak Flow (m^3/s)				
	Drainage Area (km^2)	Single Station Frequency Analysis Transposed (Wills 2023)	MNR Index Flow Method	Single Station Frequency Analysis and Transposed by Wills (WESA 2009)	Lathem Group Report (1983)
Drainage Area at Durham Upper Dam	347.3	189.3	135.0	155.2	185

In general, review of the comparison peak flows show that the MNR IFM results are lower than those produced through the SSFA completed by Wills. Wills SSFA was found to be slightly higher than Lathem Group Report 1983 which used downstream gauges on the Saugeen River (i.e., not the Saugeen River Above Durham Gauge) to estimate the 1% AEP. The SSFA completed by WESA was lower than what was estimated by Wills. Wills SSFA has a significantly longer period of record that was analyzed and therefore the results were accepted as the AEP flood events for the purposes of this study.

3.5.5 Hurricane Hazel Regional Storm

The hydrologic model was calibrated and verified for the Saugeen River using historic rainfall and flow data. In general, the model does a satisfactory job at modeling peak flows during the calibration and verification events. Therefore, the estimated peak flows calculated by the model for Hurricane Hazel Storm were assumed for the purposes of this study for both the Durham Creek and Saugeen River at the Durham Upper Dam.

3.6 Comparison to Past Study Results

The previous floodplain mapping for the Town of Durham, Ontario along the Saugeen River was completed in 1983 by Latham Group, and in 2009 by WESA. The results of the modeling for the Hurricane Hazel Storm compare reasonably well with the original peak flows produced in these studies. The Hurricane Hazel Storm flow rate calculated by Wills was 276.4 m^3/s compared to the 305 m^3/s WESA calculated. It was unclear from the report if the WESA HEC-HMS model had been calibrated.

Wills reviewed the Durham Creek background data, and it does not have previous hydrology completed.

3.7 Summary and Selection of Peak Flows for Hydraulic Model

3.7.1 Hydrology Study Summary

Wills developed a hydrologic model for the Saugeen River and Durham Creek. The model includes 38 sub-catchments based on the various tributaries as well as the anticipated flow change locations in the hydraulic model. The hydrologic model was developed with existing hydrologic parameters as most of Durham Creek is already developed.

3.7.2 Selection of the Flood Risk Mapping Peak Flows

Flood hazard mapping was completed for the 4%, 2%, and 1% AEP storms and the Regional (Hurricane Hazel) Storm plus the same storms with considerations for climate change. The peak flows recommended for use in the flood risk mapping for Durham Creek are those produced by the hydrologic model for the 6-hour SCS Type II storm distribution and Regional (Hurricane Hazel) Storm. The peak flows recommended for use in the flood risk mapping for the Saugeen River are those produced by the hydrologic model for Regional (Hurricane Hazel) Storm and the AEP flows from the SSFA.

3.7.3 Selection of the Regulatory Flood

Within the jurisdiction of the SVCA, and in keeping with the Technical Guide - River and Stream Systems: Flood Hazard Limit (MNR, 2002), Figure B-1, the subject area is in Zone 1 and therefore the Regulatory Flood is selected as the flood resulting from the Regional (Hurricane Hazel) Storm or the 1% AEP storm, whichever is greater. Based on the results of the hydrologic model results for existing conditions shown in Table 10 and described in Section 3.4, the Hurricane Hazel Storm peak flows will be used for Durham Creek. The Hurricane Hazel Storm peak flows produced higher peak flows, except for Subbasin 137 where the 1% AEP storm produced slightly higher peak flows for the individual basin (but not in the junctions or routing reach). Therefore, it is recommended that the Hurricane Hazel event be used for regulatory purposes for Durham Creek. A summary of which storm and peak flow to be used for regulatory mapping can be found in Table 21.

Table 21 – Regulatory Floodplain Mapping Peak Flows

Location	Regulatory Flood	Peak Flow (m^3/s)
Subbasin_134	Regional	2.3
Junction_119	Regional	2.3
Reach_1019	Regional	2.3
Subbasin_135	Regional	3.2
Reach_1020	Regional	4.6
Subbasin_137	Regional	3.2
OurflowDurham	Regional	7.4
Junction 118 (Inflow to Durham Upper Dam)	Regional	276.4

4.0 Hydraulics

4.1 Model Selection

The HEC-RAS (Version 6.4.1) hydraulic model was selected by the project team and the SVCA as the preferred hydraulic model to be used for this project. HEC-RAS is a free hydraulic modeling software developed and maintained by the U.S. Army Corps of Engineers' (USACE) Hydrologic Engineering Centre (HEC) with a long history of use in Canada and internationally. The software can perform hydraulic calculations in one-dimensional steady flow, one-dimensional (1D) unsteady flow, two-dimensional (2D) unsteady flow, and coupled one-dimensional/two-dimensional (1D/2D) flow conditions for a full range of natural and constructed channels. The software is suitable for many applications including floodplain mapping, open channel and hydraulic structure design, dam breach analysis, rain on grid, and sediment transport modeling. HEC-RAS includes built in GIS tools with which a significant portion of the hydraulic model can be developed, and the modeling results viewed.

The following information is required to calculate the input parameters for HEC-RAS to compute water surface elevation and velocity:

- Topographic, bathymetric, and aerial imagery information for the channel and overbanks to define the physical characteristics of the watercourse including slope, length, geometry, and Manning's roughness.
- Bridge, culvert, inline structure, and lateral structure information including geometry, construction material, alignment, and operating rules (if applicable).

- Location and geometry of obstructions to flow such as dwellings and auxiliary structures.
- Peak flows are required for a steady flow model and a hydrograph for an unsteady flow model.
- Flow and water surface elevations of past events for calibration and verification of model parameters.

The objective of the hydraulic model is to compute accurate water surface elevations and floodplain extents for several AEP and Hurricane Hazel storm events through the Town of Durham. Wills reviewed the topography, historic floodplain mapping, available background information from the SVCA, anecdotal information received from residents during the field program, and information gathered during the first Public Information Centre. Wills determined that there are several locations within the study area, including the spill into Durham Creek from the Saugeen River, where flow is two dimensional (2D). Therefore, a 2D unsteady state modeling approach was chosen by Wills based on modeling objectives, available data, topography, and the complexity of flow direction throughout the study area.

4.2 Hydraulic Model Development

4.2.1 Hydraulic Model Domain

The 2D hydraulic model covers an area of approximately 5.4 km^2. The model extends for approximately 7.3 km along the Saugeen River, extending from Grey County Road 4 (downstream end of the model) to Concession 2 (upstream end of the model) and includes the anticipated Saugeen River floodplain as well as the Durham Creek study area. The flow length of Durham Creek is approximately 1.5 km. The 2D model extents are shown in Figure 12 with a red outline and hatching.

Figure 12
Saugeen River and Durham Creek
Hydraulic Modelling Domain

Legend
2D Model Boundary Conditions
2D Flow Area

Data Sources:
SWOOP 2020, Grey County

NAD 1983 UTM Zone 17N
1:15,000

Meters
0 130 260 520 780 1,040

N

Drawn By:	DG
Checked By:	MC
Map Date:	2/29/24
Project Number:	5591
Map File Number	5591-Domain

WILLS

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150 Jameson Drive
Peterborough, Ontario
K9J 0B9

P. 705.742.2297
F. 705.748.9944
E. wills@dmwills.com

4.2.2 Topographic and Bathymetric Data

Wills used the 0.5 m LiDAR DTM discussed in Section 2.2 as the terrain file for the hydraulic model. The LiDAR DTM does not include points for the ground surface below the water surface. Therefore, it is generally necessary to supplement these areas with surveyed data to create accurate river geometry. Topographic and bathymetry surveys were completed for all hydraulic structures and selected river/creek cross sections in the study area. Bathymetric survey points were taken in-channel up to the top of bank throughout the study area, including in Durham Creek and along the Saugeen River where conditions permitted. The surveyed data between the banks was merged into the terrain in HEC-RAS. Data sources generated by different entities were placed into the same projection and datum for consistency in processing.

Road and rail crossings have one of the most significant impacts on the regulatory floodplain. Considerable backwater conditions may be present upstream of a crossing that is unable to convey the regulatory flow, causing a widespread floodplain. There are a significant number of structures that cross Durham Creek and the Saugeen River. Wills completed field surveys of all hydraulic structures within the study area. Detailed structure data sheets and photos for each crossing are contained in Appendix A.

4.2.3 2D Flow Areas

Wills created a single 2D flow area within the HEC-RAS model, as shown in Figure 12. The default initial cell size used was a 10 m resolution. The 2D area's cell sizes were further refined along the watercourse and linear infrastructure using breaklines and SA/2D Connections enforced as breaklines to ensure cell faces were aligned perpendicular to the major flow paths and the Courant numbers remained below one. Breaklines and refinement regions used near spacing between 3 m and 4 m with near repeats ranging between 1 and 9, depending on the width of the floodplain.

4.2.4 **Manning's Roughness Values**

Wills imported the SOLRIS landcover GIS layer to HEC-RAS to estimate the initial Manning's roughness values for the 2D domain. The Manning's roughness values were then further refined as needed using aerial imagery, and geospatial refinement regions within HEC-RAS. A summary of the Manning's roughness values for each type of land cover and typical calibration ranges can be found in table in Table 22.

Table 22 – Mannings Roughness Values

Raster Value SOLRIS	Land Cover Description	'n' Standard	Calibration Range	
			Minimum	Maximum
Channel				
Manual Input	Watercourse	0.035	0.025	0.045
Overbank				
90	Forest	0.08	0.04	0.12
91	Coniferous Forest	0.08	0.04	0.12
92	Mixed Forest	0.08	0.04	0.12
93	Deciduous Forest	0.08	0.04	0.12
131	Treed Swamp	0.08	0.04	0.12
135	Thicket Swamp	0.08	0.035	0.07
160	Marsh	0.08	0.035	0.07
170	Open Water	0.035	0.035	0.07
191	Plantation	0.08	0.04	0.12
192	Hedge Rows	0.08	0.04	0.12
193	Agriculture/Tilled	0.055	0.035	0.07
201	Transportation (Asphalt)[1]	0.06	-	-
202	Built Up Area-Pervious	0.045	0.03	0.055
203	Built Up Area-Impervious[1]	0.06	0.03	0.055
204	Aggregate Extraction	0.1	-	-
250	Undifferentiated	0.055	0.035	0.07
Conduit				
Manual Input	Corrugated Steel Pipe	0.024	0.021	0.027
Manual Input	Concrete	0.013	0.011	0.015

1. Transportation and Built Up-Impervious were lumped into a single composite land cover manning's value which is consistent with published low intensity developed areas from HEC-RAS 2D User Manual.

4.2.5 Hydraulic Structures

Wills completed topographic surveys of all road crossings, several private foot bridges, and three dams along Durham Creek and the Saugeen River. All road crossings were included in the model as SA/2D Connections. Private foot bridge structures without concrete abutments were not included in the model as they are likely to wash away during a high magnitude flood event. Additionally, several of the private foot bridges did not have railings and therefore represent only a small reduction in overall conveyance if they did not fail.

All galvanized guard rails were assumed to be blocked and were therefore modeled as solid portions of the bridge/culvert structure. Structures with concrete parapet walls were modeled as solid portions of the bridge/culvert structure. Steel tube railings with 1 m or greater between vertical posts were assumed to still convey flow and were therefore not included in the bridge/culvert structure. This was assumed as they are significantly less likely to become blocked during a storm. Table 23 shows the typical values for the weir coefficients used by Wills and the calibration range.

Table 23 – Weir Coefficients

Weir Flow Coefficients	'C' Standard (2D HEC-RAS Default)	Calibration Range	
		Minimum	Maximum
Broad Crested (i.e., Dams and Road Embankments)	1.66	1.4	1.7

4.2.6 Obstructions

Generally, there are two methods to include barriers to flow such as dwellings or auxiliary structures in a 2D model. The first method is to raise the terrain of the DTM to include the structure and carefully construct the cells faces for each dwelling. The second method is to significantly increase the Manning's n values for the cells within the building footprint so that water can enter the building footprint (i.e., flood the structure), but it does not account for significant conveyance. Both methods can generally produce accurate mapping if implemented correctly. Method 1 was chosen due to the ease of application and that it does not account for flow entering structures, which is conservative in terms of floodplain limits.

4.2.7 Boundary Conditions

Durham Creek and the Saugeen River required several boundary conditions in HEC-RAS as it is an unsteady model and there are multiple inflow locations. In HEC-RAS the upstream flow hydrograph boundary condition, the internal flow hydrograph boundary condition, and the downstream boundary condition all require an initial estimate of the friction slope. Wills estimated the friction slope to be the average bed slope of the terrain upstream and downstream of the boundary condition. The location, type of boundary condition, and the estimated initial friction slope can be found can be found in Table 24.

Table 24 – Boundary Conditions

Name	Location	Boundary Condition Type	Estimated Initial Friction Slope (m/m)
Saugeen Inflow BC	External	Flow Hydrograph	0.0039
Durham Creek Upstream BC	Internal	Flow Hydrograph	0.008
Durham Creek J20 BC	Internal	Flow Hydrograph	0.003
Durham Creek J21 BC	Internal	Flow Hydrograph	0.0047
Saugeen Outflow BC	External	Normal Depth	0.0023

4.2.8 Flow Data for Hydraulic Model

2D hydraulic models require the use of an unsteady flow regime. This means that an inflow hydrograph time series needs to be defined rather just a constant peak flow that is used in a steady state model. There are two approaches that can be taken to define this hydrograph. The first approach is to define the actual full hydrograph that was computed by the hydrologic model, including rising and falling limbs. The second approach is to define a "quasi" unsteady hydrograph such that the hydrograph is the peak flow calculated by the hydrologic model for all ordinates of the time series. The "quasi" unsteady hydrograph approach was used by Wills for the undertaking the hydraulic assessment as it most closely mirrors the assumptions used in a steady state model, which is recommended in the Technical Guide – River and Stream Systems: Flooding Hazard Limit (MNR, 2002).

The existing condition flows discussed in Section 3.4.1 were used for the purposes of floodplain mapping for the 4% AEP storm, 2% AEP storm, 1% AEP storm, and the Hurricane Hazel storm as well as the same events with considerations for climate change. The flow data used for inflow hydrographs at the boundary conditions can be found in Table 25 for the standard storm events and in Table 26 for the climate change scenarios. Note these are steady inflow hydrographs and are incremental for Durham Creek.

Table 25 – Inflow Hydrographs for Hydraulic Model at Boundary Conditions

Hydrologic Element	4% AEP (m^3/s)	2% AEP (m^3/s)	1% AEP (m^3/s)	Hurricane Hazel (m^3/s)
Saugeen Inflow BC	135.1	154.6	174.4	276.4
Durham Creek Upstream BC	1.1	1.3	1.4	2.3
Durham Creek J20 BC	1.5	1.7	2.0	2.3
Durham Creek J21 BC	2.2	2.6	2.9	2.8

Table 26 – Inflow Hydrographs with Climate Change Used for Hydraulic Modeling

Hydrologic Element	4% AEP Climate Change (m^3/s)	2% AEP Climate Change (m^3/s)	1% AEP Climate Change (m^3/s)	Hurricane Hazel Climate Change (m^3/s)
Saugeen Inflow BC	135.1	154.6	174.4	276.4
Durham Creek Upstream BC	1.4	1.6	1.8	2.9
Durham Creek J20 BC	2.0	2.3	2.6	3
Durham Creek J21 BC	2.8	3.3	3.7	3.6

4.3 Calibration/Validation

The development of a hydraulic model requires several input parameters. Some of the parameters are based on field measurements (i.e., survey, measurements of bridges and culverts, etc.), while other parameters are left to engineering experience and judgement based on available information (Manning's n, loss coefficients, etc.). For this reason, it is ideal to compare computed water levels to those observed in the field. Model parameters can then be adjusted (calibrated) to replicate the observed water levels more accurately during a historic flood event. Wills completed a background review of all available information and found no documentation of historic flood events within Durham Creek for which to calibrate the hydraulic model. Therefore, typical published parameters were relied upon to produce water surface elevations for the purposes of this study.

4.4 Hydraulic Model Results

Water surface elevations are shown on the engineered floodplain maps in Appendix D and the digital raster outputs which have been provided in an ESRI file geodatabase.

4.5 Sensitivity Analysis

Wills completed a sensitivity analysis of the hydraulic model using the Hurricane Hazel storm profile. In general, the most sensitive parameter within a hydraulic model is Manning's roughness. Manning's roughness is a highly variable and subjective parameter that has a significant influence on the computed water surface elevations. Therefore, it is necessary to assess the sensitivity of computed water surface elevations to changes in manning's roughness values. The typical range for sensitivity analysis for floodplain mapping is 75% to 125% of the estimated parameter values (EWRG, 2017). A summary of the results of the sensitivity analysis can be found in the histograms shown in Figure 13 (125% Initial Manning's Roughness) and Figure 14 (75% Initial Manning's Roughness. It is noted that the histograms are based on the raster water surface elevation outputs from HEC-RAS which have a cell size of 0.5 m and not the computational grid.

The results of the sensitivity analysis show that when the Manning's roughness is increased to 125% of the initial roughness, the mean increase in water level is 0.12 m. The results of the sensitivity analysis also show that when the Manning's roughness is decreased to 75% of the initial roughness, the mean decrease in water level is 0.14 m.

Figure 13 **– 125% of Initial Manning's Roughness**

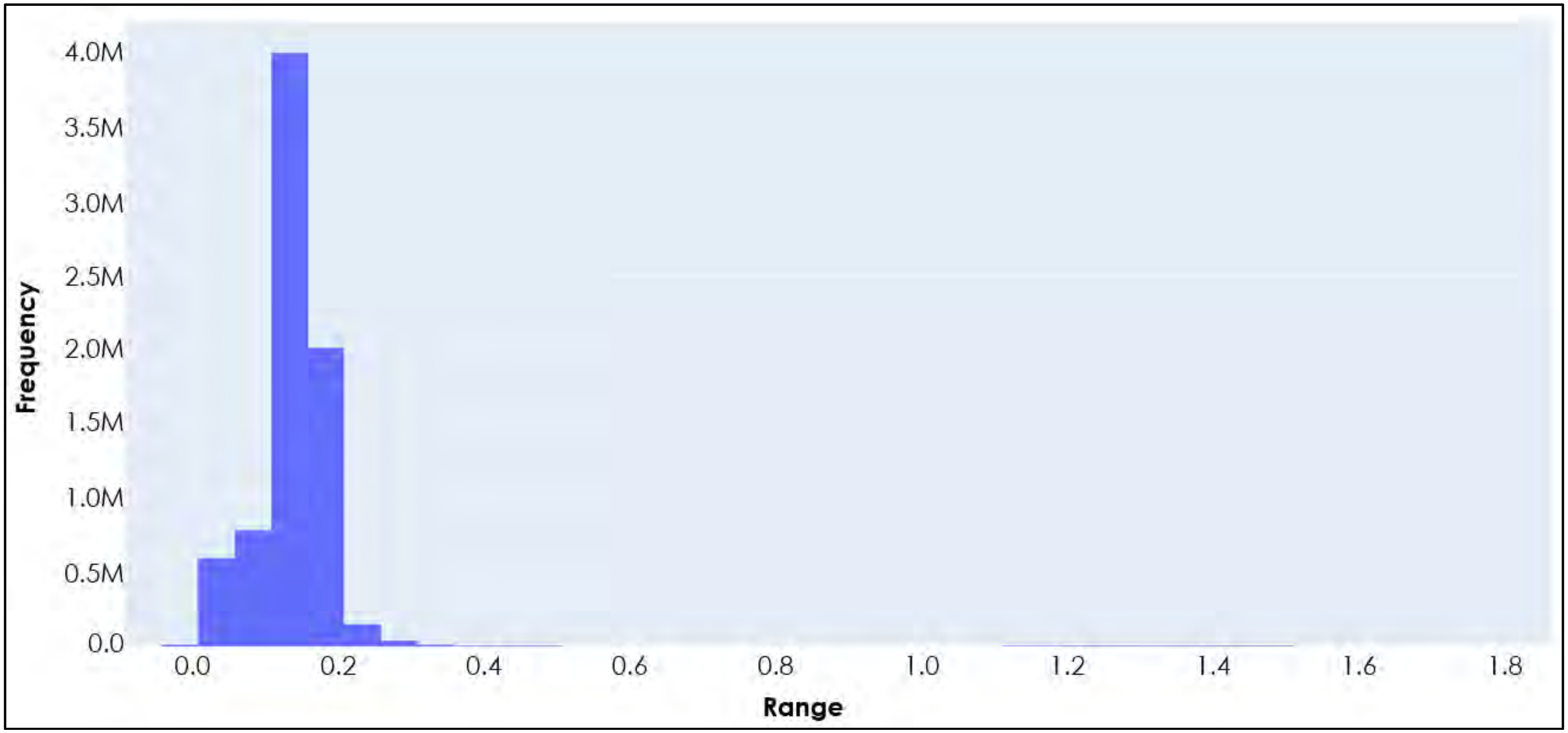
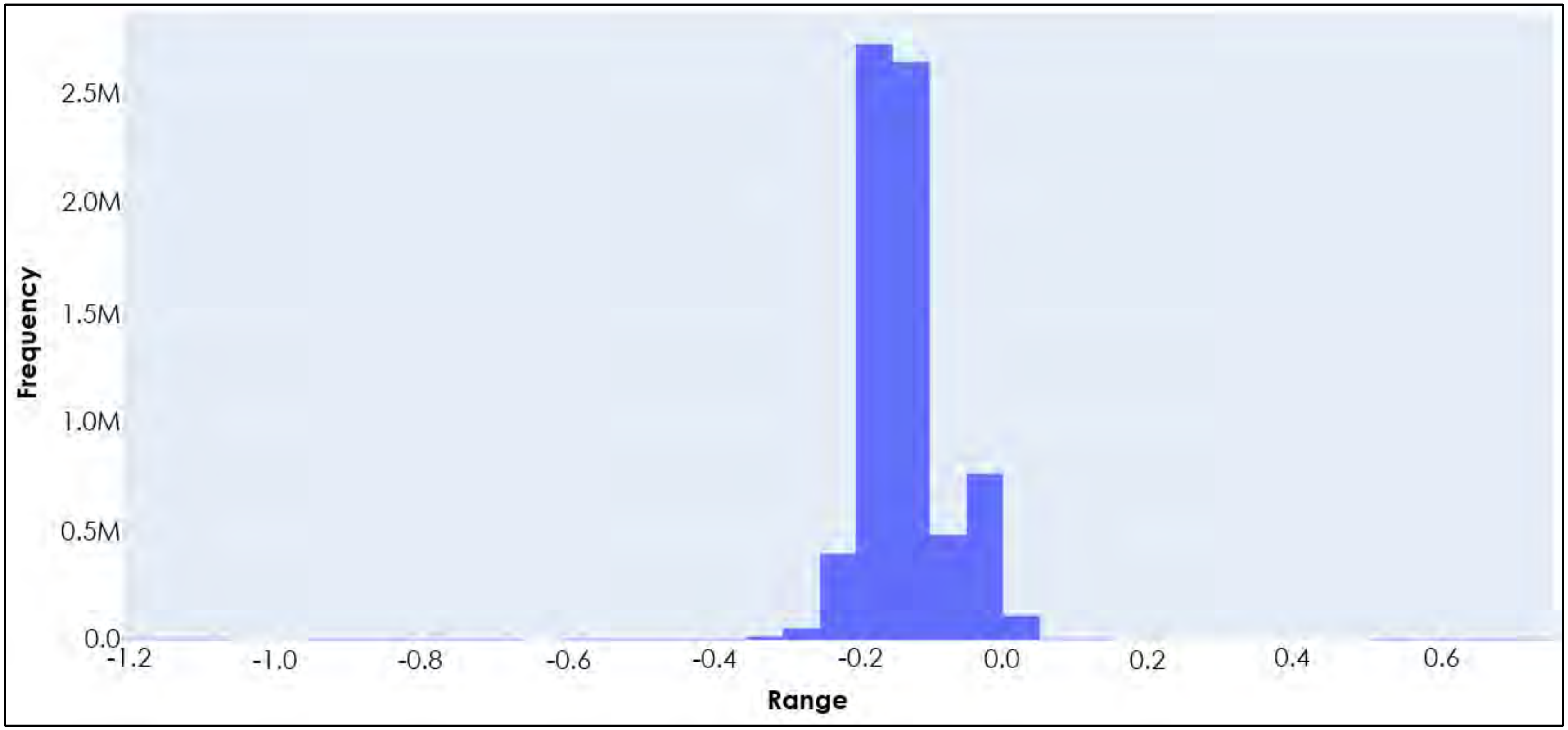


Figure 14 **– 75% of Initial Manning's Roughness**



5.0 Mapping

5.1 Overview

The regulatory floodplain and flood risk mapping is the final product produced after the water surface elevations are determined using the hydraulic model. Wills utilized the tools within HEC-RAS as well as manual interpretation and refinement in ArcGIS to delineate the floodlines.

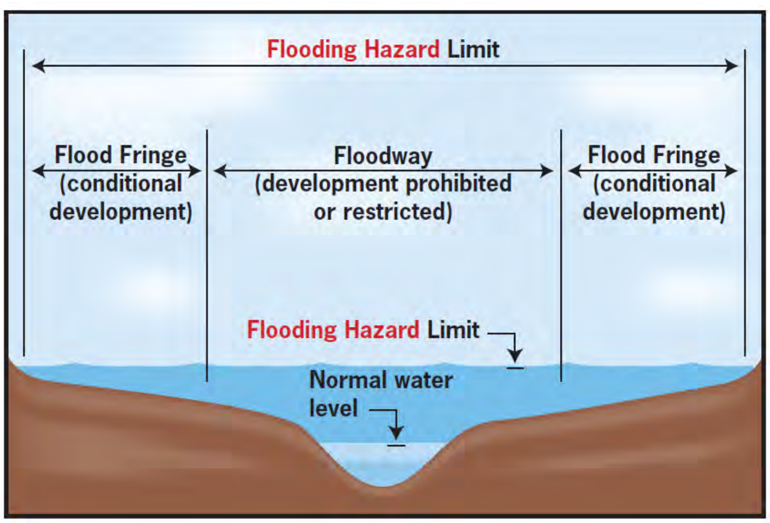
The 2020 South Western Ontario Orthophotography Project (SWOOP) Aerial Imagery was used as the background layer for all mapping. The orthoimagery was obtained from the Grey County GIS Server. The LiDAR DTM discussed earlier in the report is the base topographic dataset used for computing inundation boundaries, depths, and water surface elevations. For visualization purposes, contours were created from the DTM at 1.0 m and 5.0 m intervals.

The regulatory floodplain and flood risk maps are provided in Appendix D.

5.2 Two Zone Flood Hazard Concept

The Municipality of West Grey has adopted a two zone flood hazard policy approach for Durham Creek. The two zone approach recognizes the fact that the flood hazard can often be divided into two zones, the floodway, and the flood fringe. The floodway is the inner portion of the flood hazard that represents the area required for the safe passage of flood flow and/or the area where flood depth and/or velocities are considered to be such that they pose a potential threat to life and/or property damage. The two zone approach is shown in Figure 15.

Figure 15 – Two Zone Flood Hazard Approach



The two zone flood hazard limit for Durham Creek is complicated by the presence of a flood dike at the Durham Upper Dam. This dike stops the Saugeen River from spilling into Durham Creek. The Technical Guide – River and Stream Systems: Flooding Hazard Limit

(MNR, 2002) states that the area behind a dike is regarded as flood fringe if the dike is high enough to provide protection against the Regional flood. The dike at the Durham Upper Dam has a freeboard of approximately 0.50 m during the Regional flood; therefore, the area that the dike protects from flooding can be considered as flood fringe.

In summary, the outer extent of the flood hazard limit is defined as the Regional flood limit for Durham Creek plus the Regional flood limit for the case where the dike at the Durham Upper Dam is not present. The floodway is defined by looking at a combination of the depth (>0.8 m), velocity (>1.7 m/s), and depth x velocity (>0.40 m^2/s).

5.3 Floodline Delineation

RAS Mapper, a tool within HEC-RAS, was used to generate the floodlines for the regulatory floodplain and flood risk mapping. RAS Mapper projects the hydraulic model results across the terrain data (LiDAR DEM) to create the floodlines for the chosen plans. The computed floodlines are a reasonable estimate; however, further evaluation and revisions to correct abnormalities is generally required. Manual interpretation and refinement were completed within ArcGIS to ensure all floodlines conform to the principles of hydraulic engineering. Areas shown as inundated that are not hydraulically connected were excluded from the floodplain. Furthermore, high points of land that are not subject to flooding during a regional event but are surrounded by flooded land are within the limits of the delineated flood line. Some engineering judgement was used for properties within an "island" that were clearly built to be higher than the floodplain.

The following summarized the manual adjustments of interest that were made to create the floodlines for Durham Creek:

- All islands within the floodplain were removed.
- Areas resembling an island connected only by a narrow strip of land were removed and considered to be within the floodplain.
- Connection of the floodlines were made for any overtopping hydraulic structures.
- The floodway was defined using GIS tools and the depth, velocity, and depth x velocity HEC-RAS outputs.

The results of the floodline delineation are shown on the regulatory floodplain and flood risk maps in Appendix D.

5.4 Floodplain Mapping Results

5.4.1 Floodline Comparison

There are no existing floodlines for Durham Creek with which to compare the current Durham Creek floodlines. Therefore, Wills compared the results of the 1983 Latham Group floodplain mapping for the Saugeen River to the results of Wills 2D hydraulic model for the Saugeen River. The two results compare reasonably well; however, the

1983 floodlines show more flooded area in most places. These differences are most likely attributable to the differences in topographic data sources, and changes in the modelling approach.

5.4.2 Roadway Overtopping

There are several culvert structures along Durham Creek that overtop during the modelled flood events. Will identified these culverts by analyzing the results of the HEC-RAS model. The results of the analyses for each event were extracted from HEC-RAS and input into a Microsoft Excel spreadsheet where they were formatted for input into the report.

The results of the analyses are included in Table 27 and in Table 28 for the climate change scenarios. There are a number of culverts that overtop under the various scenarios, including many where the Maximum Overtopping Depth exceeds 0.30 m (the maximum allowable depth for safe access). These locations/events are highlighted in red/bold in Tables 27 and 28. The Overtopping Velocities are generally within the erosion threshold for gravel substrates, which is in the range of 0.75 m/s to 1.2 m/s based on Design Chart 2.17 from the MTO Drainage Management Manual (MTO, 2023). The locations/events that exceed 0.75 m/s are shown in orange/bold in Tables 27 and 28 and the locations/events that exceed 1.2 m/s are highlighted in red/bold in Tables 27 and 28. Locations where the erosion threshold of 1.2 m/s is exceeded have an increased risk of erosion during overtopping.

5.4.3 Impacts to Buildings

There are several buildings included in the floodplain for the various flood events. These buildings were identified by Wills through an analysis completed in ArcGIS using the outputs from the HEC-RAS model, DTM, building footprints, and Grey County parcel fabric. Wills related the building footprints with the parcel fabric so that each building had a 911 address associated with it. The minimum DTM elevation, maximum water surface elevation, and maximum flood depth were then determined for each building.

The results of the analyses are included in Table 29 for the regular flood events and Table 30 for the climate change events. In total, there are approximately 174 buildings that could be flooded under different scenarios. Of the 174 buildings that that could be impacted, approximately 58 of them are only flooded in the case where the dike at the Durham Upper Dam remains in place.

Table 27 – Roadway Overtopping

Street	25-Year			50-Year			100-Year			Hazel			Hazel No Dike		
	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)
Lambton Street East	1.1	0.30	0.56	1.3	0.34	0.58	1.4	0.36	0.60	2.3	0.38	0.65	160.7	1.27	2.37
Kincardine Street North	2.6	0.61	0.25	2.4	0.65	0.37	2.8	0.69	0.28	4.0	0.78	0.32	175.9	1.78	1.52
Elgin Street South	4.8	0.35	0.47	5.6	0.37	0.50	6.3	0.39	0.52	7.4	0.41	0.54	163.0	1.25	2.22
Saddler Street East	4.8	0.84	0.58	5.6	0.89	0.57	6.3	0.92	0.59	7.4	0.93	0.65	162.9	2.18	2.04
Albert Street South	4.4	0.89	0.32	5.2	0.93	0.34	5.9	0.97	0.35	6.7	1.01	0.36	150.9	1.84	1.94
Highway 6	4.8	0.64	0.24	5.6	0.69	0.27	6.3	0.72	0.29	7.4	0.77	0.31	151.3	1.93	1.44
Queen Street South	4.7	0.97	0.62	5.5	1.09	0.71	6.3	1.20	0.79	8.7	1.56	1.07	159.6	1.52	1.40

Table 28 – Roadway Overtopping Climate Change

Street	25-Year CC			50-Year CC			100-Year CC			Hazel CC		
	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)	Flow (m^3/s)	Maximum Overtopping Velocity (m/s)	Maximum Overtopping Depth (m)
Lambton Street East	1.4	0.41	0.60	1.6	0.35	0.62	1.8	0.37	0.64	2.9	0.44	0.70
Kincardine Street North	3.4	0.69	0.28	3.9	0.73	0.30	4.4	0.77	0.31	5.9	0.86	0.35
Elgin Street South	6.2	0.40	0.52	7.2	0.41	0.54	8.1	0.43	0.57	9.5	0.47	0.60
Saddler Street East	6.2	0.92	0.62	7.2	0.95	0.61	8.1	0.99	0.63	9.5	1.03	0.69
Albert Street South	5.8	0.96	0.35	6.8	1.01	0.36	7.7	1.04	0.37	9.1	1.08	0.40
Highway 6	6.2	0.72	0.28	7.2	0.76	0.31	8.1	0.80	0.33	9.5	0.84	0.36
Queen Street South	6.1	0.99	0.64	7.1	1.08	0.71	8.1	1.18	0.79	10.8	1.54	1.08

Table 29 – Impacts to Buildings and Structures

Address	Lowest DTM Elevation (m)	25-Year		50-Year		100-Year		Hazel		Hazel No Dike	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
592 Lambton St East	348.73									349.71	0.76
573 George St East	347.53									349.21	1.39
561 George St East	348.33									348.80	0.51
165 Cross St S	343.20	344.56	0.23	344.56	0.23	344.57	0.24	344.55	0.25	344.69	1.44
429 Lambton St E	343.02									344.28	1.43
421 Lambton St E	343.96									344.28	0.42
155 Kincardine St S	342.86									344.28	1.41
175 Kincardine St S	342.93									344.14	1.16
176 Kincardine St S	341.27	342.36	0.37	342.39	0.39	342.41	0.41	342.45	0.46	343.75	1.65
180 Kincardine St S	340.44	342.37	0.45	342.39	0.47	342.41	0.49	342.46	0.53	343.78	2.19
196 Kincardine St S	342.07									343.80	0.93
154 Kincardine St S	340.69	340.75	0.07	340.78	0.10	340.84	0.13	342.32	0.33	343.80	2.01
122 Kincardine St S	341.75									343.85	1.23
479 Lambton St E	342.44	342.72	0.32	342.75	0.34	342.77	0.36	342.82	0.41	344.48	2.04
493 Lambton St E	344.32									344.65	0.28
489 Lambton St E	343.94									344.57	0.48
582 Cedar Ln	344.45									344.43	0.08
580 Cedar Ln	343.74									344.43	0.64
380 Saddler St E	341.49									343.36	1.24
368 Saddler St E	340.70	340.91	0.10	340.97	0.12	340.99	0.15	340.99	0.18	342.62	1.94
344 Saddler St E	340.40	340.85	0.32	340.96	0.34	341.05	0.40	341.04	0.43	342.61	2.14
191 Elgin St S	340.56	340.84	0.19	340.86	0.22	340.86	0.24	340.83	0.27	342.47	1.94
187 Elgin St S	340.18	340.71	0.53	340.74	0.56	340.77	0.59	340.81	0.62	342.66	2.32
175 Elgin St S	340.40	340.73	0.25	340.77	0.28	340.80	0.30	340.84	0.34	342.73	2.14
169 Elgin St S	340.75	340.73	0.02	340.77	0.06	340.80	0.08	340.85	0.12	342.70	1.97
157 Elgin St S	340.25	340.74	0.57	340.78	0.60	340.81	0.63	340.85	0.67	342.69	2.51
209 Garafraxa St N	338.52	342.02	3.38	342.34	3.70	342.63	3.96	344.28	5.58	341.58	3.01
144 Garafraxa St N	340.06	340.67	0.55	340.86	0.76	341.06	0.97	343.49	2.26	340.51	0.40
120 Garafraxa St N	341.06			340.82	0.03	341.04	0.02	343.43	1.11		
108 Garafraxa St S	342.45							343.14	0.38		
115 Lambton St W	342.54							342.92	0.34		
169 Lambton St W	342.30							342.72	0.18		
118 Queen St S	341.97							342.56	0.13		
124 Garafraxa St S	341.48							342.59	0.39		
157 Garafraxa St S	342.77							343.72	0.79		
137 Garafraxa St S	343.10							343.43	0.34		
105 Garafraxa St S	343.15							343.41	0.25		

Address	Lowest DTM Elevation (m)	25-Year		50-Year		100-Year		Hazel		Hazel No Dike	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
150 Mill St East	344.09							344.32	0.24		
119 Garafraxa St S	342.24							343.18	0.12		
156 Garafraxa St S	340.76							341.67	0.22		
157 Garafraxa St S	340.98							341.07	0.09		
168 Garafraxa St S	340.29							340.60	0.34		
168 Garafraxa St S	339.90							340.28	0.18	340.19	0.24
190 Garafraxa St S	339.30							340.03	0.11	340.12	0.32
173 Garafraxa St S	340.30								0.00		
185 Garafraxa St S	340.07							340.29	0.29	340.19	0.10
193 Garafraxa St S	340.17							340.28	0.06	340.20	0.05
197 Garafraxa St S	341.02									340.21	0.03
292 Saddler St E	340.64	340.64	0.03	340.66	0.05	340.69	0.08	340.72	0.11	342.36	1.74
176 Elgin St S	340.65	340.61	0.11	340.64	0.13	340.67	0.16	340.70	0.19	342.42	1.85
190 Elgin St S	340.37	340.61	0.45	340.64	0.48	340.66	0.50	340.70	0.53	342.44	2.26
270 Saddler St E	340.24	340.60	0.64	340.62	0.66	340.64	0.68	340.67	0.71	342.22	2.11
242 Saddler St E	339.94	340.58	0.84	340.60	0.86	340.62	0.87	340.64	0.90	342.15	2.12
193 Albert St S	341.15									341.87	1.00
208 Queen St S	338.04	338.63	0.57	338.72	0.66	338.81	0.74	339.11	1.04	339.21	1.12
212 Queen St S	338.29	338.56	0.43	338.66	0.50	338.74	0.56	339.05	0.69	339.17	0.83
216 Queen St S	338.28	338.41	0.14	338.50	0.22	338.56	0.29	338.80	0.53	339.10	0.82
226 Queen St S	337.83	338.38	0.29	338.43	0.37	338.48	0.43	338.64	0.68	339.07	1.15
248 Queen St S	337.89	338.16	0.19	338.22	0.26	338.27	0.30	338.40	0.44	338.85	0.90
252 Queen St S	337.32	337.75	0.43	337.81	0.49	337.87	0.54	338.06	0.73	338.55	1.20
264 Queen St S	337.29	337.65	0.37	337.71	0.43	337.76	0.48	337.93	0.65	338.33	1.05
270 Queen St S	337.40	337.60	0.21	337.67	0.27	337.72	0.32	337.87	0.48	338.27	0.88
278 Queen St S	336.92	337.36	0.37	337.42	0.43	337.47	0.48	337.64	0.65	338.12	1.12
284 Queen St S	336.68	337.30	0.50	337.36	0.57	337.41	0.61	337.57	0.76	338.04	1.23
292 Queen St S	337.38	337.12	0.14	337.18	0.11	337.22	0.15	337.47	0.27	337.95	0.71
250 South Street W	336.26	337.12	0.91	337.18	0.97	337.22	1.01	337.34	1.12	337.80	1.53
274 South Street W	336.11	337.12	1.05	337.18	1.11	337.22	1.14	337.33	1.25	337.77	1.62
273 Countess St S	337.10	337.10	0.00	337.17	0.03	337.20	0.06	337.31	0.15	337.68	0.52
279 Countess St S	336.92	337.12	0.09	337.17	0.16	337.21	0.19	337.31	0.29	337.69	0.65
285 Countess St S	336.95	337.11	0.13	337.17	0.19	337.19	0.18	337.29	0.29	337.66	0.63
209 Queen St S	338.47	338.73	0.25	338.85	0.35	338.95	0.44	339.32	0.80	339.29	0.77
151 Saddler St W	338.57	338.74	0.19	338.85	0.31	338.96	0.41	339.32	0.77	339.48	0.88
213 Queen St S	338.56			338.60	0.09	338.85	0.17	339.12	0.45	339.42	0.66
217 Queen St S	338.54			338.70	0.02	338.70	0.09	339.06	0.40	339.41	0.86
223 Queen St S	337.52	338.38	0.73	338.46	0.79	338.53	0.85	338.77	1.05	339.31	1.79
231 Queen St S	337.86	338.15	0.29	338.21	0.35	338.27	0.40	338.49	0.61	339.22	1.36

Address	Lowest DTM Elevation (m)	25-Year		50-Year		100-Year		Hazel		Hazel No Dike	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
245 Queen St S	337.66	338.08	0.44	338.14	0.50	338.19	0.56	338.40	0.76	339.09	1.45
249 Queen St S	337.65	337.99	0.28	338.04	0.33	338.09	0.38	338.28	0.59	338.93	1.21
253 Queen St S	337.62	337.84	0.15	337.90	0.21	337.95	0.26	338.16	0.46	338.78	1.08
265 Queen St S	337.21	337.68	0.46	337.74	0.52	337.80	0.58	338.00	0.78	338.58	1.35
269 Queen St S	337.62			337.65	0.04	337.70	0.09	337.88	0.26	338.34	0.66
295 Queen St S	336.33	337.34	1.24	337.41	1.29	337.47	1.34	337.64	1.52	338.14	2.01
204 Garafraxa St S	339.02	339.26	0.02	339.27	0.11	339.27	0.21	339.37	0.58	340.17	0.91
218 Garafraxa St S	338.35	338.97	0.27	338.99	0.29	339.00	0.31	339.05	0.40	340.08	1.38
226 Garafraxa St S	337.85	338.95	0.43	338.97	0.46	338.98	0.48	339.00	0.57	339.98	1.45
232 Garafraxa St S	337.69	339.08	1.07	339.09	1.09	339.10	1.11	338.97	1.14	339.97	2.03
232 Garafraxa St S	338.03	339.08	1.07	338.48	0.45	338.49	0.47	338.57	0.59	339.43	1.45
240 Garafraxa St S	337.97	338.27	0.20	338.28	0.21	338.29	0.22	338.36	0.43	340.08	1.27
248 Garafraxa St S	338.39	337.99	0.04	338.07	0.10	338.11	0.07	338.34	0.29	339.44	1.03
266 Garafraxa St S	340.50									340.55	0.05
280 Garafraxa St S	339.26									340.04	0.69
282 Garafraxa St S	340.02									340.49	0.17
176 South Street W	337.76							337.77	0.01	338.08	0.36
293 Queen St S	337.75							337.76	0.01	338.16	0.44
194 South St W	337.23			337.26	0.05	337.36	0.10	337.56	0.27	338.07	0.77
307 Queen St S	336.48	337.14	0.68	337.20	0.74	337.25	0.79	337.39	0.93	337.90	1.44
189 South Street W	336.79	337.14	0.36	337.20	0.43	337.25	0.47	337.39	0.62	337.90	1.12
175 South Street W	337.45							337.38	0.10	337.90	0.62
315 Queen St S	336.42	337.13	0.77	337.20	0.84	337.24	0.88	337.38	1.02	337.90	1.54
321 Queen St S	336.13	337.13	1.03	337.19	1.09	337.24	1.14	337.38	1.28	337.90	1.79
320 Queen St S	336.24	337.13	0.89	337.19	0.96	337.24	1.00	337.38	1.14	337.89	1.62
332 Queen St S	336.68	337.13	0.50	337.19	0.56	337.24	0.61	337.38	0.75	337.89	1.26
333 Queen St S	336.28	337.13	0.97	337.19	1.04	337.24	1.08	337.38	1.23	337.90	1.74
351 Queen St S	336.25	337.13	0.91	337.19	0.98	337.24	1.02	337.38	1.16	337.90	1.68
367 Queen St S	336.11	337.13	1.07	337.19	1.13	337.24	1.18	337.38	1.32	337.91	1.83
373 Queen St S	336.87	337.13	0.29	337.19	0.35	337.24	0.40	337.38	0.54	337.91	1.06
308 Queen St S	336.48	337.13	0.70	337.20	0.76	337.24	0.80	337.39	0.94	337.89	1.42
314 Queen St S	336.50	337.13	0.66	337.19	0.72	337.24	0.76	337.38	0.90	337.89	1.39
249 South Street W	336.18	337.12	0.97	337.18	1.03	337.22	1.07	337.36	1.21	337.84	1.69
293 South Street W	336.34	337.11	0.82	337.17	0.87	337.21	0.90	337.32	1.01	337.78	1.35
348 Queen St S	337.32					337.24	0.01	337.38	0.10	337.89	0.61
356 Queen St S	337.35								0.03	337.89	0.54
374 Queen St S	337.89									337.89	0.07
344 Garafraxa St S	336.69	337.13	0.53	337.19	0.59	337.24	0.64	337.38	0.78	338.06	1.30
378 Garafraxa St S	337.64									338.06	0.64

Address	Lowest DTM Elevation (m)	25-Year		50-Year		100-Year		Hazel		Hazel No Dike	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
150 Elizabeth St W	337.77									338.06	0.39
132 Elizabeth St W	337.00							337.19	0.19	338.06	1.06
390 Garafraxa St S	336.54							337.19	0.66	338.06	1.52
205 Albert St S	340.43	340.32	0.56	340.34	0.58	340.28	0.56	340.62	0.58	341.80	1.86
233 Saddler St E	340.61	340.57	0.01	340.59	0.03	340.61	0.04	340.63	0.06	342.00	1.26
257 Saddler St E	340.21	340.59	0.36	340.61	0.39	340.63	0.40	340.65	0.43	342.07	1.85
275 Saddler St E	339.93	340.59	0.41	340.61	0.43	340.63	0.45	340.66	0.48	342.15	1.88
204 Elgin St S	340.45	340.62	0.20	340.64	0.22	340.66	0.24	340.69	0.26	342.27	1.82
216 Elgin St S	339.82	340.39	0.31	340.42	0.33	340.45	0.35	340.48	0.39	342.25	1.82
224 Elgin St S	341.16									342.24	1.07
236 Elgin St S	341.70									342.19	0.44
240 Elgin St S	341.84									342.16	0.27
244 Elgin St S	341.55									341.97	0.33
291 Albert St S	339.03									340.01	0.95
289 Albert St S	339.30									340.23	0.81
283 Albert St S	339.66									340.46	0.62
279 Albert St S	339.73									340.60	0.79
271 Albert St S	340.29									340.76	0.40
267 Albert St S	340.60									340.79	0.16
225 Albert St S	341.33									341.62	0.25
219 Albert St S	340.32									341.74	1.23
215 Albert St S	339.98	340.22	0.23	340.25	0.26	340.28	0.29	340.32	0.33	341.81	1.82
211 Albert St S	339.69	340.21	0.45	340.25	0.48	340.28	0.51	340.32	0.54	341.81	1.92
341 Saddler St E	342.01									342.41	0.45
207 Elgin St S	341.16									342.38	1.20
215 Elgin St S	341.76									342.28	0.42
203 Garafraxa St S	337.77	339.63	0.65	339.63	0.68	339.64	0.71	339.64	0.75	341.14	2.33
215 Garafraxa St S	338.60	339.45	0.95	339.48	0.98	339.51	1.01	339.55	1.05	341.17	2.67
229 Garafraxa St S	339.06	339.36	0.30	339.40	0.33	339.42	0.36	339.46	0.39	341.00	1.89
145 Saddler St E	340.01									341.20	1.10
161 Saddler St E	339.85	340.01	0.08	340.01	0.09	340.02	0.09	340.02	0.10	341.27	1.38
173 Saddler St E	339.64	339.95	0.17	339.95	0.18	339.96	0.18	339.94	0.20	341.27	1.66
185 Saddler St E	339.52	340.01	0.20	340.03	0.21	340.04	0.21	340.05	0.23	341.41	1.71
197 Saddler St E	339.65	340.05	0.15	340.06	0.18	340.06	0.21	340.07	0.26	341.54	1.83
210 Albert St S	338.79	339.74	0.69	339.75	0.73	339.76	0.76	339.79	0.80	341.46	2.40
218 Albert St S	339.59			339.77	0.08	339.78	0.10	339.80	0.12	341.45	1.76
222 Albert St S	339.97									341.36	1.20
273 Garafraxa St S	340.27									340.61	0.30
265 Garafraxa St S	340.24									340.83	0.62

Address	Lowest DTM Elevation (m)	25-Year		50-Year		100-Year		Hazel		Hazel No Dike	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
239 Garafraxa St S	339.95									341.00	1.15
247 Garafraxa St S	340.49									340.98	0.49
269 Garafraxa St S	340.19									340.83	0.51
299 Garafraxa St S	339.66									340.04	0.26
286 Albert St S	339.11									339.92	0.85
290 Albert St S	338.09									339.92	1.70
172 South Street E	338.76									339.92	1.23
172 South Street E	338.93									339.91	1.03
317 Garafraxa St S	339.78									339.90	0.25
345 Garafraxa St S	339.15									339.37	0.15
317 Garafraxa St S	338.68									339.37	0.25
351 Garafraxa St S	338.10									338.63	0.40
377 Garafraxa St S	337.88									338.74	0.34
411 Garafraxa St S	337.14							337.16	0.02	338.06	0.95
268 George St East	344.97							345.66	0.70		
255 South Street E	339.75									339.92	0.16
263 South Street E	339.89									339.92	0.14
280 Albert St S	339.92									339.94	0.10
111 Elizabeth St W	338.08									338.06	0.04
240 Queen St S	337.98	338.29	0.15	338.33	0.19	338.36	0.22	338.45	0.32	338.81	0.68

Table 30 – Impacts to Buildings and Structures Climate Change

Address	Lowest DTM Elevation (m)	25-Year CC		50-Year CC		100-Year CC		Hazel CC	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
592 Lambton St East	348.73								
573 George St East	347.53								
561 George St East	348.33								
165 Cross St S	343.20	344.57	0.24	344.57	0.24	344.58	0.25	344.59	0.26
429 Lambton St E	343.02							342.86	0.02
421 Lambton St E	343.96								
155 Kincardine St S	342.86							342.86	0.04
175 Kincardine St S	342.93								
176 Kincardine St S	341.27	342.41	0.41	342.43	0.43	342.45	0.45	342.50	0.49
180 Kincardine St S	340.44	342.41	0.48	342.44	0.50	342.45	0.53	342.51	0.59
196 Kincardine St S	342.07								
154 Kincardine St S	340.69	340.84	0.13	340.88	0.17	342.31	0.34	342.34	0.38
122 Kincardine St S	341.75								
479 Lambton St E	342.44	342.77	0.36	342.79	0.38	342.81	0.41	342.87	0.46
493 Lambton St E	344.32								
489 Lambton St E	343.94								
582 Cedar Ln	344.45								
580 Cedar Ln	343.74								
380 Saddler St E	341.49								
368 Saddler St E	340.70	340.98	0.14	341.17	0.19	341.22	0.22	341.28	0.26
344 Saddler St E	340.40	341.05	0.39	341.14	0.43	341.16	0.45	341.25	0.50
191 Elgin St S	340.56	340.86	0.23	340.87	0.26	340.87	0.29	340.87	0.32
187 Elgin St S	340.18	340.77	0.58	340.80	0.62	340.84	0.64	340.88	0.69
175 Elgin St S	340.40	340.79	0.30	340.83	0.33	340.86	0.36	340.91	0.39
169 Elgin St S	340.75	340.80	0.08	340.84	0.12	340.87	0.14	340.91	0.19
157 Elgin St S	340.25	340.80	0.63	340.84	0.67	340.87	0.70	340.92	0.75
209 Garafraxa St N	338.52	342.02	3.38	342.34	3.70	342.63	3.96	344.31	5.58
144 Garafraxa St N	340.06	340.67	0.55	340.86	0.76	341.06	0.97	343.49	2.26
120 Garafraxa St N	341.06			340.82	0.03	341.04	0.02	343.43	1.11
108 Garafraxa St S	342.45							343.14	0.38
115 Lambton St W	342.54							342.92	0.34
169 Lambton St W	342.30							342.72	0.18
118 Queen St S	341.97							342.56	0.13
124 Garafraxa St S	341.48							342.59	0.39
157 Garafraxa St S	342.77							343.73	0.79
137 Garafraxa St S	343.10							343.43	0.34
105 Garafraxa St S	343.15							343.41	0.25

Address	Lowest DTM Elevation (m)	25-Year CC		50-Year CC		100-Year CC		Hazel CC	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
150 Mill St East	344.09							344.32	0.24
119 Garafraxa St S	342.24							343.19	0.12
156 Garafraxa St S	340.76							341.70	0.22
157 Garafraxa St S	340.98							341.65	0.09
168 Garafraxa St S	340.29							340.60	0.33
168 Garafraxa St S	339.90							340.29	0.18
190 Garafraxa St S	339.30							340.03	0.11
173 Garafraxa St S	340.30							340.33	0.00
185 Garafraxa St S	340.07							340.29	0.29
193 Garafraxa St S	340.17							340.28	0.06
197 Garafraxa St S	341.02								
292 Saddler St E	340.64	340.68	0.07	340.71	0.10	340.74	0.13	340.77	0.16
176 Elgin St S	340.65	340.66	0.15	340.69	0.18	340.72	0.21	340.76	0.24
190 Elgin St S	340.37	340.66	0.50	340.69	0.53	340.72	0.55	340.75	0.59
270 Saddler St E	340.24	340.64	0.68	340.67	0.70	340.69	0.72	340.72	0.75
242 Saddler St E	339.94	340.61	0.87	340.63	0.89	340.65	0.91	340.68	0.94
193 Albert St S	341.15								
208 Queen St S	338.04	338.63	0.57	338.72	0.66	338.81	0.74	339.12	1.04
212 Queen St S	338.29	338.56	0.44	338.66	0.30	338.74	0.56	339.05	0.76
216 Queen St S	338.28	338.41	0.14	338.50	0.23	338.57	0.29	338.81	0.53
226 Queen St S	337.83	338.38	0.31	338.43	0.38	338.48	0.44	338.64	0.69
248 Queen St S	337.89	338.16	0.20	338.23	0.26	338.27	0.31	338.41	0.45
252 Queen St S	337.32	337.77	0.45	337.84	0.51	337.89	0.56	338.08	0.74
264 Queen St S	337.29	337.67	0.39	337.73	0.45	337.78	0.50	337.94	0.66
270 Queen St S	337.40	337.62	0.23	337.69	0.29	337.74	0.34	337.89	0.50
278 Queen St S	336.92	337.38	0.39	337.44	0.45	337.49	0.50	337.66	0.67
284 Queen St S	336.68	337.32	0.53	337.38	0.59	337.43	0.63	337.59	0.77
292 Queen St S	337.38	337.14	0.07	337.20	0.13	337.24	0.17	337.49	0.29
250 South Street W	336.26	337.15	0.93	337.20	0.99	337.24	1.02	337.36	1.13
274 South Street W	336.11	337.14	1.07	337.20	1.13	337.23	1.16	337.34	1.26
273 Countess St S	337.10	337.13	0.02	337.19	0.05	337.22	0.07	337.32	0.17
279 Countess St S	336.92	337.14	0.12	337.19	0.18	337.22	0.20	337.33	0.30
285 Countess St S	336.95	337.13	0.16	337.17	0.17	337.20	0.20	337.30	0.30
209 Queen St S	338.47	338.73	0.25	338.85	0.35	338.95	0.44	339.32	0.80
151 Saddler St W	338.57	338.87	0.19	338.87	0.31	338.96	0.41	339.32	0.77
213 Queen St S	338.56	338.83	0.06	338.84	0.09	338.85	0.17	339.13	0.45
217 Queen St S	338.54	338.69	0.03	338.71	0.05	338.72	0.09	339.06	0.41
223 Queen St S	337.52	338.38	0.76	338.47	0.82	338.53	0.87	338.78	1.07
231 Queen St S	337.86	338.19	0.32	338.24	0.38	338.29	0.43	338.51	0.63

Address	Lowest DTM Elevation (m)	25-Year CC		50-Year CC		100-Year CC		Hazel CC	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
245 Queen St S	337.66	338.11	0.47	338.17	0.53	338.22	0.58	338.42	0.78
249 Queen St S	337.65	338.01	0.31	338.07	0.36	338.12	0.41	338.30	0.61
253 Queen St S	337.62	337.87	0.18	337.93	0.23	337.98	0.29	338.18	0.48
265 Queen St S	337.21	337.71	0.49	337.77	0.55	337.83	0.61	338.03	0.80
269 Queen St S	337.62	337.60	0.01	337.67	0.06	337.72	0.11	337.90	0.27
295 Queen St S	336.33	337.37	1.25	337.43	1.31	337.49	1.36	337.66	1.53
204 Garafraxa St S	339.02	339.27	0.02	339.27	0.11	339.27	0.21	339.38	0.58
218 Garafraxa St S	338.35	339.00	0.30	339.02	0.33	339.04	0.35	339.09	0.43
226 Garafraxa St S	337.85	338.98	0.47	339.00	0.50	339.02	0.52	339.05	0.61
232 Garafraxa St S	337.69	339.10	1.10	339.12	1.12	339.14	1.14	339.16	1.17
232 Garafraxa St S	338.03	339.10	1.10	338.50	0.49	338.52	0.51	338.61	0.62
240 Garafraxa St S	337.97	338.29	0.22	338.30	0.23	338.33	0.25	338.42	0.46
248 Garafraxa St S	338.39	338.04	0.07	338.09	0.04	338.15	0.10	338.37	0.32
266 Garafraxa St S	340.50								
280 Garafraxa St S	339.26								
282 Garafraxa St S	340.02								
176 South Street W	337.76							337.58	0.03
293 Queen St S	337.75							337.67	0.02
194 South St W	337.23	337.22	0.01	337.32	0.07	337.39	0.12	337.58	0.29
307 Queen St S	336.48	337.16	0.71	337.22	0.77	337.27	0.81	337.41	0.95
189 South Street W	336.79	337.16	0.39	337.22	0.45	337.27	0.49	337.41	0.63
175 South Street W	337.45							337.40	0.12
315 Queen St S	336.42	337.16	0.80	337.22	0.86	337.26	0.90	337.40	1.04
321 Queen St S	336.13	337.16	1.05	337.22	1.11	337.26	1.16	337.40	1.30
320 Queen St S	336.24	337.16	0.92	337.22	0.98	337.26	1.02	337.40	1.15
332 Queen St S	336.68	337.16	0.52	337.22	0.58	337.26	0.62	337.40	0.76
333 Queen St S	336.28	337.16	1.00	337.22	1.06	337.26	1.10	337.40	1.24
351 Queen St S	336.25	337.16	0.94	337.22	1.00	337.26	1.04	337.40	1.18
367 Queen St S	336.11	337.16	1.09	337.22	1.15	337.26	1.20	337.40	1.34
373 Queen St S	336.87	337.16	0.31	337.22	0.37	337.26	0.41	337.40	0.55
308 Queen St S	336.48	337.16	0.72	337.22	0.78	337.26	0.82	337.40	0.95
314 Queen St S	336.50	337.16	0.68	337.22	0.74	337.26	0.78	337.40	0.91
249 South Street W	336.18	337.14	1.00	337.20	1.05	337.24	1.09	337.37	1.22
293 South Street W	336.34	337.13	0.84	337.19	0.89	337.22	0.92	337.35	1.02
348 Queen St S	337.32					337.26	0.03	337.40	0.12
356 Queen St S	337.35							337.40	0.05
374 Queen St S	337.89								
344 Garafraxa St S	336.69	337.16	0.55	337.22	0.61	337.26	0.66	337.40	0.80
378 Garafraxa St S	337.64								

Address	Lowest DTM Elevation (m)	25-Year CC		50-Year CC		100-Year CC		Hazel CC	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
150 Elizabeth St W	337.77								
132 Elizabeth St W	337.00							337.21	0.21
390 Garafraxa St S	336.54					336.56	0.02	337.21	0.67
205 Albert St S	340.43	340.28	0.56	340.62	0.57	340.64	0.59	340.65	0.60
233 Saddler St E	340.61	340.61	0.04	340.63	0.06	340.65	0.07	340.67	0.10
257 Saddler St E	340.21	340.62	0.40	340.65	0.43	340.67	0.44	340.69	0.47
275 Saddler St E	339.93	340.63	0.45	340.65	0.48	340.67	0.51	340.70	0.55
204 Elgin St S	340.45	340.66	0.24	340.68	0.26	340.70	0.28	340.73	0.30
216 Elgin St S	339.82	340.44	0.35	340.47	0.38	340.51	0.41	340.56	0.45
224 Elgin St S	341.16								
236 Elgin St S	341.70								
240 Elgin St S	341.84								
244 Elgin St S	341.55								
291 Albert St S	339.03								
289 Albert St S	339.30								
283 Albert St S	339.66								
279 Albert St S	339.73								
271 Albert St S	340.29								
267 Albert St S	340.60								
225 Albert St S	341.33								
219 Albert St S	340.32								
215 Albert St S	339.98	340.28	0.28	340.32	0.32	340.35	0.35	340.40	0.40
211 Albert St S	339.69	340.27	0.50	340.31	0.54	340.35	0.56	340.40	0.60
341 Saddler St E	342.01								
207 Elgin St S	341.16								
215 Elgin St S	341.76								
203 Garafraxa St S	337.77	339.64	0.71	339.64	0.74	339.65	0.78	339.66	0.82
215 Garafraxa St S	338.60	339.50	1.00	339.54	1.04	339.57	1.07	339.62	1.12
229 Garafraxa St S	339.06	339.42	0.35	339.46	0.39	339.49	0.41	339.53	0.45
145 Saddler St E	340.01							340.05	0.01
161 Saddler St E	339.85	340.02	0.09	340.03	0.10	340.03	0.10	340.04	0.11
173 Saddler St E	339.64	339.96	0.18	339.96	0.19	339.96	0.20	339.97	0.22
185 Saddler St E	339.52	340.04	0.21	340.05	0.23	340.06	0.24	340.07	0.26
197 Saddler St E	339.65	340.06	0.21	340.07	0.25	340.08	0.28	340.10	0.32
210 Albert St S	338.79	339.76	0.75	339.80	0.79	339.82	0.83	339.85	0.87
218 Albert St S	339.59	339.78	0.10	339.79	0.11	339.81	0.13	339.83	0.17
222 Albert St S	339.97								
273 Garafraxa St S	340.27								
265 Garafraxa St S	340.24								

Address	Lowest DTM Elevation (m)	25-Year CC		50-Year CC		100-Year CC		Hazel CC	
		WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)	WSE (m)	Depth (m)
239 Garafraxa St S	339.95								
247 Garafraxa St S	340.49								
269 Garafraxa St S	340.19								
299 Garafraxa St S	339.66								
286 Albert St S	339.11								
290 Albert St S	338.09								
172 South Street E	338.76								
172 South Street E	338.93								
317 Garafraxa St S	339.78								
345 Garafraxa St S	339.15								
317 Garafraxa St S	338.68								
351 Garafraxa St S	338.10								
377 Garafraxa St S	337.88								
411 Garafraxa St S	337.14							337.20	0.03
268 George St East	344.97							345.66	0.70
255 South Street E	339.75								
263 South Street E	339.89								
280 Albert St S	339.92								
111 Elizabeth St W	338.08								
240 Queen St S	337.98	338.29	0.15	338.33	0.19	338.36	0.22	338.46	0.32

5.4.4 Mitigation Options

Wills undertook a high-level assessment of potential flood mitigation options for Durham Creek. The most significant flood mitigation measure, the dike at the Durham Upper Dam, has already been put in place. This dike significantly reduces the amount of flooding in Durham Creek. During the Hurricane Hazel flood, the flow in the Saugeen River is approximately 276.4 m^3/s. If the dike were not in place, approximately 160.8 m^3/s would spill through Durham Creek. Without the dike in place there would be significant property damages as well as damage to built infrastructure such as roads and culverts. The inspection and maintenance of this dike should be seen as a high priority for the SVCA and Municipality of West Grey.

Another similar flood mitigation measure would be to construct a new flood dike at the downstream end of Durham Creek along the east bank of the Saugeen River to prevent the Saugeen River from backing up into Durham Creek. The new dike would incorporate (and raise) the existing dike at the Durham Lower Dam and would extend downstream to approximately 120 m south of South Street West. The Durham Creek outlet would need to incorporate a flap gate, or manually controlled valve, and possibly a stormwater pumping station to pump water out of Durham Creek and into the Saugeen River when the river is at flood stage. There appears to be sufficient property available to construct the dike and the existing trail could be incorporated into the new dike crest. Additional detailed studies would be required to determine the potential impacts to the remainder of the Saugeen River floodplain and to determine if there is a large enough reduction in the Durham Creek floodplain limits to make the significant cost worthwhile.

During the two Public Information Centers (PICs) that were held in the Town of Durham, many residents provided comments related to flooding during the most frequent flood events (i.e., annual floods). Methods that could be used to reduce flooding during these events include:

- Clear vegetation, sediment, and debris from the Durham Creek Channel. This work would need to incorporate considerations for fisheries and timing windows.
- Expand the capacity of the Durham Creek Channel. This work would need to incorporate considerations for fisheries and timing windows.
- Clear sediment from the existing culverts.
- Consider increasing culvert sizes to the maximum allowable size based on cover and other geometrical restrictions. This could be completed during future road reconstructions or as one-off culvert improvements.
- Expand the capacity of the storm sewer systems on the streets within Durham Creek and potentially construct a larger trunk sewer that could convey a more significant quantity of water directly to the Saugeen River, rather than into Durham Creek.

While these mitigation measures may have a positive impact on drainage during the more frequent flood events (i.e., annually), it is anticipated that they would only have a small impact on the extents of the Regulatory floodplain and floodway.

6.0 Conclusion

The Saugeen Valley Conservation Authority (SVCA), in partnership with the Municipality of West Grey, has recognized the need to develop hydrologic and hydraulic modelling and regulatory flood hazard mapping for Durham Creek in the Town of Durham, Municipality of West Grey, Ontario. There is no existing flood hazard mapping for Durham Creek. The intent of this hydrology report is to provide the hydrologic inputs to the floodplain mapping. This hydrology report included the following key phases:

- Background Data Collection and Review – Wills reviewed all available background information provided by the SVCA.
- Site Reconnaissance and Topographic/Bathymetric Survey – Wills undertook a site reconnaissance of the entire study reach and collected topographic and bathymetric survey data to define the numerous structures crossing the Saugeen River and Durham Creek and to validate the LiDAR DTM. The quality and accuracy of the DTM was validated.
- Hydrology Study – Wills undertook a hydrology study to define the peak flows that would be used in the hydraulic model. The hydrology study was completed using HEC-HMS (Version 4.11). Wills completed a calibration and verification exercise on the hydrologic model for two historic storms. Wills computed flood flows for the 6 hour SCS Type-2 AEP storms and the Regional storm. Wills also computed the peak flows for the same storms while considering the potential impacts of climate change.
- Hydraulics Study – Wills undertook a hydraulics study to develop a hydraulic model to compute water surface elevation, velocity, and depth for all parts of the modeling domain for the 4% AEP, 2% AEP storm, 1% AEP storm, Hurricane Hazel storm. The impacts the hydraulics study was completed using HEC-RAS (Version 6.4.1). Wills also computed the hydraulic parameters for the same storms while considering the potential impacts of climate change.
- Development of Regulatory Floodplain and Flood Risk Maps – Wills developed regulatory floodplain and flood risk maps using the outputs from the hydraulic modelling to create the final mapping products in ArcGIS.
- Preparation of the Regulatory Floodplain and Flood Risk Mapping Report – Wills prepared this report documenting the inputs and results of all analyses associated with the project as well as the results.

Based on the results of the analyses completed, Wills recommends that the SVCA and the Municipality of West Grey update the regulatory floodplain mapping for the Saugeen River and then consider updates to their two zone floodplain planning policies and development approvals processes for both Durham Creek and the Saugeen River together. Additionally, given the potential significant impacts of a failure of the dike at the Durham Upper Dam, the SVCA and Municipality of West Grey should consider the development of an Emergency Preparedness and Response Plan (EPRP) for the structure. The EPRP could be incorporated within the West Grey's existing Emergency Plan or could be a stand-alone document that is coordinated with West Grey's existing Emergency Plan.

Respectfully submitted,

Matt Churly, P.Eng.
Senior Project Engineer,
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Project Engineer,
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MC/DG/SO

7.0 References

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Appendix A

Hydraulic Structure Surveys

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID:
Township:
Highway ID: Countess St
Chainage or LHRS:
Type:
Location: 285 Countess LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP
Desc: 0 Culvert
Size (mm): 730 (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

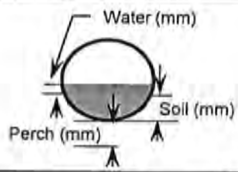
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

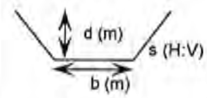
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

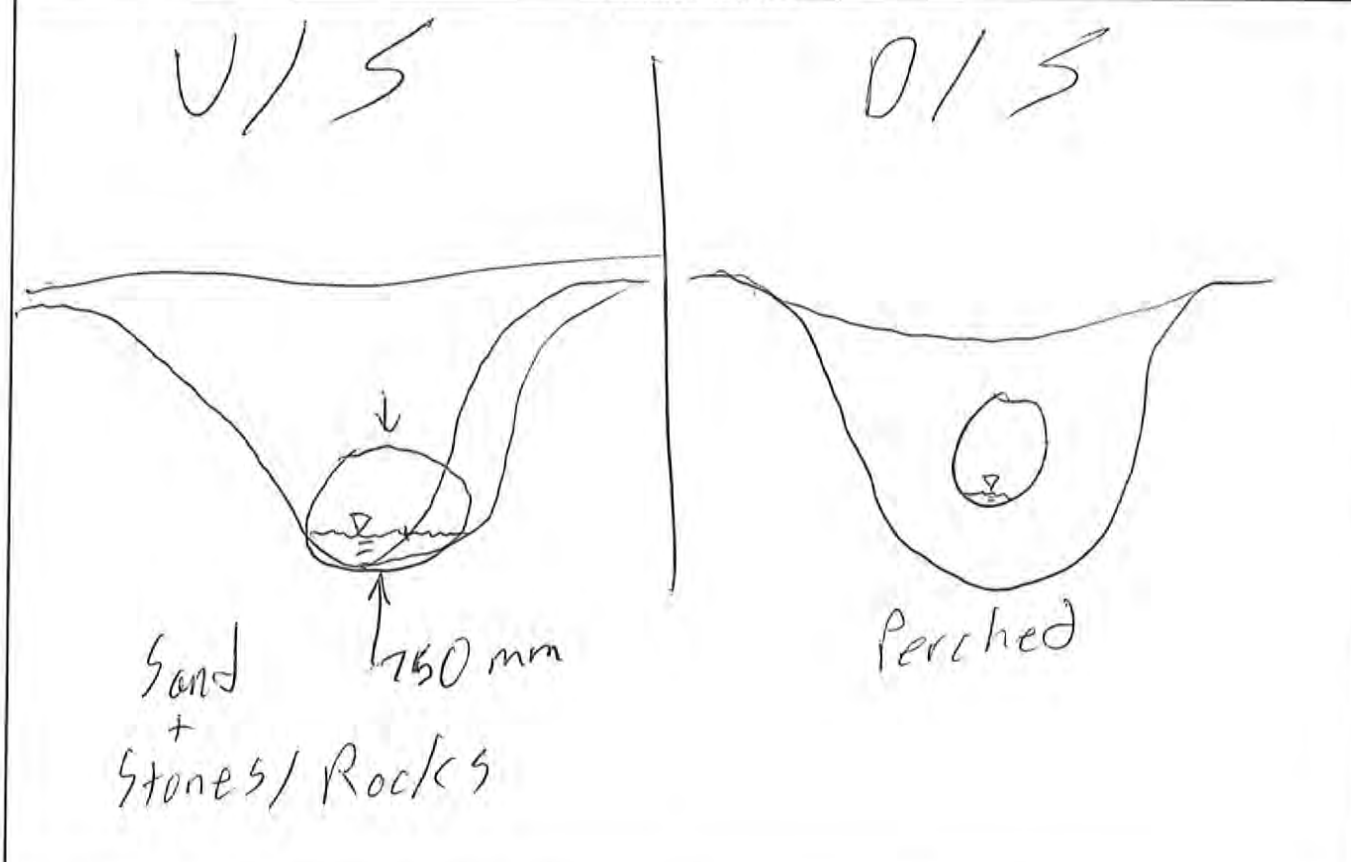


Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes



Filename: 20230704_115210.jpg Photo 1 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Countess St S Upstream Face

Filename: 20230704_115225.jpg Photo 2 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Countess St S Looking Upstream

Filename: 20230704_124727.jpg Photo 3 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Diversion Structure

Filename: 20230704_115315.jpg Photo 4 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Countess St S Looking Downstream

Filename: 20230704_120149.jpg Photo 5 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Countess St S Donwnstream End

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Culvert 2
Township: Durham ON
Highway ID: South St W
Chainage or LHRS:
Type:
Location: 274 South St W LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP
Desc: ~~&~~ Culvert (Oval)
Size (mm): 600 h x 900 w (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat
RT: Long
LT: Lat
LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

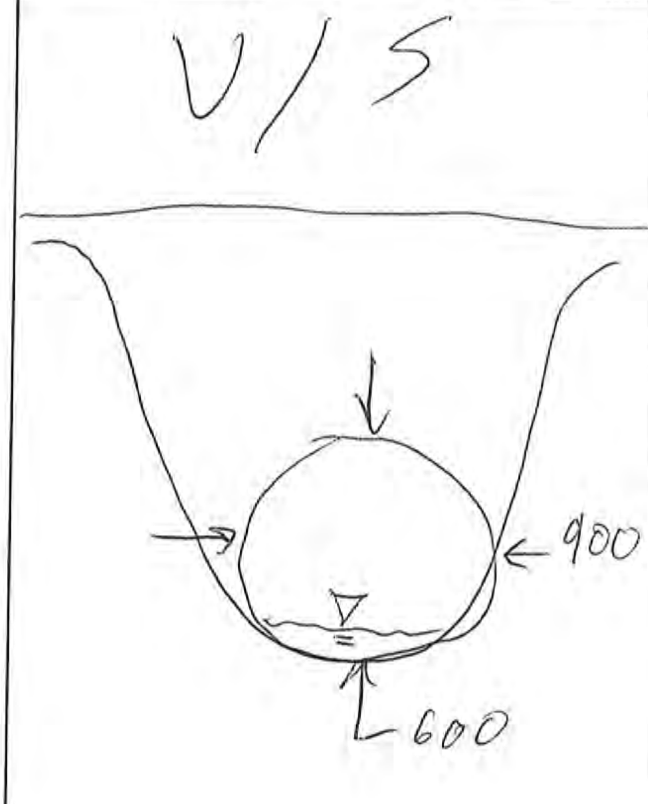
Water (mm)
Soil (mm)
Perch (mm)

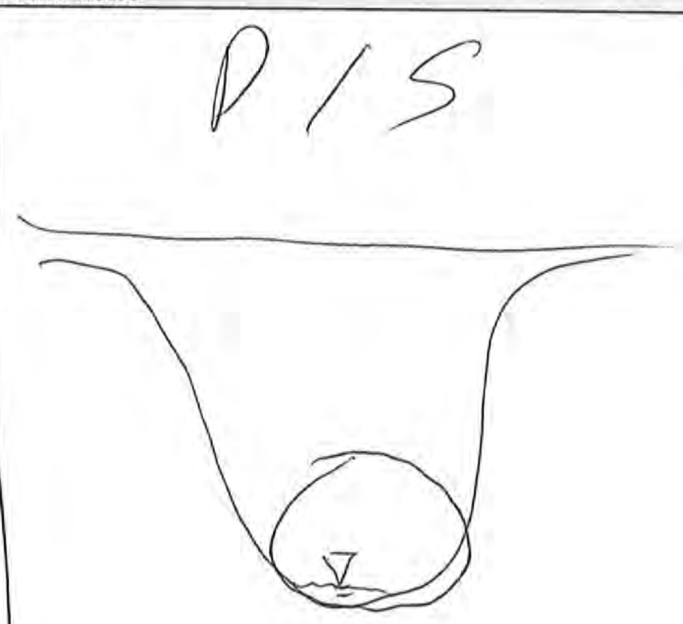
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes





Filename: 20230704_125745.jpg

Photo 7 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 274 South St W Driveway Upstream Face

Filename: 20230704_125804.jpg

Photo 8 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 274 South St W Driveway Looking Upstream

Filename: 20230704_125815.jpg

Photo 9 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 274 South St W Driveway Facing Downstream

Filename: 20230704_125833.jpg

Photo 10 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 274 South St W Driveway Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Culvert 3
Township: Durham
Highway ID: Queen St S
Chainage or LHRS:
Type:
Location: Queen @ South LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP culvert
Desc: 0 30° skew Oval
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark: (% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

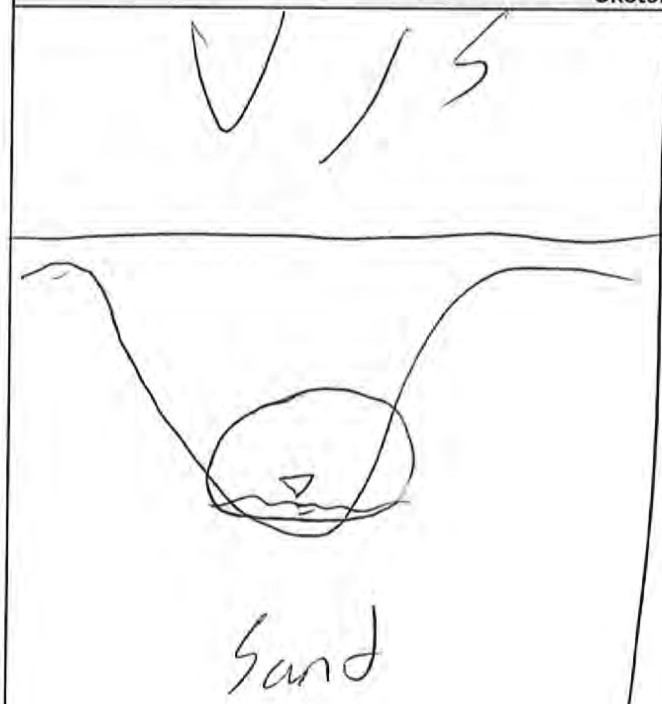
Water (mm)
Soil (mm)
Perch (mm)

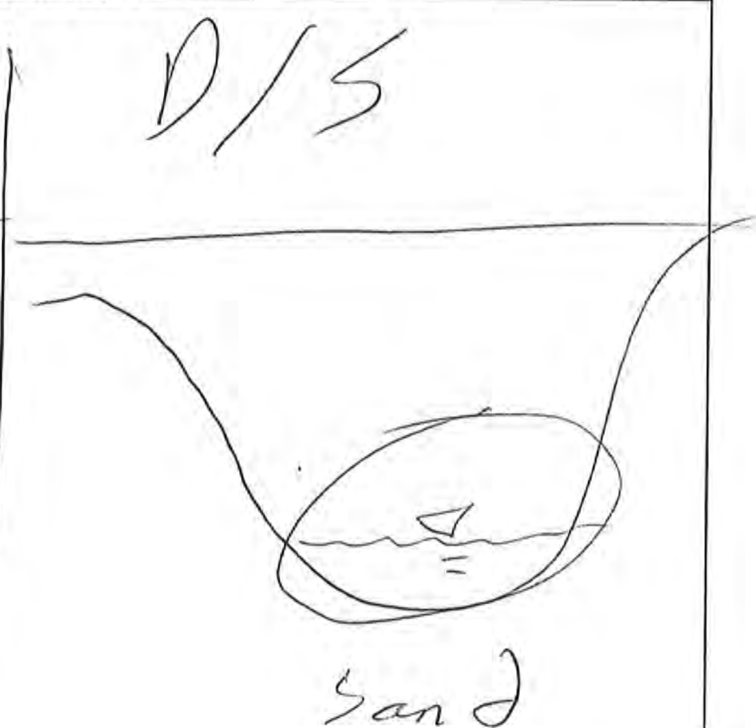
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes





Filename: 20230704_131413.jpg Photo 13 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Queen St S Upstream Face

Filename: 20230704_131426.jpg Photo 14 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Queen St S Looking Upstream

Filename: 20230704_131509.jpg Photo 15 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Queen St S Looking Downstream

Filename: 20230704_131455.jpg Photo 16 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Queen St S Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Culvert 4
Township: Durham
Highway ID: Queen St W
Chainage or LHRS:
Type:
Location: 295 Queen St LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP Culvert
Desc: Oval
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes

Filename: 20230704_133408.jpg Photo 19 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 295 Queen St S Driveway Upstream Face

Filename: 20230704_133425.jpg Photo 20 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 295 Queen St S Driveway Looking Upstream

Filename: 20230704_133433.jpg Photo 21 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 295 Queen St S Driveway Looking Downstream

Filename: 20230704_133445.jpg Photo 22 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 295 Queen St S Driveway Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Crossing 3
Township: Durham
Highway ID: Queen
Chainage or LHRS:
Type:
Location: 269 Queen LT/RT:

Physical Characteristics

Structure: Bridge (Pedestrian)
Desc.: Wood
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

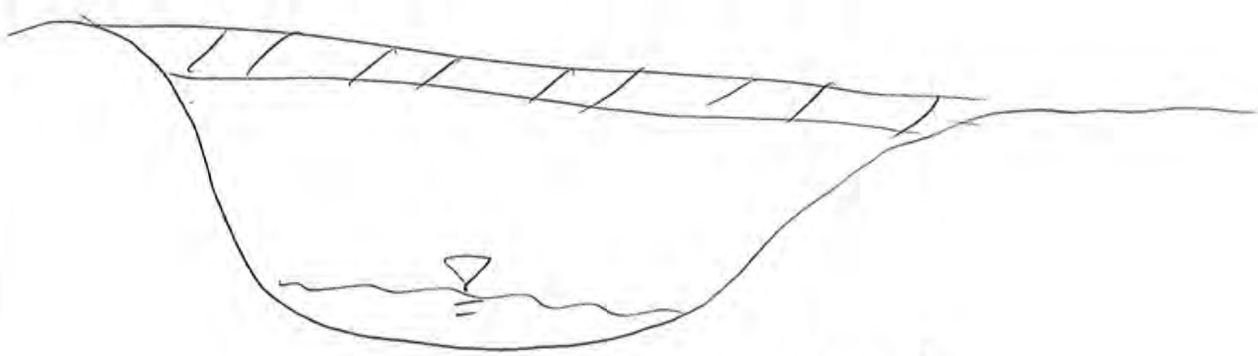
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes



Stones and Sand

Filename: 20230704_151342.jpg Photo 25 - October 26, 2023

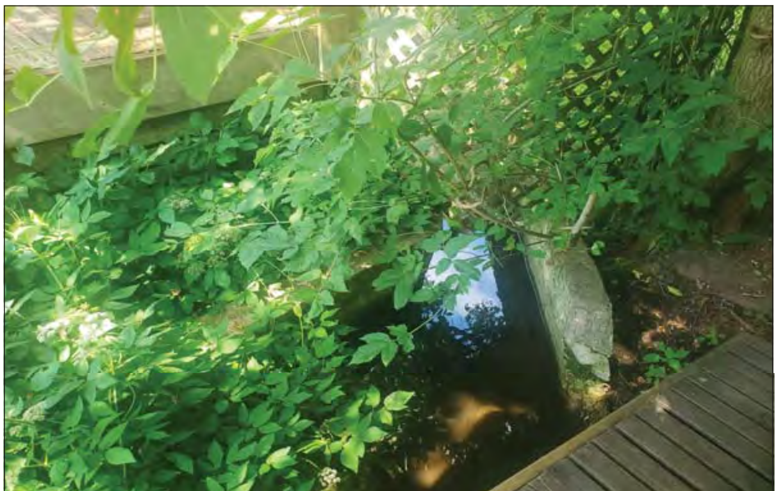
Durham Creek Flood Plain Mapping

Durham Creek: 269 Queen St S Fence

Filename: 20230704_155826.jpg Photo 26 - October 26, 2023

Durham Creek Flood Plain Mapping

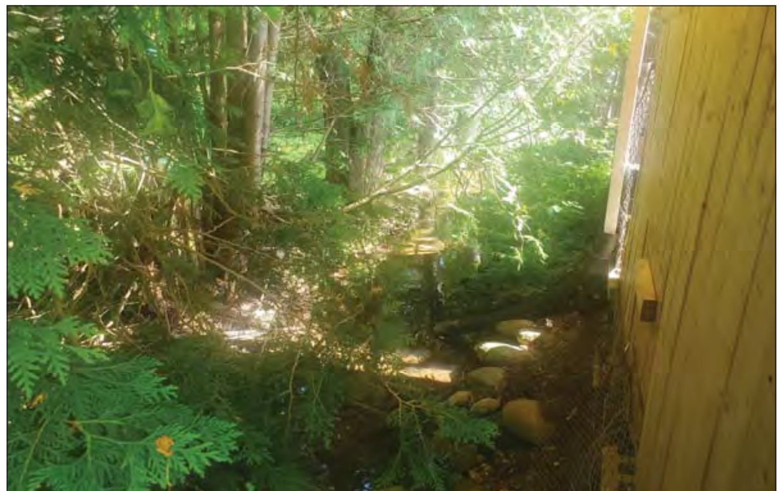
Durham Creek: 269 Queen St S Backyard Footbridge



Filename: 20230704_155546.jpg Photo 27 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 269 Queen St S Footbridge Looking Upstream



Filename: 20230704_155554.jpg Photo 28 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 269 Queen St S Footbridge Looking Downstream

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Crossing 6+7
Township: Durham
Highway ID: Queen St
Chainage or LHRS:
Type:
Location: 265 Queen LT/RT:

Physical Characteristics

Structure: Bridge foot bridges
Desc: concrete
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

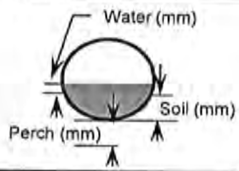
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

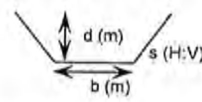
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:



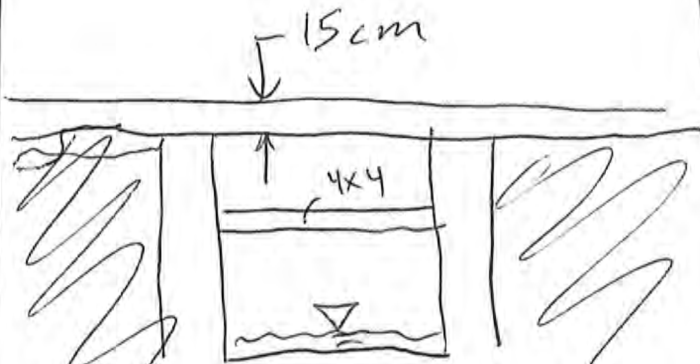
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

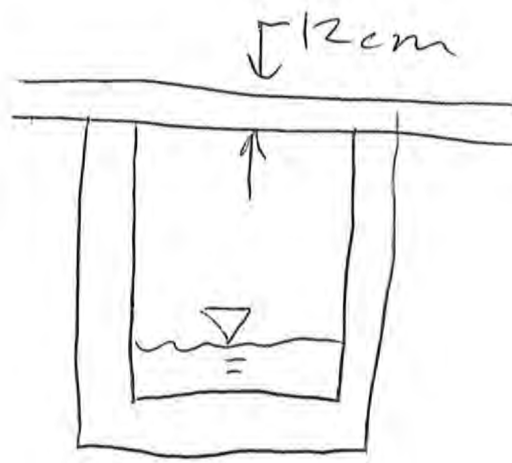


Sketch and Notes

Crossing 6



Crossing 7



Filename: 20230704_155806.jpg Photo 31 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Channel Looking Downstream

Filename: 20230704_155813.jpg Photo 32 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Channel Looking Upstream

Filename: 20230704_163742.jpg Photo 33 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Channel Looking Downstream

Filename: 20230704_163750.jpg Photo 34 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Channel Looking Upstream

Filename: 20230704_163814.jpg Photo 35 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Channel

Filename: 20230704_163805.jpg Photo 36 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 265 Queen St S Backyard Looking Upstream

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 1 Xing 8
Township: Durham ON
Highway ID:
Chainage or LHRS:
Type:
Location: 263 LT/RT:

Physical Characteristics

Structure: Bridge Foot Bridge
Desc: Wood
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

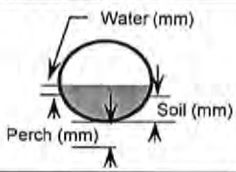
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

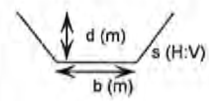
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

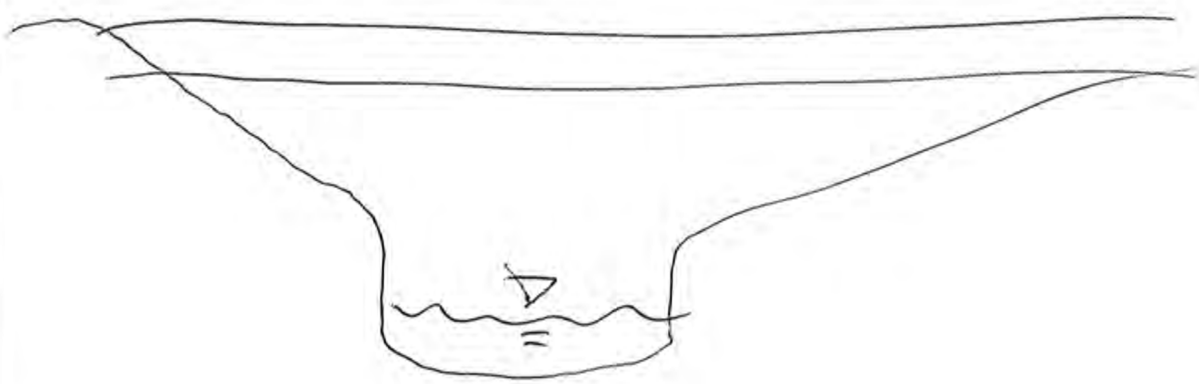


Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes



Stones and Sand

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 crossing 1+2
Township:
Highway ID:
Chainage or LHRS:
Type:
Location: 261 LT/RT:

Physical Characteristics

Structure: Bridge Foot
Desc: Wooden
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark: (% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

Water (mm)
Soil (mm)
Perch (mm)

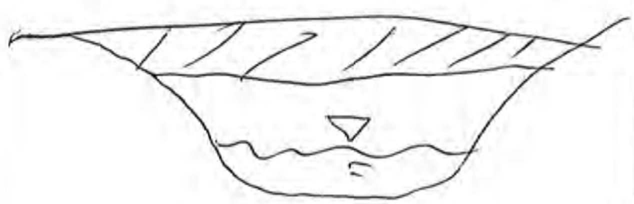
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes

1



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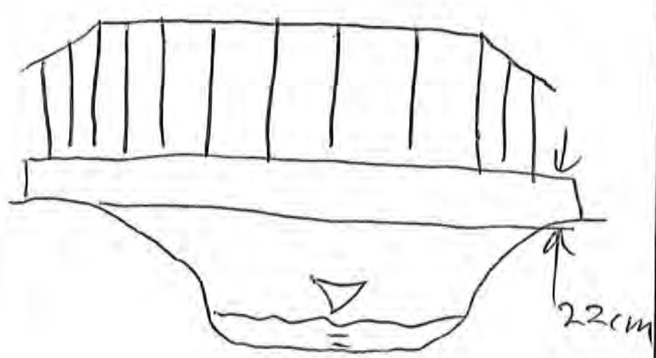


Filename: 20230705_092722.jpg Photo 37 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Wildlife Sighting

Filename: 20230705_092733.jpg Photo 38 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 1 Upstream Face

Filename: 20230705_092747.jpg Photo 39 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 1 Looking Upstream

Filename: 20230705_092806.jpg Photo 40 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 1 Looking Downstream

Filename: 20230705_092802.jpg Photo 41 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 1 Downstream Face

Filename: 20230705_093837.jpg Photo 42 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 2 Upstream Face

Filename: 20230705_093848.jpg Photo 43 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 2
Looking Upstream

Filename: 20230705_093855.jpg Photo 44 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 2
Looking Downstream

Filename: 20230705_093926.jpg Photo 45 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 249 Queen St S Backyard Footbridge 2
Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 crossing 3,4,5
Township: Durham
Highway ID:
Chainage or LHRS:
Type:
Location: LT/RT:

Physical Characteristics

Structure: Bridge Foot + Fences
Desc: 0 Wood
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

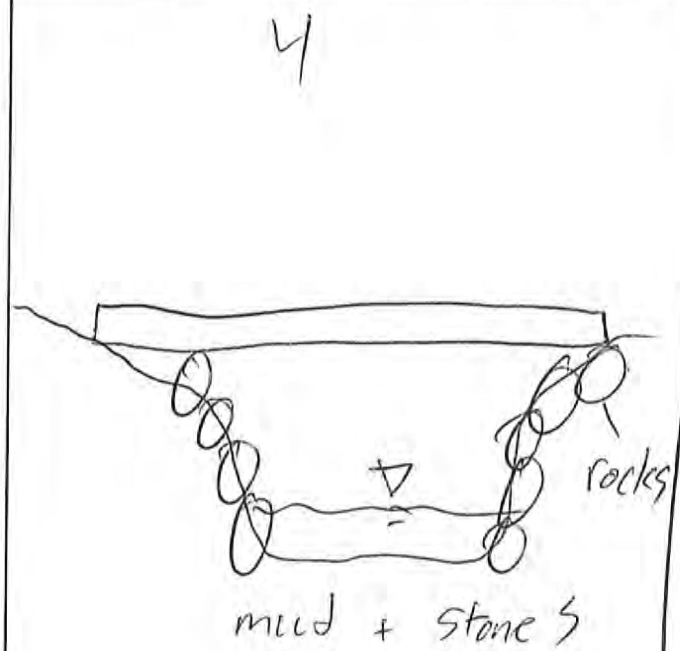
Water (mm)
Soil (mm)
Perch (mm)

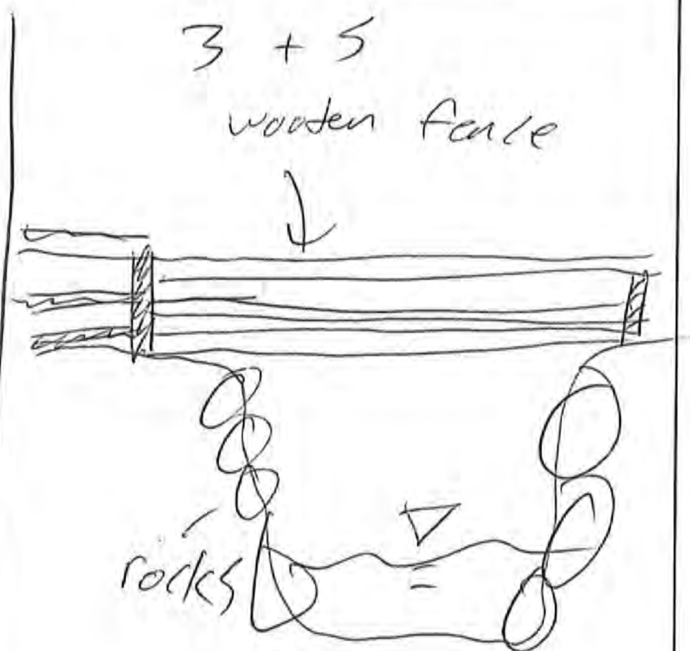
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes





Filename: 20230705_101052.jpg Photo 49 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 245 Queen St S Backyard Footbridge Upstream Face

Filename: 20230705_101059.jpg Photo 50 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 245 Queen St S Backyard Footbridge Looking Upstream

Filename: 20230705_101104.jpg Photo 51 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 245 Queen St S Backyard Footbridge Looking Downstream

Filename: 20230705_101114.jpg Photo 52 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 245 Queen St S Backyard Footbridge Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 Xing 6+7
Township: Durham ON
Highway ID: 6
Chainage or LHRS:
Type:
Location: LT/RT:

Physical Characteristics

Structure: Bridge + Fence
Desc: 0 wooden
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

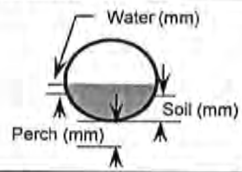
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

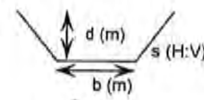
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

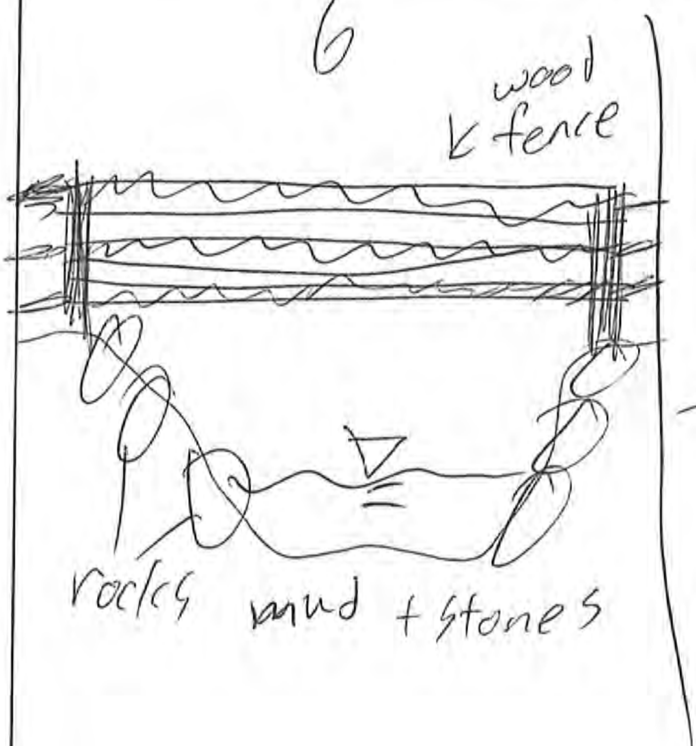


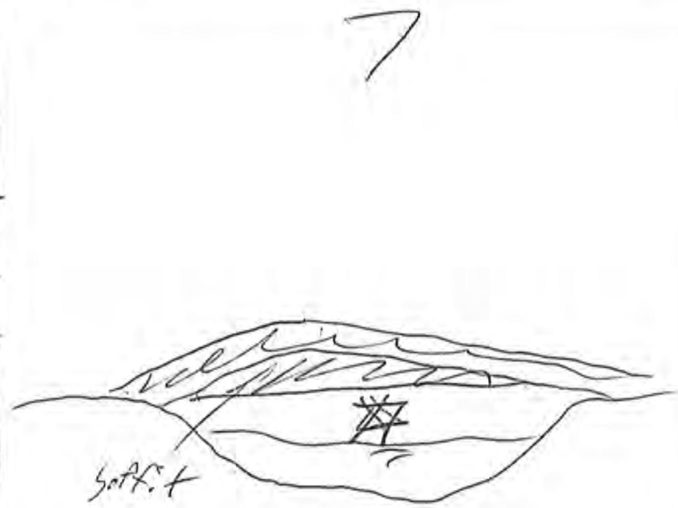
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes





Filename: 20230705_105448.jpg Photo 55 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 240 Garafraxa St S Backyard Looking Downstream

Filename: 20230705_105454.jpg Photo 56 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 240 Garafraxa St S Backyard Footbridge Downstream Face

Filename: 20230705_105515.jpg Photo 57 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 240 Garafraxa St S Backyard Footbridge Upstream Face

Filename: 20230705_105519.jpg Photo 58 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 240 Garafraxa St S Backyard Footbridge Looking Upstream

WILLS

Crossing Data Sheet:

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 Crossing 7
Township: Durham
Highway ID: Garafraxa S
Chainage or LHRS:
Type:
Location: 232 LT/RT:

Physical Characteristics

Structure: Bridge
Desc: 0
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

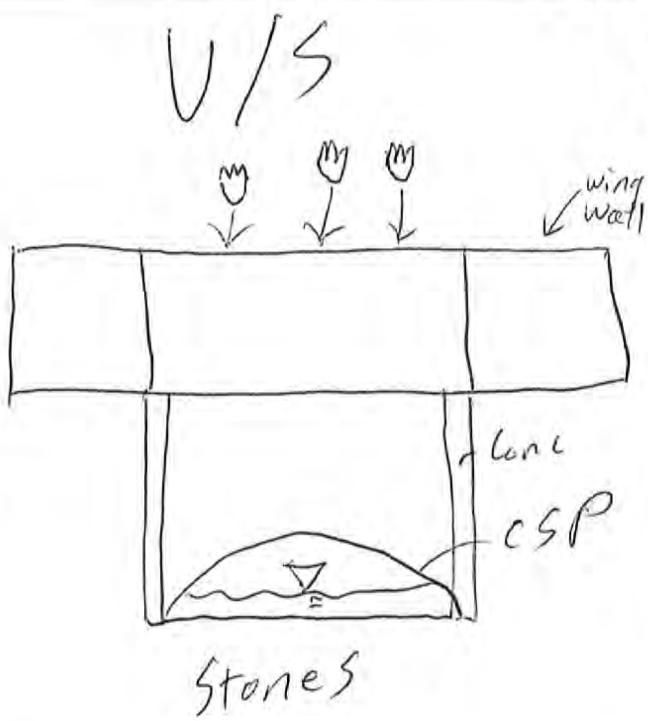
Water (mm)
Soil (mm)
Perch (mm)

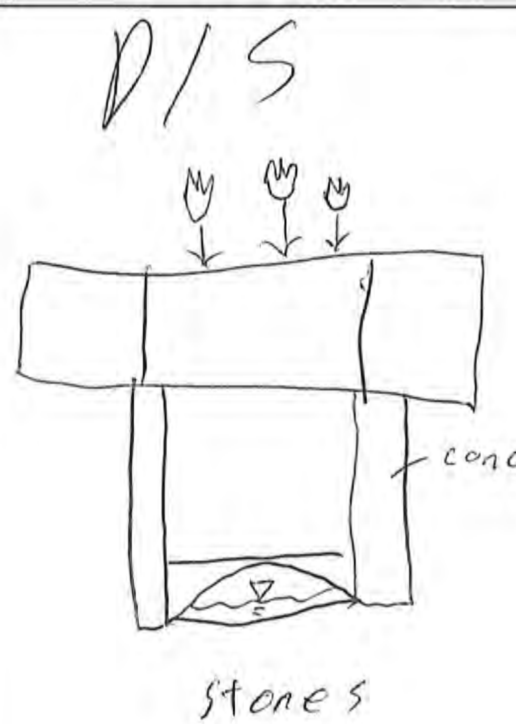
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes





Filename: 20230705_123001.jpg Photo 67 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 232 Garafraxa St S Driveway Culvert Upstream Face

Filename: 20230705_123005.jpg Photo 68 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 232 Garafraxa St S Driveway Culvert Upstream Face

Filename: 20230705_123017.jpg Photo 69 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 232 Garafraxa St S Driveway Culvert Looking Upstream

Filename: 20230705_123026.jpg Photo 70 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 232 Garafraxa St S Driveway Culvert Looking Downstream

Filename: 20230705_123037.jpg Photo 71 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 232 Garafraxa St S Driveway Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 Crossing 8?
Township: Durham
Highway ID: Grafton's Hwy 4
Chainage or LHRS:
Type:
Location: 229A LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Box Culvert
Desc: □ concrete
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

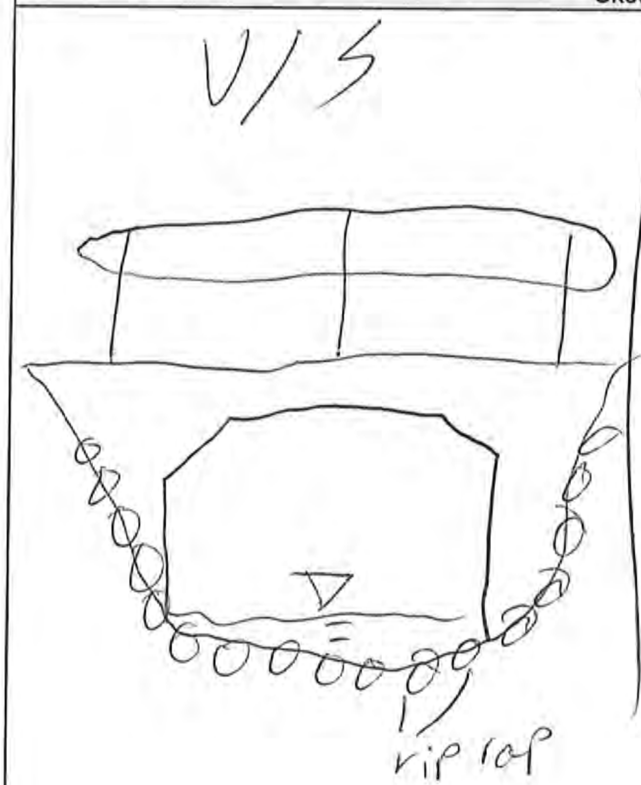
Water (mm) Soil (mm) Perch (mm)

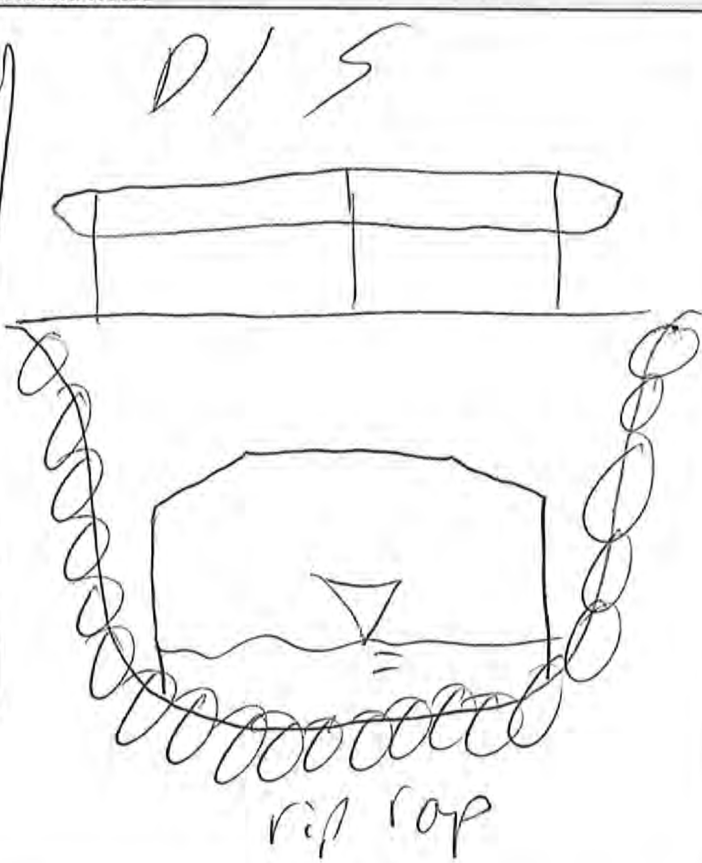
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m) s (H:V) b (m)

Sketch and Notes





Filename: 20230705_112443.jpg Photo 61 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Durham Creek: Garafraxa St S Culvert Upstream Face

Filename: 20230705_112451.jpg Photo 62 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Durham Creek: Garafraxa St S Culvert Looking Upstream

Filename: 20230705_112558.jpg Photo 63 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Durham Creek: Garafraxa St S Culvert Looking Downstream

Filename: 20230705_112548.jpg Photo 64 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Durham Creek: Garafraxa St S Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 Crossing 10
Township: Durham
Highway ID:
Chainage or LHRS:
Type:
Location: 147 Saddler St LT/RT:

Physical Characteristics

Structure: Bridge Foot
Desc: Wood
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

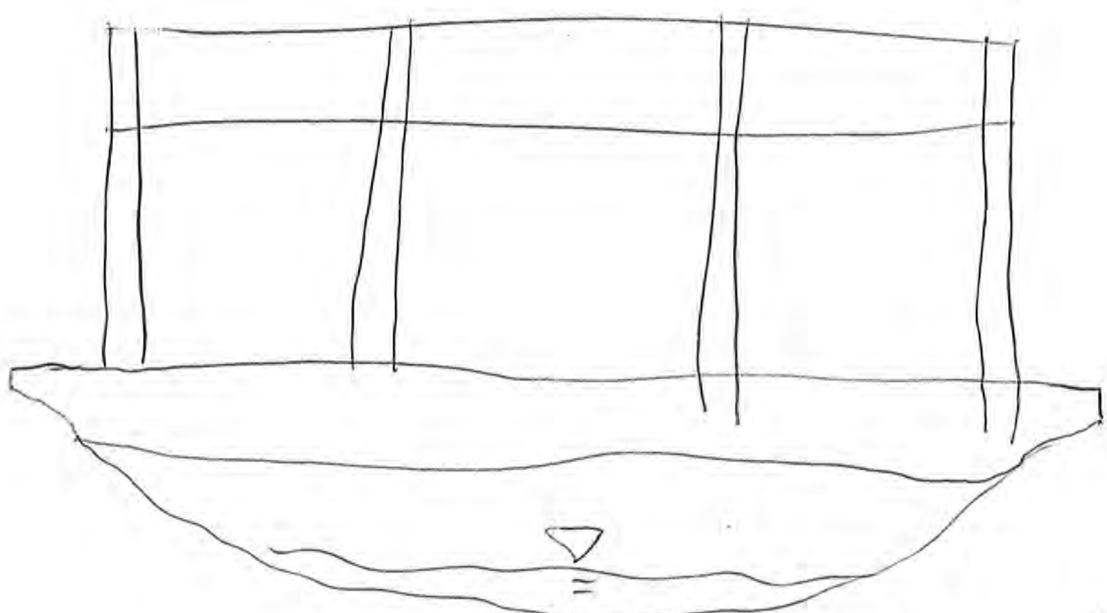
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes



grass + weeds

WILLS | Saugeen Conservation

Filename: 20230705_131036.jpg Photo 73 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 197 Saddler St E Backyard Footbridge Upstream Face

WILLS | Saugeen Conservation

Filename: 20230705_131047.jpg Photo 74 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 197 Saddler St E Backyard Footbridge Looking Upstream

WILLS | Saugeen Conservation

Filename: 20230705_131054.jpg Photo 75 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 197 Saddler St E Backyard Footbridge Looking Downstream

WILLS | Saugeen Conservation

Filename: 20230705_131104.jpg Photo 76 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: 197 Saddler St E Backyard Footbridge Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 - 11
Township:
Highway ID: Albert St
Chainage or LHRS:
Type: 205
Location: ~~Sadd~~ Albert St LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Culvert
Desc: 0 CSP
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

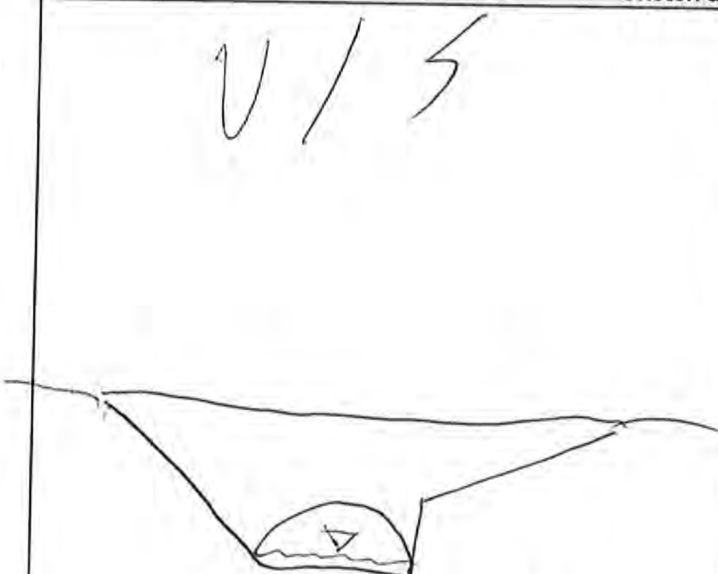
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

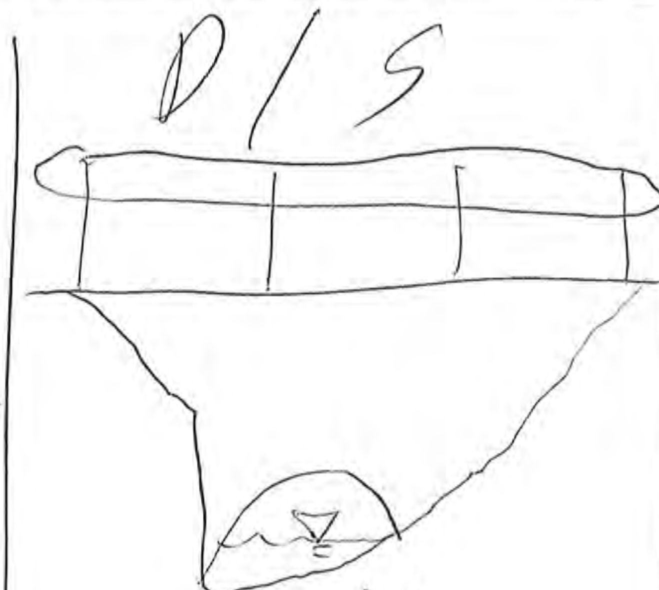
Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes



Stones + Sand



weeds

Filename: 20230705_131203.jpg Photo 79 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Albert St S Culvert Upstream Face

Filename: 20230705_131212.jpg Photo 80 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Albert St S Culvert Looking Upstream

Filename: 20230705_131124.jpg Photo 81 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 197 Saddler St E Side-yard Channel Looking Upstream

Filename: 20230705_131239.jpg Photo 82 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Albert St S Culvert Looking Downstream

Filename: 20230705_131231.jpg Photo 83 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Albert St S Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 - 12
Township:
Highway ID: Saddler St
Chainage or LHRS:
Type:
Location: @ Albert
LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Culvert
Desc: ~~0~~ CSP
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type:
Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

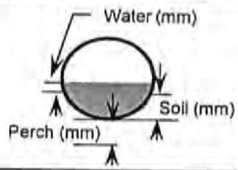
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat
LT: Lat
RT: Long
LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

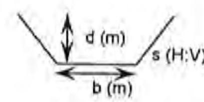
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

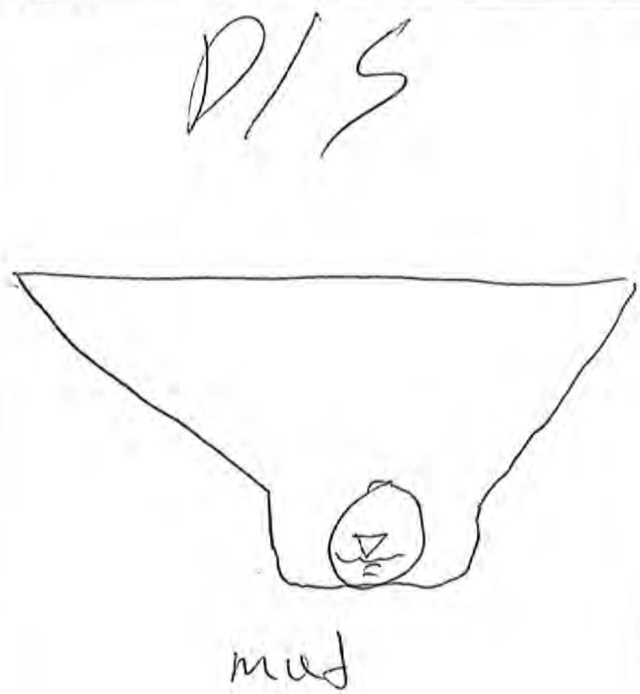


Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes



Filename: 20230705_131937.jpg Photo 85 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Saddler St E Culvert Upstream Face

Filename: 20230705_131944.jpg Photo 86 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Saddler St E Culvert Looking Upstream

Filename: 20230705_132031.jpg Photo 87 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Saddler St E Culvert Downstream Face

Filename: 20230705_132043.jpg Photo 88 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Saddler St E Culvert Looking Downstream

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 - 13
Township: Durham
Highway ID: Saddle
Chainage or LHRS:
Type:
Location: 2.42 LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP
Desc.: ~~0~~ Culverts
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

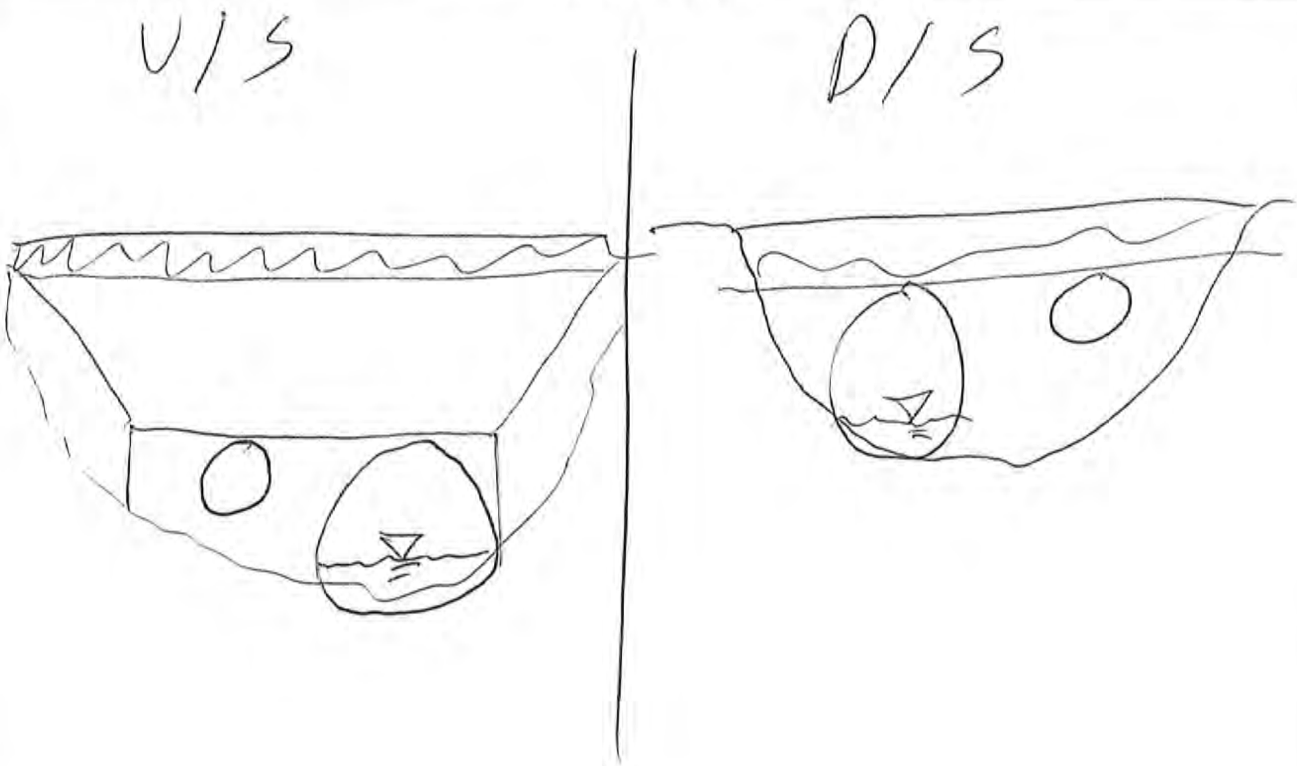
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes



Filename: 20230705_133928.jpg Photo 91 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 242 Saddler St E Driveway Culvert Upstream Face

Filename: 20230705_133939.jpg Photo 92 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 242 Saddler St E Driveway Culvert Looking Upstream

Filename: 20230705_133951.jpg Photo 93 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 242 Saddler St E Driveway Culvert Looking Downstream

Filename: 20230705_134004.jpg Photo 94 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 242 Saddler St E Driveway Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 2 - 17
Township: Durham ON
Highway ID:
Chainage or LHRS:
Type:
Location: 187
LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP
Desc: 0
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type:
Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat
RT: Long
LT: Lat
LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

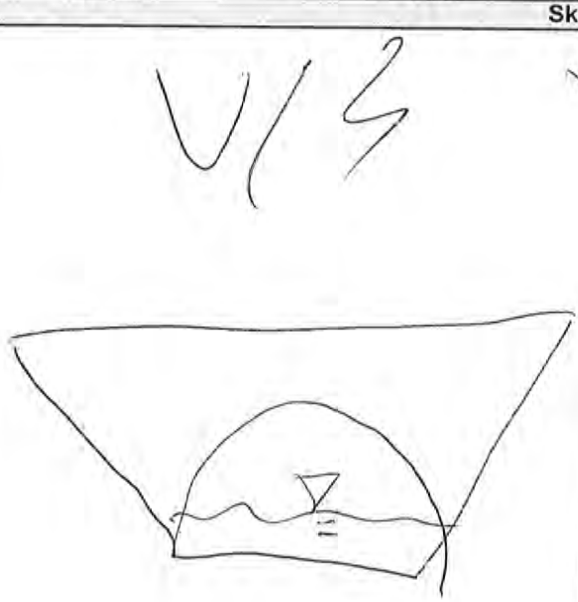
Water (mm)
Soil (mm)
Perch (mm)

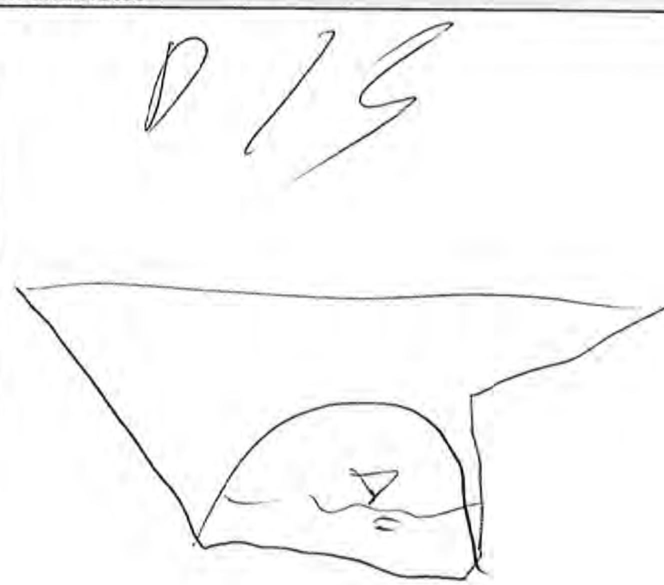
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

Sketch and Notes





Filename: 20230705_145625.jpg Photo 97 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Elgin St S Culvert Upstream Face

Filename: 20230705_145634.jpg Photo 98 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Elgin St S Culvert Looking Upstream

Filename: 20230705_145709.jpg Photo 99 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Elgin St S Culvert Looking Downstream

Filename: 20230705_145718.jpg Photo 100 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Elgin St S Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Pay 2 -15
Township:
Highway ID:
Chainage or LHRS:
Type:
Location: 180 LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ CSP
Desc: 2 culvert
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark: (% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

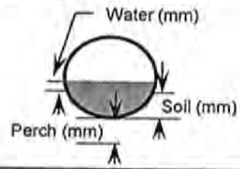
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

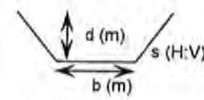
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

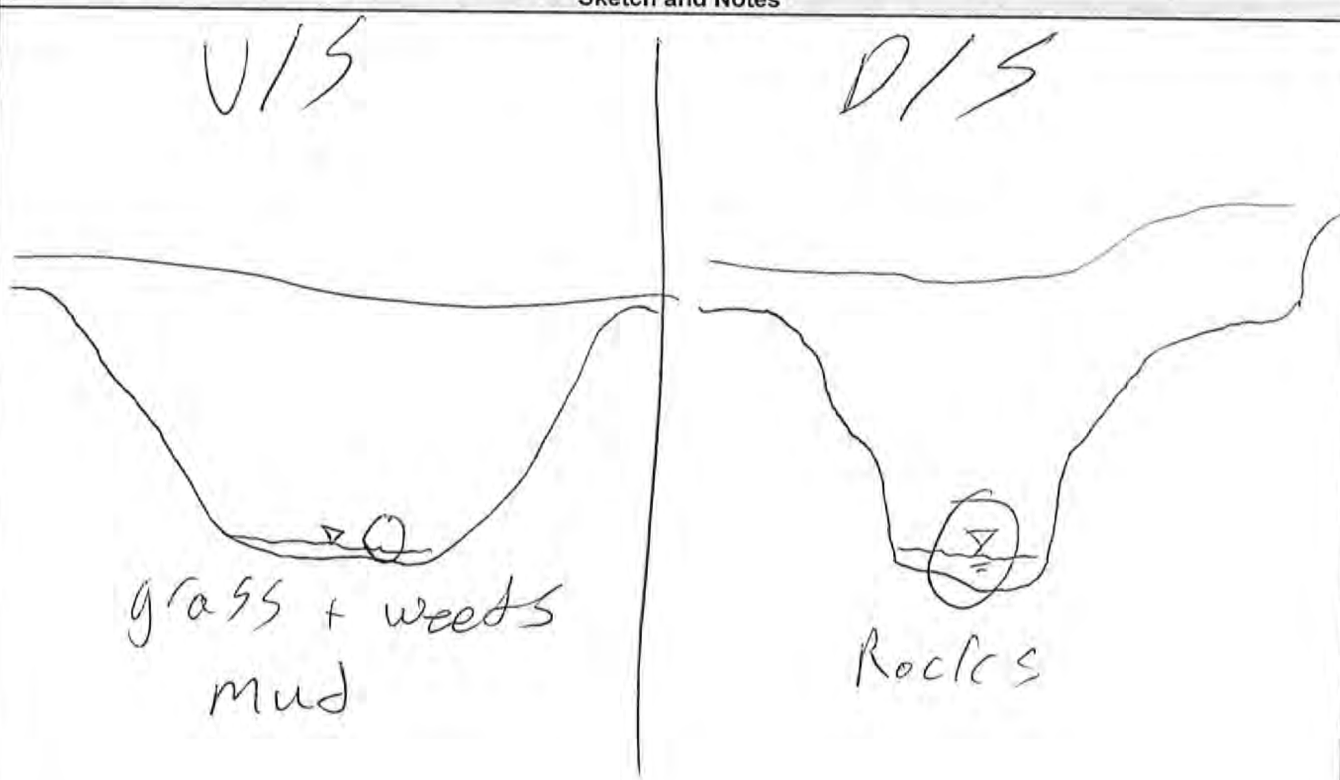


Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes



Filename: 20230705_153029.jpg Photo 103 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Kincardine St S Culvert Upstream Face

Filename: 20230705_153051.jpg Photo 104 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Kincardine St S Culvert Looking Upstream

Filename: 20230705_153204.jpg Photo 105 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Kincardine St S Culvert Looking Downstream

Filename: 20230705_153222.jpg Photo 106 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: Kincardine St S Culvert Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID:
Township:
Highway ID:
Chainage or LHRS:
Type:
Location: 479 LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Culvert
Desc: 0 CSP Driveway
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

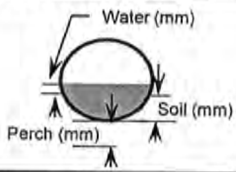
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Beaver Evidence
[ ] Groundwater Above Invert
[ ] Navigable
[ ] Animal Grate
[ ] Local Wells~200m
[ ] Nesting Structure
[ ] Sensitive Env or Pollutant

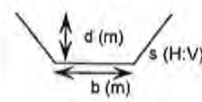
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

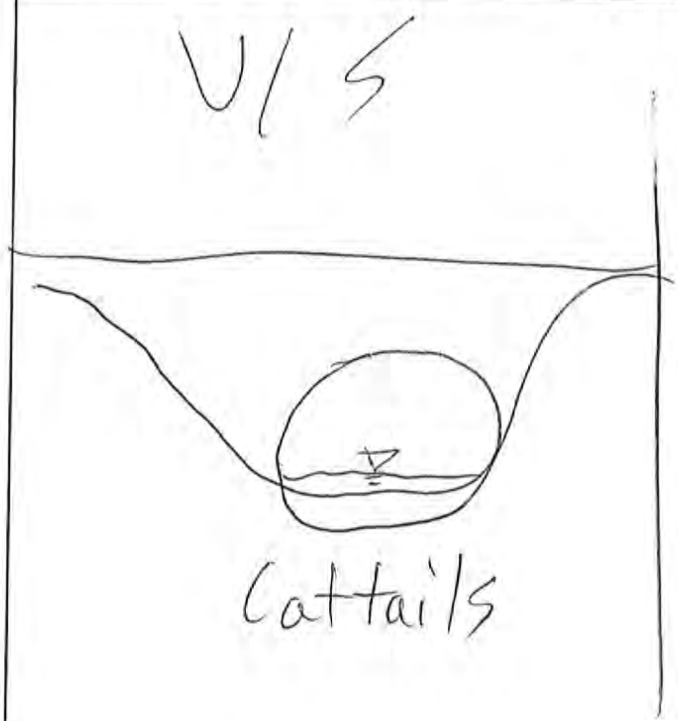


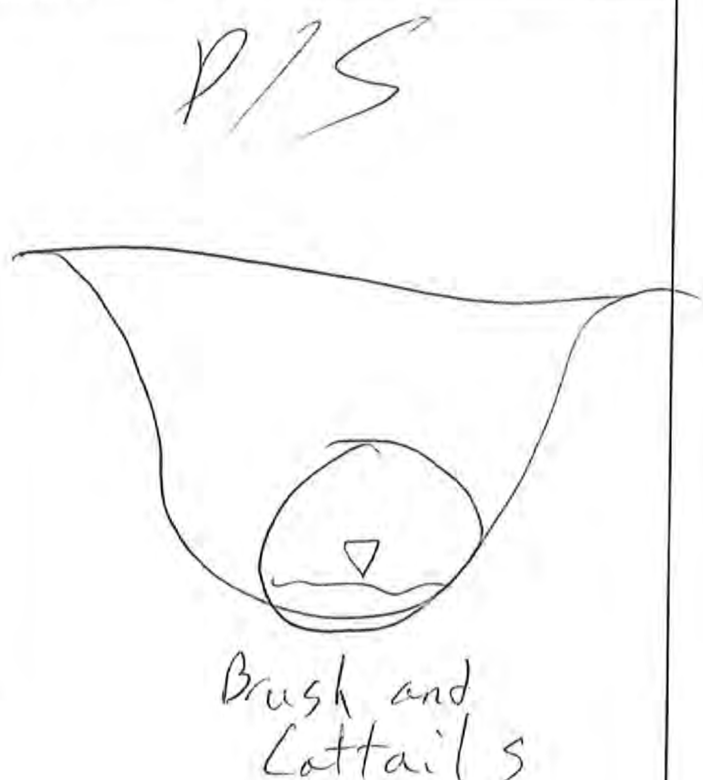
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes





Filename: 20230705_162635.jpg Photo 109 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 479 Lambton St E Driveway Culvert Upstream End

Filename: 20230705_162647.jpg Photo 110 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 479 Lambton St E Driveway Culvert Outlet

Filename: 20230705_170106.jpg Photo 111 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 479 Lambton St E SWM Pond Outlet

Filename: 20230705_165940.jpg Photo 112 - October 26, 2023
Durham Creek Flood Plain Mapping
Durham Creek: 479 Lambton St E SWM Pond

WILLS | Saugeen Conservation

Filename: 20230707_143833.jpg Photo 115 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: Grey County Rd 4 Culvert Upstream Face

WILLS | Saugeen Conservation

Filename: 20230707_143837.jpg Photo 116 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: Grey County Rd 4 Culvert Upstream Looking West

WILLS | Saugeen Conservation

Filename: 20230707_143843.jpg Photo 117 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: Grey County Rd 4 Culvert Looking Upstream

WILLS | Saugeen Conservation

Filename: 20230707_143944.jpg Photo 118 - October 26, 2023

Durham Creek Flood Plain Mapping

Durham Creek: Grey County Rd 4 Culvert Downstream Outlet

Culvert Inspection Worksheet: 17+592

WILLS

Agreement No.: Durham CK/Saugeen River
Date: 09/14/2023
Assignment No.: 5591-
Weather: Sunny w/clouds
Project Limits:
Inspectors: MC/MK

Location

Culvert ID: ~~South~~ Saugeen@Hwy 4
Township: Durham Grey RD
Highway ID:
Chainage or LHRS:
Type: Centreline
Location: Main
LT/RT:

Physical Characteristics

Material: Bridge, Single Span.
Pipe Desc:
Size (mm): N/A (dia. or span x rise)
Cover (m): N/A (Approx.)
Length (m): 11.5m (Approx.)
Fill Type:
Extensions:

Flow Information

Flow Type: Lam U.S, Turb D.S
Type of Water Feature:
Flow Direction: South to North
(Approx.) Flow Velocity:
High Water Mark:
(% of culvert height)

Samples:
[x] Water
[x] Soil

Geomatics

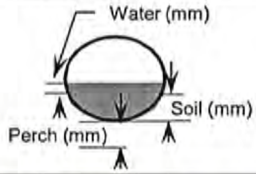
RT: Lat
RT: Long

Environmental Considerations

[x] Fish Observed
[✓] Navigable
[ ] Nesting Structure
[x] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

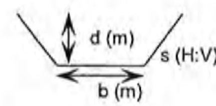
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

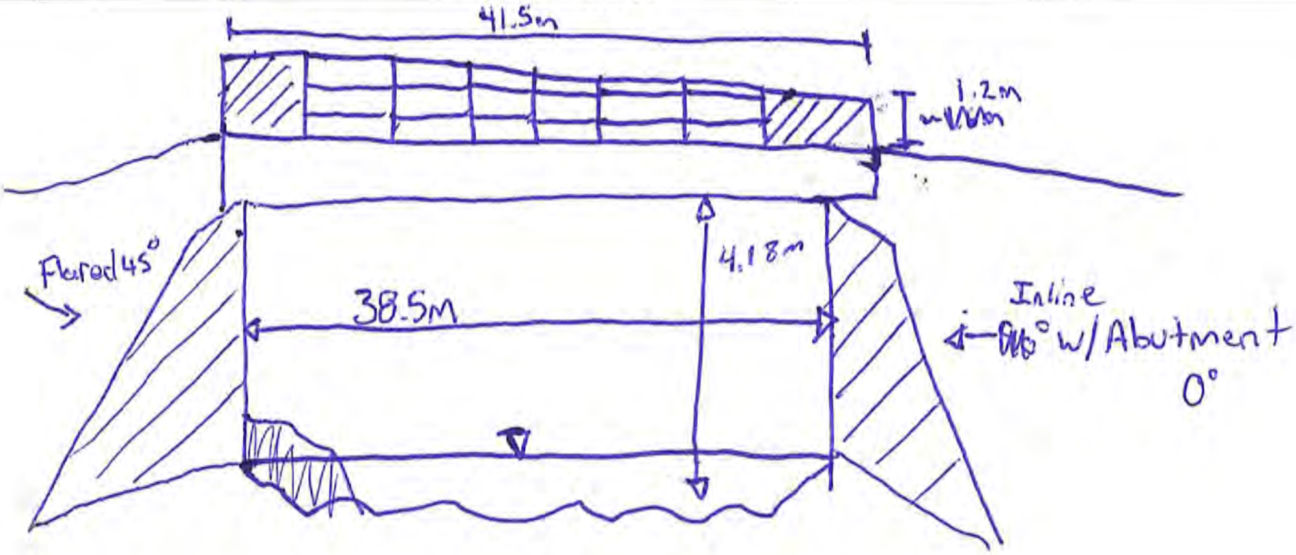


Downstream Channel Section (Rt)

Open Outlet : Yes
Bottom Width (b): yes→
Depth (d): varied
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Notes



Aerial View / Sketched Notes

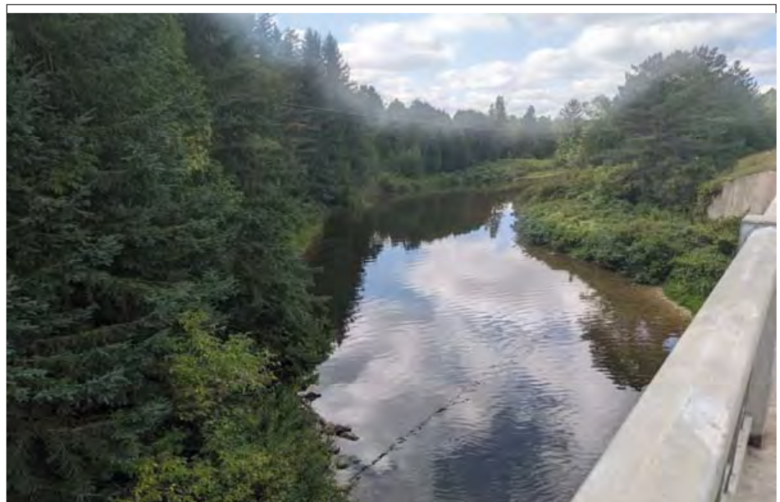
Notes: Values in Blue are taken from GIS data provided by the Ministry and found to be in general conformance in the field

**: Rt. and Lt. ends are determined when facing up-chainage. For entrance / sideroad culverts, the Lt. side is always up-chainage

Filename: PXL_20230914_161914005.jpg
Photo 1 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Upstream Face

Filename: PXL_20230914_161825667.jpg
Photo 2 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Upstream Soffit and West Wingwall

Filename: PXL_20230914_161831636.jpg
Photo 3 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Upstream Soffit and East Abutment

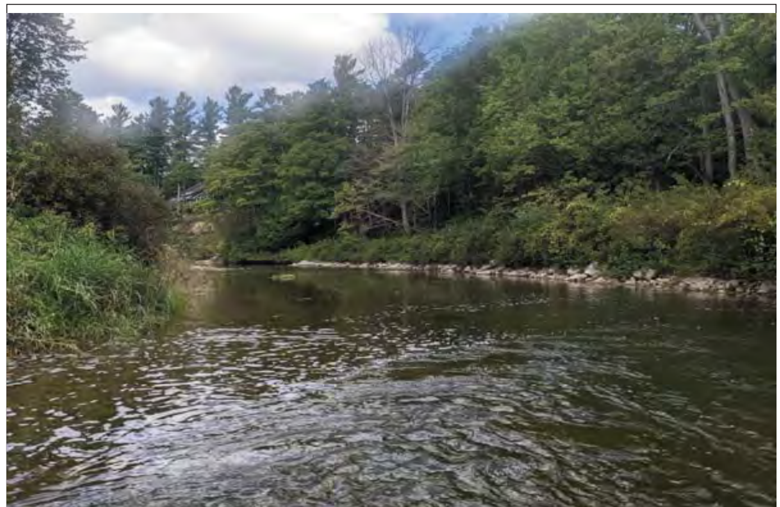


Filename: PXL_20230914_161929450.jpg
Photo 4 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Looking Upstream

Filename: PXL_20230914_161730650.jpg
Photo 5 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Downstream West Wingwall

Filename: PXL_20230914_161732619.jpg
Photo 6 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Downstream Face

Filename: PXL_20230914_161734291.jpg
Photo 7 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Downstream East Bank



Filename: PXL_20230914_161738066.jpg
Photo 8 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Looking Downstream

Filename: PXL_20230914_161940372.jpg
Photo 9 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Looking Downstream

Filename: PXL_20230914_162306638.MP.jpg
Photo 10 - September 14, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Grey County Road 4 Bridge Downstream Face

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Day 3 Dam 1
Township: Durham
Highway ID: Contess
Chainage or LHRS:
Type:
Location: 185
LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Dam
Desc: Walkway along top of Conc Struc
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type:
Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark: (% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat
LT: Lat
RT: Long
LT: Long

Environmental Considerations

[ ] Fish Observed
[ ] Navigable
[ ] Nesting Structure
[ ] Beaver Evidence
[ ] Animal Grate
[ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert
[ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

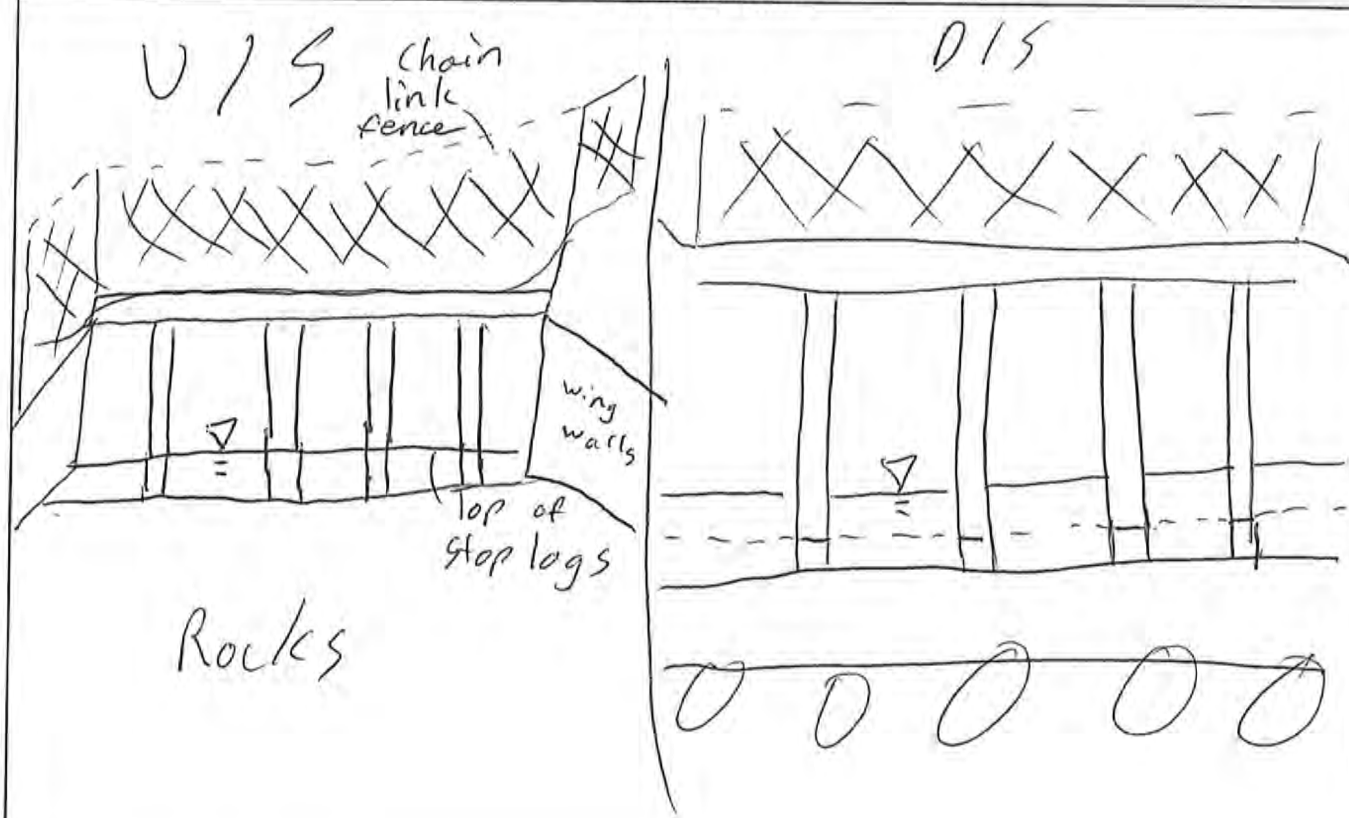
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet:
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

d (m)
s (H:V)
b (m)

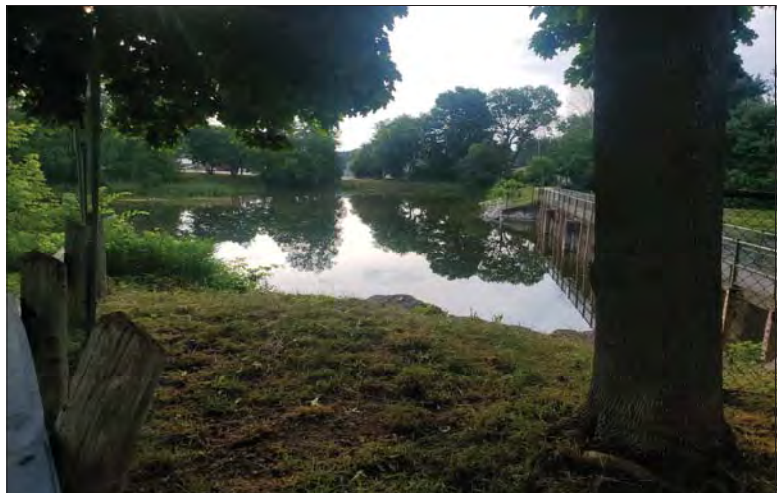
Sketch and Notes



Filename: 20230706_075917.jpg Photo 121 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Upstream Face

Filename: 20230706_081312.jpg Photo 122 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Immediately Upstream

Filename: 20230706_080029.jpg Photo 123 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Upstream



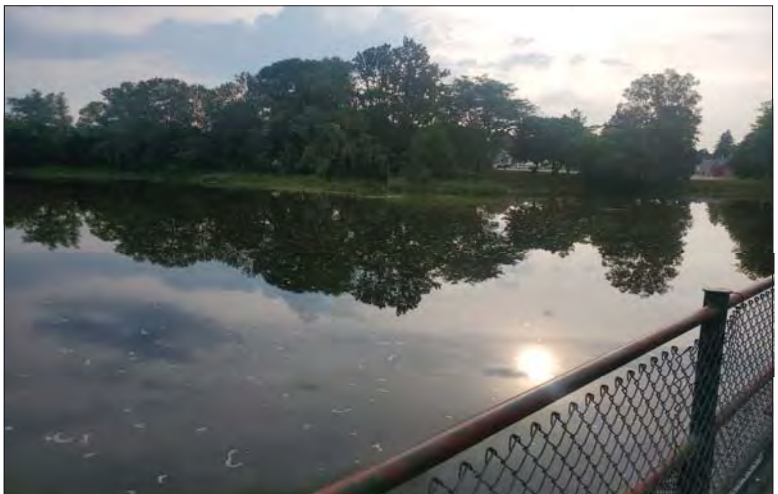
Filename: 20230706_075952.jpg Photo 124 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir

Filename: 20230706_075937.jpg Photo 125 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam From Countess St S

Filename: 20230706_080034.jpg Photo 126 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Access Gate

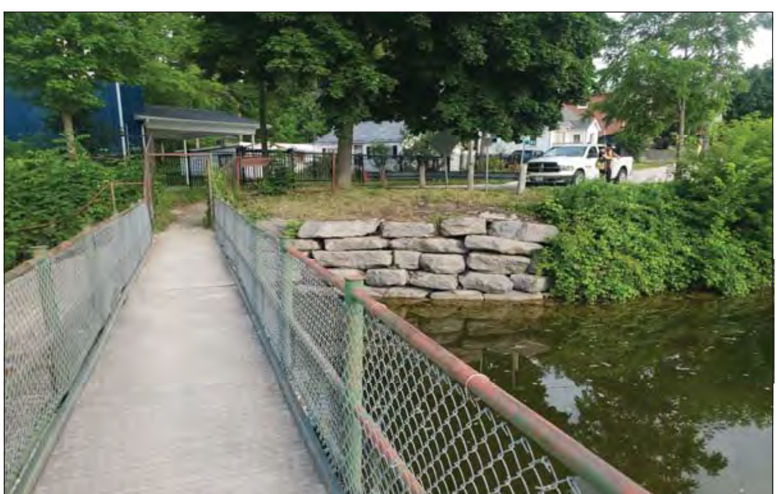
Filename: 20230706_080003.jpg Photo 127 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Top of Deck

Filename: 20230706_080024.jpg Photo 128 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Downstream

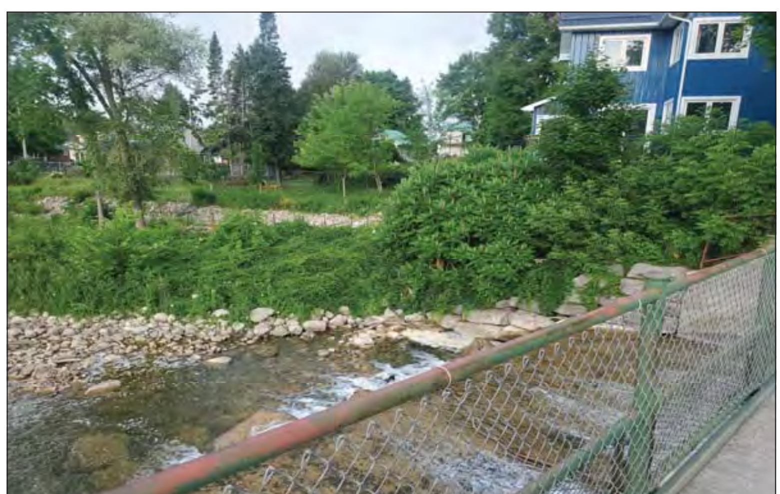


Filename: 20230706_080057.jpg Photo 129 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir

Filename: 20230706_080102.jpg Photo 130 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Upstream



Filename: 20230706_080109.jpg Photo 131 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Upstream West Bank



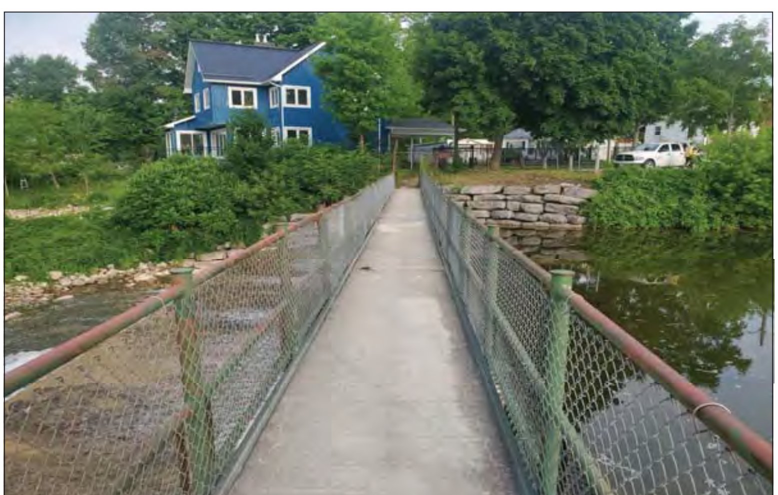
Filename: 20230706_080113.jpg Photo 132 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream West Bank

Filename: 20230706_080117.jpg Photo 133 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Downstream

Filename: 20230706_080121.jpg Photo 134 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream East Bank

Filename: 20230706_080145.jpg Photo 135 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Upstream

Filename: 20230706_080151.jpg Photo 136 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Upstream West Bank



Filename: 20230706_080155.jpg Photo 137 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Deck

Filename: 20230706_080159.jpg Photo 138 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream West Bank

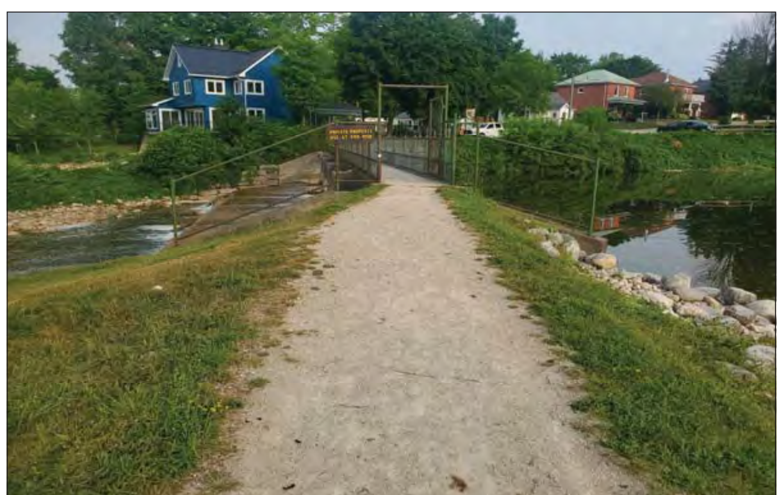
WILLS Saugeen Conservation
Filename: 20230706_080202.jpg Photo 139 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Looking Downstream

WILLS Saugeen Conservation
Filename: 20230706_080206.jpg Photo 140 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream East Bank

WILLS Saugeen Conservation
Filename: 20230706_080227.jpg Photo 141 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Earth Berm

WILLS Saugeen Conservation
Filename: 20230706_080232.jpg Photo 142 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir

WILLS Saugeen Conservation
Filename: 20230706_080236.jpg Photo 143 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir



WILLS Saugeen Conservation
Filename: 20230706_080240.jpg Photo 144 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam East Approach

Filename: 20230706_080246.jpg Photo 145 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream

Filename: 20230706_080254.jpg Photo 146 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

Filename: 20230706_080803.jpg Photo 147 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

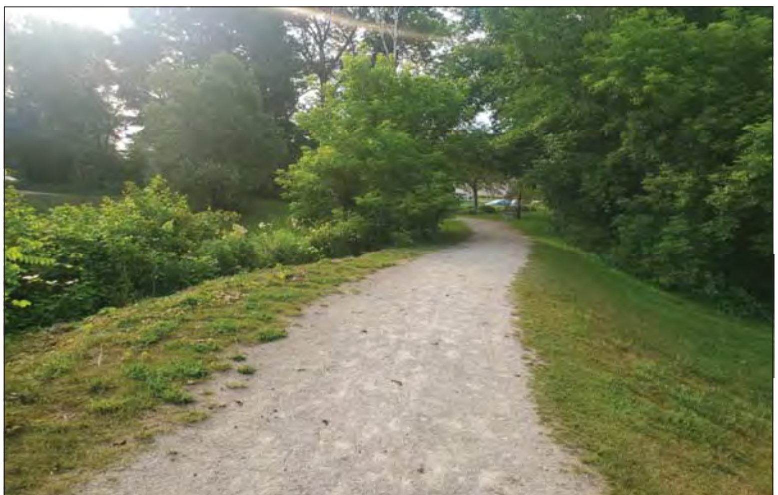
Filename: 20230706_080249.jpg Photo 148 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

Filename: 20230706_080843.jpg Photo 149 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

Filename: 20230706_080902.jpg Photo 150 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

Filename: 20230706_081019.jpg Photo 151 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam End of Emergency Spillway

Filename: 20230706_081029.jpg Photo 152 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam End of Emergency Spillway



Filename: 20230706_080318.jpg Photo 153 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Earth Berm

Filename: 20230706_080328.jpg Photo 154 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Earth Berm and Emergency Spillway

Filename: 20230706_080331.jpg Photo 155 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Emergency Spillway

Filename: 20230706_080335.jpg Photo 156 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream of Earth Berm

WILLS Saugeen Conservation
Filename: 20230706_080408.jpg Photo 157 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam East End of Earth Berm

WILLS Saugeen Conservation
Filename: 20230706_080411.jpg Photo 158 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam East End of Earth Berm

WILLS Saugeen Conservation
Filename: 20230706_080415.jpg Photo 159 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir

WILLS Saugeen Conservation
Filename: 20230706_080419.jpg Photo 160 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Earth Berm From East End

WILLS Saugeen Conservation
Filename: 20230706_080434.jpg Photo 161 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Memorial Plaque

WILLS Saugeen Conservation
Filename: 20230706_080536.jpg Photo 162 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam East End of Earth Berm

Filename: 20230706_080541.jpg Photo 163 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam East End of Earth Berm

Filename: 20230706_080546.jpg Photo 164 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Reservoir

Filename: 20230706_080550.jpg Photo 165 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Earth Berm From East End

Filename: 20230706_080627.jpg Photo 166 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Upstream Side of Earth Berm

Filename: 20230706_081002.jpg Photo 167 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream Face

Filename: 20230706_081007.jpg Photo 168 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Downstream West Bank

Filename: 20230706_081120.jpg Photo 169 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam Immediately Downstream

Filename: 20230706_081151.jpg Photo 170 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lower Durham Dam

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: County Rd 4
Township: Durham
Highway ID:
Chainage or LHRS:
Type:
Location: ~~Queens~~ Lambton St @ Queen LT/RT:

Physical Characteristics

Structure: Bridge
Desc: ~~0~~ Concrete
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

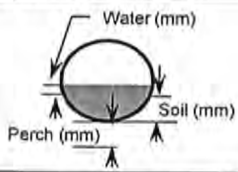
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

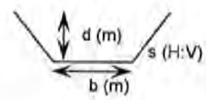
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

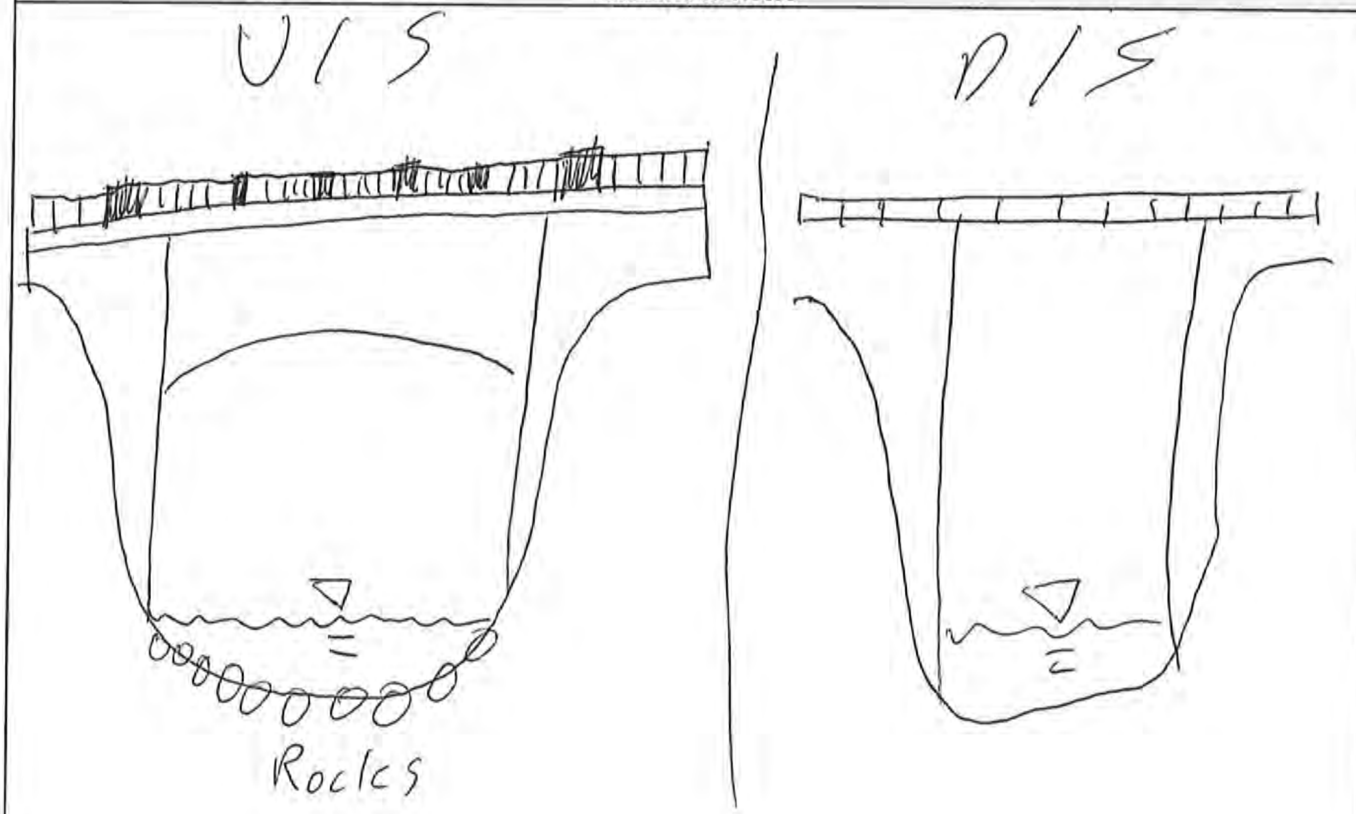


Downstream Channel Section ()

Open Outlet:
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



Sketch and Notes

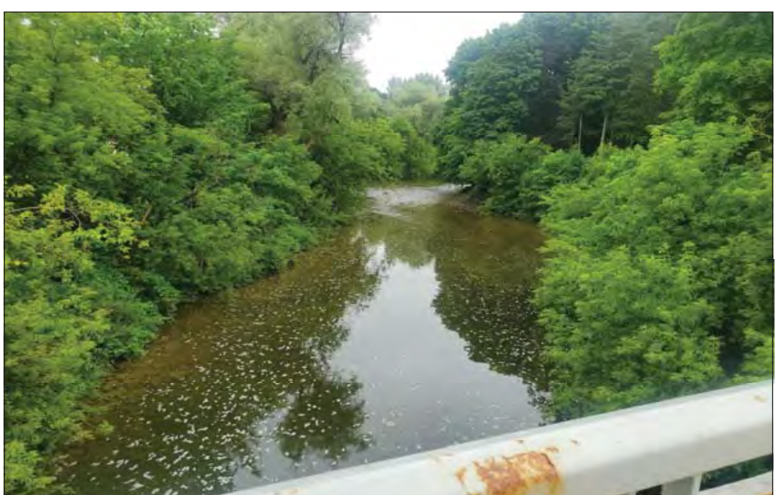


Filename: 20230706_154354.jpg Photo 175 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Upstream Face

Filename: 20230706_154405.jpg Photo 176 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Upstream Face and West Wingwall

Filename: 20230706_170811.jpg Photo 177 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Upstream Face

Filename: 20230706_154549.jpg Photo 178 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Looking Downstream at the Lambton St E Bridge



Filename: 20230706_154325.jpg Photo 179 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking Upstream

Filename: 20230706_154202.jpg Photo 180 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking Downstream

Filename: 20230706_154207.jpg Photo 181 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking East

Filename: 20230706_154214.jpg Photo 182 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking North

Filename: 20230706_154331.jpg Photo 183 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking West

Filename: 20230706_154335.jpg Photo 184 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Lambton St E Bridge Looking East

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Hwy 6 Bridge
Township: Durham
Highway ID: Hwy 6
Chainage or LHRS:
Type:
Location: Durham LT/RT:

Physical Characteristics

Structure: Bridge
Desc: ~~0~~ Concrete
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

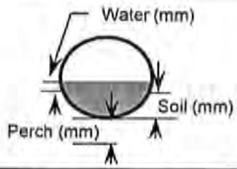
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

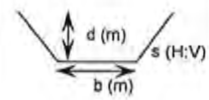
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:



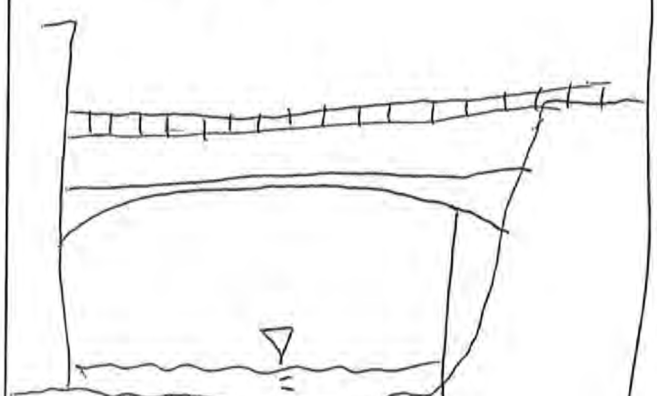
Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:



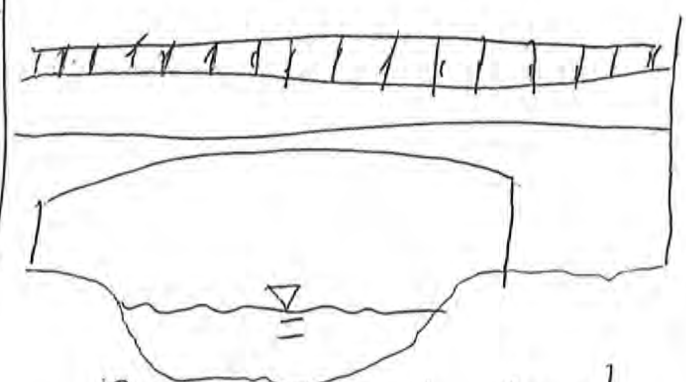
Sketch and Notes

U/S



Rocks + Sand

D/S



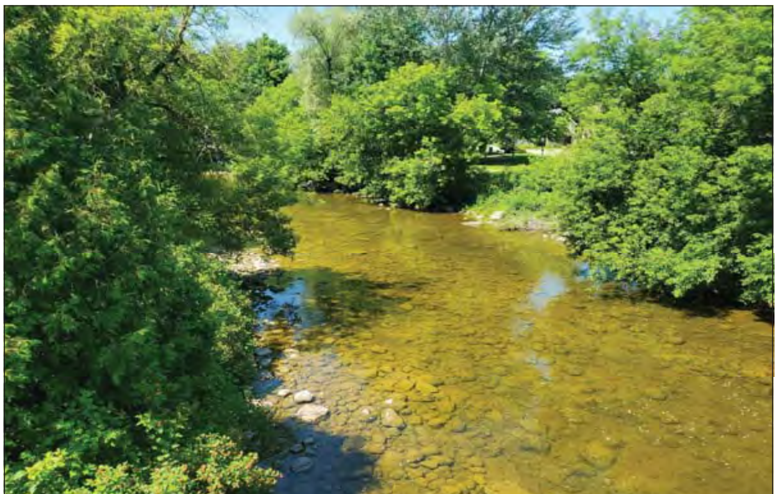
Rocks and Sand

WILLS Saugeen Conservation

Filename: 20230707_122654.jpg Photo 187 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Upstream Face

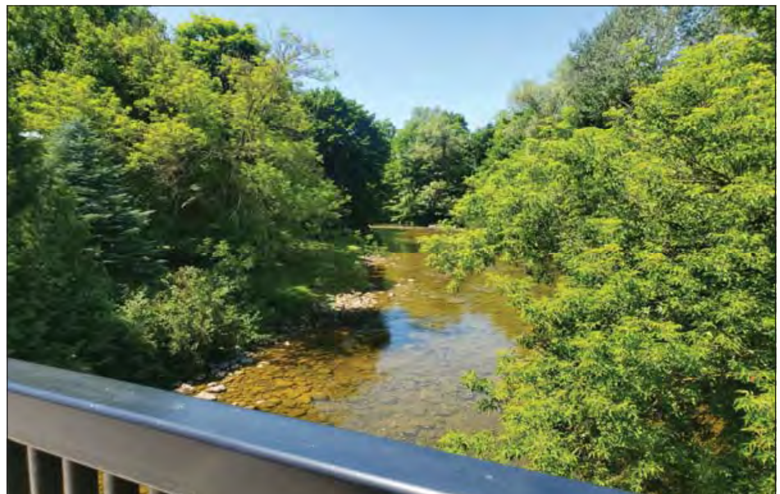
WILLS Saugeen Conservation

Filename: 20230707_122818.jpg Photo 188 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Looking Upstream



WILLS Saugeen Conservation

Filename: 20230707_123034.jpg Photo 189 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Looking Downstream

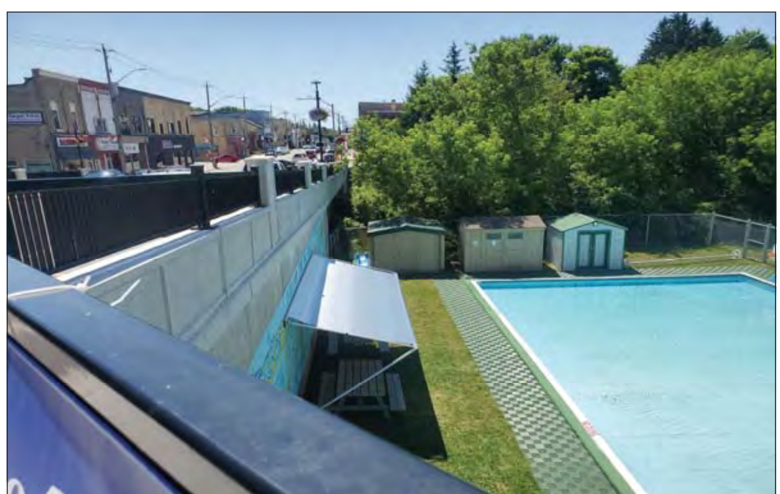


WILLS Saugeen Conservation

Filename: 20230707_123053.jpg Photo 190 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Looking Downstream

WILLS Saugeen Conservation

Filename: 20230707_122929.jpg Photo 191 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Downstream Face



WILLS Saugeen Conservation

Filename: 20230707_122551.jpg Photo 192 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Downstream Face

Filename: 20230707_122557.jpg Photo 193 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge North Abutment Looking West Along George St W

Filename: 20230707_122601.jpg Photo 194 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge North Abutment Looking North

Filename: 20230707_122604.jpg Photo 195 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge North Abutment Looking East

Filename: 20230707_122612.jpg Photo 196 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge North Abutment Looking South

Filename: 20230707_122805.jpg Photo 197 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Upstream South Bank

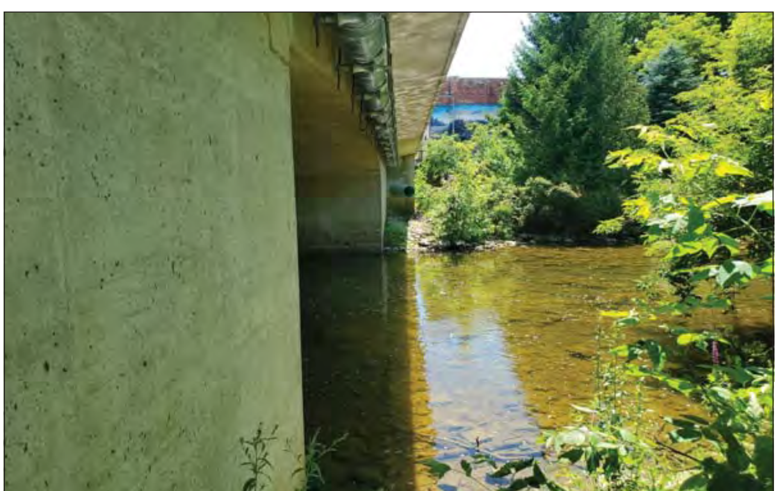
Filename: 20230707_122826.jpg Photo 198 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Upstream North Bank

Filename: 20230707_122940.jpg Photo 199 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge South Abutment Looking North

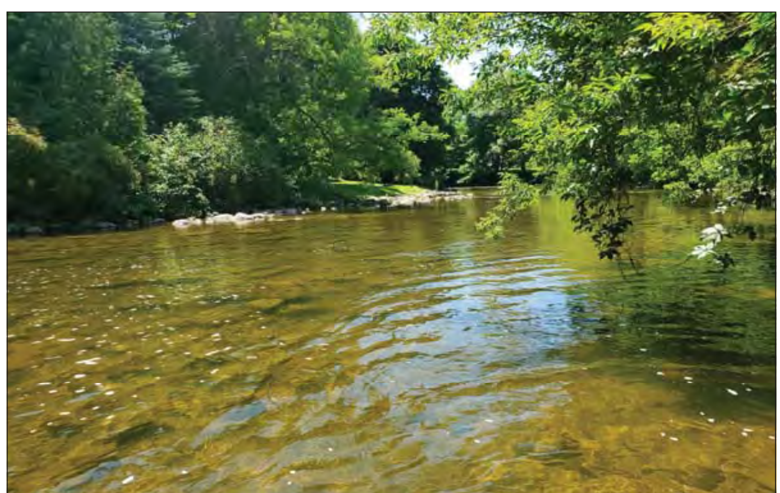
Filename: 20230707_122934.jpg Photo 200 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge South Abutment Looking South

Filename: 20230707_122842.jpg Photo 201 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge South Abutment Looking North

Filename: 20230707_133916.jpg Photo 202 - October 26, 2023
Durham Creek Flood Plain Mapping



Filename: 20230707_133940.jpg Photo 203 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Downstream Opening



Filename: 20230707_134053.jpg Photo 204 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Looking Downstream

Filename: 20230707_134007.jpg Photo 205 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Soffit Looking Upstream

Filename: 20230707_134142.jpg Photo 206 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Highway 6 Bridge Soffit Looking Upstream

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Pedestrian Bridge
Township:
Highway ID:
Chainage or LHRS:
Type:
Location: LT/RT:

Physical Characteristics

Structure: Bridge Pedestrian
Desc: ~~0~~ Wood Piers
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark:
(% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

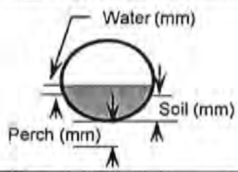
GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

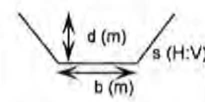
Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

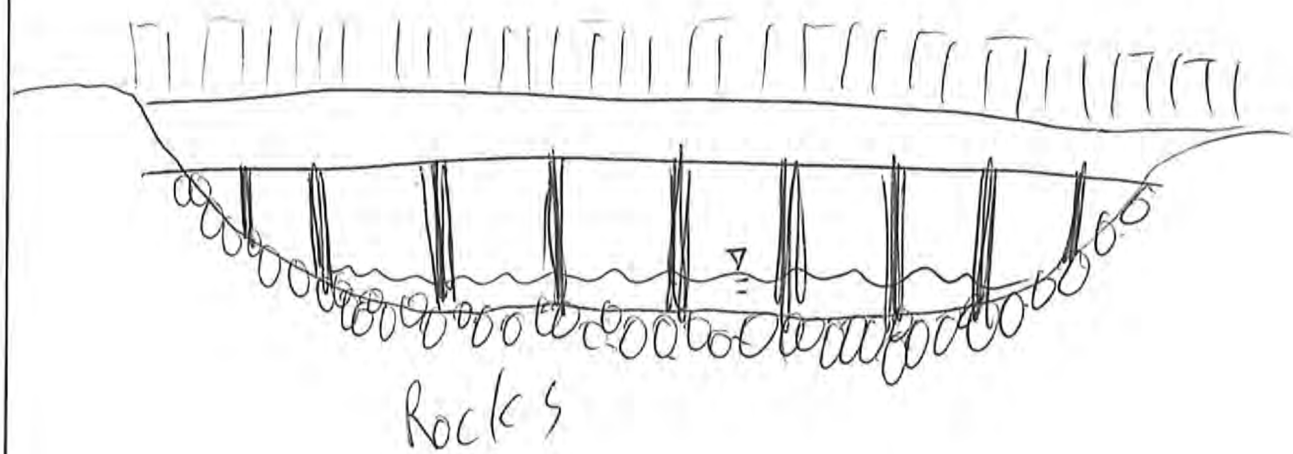


Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

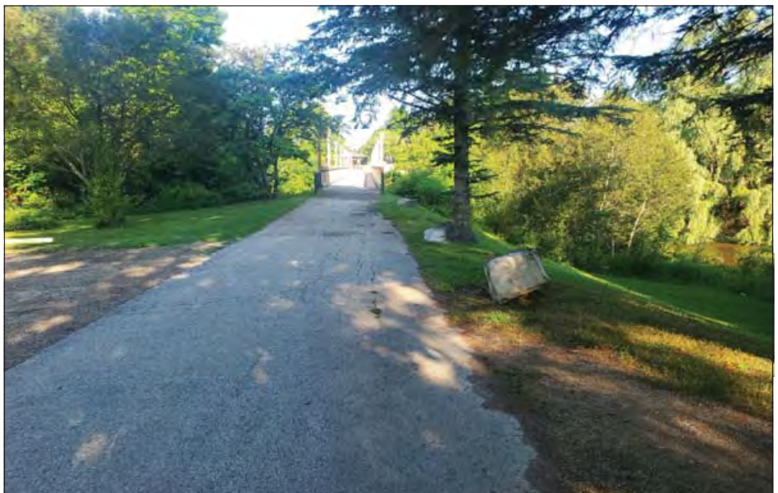


Sketch and Notes



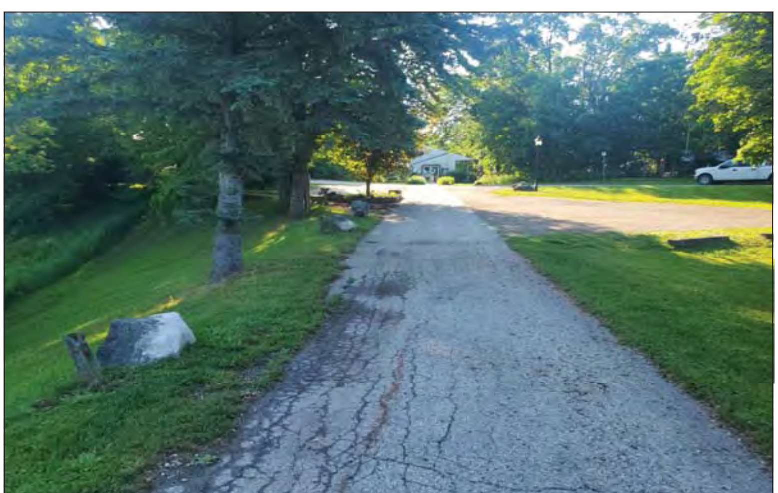
Filename: 20230707_105916.jpg Photo 211 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Upstream Face

Filename: 20230707_081601.jpg Photo 212 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking Upstream



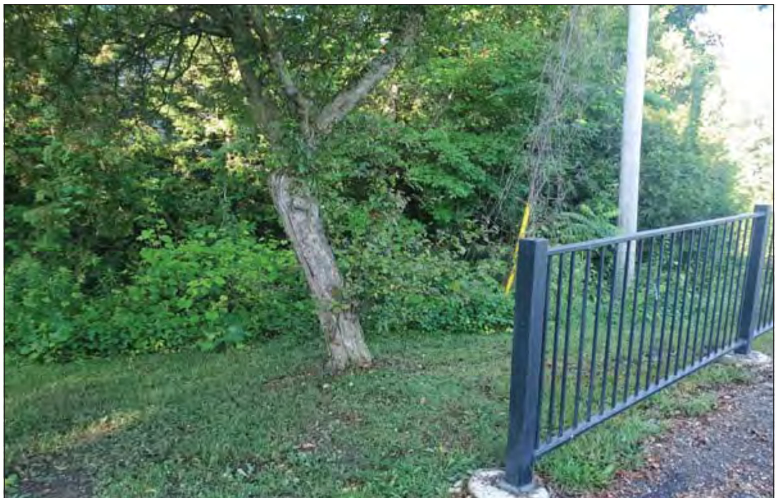
Filename: 20230707_081452.jpg Photo 213 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Approach

Filename: 20230707_081519.jpg Photo 214 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Abutment Looking West

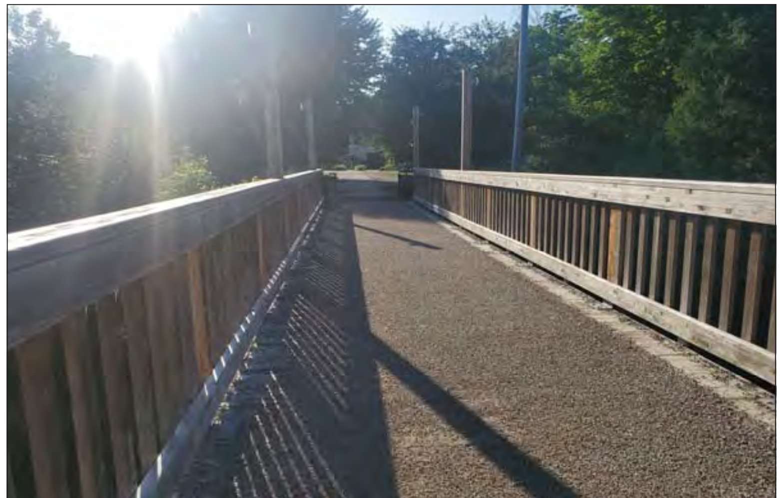


Filename: 20230707_081523.jpg Photo 215 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Abutment Looking East

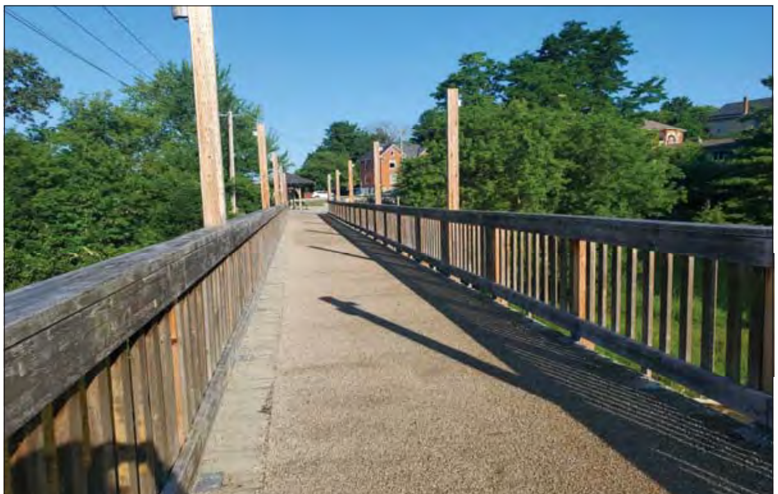
Filename: 20230707_081526.jpg Photo 216 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Abutment Looking North



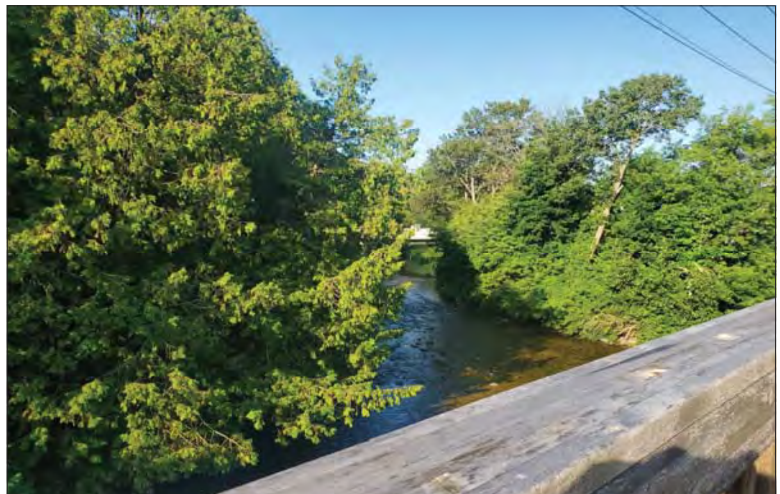
Filename: 20230707_081531.jpg Photo 217 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Abutment Looking South



Filename: 20230707_081604.jpg Photo 218 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Deck Looking East

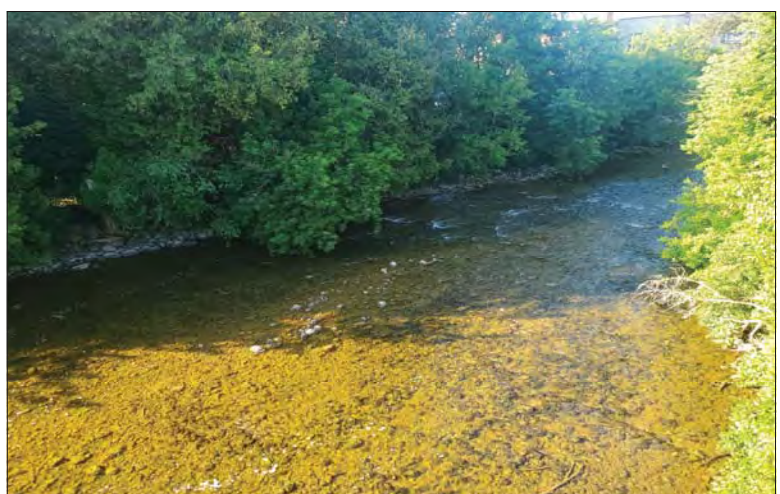


Filename: 20230707_081613.jpg Photo 219 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Deck Looking West



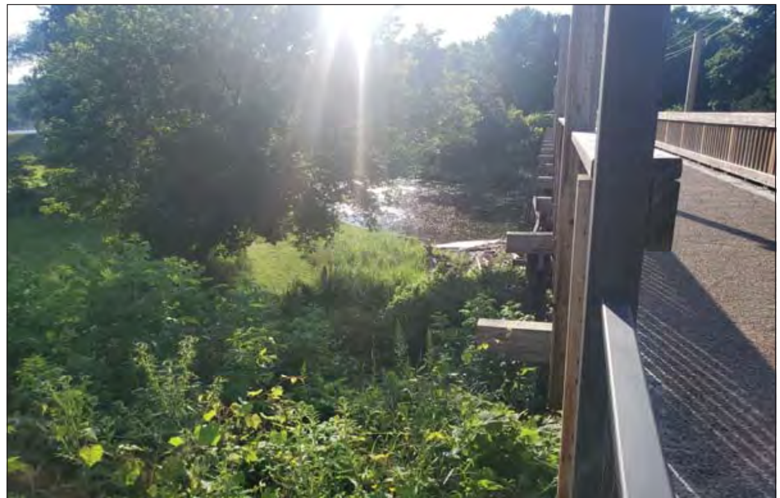
Filename: 20230707_081611.jpg Photo 220 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking Downstream

Filename: 20230707_081622.jpg Photo 221 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking Downstream



Filename: 20230707_081712.jpg Photo 222 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking Downstream

Filename: 20230707_081650.jpg Photo 223 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking North



Filename: 20230707_081748.jpg Photo 224 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge

Filename: 20230707_081752.jpg Photo 225 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking at Middle Durham Dam North Embankment

Filename: 20230707_081825.jpg Photo 226 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge West Stairs to River

Filename: 20230707_081830.jpg Photo 227 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Looking North from West Stairs

Filename: 20230707_112804.jpg Photo 228 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge Piers

Filename: 20230707_112808.jpg Photo 229 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge West Bank

Filename: 20230707_112812.jpg Photo 230 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Heritage Walkway Bridge East Bank

Crossing Data Sheet:

WILLS

Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

Date:
Weather:
Inspectors: JTF/MK

Location

Culvert ID: Middle Dam
Township:
Highway ID:
Chainage or LHRS:
Type:
Location: LT/RT:

Physical Characteristics

Structure: ~~Bridge~~ Dam, Conc
Desc: 0
Size (mm): (dia. or span x rise)
Cover (m): (Approx.)
Length (m): (Approx.)
Fill Type: Extensions:

Flow Information

Flow Type:
Type of Water Feature:
Flow Direction:
(Approx.) Flow Velocity: m/s
High Water Mark: (% of culvert height)

Samples:
[ ] Water
[ ] Soil

Geomatics

GPS Coord System: Lat / Long: Dec. - Deg.
RT: Lat LT: Lat
RT: Long LT: Long

Environmental Considerations

[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements

Water Rt:
Soil Rt:
Perch Rt:
Water Lt:
Soil Lt:
Perch Lt:

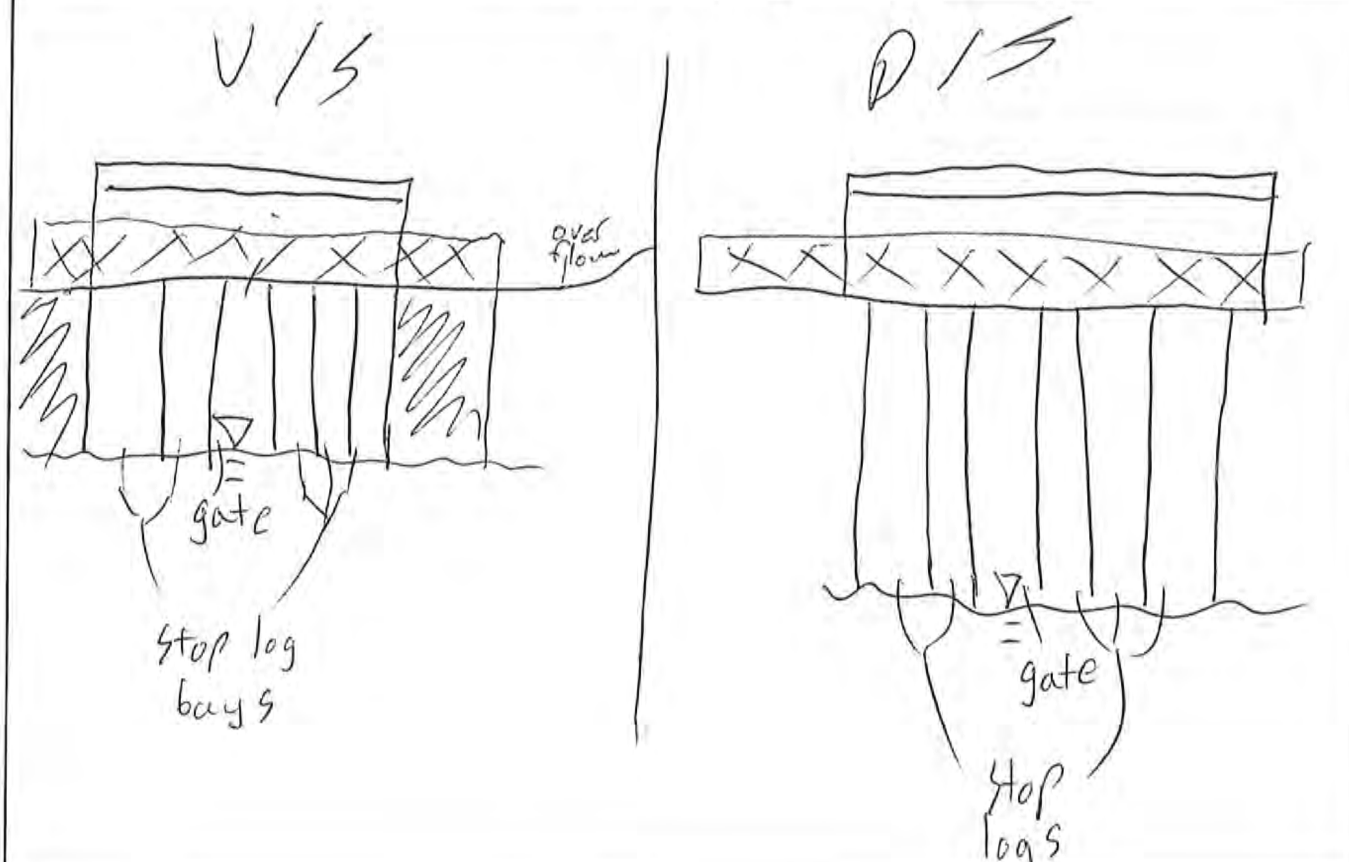
Water (mm)
Soil (mm)
Perch (mm)

Downstream Channel Section ()

Open Outlet :
Bottom Width (b):
Depth (d):
(Approx. Rt-Lt) Slopes (s):
(Approx.) T/W Depth:

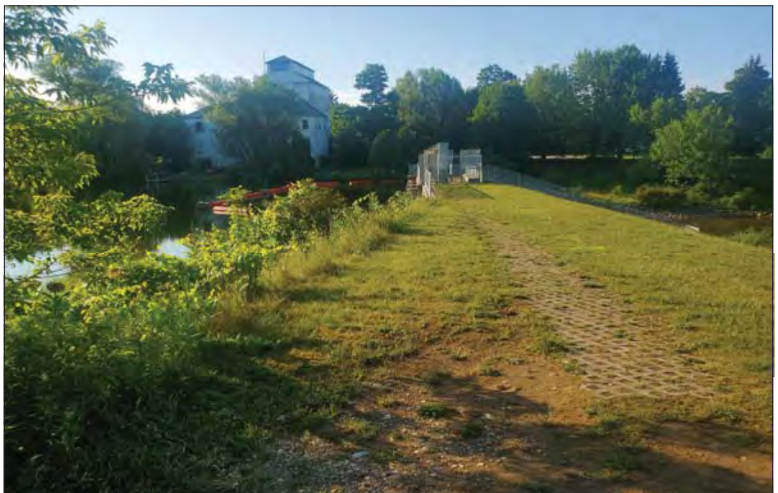
d (m)
s (H:V)
b (m)

Sketch and Notes



Filename: 20230707_080256.jpg Photo 235 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Upstream Face

Filename: 20230707_081324.jpg Photo 236 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Upstream Face



Filename: 20230707_080212.jpg Photo 237 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Southeast

Filename: 20230707_080215.jpg Photo 238 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Southwest

Filename: 20230707_080220.jpg Photo 239 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Northwest

Filename: 20230707_080234.jpg Photo 240 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Northeast

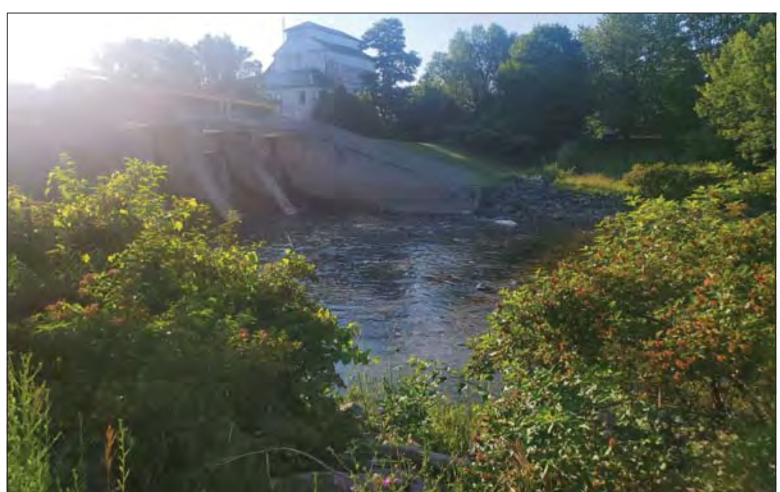
Filename: 20230707_075358.jpg Photo 241 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream of Dam Looking North

Filename: 20230707_075354.jpg Photo 242 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream of Dam Looking Northwest

Filename: 20230707_075341.jpg Photo 243 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream Face

Filename: 20230707_075413.jpg Photo 244 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream Face

Filename: 20230707_075420.jpg Photo 245 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream Face



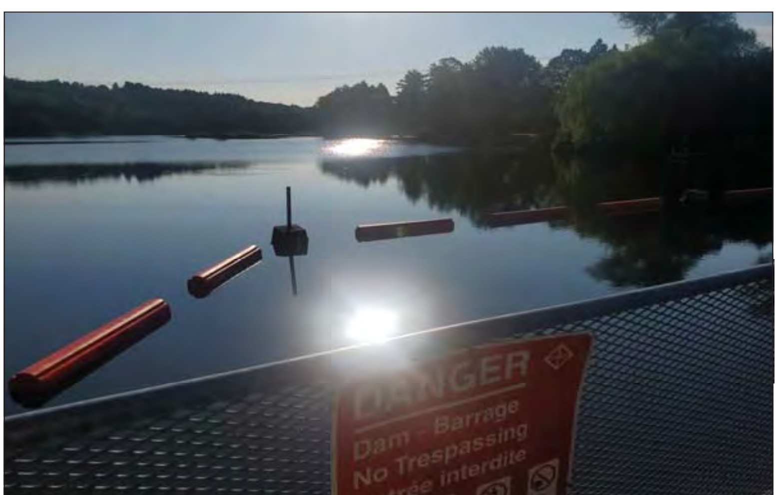
Filename: 20230707_075349.jpg Photo 246 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking at Downstream South Bank

Filename: 20230707_075439.jpg Photo 247 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking at Downstream South Bank

Filename: 20230707_075503.jpg Photo 248 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Downstream

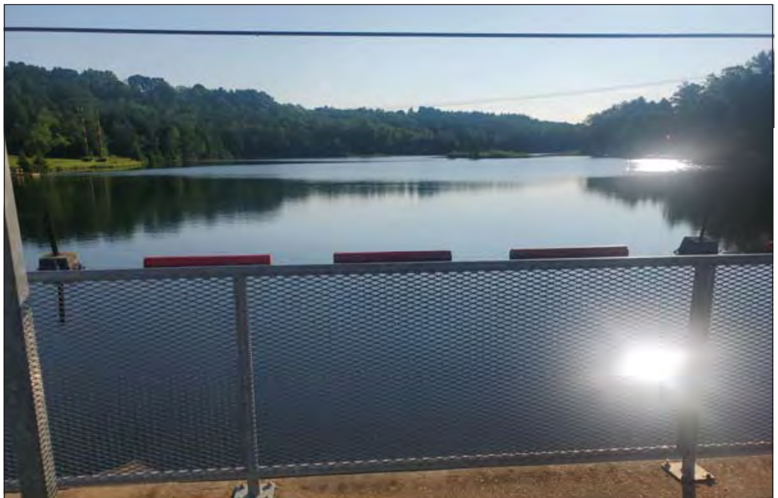
Filename: 20230707_075616.jpg Photo 249 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Northwest

Filename: 20230707_075659.jpg Photo 250 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Northwest Access Gate



Filename: 20230707_075631.jpg Photo 251 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Upstream

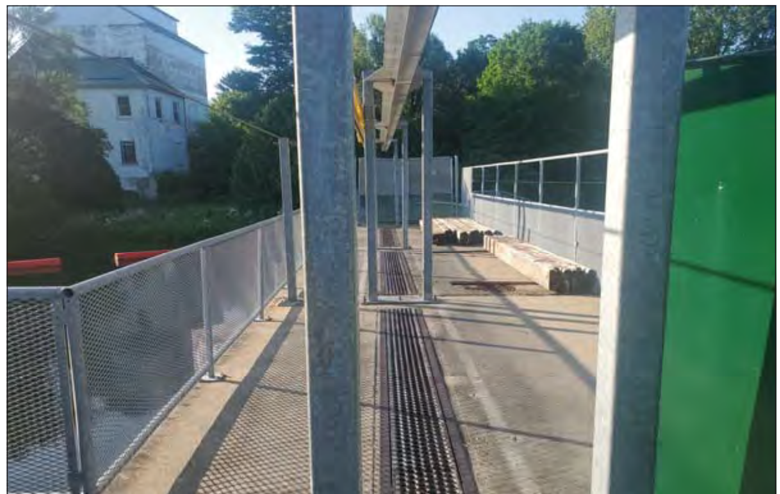
Filename: 20230707_075654.jpg Photo 252 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Downstream



Filename: 20230707_075703.jpg Photo 253 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Upstream

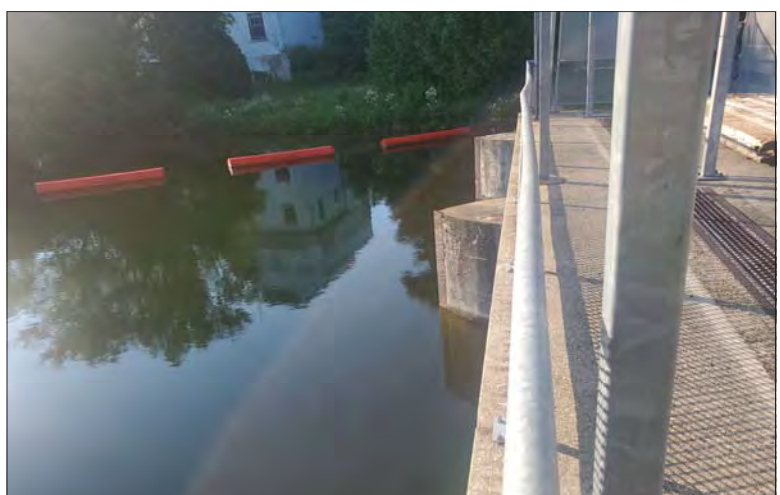
Filename: 20230707_075707.jpg Photo 254 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Deck Looking Southeast

Filename: 20230707_075734.jpg Photo 255 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Sluice Gate



Filename: 20230707_075753.jpg Photo 256 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Deck Looking Southeast

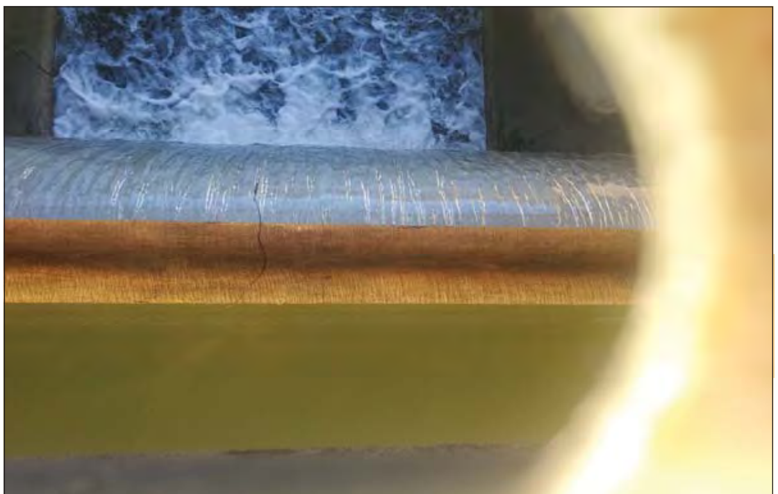
Filename: 20230707_075809.jpg Photo 257 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking at Downstream South Bank



Filename: 20230707_075822.jpg Photo 258 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Upstream Piers and Railing

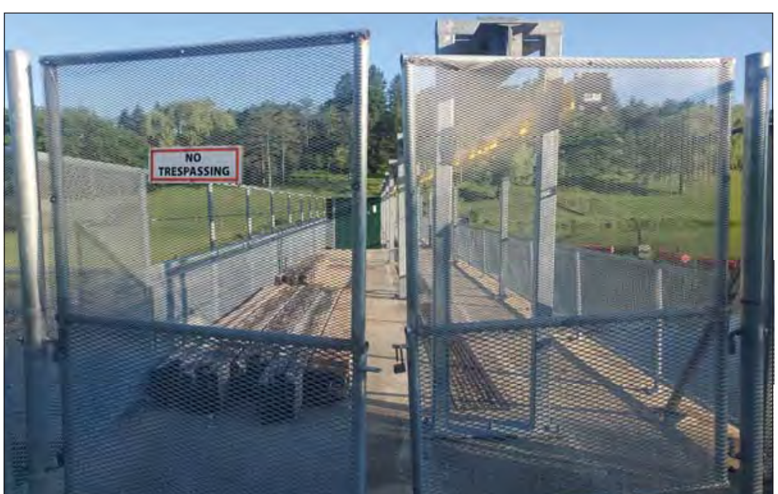
Filename: 20230707_080523.jpg Photo 259 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Stoplogs

Filename: 20230707_080044.jpg Photo 260 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Stoplog Channel



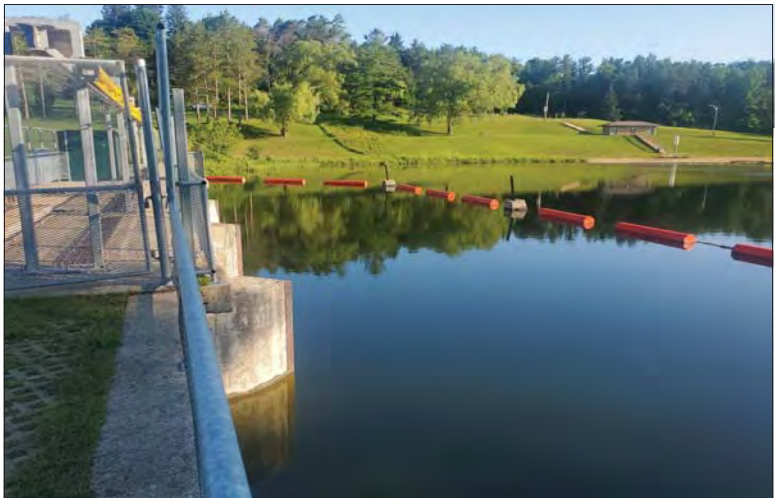
Filename: 20230707_080056.jpg Photo 261 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Stoplog

Filename: 20230707_080014.jpg Photo 262 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Tailwater



Filename: 20230707_075845.jpg Photo 263 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Southeast Access Gate

Filename: 20230707_075850.jpg Photo 264 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Danger Sign

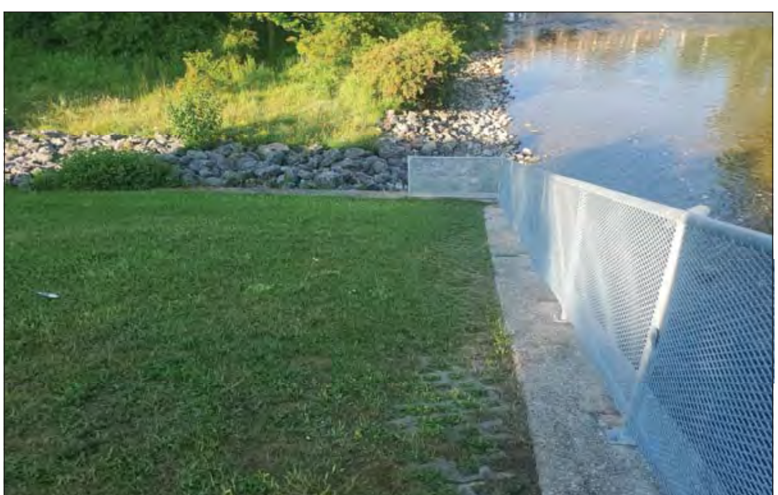


Filename: 20230707_075857.jpg Photo 265 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Headpond

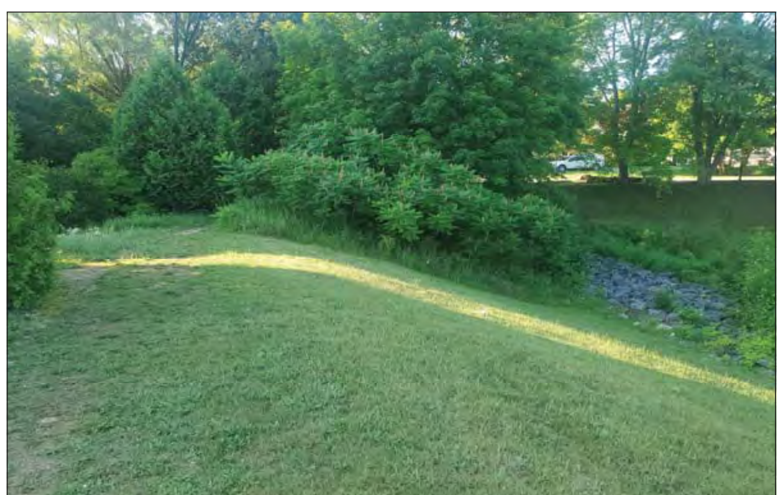
Filename: 20230707_075900.jpg Photo 266 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Reservoir

Filename: 20230707_075908.jpg Photo 267 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Downstream from South Bank

Filename: 20230707_080018.jpg Photo 268 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Downstream



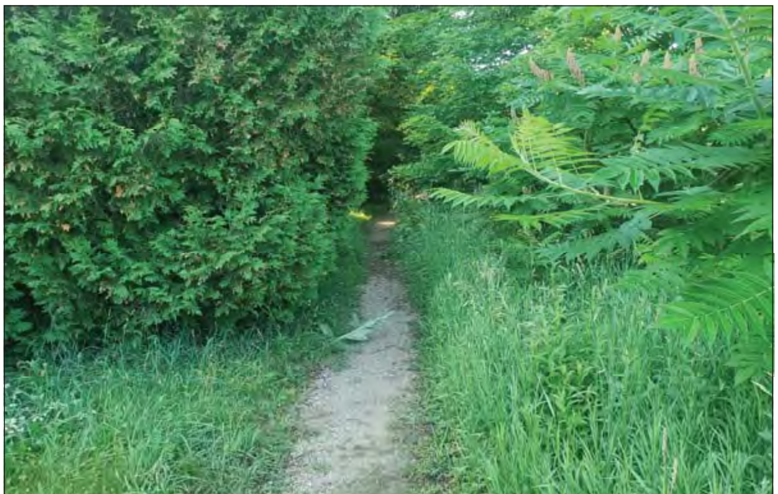
Filename: 20230707_080022.jpg Photo 269 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream South Bank



Filename: 20230707_075912.jpg Photo 270 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Southeast

WILLS Saugeen Conservation
Filename: 20230707_075933.jpg Photo 271 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Looking Northwest

WILLS Saugeen Conservation
Filename: 20230707_075946.jpg Photo 272 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam South Bank Looking Upstream



WILLS Saugeen Conservation
Filename: 20230707_075937.jpg Photo 273 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam South Bank Trail to Parking Area

WILLS Saugeen Conservation
Filename: 20230707_081410.jpg Photo 274 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam South Bank Parking Area

WILLS Saugeen Conservation
Filename: 20230707_112758.jpg Photo 275 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Middle Durham Dam Downstream Face

Crossing Data Sheet:

WILLS

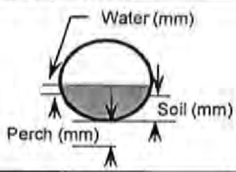
Agreement No.: SVCA
Assignment No.: 5591
Project Limits: Durham Ck

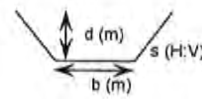
Date:
Weather:
Inspectors: JTF/MK

Location	Physical Characteristics
Culvert ID: Day 3 Upper Dam	Structure: ~~Bridge~~ Dam
Township:	Desc: ~~0~~ Concrete + steel deck
Highway ID:	Size (mm): (dia. or span x rise)
Chainage or LHRS:	Cover (m): (Approx.)
Type:	Length (m): (Approx.)
Location: LT/RT:	Fill Type: Extensions:

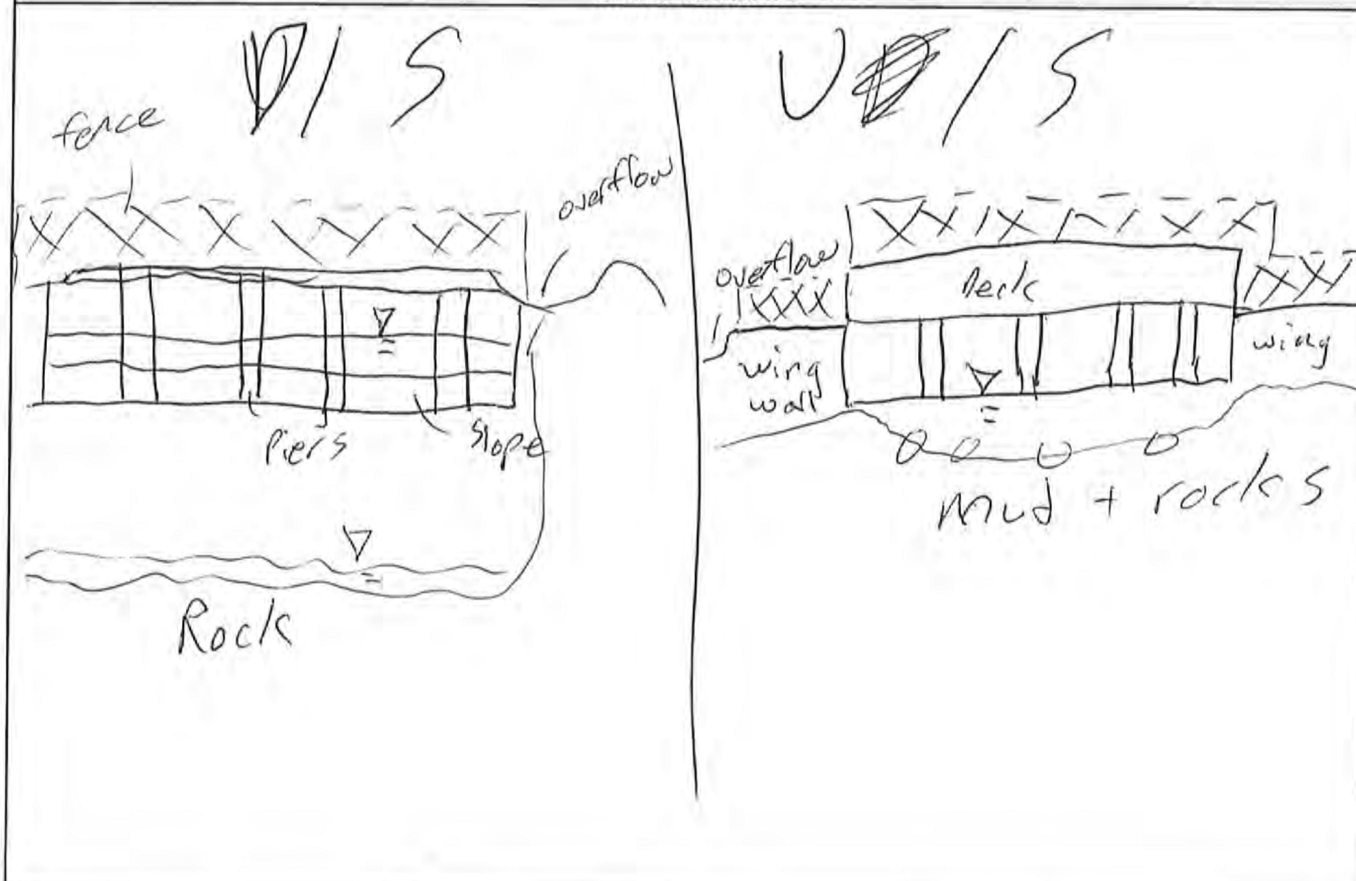
Flow Information	Geomatics
Flow Type:	GPS Coord System: Lat / Long: Dec. - Deg.
Type of Water Feature:	RT: Lat LT: Lat
Flow Direction: Samples:	RT: Long LT: Long
(Approx.) Flow Velocity: m/s [ ] Water	**Environmental Considerations**
High Water Mark: [ ] Soil	[ ] Fish Observed [ ] Navigable [ ] Nesting Structure
(% of culvert height)	[ ] Beaver Evidence [ ] Animal Grate [ ] Sensitive Env or Pollutant
	[ ] Groundwater Above Invert [ ] Local Wells~200m

Water / Sediment Measurements	Downstream Channel Section ()
Water Rt:	Open Outlet :
Soil Rt:	Bottom Width (b):
Perch Rt:	Depth (d):
Water Lt:	(Approx. Rt-Lt) Slopes (s):
Soil Lt:	(Approx.) T/W Depth:
Perch Lt:	





Sketch and Notes



Filename: 20230706_112101.jpg Photo 277 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream Face

Filename: 20230706_111333.jpg Photo 278 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam From Downstream

Filename: 20230706_111340.jpg Photo 279 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam From Downstream

Filename: 20230706_111409.jpg Photo 280 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam

Filename: 20230706_111414.jpg Photo 281 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Downstream Face

Filename: 20230706_111417.jpg Photo 282 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Downstream Area

Filename: 20230706_111524.jpg Photo 283 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking Downstream

Filename: 20230706_111527.jpg Photo 284 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking Downstream

Filename: 20230706_111536.jpg Photo 285 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking Upstream

Filename: 20230706_111545.jpg Photo 286 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking Upstream

Filename: 20230706_111604.jpg Photo 287 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam

Filename: 20230706_111625.jpg Photo 288 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Deck

WILLS | Saugeen Conservation

Filename: 20230706_111632.jpg Photo 289 - October 26, 2023

Durham Creek Flood Plain Mapping

Saugeen River: Upper Durham Dam Deck Signs

WILLS | Saugeen Conservation

Filename: 20230706_111638.jpg Photo 290 - October 26, 2023

Durham Creek Flood Plain Mapping

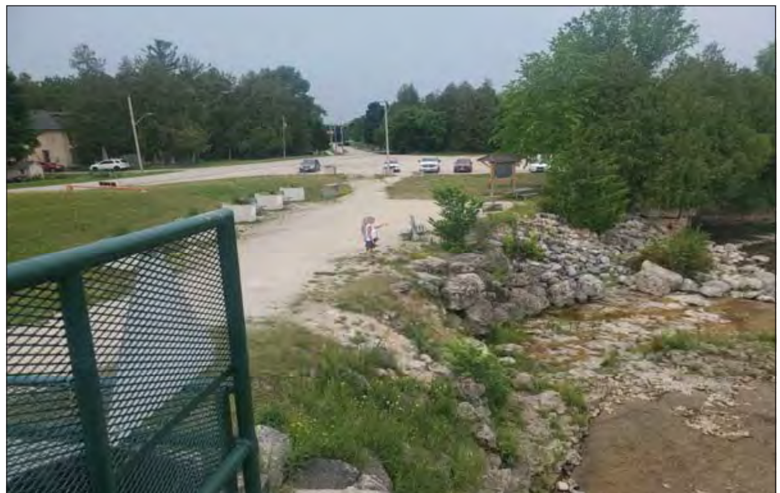
Saugeen River: Upper Durham Dam Looking Downstream

WILLS | Saugeen Conservation

Filename: 20230706_111641.jpg Photo 291 - October 26, 2023

Durham Creek Flood Plain Mapping

Saugeen River: Upper Durham Dam Deck

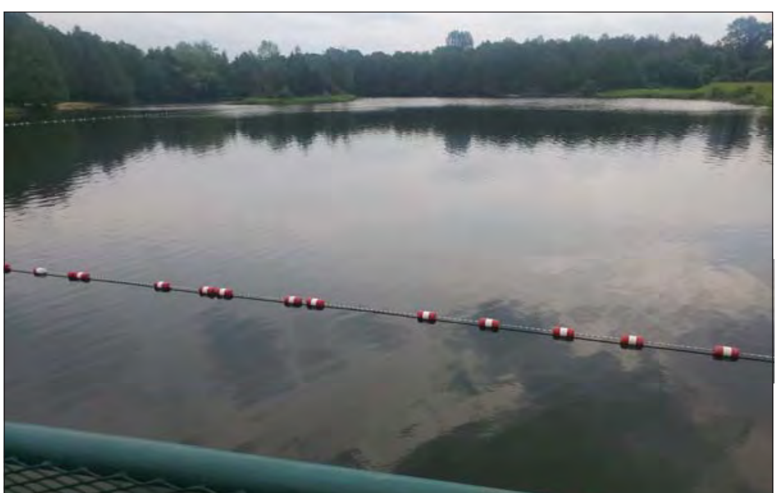


WILLS | Saugeen Conservation

Filename: 20230706_111650.jpg Photo 292 - October 26, 2023

Durham Creek Flood Plain Mapping

Saugeen River: Upper Durham Dam Downstream South Bank

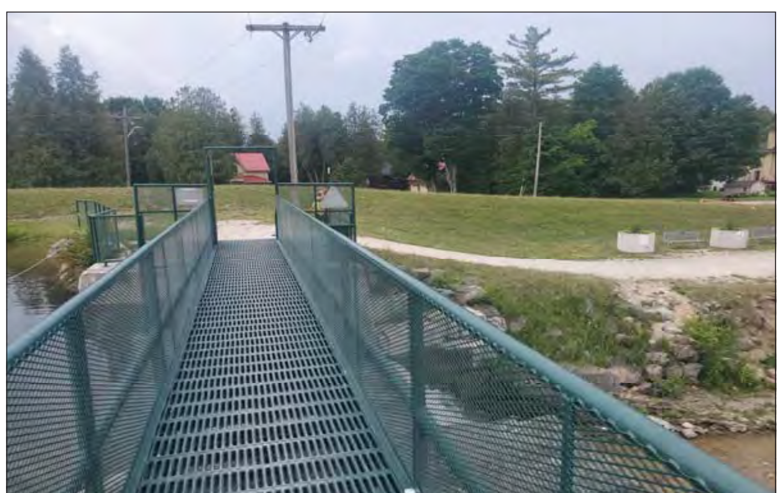


WILLS | Saugeen Conservation

Filename: 20230706_111656.jpg Photo 293 - October 26, 2023

Durham Creek Flood Plain Mapping

Saugeen River: Upper Durham Dam Looking Upstream



WILLS | Saugeen Conservation

Filename: 20230706_111715.jpg Photo 294 - October 26, 2023

Durham Creek Flood Plain Mapping

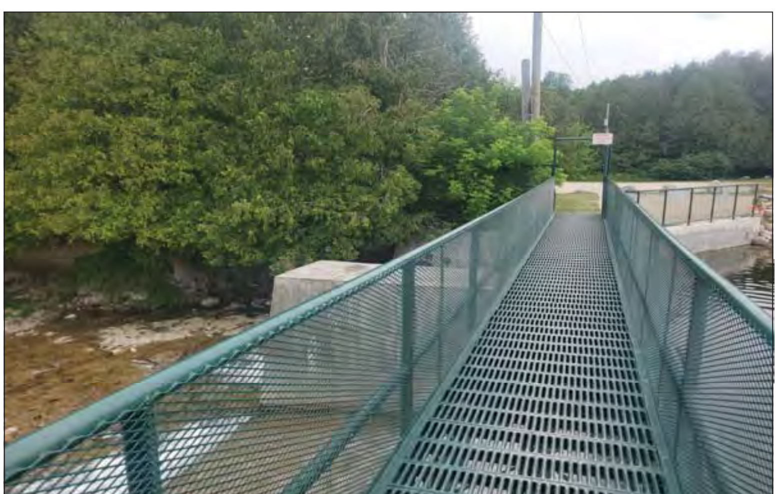
Saugeen River: Upper Durham Dam Deck and Earth Berm

Filename: 20230706_111719.jpg Photo 295 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream South Bank and Earth Berm

Filename: 20230706_111722.jpg Photo 296 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking Upstream

Filename: 20230706_111725.jpg Photo 297 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Deck

Filename: 20230706_111747.jpg Photo 298 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream Face



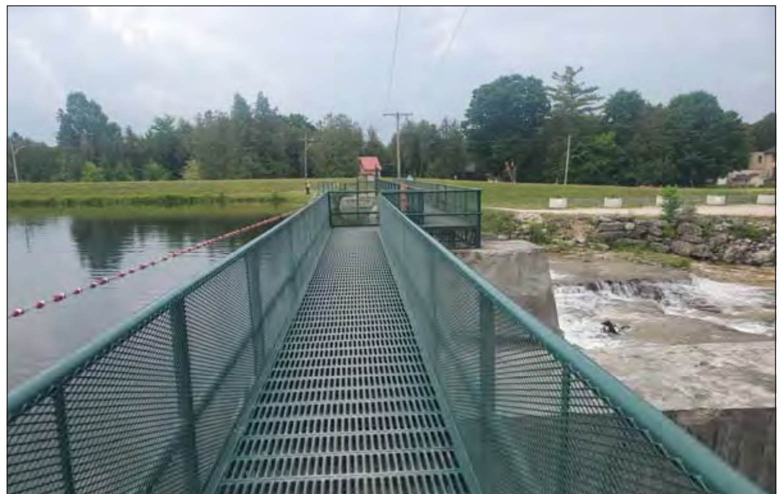
Filename: 20230706_111755.jpg Photo 299 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Deck Looking North

Filename: 20230706_111805.jpg Photo 300 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream Face of Middle Spillway

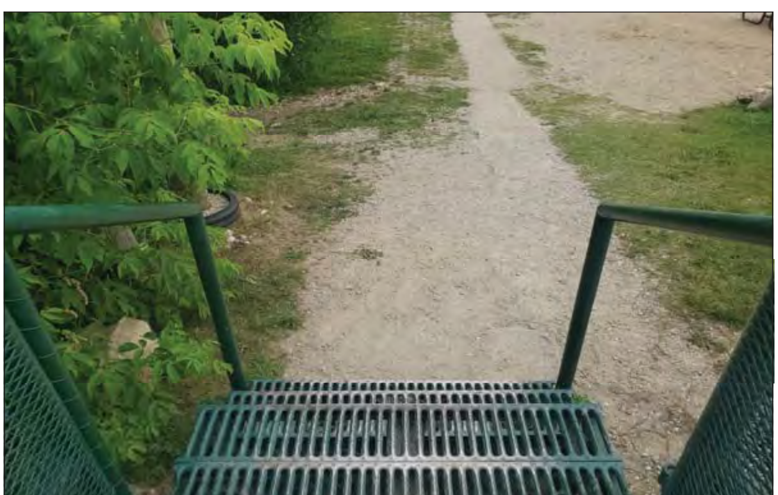
Filename: 20230706_111813.jpg Photo 301 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Downstream Face of North Spillways

Filename: 20230706_111821.jpg Photo 302 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Immediately Downstream

Filename: 20230706_111825.jpg Photo 303 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Immediately Downstream



Filename: 20230706_111850.jpg Photo 304 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Deck Looking South



Filename: 20230706_111902.jpg Photo 305 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Deck Stairs North Side

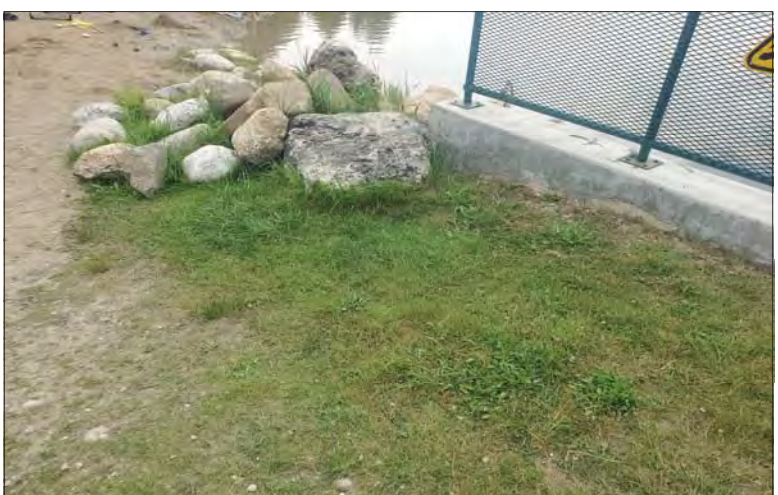
Filename: 20230706_111905.jpg Photo 306 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Looking North From Deck

Filename: 20230706_111910.jpg Photo 307 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam Looking Downstream

Filename: 20230706_111922.jpg Photo 308 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam Warning Signs

Filename: 20230706_111925.jpg Photo 309 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam North End of Deck

Filename: 20230706_111933.jpg Photo 310 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam Warning Signs



Filename: 20230706_111945.jpg Photo 311 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam Upstream Wingwall North Bank

Filename: 20230706_112032.jpg Photo 312 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen Conservation
Saugeen River: Upper Durham Dam View From the North

Filename: 20230706_112105.jpg Photo 313 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Reservoir Swimming Area

Filename: 20230706_112108.jpg Photo 314 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Reservoir Swimming Area

Filename: 20230706_112635.jpg Photo 315 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream North Bank

Filename: 20230706_112844.jpg Photo 316 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam North Bays

Filename: 20230706_112909.jpg Photo 317 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Middle Bays

Filename: 20230706_112917.jpg Photo 318 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam South Bay

Filename: 20230706_112923.jpg Photo 319 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Downstream South Bank

Filename: 20230706_112930.jpg Photo 320 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Downstream South Bank

Filename: 20230706_113117.jpg Photo 321 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream South Bank and Earth Berm

Filename: 20230706_113127.jpg Photo 322 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream Side

Filename: 20230706_113202.jpg Photo 323 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream South Bank and Earth Berm

Filename: 20230706_113206.jpg Photo 324 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam South of Earth Berm

Filename: 20230706_113209.jpg Photo 325 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam South of Earth Berm

Filename: 20230706_113211.jpg Photo 326 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm

Filename: 20230706_113215.jpg Photo 327 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Reservoir and North Bank

Filename: 20230706_113218.jpg Photo 328 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Upstream

Filename: 20230706_113303.jpg Photo 329 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm

Filename: 20230706_113306.jpg Photo 330 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam South of Earth Berm

Filename: 20230706_113309.jpg Photo 331 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam South of Earth Berm

Filename: 20230706_113312.jpg Photo 332 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm

Filename: 20230706_113315.jpg Photo 333 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam View from Earth Berm

Filename: 20230706_113318.jpg Photo 334 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam View from Earth Berm

Filename: 20230706_113355.jpg Photo 335 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earthen Berm Cover Plate

Filename: 20230706_113401.jpg Photo 336 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm Overflow Pipe Inlet

Filename: 20230706_113409.jpg Photo 337 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm Overflow Pipe Outlet

Filename: 20230706_113413.jpg Photo 338 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm Looking West

Filename: 20230706_113503.jpg Photo 339 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm Looking North at Overflow Pipe

Filename: 20230706_113836.jpg Photo 340 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir Looking North

Filename: 20230706_113841.jpg Photo 341 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir Looking South

Filename: 20230706_113930.jpg Photo 342 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir Looking North

Filename: 20230706_113926.jpg Photo 343 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_113948.jpg Photo 344 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_113956.jpg Photo 345 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_114001.jpg Photo 346 - October 26, 2023
Durham Creek Flood Plain Mapping
Welcome to Durham Sign

Filename: 20230706_114006.jpg Photo 347 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_114202.jpg Photo 348 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_114205.jpg Photo 349 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Filename: 20230706_114208.jpg Photo 350 - October 26, 2023
Durham Creek Flood Plain Mapping
Saugeen River: Upper Durham Dam Earth Berm South of Reservoir at End of Berm at Grey County Road 4

Appendix B

Hydrology

Appendix B1

Rainfall

Active coordinate

44° 10' 15" N, 80° 33' 45" W (44.170833,-80.562500)

Retrieved: Fri, 08 Sep 2023 18:05:51 GMT

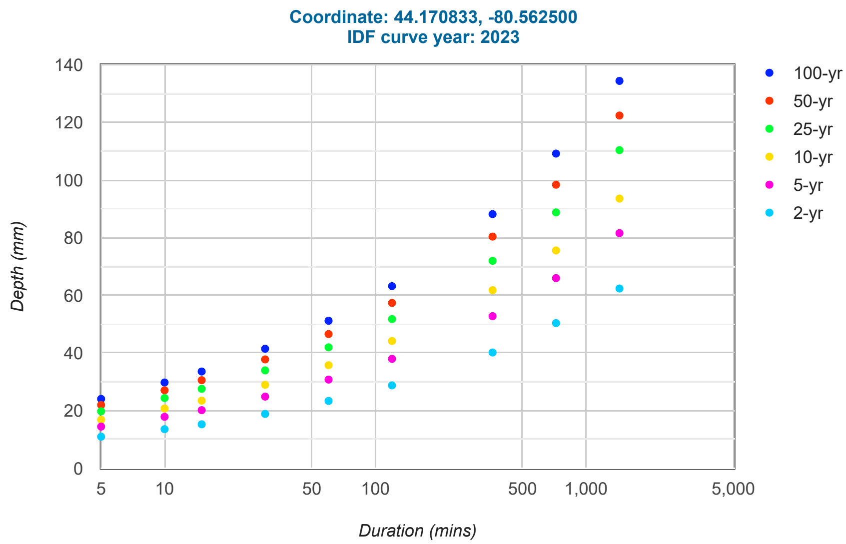
Location summary

These are the locations in the selection.

IDF Curve: 44° 10' 15" N, 80° 33' 45" W (44.170833,-80.562500)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 44° 10' 15" N, 80° 33' 45" W (44.170833,-80.562500)

Retrieved: Fri, 08 Sep 2023 18:05:51 GMT

Data year: 2010
IDF curve year: 2023

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	131.9	81.4	61.3	37.8	23.4	14.4	6.7	4.2	2.6
5-yr	173.9	107.2	80.8	49.9	30.8	19.0	8.8	5.5	3.4
10-yr	202.3	124.7	94.0	58.0	35.8	22.1	10.3	6.3	3.9
25-yr	237.5	146.4	110.3	68.0	42.0	25.9	12.0	7.4	4.6
50-yr	263.7	162.5	122.5	75.5	46.6	28.7	13.4	8.2	5.1
100-yr	289.8	178.6	134.6	83.0	51.2	31.6	14.7	9.1	5.6

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	11.0	13.6	15.3	18.9	23.4	28.8	40.2	50.4	62.4
5-yr	14.5	17.9	20.2	24.9	30.8	38.0	52.8	66.0	81.6
10-yr	16.9	20.8	23.5	29.0	35.8	44.2	61.8	75.6	93.6
25-yr	19.8	24.4	27.6	34.0	42.0	51.8	72.0	88.8	110.4
50-yr	22.0	27.1	30.6	37.8	46.6	57.4	80.4	98.4	122.4
100-yr	24.1	29.8	33.6	41.5	51.2	63.2	88.2	109.2	134.4

Terms of Use

6 hr SCS Type 2 Distribution for Durham Creek FPM

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Data Year (MTO)	2010	**Lat**	44.170833	**Areal Reduction Factor:**	1.0
Climate Year (ECCC)	2051	**Long**	-80.5625	**rcp45_tg_mean_delta7100_**	2.94

Rainfall

	Incremental 6 HR SCS (mm)								
Time (hrs)	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**25-Year CC**	**50-Year CC**	**100-Year CC**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.25	0.45	0.59	0.70	0.81	0.90	0.99	0.99	1.10	1.21
0.50	0.46	0.60	0.70	0.82	0.91	1.00	0.99	1.11	1.22
0.75	0.47	0.61	0.72	0.84	0.93	1.02	1.02	1.14	1.25
1.00	0.52	0.68	0.79	0.93	1.03	1.13	1.13	1.26	1.38
1.25	0.58	0.76	0.89	1.04	1.16	1.28	1.27	1.42	1.56
1.50	0.66	0.87	1.02	1.18	1.32	1.45	1.44	1.61	1.77
1.75	0.76	1.00	1.17	1.36	1.52	1.67	1.66	1.86	2.04
2.00	0.89	1.17	1.37	1.60	1.79	1.96	1.95	2.18	2.39
2.25	1.08	1.42	1.66	1.94	2.16	2.37	2.36	2.64	2.89
2.50	1.39	1.83	2.14	2.49	2.79	3.06	3.04	3.40	3.73
2.75	3.36	4.42	5.17	6.02	6.73	7.38	7.35	8.21	9.00
3.00	13.50	17.73	20.75	24.18	27.00	29.61	29.50	32.94	36.13
3.25	6.97	9.15	10.71	12.48	13.93	15.28	15.22	17.00	18.65
3.50	1.98	2.60	3.05	3.55	3.97	4.35	4.33	4.84	5.31
3.75	1.27	1.66	1.95	2.27	2.53	2.78	2.77	3.09	3.39
4.00	1.04	1.36	1.60	1.86	2.08	2.28	2.27	2.53	2.78
4.25	0.86	1.13	1.33	1.54	1.72	1.89	1.88	2.10	2.31
4.50	0.76	1.00	1.17	1.36	1.52	1.67	1.66	1.85	2.03
4.75	0.66	0.87	1.02	1.19	1.32	1.45	1.45	1.62	1.77
5.00	0.59	0.78	0.91	1.06	1.18	1.30	1.29	1.44	1.58
5.25	0.53	0.69	0.81	0.94	1.05	1.16	1.15	1.29	1.41
5.50	0.50	0.66	0.77	0.89	1.00	1.10	1.09	1.22	1.34
5.75	0.47	0.62	0.73	0.85	0.95	1.04	1.03	1.16	1.27
6.00	0.45	0.59	0.69	0.81	0.90	0.99	0.98	1.10	1.20
Total	**40.20**	**52.80**	**61.80**	**72.00**	**80.40**	**88.20**	**87.85**	**98.09**	**107.61**

Hurricane Hazel for Durham Creek FPM

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: MC
Date: 14-Dec-23

Data Year	1954	lat	44.20833321	Areal Reduction Factor:	0.766
Climate Chang	2051	long	-80.79166908	rcp45_tg_mean_delta7100_p50:	2.94

Rainfall

Time (hrs)	Hazel (mm)	Hazel (mm) with ARF=1 and Climate Change ΔT=2.94	Hazel (mm) with Areal Reduction Factor =0.766	Hazel (mm) with ARF=0.766 and Climate Change ΔT=2.94
0.00	0.0	0.00	0.00	0.00
1.00	2.0	2.44	1.53	1.87
2.00	2.0	2.44	1.53	1.87
3.00	2.0	2.44	1.53	1.87
4.00	2.0	2.44	1.53	1.87
5.00	2.0	2.44	1.53	1.87
6.00	2.0	2.44	1.53	1.87
7.00	2.0	2.44	1.53	1.87
8.00	2.0	2.44	1.53	1.87
9.00	2.0	2.44	1.53	1.87
10.00	2.0	2.44	1.53	1.87
11.00	2.0	2.44	1.53	1.87
12.00	2.0	2.44	1.53	1.87
13.00	2.0	2.44	1.53	1.87
14.00	2.0	2.44	1.53	1.87
15.00	2.0	2.44	1.53	1.87
16.00	2.0	2.44	1.53	1.87
17.00	2.0	2.44	1.53	1.87
18.00	2.0	2.44	1.53	1.87
19.00	2.0	2.44	1.53	1.87
20.00	2.0	2.44	1.53	1.87
21.00	2.0	2.44	1.53	1.87
22.00	2.0	2.44	1.53	1.87
23.00	2.0	2.44	1.53	1.87
24.00	2.0	2.44	1.53	1.87
25.00	2.0	2.44	1.53	1.87
26.00	2.0	2.44	1.53	1.87
27.00	2.0	2.44	1.53	1.87
28.00	2.0	2.44	1.53	1.87
29.00	2.0	2.44	1.53	1.87
30.00	2.0	2.44	1.53	1.87
31.00	2.0	2.44	1.53	1.87
32.00	2.0	2.44	1.53	1.87
33.00	2.0	2.44	1.53	1.87
34.00	2.0	2.44	1.53	1.87
35.00	2.0	2.44	1.53	1.87
36.00	3.0	3.66	2.30	2.80
37.00	6.0	7.32	4.60	5.61
38.00	4.0	4.88	3.06	3.74
39.00	6.0	7.32	4.60	5.61
40.00	13.0	15.86	9.96	12.15
41.00	17.0	20.74	13.02	15.89
42.00	13.0	15.86	9.96	12.15
43.00	23.0	28.06	17.62	21.50
44.00	13.0	15.86	9.96	12.15
45.00	13.0	15.86	9.96	12.15
46.00	53.0	64.66	40.60	49.53
47.00	38.0	46.36	29.11	35.51
48.00	13.0	15.86	9.96	12.15
Total	285.0	347.7	218.3	266.4

Areal Reduction Factors Hazel

Equivalent Circle Diamter (km^2)	Areal Reduction Factor
0 to 25	100.00
26 to 45	99.20
46 to 65	98.20
66 to 90	97.10
91 to 115	96.30
116 to 140	95.40
141 to 165	94.80
166 to 195	94.20
196 to 220	93.50
221 to 245	92.70
246 to 270	92.00
271 to 450	89.40
451 to 575	86.70
576 to 700	84.00
701 to 850	82.40
851 to 1000	80.80
1001 to 1200	79.30
1201 to 1500	76.60
1501 to 1700	74.40
1701 to 2000	73.30
2001 to 2200	71.70
2201 to 2500	70.20
2501 to 2700	69.00
2701 to 4500	64.40
4501 to 6000	61.40
6001 to 7000	58.90
7001 to 8000	57.40

Appendix B2

Time of Concentration and HEC-HMS Model Parameter Calculations

Time of Concentration Calculations

1

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_101

				X	Y	
SubBasin_101				18580.13	524.53	
				18470.46	524.47	
		Sheet Flow	**Slope AB**	**0.000547096**		
				18470.46	524.47	
				10917.1	522.16	
		Shallow Concentrated Flow	**Slope BC**	**0.000305823**		
				10917.08	522.16	
				2833	507.12	
		Channel flow	**Slope CD**	**0.001860447**		
				2833	507.12	
				0	493.18	
		Channel flow	**Slope DE**	**0.004920579**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	109.67	0	359.81	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.001	0	0.001	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**8.36**	**#DIV/0!**	**8.36**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	7553.4	0	24781.43	0.00	
9. Watercourse slope, s	s	0.000305823	0	0.000306	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		0.28	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			24.40	#DIV/0!	**24.40**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	6.16	83.16	66.31	895.08	
13. Wetted perimeter, pw	p_w	12.25	54.69	40.19	179.44	
14. Hydraulic radius, r= Compute r	r			1.65	4.99	
15 Channel slope, s	s			0.002	0.005	
16. Manning's roughness coefficient, n	n	0.035	0.035	0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			2.56	8.72	
18. Flow length, L	L	8084.08	2833	26522.57	9294.62	
19 $T_t = \frac{L}{3600V}$	T_channel			2.87	0.30	**3.17**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**35.92**
					Tc (mins)	**2155.38**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_102

				X	Y	
SubBasin_102				9973.49	539.13	
				9874.21	538.1	
		Sheet Flow	**Slope AB**	**0.010374698**		
				9874.21	538.1	
				5625.4	520.7	
		Shallow Concentrated Flow	**Slope BC**	**0.004095264**		
				5625.4	520.7	
				2180.5	497.74	
		Channel flow	**Slope CD**	**0.006664925**		
				2180.5	497.74	
				0	493.06	
		Channel flow	**Slope DE**	**0.002146297**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.170	0	0.170	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.28	0	325.72	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.40	0	2.457	0.00	
5. Land slope, s	Land Slope	0.0104	0	0.0104	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.69**	**#DIV/0!**	**0.69**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	4248.8	0	13939.67	0.00	
9. Watercourse slope, s	s	0.0041	0	0.004	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.03	0.00	
Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			3.75	#DIV/0!	**3.75**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.23	3.44	13.25	37.03	
13. Wetted perimeter, pw	p_w	10.27	7.06	33.70	23.17	
14. Hydraulic radius, r= Compute r	r			0.39	1.60	
15 Channel slope, s	s			0.0067	0.0021	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.87	2.70	
18. Flow length, L	L	3444.9	2180.5	11302.17	7153.87	
19 $T_t = \frac{L}{3600V}$	T_channel			1.68	0.74	**2.42**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**6.86**
					Tc (mins)	**411.54**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_103

				X	Y	
SubBasin_103				14717.92	530.7	
				14612.87	529.45	
		Sheet Flow	**Slope AB**	**0.011899096**		
				14612.87	529.45	
				8350.7	507.23	
		Shallow Concentrated Flow	**Slope BC**	**0.003548262**		
				8350.65	507.23	
				0	492.03	
		Channel flow	**Slope CD**	**0.001820218**		
		N/A	**Slope DE**	**#DIV/0!**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	105.05	0	344.65	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.0119	0	0.0119	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.68**	**#DIV/0!**	**0.68**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	6262.2	0	20545.34	0.00	
9. Watercourse slope, s	s	0.0035	0.0000	0.004	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		0.96	0.00	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			5.94	#DIV/0!	**5.94**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	11.94	0.00	128.53	0.00	
13. Wetted perimeter, pw	p_w	11.91	0.00	39.07	0.00	
14. Hydraulic radius, r= Compute r	r			3.29	#DIV/0!	
15 Channel slope, s	s			0.002	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			4.02	#DIV/0!	
18. Flow length, L	L	8350.65	0	27397.15	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.89	#DIV/0!	**1.89**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**8.51**
					Tc (mins)	**510.89**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_104

				X	Y	
SubBasin_104				3451.69	507.86	
				3350.42	499.52	
		Sheet Flow	**Slope AB**	**0.082354103**		
				3350.42	499.52	
				3250.6	496.6	
		Shallow Concentrated Flow	**Slope BC**	**0.029246795**		
				3250.58	496.6	
				1612.24	493.05	
		Shallow Concentrated Flow	**Slope CD**	**0.002166827**		
				1612.24	493.05	
				0	491.71	
		Channel flow	**Slope DE**	**0.000831142**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.27	0	332.25	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.082	0	0.08	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.06**	**#DIV/0!**	**1.06**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	99.8	1638.34	327.56	5375.13	
9. Watercourse slope, s	s	0.0292	0.0022	0.029	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		2.76	0.95	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.03	1.58	**1.61**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	2.60	0.00	28.03	0.00	
13. Wetted perimeter, pw	p_w	16.81	0.00	55.16	0.00	
14. Hydraulic radius, r= Compute r	r			0.51	#DIV/0!	
15 Channel slope, s	s			0.001	0.001	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.78	#DIV/0!	
18. Flow length, L	L	1612.24	0	5289.50	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.88	#DIV/0!	**1.88**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**4.55**
					Tc (mins)	**272.75**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_105

				X	Y	
SubBasin_105				11064.03	516.89	
				10959.18	513.12	
		Sheet Flow	**Slope AB**	**0.035956128**		
				10959.18	513.12	
				6165.9	494.64	
		Shallow Concentrated Flow	**Slope BC**	**0.003855398**		
				6165.9	494.64	
				2750	480.66	
		Channel flow	**Slope CD**	**0.004092626**		
				2750	480.66	
				0	478.15	
		Channel flow	**Slope DE**	**0.000912727**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	104.85	0	344.00	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.036	0	0.04	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}s^{0.4}}$	T_sheet			**0.44**	**#DIV/0!**	**0.44**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	4793.3	0	15725.98	0.00	
9. Watercourse slope, s	s	0.003855398	0	0.004	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.00	0.00	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			4.36	#DIV/0!	**4.36**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	4.48	5.43	48.19	58.40	
13. Wetted perimeter, pw	p_w	10.79	11.14	35.41	36.54	
14. Hydraulic radius, r= Compute r	r			1.36	1.60	
15 Channel slope, s	s			0.004	0.001	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			3.34	1.76	
18. Flow length, L	L	3415.9	2750	11207.02	9022.31	
19 $T_t = \frac{L}{3600V}$	T_channel			0.93	1.43	**2.36**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**7.15**
					Tc (mins)	**429.26**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_106

				X	Y	
SubBasin_106				11730.82	520.34	
				11646.32	518.93	
		Sheet Flow	**Slope AB**	**0.016686391**		
				11646.32	518.93	
				4978.0	495.55	
		Shallow Concentrated Flow	**Slope BC**	**0.003506146**		
				4978.03	495.55	
				0	478.18	
		Channel flow	**Slope CD**	**0.003489332**		
				0	478.18	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	84.5	0	277.23	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.017	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.50**	**#DIV/0!**	**0.50**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	6668.3	0	21877.59	0.00	
9. Watercourse slope, s	s	0.003506146	0	0.004	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		0.96	0.00	
Unpaved $V = 16.1345 S^{0.5}$						
Paved V= $20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			6.36	#DIV/0!	**6.36**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.04	0.00	11.18	0.00	
13. Wetted perimeter, pw	p_w	9.90	0.00	32.48	0.00	
14. Hydraulic radius, r= Compute r	r			0.34	#DIV/0!	
15 Channel slope, s	s			0.003	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.24	#DIV/0!	
18. Flow length, L	L	4978.03	0	16332.12	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			3.67	#DIV/0!	**3.67**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**10.54**
					Tc (mins)	**632.11**

Time of Concentration Calculations	7

Project No:	5591
Project Name:	Durham Creek FPM
Designed/Checked By:	JTF/MC
Date:	12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_107

				X	Y	
SubBasin_107				13754.54	504.23	
				13645.04	500.67	
		Sheet Flow	**Slope AB**	**0.032511416**		
				13645.04	500.67	
				11107.2	491.65	
		Shallow Concentrated Flow	**Slope BC**	**0.00355419**		
				11107.19	491.65	
				0	472.71	
		Channel flow	**Slope CD**	**0.001705202**		
				0	472.71	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	109.5	0	359.25	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.033	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.63**	**#DIV/0!**	**1.63**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2537.9	0	8326.28	0.00	
9. Watercourse slope, s	s	0.00355419	0	0.004	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		0.96	0.00	
Unpaved $V = 16.1345 S^{0.5}$						
Paved $V = 20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			2.40	#DIV/0!	**2.40**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	29.97	0.00	322.62	0.00	
13. Wetted perimeter, pw	p_w	45.83	0.00	150.38	0.00	
14. Hydraulic radius, r= Compute r	r			2.15	#DIV/0!	
15 Channel slope, s	s			0.002	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.92	#DIV/0!	
18. Flow length, L	L	11107.19	0	36440.91	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			3.46	#DIV/0!	**3.46**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**7.49**
					Tc (mins)	**449.70**

Time of Concentration Calculations

8

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_108

				X	Y	
SubBasin_108				5667.38	494.04	
				5567.21	491.5	
		Sheet Flow	**Slope AB**	**0.025356893**		
				5567.21	491.5	
				3153.1	478.23	
		Shallow Concentrated Flow	**Slope BC**	**0.00549685**		
				3153.1	478.23	
				0	472.69	
		Channel flow	**Slope CD**	**0.001757001**		
				0	472.69	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.17	0	328.64	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.025	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.49**	**#DIV/0!**	**0.49**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2414.1	0	7920.31	0.00	
9. Watercourse slope, s	s	0.00549685	0	0.005	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.20	0.00	
Unpaved $V = 16.1345 S^{0.5}$						
Paved V= $20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			1.84	#DIV/0!	**1.84**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	38.00	0.00	409.07	0.00	
13. Wetted perimeter, pw	p_w	26.93	0.00	88.35	0.00	
14. Hydraulic radius, r= Compute r	r			4.63	#DIV/0!	
15 Channel slope, s	s			0.002	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			4.96	#DIV/0!	
18. Flow length, L	L	3153.1	0	10344.82	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.58	#DIV/0!	**0.58**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.90**
					Tc (mins)	**174.25**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_109

				X	Y	
SubBasin_109				7868.75	486.97	
				7768.76	484.45	
		Sheet Flow	**Slope AB**	**0.02520252**		
				7768.76	484.45	
				7594.4	479.57	
		Shallow Concent	**Slope BC**	**0.027988071**		
				7594.4	479.57	
				4431.66	474.87	
		Shallow Concent	**Slope CD**	**0.001486053**		
				4431.66	474.87	
				0	469.85	
		Channel flow	**Slope DE**	**0.001132758**		
		Sheet Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.99	0	328.05	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.025	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.68**	**#DIV/0!**	**1.68**
		Shallow Concentrated Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	174.4	3162.74	572.05	10376.44	
9. Watercourse slope, s	s	0.027988071	0.001486053	0.028	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		2.70	0.78	
Unpaved $V = 16.1345 S^{0.5}$						
Paved V= $20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.06	3.68	**3.74**
		Channel flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	3.49	0.00	37.57	0.00	
13. Wetted perimeter, pw	p_w	26.86	0.00	88.11	0.00	
14. Hydraulic radius, r= Compute r	r			0.43	#DIV/0!	
15 Channel slope, s	s			0.001	0.001	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.81	#DIV/0!	
18. Flow length, L	L	4431.66	0	14539.57	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			4.98	#DIV/0!	**4.98**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**10.39**
					Tc (mins)	**623.38**

Project No:	5591
Project Name:	Durham Creek FPM
Designed/Checked By:	JTF/MC
Date:	12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_110

				X	Y	
SubBasin_110				11593.2	505.09	
				11493.96	500.22	
		Sheet Flow	**Slope AB**	**0.049072954**		
				11493.96	500.22	
				7933.2	479.95	
		Shallow Concentrated Flow	**Slope BC**	**0.005692541**		
				7933.16	479.95	
				6272.96	472.34	
		Channel flow	**Slope CD**	**0.004583785**		
				6272.96	472.34	
				0	469.6	
		Channel flow	**Slope DE**	**0.000436795**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.24	0	325.59	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.049	0	0.05	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.37**	**#DIV/0!**	**0.37**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	3560.8	0	11682.41	0.00	
9. Watercourse slope, s	s	0.005692541	0	0.006	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.22	0.00	
Unpaved $V = 16.1345 S^{0.5}$						
Paved $V = 20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			2.67	#DIV/0!	**2.67**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.03	25.95	11.04	279.32	
13. Wetted perimeter, pw	p_w	9.33	34.73	30.61	113.94	
14. Hydraulic radius, r= Compute r	r			0.36	2.45	
15 Channel slope, s	s			0.005	0.000	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.46	1.62	
18. Flow length, L	L	1660.2	6272.96	5446.85	20580.58	
19 $T_t = \frac{L}{3600V}$	T_channel			1.04	3.53	**4.57**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**7.61**
					Tc (mins)	**456.37**

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_111

				X	Y	
SubBasin_111				14002.32	501.06	
				13898.72	499.08	
		Sheet Flow	**Slope AB**	**0.019111969**		
				13898.72	499.08	
				12652.5	491.96	
		Shallow Concentrated Flow	**Slope BC**	**0.005713277**		
				12652.5	491.96	
				3886.36	476.02	
		Shallow Concentrated Flow	**Slope CD**	**0.00181836**		
				3886.36	476.02	
				0	468.53	
		Channel flow	**Slope DE**	**0.001927253**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	103.6	0	339.90	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.019	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.56**	**#DIV/0!**	**0.56**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1246.2	8766.14	4088.65	28760.30	
9. Watercourse slope, s	s	0.005713277	0.00181836	0.006	0.002	
10. Average velocity, V (figure 3-1)	V	N/A		1.22	0.688	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.93	11.61	**12.54**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.03	0.00	11.04	0.00	
13. Wetted perimeter, pw	p_w	9.33	0.00	30.61	0.00	
14. Hydraulic radius, r= Compute r	r			0.36	#DIV/0!	
15 Channel slope, s	s			0.002	0.002	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.95	#DIV/0!	
18. Flow length, L	L	3886.36		12750.52	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			3.74	#DIV/0!	**3.74**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**16.84**
					Tc (mins)	**1010.56**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_112

				X	Y	
SubBasin_112				8104.34	485.88	
				8003.48	483.47	
		Sheet Flow	**Slope AB**	**0.023894507**		
				8003.48	483.47	
				7630.3	474.39	
		Shallow Concentrated Flow	**Slope BC**	**0.02433077**		
				7630.29	474.39	
				4445.14	470.07	
		Shallow Concentrated Flow	**Slope CD**	**0.001356294**		
				4445.14	470.07	
				0	468.53	
		Channel flow	**Slope DE**	**0.000346446**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.86	0	330.91	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.024	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.50**	**#DIV/0!**	**0.50**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	373.2	3185.15	1224.38	10449.97	
9. Watercourse slope, s	s	0.02433077	0.001356294	0.024	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		2.52	0.59	
Unpaved $V = 16.1345 S^{0.5}$						
Paved $V = 20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.14	4.89	**5.02**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.03	0.00	11.04	0.00	
13. Wetted perimeter, pw	p_w	9.33	0.00	30.61	0.00	
14. Hydraulic radius, r= Compute r	r			0.36	#DIV/0!	
15 Channel slope, s	s			0.000	0.000	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.40	#DIV/0!	
18. Flow length, L	L	4445.14		14583.79	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			10.09	#DIV/0!	**10.09**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**15.61**
					Tc (mins)	**936.80**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_113

				X	Y	
SubBasin_113				6550.01	494.52	
				6450.85	490.65	
		Sheet Flow	**Slope AB**	**0.039027834**		
				6450.85	490.65	
				1452.3	473.2	
		Shallow Concentrated Flow	**Slope BC**	**0.003491012**		
				1452.3	473.2	
				0	467.42	
		Channel flow	**Slope CD**	**0.003979894**		
				0	467.42	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.16	0	325.33	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.039	0	0.04	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.40**	**#DIV/0!**	**1.40**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	4998.6	0	16399.44	0.00	
9. Watercourse slope, s	s	0.003491012	0	0.003	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved V= $20.3282S^{0.5}$	V	N/A		0.95	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			4.78	#DIV/0!	**4.78**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	4.22	0.00	45.43	0.00	
13. Wetted perimeter, pw	p_w	12.67	0.00	41.57	0.00	
14. Hydraulic radius, r= Compute r	r			1.09	#DIV/0!	
15 Channel slope, s	s			0.004	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.85	#DIV/0!	
18. Flow length, L	L	1452.3		4764.76	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.46	#DIV/0!	**0.46**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**6.64**
					Tc (mins)	**398.50**

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_114

				X	Y	
SubBasin_114				7766.77	492.84	
				7666.68	491.36	
		Sheet Flow	**Slope AB**	**0.014786692**		
				7666.68	491.36	
				5974.7	477.56	
		Shallow Concentrated Flow	**Slope BC**	**0.008155932**		
				5974.66	477.56	
				0	467.31	
		Channel flow	**Slope CD**	**0.001715579**		
				0	467.31	
		N/A	**Slope DE**	**#DIV/0!**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.09	0	328.38	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.015	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**2.08**	**#DIV/0!**	**2.08**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	1692.0	0	5551.25	0.00	
9. Watercourse slope, s	s	0.008155932	0	0.008	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		1.46	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			1.06	#DIV/0!	**1.06**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.09	0.00	11.74	0.00	
13. Wetted perimeter, pw	p_w	8.41	0.00	27.58	0.00	
14. Hydraulic radius, r= Compute r	r			0.43	#DIV/0!	
15 Channel slope, s	s			0.002	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.00	#DIV/0!	
18. Flow length, L	L	5974.66		19601.90	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			5.46	#DIV/0!	**5.46**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**8.59**
					Tc (mins)	**515.56**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_115

				X	Y	
SubBasin_115				3274.56	490.71	
				3174.4	487.52	
		Sheet Flow	**Slope AB**	**0.031849042**		
				3174.4	487.52	
				343.8	467.29	
		Shallow Concentrated Flow	**Slope BC**	**0.007146819**		
				343.77	467.29	
				0	467.28	
		Channel flow	**Slope CD**	**2.90892E-05**		
				0	467.28	
		N/A	**Slope DE**	**#DIV/0!**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.16	0	328.61	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.032	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}s^{0.4}}$	T_sheet			**0.44**	**#DIV/0!**	**0.44**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2830.6	0	9286.84	0.00	
9. Watercourse slope, s	s	0.007146819	0	0.007	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.36	0.00	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			1.89	#DIV/0!	**1.89**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	14.45	0.00	155.56	0.00	
13. Wetted perimeter, pw	p_w	29.53	0.00	96.89	0.00	
14. Hydraulic radius, r= Compute r	r			1.61	#DIV/0!	
15 Channel slope, s	s			0.000	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			0.31	#DIV/0!	
18. Flow length, L	L	343.77		1127.85	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.00	#DIV/0!	**1.00**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.33**
					Tc (mins)	**199.77**

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_116

				X	Y	
SubBasin_116				3227.34	489.66	
				3127.13	486.87	
		Sheet Flow	**Slope AB**	**0.027841533**		
				3127.13	486.87	
				436.5	469.87	
		Shallow Concentrated Flow	**Slope BC**	**0.006318223**		
				436.5	469.87	
				0	466.51	
		Channel flow	**Slope CD**	**0.007697595**		
				0	466.51	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.21	0	328.77	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.028	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.47**	**#DIV/0!**	**0.47**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2690.6	0	8827.53	0.00	
9. Watercourse slope, s	s	0.006318223	0	0.006	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345 S^{0.5}$ Paved $V = 20.3282 S^{0.5}$	V	N/A		1.28	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			1.91	#DIV/0!	**1.91**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	0.00	0.00	0.00	0.00	
13. Wetted perimeter, pw	p_w	0.00	0.00	0.00	0.00	
14. Hydraulic radius, r= Compute r	r			#DIV/0!	#DIV/0!	
15 Channel slope, s	s			0.008	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			#DIV/0!	#DIV/0!	
18. Flow length, L	L	436.5		1432.09	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			#DIV/0!	#DIV/0!	**0.00**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.38**
					Tc (mins)	**142.78**

Time of Concentration Calculations	17

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_117

				X	Y	
SubBasin_117				10892.38	492.75	
				10792.02	490.57	
		Sheet Flow	**Slope AB**	**0.021721802**		
				10792.02	490.57	
				9538.7	483.18	
		Shallow Concentrated Flow	**Slope BC**	**0.005896339**		
				9538.7	483.18	
				1219.93	459.2	
		Shallow Concentrated Flow	**Slope CD**	**0.002882638**		
				1219.93	459.2	
				0	456.48	
		Channel flow	**Slope DE**	**0.002229636**		
			Sheet Flow			
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.36	0	329.27	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.022	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.52**	**#DIV/0!**	**0.52**
			Shallow Concentrated Flow			
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	1253.3	8318.77	4111.94	27292.55	
9. Watercourse slope, s	s	0.005896339	0.002882638	0.006	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.24	1.09	
Unpaved $V = 16.1345 S^{0.5}$						
Paved $V = 20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.92	6.95	**7.87**
			Channel flow			
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	4.17	0.00	44.88	0.00	
13. Wetted perimeter, pw	p_w	20.36	0.00	66.79	0.00	
14. Hydraulic radius, r= Compute r	r			0.67	#DIV/0!	
15 Channel slope, s	s			0.002	0.002	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.54	#DIV/0!	
18. Flow length, L	L	1219.93		4002.40	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.72	#DIV/0!	**0.72**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**9.11**
					Tc (mins)	**546.37**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_118

				X	Y	
SubBasin_118				9267.13	491.28	
				9167.52	490.05	
		Sheet Flow	**Slope AB**	**0.012348158**		
				9167.52	490.05	
				7302.5	466.07	
		Shallow Concentrated Flow	**Slope BC**	**0.012857978**		
				7302.53	466.07	
				0	456.49	
		Channel flow	**Slope CD**	**0.001311874**		
				0	456.49	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.61	0	326.80	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.012	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.64**	**#DIV/0!**	**0.64**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	1865.0	0	6118.73	0.00	
9. Watercourse slope, s	s	0.012857978	0	0.013	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.83	0.00	
Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.93	#DIV/0!	**0.93**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	46.24	0.00	497.69	0.00	
13. Wetted perimeter, pw	p_w	40.24	0.00	132.03	0.00	
14. Hydraulic radius, r= Compute r	r			3.77	#DIV/0!	
15 Channel slope, s	s			0.001	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			3.73	#DIV/0!	
18. Flow length, L	L	7302.53		23958.43	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.78	#DIV/0!	**1.78**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.36**
					Tc (mins)	**201.32**

Time of Concentration Calculations	19

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_119

				X	Y	
SubBasin_119				4587.17	489.45	
				4487.78	487.04	
		Sheet Flow	**Slope AB**	**0.024247912**		
				4487.78	487.04	
				2101.6	466.2	
		Shallow Concentrated Flow	**Slope BC**	**0.008733588**		
				2101.59	466.2	
				1133.44	454.8	
		Channel flow	**Slope CD**	**0.011775035**		
				1133.44	454.8	
				0	451.78	
		Channel flow	**Slope DE**	**0.002664455**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.39	0	326.08	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.024	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.49**	**#DIV/0!**	**0.49**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2386.2	0	7828.71	0.00	
9. Watercourse slope, s	s	0.008733588	0	0.009	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		1.51	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			1.44	#DIV/0!	**1.44**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	32.32	254.94	347.88	2744.17	
13. Wetted perimeter, pw	p_w	34.41	125.66	112.89	412.27	
14. Hydraulic radius, r= Compute r	r			3.08	6.66	
15 Channel slope, s	s			0.012	0.003	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			9.78	7.78	
18. Flow length, L	L	968.15	1133.44	3176.35	3718.64	
19 $T_t = \frac{L}{3600V}$	T_channel			0.09	0.13	**0.22**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.16**
					Tc (mins)	**129.38**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_120

				X	Y	
SubBasin_120				6026.88	480.27	
				5926.75	477.95	
		Sheet Flow	**Slope AB**	**0.023169879**		
				5926.75	477.95	
				4492.3	473.31	
		Shallow Concentrated Flow	**Slope BC**	**0.003234779**		
				4492.34	473.31	
				0	456.48	
		Channel flow	**Slope CD**	**0.003746377**		
				0	456.48	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.13	0	328.51	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.023	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.50**	**#DIV/0!**	**0.50**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	1434.4	0	4706.07	0.00	
9. Watercourse slope, s	s	0.003234779	0	0.003	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		0.92	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			1.42	#DIV/0!	**1.42**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	32.32	0.00	347.88	0.00	
13. Wetted perimeter, pw	p_w	34.41	0.00	112.89	0.00	
14. Hydraulic radius, r= Compute r	r			3.08	#DIV/0!	
15 Channel slope, s	s			0.004	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			5.52	#DIV/0!	
18. Flow length, L	L	4492.34	0	14738.65	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.74	#DIV/0!	**0.74**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.67**
					Tc (mins)	**160.17**

Time of Concentration Calculations

21

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_121

				X	Y	
SubBasin_121				10892.38	492.75	
				10792.42	490.57	
		Sheet Flow	**Slope AB**	**0.021808723**		
				10792.42	490.57	
				7150.2	479.76	
		Shallow Concentrated Flow	**Slope BC**	**0.002968003**		
				7150.24	479.76	
				2686.89	463.08	
		Shallow Concentrated Flow	**Slope CD**	**0.003737103**		
				2686.89	463.08	
				0	456.5	
		Channel flow	**Slope DE**	**0.002448928**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.96	0	327.95	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.022	0	0.02	0.00	
6 $T_t=\frac{0.007(nL)^{0.8}}{P_2^{0.5}s^{0.4}}$	T_sheet			**0.51**	**#DIV/0!**	**0.51**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	3642.2	4463.35	11949.41	14643.54	
9. Watercourse slope, s	s	0.002968003	0.003737103	0.003	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		0.88	1.24	
Unpaved $V=16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t=\frac{L}{3600V}$	T_shallow			3.78	3.27	**7.05**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	27.98	0.00	301.19	0.00	
13. Wetted perimeter, pw	p_w	30.48	0.00	99.99	0.00	
14. Hydraulic radius, r= Compute r	r			3.01	#DIV/0!	
15 Channel slope, s	s			0.002	0.002	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V=\frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			4.39	#DIV/0!	
18. Flow length, L	L	2686.89	2686.89	8815.26	8815.26	
19 $T_t=\frac{L}{3600V}$	T_channel			0.56	#DIV/0!	**0.56**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**8.12**
					Tc (mins)	**487.28**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_122

				X	Y	
SubBasin_122				4557.55	474.31	
				4450.35	473.68	
		Sheet Flow	**Slope AB**	**0.005876866**		
				4450.35	473.68	
				1926.4	458.76	
		Shallow Concentrated Flow	**Slope BC**	**0.005911393**		
				1926.41	458.76	
				207.53	443.13	
		Shallow Concentrated Flow	**Slope CD**	**0.00909313**		
				207.53	443.13	
				0	443.06	
		Channel flow	**Slope DE**	**0.000337301**		
			Sheet Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	107.2	0	351.71	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.006	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.92**	**#DIV/0!**	**0.92**
			Shallow Concentrated Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	2523.9	1718.88	8280.64	5639.37	
9. Watercourse slope, s	s	0.005911393	0.00909313	0.006	0.01	
10. Average velocity, V (figure 3-1)	V	N/A		1.24	1.94	
Unpaved $V = 16.1345 S^{0.5}$						
Paved $V = 20.3282 S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			1.85	0.81	**2.66**
			Channel flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1150.01	0.00	12378.62	0.00	
13. Wetted perimeter, pw	p_w	207.41	0.00	680.48	0.00	
14. Hydraulic radius, r= Compute r	r			18.19	#DIV/0!	
15 Channel slope, s	s			0.000	0.000	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			5.41	#DIV/0!	
18. Flow length, L	L	207.53	0	680.87	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.03	#DIV/0!	**0.03**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.62**
					Tc (mins)	**217.01**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_123

				X	Y	
SubBasin_123				12398.15	466.08	
				12294.51	464.15	
		Sheet Flow	**Slope AB**	**0.018622154**		
				12294.51	464.15	
				10666.5	442.32	
		Shallow Concentrated Flow	**Slope BC**	**0.013408844**		
				10666.48	442.32	
				0	392.52	
		Channel flow	**Slope CD**	**0.004668832**		
				0	392.52	
		N/A	**Slope DE**	**#DIV/0!**		
		Sheet Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	103.64	0	340.03	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.019	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.95**	**#DIV/0!**	**1.95**
		Shallow Concentrated Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	1628.0	0	5341.31	0.00	
9. Watercourse slope, s	s	0.013408844	0	0.013	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.87	0.00	
Unpaved $V = 16.1345S^{0.5}$						
Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.79	#DIV/0!	**0.79**
		Channel flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	942.14	0.00	10141.12	0.00	
13. Wetted perimeter, pw	p_w	168.58	0.00	553.09	0.00	
14. Hydraulic radius, r= Compute r	r			18.34	#DIV/0!	
15 Channel slope, s	s			0.005	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			20.23	#DIV/0!	
18. Flow length, L	L	10666.48	0	34995.01	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.48	#DIV/0!	**0.48**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.22**
					Tc (mins)	**193.37**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_124

				X	Y	
SubBasin_124				7728.3	467.94	
				7628.56	466.95	
		Sheet Flow	**Slope AB**	**0.009925807**		
				7628.56	466.95	
				814.3	397.95	
		Shallow Concentrated Flow	**Slope BC**	**0.010125884**		
				814.34	397.95	
				0	392.36	
		Channel flow	**Slope CD**	**0.006864455**		
				0	392.36	
		N/A	**Slope DE**	**#DIV/0!**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	99.74	0	327.23	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.010	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.70**	**#DIV/0!**	**0.70**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	6814.2	0	22356.36	0.00	
9. Watercourse slope, s	s	0.010125884	0	0.010	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		1.62	0.00	
Unpaved $V = 16.1345S^{0.5}$						
Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			3.82	#DIV/0!	**3.82**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	2.50	0.00	26.92	0.00	
13. Wetted perimeter, pw	p_w	13.54	0.00	44.42	0.00	
14. Hydraulic radius, r= Compute r	r			0.61	#DIV/0!	
15 Channel slope, s	s			0.007	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.53	#DIV/0!	
18. Flow length, L	L	814.34	0	2671.72	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.29	#DIV/0!	**0.29**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**4.82**
					Tc (mins)	**289.35**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_125

				X	Y	
SubBasin_125				8021.68	442.7	
				7920.91	431.95	
		Sheet Flow	**Slope AB**	**0.106678575**		
				7920.91	431.95	
				4183.9	391.97	
		Shallow Concentrated Flow	**Slope BC**	**0.010698249**		
				4183.85	391.97	
				3520.44	388.3	
		Channel flow	**Slope CD**	**0.005532024**		
				3520.44	388.3	
				0	374.04	
		Channel flow	**Slope DE**	**0.00405063**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.77	0	330.61	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.107	0	0.11	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.95**	**#DIV/0!**	**0.95**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	3737.1	0	12260.70	0.00	
9. Watercourse slope, s	s	0.010698249	0	0.011	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		1.67	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			2.04	#DIV/0!	**2.04**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	6.23	29.61	67.05	318.69	
13. Wetted perimeter, pw	p_w	13.81	31.60	45.31	103.66	
14. Hydraulic radius, r= Compute r	r			1.48	3.07	
15 Channel slope, s	s			0.006	0.004	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			4.11	5.73	
18. Flow length, L	L	663.41	3520.44	2176.54	11550.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.15	0.56	**0.71**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.70**
					Tc (mins)	**221.73**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_126

				X	Y	
SubBasin_126				7003.33	416.95	
				6902.18	412.33	
		Sheet Flow	**Slope AB**	**0.04567474**		
				6902.18	412.33	
				6640.2	398.3	
		Shallow Concentrated Flow	**Slope BC**	**0.053551662**		
				6640.19	398.3	
				3142.74	385.93	
		Shallow Concentrated Flow	**Slope CD**	**0.003536863**		
				3142.74	385.93	
				0	373.98	
		Channel flow	**Slope DE**	**0.003802414**		
		Sheet Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.15	0	331.86	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.046	0	0.05	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.39**	**#DIV/0!**	**0.39**
		Shallow Concentrated Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	N/A	Unpaved	N/A	
8. Flow length, L	L	262.0	3497.45	859.55	11474.57	
9. Watercourse slope, s	s	0.053551662	0.003536863	0.054	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		3.73	1.21	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.06	2.64	**2.70**
		Channel flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	3.94	0.00	42.42	0.00	
13. Wetted perimeter, pw	p_w	13.41	0.00	44.00	0.00	
14. Hydraulic radius, r= Compute r	r			0.96	#DIV/0!	
15 Channel slope, s	s			0.004	0.004	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.56	#DIV/0!	
18. Flow length, L	L	3142.74	0	10310.83	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.12	#DIV/0!	**1.12**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**4.20**
					Tc (mins)	**252.30**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_127

				X	Y	
SubBasin_127				7287.21	401.09	
				7186.08	399.81	
		Sheet Flow	**Slope AB**	**0.012656976**		
				7186.08	399.81	
				6037.9	378.25	
		Shallow Concentrated Flow	**Slope BC**	**0.018777217**		
				6037.88	378.25	
				4357.78	370	
		Shallow Concentrated Flow	**Slope CD**	**0.004910422**		
				4357.78	370	
				0	362.25	
		Channel flow	**Slope DE**	**0.001778428**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.13	0	331.79	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.013	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.65**	**#DIV/0!**	**0.65**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1148.2	1680.1	3767.06	5512.14	
9. Watercourse slope, s	s	0.018777217	0.004910422	0.019	0.00	
10. Average velocity, V (figure 3-1)	V	N/A		2.21	1.13	
Unpaved $V = 16.1345S^{0.5}$						
Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.47	1.35	**1.83**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	2.04	0.00	21.98	0.00	
13. Wetted perimeter, pw	p_w	17.03	0.00	55.86	0.00	
14. Hydraulic radius, r= Compute r	r			0.39	#DIV/0!	
15 Channel slope, s	s			0.002	0.002	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.96	#DIV/0!	
18. Flow length, L	L	4357.78	0	14297.18	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			4.12	#DIV/0!	**4.12**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**6.59**
					Tc (mins)	**395.55**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_128

				X	Y	
SubBasin_128				4562.58	405.38	
				4461.69	401.68	
		Sheet Flow	**Slope AB**	**0.036673605**		
				4461.69	401.68	
				3312.2	376.61	
		Shallow Concentrated Flow	**Slope BC**	**0.021810241**		
				3312.23	376.61	
				2619.64	371.33	
		Shallow Concentrated Flow	**Slope CD**	**0.007623558**		
				2619.64	371.33	
				0	362.27	
		Channel flow	**Slope DE**	**0.00345849**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.89	0	331.00	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.037	0	0.04	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.42**	**#DIV/0!**	**0.42**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1149.5	692.59	3771.19	2272.28	
9. Watercourse slope, s	s	0.021810241	0.007623558	0.022	0.01	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		2.38	1.41	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.44	0.45	**0.89**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	16.45	0.00	177.07	0.00	
13. Wetted perimeter, pw	p_w	26.98	0.00	88.52	0.00	
14. Hydraulic radius, r= Compute r	r			2.00	#DIV/0!	
15 Channel slope, s	s			0.003	0.003	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			3.97	#DIV/0!	
18. Flow length, L	L	2619.64	0	8594.62	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.60	#DIV/0!	**0.60**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**1.91**
					Tc (mins)	**114.57**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_129

				X	Y	
SubBasin_129				15686.98	477.16	
				15574.58	476.18	
		Sheet Flow	**Slope AB**	**0.008718861**		
				15574.58	476.18	
				10755.7	457.16	
		Shallow Concentrated Flow	**Slope BC**	**0.003946959**		
				10755.68	457.16	
				3834.59	415.52	
		Channel flow	**Slope CD**	**0.006016393**		
				3834.59	415.52	
				0	374.29	
		Channel flow	**Slope DE**	**0.010752127**		
		Sheet Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	112.4	0	368.77	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.009	0	0.01	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.82**	**#DIV/0!**	**0.82**
		Shallow Concentrated Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	4818.9	0	15810.04	0.00	
9. Watercourse slope, s	s	0.003946959	0	0.004	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		1.01	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			4.33	#DIV/0!	**4.33**
		Channel flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	5.47	30.43	58.86	327.50	
13. Wetted perimeter, pw	p_w	28.79	50.35	94.46	165.18	
14. Hydraulic radius, r= Compute r	r			0.62	1.98	
15 Channel slope, s	s			0.006	0.011	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.41	6.97	
18. Flow length, L	L	6921.09	3834.59	22706.99	12580.68	
19 $T_t = \frac{L}{3600V}$	T_channel			2.62	0.50	**3.12**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**8.27**
					Tc (mins)	**496.08**

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_130

				X	Y	
SubBasin_130				6049.21	431.78	
				5948.00	429.03	
		Sheet Flow	**Slope AB**	**0.027171228**		
				5948.00	429.03	
				4625.89	399.30	
		Shallow Concentrated Flow	**Slope BC**	**0.022486782**		
				4625.89	399.30	
				832.62	374.85	
		Shallow Concentrated Flow	**Slope CD**	**0.006445626**		
				832.62	374.85	
				0	374.29	
		Channel flow	**Slope DE**	**0.000672576**		
		Sheet Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.21	0	332.05	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.027	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.48**	**#DIV/0!**	**0.48**
		Shallow Concentrated Flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1322.1	3793.27	4337.63	12445.11	
9. Watercourse slope, s	s	0.022486782	0.006445626	0.022	0.01	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		2.42	1.30	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.50	2.67	**3.17**
		Channel flow				
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	1.21	0.00	12.99	0.00	
13. Wetted perimeter, pw	p_w	20.12	0.00	66.02	0.00	
14. Hydraulic radius, r= Compute r	r			0.20	#DIV/0!	
15 Channel slope, s	s			0.001	0.001	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			0.37	#DIV/0!	
18. Flow length, L	L	832.62	0	2731.69	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			2.03	#DIV/0!	**2.03**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**5.67**
					Tc (mins)	**340.43**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_131

				X	Y	
SubBasin_131				5704.39	401.55	
				5603.83	398.66	
		Sheet Flow	**Slope AB**	**0.028739061**		
				5603.83	398.66	
				4006.36	374.20	
		Shallow Concentrated Flow	**Slope BC**	**0.015311712**		
				4006.36	374.20	
				1126.79	367.84	
		Channel flow	**Slope CD**	**0.002208663**		
				1126.79	367.84	
				0	353.75	
		Channel flow	**Slope DE**	**0.012504548**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.56	0	329.92	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.029	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.46**	**#DIV/0!**	**0.46**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1597.5	0	5241.04	0.00	
9. Watercourse slope, s	s	0.015311712	0	0.015	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		2.00	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.73	#DIV/0!	**0.73**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	749.50	273.60	8067.59	2944.98	
13. Wetted perimeter, pw	p_w	186.09	195.10	610.53	640.09	
14. Hydraulic radius, r= Compute r	r			13.21	4.60	
15 Channel slope, s	s			0.002	0.013	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			11.18	13.17	
18. Flow length, L	L	2879.57	1126.79	9447.41	3696.82	
19 $T_t = \frac{L}{3600V}$	T_channel			0.23	0.08	**0.31**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**1.50**
					Tc (mins)	**90.29**

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_132

				X	Y	
SubBasin_132				3948.47	401.51	
				3848.27	399.38	
		Sheet Flow	**Slope AB**	**0.021257485**		
				3848.27	399.38	
				3242.00	388.41	
		Shallow Concentrated Flow	**Slope BC**	**0.018094248**		
				3242.00	388.41	
				2902.07	362.32	
		Shallow Concentrated Flow	**Slope CD**	**0.076751096**		
				2902.07	362.32	
				0	353.76	
		Channel flow	**Slope DE**	**0.002949619**		
Sheet Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.2	0	328.74	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.021	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.52**	**#DIV/0!**	**0.52**
Shallow Concentrated Flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	606.3	339.93	1989.07	1115.26	
9. Watercourse slope, s	s	0.018094248	0.076751096	0.018	0.08	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		2.17	4.47	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.25	0.07	**0.32**
Channel flow						
	Segment ID	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	26.79	0.00	288.42	0.00	
13. Wetted perimeter, pw	p_w	38.78	0.00	127.23	0.00	
14. Hydraulic radius, r= Compute r	r			2.27	#DIV/0!	
15 Channel slope, s	s			0.003	0.003	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			3.99	#DIV/0!	
18. Flow length, L	L	2902.07	0	9521.23	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.66	#DIV/0!	**0.66**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**1.51**
					Tc (mins)	**90.46**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_133

				X	Y	
SubBasin_133				3495.41	380.61	
				3395.01	377.38	
		Sheet Flow	**Slope AB**	**0.032171315**		
				3395.01	377.38	
				2929.14	367.68	
		Shallow Concentrated Flow	**Slope BC**	**0.020821259**		
				2929.14	367.68	
				697.06	352.80	
		Shallow Concentrated Flow	**Slope CD**	**0.006666428**		
				697.06	352.80	
				0	350.80	
		Channel flow	**Slope DE**	**0.002869193**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.4	0	329.40	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.032	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.44**	**#DIV/0!**	**0.44**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	465.9	2232.08	1528.44	7323.10	
9. Watercourse slope, s	s	0.020821259	0.006666428	0.021	0.01	
10. Average velocity, V (figure 3-1)	V	N/A		2.33	1.32	
Unpaved $V = 16.1345S^{0.5}$						
Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.18	1.54	**1.73**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	211.82	0.00	2279.96	0.00	
13. Wetted perimeter, pw	p_w	133.27	0.00	437.24	0.00	
14. Hydraulic radius, r= Compute r	r			5.21	#DIV/0!	
15 Channel slope, s	s			0.003	0.003	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			6.86	#DIV/0!	
18. Flow length, L	L	697.06	0	2286.94	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.09	#DIV/0!	**0.09**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.26**
					Tc (mins)	**135.67**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_134

				X	Y	
SubBasin_134				1696.83	360.48	
				1595.14	358.41	
		Sheet Flow	**Slope AB**	**0.020355984**		
				1595.14	358.41	
				344.79	350.83	
		Shallow Concentrated Flow	**Slope BC**	**0.006062303**		
				344.79	350.83	
				45.78	342.48	
		Shallow Concentrated Flow	**Slope CD**	**0.027925487**		
				45.78	342.48	
				0	342.20	
		Channel flow	**Slope DE**	**0.006116208**		
		Sheet Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Heavy Underbush	N/A	Heavy Underbush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.8	0	0.80	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.69	0	333.63	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.020	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**1.85**	**#DIV/0!**	**1.85**
		Shallow Concentrated Flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1250.4	299.01	4102.20	981.00	
9. Watercourse slope, s	s	0.006062303	0.027925487	0.006	0.03	
10. Average velocity, V (figure 3-1)	V	N/A		1.26	2.70	
Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.91	0.10	**1.01**
		Channel flow				
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	0.30	0.00	3.23	0.00	
13. Wetted perimeter, pw	p_w	1.70	0.00	5.58	0.00	
14. Hydraulic radius, r= Compute r	r			0.58	#DIV/0!	
15 Channel slope, s	s			0.006	0.006	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			2.31	#DIV/0!	
18. Flow length, L	L	45.78	0	150.20	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.02	#DIV/0!	**0.02**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**2.88**
					Tc (mins)	**172.66**

Time of Concentration Calculations

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_135

				X	Y	
SubBasin_135				1115.94	358.66	
				1015.19	355.59	
		Sheet Flow	**Slope AB**	**0.030471464**		
				1015.19	355.59	
				957.00	353.13	
		Shallow Concentrated Flow	**Slope BC**	**0.042275305**		
				957.00	353.13	
				28.24	342.76	
		Shallow Concentrated Flow	**Slope CD**	**0.011165425**		
				28.24	342.76	
				8.54	340.34	
		Channel flow	**Slope DE**	**0.12284264**		
			Sheet Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Dense grasses, including species	N/A	Dense grasses, including s	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.24	0	0.24	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.75	0	330.54	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.030	0	0.03	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.60**	**#DIV/0!**	**0.60**
			Shallow Concentrated Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	58.2	928.76	190.91	3047.11	
9. Watercourse slope, s	s	0.042275305	0.011165425	0.042	0.01	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		3.32	1.70	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.02	0.50	**0.51**
			Channel flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	0.07	0.00	0.72	0.00	
13. Wetted perimeter, pw	p_w	4.43	0.00	14.54	0.00	
14. Hydraulic radius, r= Compute r	r			0.05	#DIV/0!	
15 Channel slope, s	s			0.123	0.123	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			2.00	#DIV/0!	
18. Flow length, L	L	19.7	0	64.63	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.01	#DIV/0!	**0.01**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**1.12**
					Tc (mins)	**67.10**

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_136

				X	Y	
SubBasin_136				3340.56	390.39	
				3237.03	388.58	
		Sheet Flow	**Slope AB**	**0.017482855**		
				3237.03	388.58	
				1860.38	377.05	
		Shallow Concentrated Flow	**Slope BC**	**0.008375404**		
				1860.38	377.05	
				1211.83	341.29	
		Shallow Concentrated Flow	**Slope CD**	**0.055138386**		
				1211.83	341.29	
				0	333.32	
		Channel flow	**Slope DE**	**0.00657683**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Residue cover > 20%	N/A	Residue cover > 20%	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.17	0	0.17	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	103.53	0	339.67	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.017	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.58**	**#DIV/0!**	**0.58**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	1376.7	648.55	4516.57	2127.79	
9. Watercourse slope, s	s	0.008375404	0.055138386	0.008	0.06	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		1.48	3.79	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.85	0.16	**1.01**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	85.58	0.00	921.14	0.00	
13. Wetted perimeter, pw	p_w	59.10	0.00	193.91	0.00	
14. Hydraulic radius, r= Compute r	r			4.75	#DIV/0!	
15 Channel slope, s	s			0.007	0.007	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			9.76	#DIV/0!	
18. Flow length, L	L	1211.83	0	3975.82	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.11	#DIV/0!	**0.11**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**1.70**
					Tc (mins)	**101.82**

Time of Concentration Calculations	37

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_137

				X	Y	
SubBasin_137				1277.00	359.32	
				1175.43	348.6	
		Sheet Flow	**Slope AB**	**0.105542975**		
				1175.43	348.6	
				605.42	339.46	
		Shallow Concentrated Flow	**Slope BC**	**0.016034806**		
				605.42	339.46	
				0	333.30	
		Channel flow	**Slope CD**	**0.010174755**		
				0	333.30	
				0	0.00	
		N/A	**Slope DE**	**#DIV/0!**		
			Sheet Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Light underbrush	N/A	Light underbrush	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.4	0	0.40	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	101.57	0	333.23	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.106	0	0.11	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.55**	**#DIV/0!**	**0.55**
			Shallow Concentrated Flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	570.0	0	1870.11	0.00	
9. Watercourse slope, s	s	0.016034806	0	0.016	0.00	
10. Average velocity, V (figure 3-1) Unpaved $V = 16.1345S^{0.5}$ Paved $V = 20.3282S^{0.5}$	V	N/A		2.04	0.00	
11 $T_t = \frac{L}{3600V}$	T_shallow			0.25	#DIV/0!	**0.25**
			Channel flow			
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	2.40	0.00	25.85	0.00	
13. Wetted perimeter, pw	p_w	7.29	0.00	23.93	0.00	
14. Hydraulic radius, r= Compute r	r			1.08	#DIV/0!	
15 Channel slope, s	s			0.010	#DIV/0!	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$	V			4.52	#DIV/0!	
18. Flow length, L	L	605.42	0	1986.29	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			0.12	#DIV/0!	**0.12**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**0.93**
					Tc (mins)	**55.58**

Time of Concentration Calculations

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: JTF/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Durham

Time of Concentration TR55 SubBasin_138

				X	Y	
SubBasin_138				6096.55	382.16	
				5995.78	379.75	
		Sheet Flow	**Slope AB**	**0.023915848**		
				5995.78	379.75	
				5349.21	349.30	
		Shallow Concentrated Flow	**Slope BC**	**0.047094669**		
				5349.21	349.30	
				3814.17	332.11	
		Shallow Concentrated Flow	**Slope CD**	**0.011198405**		
				3814.17	332.11	
				0	330.63	
		Channel flow	**Slope DE**	**0.000388027**		
Sheet Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
1. Surface description (table 3-1)		Dense grasses, including species	N/A	Dense grasses, including s	N/A	
2. Manning's roughness coefficient, n (table 3-1)	n	0.24	0	0.24	0.00	
3. Flow length, L (total L ≤ 300 ft)	L	100.77	0	330.61	0.00	
4. Two-year 24-hour rainfall, P2	P_2	62.4	0	2.46	0.00	
5. Land slope, s	Land Slope	0.024	0	0.02	0.00	
6 $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	T_sheet			**0.66**	**#DIV/0!**	**0.66**
Shallow Concentrated Flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	Unpaved	Unpaved	
8. Flow length, L	L	646.6	1535.04	2121.29	5036.22	
9. Watercourse slope, s	s	0.047094669	0.011198405	0.047	0.01	
10. Average velocity, V (figure 3-1)	V	N/A		3.50	1.71	
Unpaved $V = 16.1345S^{0.5}$ Paved V= $20.3282S^{0.5}$						
11 $T_t = \frac{L}{3600V}$	T_shallow			0.17	0.82	**0.99**
Channel flow						
	Segment II	Segment 1 (SI)	Segment 2 (SI)	Segment 1 (Imperial)	Segment 2 (Imperial)	
12. Cross sectional flow area, a	area	23.78	0.00	255.94	0.00	
13. Wetted perimeter, pw	p_w	25.74	0.00	84.46	0.00	
14. Hydraulic radius, r= Compute r	r			3.03	#DIV/0!	
15 Channel slope, s	s			0.000	0.000	
16. Manning's roughness coefficient, n	n			0.035	0.035	
17 $V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$	V			1.76	#DIV/0!	
18. Flow length, L	L	3814.17	0	12513.68	0.00	
19 $T_t = \frac{L}{3600V}$	T_channel			1.98	#DIV/0!	**1.98**
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					Tc (Hr)	**3.62**
					Tc (mins)	**217.49**

Loss Method Watershed Parameters															
Subbasin	Texture Code	Texture	HYDRO Class	Porosity	Effective Porosity	Soil Suction Head at the wetting front (mm) (Low)	Soil Suction Head at the wetting front (mm) (Average)	Soil Suction Head at the wetting front (mm) (High)	Saturated Hydraulic Conductity (mm/h)	Field Capacity Θ_o	Wilting Point Θ_w	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Percentage of Watershed
Subbasin_101	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	36.117	3611.7	60.11	1.66%
Subbasin_101	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	36.117	3611.7	69.08	1.91%
Subbasin_101	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	36.117	3611.7	126.54	3.50%
Subbasin_101	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	36.117	3611.7	1391.18	38.52%
Subbasin_101	SL	Sandy Loam	B	0.453	0.412	110	180	250	11	0.19	0.085	36.117	3611.7	17.65	0.49%
Subbasin_101	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	36.117	3611.7	292.70	8.10%
Subbasin_101	S	Sand	C	0.437	0.417	49	99.5	150	120	0.062	0.024	36.117	3611.7	34.33	0.95%
Subbasin_101	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	36.117	3611.7	76.78	2.13%
Subbasin_101	CL	Clay Loam	D	0.464	0.309	210	210	210	1	0.31	0.187	36.117	3611.7	52.96	1.47%
Subbasin_101	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	36.117	3611.7	1489.60	41.24%
Subbasin_102	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	12.722	1272.2	10.21	0.80%
Subbasin_102	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	12.722	1272.2	8.20	0.64%
Subbasin_102	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	12.722	1272.2	280.39	22.04%
Subbasin_102	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	12.722	1272.2	637.21	50.09%
Subbasin_102	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	12.722	1272.2	28.33	2.23%
Subbasin_102	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	12.722	1272.2	0.12	0.01%
Subbasin_102	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	12.722	1272.2	307.63	24.18%
Subbasin_103	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	24.35	2435	7.29	0.30%
Subbasin_103	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	24.35	2435	244.52	10.04%
Subbasin_103	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	24.35	2435	1425.16	58.53%
Subbasin_103	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	24.35	2435	221.07	9.08%
Subbasin_103	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	24.35	2435	42.63	1.75%
Subbasin_103	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	24.35	2435	494.07	20.29%
Subbasin_104	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	1.18	118	0.36	0.31%
Subbasin_104	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	1.18	118	3.11	2.64%
Subbasin_104	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	1.18	118	59.72	50.61%
Subbasin_104	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	1.18	118	6.25	5.29%
Subbasin_104	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	1.18	118	48.55	41.15%
Subbasin_105	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	20.996	2099.6	0.36	0.02%
Subbasin_105	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	20.996	2099.6	118.21	5.63%
Subbasin_105	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	20.996	2099.6	963.79	45.90%
Subbasin_105	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	20.996	2099.6	184.68	8.80%
Subbasin_105	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	20.996	2099.6	3.91	0.19%
Subbasin_105	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	20.996	2099.6	828.16	39.44%
Subbasin_106	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	18.315	1831.5	0.00	0.00%
Subbasin_106	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	18.315	1831.5	139.85	7.64%
Subbasin_106	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	18.315	1831.5	1139.79	62.23%
Subbasin_106	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	18.315	1831.5	234.52	12.80%
Subbasin_106	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	18.315	1831.5	89.31	4.88%
Subbasin_106	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	18.315	1831.5	227.75	12.44%
Subbasin_107	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	20.669	2066.9	16.40	0.79%
Subbasin_107	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	20.669	2066.9	211.98	10.26%
Subbasin_107	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	20.669	2066.9	1169.14	56.56%
Subbasin_107	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	20.669	2066.9	176.27	8.53%
Subbasin_107	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	20.669	2066.9	101.24	4.90%
Subbasin_107	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	20.669	2066.9	391.88	18.96%
Subbasin_108	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	3.3357	333.57	2.96	0.89%
Subbasin_108	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	3.3357	333.57	21.37	6.41%

Loss Method Watershed Parameters															
Subbasin	Texture Code	Texture	HYDRO Class	Porosity	Effective Porosity	Soil Suction Head at the wetting front (mm) (Low)	Soil Suction Head at the wetting front (mm) (Average)	Soil Suction Head at the wetting front (mm) (High)	Saturated Hydraulic Conductity (mm/h)	Field Capacity Θ_o	Wilting Point Θ_w	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Percentage of Watershed
Subbasin_108	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	3.3357	333.57	118.37	35.48%
Subbasin_108	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	3.3357	333.57	148.58	44.54%
Subbasin_108	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	3.3357	333.57	41.73	12.51%
Subbasin_108	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	3.3357	333.57	0.56	0.17%
Subbasin_109	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	11.359	1135.9	173.17	15.24%
Subbasin_109	S	Sand	A	0.437	0.417	49	99.5	150	120	0.062	0.024	11.359	1135.9	8.35	0.73%
Subbasin_109	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	11.359	1135.9	158.33	13.94%
Subbasin_109	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	11.359	1135.9	83.59	7.36%
Subbasin_109	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	11.359	1135.9	177.91	15.66%
Subbasin_109	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	11.359	1135.9	223.04	19.64%
Subbasin_109	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	11.359	1135.9	1.71	0.15%
Subbasin_109	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	11.359	1135.9	309.77	27.27%
Subbasin_110	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	9.4843	948.43	16.66	1.76%
Subbasin_110	S	Sand	A	0.437	0.417	49	99.5	150	120	0.062	0.024	9.4843	948.43	2.15	0.23%
Subbasin_110	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	9.4843	948.43	2.37	0.25%
Subbasin_110	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	9.4843	948.43	155.47	16.39%
Subbasin_110	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	9.4843	948.43	331.15	34.92%
Subbasin_110	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	9.4843	948.43	228.83	24.13%
Subbasin_110	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	9.4843	948.43	39.52	4.17%
Subbasin_110	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	9.4843	948.43	172.27	18.16%
Subbasin_111	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	25.593	2559.3	108.21	4.23%
Subbasin_111	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	25.593	2559.3	353.14	13.80%
Subbasin_111	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	25.593	2559.3	980.37	38.31%
Subbasin_111	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	25.593	2559.3	191.75	7.49%
Subbasin_111	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	25.593	2559.3	56.46	2.21%
Subbasin_111	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	25.593	2559.3	868.66	33.94%
Subbasin_112	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	6.8095	680.95	86.10	12.64%
Subbasin_112	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	6.8095	680.95	17.30	2.54%
Subbasin_112	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	6.8095	680.95	239.44	35.16%
Subbasin_112	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	6.8095	680.95	22.12	3.25%
Subbasin_112	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	6.8095	680.95	10.08	1.48%
Subbasin_112	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	6.8095	680.95	305.91	44.92%
Subbasin_113	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	7.99	799	57.69	7.22%
Subbasin_113	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	7.99	799	79.03	9.89%
Subbasin_113	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	7.99	799	222.02	27.79%
Subbasin_113	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	7.99	799	202.50	25.34%
Subbasin_113	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	7.99	799	98.59	12.34%
Subbasin_113	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	7.99	799	43.47	5.44%
Subbasin_113	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	7.99	799	95.70	11.98%
Subbasin_114	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	16.996	1699.6	35.72	2.10%
Subbasin_114	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	16.996	1699.6	87.93	5.17%
Subbasin_114	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	16.996	1699.6	145.31	8.55%
Subbasin_114	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	16.996	1699.6	965.86	56.83%
Subbasin_114	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	16.996	1699.6	150.69	8.87%
Subbasin_114	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	16.996	1699.6	5.59	0.33%
Subbasin_114	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	16.996	1699.6	307.91	18.12%
Subbasin_115	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	1.3733	137.33	71.67	52.19%
Subbasin_115	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	1.3733	137.33	22.31	16.24%

Loss Method Watershed Parameters															
Subbasin	Texture Code	Texture	HYDRO Class	Porosity	Effective Porosity	Soil Suction Head at the wetting front (mm) (Low)	Soil Suction Head at the wetting front (mm) (Average)	Soil Suction Head at the wetting front (mm) (High)	Saturated Hydraulic Conductity (mm/h)	Field Capacity Θ_o	Wilting Point Θ_w	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Percentage of Watershed
Subbasin_115	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	1.3733	137.33	10.70	7.79%
Subbasin_115	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	1.3733	137.33	13.43	9.78%
Subbasin_115	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	1.3733	137.33	19.22	13.99%
Subbasin_116	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	1.2656	126.56	70.43	55.65%
Subbasin_116	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	1.2656	126.56	3.88	3.06%
Subbasin_116	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	1.2656	126.56	18.14	14.33%
Subbasin_116	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	1.2656	126.56	34.12	26.96%
Subbasin_117	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	9.505	950.5	417.96	43.97%
Subbasin_117	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	9.505	950.5	142.86	15.03%
Subbasin_117	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	9.505	950.5	91.88	9.67%
Subbasin_117	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	9.505	950.5	44.14	4.64%
Subbasin_117	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	9.505	950.5	67.14	7.06%
Subbasin_117	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	9.505	950.5	186.30	19.60%
Subbasin_118	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	9.2346	923.46	336.35	36.42%
Subbasin_118	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	9.2346	923.46	184.11	19.94%
Subbasin_118	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	9.2346	923.46	193.81	20.99%
Subbasin_118	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	9.2346	923.46	55.77	6.04%
Subbasin_118	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	9.2346	923.46	102.39	11.09%
Subbasin_118	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	9.2346	923.46	51.03	5.53%
Subbasin_119	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	4.4575	445.75	341.29	76.56%
Subbasin_119	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	4.4575	445.75	45.55	10.22%
Subbasin_119	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	4.4575	445.75	34.02	7.63%
Subbasin_119	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	4.4575	445.75	24.81	5.57%
Subbasin_120	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	3.2915	329.15	225.59	68.54%
Subbasin_120	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	3.2915	329.15	4.83	1.47%
Subbasin_120	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	3.2915	329.15	5.80	1.76%
Subbasin_120	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	3.2915	329.15	0.94	0.28%
Subbasin_120	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	3.2915	329.15	91.85	27.90%
Subbasin_121	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	14.987	1498.7	766.79	51.16%
Subbasin_121	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	14.987	1498.7	11.85	0.79%
Subbasin_121	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	14.987	1498.7	341.55	22.79%
Subbasin_121	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	14.987	1498.7	102.35	6.83%
Subbasin_121	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	14.987	1498.7	103.30	6.89%
Subbasin_121	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	14.987	1498.7	67.46	4.50%
Subbasin_121	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	14.987	1498.7	105.13	7.01%
Subbasin_122	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	4.2171	421.71	282.47	66.98%
Subbasin_122	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	4.2171	421.71	47.19	11.19%
Subbasin_122	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	4.2171	421.71	9.16	2.17%
Subbasin_122	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	4.2171	421.71	13.06	3.10%
Subbasin_122	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	4.2171	421.71	58.26	13.81%
Subbasin_122	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	4.2171	421.71	11.56	2.74%
Subbasin_123	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	9.5452	954.52	738.06	77.32%
Subbasin_123	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	9.5452	954.52	19.73	2.07%
Subbasin_123	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	9.5452	954.52	0.31	0.03%
Subbasin_123	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	9.5452	954.52	28.50	2.99%
Subbasin_123	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	9.5452	954.52	152.23	15.95%
Subbasin_123	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	9.5452	954.52	15.70	1.65%
Subbasin_124	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	5.4237	542.37	454.99	83.89%

Loss Method Watershed Parameters															
Subbasin	Texture Code	Texture	HYDRO Class	Porosity	Effective Porosity	Soil Suction Head at the wetting front (mm) (Low)	Soil Suction Head at the wetting front (mm) (Average)	Soil Suction Head at the wetting front (mm) (High)	Saturated Hydraulic Conductity (mm/h)	Field Capacity Θ_o	Wilting Point Θ_w	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Percentage of Watershed
Subbasin_124	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	5.4237	542.37	15.18	2.80%
Subbasin_124	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	5.4237	542.37	21.62	3.99%
Subbasin_124	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	5.4237	542.37	1.91	0.35%
Subbasin_124	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	5.4237	542.37	48.60	8.96%
Subbasin_125	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	9.0317	903.17	603.41	66.81%
Subbasin_125	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	9.0317	903.17	144.16	15.96%
Subbasin_125	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	9.0317	903.17	7.79	0.86%
Subbasin_125	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	9.0317	903.17	108.71	12.04%
Subbasin_125	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	9.0317	903.17	39.08	4.33%
Subbasin_126	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	7.7236	772.36	171.95	22.26%
Subbasin_126	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	7.7236	772.36	127.80	16.55%
Subbasin_126	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	7.7236	772.36	276.94	35.86%
Subbasin_126	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	7.7236	772.36	74.42	9.64%
Subbasin_126	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	7.7236	772.36	13.65	1.77%
Subbasin_126	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	7.7236	772.36	107.45	13.91%
Subbasin_127	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	11.403	1140.3	436.44	38.27%
Subbasin_127	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	11.403	1140.3	22.15	1.94%
Subbasin_127	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	11.403	1140.3	122.98	10.78%
Subbasin_127	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	11.403	1140.3	313.17	27.46%
Subbasin_127	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	11.403	1140.3	19.59	1.72%
Subbasin_127	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	11.403	1140.3	2.55	0.22%
Subbasin_127	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	11.403	1140.3	223.12	19.57%
Subbasin_128	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	1.8478	184.78	130.03	70.37%
Subbasin_128	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	1.8478	184.78	10.60	5.74%
Subbasin_128	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	1.8478	184.78	44.14	23.89%
Subbasin_128	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	1.8478	184.78	0.00	0.00%
Subbasin_129	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	24.814	2481.4	1995.01	80.40%
Subbasin_129	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	24.814	2481.4	108.42	4.37%
Subbasin_129	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	24.814	2481.4	139.06	5.60%
Subbasin_129	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	24.814	2481.4	88.74	3.58%
Subbasin_129	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	24.814	2481.4	149.04	6.01%
Subbasin_130	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	5.4488	544.88	390.66	71.70%
Subbasin_130	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	5.4488	544.88	86.98	15.96%
Subbasin_130	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	5.4488	544.88	67.24	12.34%
Subbasin_131	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	3.1071	310.71	139.91	45.03%
Subbasin_131	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	3.1071	310.71	91.72	29.52%
Subbasin_131	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	3.1071	310.71	1.66	0.54%
Subbasin_131	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	3.1071	310.71	5.64	1.82%
Subbasin_131	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	3.1071	310.71	71.64	23.06%
Subbasin_132	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	2.1852	218.52	46.21	21.15%
Subbasin_132	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	2.1852	218.52	27.08	12.39%
Subbasin_132	L	Loam	B	0.463	0.434	89	219.5	350	3	0.232	0.116	2.1852	218.52	70.72	32.36%
Subbasin_132	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	2.1852	218.52	21.32	9.76%
Subbasin_132	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	2.1852	218.52	0.94	0.43%
Subbasin_132	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	2.1852	218.52	38.46	17.60%
Subbasin_132	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	2.1852	218.52	13.75	6.29%
Subbasin_133	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	2.5688	256.88	161.19	62.75%
Subbasin_133	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	2.5688	256.88	16.73	6.51%

Loss Method Watershed Parameters															
Subbasin	**Texture Code**	**Texture**	**HYDRO Class**	**Porosity**	**Effective Porosity**	**Soil Suction Head at the wetting front (mm) (Low)**	**Soil Suction Head at the wetting front (mm) (Average)**	**Soil Suction Head at the wetting front (mm) (High)**	**Saturated Hydraulic Conductity (mm/h)**	**Field Capacity Θ_o**	**Wilting Point Θ_w**	**Area Watershed (km2)**	**Area Watershed (ha)**	**Area Soil Texture (ha)**	**Percentage of Watershed**
Subbasin_133	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	2.5688	256.88	23.01	8.96%
Subbasin_133	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	2.5688	256.88	39.65	15.43%
Subbasin_133	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	2.5688	256.88	16.08	6.26%
Subbasin_134	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	0.2685	26.85	26.77	99.71%
Subbasin_135	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	0.3158	31.58	31.51	99.78%
Subbasin_136	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	1.7062	170.62	5.38	3.16%
Subbasin_136	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	1.7062	170.62	135.26	79.28%
Subbasin_136	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	1.7062	170.62	29.97	17.56%
Subbasin_137	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	0.282	28.2	0.11	0.38%
Subbasin_137	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	0.282	28.2	27.97	99.18%
Subbasin_137	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	0.282	28.2	0.02	0.09%
Subbasin_138	L	Loam	A	0.463	0.434	89	219.5	350	3	0.232	0.116	4.8845	488.45	174.07	35.64%
Subbasin_138	SL	Sandy Loam	A	0.453	0.412	110	180	250	11	0.19	0.085	4.8845	488.45	28.37	5.81%
Subbasin_138	SIL	Silt Loam	B	0.501	0.486	170	170	170	7	0.284	0.135	4.8845	488.45	195.56	40.04%
Subbasin_138	L	Loam	C	0.463	0.434	89	219.5	350	3	0.232	0.116	4.8845	488.45	29.86	6.11%
Subbasin_138	SICL	Silty Clay Loam	C	0.471	0.432	270	270	270	1	0.342	0.21	4.8845	488.45	57.07	11.68%
Subbasin_138	ORG	Organic	D	0.56	0.56	180	200	220	0.1	0.46	0.27	4.8845	488.45	3.19	0.65%

Percent Impervious and Initial Abstraction Basin Parameters											
Subbasin ID	gridcode	Land Cover	Percent Impervious	Canopy Storage (mm)	Depression Storage (mm)	Total Abstraction (mm)	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Impervious Area (ha)	Percentage of Watershed
Subbasin_101	1	Forest	0	5	5	10	36.117	3611.7	30.26	0.00	0.84%
Subbasin_101	2	Agriculture	0	1	6	7	36.117	3611.7	1843.58	0.00	51.04%
Subbasin_101	3	Wetland	0	3	15	18	36.117	3611.7	1670.72	0.00	46.26%
Subbasin_101	4	Open Water	100	0	0	0	36.117	3611.7	2.47	2.47	0.07%
Subbasin_101	5	Transportation	100	1	1	2	36.117	3611.7	61.70	61.70	1.71%
Subbasin_102	1	Forest	0	5	5	10	12.722	1272.2	23.24	0.00	1.83%
Subbasin_102	2	Agriculture	0	1	6	7	12.722	1272.2	773.32	0.00	60.79%
Subbasin_102	3	Wetland	0	3	15	18	12.722	1272.2	445.91	0.00	35.05%
Subbasin_102	4	Open Water	100	0	0	0	12.722	1272.2	1.84	1.84	0.14%
Subbasin_102	5	Transportation	100	1	1	2	12.722	1272.2	25.91	25.91	2.04%
Subbasin_103	1	Forest	0	5	5	10	24.35	2435	66.80	0.00	2.74%
Subbasin_103	2	Agriculture	0	1	6	7	24.35	2435	1667.91	0.00	68.50%
Subbasin_103	3	Wetland	0	3	15	18	24.35	2435	648.75	0.00	26.64%
Subbasin_103	4	Open Water	100	0	0	0	24.35	2435	2.16	2.16	0.09%
Subbasin_103	5	Transportation	100	1	1	2	24.35	2435	48.60	48.60	2.00%
Subbasin_104	1	Forest	0	5	5	10	1.18	118	3.27	0.00	2.77%
Subbasin_104	2	Agriculture	0	1	6	7	1.18	118	67.03	0.00	56.80%
Subbasin_104	3	Wetland	0	3	15	18	1.18	118	45.88	0.00	38.88%
Subbasin_104	4	Open Water	100	0	0	0	1.18	118	1.55	1.55	1.32%
Subbasin_104	5	Transportation	100	1	1	2	1.18	118	0.24	0.24	0.20%
Subbasin_105	1	Forest	0	5	5	10	20.996	2099.6	30.47	0.00	1.45%
Subbasin_105	2	Agriculture	0	1	6	7	20.996	2099.6	1287.12	0.00	61.30%
Subbasin_105	3	Wetland	0	3	15	18	20.996	2099.6	722.18	0.00	34.40%
Subbasin_105	4	Open Water	100	0	0	0	20.996	2099.6	3.75	3.75	0.18%
Subbasin_105	5	Transportation	100	1	1	2	20.996	2099.6	50.91	50.91	2.42%
Subbasin_105	7	Built -Up Area – Impervious	45	1	1	2	20.996	2099.6	3.71	1.67	0.18%
Subbasin_106	1	Forest	0	5	5	10	18.315	1831.5	45.32	0.00	2.47%
Subbasin_106	2	Agriculture	0	1	6	7	18.315	1831.5	1440.96	0.00	78.68%
Subbasin_106	3	Wetland	0	3	15	18	18.315	1831.5	297.60	0.00	16.25%
Subbasin_106	4	Open Water	100	0	0	0	18.315	1831.5	8.99	8.99	0.49%
Subbasin_106	5	Transportation	100	1	1	2	18.315	1831.5	37.18	37.18	2.03%
Subbasin_106	7	Built -Up Area – Impervious	45	1	1	2	18.315	1831.5	0.65	0.29	0.04%
Subbasin_107	1	Forest	0	5	5	10	20.669	2066.9	86.51	0.00	4.19%
Subbasin_107	2	Agriculture	0	1	6	7	20.669	2066.9	1274.41	0.00	61.66%
Subbasin_107	3	Wetland	0	3	15	18	20.669	2066.9	653.40	0.00	31.61%
Subbasin_107	4	Open Water	100	0	0	0	20.669	2066.9	18.61	18.61	0.90%
Subbasin_107	5	Transportation	100	1	1	2	20.669	2066.9	32.27	32.27	1.56%
Subbasin_108	1	Forest	0	5	5	10	3.3357	333.57	0.30	0.00	0.09%
Subbasin_108	2	Agriculture	0	1	6	7	3.3357	333.57	298.60	0.00	89.52%
Subbasin_108	3	Wetland	0	3	15	18	3.3357	333.57	28.97	0.00	8.68%
Subbasin_108	4	Open Water	100	0	0	0	3.3357	333.57	0.02	0.02	0.00%
Subbasin_108	5	Transportation	100	1	1	2	3.3357	333.57	5.68	5.68	1.70%
Subbasin_109	1	Forest	0	5	5	10	11.359	1135.9	20.75	0.00	1.83%
Subbasin_109	2	Agriculture	0	1	6	7	11.359	1135.9	545.89	0.00	48.06%
Subbasin_109	3	Wetland	0	3	15	18	11.359	1135.9	511.39	0.00	45.02%
Subbasin_109	4	Open Water	100	0	0	0	11.359	1135.9	17.38	17.38	1.53%
Subbasin_109	5	Transportation	100	1	1	2	11.359	1135.9	20.41	20.41	1.80%
Subbasin_109	6	Built -Up Area – Pervious	10	1	4	5	11.359	1135.9	18.53	1.85	1.63%
Subbasin_110	1	Forest	0	5	5	10	9.4843	948.43	17.73	0.00	1.87%
Subbasin_110	2	Agriculture	0	1	6	7	9.4843	948.43	611.46	0.00	64.47%
Subbasin_110	3	Wetland	0	3	15	18	9.4843	948.43	287.65	0.00	30.33%
Subbasin_110	4	Open Water	100	0	0	0	9.4843	948.43	14.91	14.91	1.57%
Subbasin_110	5	Transportation	100	1	1	2	9.4843	948.43	16.07	16.07	1.69%
Subbasin_111	1	Forest	0	5	5	10	25.593	2559.3	66.67	0.00	2.60%
Subbasin_111	2	Agriculture	0	1	6	7	25.593	2559.3	1492.83	0.00	58.33%
Subbasin_111	3	Wetland	0	3	15	18	25.593	2559.3	945.06	0.00	36.93%
Subbasin_111	4	Open Water	100	0	0	0	25.593	2559.3	7.74	7.74	0.30%
Subbasin_111	5	Transportation	100	1	1	2	25.593	2559.3	37.13	37.13	1.45%
Subbasin_111	7	Built -Up Area – Impervious	45	1	1	2	25.593	2559.3	1.53	0.69	0.06%
Subbasin_111	8	Extraction – Aggregate	0	0	5	5	25.593	2559.3	6.13	0.00	0.24%
Subbasin_112	1	Forest	0	5	5	10	6.8095	680.95	10.97	0.00	1.61%
Subbasin_112	2	Agriculture	0	1	6	7	6.8095	680.95	347.09	0.00	50.97%
Subbasin_112	3	Wetland	0	3	15	18	6.8095	680.95	303.82	0.00	44.62%
Subbasin_112	4	Open Water	100	0	0	0	6.8095	680.95	11.27	11.27	1.65%
Subbasin_112	5	Transportation	100	1	1	2	6.8095	680.95	7.81	7.81	1.15%
Subbasin_113	1	Forest	0	5	5	10	7.99	799	28.52	0.00	3.57%
Subbasin_113	2	Agriculture	0	1	6	7	7.99	799	551.58	0.00	69.03%
Subbasin_113	3	Wetland	0	3	15	18	7.99	799	192.17	0.00	24.05%
Subbasin_113	4	Open Water	100	0	0	0	7.99	799	6.00	6.00	0.75%
Subbasin_113	5	Transportation	100	1	1	2	7.99	799	20.71	20.71	2.59%
Subbasin_114	1	Forest	0	5	5	10	16.996	1699.6	55.00	0.00	3.24%
Subbasin_114	2	Agriculture	0	1	6	7	16.996	1699.6	1116.39	0.00	65.69%
Subbasin_114	3	Wetland	0	3	15	18	16.996	1699.6	489.28	0.00	28.79%
Subbasin_114	4	Open Water	100	0	0	0	16.996	1699.6	1.09	1.09	0.06%
Subbasin_114	5	Transportation	100	1	1	2	16.996	1699.6	35.35	35.35	2.08%

Percent Impervious and Initial Abstraction Basin Parameters											
Subbasin ID	gridcode	Land Cover	Percent Impervious	Canopy Storage (mm)	Depression Storage (mm)	Total Abstraction (mm)	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Impervious Area (ha)	Percentage of Watershed
Subbasin_114	7	Built -Up Area – Impervious	45	1	1	2	16.996	1699.6	0.54	0.24	0.03%
Subbasin_115	1	Forest	0	5	5	10	1.3733	137.33	3.05	0.00	2.22%
Subbasin_115	2	Agriculture	0	1	6	7	1.3733	137.33	101.94	0.00	74.23%
Subbasin_115	3	Wetland	0	3	15	18	1.3733	137.33	27.82	0.00	20.26%
Subbasin_115	4	Open Water	100	0	0	0	1.3733	137.33	1.72	1.72	1.25%
Subbasin_115	5	Transportation	100	1	1	2	1.3733	137.33	2.79	2.79	2.03%
Subbasin_116	1	Forest	0	5	5	10	1.2656	126.56	5.74	0.00	4.53%
Subbasin_116	2	Agriculture	0	1	6	7	1.2656	126.56	81.62	0.00	64.49%
Subbasin_116	3	Wetland	0	3	15	18	1.2656	126.56	34.88	0.00	27.56%
Subbasin_116	4	Open Water	100	0	0	0	1.2656	126.56	1.28	1.28	1.01%
Subbasin_116	5	Transportation	100	1	1	2	1.2656	126.56	3.04	3.04	2.40%
Subbasin_117	1	Forest	0	5	5	10	9.505	950.5	128.15	0.00	13.48%
Subbasin_117	2	Agriculture	0	1	6	7	9.505	950.5	511.52	0.00	53.82%
Subbasin_117	3	Wetland	0	3	15	18	9.505	950.5	285.42	0.00	30.03%
Subbasin_117	4	Open Water	100	0	0	0	9.505	950.5	1.37	1.37	0.14%
Subbasin_117	5	Transportation	100	1	1	2	9.505	950.5	22.07	22.07	2.32%
Subbasin_117	7	Built -Up Area – Impervious	45	1	1	2	9.505	950.5	1.20	0.54	0.13%
Subbasin_118	1	Forest	0	5	5	10	9.2346	923.46	135.49	0.00	14.67%
Subbasin_118	2	Agriculture	0	1	6	7	9.2346	923.46	635.37	0.00	68.80%
Subbasin_118	3	Wetland	0	3	15	18	9.2346	923.46	118.91	0.00	12.88%
Subbasin_118	4	Open Water	100	0	0	0	9.2346	923.46	15.54	15.54	1.68%
Subbasin_118	5	Transportation	100	1	1	2	9.2346	923.46	16.22	16.22	1.76%
Subbasin_118	7	Built -Up Area – Impervious	45	1	1	2	9.2346	923.46	1.80	0.81	0.19%
Subbasin_119	1	Forest	0	5	5	10	4.4575	445.75	29.13	0.00	6.54%
Subbasin_119	2	Agriculture	0	1	6	7	4.4575	445.75	259.92	0.00	58.31%
Subbasin_119	3	Wetland	0	3	15	18	4.4575	445.75	73.78	0.00	16.55%
Subbasin_119	4	Open Water	100	0	0	0	4.4575	445.75	5.73	5.73	1.28%
Subbasin_119	5	Transportation	100	1	1	2	4.4575	445.75	23.43	23.43	5.26%
Subbasin_119	6	Built -Up Area – Pervious	10	1	4	5	4.4575	445.75	22.98	2.30	5.16%
Subbasin_119	7	Built -Up Area – Impervious	45	1	1	2	4.4575	445.75	30.28	13.62	6.79%
Subbasin_120	1	Forest	0	5	5	10	3.2915	329.15	34.02	0.00	10.34%
Subbasin_120	2	Agriculture	0	1	6	7	3.2915	329.15	163.23	0.00	49.59%
Subbasin_120	3	Wetland	0	3	15	18	3.2915	329.15	125.11	0.00	38.01%
Subbasin_120	4	Open Water	100	0	0	0	3.2915	329.15	2.18	2.18	0.66%
Subbasin_120	5	Transportation	100	1	1	2	3.2915	329.15	3.19	3.19	0.97%
Subbasin_120	7	Built -Up Area – Impervious	45	1	1	2	3.2915	329.15	0.72	0.32	0.22%
Subbasin_121	1	Forest	0	5	5	10	14.987	1498.7	123.18	0.00	8.22%
Subbasin_121	2	Agriculture	0	1	6	7	14.987	1498.7	980.06	0.00	65.39%
Subbasin_121	3	Wetland	0	3	15	18	14.987	1498.7	359.65	0.00	24.00%
Subbasin_121	4	Open Water	100	0	0	0	14.987	1498.7	5.50	5.50	0.37%
Subbasin_121	5	Transportation	100	1	1	2	14.987	1498.7	28.07	28.07	1.87%
Subbasin_122	1	Forest	0	5	5	10	4.2171	421.71	57.20	0.00	13.56%
Subbasin_122	2	Agriculture	0	1	6	7	4.2171	421.71	250.13	0.00	59.31%
Subbasin_122	3	Wetland	0	3	15	18	4.2171	421.71	99.73	0.00	23.65%
Subbasin_122	4	Open Water	100	0	0	0	4.2171	421.71	8.12	8.12	1.93%
Subbasin_122	5	Transportation	100	1	1	2	4.2171	421.71	6.53	6.53	1.55%
Subbasin_123	1	Forest	0	5	5	10	9.5452	954.52	412.12	0.00	43.18%
Subbasin_123	2	Agriculture	0	1	6	7	9.5452	954.52	289.92	0.00	30.37%
Subbasin_123	3	Wetland	0	3	15	18	9.5452	954.52	204.29	0.00	21.40%
Subbasin_123	4	Open Water	100	0	0	0	9.5452	954.52	27.39	27.39	2.87%
Subbasin_123	5	Transportation	100	1	1	2	9.5452	954.52	20.81	20.81	2.18%
Subbasin_124	1	Forest	0	5	5	10	5.4237	542.37	145.51	0.00	26.83%
Subbasin_124	2	Agriculture	0	1	6	7	5.4237	542.37	207.50	0.00	38.26%
Subbasin_124	3	Wetland	0	3	15	18	5.4237	542.37	173.53	0.00	31.99%
Subbasin_124	4	Open Water	100	0	0	0	5.4237	542.37	3.94	3.94	0.73%
Subbasin_124	5	Transportation	100	1	1	2	5.4237	542.37	10.34	10.34	1.91%
Subbasin_125	1	Forest	0	5	5	10	9.0317	903.17	149.39	0.00	16.54%
Subbasin_125	2	Agriculture	0	1	6	7	9.0317	903.17	510.54	0.00	56.53%
Subbasin_125	3	Wetland	0	3	15	18	9.0317	903.17	214.80	0.00	23.78%
Subbasin_125	4	Open Water	100	0	0	0	9.0317	903.17	9.07	9.07	1.00%
Subbasin_125	5	Transportation	100	1	1	2	9.0317	903.17	19.17	19.17	2.12%
Subbasin_126	1	Forest	0	5	5	10	7.7236	772.36	70.39	0.00	9.11%
Subbasin_126	2	Agriculture	0	1	6	7	7.7236	772.36	467.73	0.00	60.56%
Subbasin_126	3	Wetland	0	3	15	18	7.7236	772.36	220.92	0.00	28.60%
Subbasin_126	4	Open Water	100	0	0	0	7.7236	772.36	2.29	2.29	0.30%
Subbasin_126	5	Transportation	100	1	1	2	7.7236	772.36	9.41	9.41	1.22%
Subbasin_127	1	Forest	0	5	5	10	11.403	1140.3	169.05	0.00	14.83%
Subbasin_127	2	Agriculture	0	1	6	7	11.403	1140.3	685.51	0.00	60.12%
Subbasin_127	3	Wetland	0	3	15	18	11.403	1140.3	264.93	0.00	23.23%
Subbasin_127	4	Open Water	100	0	0	0	11.403	1140.3	1.25	1.25	0.11%
Subbasin_127	5	Transportation	100	1	1	2	11.403	1140.3	17.33	17.33	1.52%
Subbasin_128	1	Forest	0	5	5	10	1.8478	184.78	41.54	0.00	22.48%
Subbasin_128	2	Agriculture	0	1	6	7	1.8478	184.78	100.05	0.00	54.14%
Subbasin_128	3	Wetland	0	3	15	18	1.8478	184.78	33.29	0.00	18.01%
Subbasin_128	4	Open Water	100	0	0	0	1.8478	184.78	6.03	6.03	3.26%

Percent Impervious and Initial Abstraction Basin Parameters											
Subbasin ID	gridcode	Land Cover	Percent Impervious	Canopy Storage (mm)	Depression Storage (mm)	Total Abstraction (mm)	Area Watershed (km2)	Area Watershed (ha)	Area Soil Texture (ha)	Impervious Area (ha)	Percentage of Watershed
Subbasin_128	5	Transportation	100	1	1	2	1.8478	184.78	3.88	3.88	2.10%
Subbasin_129	1	Forest	0	5	5	10	24.814	2481.4	439.54	0.00	17.71%
Subbasin_129	2	Agriculture	0	1	6	7	24.814	2481.4	1538.66	0.00	62.01%
Subbasin_129	3	Wetland	0	3	15	18	24.814	2481.4	416.17	0.00	16.77%
Subbasin_129	4	Open Water	100	0	0	0	24.814	2481.4	14.98	14.98	0.60%
Subbasin_129	5	Transportation	100	1	1	2	24.814	2481.4	53.10	53.10	2.14%
Subbasin_129	8	Extraction – Aggregate	0	0	5	5	24.814	2481.4	15.67	0.00	0.63%
Subbasin_130	1	Forest	0	5	5	10	5.4488	544.88	94.83	0.00	17.40%
Subbasin_130	2	Agriculture	0	1	6	7	5.4488	544.88	294.48	0.00	54.05%
Subbasin_130	3	Wetland	0	3	15	18	5.4488	544.88	133.51	0.00	24.50%
Subbasin_130	4	Open Water	100	0	0	0	5.4488	544.88	0.02	0.02	0.00%
Subbasin_130	5	Transportation	100	1	1	2	5.4488	544.88	12.58	12.58	2.31%
Subbasin_130	8	Extraction – Aggregate	0	0	5	5	5.4488	544.88	9.46	0.00	1.74%
Subbasin_131	1	Forest	0	5	5	10	3.1071	310.71	72.72	0.00	23.40%
Subbasin_131	2	Agriculture	0	1	6	7	3.1071	310.71	136.58	0.00	43.96%
Subbasin_131	3	Wetland	0	3	15	18	3.1071	310.71	91.05	0.00	29.30%
Subbasin_131	4	Open Water	100	0	0	0	3.1071	310.71	1.31	1.31	0.42%
Subbasin_131	5	Transportation	100	1	1	2	3.1071	310.71	8.70	8.70	2.80%
Subbasin_132	1	Forest	0	5	5	10	2.1852	218.52	52.49	0.00	24.02%
Subbasin_132	2	Agriculture	0	1	6	7	2.1852	218.52	128.94	0.00	59.00%
Subbasin_132	3	Wetland	0	3	15	18	2.1852	218.52	25.78	0.00	11.80%
Subbasin_132	4	Open Water	100	0	0	0	2.1852	218.52	5.55	5.55	2.54%
Subbasin_132	5	Transportation	100	1	1	2	2.1852	218.52	5.33	5.33	2.44%
Subbasin_133	1	Forest	0	5	5	10	2.5688	256.88	47.57	0.00	18.52%
Subbasin_133	2	Agriculture	0	1	6	7	2.5688	256.88	119.27	0.00	46.43%
Subbasin_133	3	Wetland	0	3	15	18	2.5688	256.88	50.50	0.00	19.66%
Subbasin_133	4	Open Water	100	0	0	0	2.5688	256.88	2.46	2.46	0.96%
Subbasin_133	5	Transportation	100	1	1	2	2.5688	256.88	8.08	8.08	3.15%
Subbasin_133	6	Built -Up Area – Pervious	10	1	4	5	2.5688	256.88	9.76	0.98	3.80%
Subbasin_133	7	Built -Up Area – Impervious	45	1	1	2	2.5688	256.88	10.07	4.53	3.92%
Subbasin_133	8	Extraction – Aggregate	0	0	5	5	2.5688	256.88	7.85	0.00	3.06%
Subbasin_134	1	Forest	0	5	5	10	0.2685	26.85	2.11	0.00	7.86%
Subbasin_134	2	Agriculture	0	1	6	7	0.2685	26.85	0.07	0.00	0.26%
Subbasin_134	3	Wetland	0	3	15	18	0.2685	26.85	3.82	0.00	14.22%
Subbasin_134	5	Transportation	100	1	1	2	0.2685	26.85	4.41	4.41	16.42%
Subbasin_134	6	Built -Up Area – Pervious	10	1	4	5	0.2685	26.85	2.89	0.29	10.76%
Subbasin_134	7	Built -Up Area – Impervious	45	1	1	2	0.2685	26.85	13.36	6.01	49.77%
Subbasin_135	1	Forest	0	5	5	10	0.3158	31.58	2.21	0.00	7.00%
Subbasin_135	2	Agriculture	0	1	6	7	0.3158	31.58	4.89	0.00	15.49%
Subbasin_135	5	Transportation	100	1	1	2	0.3158	31.58	3.15	3.15	9.98%
Subbasin_135	7	Built -Up Area – Impervious	45	1	1	2	0.3158	31.58	20.38	9.17	64.54%
Subbasin_135	8	Extraction – Aggregate	0	0	5	5	0.3158	31.58	0.71	0.00	2.26%
Subbasin_136	1	Forest	0	5	5	10	1.7062	170.62	20.49	0.00	12.01%
Subbasin_136	2	Agriculture	0	1	6	7	1.7062	170.62	65.23	0.00	38.23%
Subbasin_136	3	Wetland	0	3	15	18	1.7062	170.62	12.15	0.00	7.12%
Subbasin_136	4	Open Water	100	0	0	0	1.7062	170.62	3.89	3.89	2.28%
Subbasin_136	5	Transportation	100	1	1	2	1.7062	170.62	15.09	15.09	8.85%
Subbasin_136	6	Built -Up Area – Pervious	10	1	4	5	1.7062	170.62	11.16	1.12	6.54%
Subbasin_136	7	Built -Up Area – Impervious	45	1	1	2	1.7062	170.62	42.40	19.08	24.85%
Subbasin_137	1	Forest	0	5	5	10	0.282	28.2	0.25	0.00	0.88%
Subbasin_137	2	Agriculture	0	1	6	7	0.282	28.2	0.87	0.00	3.08%
Subbasin_137	5	Transportation	100	1	1	2	0.282	28.2	7.09	7.09	25.15%
Subbasin_137	7	Built -Up Area – Impervious	45	1	1	2	0.282	28.2	19.68	8.86	69.80%
Subbasin_138	1	Forest	0	5	5	10	4.8845	488.45	83.65	0.00	17.13%
Subbasin_138	2	Agriculture	0	1	6	7	4.8845	488.45	226.02	0.00	46.27%
Subbasin_138	3	Wetland	0	3	15	18	4.8845	488.45	69.77	0.00	14.28%
Subbasin_138	4	Open Water	100	0	0	0	4.8845	488.45	7.57	7.57	1.55%
Subbasin_138	5	Transportation	100	1	1	2	4.8845	488.45	23.19	23.19	4.75%
Subbasin_138	6	Built -Up Area – Pervious	10	1	4	5	4.8845	488.45	13.79	1.38	2.82%
Subbasin_138	7	Built -Up Area – Impervious	45	1	1	2	4.8845	488.45	62.73	28.23	12.84%

Appendix B3

Model Results

Hydrologic Peak Flow Results - Existing Conditions

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated

Areal Reduction Factor: Hazel 0.766; Durham 1.0

Peak Flow Results

Hazel ARF Durham=1, ARF Saugeen=0.766

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	37.1	17 October 1954, 03:15	168.38
Subbasin_130	5.4	10.8	17 October 1954, 01:40	198.08
Junction_116	30.3	47.5	17 October 1954, 02:45	173.73
Subbasin_101	36.1	10.6	17 October 1954, 23:00	62.35
Subbasin_102	12.7	18.9	17 October 1954, 02:30	156.41
Junction_101	48.8	25.3	17 October 1954, 03:50	86.85
Reach_1001	48.8	25.2	17 October 1954, 05:00	86.17
Subbasin_103	24.4	28.4	17 October 1954, 03:35	131.80
Subbasin_104	1.2	2.7	17 October 1954, 01:00	219.76
Junction_102	74.4	55.5	17 October 1954, 04:10	103.23
Reach_1002	74.4	55.4	17 October 1954, 07:35	100.50
Subbasin_105	21.0	33.0	17 October 1954, 02:35	168.17
Subbasin_106	18.3	17.1	17 October 1954, 05:00	114.09
Junction_103	39.3	49.5	17 October 1954, 03:10	142.98
Reach_1003	39.3	49.4	17 October 1954, 03:50	141.82
Subbasin_107	20.7	27.3	17 October 1954, 02:55	143.11
Subbasin_108	3.3	10.3	17 October 1954, 00:05	270.26
Junction_104	137.7	131.0	17 October 1954, 04:40	122.80
Reach_1004	137.7	127.1	17 October 1954, 10:25	117.18
Subbasin_109	11.4	10.8	17 October 1954, 04:55	116.45
Subbasin_110	9.5	13.4	17 October 1954, 02:55	154.66
Junction_105	158.5	146.0	17 October 1954, 09:55	119.37
Reach_1005	158.5	119.5	17 October 1954, 18:15	109.54
Subbasin_111	25.6	17.1	17 October 1954, 09:20	100.47
Subbasin_112	6.8	4.8	17 October 1954, 08:25	103.04
Junction_106	190.9	138.6	17 October 1954, 17:45	108.09
Reach_1006	190.9	138.3	17 October 1954, 18:30	106.65
Subbasin_113	8.0	12.3	17 October 1954, 02:20	160.52
Junction_107	198.9	142.5	17 October 1954, 18:30	108.81
Reach_1007	198.9	142.0	17 October 1954, 18:55	108.23
Subbasin_114	17.0	18.5	17 October 1954, 03:45	122.99
Subbasin_115	1.4	4.4	17 October 1954, 00:20	285.25
Junction_108	217.3	151.1	17 October 1954, 18:15	110.50
Reach_1008	217.3	151.1	17 October 1954, 18:20	110.36
Subbasin_116	1.3	5.2	16 October 1954, 23:50	355.19
Junction_109	218.6	152.7	17 October 1954, 18:20	111.78
Reach_1009	218.6	152.6	17 October 1954, 19:45	109.76
Subbasin_117	9.5	13.1	17 October 1954, 03:50	160.85
Subbasin_118	9.2	28.1	17 October 1954, 00:20	274.14

1% AEP 6 Hour SCS Type 2 - ARF Durham=1, ARF Saugeen=1

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	15.4	1 January 2100, 09:00	51.38
Subbasin_130	5.4	4.6	1 January 2100, 07:05	60.70
Junction_116	30.3	19.8	1 January 2100, 08:25	53.06
Subbasin_101	36.1	4.4	2 January 2100, 04:55	16.55
Subbasin_102	12.7	8.2	1 January 2100, 08:00	49.48
Junction_101	48.8	10.7	1 January 2100, 09:20	25.13
Reach_1001	48.8	10.7	1 January 2100, 10:35	24.75
Subbasin_103	24.4	12.6	1 January 2100, 09:10	43.27
Subbasin_104	1.2	1.2	1 January 2100, 06:20	68.98
Junction_102	74.4	24.1	1 January 2100, 09:35	31.52
Reach_1002	74.4	24.1	1 January 2100, 12:20	29.79
Subbasin_105	21.0	14.0	1 January 2100, 08:10	52.37
Subbasin_106	18.3	7.7	1 January 2100, 10:35	38.88
Junction_103	39.3	21.5	1 January 2100, 08:50	46.08
Reach_1003	39.3	21.5	1 January 2100, 09:35	45.34
Subbasin_107	20.7	12.0	1 January 2100, 08:25	46.37
Subbasin_108	3.3	5.2	1 January 2100, 05:05	93.06
Junction_104	137.7	58.0	1 January 2100, 10:30	38.25
Reach_1004	137.7	55.9	1 January 2100, 15:55	34.71
Subbasin_109	11.4	4.7	1 January 2100, 10:30	37.50
Subbasin_110	9.5	5.8	1 January 2100, 08:30	48.82
Junction_105	158.5	64.1	1 January 2100, 15:35	35.76
Reach_1005	158.5	52.7	1 January 2100, 24:00	30.75
Subbasin_111	25.6	7.0	1 January 2100, 15:10	31.53
Subbasin_112	6.8	2.0	1 January 2100, 14:20	32.45
Junction_106	190.9	60.6	1 January 2100, 23:40	30.91
Reach_1006	190.9	60.4	2 January 2100, 00:40	29.94
Subbasin_113	8.0	5.4	1 January 2100, 07:50	51.50
Junction_107	198.9	62.2	2 January 2100, 00:40	30.81
Reach_1007	198.9	61.5	2 January 2100, 01:25	30.44
Subbasin_114	17.0	8.3	1 January 2100, 09:15	41.24
Subbasin_115	1.4	2.1	1 January 2100, 05:25	92.47
Junction_108	217.3	65.3	2 January 2100, 01:00	31.68
Reach_1008	217.3	65.3	2 January 2100, 01:10	31.58
Subbasin_116	1.3	2.7	1 January 2100, 04:50	121.30
Junction_109	218.6	66.1	2 January 2100, 01:05	32.10
Reach_1009	218.6	66.0	2 January 2100, 02:50	30.77
Subbasin_117	9.5	5.4	1 January 2100, 09:35	48.83
Subbasin_118	9.2	13.4	1 January 2100, 05:30	90.29

Junction_110	237.3	166.9	17 October 1954, 19:15	118.20
Reach_1010	237.3	166.9	17 October 1954, 19:30	117.76
Subbasin_119	4.5	19.6	16 October 1954, 23:40	383.41
Subbasin_120	3.3	13.1	16 October 1954, 24:00	348.28
Junction_111	245.0	176.8	17 October 1954, 19:25	125.68
Reach_1011	245.0	176.8	17 October 1954, 19:55	124.70
Subbasin_121	15.0	21.9	17 October 1954, 03:10	163.02
Subbasin_122	4.2	12.8	17 October 1954, 00:25	277.94
Junction_112	264.2	188.4	17 October 1954, 19:50	129.31
Reach_1012	264.2	188.4	17 October 1954, 20:50	127.07
Subbasin_123	9.5	32.1	17 October 1954, 00:15	303.51
Subbasin_124	5.4	12.8	17 October 1954, 01:05	227.50
Junction_113	279.2	202.3	17 October 1954, 20:40	135.05
Reach_1013	279.2	202.3	17 October 1954, 21:15	134.24
Subbasin_125	9.0	25.6	17 October 1954, 00:30	259.35
Subbasin_126	7.7	18.2	17 October 1954, 00:45	218.94
Junction_114	296.0	216.0	17 October 1954, 20:35	140.27
Reach_1014	296.0	216.0	17 October 1954, 21:05	139.22
Subbasin_127	11.4	19.0	17 October 1954, 02:15	173.26
Subbasin_128	1.8	8.8	16 October 1954, 23:30	404.61
Junction_115	309.2	224.9	17 October 1954, 20:55	142.06
Reach_1015	309.2	224.8	17 October 1954, 21:35	141.28
Subbasin_132	2.2	10.8	16 October 1954, 23:15	408.21
Saugeen Flow Gauge	311.4	228.0	17 October 1954, 21:30	143.16
Reach_1016	30.3	47.5	17 October 1954, 03:55	172.59
Subbasin_131	3.1	17.0	16 October 1954, 23:15	116.15
Junction_117	344.8	273.0	17 October 1954, 04:25	145.50
Reach_1017	344.8	272.9	17 October 1954, 04:35	145.21
Subbasin_133	2.6	10.0	16 October 1954, 23:45	332.75
Junction_118	347.3	276.4	17 October 1954, 04:35	146.59
Reach_1018	347.3	276.4	17 October 1954, 04:50	146.21
Subbasin_136	1.7	7.6	16 October 1954, 23:20	107.63
Subbasin_134	0.3	2.3	17 October 1954, 00:05	206.89
Junction_119	0.3	2.3	17 October 1954, 00:05	206.89
Reach_1019	0.3	2.3	17 October 1954, 00:15	206.74
Subbasin_135	0.3	3.2	16 October 1954, 22:35	153.49
Junction_120	0.6	4.6	16 October 1954, 23:10	177.96
Reach_1020	0.6	4.6	16 October 1954, 23:20	177.97
Subbasin_137	0.3	3.2	16 October 1954, 22:25	191.88
OutflowDurham	0.9	7.4	16 October 1954, 22:45	182.50
Junction_121	349.9	277.7	17 October 1954, 04:45	146.11
Reach_1021	349.9	275.2	17 October 1954, 05:45	143.89
Subbasin_138	4.9	23.7	17 October 1954, 00:35	400.74
Sink-1	354.8	283.4	17 October 1954, 05:45	147.42

Junction_110	237.3	72.2	2 January 2100, 02:35	33.81
Reach_1010	237.3	72.2	2 January 2100, 02:55	33.51
Subbasin_119	4.5	11.0	1 January 2100, 04:40	141.07
Subbasin_120	3.3	6.4	1 January 2100, 05:05	115.00
Junction_111	245.0	77.4	2 January 2100, 02:50	36.56
Reach_1011	245.0	77.4	2 January 2100, 03:30	35.87
Subbasin_121	15.0	9.0	1 January 2100, 08:55	49.50
Subbasin_122	4.2	5.8	1 January 2100, 05:40	87.47
Junction_112	264.2	82.2	2 January 2100, 03:30	37.46
Reach_1012	264.2	82.2	2 January 2100, 05:05	35.92
Subbasin_123	9.5	15.1	1 January 2100, 05:25	97.45
Subbasin_124	5.4	5.4	1 January 2100, 06:30	68.33
Junction_113	279.2	88.4	2 January 2100, 05:00	38.66
Reach_1013	279.2	88.4	2 January 2100, 05:30	38.08
Subbasin_125	9.0	11.7	1 January 2100, 05:45	81.91
Subbasin_126	7.7	8.1	1 January 2100, 06:05	69.15
Junction_114	296.0	94.4	2 January 2100, 05:25	40.23
Reach_1014	296.0	94.4	2 January 2100, 06:10	39.51
Subbasin_127	11.4	8.1	1 January 2100, 07:45	53.97
Subbasin_128	1.8	5.0	1 January 2100, 04:30	151.46
Junction_115	309.2	98.4	2 January 2100, 06:05	40.71
Reach_1015	309.2	98.4	2 January 2100, 06:50	40.25
Subbasin_132	2.2	6.8	1 January 2100, 04:05	166.65
Saugeen Flow Gauge	311.4	100.3	2 January 2100, 06:50	41.14
Reach_1016	30.3	19.8	1 January 2100, 09:35	52.41
Subbasin_131	3.1	10.4	1 January 2100, 04:15	45.75
Junction_117	344.8	112.4	1 January 2100, 09:50	42.17
Reach_1017	344.8	112.4	1 January 2100, 10:00	41.97
Subbasin_133	2.6	5.3	1 January 2100, 04:40	118.55
Junction_118	347.3	114.2	1 January 2100, 10:00	42.53
Reach_1018	347.3	114.2	1 January 2100, 10:15	42.27
Subbasin_136	1.7	5.2	1 January 2100, 04:15	48.41
Subbasin_134	0.3	1.4	1 January 2100, 05:05	61.15
Junction_119	0.3	1.4	1 January 2100, 05:05	61.15
Reach_1019	0.3	1.4	1 January 2100, 05:20	60.96
Subbasin_135	0.3	3.0	1 January 2100, 03:45	52.00
Junction_120	0.6	3.4	1 January 2100, 03:50	56.12
Reach_1020	0.6	3.4	1 January 2100, 04:00	56.14
Subbasin_137	0.3	3.4	1 January 2100, 03:40	62.65
OutflowDurham	0.9	6.3	1 January 2100, 03:50	58.26
Junction_121	349.9	114.9	1 January 2100, 10:15	42.34
Reach_1021	349.9	111.6	1 January 2100, 12:10	40.77
Subbasin_138	4.9	15.8	1 January 2100, 05:35	171.83
Sink-1	354.8	116.9	1 January 2100, 12:10	42.58

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated **Areal Reduction Factor:** 1.0

Peak Flow Results

2% AEP 6 Hour SCS Type 2				
Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	13.2	1 January 2100, 09:00	43.98
Subbasin_130	5.4	3.9	1 January 2100, 07:05	51.64
Junction_116	30.3	16.9	1 January 2100, 08:25	45.35
Subbasin_101	36.1	3.7	2 January 2100, 04:55	13.93
Subbasin_102	12.7	6.9	1 January 2100, 08:00	41.75
Junction_101	48.8	9.1	1 January 2100, 09:20	21.18
Reach_1001	48.8	9.0	1 January 2100, 10:30	20.87
Subbasin_103	24.4	10.6	1 January 2100, 09:10	36.60
Subbasin_104	1.2	1.0	1 January 2100, 06:20	58.54
Junction_102	74.4	20.4	1 January 2100, 09:35	26.62
Reach_1002	74.4	20.3	1 January 2100, 12:25	25.16
Subbasin_105	21.0	12.0	1 January 2100, 08:10	44.58
Subbasin_106	18.3	6.6	1 January 2100, 10:35	33.06
Junction_103	39.3	18.3	1 January 2100, 08:50	39.21
Reach_1003	39.3	18.3	1 January 2100, 09:40	38.57
Subbasin_107	20.7	10.2	1 January 2100, 08:25	39.15
Subbasin_108	3.3	4.4	1 January 2100, 05:05	79.20
Junction_104	137.7	49.0	1 January 2100, 10:35	32.40
Reach_1004	137.7	47.2	1 January 2100, 16:15	29.34
Subbasin_109	11.4	3.9	1 January 2100, 10:30	31.53
Subbasin_110	9.5	4.9	1 January 2100, 08:30	41.48
Junction_105	158.5	54.0	1 January 2100, 15:55	30.23
Reach_1005	158.5	44.0	2 January 2100, 01:05	25.86
Subbasin_111	25.6	5.9	1 January 2100, 15:10	26.67
Subbasin_112	6.8	1.7	1 January 2100, 14:20	27.43
Junction_106	190.9	50.5	2 January 2100, 00:45	26.03
Reach_1006	190.9	50.3	2 January 2100, 01:45	25.19
Subbasin_113	8.0	4.6	1 January 2100, 07:50	43.67
Junction_107	198.9	51.8	2 January 2100, 01:45	25.94
Reach_1007	198.9	51.3	2 January 2100, 02:30	25.61
Subbasin_114	17.0	7.0	1 January 2100, 09:15	34.76
Subbasin_115	1.4	1.8	1 January 2100, 05:25	79.15
Junction_108	217.3	54.3	2 January 2100, 02:30	26.67
Reach_1008	217.3	54.3	2 January 2100, 02:35	26.58
Subbasin_116	1.3	2.3	1 January 2100, 04:45	103.47
Junction_109	218.6	55.0	2 January 2100, 02:35	27.03
Reach_1009	218.6	54.9	2 January 2100, 04:15	25.85
Subbasin_117	9.5	4.6	1 January 2100, 09:35	41.52
Subbasin_118	9.2	11.5	1 January 2100, 05:25	77.29

4% AEP 6 Hour SCS Type 2				
Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	10.8	1 January 2100, 09:00	36.21
Subbasin_130	5.4	3.2	1 January 2100, 07:05	42.12
Junction_116	30.3	13.9	1 January 2100, 08:25	37.27
Subbasin_101	36.1	3.0	2 January 2100, 04:55	11.18
Subbasin_102	12.7	5.6	1 January 2100, 08:00	33.69
Junction_101	48.8	7.3	1 January 2100, 09:20	17.04
Reach_1001	48.8	7.3	1 January 2100, 10:30	16.81
Subbasin_103	24.4	8.6	1 January 2100, 09:10	29.54
Subbasin_104	1.2	0.8	1 January 2100, 06:20	47.53
Junction_102	74.4	16.5	1 January 2100, 09:35	21.47
Reach_1002	74.4	16.4	1 January 2100, 12:35	20.29
Subbasin_105	21.0	9.8	1 January 2100, 08:10	36.36
Subbasin_106	18.3	5.3	1 January 2100, 10:35	26.78
Junction_103	39.3	14.9	1 January 2100, 08:50	31.90
Reach_1003	39.3	14.9	1 January 2100, 09:40	31.36
Subbasin_107	20.7	8.2	1 January 2100, 08:25	31.53
Subbasin_108	3.3	3.6	1 January 2100, 05:05	64.70
Junction_104	137.7	39.6	1 January 2100, 10:40	26.21
Reach_1004	137.7	38.0	1 January 2100, 16:45	23.70
Subbasin_109	11.4	3.1	1 January 2100, 10:30	25.16
Subbasin_110	9.5	4.0	1 January 2100, 08:30	33.76
Junction_105	158.5	43.4	1 January 2100, 16:20	24.41
Reach_1005	158.5	34.4	2 January 2100, 02:15	20.58
Subbasin_111	25.6	4.8	1 January 2100, 15:10	21.56
Subbasin_112	6.8	1.4	1 January 2100, 14:20	22.13
Junction_106	190.9	39.4	2 January 2100, 01:50	20.77
Reach_1006	190.9	39.3	2 January 2100, 03:00	20.09
Subbasin_113	8.0	3.7	1 January 2100, 07:50	35.42
Junction_107	198.9	40.5	2 January 2100, 02:55	20.70
Reach_1007	198.9	40.2	2 January 2100, 03:40	20.43
Subbasin_114	17.0	5.6	1 January 2100, 09:15	27.70
Subbasin_115	1.4	1.4	1 January 2100, 05:25	65.14
Junction_108	217.3	42.5	2 January 2100, 03:40	21.29
Reach_1008	217.3	42.5	2 January 2100, 03:45	21.21
Subbasin_116	1.3	1.9	1 January 2100, 04:45	85.13
Junction_109	218.6	43.1	2 January 2100, 03:45	21.58
Reach_1009	218.6	43.0	2 January 2100, 05:30	20.58
Subbasin_117	9.5	3.8	1 January 2100, 09:35	34.08
Subbasin_118	9.2	9.5	1 January 2100, 05:25	63.60

Junction_110	237.3	60.0	2 January 2100, 04:10	28.48
Reach_1010	237.3	60.0	2 January 2100, 04:30	28.21
Subbasin_119	4.5	9.5	1 January 2100, 04:35	122.01
Subbasin_120	3.3	5.5	1 January 2100, 05:00	97.97
Junction_111	245.0	64.4	2 January 2100, 04:25	30.86
Reach_1011	245.0	64.4	2 January 2100, 05:05	30.25
Subbasin_121	15.0	7.7	1 January 2100, 08:55	42.21
Subbasin_122	4.2	5.0	1 January 2100, 05:40	74.77
Junction_112	264.2	68.5	2 January 2100, 05:00	31.63
Reach_1012	264.2	68.5	2 January 2100, 06:40	30.28
Subbasin_123	9.5	13.0	1 January 2100, 05:25	83.54
Subbasin_124	5.4	4.6	1 January 2100, 06:30	58.09
Junction_113	279.2	73.7	2 January 2100, 06:30	32.64
Reach_1013	279.2	73.7	2 January 2100, 07:00	32.13
Subbasin_125	9.0	9.9	1 January 2100, 05:45	69.73
Subbasin_126	7.7	6.9	1 January 2100, 06:05	58.47
Junction_114	296.0	78.7	2 January 2100, 06:55	33.97
Reach_1014	296.0	78.7	2 January 2100, 07:40	33.33
Subbasin_127	11.4	6.9	1 January 2100, 07:45	45.85
Subbasin_128	1.8	4.3	1 January 2100, 04:25	130.20
Junction_115	309.2	82.1	2 January 2100, 07:35	34.37
Reach_1015	309.2	82.1	2 January 2100, 08:15	33.99
Subbasin_132	2.2	5.8	1 January 2100, 04:05	143.01
Saugeen Flow Gauge	311.4	83.7	2 January 2100, 08:15	34.75
Reach_1016	30.3	16.9	1 January 2100, 09:30	44.80
Subbasin_131	3.1	9.0	1 January 2100, 04:10	39.02
Junction_117	344.8	95.5	1 January 2100, 09:55	35.67
Reach_1017	344.8	95.5	1 January 2100, 10:10	35.49
Subbasin_133	2.6	4.5	1 January 2100, 04:40	101.33
Junction_118	347.3	97.0	1 January 2100, 10:10	35.98
Reach_1018	347.3	97.0	1 January 2100, 10:20	35.74
Subbasin_136	1.7	4.6	1 January 2100, 04:15	42.36
Subbasin_134	0.3	1.3	1 January 2100, 05:05	54.41
Junction_119	0.3	1.3	1 January 2100, 05:05	54.41
Reach_1019	0.3	1.2	1 January 2100, 05:20	54.25
Subbasin_135	0.3	2.6	1 January 2100, 03:45	46.22
Junction_120	0.6	3.0	1 January 2100, 03:50	49.91
Reach_1020	0.6	3.0	1 January 2100, 04:00	49.93
Subbasin_137	0.3	3.0	1 January 2100, 03:40	56.28
OutflowDurham	0.9	5.6	1 January 2100, 03:50	52.00
Junction_121	349.9	97.6	1 January 2100, 10:20	35.82
Reach_1021	349.9	94.7	1 January 2100, 12:20	34.44
Subbasin_138	4.9	13.6	1 January 2100, 05:35	148.32
Sink-1	354.8	99.3	1 January 2100, 12:20	36.01

Junction_110	237.3	47.2	2 January 2100, 05:25	22.79
Reach_1010	237.3	47.2	2 January 2100, 05:45	22.56
Subbasin_119	4.5	8.0	1 January 2100, 04:35	102.10
Subbasin_120	3.3	4.5	1 January 2100, 05:00	80.03
Junction_111	245.0	50.8	2 January 2100, 05:40	24.78
Reach_1011	245.0	50.8	2 January 2100, 06:30	24.26
Subbasin_121	15.0	6.3	1 January 2100, 08:55	34.50
Subbasin_122	4.2	4.1	1 January 2100, 05:40	61.42
Junction_112	264.2	54.1	2 January 2100, 06:25	25.43
Reach_1012	264.2	54.1	2 January 2100, 08:10	24.29
Subbasin_123	9.5	10.7	1 January 2100, 05:25	68.84
Subbasin_124	5.4	3.8	1 January 2100, 06:30	47.26
Junction_113	279.2	58.3	2 January 2100, 08:05	26.26
Reach_1013	279.2	58.3	2 January 2100, 08:40	25.81
Subbasin_125	9.0	8.1	1 January 2100, 05:45	56.95
Subbasin_126	7.7	5.6	1 January 2100, 06:05	47.27
Junction_114	296.0	62.3	2 January 2100, 08:30	27.32
Reach_1014	296.0	62.3	2 January 2100, 09:20	26.79
Subbasin_127	11.4	5.6	1 January 2100, 07:45	37.32
Subbasin_128	1.8	3.6	1 January 2100, 04:25	108.27
Junction_115	309.2	65.1	2 January 2100, 09:15	27.67
Reach_1015	309.2	65.0	2 January 2100, 09:55	27.35
Subbasin_132	2.2	4.8	1 January 2100, 04:05	117.96
Saugeen Flow Gauge	311.4	66.4	2 January 2100, 09:55	27.99
Reach_1016	30.3	13.9	1 January 2100, 09:30	36.81
Subbasin_131	3.1	7.4	1 January 2100, 04:10	32.08
Junction_117	344.8	77.8	1 January 2100, 10:05	28.80
Reach_1017	344.8	77.7	1 January 2100, 10:20	28.65
Subbasin_133	2.6	3.7	1 January 2100, 04:40	83.30
Junction_118	347.3	79.0	1 January 2100, 10:20	29.05
Reach_1018	347.3	79.0	1 January 2100, 10:35	28.85
Subbasin_136	1.7	3.8	1 January 2100, 04:15	35.79
Subbasin_134	0.3	1.1	1 January 2100, 05:05	47.26
Junction_119	0.3	1.1	1 January 2100, 05:05	47.26
Reach_1019	0.3	1.1	1 January 2100, 05:20	47.11
Subbasin_135	0.3	2.3	1 January 2100, 03:45	39.95
Junction_120	0.6	2.6	1 January 2100, 03:50	43.24
Reach_1020	0.6	2.6	1 January 2100, 04:00	43.26
Subbasin_137	0.3	2.7	1 January 2100, 03:40	49.42
OutflowDurham	0.9	4.8	1 January 2100, 03:50	45.27
Junction_121	349.9	79.5	1 January 2100, 10:30	28.92
Reach_1021	349.9	77.1	1 January 2100, 12:30	27.76
Subbasin_138	4.9	11.2	1 January 2100, 05:40	122.75
Sink-1	354.8	80.9	1 January 2100, 12:30	29.07

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated **Areal Reduction Factor:** 1.0

Peak Flow Results

10% AEP 6 Hour SCS Type 2

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	8.1	1 January 2100, 09:00	27.10
Subbasin_130	5.4	2.3	1 January 2100, 07:10	30.92
Junction_116	30.3	10.4	1 January 2100, 08:25	27.79
Subbasin_101	36.1	2.1	2 January 2100, 05:00	7.84
Subbasin_102	12.7	3.9	1 January 2100, 08:00	23.83
Junction_101	48.8	5.1	1 January 2100, 09:20	12.00
Reach_1001	48.8	5.1	1 January 2100, 10:25	11.85
Subbasin_103	24.4	6.1	1 January 2100, 09:10	20.87
Subbasin_104	1.2	0.6	1 January 2100, 06:20	34.58
Junction_102	74.4	11.6	1 January 2100, 09:30	15.16
Reach_1002	74.4	11.6	1 January 2100, 12:45	14.33
Subbasin_105	21.0	7.2	1 January 2100, 08:10	26.69
Subbasin_106	18.3	3.8	1 January 2100, 10:40	19.13
Junction_103	39.3	10.8	1 January 2100, 08:50	23.17
Reach_1003	39.3	10.8	1 January 2100, 09:45	22.76
Subbasin_107	20.7	5.7	1 January 2100, 08:25	22.15
Subbasin_108	3.3	2.6	1 January 2100, 05:05	46.86
Junction_104	137.7	28.2	1 January 2100, 11:10	18.70
Reach_1004	137.7	27.0	1 January 2100, 17:25	17.01
Subbasin_109	11.4	2.2	1 January 2100, 10:35	17.35
Subbasin_110	9.5	2.9	1 January 2100, 08:30	24.48
Junction_105	158.5	30.6	1 January 2100, 17:05	17.48
Reach_1005	158.5	24.5	2 January 2100, 03:15	14.78
Subbasin_111	25.6	3.5	1 January 2100, 15:10	15.55
Subbasin_112	6.8	1.0	1 January 2100, 14:20	15.88
Junction_106	190.9	28.0	2 January 2100, 02:45	14.93
Reach_1006	190.9	27.7	2 January 2100, 04:45	14.36
Subbasin_113	8.0	2.7	1 January 2100, 07:50	25.28
Junction_107	198.9	28.6	2 January 2100, 04:40	14.80
Reach_1007	198.9	28.4	2 January 2100, 05:15	14.60
Subbasin_114	17.0	3.9	1 January 2100, 09:15	19.32
Subbasin_115	1.4	1.1	1 January 2100, 05:25	48.69
Junction_108	217.3	30.1	2 January 2100, 05:10	15.19
Reach_1008	217.3	30.1	2 January 2100, 05:20	15.13
Subbasin_116	1.3	1.4	1 January 2100, 04:45	63.34
Junction_109	218.6	30.5	2 January 2100, 05:20	15.41
Reach_1009	218.6	30.5	2 January 2100, 07:00	14.64
Subbasin_117	9.5	2.8	1 January 2100, 09:35	25.29
Subbasin_118	9.2	7.1	1 January 2100, 05:30	47.54

20% AEP 6 Hour SCS Type 2

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	5.8	1 January 2100, 09:00	19.22
Subbasin_130	5.4	1.6	1 January 2100, 07:10	21.04
Junction_116	30.3	7.3	1 January 2100, 08:30	19.55
Subbasin_101	36.1	1.3	2 January 2100, 05:00	4.99
Subbasin_102	12.7	2.6	1 January 2100, 08:00	15.71
Junction_101	48.8	3.4	1 January 2100, 09:20	7.78
Reach_1001	48.8	3.4	1 January 2100, 10:05	7.69
Subbasin_103	24.4	4.1	1 January 2100, 09:10	14.10
Subbasin_104	1.2	0.4	1 January 2100, 06:20	23.19
Junction_102	74.4	7.8	1 January 2100, 09:20	10.03
Reach_1002	74.4	7.8	1 January 2100, 12:55	9.48
Subbasin_105	21.0	4.9	1 January 2100, 08:15	18.16
Subbasin_106	18.3	2.7	1 January 2100, 10:40	13.32
Junction_103	39.3	7.4	1 January 2100, 08:50	15.91
Reach_1003	39.3	7.4	1 January 2100, 09:55	15.63
Subbasin_107	20.7	3.9	1 January 2100, 08:30	14.85
Subbasin_108	3.3	1.8	1 January 2100, 05:10	32.67
Junction_104	137.7	19.0	1 January 2100, 11:15	12.60
Reach_1004	137.7	18.0	1 January 2100, 18:25	11.58
Subbasin_109	11.4	1.4	1 January 2100, 10:35	11.39
Subbasin_110	9.5	2.0	1 January 2100, 08:35	16.51
Junction_105	158.5	20.3	1 January 2100, 18:05	11.86
Reach_1005	158.5	16.7	2 January 2100, 04:35	10.14
Subbasin_111	25.6	2.3	1 January 2100, 15:10	10.21
Subbasin_112	6.8	0.6	1 January 2100, 14:20	10.34
Junction_106	190.9	18.9	2 January 2100, 04:00	10.15
Reach_1006	190.9	18.8	2 January 2100, 05:25	9.75
Subbasin_113	8.0	1.8	1 January 2100, 07:50	17.38
Junction_107	198.9	19.4	2 January 2100, 05:20	10.06
Reach_1007	198.9	19.3	2 January 2100, 05:55	9.91
Subbasin_114	17.0	2.6	1 January 2100, 09:15	12.96
Subbasin_115	1.4	0.8	1 January 2100, 05:30	34.34
Junction_108	217.3	20.4	2 January 2100, 05:50	10.31
Reach_1008	217.3	20.4	2 January 2100, 06:00	10.26
Subbasin_116	1.3	1.0	1 January 2100, 04:45	44.82
Junction_109	218.6	20.7	2 January 2100, 06:00	10.46
Reach_1009	218.6	20.7	2 January 2100, 07:55	9.90
Subbasin_117	9.5	2.0	1 January 2100, 09:35	17.83
Subbasin_118	9.2	5.0	1 January 2100, 05:30	33.29

Junction_110	237.3	33.5	2 January 2100, 06:50	16.34
Reach_1010	237.3	33.5	2 January 2100, 07:15	16.16
Subbasin_119	4.5	6.1	1 January 2100, 04:35	78.57
Subbasin_120	3.3	3.3	1 January 2100, 05:00	59.48
Junction_111	245.0	36.2	2 January 2100, 07:10	17.88
Reach_1011	245.0	36.2	2 January 2100, 08:05	17.49
Subbasin_121	15.0	4.6	1 January 2100, 08:55	25.45
Subbasin_122	4.2	3.1	1 January 2100, 05:40	45.74
Junction_112	264.2	38.6	2 January 2100, 07:55	18.39
Reach_1012	264.2	38.6	2 January 2100, 09:55	17.52
Subbasin_123	9.5	8.0	1 January 2100, 05:25	51.55
Subbasin_124	5.4	2.7	1 January 2100, 06:30	34.53
Junction_113	279.2	41.7	2 January 2100, 09:45	19.01
Reach_1013	279.2	41.7	2 January 2100, 10:25	18.66
Subbasin_125	9.0	6.0	1 January 2100, 05:45	41.91
Subbasin_126	7.7	4.0	1 January 2100, 06:05	33.63
Junction_114	296.0	44.6	2 January 2100, 10:15	19.76
Reach_1014	296.0	44.6	2 January 2100, 11:10	19.36
Subbasin_127	11.4	4.1	1 January 2100, 07:45	27.24
Subbasin_128	1.8	2.7	1 January 2100, 04:25	82.11
Junction_115	309.2	46.6	2 January 2100, 11:05	20.03
Reach_1015	309.2	46.6	2 January 2100, 11:35	19.79
Subbasin_132	2.2	3.6	1 January 2100, 04:05	87.76
Saugeen Flow Gauge	311.4	47.5	2 January 2100, 11:35	20.27
Reach_1016	30.3	10.4	1 January 2100, 09:25	27.44
Subbasin_131	3.1	5.6	1 January 2100, 04:10	24.05
Junction_117	344.8	57.0	1 January 2100, 10:20	20.93
Reach_1017	344.8	57.0	1 January 2100, 10:35	20.82
Subbasin_133	2.6	2.7	1 January 2100, 04:40	61.26
Junction_118	347.3	57.9	1 January 2100, 10:35	21.12
Reach_1018	347.3	57.9	1 January 2100, 10:50	20.95
Subbasin_136	1.7	3.0	1 January 2100, 04:15	28.26
Subbasin_134	0.3	0.9	1 January 2100, 05:05	38.72
Junction_119	0.3	0.9	1 January 2100, 05:05	38.72
Reach_1019	0.3	0.9	1 January 2100, 05:20	38.60
Subbasin_135	0.3	1.8	1 January 2100, 03:45	32.26
Junction_120	0.6	2.1	1 January 2100, 03:50	35.17
Reach_1020	0.6	2.0	1 January 2100, 04:05	35.19
Subbasin_137	0.3	2.2	1 January 2100, 03:40	41.01
OutflowDurham	0.9	3.9	1 January 2100, 03:50	37.09
Junction_121	349.9	58.2	1 January 2100, 10:45	21.03
Reach_1021	349.9	56.8	1 January 2100, 12:45	20.14
Subbasin_138	4.9	8.4	1 January 2100, 05:40	92.26
Sink-1	354.8	59.7	1 January 2100, 12:40	21.13

Junction_110	237.3	22.8	2 January 2100, 07:45	11.13
Reach_1010	237.3	22.8	2 January 2100, 08:15	10.99
Subbasin_119	4.5	4.6	1 January 2100, 04:40	58.24
Subbasin_120	3.3	2.3	1 January 2100, 05:00	41.89
Junction_111	245.0	24.8	2 January 2100, 08:05	12.27
Reach_1011	245.0	24.8	2 January 2100, 09:05	11.98
Subbasin_121	15.0	3.2	1 January 2100, 08:55	17.51
Subbasin_122	4.2	2.1	1 January 2100, 05:40	32.15
Junction_112	264.2	26.4	2 January 2100, 08:55	12.62
Reach_1012	264.2	26.4	2 January 2100, 11:05	11.99
Subbasin_123	9.5	5.7	1 January 2100, 05:25	36.61
Subbasin_124	5.4	1.9	1 January 2100, 06:35	23.44
Junction_113	279.2	28.6	2 January 2100, 10:55	13.05
Reach_1013	279.2	28.6	2 January 2100, 11:35	12.79
Subbasin_125	9.0	4.1	1 January 2100, 05:45	28.64
Subbasin_126	7.7	2.6	1 January 2100, 06:05	22.37
Junction_114	296.0	30.5	2 January 2100, 11:30	13.52
Reach_1014	296.0	30.5	2 January 2100, 12:25	13.24
Subbasin_127	11.4	2.8	1 January 2100, 07:50	18.40
Subbasin_128	1.8	2.0	1 January 2100, 04:25	59.79
Junction_115	309.2	31.8	2 January 2100, 12:20	13.71
Reach_1015	309.2	31.8	2 January 2100, 12:50	13.52
Subbasin_132	2.2	2.5	1 January 2100, 04:10	62.05
Saugeen Flow Gauge	311.4	32.6	1 January 2100, 10:20	13.86
Reach_1016	30.3	7.3	1 January 2100, 09:20	19.30
Subbasin_131	3.1	4.0	1 January 2100, 04:10	17.25
Junction_117	344.8	40.2	1 January 2100, 10:15	14.37
Reach_1017	344.8	40.1	1 January 2100, 10:30	14.29
Subbasin_133	2.6	1.9	1 January 2100, 04:40	43.40
Junction_118	347.3	40.8	1 January 2100, 10:30	14.51
Reach_1018	347.3	40.8	1 January 2100, 10:50	14.38
Subbasin_136	1.7	2.3	1 January 2100, 04:20	22.12
Subbasin_134	0.3	0.7	1 January 2100, 05:05	31.18
Junction_119	0.3	0.7	1 January 2100, 05:05	31.18
Reach_1019	0.3	0.7	1 January 2100, 05:20	31.09
Subbasin_135	0.3	1.4	1 January 2100, 03:45	25.37
Junction_120	0.6	1.6	1 January 2100, 03:50	28.00
Reach_1020	0.6	1.6	1 January 2100, 04:05	28.02
Subbasin_137	0.3	1.8	1 January 2100, 03:40	33.51
OutflowDurham	0.9	3.0	1 January 2100, 03:50	29.81
Junction_121	349.9	41.0	1 January 2100, 10:45	14.46
Reach_1021	349.9	39.9	1 January 2100, 13:00	13.81
Subbasin_138	4.9	6.3	1 January 2100, 05:40	68.68
Sink-1	354.8	42.0	1 January 2100, 12:55	14.56

Hydrologic Peak Flow Results - Existing Conditions

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated **Areal Reduction Factor:** 1.0

Peak Flow Results

50% AEP 6 Hour SCS Type 2

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.8	2.8	1 January 2100, 09:05	9.34
Subbasin_130	5.4	0.7	1 January 2100, 07:10	9.31
Junction_116	30.3	3.5	1 January 2100, 08:35	9.33
Subbasin_101	36.1	0.4	2 January 2100, 05:05	1.55
Subbasin_102	12.7	0.9	1 January 2100, 08:05	5.59
Junction_101	48.8	1.2	1 January 2100, 09:15	2.60
Reach_1001	48.8	1.2	1 January 2100, 09:55	2.57
Subbasin_103	24.4	1.5	1 January 2100, 09:15	5.21
Subbasin_104	1.2	0.2	1 January 2100, 06:25	9.10
Junction_102	74.4	2.8	1 January 2100, 09:20	3.54
Reach_1002	74.4	2.8	1 January 2100, 13:00	3.35
Subbasin_105	21.0	2.1	1 January 2100, 08:15	7.69
Subbasin_106	18.3	1.1	1 January 2100, 10:40	5.39
Junction_103	39.3	3.1	1 January 2100, 08:50	6.62
Reach_1003	39.3	3.1	1 January 2100, 10:10	6.51
Subbasin_107	20.7	1.4	1 January 2100, 08:35	5.22
Subbasin_108	3.3	0.8	1 January 2100, 05:10	14.42
Junction_104	137.7	7.3	1 January 2100, 11:20	4.80
Reach_1004	137.7	6.6	1 January 2100, 16:55	4.23
Subbasin_109	11.4	0.4	1 January 2100, 10:40	3.32
Subbasin_110	9.5	0.8	1 January 2100, 08:35	6.89
Junction_105	158.5	7.5	1 January 2100, 16:05	4.32
Reach_1005	158.5	6.5	2 January 2100, 01:25	3.72
Subbasin_111	25.6	0.9	1 January 2100, 15:15	3.91
Subbasin_112	6.8	0.2	1 January 2100, 14:25	3.78
Junction_106	190.9	7.4	2 January 2100, 01:00	3.75
Reach_1006	190.9	7.4	2 January 2100, 02:40	3.59
Subbasin_113	8.0	0.7	1 January 2100, 07:55	6.93
Junction_107	198.9	7.6	2 January 2100, 02:40	3.73
Reach_1007	198.9	7.6	2 January 2100, 03:10	3.66
Subbasin_114	17.0	0.8	1 January 2100, 09:20	4.02
Subbasin_115	1.4	0.4	1 January 2100, 05:30	16.40
Junction_108	217.3	8.0	2 January 2100, 03:10	3.77
Reach_1008	217.3	8.0	2 January 2100, 03:20	3.75
Subbasin_116	1.3	0.5	1 January 2100, 04:50	20.71
Junction_109	218.6	8.1	2 January 2100, 03:20	3.85
Reach_1009	218.6	8.1	2 January 2100, 05:50	3.66
Subbasin_117	9.5	0.9	1 January 2100, 09:40	8.05
Subbasin_118	9.2	2.4	1 January 2100, 05:35	16.41

Junction_110	237.3	9.2	2 January 2100, 05:35	4.33
Reach_1010	237.3	9.2	2 January 2100, 06:10	4.28
Subbasin_119	4.5	2.5	1 January 2100, 04:40	32.05
Subbasin_120	3.3	1.0	1 January 2100, 05:00	18.27
Junction_111	245.0	10.2	2 January 2100, 06:00	4.97
Reach_1011	245.0	10.2	2 January 2100, 07:05	4.87
Subbasin_121	15.0	1.4	1 January 2100, 08:55	7.87
Subbasin_122	4.2	1.0	1 January 2100, 05:45	15.14
Junction_112	264.2	11.0	2 January 2100, 06:55	5.20
Reach_1012	264.2	11.0	2 January 2100, 09:10	4.95
Subbasin_123	9.5	2.8	1 January 2100, 05:30	18.07
Subbasin_124	5.4	0.8	1 January 2100, 06:35	9.99
Junction_113	279.2	12.0	2 January 2100, 09:00	5.50
Reach_1013	279.2	12.0	2 January 2100, 09:55	5.39
Subbasin_125	9.0	1.8	1 January 2100, 05:50	12.92
Subbasin_126	7.7	1.0	1 January 2100, 06:10	8.40
Junction_114	296.0	13.2	1 January 2100, 09:25	5.69
Reach_1014	296.0	13.2	1 January 2100, 10:20	5.58
Subbasin_127	11.4	1.2	1 January 2100, 07:50	7.93
Subbasin_128	1.8	1.0	1 January 2100, 04:30	30.50
Junction_115	309.2	14.6	1 January 2100, 10:20	5.82
Reach_1015	309.2	14.6	1 January 2100, 10:50	5.73
Subbasin_132	2.2	1.2	1 January 2100, 04:10	30.63
Saugeen Flow Gauge	311.4	15.1	1 January 2100, 10:50	5.91
Reach_1016	30.3	3.5	1 January 2100, 09:30	9.21
Subbasin_131	3.1	1.9	1 January 2100, 04:10	8.13
Junction_117	344.8	18.6	1 January 2100, 10:45	6.22
Reach_1017	344.8	18.6	1 January 2100, 11:00	6.18
Subbasin_133	2.6	0.9	1 January 2100, 04:45	20.49
Junction_118	347.3	18.9	1 January 2100, 11:00	6.29
Reach_1018	347.3	18.9	1 January 2100, 11:20	6.23
Subbasin_136	1.7	1.4	1 January 2100, 04:20	13.38
Subbasin_134	0.3	0.5	1 January 2100, 05:05	21.44
Junction_119	0.3	0.5	1 January 2100, 05:05	21.44
Reach_1019	0.3	0.5	1 January 2100, 05:20	21.40
Subbasin_135	0.3	0.8	1 January 2100, 03:45	15.86
Junction_120	0.6	0.9	1 January 2100, 03:50	18.40
Reach_1020	0.6	0.9	1 January 2100, 04:05	18.42
Subbasin_137	0.3	1.2	1 January 2100, 03:40	23.10
OutflowDurham	0.9	1.9	1 January 2100, 03:50	19.94
Junction_121	349.9	19.0	1 January 2100, 11:20	6.30
Reach_1021	349.9	18.5	1 January 2100, 13:40	6.04
Subbasin_138	4.9	3.2	1 January 2100, 05:40	35.42
Sink-1	354.8	19.6	1 January 2100, 13:40	6.45

Hydrologic Peak Flow Results - Climate Change	5

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated

Areal Reduction Factor: Hazel 0.766; Durham 1.0

Peak Flow Results

Regional Storm - Hurricane Hazel - Climate Change ΔT=2.94

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.81	49.400	17 October 1954, 03:10	225.2
Subbasin_130	5.45	14.420	17 October 1954, 01:35	266.7
Junction_116	30.26	63.360	17 October 1954, 02:40	232.7
Subbasin_101	36.12	14.740	17 October 1954, 22:50	87.3
Subbasin_102	12.72	26.110	17 October 1954, 02:20	217.1
Junction_101	48.84	35.030	17 October 1954, 03:45	121.1
Reach_1001	48.84	34.950	17 October 1954, 04:55	120.1
Subbasin_103	24.35	39.820	17 October 1954, 03:25	185.5
Subbasin_104	1.18	3.670	17 October 1954, 00:55	296.6
Junction_102	74.37	77.340	17 October 1954, 04:00	144.3
Reach_1002	74.37	77.160	17 October 1954, 06:55	140.7
Subbasin_105	21.00	44.420	17 October 1954, 02:30	227.6
Subbasin_106	18.32	24.120	17 October 1954, 04:50	161.9
Junction_103	39.31	67.800	17 October 1954, 03:05	197.0
Reach_1003	39.31	67.740	17 October 1954, 03:45	195.5
Subbasin_107	20.67	38.170	17 October 1954, 02:45	201.0
Subbasin_108	3.34	13.900	17 October 1954, 00:05	367.7
Junction_104	137.68	182.470	17 October 1954, 05:05	170.9
Reach_1004	137.68	175.910	17 October 1954, 09:50	163.4
Subbasin_109	11.36	15.280	17 October 1954, 04:45	164.7
Subbasin_110	9.48	18.310	17 October 1954, 02:50	211.9
Junction_105	158.53	202.840	17 October 1954, 09:25	166.4
Reach_1005	158.53	168.310	17 October 1954, 17:20	155.1
Subbasin_111	25.59	23.400	17 October 1954, 09:10	137.6
Subbasin_112	6.81	6.620	17 October 1954, 08:15	141.5
Junction_106	190.93	194.870	17 October 1954, 17:00	152.3
Reach_1006	190.93	194.340	17 October 1954, 17:40	150.5
Subbasin_113	7.99	16.920	17 October 1954, 02:10	222.9
Junction_107	198.92	200.140	17 October 1954, 17:40	153.4
Reach_1007	198.92	199.300	17 October 1954, 18:05	152.6
Subbasin_114	17.00	26.410	17 October 1954, 03:35	176.7
Subbasin_115	1.37	5.700	17 October 1954, 00:15	377.4
Junction_108	217.29	212.800	17 October 1954, 17:30	155.9
Reach_1008	217.29	212.790	17 October 1954, 17:35	155.7
Subbasin_116	1.27	6.710	16 October 1954, 23:50	463.6
Junction_109	218.56	214.870	17 October 1954, 17:35	157.5
Reach_1009	218.56	214.680	17 October 1954, 18:50	154.8
Subbasin_117	9.51	17.490	17 October 1954, 03:40	215.1
Subbasin_118	9.23	37.120	17 October 1954, 00:15	365.3

1% AEP 6 Hour SCS Type 2 Climate Change (ΔT=2.94), ARF Durham=1, ARF Saugeen=1

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.81	21.300	1 January 2100, 09:00	71.1
Subbasin_130	5.45	6.410	1 January 2100, 07:10	84.7
Junction_116	30.26	27.440	1 January 2100, 08:30	73.6
Subbasin_101	36.12	6.220	2 January 2100, 04:55	23.5
Subbasin_102	12.72	11.500	1 January 2100, 08:00	69.6
Junction_101	48.84	15.130	1 January 2100, 09:20	35.5
Reach_1001	48.84	15.090	1 January 2100, 10:40	34.9
Subbasin_103	24.35	17.570	1 January 2100, 09:10	60.5
Subbasin_104	1.18	1.700	1 January 2100, 06:20	97.0
Junction_102	74.37	33.830	1 January 2100, 09:40	44.3
Reach_1002	74.37	33.740	1 January 2100, 13:00	41.9
Subbasin_105	21.00	19.660	1 January 2100, 08:15	73.3
Subbasin_106	18.32	10.760	1 January 2100, 10:35	54.1
Junction_103	39.31	30.080	1 January 2100, 08:50	64.3
Reach_1003	39.31	30.050	1 January 2100, 09:35	63.4
Subbasin_107	20.67	16.860	1 January 2100, 08:25	65.0
Subbasin_108	3.34	7.170	1 January 2100, 05:10	128.9
Junction_104	137.68	81.420	1 January 2100, 10:20	53.6
Reach_1004	137.68	79.470	1 January 2100, 14:55	49.0
Subbasin_109	11.36	6.580	1 January 2100, 10:30	53.0
Subbasin_110	9.48	8.070	1 January 2100, 08:30	68.2
Junction_105	158.53	91.620	1 January 2100, 14:35	50.4
Reach_1005	158.53	75.100	1 January 2100, 22:20	43.5
Subbasin_111	25.59	9.850	1 January 2100, 15:10	44.4
Subbasin_112	6.81	2.800	1 January 2100, 14:20	45.7
Junction_106	190.93	86.560	1 January 2100, 22:05	43.7
Reach_1006	190.93	86.250	1 January 2100, 23:00	42.4
Subbasin_113	7.99	7.530	1 January 2100, 07:50	71.7
Junction_107	198.92	88.840	1 January 2100, 23:00	43.6
Reach_1007	198.92	88.000	1 January 2100, 23:40	43.1
Subbasin_114	17.00	11.740	1 January 2100, 09:15	58.1
Subbasin_115	1.37	2.840	1 January 2100, 05:30	127.9
Junction_108	217.29	94.090	1 January 2100, 23:15	44.8
Reach_1008	217.29	94.080	1 January 2100, 23:20	44.7
Subbasin_116	1.27	3.660	1 January 2100, 04:50	167.3
Junction_109	218.56	95.210	1 January 2100, 23:20	45.4
Reach_1009	218.56	95.090	2 January 2100, 00:55	43.7
Subbasin_117	9.51	7.470	1 January 2100, 09:40	67.8
Subbasin_118	9.23	18.540	1 January 2100, 05:30	124.5

Junction_110	237.30	234.120	17 October 1954, 18:25	165.4
Reach_1010	237.30	234.110	17 October 1954, 18:45	164.9
Subbasin_119	4.46	25.180	16 October 1954, 23:40	496.0
Subbasin_120	3.29	16.800	16 October 1954, 24:00	452.4
Junction_111	245.04	246.980	17 October 1954, 18:40	174.8
Reach_1011	245.04	246.960	17 October 1954, 19:05	173.5
Subbasin_121	14.99	29.310	17 October 1954, 03:05	219.2
Subbasin_122	4.22	16.810	17 October 1954, 00:25	367.8
Junction_112	264.25	262.830	17 October 1954, 18:30	179.2
Reach_1012	264.25	262.810	17 October 1954, 19:30	176.3
Subbasin_123	9.55	41.820	17 October 1954, 00:15	398.9
Subbasin_124	5.42	16.970	17 October 1954, 01:00	303.9
Junction_113	279.22	281.270	17 October 1954, 19:20	186.4
Reach_1013	279.22	281.260	17 October 1954, 20:00	185.4
Subbasin_125	9.03	33.960	17 October 1954, 00:25	346.6
Subbasin_126	7.72	24.700	17 October 1954, 00:45	299.4
Junction_114	295.97	299.680	17 October 1954, 19:50	193.3
Reach_1014	295.97	299.680	17 October 1954, 20:20	192.0
Subbasin_127	11.40	25.650	17 October 1954, 02:10	235.5
Subbasin_128	1.85	11.190	16 October 1954, 23:30	522.4
Junction_115	309.22	311.590	17 October 1954, 20:15	195.6
Reach_1015	309.22	311.560	17 October 1954, 20:45	194.5
Subbasin_132	2.19	13.980	16 October 1954, 23:15	534.0
Saugeen Flow Gauge	311.41	315.690	17 October 1954, 20:45	196.9
Reach_1016	30.26	63.340	17 October 1954, 03:45	231.1
Subbasin_131	3.11	21.460	16 October 1954, 23:15	154.1
Junction_117	344.78	376.030	17 October 1954, 03:35	199.5
Reach_1017	344.78	375.930	17 October 1954, 03:40	199.1
Subbasin_133	2.57	13.080	16 October 1954, 23:45	441.6
Junction_118	347.35	381.500	17 October 1954, 03:40	200.9
Reach_1018	347.35	381.480	17 October 1954, 03:55	200.4
Subbasin_136	1.71	9.900	16 October 1954, 23:20	145.9
Subbasin_134	0.27	2.870	17 October 1954, 00:05	261.3
Junction_119	0.27	2.870	17 October 1954, 00:05	261.3
Reach_1019	0.27	2.840	17 October 1954, 00:15	261.1
Subbasin_135	0.32	4.040	16 October 1954, 22:35	204.8
Junction_120	0.58	5.890	16 October 1954, 23:10	230.7
Reach_1020	0.58	5.890	16 October 1954, 23:20	230.7
Subbasin_137	0.28	3.980	16 October 1954, 22:25	246.4
OutflowDurham	0.87	9.450	16 October 1954, 22:40	235.8
Junction_121	349.92	384.310	17 October 1954, 03:50	200.2
Reach_1021	349.92	377.780	17 October 1954, 05:05	197.4
Subbasin_138	4.88	30.880	17 October 1954, 00:30	528.4
Sink-1	354.80	388.410	17 October 1954, 05:05	202.0

Junction_110	237.30	104.160	2 January 2100, 00:40	47.8
Reach_1010	237.30	104.150	2 January 2100, 01:00	47.4
Subbasin_119	4.46	14.870	1 January 2100, 04:40	190.4
Subbasin_120	3.29	8.820	1 January 2100, 05:10	158.8
Junction_111	245.04	111.340	2 January 2100, 00:55	51.5
Reach_1011	245.04	111.330	2 January 2100, 01:30	50.6
Subbasin_121	14.99	12.580	1 January 2100, 08:55	69.1
Subbasin_122	4.22	8.090	1 January 2100, 05:45	121.3
Junction_112	264.25	118.240	2 January 2100, 01:25	52.8
Reach_1012	264.25	118.220	2 January 2100, 02:55	50.8
Subbasin_123	9.55	20.850	1 January 2100, 05:25	134.4
Subbasin_124	5.42	7.590	1 January 2100, 06:35	95.7
Junction_113	279.22	126.980	2 January 2100, 02:50	54.5
Reach_1013	279.22	126.970	2 January 2100, 03:15	53.8
Subbasin_125	9.03	16.210	1 January 2100, 05:45	113.9
Subbasin_126	7.72	11.420	1 January 2100, 06:05	97.1
Junction_114	295.97	135.500	2 January 2100, 03:10	56.8
Reach_1014	295.97	135.500	2 January 2100, 03:45	55.9
Subbasin_127	11.40	11.320	1 January 2100, 07:50	75.4
Subbasin_128	1.85	6.790	1 January 2100, 04:30	205.5
Junction_115	309.22	141.200	2 January 2100, 03:40	57.5
Reach_1015	309.22	141.190	2 January 2100, 04:25	56.8
Subbasin_132	2.19	9.230	1 January 2100, 04:10	227.7
Saugeen Flow Gauge	311.41	143.840	2 January 2100, 04:20	58.0
Reach_1016	30.26	27.430	1 January 2100, 09:35	72.7
Subbasin_131	3.11	14.080	1 January 2100, 04:15	63.3
Junction_117	344.78	157.630	1 January 2100, 09:30	59.3
Reach_1017	344.78	157.550	1 January 2100, 09:40	59.1
Subbasin_133	2.57	7.310	1 January 2100, 04:40	163.0
Junction_118	347.35	160.100	1 January 2100, 09:40	59.9
Reach_1018	347.35	160.050	1 January 2100, 10:00	59.5
Subbasin_136	1.71	6.890	1 January 2100, 04:15	63.7
Subbasin_134	0.27	1.830	1 January 2100, 05:05	78.6
Junction_119	0.27	1.830	1 January 2100, 05:05	78.6
Reach_1019	0.27	1.790	1 January 2100, 05:20	78.4
Subbasin_135	0.32	3.880	1 January 2100, 03:45	66.9
Junction_120	0.58	4.380	1 January 2100, 03:50	72.2
Reach_1020	0.58	4.380	1 January 2100, 04:00	72.2
Subbasin_137	0.28	4.330	1 January 2100, 03:40	78.9
OutflowDurham	0.87	8.070	1 January 2100, 03:50	74.4
Junction_121	349.92	161.100	1 January 2100, 10:00	59.6
Reach_1021	349.92	157.680	1 January 2100, 12:20	57.6
Subbasin_138	4.88	21.340	1 January 2100, 05:40	232.7
Sink-1	354.80	164.850	1 January 2100, 12:20	60.0

Hydrologic Peak Flow Results - Climate Change	6

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model: Saugeen_HMS_Calibrated **Areal Reduction Factor:** 1.0

Peak Flow Results

2% AEP 6 Hour SCS Type 2 Climate Change (ΔT=2.94), ARF Durham=1, ARF Saugeen=1

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.81	18.370	1 January 2100, 09:00	61.4
Subbasin_130	5.45	5.500	1 January 2100, 07:10	72.6
Junction_116	30.26	23.630	1 January 2100, 08:25	63.4
Subbasin_101	36.12	5.300	2 January 2100, 04:55	20.0
Subbasin_102	12.72	9.840	1 January 2100, 08:00	59.5
Junction_101	48.84	12.930	1 January 2100, 09:20	30.3
Reach_1001	48.84	12.900	1 January 2100, 10:35	29.8
Subbasin_103	24.35	15.090	1 January 2100, 09:10	52.0
Subbasin_104	1.18	1.460	1 January 2100, 06:20	83.1
Junction_102	74.37	29.000	1 January 2100, 09:40	37.9
Reach_1002	74.37	28.950	1 January 2100, 12:15	35.9
Subbasin_105	21.00	16.880	1 January 2100, 08:10	62.9
Subbasin_106	18.32	9.260	1 January 2100, 10:35	46.5
Junction_103	39.31	25.840	1 January 2100, 08:50	55.3
Reach_1003	39.31	25.820	1 January 2100, 09:35	54.4
Subbasin_107	20.67	14.470	1 January 2100, 08:25	55.8
Subbasin_108	3.34	6.180	1 January 2100, 05:05	111.1
Junction_104	137.68	69.750	1 January 2100, 10:25	46.0
Reach_1004	137.68	68.120	1 January 2100, 14:55	41.9
Subbasin_109	11.36	5.630	1 January 2100, 10:30	45.3
Subbasin_110	9.48	6.910	1 January 2100, 08:30	58.4
Junction_105	158.53	78.490	1 January 2100, 14:40	43.1
Reach_1005	158.53	64.150	1 January 2100, 23:05	37.2
Subbasin_111	25.59	8.410	1 January 2100, 15:10	37.9
Subbasin_112	6.81	2.390	1 January 2100, 14:20	39.1
Junction_106	190.93	73.770	1 January 2100, 22:50	37.3
Reach_1006	190.93	73.510	1 January 2100, 23:45	36.2
Subbasin_113	7.99	6.480	1 January 2100, 07:50	61.7
Junction_107	198.92	75.720	1 January 2100, 23:45	37.2
Reach_1007	198.92	74.940	2 January 2100, 00:25	36.8
Subbasin_114	17.00	10.050	1 January 2100, 09:15	49.8
Subbasin_115	1.37	2.450	1 January 2100, 05:30	110.4
Junction_108	217.29	79.870	1 January 2100, 24:00	38.3
Reach_1008	217.29	79.870	2 January 2100, 00:10	38.2
Subbasin_116	1.27	3.170	1 January 2100, 04:50	144.6
Junction_109	218.56	80.840	2 January 2100, 00:10	38.8
Reach_1009	218.56	80.730	2 January 2100, 01:45	37.2
Subbasin_117	9.51	6.430	1 January 2100, 09:40	58.4
Subbasin_118	9.23	15.980	1 January 2100, 05:30	107.3

4% AEP 6 Hour SCS Type 2 Climate Change (ΔT=2.94), ARF Durham=1, ARF Saugeen=1

Hydrologic Element	Drainage Area	Peak Discharge	Time of Peak	Volume (mm)
Subbasin_129	24.81	15.280	1 January 2100, 09:00	51.0
Subbasin_130	5.45	4.560	1 January 2100, 07:05	60.3
Junction_116	30.26	19.650	1 January 2100, 08:25	52.7
Subbasin_101	36.12	4.350	2 January 2100, 04:55	16.4
Subbasin_102	12.72	8.120	1 January 2100, 08:00	49.1
Junction_101	48.84	10.660	1 January 2100, 09:20	25.0
Reach_1001	48.84	10.640	1 January 2100, 10:35	24.6
Subbasin_103	24.35	12.470	1 January 2100, 09:10	43.0
Subbasin_104	1.18	1.200	1 January 2100, 06:20	68.5
Junction_102	74.37	23.950	1 January 2100, 09:35	31.3
Reach_1002	74.37	23.910	1 January 2100, 12:20	29.6
Subbasin_105	21.00	13.950	1 January 2100, 08:10	52.0
Subbasin_106	18.32	7.680	1 January 2100, 10:35	38.6
Junction_103	39.31	21.390	1 January 2100, 08:50	45.8
Reach_1003	39.31	21.370	1 January 2100, 09:35	45.0
Subbasin_107	20.67	11.940	1 January 2100, 08:25	46.0
Subbasin_108	3.34	5.140	1 January 2100, 05:05	92.4
Junction_104	137.68	57.550	1 January 2100, 10:30	38.0
Reach_1004	137.68	55.530	1 January 2100, 15:55	34.5
Subbasin_109	11.36	4.620	1 January 2100, 10:30	37.2
Subbasin_110	9.48	5.740	1 January 2100, 08:30	48.5
Junction_105	158.53	63.640	1 January 2100, 15:35	35.5
Reach_1005	158.53	52.350	1 January 2100, 24:00	30.5
Subbasin_111	25.59	6.950	1 January 2100, 15:10	31.3
Subbasin_112	6.81	1.980	1 January 2100, 14:20	32.2
Junction_106	190.93	60.100	1 January 2100, 23:45	30.7
Reach_1006	190.93	59.900	2 January 2100, 00:45	29.7
Subbasin_113	7.99	5.370	1 January 2100, 07:50	51.2
Junction_107	198.92	61.710	2 January 2100, 00:40	30.6
Reach_1007	198.92	61.050	2 January 2100, 01:25	30.2
Subbasin_114	17.00	8.270	1 January 2100, 09:15	41.0
Subbasin_115	1.37	2.040	1 January 2100, 05:25	91.8
Junction_108	217.29	64.830	2 January 2100, 01:05	31.5
Reach_1008	217.29	64.820	2 January 2100, 01:10	31.4
Subbasin_116	1.27	2.640	1 January 2100, 04:50	120.4
Junction_109	218.56	65.620	2 January 2100, 01:10	31.9
Reach_1009	218.56	65.540	2 January 2100, 02:55	30.6
Subbasin_117	9.51	5.340	1 January 2100, 09:35	48.5
Subbasin_118	9.23	13.360	1 January 2100, 05:30	89.7

Junction_110	237.30	88.320	2 January 2100, 01:30	40.8
Reach_1010	237.30	88.310	2 January 2100, 01:50	40.5
Subbasin_119	4.46	13.000	1 January 2100, 04:40	166.2
Subbasin_120	3.29	7.640	1 January 2100, 05:05	137.1
Junction_111	245.04	94.520	2 January 2100, 01:45	44.1
Reach_1011	245.04	94.510	2 January 2100, 02:25	43.3
Subbasin_121	14.99	10.810	1 January 2100, 08:55	59.3
Subbasin_122	4.22	6.980	1 January 2100, 05:40	104.5
Junction_112	264.25	100.400	2 January 2100, 02:20	45.2
Reach_1012	264.25	100.390	2 January 2100, 03:50	43.4
Subbasin_123	9.55	18.020	1 January 2100, 05:25	116.1
Subbasin_124	5.42	6.510	1 January 2100, 06:30	82.0
Junction_113	279.22	107.870	2 January 2100, 03:45	46.6
Reach_1013	279.22	107.870	2 January 2100, 04:10	46.0
Subbasin_125	9.03	13.920	1 January 2100, 05:45	97.8
Subbasin_126	7.72	9.780	1 January 2100, 06:05	83.1
Junction_114	295.97	115.120	2 January 2100, 04:05	48.5
Reach_1014	295.97	115.110	2 January 2100, 04:45	47.7
Subbasin_127	11.40	9.700	1 January 2100, 07:45	64.6
Subbasin_128	1.85	5.920	1 January 2100, 04:30	178.9
Junction_115	309.22	119.980	2 January 2100, 04:45	49.1
Reach_1015	309.22	119.950	2 January 2100, 05:30	48.5
Subbasin_132	2.19	8.000	1 January 2100, 04:10	197.2
Saugeen Flow Gauge	311.41	122.230	2 January 2100, 05:30	49.6
Reach_1016	30.26	23.620	1 January 2100, 09:35	62.6
Subbasin_131	3.11	12.270	1 January 2100, 04:15	54.5
Junction_117	344.78	134.950	1 January 2100, 09:40	50.8
Reach_1017	344.78	134.880	1 January 2100, 09:50	50.5
Subbasin_133	2.57	6.320	1 January 2100, 04:40	140.9
Junction_118	347.35	137.080	1 January 2100, 09:50	51.2
Reach_1018	347.35	137.050	1 January 2100, 10:10	50.9
Subbasin_136	1.71	6.070	1 January 2100, 04:15	56.1
Subbasin_134	0.27	1.630	1 January 2100, 05:05	70.0
Junction_119	0.27	1.630	1 January 2100, 05:05	70.0
Reach_1019	0.27	1.590	1 January 2100, 05:20	69.8
Subbasin_135	0.32	3.430	1 January 2100, 03:45	59.5
Junction_120	0.58	3.880	1 January 2100, 03:50	64.2
Reach_1020	0.58	3.880	1 January 2100, 04:00	64.2
Subbasin_137	0.28	3.870	1 January 2100, 03:40	70.8
OutflowDurham	0.87	7.160	1 January 2100, 03:50	66.4
Junction_121	349.92	137.900	1 January 2100, 10:10	51.0
Reach_1021	349.92	134.390	1 January 2100, 12:10	49.2
Subbasin_138	4.88	18.580	1 January 2100, 05:35	202.7
Sink-1	354.80	140.650	1 January 2100, 12:10	51.3

Junction_110	237.30	71.630	2 January 2100, 02:40	33.6
Reach_1010	237.30	71.620	2 January 2100, 03:00	33.3
Subbasin_119	4.46	10.970	1 January 2100, 04:40	140.2
Subbasin_120	3.29	6.370	1 January 2100, 05:05	114.2
Junction_111	245.04	76.780	2 January 2100, 02:55	36.3
Reach_1011	245.04	76.780	2 January 2100, 03:35	35.6
Subbasin_121	14.99	8.960	1 January 2100, 08:55	49.2
Subbasin_122	4.22	5.800	1 January 2100, 05:40	86.9
Junction_112	264.25	81.610	2 January 2100, 03:30	37.2
Reach_1012	264.25	81.600	2 January 2100, 05:05	35.7
Subbasin_123	9.55	15.030	1 January 2100, 05:25	96.8
Subbasin_124	5.42	5.390	1 January 2100, 06:30	67.9
Junction_113	279.22	87.750	2 January 2100, 05:05	38.4
Reach_1013	279.22	87.750	2 January 2100, 05:35	37.8
Subbasin_125	9.03	11.580	1 January 2100, 05:45	81.4
Subbasin_126	7.72	8.080	1 January 2100, 06:05	68.7
Junction_114	295.97	93.690	2 January 2100, 05:30	39.9
Reach_1014	295.97	93.680	2 January 2100, 06:15	39.2
Subbasin_127	11.40	8.050	1 January 2100, 07:45	53.6
Subbasin_128	1.85	4.990	1 January 2100, 04:30	150.5
Junction_115	309.22	97.690	2 January 2100, 06:10	40.4
Reach_1015	309.22	97.670	2 January 2100, 06:50	40.0
Subbasin_132	2.19	6.720	1 January 2100, 04:05	165.6
Saugeen Flow Gauge	311.41	99.560	2 January 2100, 06:50	40.8
Reach_1016	30.26	19.640	1 January 2100, 09:35	52.1
Subbasin_131	3.11	10.350	1 January 2100, 04:15	45.4
Junction_117	344.78	111.640	1 January 2100, 09:50	41.9
Reach_1017	344.78	111.590	1 January 2100, 10:00	41.7
Subbasin_133	2.57	5.280	1 January 2100, 04:40	117.8
Junction_118	347.35	113.420	1 January 2100, 10:00	42.2
Reach_1018	347.35	113.400	1 January 2100, 10:20	42.0
Subbasin_136	1.71	5.190	1 January 2100, 04:15	48.1
Subbasin_134	0.27	1.420	1 January 2100, 05:05	60.8
Junction_119	0.27	1.420	1 January 2100, 05:05	60.8
Reach_1019	0.27	1.390	1 January 2100, 05:20	60.6
Subbasin_135	0.32	2.960	1 January 2100, 03:45	51.7
Junction_120	0.58	3.360	1 January 2100, 03:50	55.8
Reach_1020	0.58	3.360	1 January 2100, 04:00	55.8
Subbasin_137	0.28	3.390	1 January 2100, 03:40	62.4
OutflowDurham	0.87	6.220	1 January 2100, 03:50	58.0
Junction_121	349.92	114.100	1 January 2100, 10:15	42.0
Reach_1021	349.92	110.850	1 January 2100, 12:10	40.5
Subbasin_138	4.88	15.650	1 January 2100, 05:35	170.8
Sink-1	354.80	116.120	1 January 2100, 12:10	42.3

Sensitivity Analysis Results

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model Saugeen_HMS_Calibrated **Areal Reduction Factor:** 0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Hydraulic		Hazel 125% Hydraulic		Hazel 75% Wetting Front		Hazel 125% Wetting Front		Hazel 75% Initial Water		Hazel 125% Initial Water	
		Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)
Subbasin_129	24.80	3.3	15.4	-2.8	-13.0	1.1	5.0	-0.9	-4.3	-1.2	-5.6	1.4	6.6
Subbasin_130	5.40	1.0	19.8	-1.0	-18.4	0.3	5.9	-0.3	-5.7	-0.4	-8.0	0.4	8.6
Junction_116	30.30	4.3	16.2	-3.7	-14.0	1.4	5.1	-1.2	-4.6	-1.6	-6.0	1.9	7.0
Subbasin_101	36.10	1.5	9.0	-1.5	-8.9	0.4	2.2	-0.4	-2.1	-0.8	-4.8	0.9	5.2
Subbasin_102	12.70	2.5	21.3	-2.5	-20.9	0.7	5.8	-0.6	-5.6	-1.1	-9.5	1.2	10.1
Junction_101	48.80	3.4	12.2	-3.4	-12.0	0.9	3.1	-0.9	-3.0	-1.6	-6.0	1.7	6.5
Reach_1001	48.80	3.4	12.1	-3.4	-11.9	0.9	3.1	-0.9	-3.0	-1.6	-6.0	1.7	6.4
Subbasin_103	24.40	4.3	20.3	-4.2	-20.0	1.1	5.4	-1.1	-5.2	-1.8	-8.8	2.0	9.5
Subbasin_104	1.20	0.3	23.4	-0.3	-22.1	0.1	5.5	-0.1	-5.3	-0.2	-12.5	0.2	13.7
Junction_102	74.40	7.9	15.0	-7.8	-14.7	2.1	3.9	-2.1	-3.8	-3.6	-7.0	3.9	7.5
Reach_1002	74.40	8.0	14.6	-7.8	-14.4	2.1	3.8	-2.1	-3.7	-3.6	-6.8	3.9	7.4
Subbasin_105	21.00	3.4	18.0	-3.2	-17.0	0.9	4.5	-0.8	-4.3	-1.8	-9.3	1.9	10.2
Subbasin_106	18.30	2.8	19.1	-2.8	-18.7	0.7	5.0	-0.7	-4.8	-1.2	-8.0	1.2	8.5
Junction_103	39.30	6.2	18.5	-5.9	-17.8	1.6	4.7	-1.5	-4.6	-2.9	-8.7	3.1	9.4
Reach_1003	39.30	6.2	18.4	-5.9	-17.6	1.6	4.7	-1.5	-4.5	-2.9	-8.6	3.1	9.3
Subbasin_107	20.70	4.0	21.6	-4.0	-21.2	1.1	5.8	-1.0	-5.6	-1.8	-9.5	1.9	10.2
Subbasin_108	3.30	1.1	32.0	-1.1	-31.4	0.3	9.4	-0.3	-9.1	-0.4	-12.4	0.4	13.0
Junction_104	137.70	17.6	17.2	-16.6	-16.7	3.8	4.5	-4.0	-4.3	-6.9	-7.9	7.8	8.5
Reach_1004	137.70	16.8	16.5	-16.4	-16.0	4.2	4.3	-4.0	-4.2	-7.2	-7.5	7.9	8.1
Subbasin_109	11.40	1.7	18.3	-1.7	-17.8	0.4	4.9	-0.4	-4.7	-0.8	-8.2	0.8	8.7
Subbasin_110	9.50	1.6	18.7	-1.6	-18.3	0.4	5.1	-0.4	-5.0	-0.7	-8.7	0.8	9.2
Junction_105	158.50	19.4	16.8	-18.6	-16.3	4.9	4.4	-4.6	-4.2	-8.2	-7.6	9.1	8.2
Reach_1005	158.50	17.6	16.2	-16.4	-15.3	4.6	4.2	-4.3	-4.0	-7.7	-7.3	8.4	7.9
Subbasin_111	25.60	2.0	11.9	-1.9	-11.4	0.5	3.2	-0.5	-3.1	-1.0	-5.9	1.1	6.3
Subbasin_112	6.80	0.6	12.6	-0.6	-12.2	0.2	3.2	-0.1	-3.1	-0.3	-6.6	0.3	7.1
Junction_106	190.90	19.9	15.5	-18.3	-14.7	5.2	4.0	-4.9	-3.9	-8.8	-7.1	9.7	7.6
Reach_1006	190.90	19.8	15.4	-18.2	-14.5	5.1	4.0	-4.9	-3.8	-8.8	-7.0	9.6	7.6
Subbasin_113	8.00	1.6	22.0	-1.6	-21.5	0.5	6.5	-0.5	-6.2	-0.6	-8.7	0.7	9.3
Junction_107	198.90	20.4	15.6	-18.8	-14.8	5.3	4.1	-5.0	-3.9	-9.0	-7.1	9.9	7.6
Reach_1007	198.90	20.3	15.5	-18.7	-14.7	5.3	4.1	-5.0	-3.9	-8.9	-7.0	9.8	7.6
Subbasin_114	17.00	3.2	22.1	-3.2	-21.6	0.9	5.9	-0.8	-5.7	-1.3	-9.0	1.4	9.5
Subbasin_115	1.40	0.3	23.7	-0.3	-21.7	0.1	7.1	-0.1	-6.6	-0.1	-10.2	0.2	11.4
Junction_108	217.30	21.8	16.1	-19.8	-15.3	5.7	4.2	-5.4	-4.1	-9.5	-7.2	10.4	7.8
Reach_1008	217.30	21.8	16.1	-19.8	-15.3	5.7	4.2	-5.4	-4.1	-9.5	-7.2	10.4	7.8
Subbasin_116	1.30	0.3	23.9	-0.3	-21.5	0.1	7.6	-0.1	-7.3	-0.1	-10.2	0.1	11.3
Junction_109	218.60	21.9	16.1	-19.9	-15.3	5.7	4.3	-5.4	-4.1	-9.5	-7.2	10.5	7.8
Reach_1009	218.60	21.9	15.9	-19.8	-15.1	5.7	4.2	-5.4	-4.0	-9.5	-7.1	10.5	7.7
Subbasin_117	9.50	1.1	14.5	-1.0	-12.1	0.3	4.1	-0.3	-4.0	-0.5	-6.4	0.6	7.6
Subbasin_118	9.20	2.4	25.3	-2.3	-24.4	0.7	7.5	-0.7	-7.2	-1.0	-10.7	1.1	11.4
Junction_110	237.30	23.2	16.2	-20.7	-15.4	6.0	4.3	-5.7	-4.2	-10.0	-7.2	11.1	7.8
Reach_1010	237.30	23.1	16.2	-20.7	-15.3	6.0	4.3	-5.7	-4.2	-10.0	-7.2	11.1	7.8
Subbasin_119	4.50	1.0	23.0	-1.0	-20.6	0.3	7.4	-0.3	-6.8	-0.4	-8.8	0.4	10.0
Subbasin_120	3.30	0.7	21.2	-0.7	-19.5	0.2	7.0	-0.2	-6.6	-0.4	-10.9	0.4	12.6
Junction_111	245.00	23.7	16.4	-21.2	-15.5	6.2	4.4	-5.9	-4.2	-10.2	-7.3	11.3	7.9
Reach_1011	245.00	23.7	16.3	-21.1	-15.4	6.2	4.4	-5.9	-4.2	-10.2	-7.2	11.3	7.9
Subbasin_121	15.00	2.1	15.7	-1.9	-14.3	0.6	4.9	-0.6	-4.6	-0.8	-6.3	0.9	6.9
Subbasin_122	4.20	0.9	22.4	-0.9	-19.5	0.3	7.4	-0.3	-6.5	-0.4	-8.5	0.4	9.9
Junction_112	264.20	24.7	16.4	-21.7	-15.4	6.5	4.5	-6.2	-4.3	-10.6	-7.2	11.8	7.8
Reach_1012	264.20	24.7	16.1	-21.7	-15.2	6.5	4.4	-6.2	-4.2	-10.6	-7.1	11.8	7.7
Subbasin_123	9.50	2.2	22.6	-2.0	-19.8	0.7	7.5	-0.7	-6.8	-0.9	-8.8	1.0	10.0
Subbasin_124	5.40	1.1	20.2	-1.0	-18.0	0.4	6.7	-0.3	-6.0	-0.4	-7.4	0.5	8.6
Junction_113	279.20	25.7	16.4	-22.4	-15.4	6.9	4.5	-6.5	-4.3	-10.9	-7.2	12.2	7.8
Reach_1013	279.20	25.7	16.4	-22.4	-15.3	6.9	4.5	-6.5	-4.3	-10.9	-7.1	12.2	7.8
Subbasin_125	9.00	2.2	24.1	-2.1	-22.7	0.7	7.4	-0.6	-7.1	-0.9	-9.7	0.9	10.2
Subbasin_126	7.70	2.1	26.2	-2.0	-25.7	0.6	7.7	-0.6	-7.4	-0.8	-10.9	0.9	11.4
Junction_114	296.00	27.1	16.9	-23.5	-15.8	7.3	4.7	-6.8	-4.5	-11.4	-7.3	12.8	8.0
Reach_1014	296.00	27.1	16.8	-23.5	-15.7	7.3	4.7	-6.8	-4.5	-11.4	-7.3	12.8	7.9
Subbasin_127	11.40	2.0	19.4	-2.0	-18.6	0.6	5.5	-0.6	-5.3	-0.9	-8.5	1.0	9.1
Subbasin_128	1.80	0.4	23.5	-0.4	-21.1	0.1	7.2	-0.1	-6.9	-0.2	-10.4	0.2	11.6
Junction_115	309.20	27.9	16.9	-24.2	-15.9	7.5	4.7	-7.0	-4.5	-11.7	-7.3	13.1	8.0
Reach_1015	309.20	27.9	16.8	-24.2	-15.8	7.5	4.7	-7.0	-4.5	-11.7	-7.3	13.1	7.9
Subbasin_132	2.20	0.7	31.1	-0.7	-30.3	0.2	8.8	-0.2	-8.5	-0.3	-13.2	0.3	14.2
Saugeen Flow Gauge	311.40	28.1	16.9	-24.4	-15.9	7.5	4.7	-7.0	-4.5	-11.8	-7.3	13.2	8.0
Reach_1016	30.30	4.3	16.1	-3.7	-13.9	1.4	5.1	-1.2	-4.6	-1.6	-6.0	1.8	6.9
Subbasin_131	3.10	0.7	9.3	-0.6	-7.7	0.2	3.1	-0.2	-2.6	-0.3	-4.2	0.4	5.5
Junction_117	344.80	28.1	16.8	-26.4	-15.6	8.6	4.7	-8.1	-4.5	-11.8	-7.2	12.9	7.9
Reach_1017	344.80	28.0	16.7	-26.4	-15.6	8.6	4.7	-8.1	-4.5	-11.8	-7.2	12.8	7.8
Subbasin_133	2.60	0.8	29.7	-0.8	-29.0	0.2	9.4	-0.2	-9.0	-0.3	-10.8	0.3	11.3
Junction_118	347.30	28.3	16.8	-26.7	-15.7	8.7	4.8	-8.2	-4.5	-11.9	-7.2	12.9	7.9
Reach_1018	347.30	28.3	16.8	-26.7	-15.7	8.6	4.8	-8.2	-4.5	-11.9	-7.2	12.9	7.9
Subbasin_136	1.70	0.6	12.7	-0.6	-12.0	0.2	3.3	-0.1	-3.1	-0.2	-5.0	0.3	5.4
Subbasin_134	0.30	0.0	7.4	0.0	-6.3	0.0	2.3	0.0	-2.1	0.0	-2.3	0.0	2.7
Junction_119	0.30	0.0	7.4	0.0	-6.3	0.0	2.3	0.0	-2.1	0.0	-2.3	0.0	2.7
Reach_1019	0.30	0.0	7.4	0.0	-6.3	0.0	2.3	0.0	-2.1	0.0	-2.4	0.0	2.7
Subbasin_135	0.30	0.2	16.7	-0.2	-6.8	0.1	3.3	0.0	-1.9	0.0	-1.7	0.0	2.8
Junction_120	0.60	0.2	12.4	-0.2	-6.6	0.0	2.8	0.0	-2.0	0.0	-2.0	0.0	2.8
Reach_1020	0.60	0.2	12.4	-0.2	-6.6	0.0	2.8	0.0	-2.0	0.0	-2.0	0.0	2.8
Subbasin_137	0.30	0.1	11.7	-0.1	-4.7	0.0	2.2	0.0	-1.2	0.0	-1.0	0.0	1.9
OutflowDurham	0.90	0.4	12.2	-0.3	-6.0	0.1	2.6	-0.1	-1.7	-0.1	-1.7	0.1	2.5
Junction_121	349.90	28.7	16.8	-26.9	-15.6	8.7	4.8	-8.3	-4.5	-12.0	-7.2	13.1	7.8
Reach_1021	349.90	28.2	16.6	-26.3	-15.4	8.6	4.7	-8.1	-4.4	-11.7	-7.1	12.8	7.8
Subbasin_138	4.90	1.8	34.9	-1.7	-34.2	0.5	9.5	-0.4	-9.1	-0.6	-12.4	0.6	13.1
Sink-1	354.80	28.9	16.8	-26.9	-15.7	8.7	4.8	-8.3	-4.5	-11.9	-7.1	13.0	7.8
	Maximum	28.9	34.9	0.0	-4.7	8.7	9.5	0.0	-1.2	0.0	-1.0	13.2	14.2
	Minimum	0.0	7.4	-26.9	-34.2	0.0	2.2	-8.3	-9.1	-12.0	-13.2	0.0	1.9

Sensitivity Analysis Results	2

Project No:	5591
Project Name:	Durham Creek FPM
Designed/Checked By:	SO/MC
Date:	12-Dec-23

Basin Model	Saugeen_HMS_Calibrated	Areal Reduction Factor:	0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Hydraulic		Hazel 125% Hydraulic		Hazel 75% Wetting Front		Hazel 125% Wetting Front		Hazel 75% Initial Water		Hazel 125% Initial Water	
		Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume
Subbasin_129	24.80	8.8%	9.1%	-7.5%	-7.7%	2.9%	3.0%	-2.5%	-2.6%	-3.2%	-3.3%	3.8%	3.9%
Subbasin_130	5.40	9.5%	10.0%	-9.0%	-9.3%	2.8%	3.0%	-2.8%	-2.9%	-3.9%	-4.1%	4.1%	4.3%
Junction_116	30.30	9.0%	9.3%	-7.9%	-8.0%	2.9%	3.0%	-2.5%	-2.6%	-3.4%	-3.5%	3.9%	4.0%
Subbasin_101	36.10	14.3%	14.5%	-14.1%	-14.3%	3.5%	3.5%	-3.3%	-3.4%	-7.6%	-7.7%	8.2%	8.3%
Subbasin_102	12.70	13.2%	13.6%	-13.0%	-13.4%	3.5%	3.7%	-3.4%	-3.6%	-5.8%	-6.0%	6.2%	6.5%
Junction_101	48.80	13.6%	14.1%	-13.3%	-13.9%	3.6%	3.6%	-3.4%	-3.5%	-6.4%	-6.9%	6.9%	7.5%
Reach_1001	48.80	13.6%	14.1%	-13.5%	-13.8%	3.6%	3.6%	-3.5%	-3.5%	-6.5%	-6.9%	6.9%	7.5%
Subbasin_103	24.40	15.0%	15.4%	-14.8%	-15.2%	4.0%	4.1%	-3.8%	-4.0%	-6.5%	-6.7%	7.0%	7.2%
Subbasin_104	1.20	10.2%	10.6%	-9.5%	-10.0%	2.2%	2.5%	-2.2%	-2.4%	-5.5%	-5.7%	5.8%	6.2%
Junction_102	74.40	14.3%	14.5%	-14.1%	-14.3%	3.8%	3.8%	-3.8%	-3.6%	-6.6%	-6.8%	7.0%	7.3%
Reach_1002	74.40	14.4%	14.6%	-14.0%	-14.3%	3.8%	3.8%	-3.7%	-3.7%	-6.5%	-6.8%	7.0%	7.3%
Subbasin_105	21.00	10.4%	10.7%	-9.8%	-10.1%	2.6%	2.7%	-2.5%	-2.6%	-5.3%	-5.5%	5.9%	6.0%
Subbasin_106	18.30	16.4%	16.7%	-16.1%	-16.4%	4.3%	4.4%	-4.2%	-4.2%	-6.8%	-7.0%	7.3%	7.4%
Junction_103	39.30	12.5%	13.0%	-12.0%	-12.4%	3.2%	3.3%	-3.1%	-3.2%	-5.9%	-6.1%	6.3%	6.6%
Reach_1003	39.30	12.5%	13.0%	-12.0%	-12.4%	3.2%	3.3%	-3.1%	-3.2%	-5.9%	-6.1%	6.3%	6.6%
Subbasin_107	20.70	14.6%	15.1%	-14.5%	-14.8%	3.9%	4.0%	-3.8%	-3.9%	-6.4%	-6.6%	6.8%	7.1%
Subbasin_108	3.30	10.8%	11.9%	-10.6%	-11.6%	3.2%	3.5%	-3.0%	-3.4%	-4.1%	-4.6%	4.4%	4.8%
Junction_104	137.70	13.4%	14.0%	-12.7%	-13.6%	2.9%	3.7%	-3.0%	-3.5%	-5.3%	-6.4%	5.9%	6.9%
Reach_1004	137.70	13.2%	14.1%	-12.9%	-13.6%	3.3%	3.7%	-3.2%	-3.5%	-5.7%	-6.4%	6.2%	6.9%
Subbasin_109	11.40	15.4%	15.7%	-15.2%	-15.3%	4.1%	4.2%	-4.0%	-4.0%	-7.0%	-7.1%	7.3%	7.5%
Subbasin_110	9.50	11.8%	12.1%	-11.5%	-11.9%	3.2%	3.3%	-3.1%	-3.2%	-5.4%	-5.6%	5.7%	5.9%
Junction_105	158.50	13.3%	14.0%	-12.8%	-13.6%	3.3%	3.7%	-3.2%	-3.6%	-5.6%	-6.4%	6.2%	6.9%
Reach_1005	158.50	14.7%	14.8%	-13.7%	-14.0%	3.8%	3.8%	-3.6%	-3.7%	-6.5%	-6.6%	7.1%	7.2%
Subbasin_111	25.60	11.7%	11.9%	-11.2%	-11.4%	3.2%	3.2%	-3.0%	-3.1%	-5.7%	-5.8%	6.2%	6.3%
Subbasin_112	6.80	12.0%	12.2%	-11.8%	-11.9%	3.1%	3.1%	-2.9%	-3.0%	-6.4%	-6.4%	6.8%	6.9%
Junction_106	190.90	14.4%	14.3%	-13.2%	-13.6%	3.7%	3.7%	-3.5%	-3.6%	-6.4%	-6.5%	7.0%	7.1%
Reach_1006	190.90	14.3%	14.4%	-13.2%	-13.6%	3.7%	3.8%	-3.5%	-3.6%	-6.4%	-6.6%	7.0%	7.1%
Subbasin_113	8.00	13.3%	13.7%	-13.1%	-13.4%	3.8%	4.0%	-3.8%	-3.9%	-5.2%	-5.4%	5.6%	5.8%
Junction_107	198.90	14.3%	14.4%	-13.2%	-13.6%	3.7%	3.8%	-3.5%	-3.6%	-6.3%	-6.5%	6.9%	7.0%
Reach_1007	198.90	14.3%	14.4%	-13.2%	-13.6%	3.7%	3.8%	-3.5%	-3.6%	-6.3%	-6.5%	6.9%	7.0%
Subbasin_114	17.00	17.5%	18.0%	-17.3%	-17.6%	4.7%	4.8%	-4.5%	-4.7%	-7.1%	-7.3%	7.4%	7.7%
Subbasin_115	1.40	7.6%	8.3%	-7.1%	-7.6%	2.3%	2.5%	-2.3%	-2.3%	-3.4%	-3.6%	3.4%	4.0%
Junction_108	217.30	14.4%	14.6%	-13.1%	-13.9%	3.8%	3.8%	-3.6%	-3.7%	-6.3%	-6.5%	6.9%	7.0%
Reach_1008	217.30	14.4%	14.6%	-13.1%	-13.9%	3.7%	3.8%	-3.6%	-3.7%	-6.3%	-6.5%	6.9%	7.0%
Subbasin_116	1.30	6.0%	6.7%	-5.4%	-6.1%	1.9%	2.1%	-1.7%	-2.0%	-2.5%	-2.9%	2.9%	3.2%
Junction_109	218.60	14.3%	14.4%	-13.0%	-13.7%	3.7%	3.8%	-3.5%	-3.7%	-6.2%	-6.5%	6.9%	7.0%
Reach_1009	218.60	14.3%	14.5%	-13.0%	-13.8%	3.7%	3.8%	-3.5%	-3.7%	-6.2%	-6.5%	6.9%	7.0%
Subbasin_117	9.50	8.7%	9.0%	-7.3%	-7.5%	2.5%	2.6%	-2.4%	-2.5%	-3.8%	-4.0%	4.6%	4.7%
Subbasin_118	9.20	8.5%	9.2%	-8.3%	-8.9%	2.5%	2.7%	-2.4%	-2.6%	-3.6%	-3.9%	3.8%	4.2%
Junction_110	237.30	13.9%	13.7%	-12.4%	-13.0%	3.6%	3.7%	-3.4%	-3.5%	-6.0%	-6.1%	6.6%	6.6%
Reach_1010	237.30	13.9%	13.7%	-12.4%	-13.0%	3.6%	3.7%	-3.4%	-3.5%	-6.0%	-6.1%	6.6%	6.6%
Subbasin_119	4.50	5.2%	6.0%	-4.9%	-5.4%	1.7%	1.9%	-1.6%	-1.8%	-2.1%	-2.3%	2.2%	2.6%
Subbasin_120	3.30	5.3%	6.1%	-5.0%	-5.6%	1.7%	2.0%	-1.6%	-1.9%	-2.7%	-3.1%	3.1%	3.6%
Junction_111	245.00	13.4%	13.0%	-12.0%	-12.3%	3.5%	3.5%	-3.3%	-3.4%	-5.8%	-5.8%	6.4%	6.3%
Reach_1011	245.00	13.4%	13.1%	-12.0%	-12.3%	3.5%	3.5%	-3.3%	-3.4%	-5.8%	-5.8%	6.4%	6.3%
Subbasin_121	15.00	9.4%	9.6%	-8.5%	-8.7%	2.9%	3.0%	-2.7%	-2.8%	-3.7%	-3.8%	4.1%	4.2%
Subbasin_122	4.20	7.4%	8.1%	-6.6%	-7.0%	2.4%	2.7%	-2.2%	-2.4%	-2.8%	-3.1%	3.3%	3.5%
Junction_112	264.20	13.1%	12.6%	-11.5%	-11.9%	3.5%	3.4%	-3.3%	-3.3%	-5.6%	-5.6%	6.2%	6.1%
Reach_1012	264.20	13.1%	12.7%	-11.5%	-11.9%	3.5%	3.5%	-3.3%	-3.3%	-5.6%	-5.6%	6.2%	6.1%
Subbasin_123	9.50	6.8%	7.4%	-6.1%	-6.5%	2.2%	2.5%	-2.1%	-2.2%	-2.6%	-2.9%	3.0%	3.3%
Subbasin_124	5.40	8.3%	8.9%	-7.6%	-7.9%	2.7%	2.9%	-2.6%	-2.7%	-3.1%	-3.3%	3.5%	3.8%
Junction_113	279.20	12.7%	12.2%	-11.1%	-11.4%	3.4%	3.4%	-3.2%	-3.2%	-5.4%	-5.3%	6.0%	5.8%
Reach_1013	279.20	12.7%	12.2%	-11.1%	-11.4%	3.4%	3.4%	-3.2%	-3.2%	-5.4%	-5.3%	6.0%	5.8%
Subbasin_125	9.00	8.7%	9.3%	-8.2%	-8.8%	2.7%	2.9%	-2.5%	-2.8%	-3.5%	-3.7%	3.7%	3.9%
Subbasin_126	7.70	11.3%	12.0%	-11.0%	-11.7%	3.3%	3.5%	-3.2%	-3.4%	-4.6%	-5.0%	4.9%	5.2%
Junction_114	296.00	12.5%	12.0%	-10.9%	-11.3%	3.4%	3.4%	-3.1%	-3.2%	-5.3%	-5.2%	5.9%	5.7%
Reach_1014	296.00	12.5%	12.0%	-10.9%	-11.3%	3.4%	3.4%	-3.1%	-3.2%	-5.3%	-5.2%	5.9%	5.7%
Subbasin_127	11.40	10.8%	11.2%	-10.4%	-10.7%	3.1%	3.2%	-3.0%	-3.1%	-4.7%	-4.9%	5.0%	5.2%
Subbasin_128	1.80	4.9%	5.8%	-4.6%	-5.2%	1.6%	1.8%	-1.4%	-1.7%	-2.2%	-2.6%	2.4%	2.9%
Junction_115	309.20	12.4%	11.9%	-10.8%	-11.2%	3.3%	3.3%	-3.1%	-3.2%	-5.2%	-5.2%	5.8%	5.6%
Reach_1015	309.20	12.4%	11.9%	-10.8%	-11.2%	3.3%	3.3%	-3.1%	-3.2%	-5.2%	-5.2%	5.8%	5.6%
Subbasin_132	2.20	6.6%	7.6%	-6.4%	-7.4%	1.9%	2.1%	-1.8%	-2.1%	-2.7%	-3.2%	3.0%	3.5%
Saugeen Flow Gauge	311.40	12.3%	11.8%	-10.7%	-11.1%	3.3%	3.3%	-3.1%	-3.2%	-5.2%	-5.1%	5.8%	5.6%
Reach_1016	30.30	9.0%	9.3%	-7.9%	-8.0%	2.9%	3.0%	-2.5%	-2.6%	-3.4%	-3.5%	3.9%	4.0%
Subbasin_131	3.10	3.9%	8.0%	-3.8%	-6.6%	1.2%	2.7%	-1.2%	-2.2%	-1.9%	-3.6%	2.1%	4.7%
Junction_117	344.80	10.3%	11.5%	-9.7%	-10.7%	3.1%	3.3%	-3.0%	-3.1%	-4.3%	-4.9%	4.7%	5.4%
Reach_1017	344.80	10.3%	11.5%	-9.7%	-10.7%	3.1%	3.3%	-3.0%	-3.1%	-4.3%	-4.9%	4.7%	5.4%
Subbasin_133	2.60	8.0%	8.9%	-7.9%	-8.7%	2.4%	2.8%	-2.4%	-2.7%	-2.9%	-3.2%	3.0%	3.4%
Junction_118	347.30	10.2%	11.5%	-9.7%	-10.7%	3.1%	3.3%	-3.0%	-3.1%	-4.3%	-4.9%	4.7%	5.4%
Reach_1018	347.30	10.2%	11.5%	-9.7%	-10.7%	3.1%	3.3%	-3.0%	-3.1%	-4.3%	-4.9%	4.7%	5.4%
Subbasin_136	1.70	8.5%	11.8%	-8.6%	-11.1%	2.0%	3.0%	-2.0%	-2.9%	-3.0%	-4.6%	3.3%	5.0%
Subbasin_134	0.30	1.7%	3.6%	-2.2%	-3.1%	0.4%	1.1%	-0.9%	-1.0%	-0.9%	-1.1%	0.4%	1.3%
Junction_119	0.30	1.7%	3.6%	-2.2%	-3.1%	0.4%	1.1%	-0.9%	-1.0%	-0.9%	-1.1%	0.4%	1.3%
Reach_1019	0.30	1.7%	3.6%	-1.7%	-3.1%	0.4%	1.1%	-0.4%	-1.0%	-0.4%	-1.1%	0.4%	1.3%
Subbasin_135	0.30	6.0%	10.8%	-4.8%	-4.4%	1.6%	2.1%	-1.0%	-1.2%	-1.0%	-1.1%	1.3%	1.9%
Junction_120	0.60	4.5%	7.0%	-4.5%	-3.7%	0.9%	1.6%	-1.1%	-1.1%	-0.9%	-1.1%	0.9%	1.6%
Reach_1020	0.60	4.5%	7.0%	-4.5%	-3.7%	0.9%	1.6%	-1.1%	-1.1%	-1.1%	-1.1%	0.9%	1.6%
Subbasin_137	0.30	3.5%	6.1%	-3.2%	-2.4%	0.9%	1.1%	-0.6%	-0.6%	-0.6%	-0.5%	0.6%	1.0%
OutflowDurham	0.90	4.7%	6.7%	-4.2%	-3.3%	1.2%	1.4%	-0.8%	-0.9%	-0.8%	-0.9%	1.1%	1.4%
Junction_121	349.90	10.3%	11.5%	-9.7%	-10.7%	3.1%	3.3%	-3.0%	-3.1%	-4.3%	-4.9%	4.7%	5.4%
Reach_1021	349.90	10.3%	11.5%	-9.6%	-10.7%	3.1%	3.3%	-2.9%	-3.1%	-4.3%	-4.9%	4.6%	5.4%
Subbasin_138	4.90	7.5%	8.7%	-7.3%	-8.5%	1.9%	2.4%	-1.9%	-2.3%	-2.5%	-3.1%	2.7%	3.3%
Sink-1	354.80	10.2%	11.4%	-9.5%	-10.6%	3.1%	3.2%	-2.9%	-3.1%	-4.2%	-4.9%	4.6%	5.3%
	Maximum	17.5%	18.0%	-1.7%	-2.4%	4.7%	4.8%	-0.4%	-0.6%	-0.4%	-0.5%	8.2%	8.3%
	Minimum	1.7%	3.6%	-17.3%	-17.6%	0.4%	1.1%	-4.5%	-4.7%	-7.6%	-7.7%	0.4%	1.0%

Sensitivity Analysis Results

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model Saugeen_HMS_Calibrated **Areal Reduction Factor:** 0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Percent		Hazel 125% Percent		Hazel 75% Lag Time		Hazel 125% Lag Time		Hazel 75% Channel Slope		Hazel 125% Channel Slope	
		Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)
Subbasin_129	24.80	-0.2	-1.0	0.1	1.0	11.1	31.6	-7.0	-20.3	0.0	-0.1	0.0	-0.1
Subbasin_130	5.40	0.0	-1.0	0.0	1.0	3.0	38.8	-2.0	-25.4	0.0	0.0	0.0	0.0
Junction_116	30.30	-0.2	-1.0	0.2	1.0	14.0	32.9	-8.9	-21.2	0.0	-0.1	0.0	-0.1
Subbasin_101	36.10	-0.1	-0.5	0.1	0.4	3.5	11.3	-2.1	-9.8	0.0	0.0	0.0	0.0
Subbasin_102	12.70	-0.1	-1.0	0.1	1.0	5.6	31.1	-3.6	-19.7	0.0	0.1	0.0	0.1
Junction_101	48.80	-0.1	-0.6	0.1	0.6	7.9	16.4	-4.9	-12.4	0.0	0.0	0.0	0.0
Reach_1001	48.80	-0.1	-0.6	0.1	0.6	7.8	16.4	-4.9	-12.3	-0.1	-0.4	0.0	0.1
Subbasin_103	24.40	-0.1	-0.9	0.1	0.9	8.8	25.4	-5.4	-15.9	0.0	0.0	0.0	0.0
Subbasin_104	1.20	0.0	-0.7	0.0	0.7	0.7	43.1	-0.5	-28.9	0.0	-0.1	0.0	-0.1
Junction_102	74.40	-0.3	-0.7	0.3	0.7	16.8	19.8	-10.6	-13.8	-0.3	-0.3	0.1	0.1
Reach_1002	74.40	-0.3	-0.7	0.3	0.7	16.7	19.6	-10.4	-13.6	-0.4	-0.7	0.2	0.3
Subbasin_105	21.00	-0.1	-1.1	0.1	1.1	9.7	32.7	-6.2	-20.9	0.0	0.1	0.0	0.1
Subbasin_106	18.30	-0.1	-1.1	0.1	1.1	5.4	20.8	-3.3	-13.2	0.0	-0.1	0.0	-0.1
Junction_103	39.30	-0.3	-1.1	0.3	1.1	15.0	27.1	-9.4	-17.3	0.0	0.0	0.0	0.0
Reach_1003	39.30	-0.3	-1.1	0.3	1.1	14.9	26.9	-9.4	-17.1	0.0	-0.1	0.0	0.1
Subbasin_107	20.70	-0.2	-1.2	0.2	1.1	8.3	28.2	-5.2	-17.7	0.0	0.0	0.0	0.0
Subbasin_108	3.30	0.0	-1.0	0.0	0.9	2.3	47.8	-1.6	-34.3	0.0	0.0	0.0	0.0
Junction_104	137.70	-0.6	-0.9	0.6	0.9	34.8	23.6	-22.7	-15.7	-3.7	-0.4	2.2	0.2
Reach_1004	137.70	-0.6	-0.9	0.6	0.8	30.2	22.7	-21.0	-15.0	-5.0	-1.0	3.6	0.9
Subbasin_109	11.40	-0.1	-1.5	0.1	1.5	3.4	21.3	-2.1	-13.4	0.0	0.0	0.0	0.0
Subbasin_110	9.50	-0.1	-1.4	0.1	1.4	4.0	29.9	-2.5	-18.9	0.0	0.1	0.0	0.1
Junction_105	158.50	-0.8	-0.9	0.8	0.9	32.8	23.1	-22.9	-15.1	-6.3	-0.8	5.2	0.8
Reach_1005	158.50	-0.7	-0.9	0.8	0.9	21.2	22.3	-15.4	-14.0	-15.9	-2.9	5.5	1.4
Subbasin_111	25.60	-0.1	-0.6	0.1	0.6	5.5	16.2	-3.4	-10.4	0.0	0.0	0.0	0.0
Subbasin_112	6.80	0.0	-1.0	0.0	0.9	1.6	16.9	-1.0	-10.8	0.0	0.0	0.0	0.0
Junction_106	190.90	-0.8	-0.9	0.9	0.9	24.4	21.3	-18.0	-13.4	-16.7	-2.4	6.2	1.2
Reach_1006	190.90	-0.8	-0.9	0.8	0.9	24.2	21.1	-17.9	-13.3	-16.8	-2.7	6.2	1.2
Subbasin_113	8.00	-0.1	-1.6	0.1	1.6	3.6	31.6	-2.3	-20.3	0.0	-0.2	0.0	-0.2
Junction_107	198.90	-0.8	-0.9	0.9	0.9	25.3	21.5	-18.5	-13.6	-16.9	-2.6	6.2	1.2
Reach_1007	198.90	-0.8	-0.9	0.9	0.9	25.0	21.3	-18.3	-13.5	-17.2	-2.8	6.2	1.2
Subbasin_114	17.00	-0.1	-1.0	0.1	1.0	5.7	23.8	-3.6	-14.8	0.0	0.1	0.0	0.1
Subbasin_115	1.40	0.0	-1.5	0.0	1.5	0.9	49.2	-0.7	-35.6	0.0	0.0	0.0	0.0
Junction_108	217.30	-0.9	-0.9	0.9	0.9	25.9	21.7	-17.9	-13.7	-18.3	-2.5	7.1	1.1
Reach_1008	217.30	-0.9	-0.9	0.9	0.9	25.8	21.7	-17.9	-13.7	-18.3	-2.5	7.1	1.1
Subbasin_116	1.30	0.0	-1.5	0.0	1.5	1.0	53.6	-0.7	-39.4	0.0	-0.1	0.0	-0.1
Junction_109	218.60	-0.9	-0.9	0.9	0.9	26.1	21.9	-18.1	-13.9	-18.3	-2.5	7.1	1.1
Reach_1009	218.60	-0.9	-0.9	0.9	0.9	26.1	21.6	-18.1	-13.6	-18.3	-2.8	7.1	1.3
Subbasin_117	9.50	0.0	-0.9	0.0	0.9	4.0	29.8	-2.5	-19.0	0.0	0.0	0.0	0.0
Subbasin_118	9.20	-0.1	-1.7	0.1	1.7	6.2	47.9	-4.5	-34.5	0.0	0.0	0.0	0.0
Junction_110	237.30	-1.0	-0.9	1.0	0.9	28.2	22.9	-18.9	-14.7	-19.1	-2.6	7.8	1.2
Reach_1010	237.30	-1.0	-0.9	1.0	0.9	28.2	22.8	-18.9	-14.6	-19.1	-2.7	7.8	1.3
Subbasin_119	4.50	-0.1	-4.5	0.1	4.5	3.4	54.3	-2.5	-39.8	0.0	0.0	0.0	0.0
Subbasin_120	3.30	0.0	-0.7	0.0	0.7	2.4	52.9	-1.8	-39.9	0.0	0.0	0.0	0.0
Junction_111	245.00	-1.0	-1.0	1.1	1.0	30.0	23.8	-20.2	-15.4	-19.2	-2.6	8.0	1.2
Reach_1011	245.00	-1.0	-1.0	1.1	1.0	30.0	23.7	-20.2	-15.3	-19.2	-2.7	8.0	1.3
Subbasin_121	15.00	-0.1	-0.9	0.1	0.9	6.6	30.9	-4.1	-19.8	0.0	-0.1	0.0	-0.1
Subbasin_122	4.20	0.0	-1.5	0.0	1.5	2.9	49.1	-2.1	-35.0	0.0	0.0	0.0	0.0
Junction_112	264.20	-1.1	-1.0	1.1	1.0	32.7	24.5	-19.7	-15.9	-19.4	-2.5	8.9	1.2
Reach_1012	264.20	-1.0	-1.0	1.1	1.0	32.7	24.1	-19.7	-15.7	-19.4	-2.8	8.9	1.4
Subbasin_123	9.50	-0.1	-2.2	0.1	2.2	6.7	50.2	-5.0	-36.8	0.0	0.1	0.0	0.1
Subbasin_124	5.40	0.0	-1.1	0.0	1.1	3.4	43.7	-2.3	-29.4	0.0	-0.1	0.0	-0.1
Junction_113	279.20	-1.1	-1.0	1.2	1.0	35.6	25.4	-21.6	-16.6	-19.6	-2.6	9.2	1.3
Reach_1013	279.20	-1.1	-1.0	1.1	1.0	35.6	25.3	-21.6	-16.6	-19.6	-2.7	9.2	1.4
Subbasin_125	9.00	-0.1	-1.5	0.1	1.5	6.0	47.2	-4.3	-33.3	0.0	0.0	0.0	0.0
Subbasin_126	7.70	0.0	-0.8	0.0	0.8	4.7	43.0	-3.2	-29.0	0.0	0.0	0.0	0.0
Junction_114	296.00	-1.2	-1.0	1.2	1.0	38.7	26.4	-23.6	-17.4	-19.9	-2.6	9.4	1.3
Reach_1014	296.00	-1.2	-1.0	1.2	1.0	38.7	26.3	-23.6	-17.3	-19.9	-2.7	9.4	1.4
Subbasin_127	11.40	-0.1	-0.7	0.1	0.7	5.5	34.0	-3.5	-22.0	0.0	-0.1	0.0	-0.1
Subbasin_128	1.80	0.0	-2.3	0.0	2.3	1.4	55.5	-1.1	-41.2	0.0	0.1	0.0	0.1
Junction_115	309.20	-1.2	-1.0	1.2	1.0	42.4	26.7	-24.9	-17.6	-10.9	-2.6	9.6	1.3
Reach_1015	309.20	-1.2	-1.0	1.2	1.0	41.7	26.6	-24.9	-17.5	-11.3	-2.7	9.6	1.4
Subbasin_132	2.20	0.0	-2.7	0.0	2.7	1.7	55.0	-1.3	-42.1	0.0	0.1	0.0	0.1
Saugeen Flow Gauge	311.40	-1.2	-1.0	1.2	1.0	42.9	26.8	-25.2	-17.6	-10.7	-2.7	9.6	1.4
Reach_1016	30.30	-0.2	-1.0	0.2	1.0	14.0	32.6	-8.9	-21.0	0.0	-0.2	0.0	0.0
Subbasin_131	3.10	0.0	-0.8	0.0	0.8	2.4	0.0	-1.9	0.0	0.0	0.0	0.0	0.0
Junction_117	344.80	-2.1	-1.0	2.0	1.0	60.7	27.0	-39.6	-17.8	-7.3	-2.5	6.0	1.3
Reach_1017	344.80	-2.1	-1.0	2.0	1.0	60.5	27.0	-39.6	-17.8	-7.3	-2.5	6.1	1.3
Subbasin_133	2.60	-0.1	-3.4	0.1	3.4	1.9	52.8	-1.4	-37.6	0.0	0.2	0.0	0.2
Junction_118	347.30	-2.1	-1.0	2.1	1.0	61.2	27.2	-39.9	-17.9	-7.3	-2.5	6.2	1.3
Reach_1018	347.30	-2.1	-1.0	2.1	1.0	61.1	27.1	-39.8	-17.9	-7.3	-2.5	6.2	1.3
Subbasin_136	1.70	-0.2	-8.1	0.2	8.1	1.3	0.1	-1.0	0.1	0.0	0.0	0.0	0.0
Subbasin_134	0.30	0.0	-12.7	0.0	12.7	0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0
Junction_119	0.30	0.0	-12.7	0.0	12.7	0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0
Reach_1019	0.30	0.0	-12.7	0.0	12.7	0.3	-0.1	-0.2	0.0	0.0	-0.2	0.0	0.1
Subbasin_135	0.30	-0.1	-20.8	0.1	20.9	0.3	-0.1	-0.2	-0.1	0.0	-0.1	0.0	-0.1
Junction_120	0.60	-0.1	-17.1	0.1	17.1	0.4	-0.1	-0.3	0.0	0.0	-0.1	0.0	0.0
Reach_1020	0.60	-0.1	-17.1	0.1	17.1	0.4	-0.1	-0.3	0.0	0.0	-0.1	0.0	0.0
Subbasin_137	0.30	-0.2	-30.0	0.2	30.0	0.2	0.1	-0.2	0.1	0.0	0.1	0.0	0.1
OutflowDurham	0.90	-0.3	-21.3	0.3	21.3	0.5	0.0	-0.4	0.0	0.0	-0.1	0.0	0.0
Junction_121	349.90	-2.2	-1.1	2.1	1.1	61.0	26.9	-39.6	-17.7	-7.6	-2.5	6.5	1.3
Reach_1021	349.90	-2.1	-1.1	2.1	1.1	56.1	26.5	-38.9	-17.5	-9.5	-2.8	7.3	1.6
Subbasin_138	4.90	-0.3	-7.6	0.3	7.6	4.2	60.2	-3.1	-44.7	0.0	0.0	0.0	0.0
Sink-1	354.80	-2.2	-1.2	2.1	1.2	57.5	27.0	-39.9	-17.8	-9.6	-2.8	7.4	1.5
	Maximum	0.0	-0.5	2.1	30.0	61.2	60.2	-0.2	0.1	0.0	0.2	9.6	1.6
	Minimum	-2.2	-30.0	0.0	0.4	0.2	-0.1	-39.9	-44.7	-19.9	-2.9	0.0	-0.2

Sensitivity Analysis Results

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model Saugeen_HMS_Calibrated **Areal Reduction Factor:** 0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Percent		Hazel 125% Percent		Hazel 75% Lag Time		Hazel 125% Lag Time		Hazel 75% ChanSlope		Hazel 125% ChanSlope	
		Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume
Subbasin_129	24.80	-0.4%	-0.6%	0.4%	0.6%	29.8%	18.8%	-18.9%	-12.0%	-0.1%	-0.1%	-0.1%	-0.1%
Subbasin_130	5.40	-0.4%	-0.5%	0.3%	0.5%	27.9%	19.6%	-18.2%	-12.8%	-0.1%	0.0%	-0.1%	0.0%
Junction_116	30.30	-0.4%	-0.6%	0.4%	0.6%	29.5%	18.9%	-18.8%	-12.2%	0.0%	0.0%	0.0%	0.0%
Subbasin_101	36.10	-0.6%	-0.7%	0.7%	0.7%	33.1%	18.0%	-19.8%	-15.7%	0.0%	0.0%	0.0%	0.0%
Subbasin_102	12.70	-0.4%	-0.6%	0.4%	0.6%	29.8%	19.9%	-18.8%	-12.6%	0.1%	0.0%	0.1%	0.0%
Junction_101	48.80	-0.5%	-0.7%	0.6%	0.7%	31.2%	18.9%	-19.2%	-14.2%	0.0%	0.0%	0.0%	0.0%
Reach_1001	48.80	-0.5%	-0.7%	0.6%	0.7%	31.0%	19.1%	-19.2%	-14.3%	-0.3%	-0.4%	0.0%	0.1%
Subbasin_103	24.40	-0.5%	-0.7%	0.5%	0.7%	30.8%	19.2%	-19.1%	-12.1%	0.0%	0.0%	0.0%	0.0%
Subbasin_104	1.20	0.0%	-0.3%	0.4%	0.3%	26.3%	19.6%	-17.5%	-13.1%	0.0%	0.0%	0.0%	0.0%
Junction_102	74.40	-0.6%	-0.7%	0.5%	0.7%	30.3%	19.2%	-19.0%	-13.3%	-0.6%	-0.2%	0.1%	0.1%
Reach_1002	74.40	-0.6%	-0.7%	0.5%	0.7%	30.2%	19.5%	-18.9%	-13.5%	-0.8%	-0.7%	0.3%	0.3%
Subbasin_105	21.00	-0.4%	-0.7%	0.5%	0.7%	29.5%	19.4%	-18.7%	-12.4%	0.1%	0.1%	0.1%	0.1%
Subbasin_106	18.30	-0.7%	-0.9%	0.7%	0.9%	31.4%	18.2%	-19.3%	-11.5%	0.0%	-0.1%	0.0%	-0.1%
Junction_103	39.30	-0.5%	-0.8%	0.5%	0.8%	30.2%	19.0%	-19.0%	-12.1%	0.0%	0.0%	0.0%	0.0%
Reach_1003	39.30	-0.5%	-0.8%	0.5%	0.8%	30.1%	18.9%	-18.9%	-12.1%	-0.1%	-0.1%	0.0%	0.1%
Subbasin_107	20.70	-0.6%	-0.8%	0.5%	0.8%	30.3%	19.7%	-19.0%	-12.4%	0.0%	0.0%	0.0%	0.0%
Subbasin_108	3.30	-0.2%	-0.4%	0.3%	0.4%	21.9%	17.7%	-15.7%	-12.7%	0.0%	0.0%	0.0%	0.0%
Junction_104	137.70	-0.5%	-0.7%	0.4%	0.7%	26.6%	19.2%	-17.3%	-12.8%	-2.8%	-0.3%	1.6%	0.2%
Reach_1004	137.70	-0.5%	-0.7%	0.5%	0.7%	23.8%	19.4%	-16.5%	-12.8%	-4.0%	-0.8%	2.9%	0.8%
Subbasin_109	11.40	-0.9%	-1.3%	0.9%	1.3%	31.4%	18.3%	-19.4%	-11.5%	0.0%	0.0%	0.0%	0.0%
Subbasin_110	9.50	-0.7%	-0.9%	0.6%	0.9%	30.0%	19.3%	-18.9%	-12.2%	0.0%	0.1%	0.0%	0.1%
Junction_105	158.50	-0.5%	-0.8%	0.5%	0.8%	22.5%	19.3%	-15.7%	-12.7%	-4.3%	-0.7%	3.6%	0.7%
Reach_1005	158.50	-0.6%	-0.8%	0.6%	0.8%	17.7%	20.3%	-12.9%	-12.8%	-13.3%	-2.7%	4.6%	1.3%
Subbasin_111	25.60	-0.4%	-0.6%	0.5%	0.6%	32.4%	16.1%	-19.6%	-10.4%	0.1%	0.0%	0.1%	0.0%
Subbasin_112	6.80	-0.8%	-0.9%	0.6%	0.9%	32.1%	16.4%	-19.7%	-10.5%	0.0%	0.0%	0.0%	0.0%
Junction_106	190.90	-0.6%	-0.8%	0.6%	0.8%	17.6%	19.7%	-13.0%	-12.4%	-12.0%	-2.2%	4.4%	1.1%
Reach_1006	190.90	-0.6%	-0.8%	0.6%	0.8%	17.5%	19.7%	-12.9%	-12.5%	-12.2%	-2.5%	4.5%	1.2%
Subbasin_113	8.00	-0.7%	-1.0%	0.7%	1.0%	29.4%	19.7%	-18.7%	-12.7%	-0.1%	-0.1%	-0.1%	-0.1%
Junction_107	198.90	-0.6%	-0.8%	0.6%	0.8%	17.8%	19.7%	-13.0%	-12.5%	-11.9%	-2.4%	4.4%	1.1%
Reach_1007	198.90	-0.6%	-0.8%	0.6%	0.8%	17.6%	19.7%	-12.9%	-12.5%	-12.1%	-2.6%	4.4%	1.1%
Subbasin_114	17.00	-0.6%	-0.8%	0.5%	0.8%	31.0%	19.4%	-19.2%	-12.1%	0.1%	0.1%	0.1%	0.1%
Subbasin_115	1.40	-0.5%	-0.5%	0.2%	0.5%	21.6%	17.2%	-15.9%	-12.5%	0.0%	0.0%	0.0%	0.0%
Junction_108	217.30	-0.6%	-0.8%	0.6%	0.8%	17.1%	19.6%	-11.9%	-12.4%	-12.1%	-2.3%	4.7%	1.0%
Reach_1008	217.30	-0.6%	-0.8%	0.6%	0.8%	17.1%	19.7%	-11.9%	-12.4%	-12.1%	-2.3%	4.7%	1.0%
Subbasin_116	1.30	-0.2%	-0.4%	0.4%	0.4%	18.5%	15.1%	-13.3%	-11.1%	0.0%	0.0%	0.0%	0.0%
Junction_109	218.60	-0.6%	-0.8%	0.6%	0.8%	17.1%	19.6%	-11.9%	-12.4%	-12.0%	-2.3%	4.6%	1.0%
Reach_1009	218.60	-0.6%	-0.8%	0.6%	0.8%	17.1%	19.6%	-11.9%	-12.4%	-12.0%	-2.6%	4.7%	1.2%
Subbasin_117	9.50	-0.3%	-0.6%	0.4%	0.5%	30.3%	18.5%	-19.0%	-11.8%	0.1%	0.0%	0.1%	0.0%
Subbasin_118	9.20	-0.4%	-0.6%	0.4%	0.6%	22.2%	17.5%	-16.1%	-12.6%	0.0%	0.0%	0.0%	0.0%
Junction_110	237.30	-0.6%	-0.8%	0.6%	0.8%	16.9%	19.4%	-11.3%	-12.4%	-11.4%	-2.2%	4.7%	1.0%
Reach_1010	237.30	-0.6%	-0.8%	0.6%	0.8%	16.9%	19.4%	-11.3%	-12.4%	-11.4%	-2.3%	4.7%	1.1%
Subbasin_119	4.50	-0.7%	-1.2%	0.7%	1.2%	17.3%	14.2%	-12.6%	-10.4%	0.0%	0.0%	0.0%	0.0%
Subbasin_120	3.30	-0.1%	-0.2%	0.2%	0.2%	18.6%	15.2%	-14.0%	-11.4%	0.0%	0.0%	0.0%	0.0%
Junction_111	245.00	-0.6%	-0.8%	0.6%	0.8%	16.9%	18.9%	-11.4%	-12.3%	-10.9%	-2.0%	4.5%	1.0%
Reach_1011	245.00	-0.6%	-0.8%	0.6%	0.8%	16.9%	19.0%	-11.4%	-12.3%	-10.9%	-2.2%	4.5%	1.1%
Subbasin_121	15.00	-0.3%	-0.5%	0.4%	0.5%	29.9%	19.0%	-18.9%	-12.2%	0.0%	-0.1%	0.0%	-0.1%
Subbasin_122	4.20	-0.3%	-0.6%	0.3%	0.6%	22.7%	17.7%	-16.2%	-12.6%	0.0%	0.0%	0.0%	0.0%
Junction_112	264.20	-0.6%	-0.8%	0.6%	0.8%	17.4%	18.9%	-10.4%	-12.3%	-10.3%	-1.9%	4.7%	0.9%
Reach_1012	264.20	-0.6%	-0.8%	0.6%	0.8%	17.4%	19.0%	-10.4%	-12.3%	-10.3%	-2.2%	4.7%	1.1%
Subbasin_123	9.50	-0.4%	-0.7%	0.4%	0.7%	20.9%	16.6%	-15.4%	-12.1%	0.0%	0.0%	0.0%	0.0%
Subbasin_124	5.40	-0.3%	-0.5%	0.3%	0.5%	26.3%	19.2%	-17.7%	-12.9%	-0.1%	-0.1%	-0.1%	-0.1%
Junction_113	279.20	-0.5%	-0.8%	0.6%	0.8%	17.6%	18.8%	-10.7%	-12.3%	-9.7%	-1.9%	4.5%	1.0%
Reach_1013	279.20	-0.5%	-0.8%	0.6%	0.8%	17.6%	18.9%	-10.7%	-12.3%	-9.7%	-2.0%	4.5%	1.0%
Subbasin_125	9.00	-0.4%	-0.6%	0.4%	0.6%	23.5%	18.2%	-16.6%	-12.8%	0.0%	0.0%	0.0%	0.0%
Subbasin_126	7.70	-0.2%	-0.4%	0.2%	0.4%	26.0%	19.6%	-17.5%	-13.2%	0.0%	0.0%	0.0%	0.0%
Junction_114	296.00	-0.5%	-0.7%	0.6%	0.7%	17.9%	18.8%	-10.9%	-12.4%	-9.2%	-1.8%	4.4%	0.9%
Reach_1014	296.00	-0.5%	-0.7%	0.6%	0.7%	17.9%	18.9%	-10.9%	-12.4%	-9.2%	-1.9%	4.4%	1.0%
Subbasin_127	11.40	-0.3%	-0.4%	0.3%	0.4%	29.0%	19.6%	-18.7%	-12.7%	-0.1%	-0.1%	-0.1%	-0.1%
Subbasin_128	1.80	-0.2%	-0.6%	0.3%	0.6%	16.4%	13.7%	-12.1%	-10.2%	0.1%	0.0%	0.1%	0.0%
Junction_115	309.20	-0.5%	-0.7%	0.5%	0.7%	18.9%	18.8%	-11.1%	-12.4%	-4.8%	-1.8%	4.3%	0.9%
Reach_1015	309.20	-0.5%	-0.7%	0.5%	0.7%	18.6%	18.8%	-11.1%	-12.4%	-5.0%	-1.9%	4.3%	1.0%
Subbasin_132	2.20	-0.4%	-0.7%	0.4%	0.7%	15.7%	13.5%	-12.0%	-10.3%	0.0%	0.0%	0.0%	0.0%
ugeen Flow Gau	311.40	-0.5%	-0.7%	0.5%	0.7%	18.8%	18.7%	-11.1%	-12.3%	-4.7%	-1.9%	4.2%	1.0%
Reach_1016	30.30	-0.4%	-0.6%	0.4%	0.6%	29.5%	18.9%	-18.7%	-12.2%	0.0%	-0.1%	0.0%	0.0%
Subbasin_131	3.10	-0.2%	-0.7%	0.1%	0.7%	14.3%	0.0%	-11.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Junction_117	344.80	-0.8%	-0.7%	0.8%	0.7%	22.2%	18.6%	-14.5%	-12.2%	-2.7%	-1.7%	2.2%	0.9%
Reach_1017	344.80	-0.8%	-0.7%	0.7%	0.7%	22.2%	18.6%	-14.5%	-12.2%	-2.7%	-1.7%	2.2%	0.9%
Subbasin_133	2.60	-0.7%	-1.0%	0.6%	1.0%	19.2%	15.9%	-13.8%	-11.3%	0.0%	0.1%	0.0%	0.1%
Junction_118	347.30	-0.8%	-0.7%	0.7%	0.7%	22.1%	18.5%	-14.4%	-12.2%	-2.6%	-1.7%	2.2%	0.9%
Reach_1018	347.30	-0.8%	-0.7%	0.7%	0.7%	22.1%	18.5%	-14.4%	-12.2%	-2.6%	-1.7%	2.2%	0.9%
Subbasin_136	1.70	-2.8%	-7.5%	2.8%	7.5%	17.4%	0.1%	-12.7%	0.1%	0.0%	0.0%	0.0%	0.0%
Subbasin_134	0.30	-1.7%	-6.1%	1.3%	6.1%	12.1%	0.0%	-10.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Junction_119	0.30	-1.7%	-6.1%	1.3%	6.1%	12.1%	0.0%	-10.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Reach_1019	0.30	-1.3%	-6.1%	1.3%	6.1%	11.8%	0.0%	-10.0%	0.0%	-1.3%	-0.1%	0.4%	0.0%
Subbasin_135	0.30	-3.5%	-13.6%	3.8%	13.6%	8.6%	0.0%	-6.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Junction_120	0.60	-3.2%	-9.6%	3.0%	9.6%	9.1%	0.0%	-6.7%	0.0%	-0.6%	-0.1%	0.2%	0.0%
Reach_1020	0.60	-3.2%	-9.6%	3.0%	9.6%	9.1%	0.0%	-6.7%	0.0%	-0.6%	-0.1%	0.2%	0.0%
Subbasin_137	0.30	-4.7%	-15.6%	4.7%	15.6%	6.9%	0.0%	-6.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OutflowDurham	0.90	-4.0%	-11.7%	4.0%	11.7%	7.1%	0.0%	-5.1%	0.0%	-0.1%	0.0%	0.3%	0.0%
Junction_121	349.90	-0.8%	-0.8%	0.8%	0.8%	22.0%	18.4%	-14.3%	-12.1%	-2.7%	-1.7%	2.4%	0.9%
Reach_1021	349.90	-0.8%	-0.8%	0.7%	0.8%	20.4%	18.4%	-14.1%	-12.1%	-3.5%	-2.0%	2.7%	1.1%
Subbasin_138	4.90	-1.2%	-1.9%	1.1%	1.9%	17.7%	15.0%	-13.1%	-11.2%	0.0%	0.0%	0.0%	0.0%
Sink-1	354.80	-0.8%	-0.8%	0.8%	0.8%	20.3%	18.3%	-14.1%	-12.1%	-3.4%	-1.9%	2.6%	1.0%
	Maximum	0.00%	-0.20%	4.73%	15.62%	33.08%	20.31%	-5.11%	0.06%	0.11%	0.11%	4.71%	1.28%
	Minimum	-4.73%	-15.62%	0.12%	0.20%	6.94%	-0.04%	-19.81%	-15.67%	-13.26%	-2.67%	-0.11%	-0.09%

Sensitivity Analysis Results

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model Saugeen_HMS_Calibrated **Areal Reduction Factor:** 0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Canopy Storage		Hazel 125% Canopy Storage		Hazel 75% Depression		Hazel 125% Depression	
		Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)	Difference in Peak Flow (m^3/s)	Difference in Volume (mm)
Subbasin_129	24.80	0.0	0.1	0.0	-0.2	0.5	2.6	-0.5	-2.7
Subbasin_130	5.40	0.0	0.1	0.0	-0.2	0.2	3.4	-0.2	-3.4
Junction_116	30.30	0.0	0.1	0.0	-0.2	0.7	2.7	-0.7	-2.8
Subbasin_101	36.10	0.0	0.1	0.0	0.0	0.3	1.8	-0.3	-1.8
Subbasin_102	12.70	0.0	0.2	0.0	-0.1	0.4	3.7	-0.4	-3.6
Junction_101	48.80	0.0	0.1	0.0	0.0	0.6	2.3	-0.6	-2.3
Reach_1001	48.80	0.0	0.1	0.0	0.0	0.6	2.3	-0.6	-2.3
Subbasin_103	24.40	0.0	0.1	0.0	-0.1	0.6	3.1	-0.6	-3.0
Subbasin_104	1.20	0.0	0.1	0.0	-0.2	0.0	4.3	-0.1	-4.5
Junction_102	74.40	0.1	0.1	0.0	-0.1	1.3	2.6	-1.3	-2.5
Reach_1002	74.40	0.0	0.1	0.0	-0.1	1.3	2.5	-1.3	-2.5
Subbasin_105	21.00	0.0	0.1	0.0	-0.1	0.6	3.6	-0.6	-3.5
Subbasin_106	18.30	0.0	0.0	0.0	-0.2	0.3	2.3	-0.3	-2.5
Junction_103	39.30	0.0	0.1	0.0	-0.1	0.9	3.0	-1.0	-3.0
Reach_1003	39.30	0.0	0.1	0.0	-0.1	0.9	3.0	-1.0	-3.0
Subbasin_107	20.70	0.0	0.2	0.0	-0.1	0.6	3.4	-0.6	-3.3
Subbasin_108	3.30	0.0	0.1	0.0	-0.1	0.1	3.1	-0.1	-3.2
Junction_104	137.70	0.1	0.1	-0.1	-0.1	2.2	2.8	-2.3	-2.8
Reach_1004	137.70	0.1	0.1	-0.1	-0.1	2.4	2.7	-2.4	-2.6
Subbasin_109	11.40	0.0	0.1	0.0	-0.1	0.3	3.2	-0.3	-3.2
Subbasin_110	9.50	0.0	0.2	0.0	-0.1	0.3	3.3	-0.3	-3.2
Junction_105	158.50	0.1	0.1	-0.1	-0.1	2.8	2.8	-2.8	-2.7
Reach_1005	158.50	0.1	0.1	0.0	-0.1	2.8	2.6	-2.7	-2.6
Subbasin_111	25.60	0.0	0.1	0.0	0.0	0.4	2.5	-0.4	-2.4
Subbasin_112	6.80	0.0	0.1	0.0	-0.1	0.1	2.7	-0.1	-2.7
Junction_106	190.90	0.1	0.1	-0.1	-0.1	3.2	2.6	-3.2	-2.6
Reach_1006	190.90	0.1	0.1	-0.1	-0.1	3.2	2.6	-3.1	-2.6
Subbasin_113	8.00	0.0	0.0	0.0	-0.2	0.2	3.1	-0.2	-3.3
Junction_107	198.90	0.1	0.1	-0.1	-0.1	3.3	2.6	-3.2	-2.6
Reach_1007	198.90	0.1	0.1	-0.1	-0.1	3.3	2.6	-3.2	-2.6
Subbasin_114	17.00	0.0	0.2	0.0	0.0	0.4	3.2	-0.4	-3.0
Subbasin_115	1.40	0.0	0.1	0.0	-0.1	0.0	3.5	0.0	-3.5
Junction_108	217.30	0.1	0.1	-0.1	-0.1	3.4	2.7	-3.4	-2.6
Reach_1008	217.30	0.1	0.1	-0.1	-0.1	3.4	2.7	-3.4	-2.6
Subbasin_116	1.30	0.0	0.1	0.0	-0.2	0.0	3.4	0.0	-3.6
Junction_109	218.60	0.1	0.1	-0.1	-0.1	3.5	2.7	-3.4	-2.6
Reach_1009	218.60	0.1	0.1	-0.1	-0.1	3.5	2.6	-3.4	-2.6
Subbasin_117	9.50	0.0	0.1	0.0	-0.2	0.2	2.9	-0.2	-3.0
Subbasin_118	9.20	0.0	0.1	0.0	-0.2	0.2	3.0	-0.3	-3.2
Junction_110	237.30	0.1	0.1	-0.1	-0.1	3.6	2.7	-3.6	-2.6
Reach_1010	237.30	0.1	0.1	-0.1	-0.1	3.6	2.6	-3.6	-2.6
Subbasin_119	4.50	0.0	0.2	0.0	-0.2	0.1	2.4	-0.1	-2.5
Subbasin_120	3.30	0.0	0.2	0.0	-0.3	0.1	3.9	-0.1	-4.1
Junction_111	245.00	0.1	0.1	-0.1	-0.1	3.7	2.7	-3.6	-2.6
Reach_1011	245.00	0.1	0.1	-0.1	-0.1	3.7	2.6	-3.6	-2.6
Subbasin_121	15.00	0.0	0.0	0.0	-0.2	0.4	2.9	-0.4	-3.0
Subbasin_122	4.20	0.0	0.2	0.0	-0.2	0.1	3.6	-0.1	-3.6
Junction_112	264.20	0.1	0.1	-0.1	-0.1	3.8	2.7	-3.8	-2.7
Reach_1012	264.20	0.1	0.1	-0.1	-0.1	3.9	2.6	-3.8	-2.6
Subbasin_123	9.50	0.0	0.4	0.0	-0.2	0.3	3.3	-0.2	-3.1
Subbasin_124	5.40	0.0	0.2	0.0	-0.3	0.2	3.7	-0.2	-3.9
Junction_113	279.20	0.1	0.1	-0.1	-0.1	4.0	2.7	-3.9	-2.7
Reach_1013	279.20	0.1	0.1	-0.1	-0.1	4.0	2.7	-3.9	-2.7
Subbasin_125	9.00	0.0	0.1	0.0	-0.2	0.3	3.5	-0.3	-3.7
Subbasin_126	7.70	0.0	0.2	0.0	-0.2	0.3	3.9	-0.3	-4.0
Junction_114	296.00	0.1	0.1	-0.1	-0.1	4.2	2.7	-4.1	-2.7
Reach_1014	296.00	0.1	0.1	-0.1	-0.1	4.2	2.7	-4.1	-2.7
Subbasin_127	11.40	0.0	0.1	0.0	-0.2	0.3	3.2	-0.3	-3.3
Subbasin_128	1.80	0.0	0.3	0.0	-0.2	0.0	2.6	0.0	-2.6
Junction_115	309.20	0.1	0.1	-0.1	-0.1	4.3	2.7	-4.2	-2.7
Reach_1015	309.20	0.1	0.1	-0.1	-0.1	4.3	2.7	-4.2	-2.7
Subbasin_132	2.20	0.0	0.3	0.0	-0.2	0.0	2.2	0.0	-2.2
ugeen Flow Ga	311.40	0.1	0.1	-0.1	-0.1	4.3	2.7	-4.2	-2.7
Reach_1016	30.30	0.0	0.1	0.0	-0.2	0.7	2.7	-0.7	-2.8
Subbasin_131	3.10	0.0	0.1	0.0	-0.2	0.0	2.0	0.0	-2.0
Junction_117	344.80	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.6	-2.7
Reach_1017	344.80	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.6	-2.7
Subbasin_133	2.60	0.0	0.4	0.0	-0.1	0.0	2.9	-0.1	-2.9
Junction_118	347.30	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.7	-2.7
Reach_1018	347.30	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.6	-2.7
Subbasin_136	1.70	0.0	0.2	0.0	-0.1	0.0	0.9	0.0	-0.8
Subbasin_134	0.30	0.0	0.2	0.0	-0.2	0.0	0.6	0.0	-0.5
Junction_119	0.30	0.0	0.2	0.0	-0.2	0.0	0.6	0.0	-0.5
Reach_1019	0.30	0.0	0.2	0.0	-0.2	0.0	0.5	0.0	-0.5
Subbasin_135	0.30	0.0	0.1	0.0	-0.2	0.0	0.2	0.0	-0.4
Junction_120	0.60	0.0	0.1	0.0	-0.2	0.0	0.4	0.0	-0.5
Reach_1020	0.60	0.0	0.1	0.0	-0.2	0.0	0.4	0.0	-0.5
Subbasin_137	0.30	0.0	0.2	0.0	-0.1	0.0	0.5	0.0	-0.2
OutflowDurham	0.90	0.0	0.2	0.0	-0.2	0.0	0.4	0.0	-0.4
Junction_121	349.90	0.2	0.1	-0.2	-0.1	4.7	2.7	-4.7	-2.7
Reach_1021	349.90	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.6	-2.7
Subbasin_138	4.90	0.0	0.3	0.0	-0.1	0.0	1.7	0.0	-1.6
Sink-1	354.80	0.2	0.1	-0.2	-0.1	4.6	2.7	-4.6	-2.7
	Maximum	0.2	0.4	0.0	0.0	4.7	4.3	0.0	-0.2
	Minimum	0.0	0.0	-0.2	-0.3	0.0	0.2	-4.7	-4.5

Sensitivity Analysis Results

WILLS

Project No: 5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: 12-Dec-23

Basin Model Saugeen_HMS_Calibrated **Areal Reduction Factor:** 0.766

Peak Flow and Runoff Volume Percent Change

Hydrologic Element	Drainage Area (km^2)	Hazel 75% Canopy Storage		Hazel 125% Canopy		Hazel 75% Depression		Hazel 125% Depression	
		Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume	Percent Difference in Peak Flow	Percent Difference in Volume
Subbasin_129	24.80	0.1%	0.0%	-0.1%	-0.1%	1.4%	1.5%	-1.4%	-1.6%
Subbasin_130	5.40	0.0%	0.1%	-0.1%	-0.1%	1.4%	1.7%	-1.6%	-1.7%
Junction_116	30.30	0.1%	0.1%	-0.1%	-0.1%	1.4%	1.6%	-1.5%	-1.6%
Subbasin_101	36.10	0.1%	0.1%	0.0%	-0.1%	2.8%	2.9%	-2.7%	-2.9%
Subbasin_102	12.70	0.1%	0.1%	-0.1%	-0.1%	2.1%	2.3%	-2.1%	-2.3%
Junction_101	48.80	0.1%	0.1%	0.0%	-0.1%	2.4%	2.6%	-2.3%	-2.6%
Reach_1001	48.80	0.1%	0.1%	0.0%	-0.1%	2.4%	2.6%	-2.5%	-2.6%
Subbasin_103	24.40	0.1%	0.1%	0.0%	-0.1%	2.1%	2.3%	-2.1%	-2.3%
Subbasin_104	1.20	0.0%	0.0%	0.0%	-0.1%	1.5%	2.0%	-1.8%	-2.0%
Junction_102	74.40	0.1%	0.1%	-0.1%	-0.1%	2.3%	2.5%	-2.4%	-2.5%
Reach_1002	74.40	0.1%	0.1%	-0.1%	-0.1%	2.3%	2.5%	-2.3%	-2.5%
Subbasin_105	21.00	0.1%	0.1%	0.0%	0.0%	1.9%	2.1%	-1.9%	-2.1%
Subbasin_106	18.30	0.1%	0.0%	-0.1%	-0.1%	1.9%	2.1%	-2.0%	-2.2%
Junction_103	39.30	0.1%	0.1%	-0.1%	-0.1%	1.9%	2.1%	-1.9%	-2.1%
Reach_1003	39.30	0.0%	0.1%	-0.1%	-0.1%	1.9%	2.1%	-1.9%	-2.1%
Subbasin_107	20.70	0.1%	0.1%	0.0%	0.0%	2.1%	2.4%	-2.1%	-2.3%
Subbasin_108	3.30	0.1%	0.0%	0.0%	-0.1%	0.8%	1.1%	-0.9%	-1.2%
Junction_104	137.70	0.1%	0.1%	-0.1%	-0.1%	1.7%	2.3%	-1.8%	-2.2%
Reach_1004	137.70	0.1%	0.1%	-0.1%	-0.1%	1.9%	2.3%	-1.9%	-2.3%
Subbasin_109	11.40	0.1%	0.1%	-0.1%	-0.1%	2.6%	2.8%	-2.7%	-2.8%
Subbasin_110	9.50	0.1%	0.1%	-0.1%	0.0%	1.9%	2.1%	-1.9%	-2.1%
Junction_105	158.50	0.1%	0.1%	0.0%	-0.1%	1.9%	2.3%	-1.9%	-2.3%
Reach_1005	158.50	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.3%	-2.4%
Subbasin_111	25.60	0.1%	0.1%	0.0%	0.0%	2.3%	2.4%	-2.3%	-2.4%
Subbasin_112	6.80	0.0%	0.1%	0.0%	-0.1%	2.5%	2.6%	-2.5%	-2.6%
Junction_106	190.90	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.3%	-2.4%
Reach_1006	190.90	0.1%	0.1%	-0.1%	-0.1%	2.3%	2.4%	-2.3%	-2.4%
Subbasin_113	8.00	0.0%	0.0%	-0.1%	-0.1%	1.7%	1.9%	-1.8%	-2.1%
Junction_107	198.90	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.3%	-2.4%
Reach_1007	198.90	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.2%	-2.4%
Subbasin_114	17.00	0.1%	0.2%	-0.1%	0.0%	2.3%	2.6%	-2.3%	-2.5%
Subbasin_115	1.40	0.0%	0.0%	-0.2%	0.0%	0.9%	1.2%	-0.9%	-1.2%
Junction_108	217.30	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.2%	-2.4%
Reach_1008	217.30	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.2%	-2.4%
Subbasin_116	1.30	0.2%	0.0%	0.0%	-0.1%	0.6%	1.0%	-0.6%	-1.0%
Junction_109	218.60	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.2%	-2.4%
Reach_1009	218.60	0.1%	0.1%	0.0%	-0.1%	2.3%	2.4%	-2.2%	-2.4%
Subbasin_117	9.50	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.8%	-1.7%	-1.9%
Subbasin_118	9.20	0.0%	0.0%	-0.1%	-0.1%	0.8%	1.1%	-0.9%	-1.2%
Junction_110	237.30	0.1%	0.1%	0.0%	-0.1%	2.2%	2.3%	-2.1%	-2.2%
Reach_1010	237.30	0.1%	0.1%	0.0%	-0.1%	2.2%	2.2%	-2.1%	-2.2%
Subbasin_119	4.50	0.0%	0.0%	-0.1%	0.0%	0.4%	0.6%	-0.4%	-0.7%
Subbasin_120	3.30	0.1%	0.0%	-0.1%	-0.1%	0.7%	1.1%	-0.8%	-1.2%
Junction_111	245.00	0.1%	0.1%	0.0%	-0.1%	2.1%	2.1%	-2.1%	-2.1%
Reach_1011	245.00	0.1%	0.1%	0.0%	-0.1%	2.1%	2.1%	-2.1%	-2.1%
Subbasin_121	15.00	0.0%	0.0%	-0.1%	-0.1%	1.6%	1.8%	-1.6%	-1.9%
Subbasin_122	4.20	0.1%	0.1%	-0.1%	-0.1%	0.9%	1.3%	-1.0%	-1.3%
Junction_112	264.20	0.1%	0.1%	0.0%	-0.1%	2.0%	2.1%	-2.0%	-2.1%
Reach_1012	264.20	0.1%	0.1%	0.0%	-0.1%	2.0%	2.1%	-2.0%	-2.1%
Subbasin_123	9.50	0.1%	0.1%	-0.1%	-0.1%	0.8%	1.1%	-0.7%	-1.0%
Subbasin_124	5.40	0.0%	0.1%	-0.2%	-0.1%	1.3%	1.6%	-1.5%	-1.7%
Junction_113	279.20	0.1%	0.1%	0.0%	-0.1%	2.0%	2.0%	-1.9%	-2.0%
Reach_1013	279.20	0.1%	0.1%	0.0%	-0.1%	2.0%	2.0%	-1.9%	-2.0%
Subbasin_125	9.00	0.0%	0.1%	-0.1%	-0.1%	1.1%	1.4%	-1.1%	-1.4%
Subbasin_126	7.70	0.1%	0.1%	-0.1%	-0.1%	1.5%	1.8%	-1.5%	-1.8%
Junction_114	296.00	0.1%	0.1%	-0.1%	-0.1%	1.9%	2.0%	-1.9%	-1.9%
Reach_1014	296.00	0.1%	0.1%	-0.1%	-0.1%	1.9%	2.0%	-1.9%	-2.0%
Subbasin_127	11.40	0.0%	0.1%	-0.1%	-0.1%	1.6%	1.8%	-1.7%	-1.9%
Subbasin_128	1.80	0.1%	0.1%	0.0%	0.0%	0.3%	0.6%	-0.2%	-0.6%
Junction_115	309.20	0.1%	0.1%	-0.1%	-0.1%	1.9%	1.9%	-1.9%	-1.9%
Reach_1015	309.20	0.1%	0.1%	-0.1%	-0.1%	1.9%	1.9%	-1.9%	-1.9%
Subbasin_132	2.20	0.1%	0.1%	0.0%	0.0%	0.2%	0.5%	-0.2%	-0.5%
Saugeen Flow Gauge	311.40	0.1%	0.1%	-0.1%	-0.1%	1.9%	1.9%	-1.8%	-1.9%
Reach_1016	30.30	0.0%	0.1%	-0.1%	-0.1%	1.4%	1.6%	-1.5%	-1.6%
Subbasin_131	3.10	0.0%	0.1%	-0.1%	-0.1%	0.2%	1.7%	-0.2%	-1.7%
Junction_117	344.80	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.9%	-1.7%	-1.9%
Reach_1017	344.80	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.9%	-1.7%	-1.9%
Subbasin_133	2.60	0.0%	0.1%	-0.1%	0.0%	0.5%	0.9%	-0.6%	-0.9%
Junction_118	347.30	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.8%	-1.7%	-1.9%
Reach_1018	347.30	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.8%	-1.7%	-1.9%
Subbasin_136	1.70	0.0%	0.2%	0.0%	-0.1%	0.3%	0.9%	-0.1%	-0.8%
Subbasin_134	0.30	0.0%	0.1%	0.0%	-0.1%	0.0%	0.3%	0.0%	-0.3%
Junction_119	0.30	0.0%	0.1%	0.0%	-0.1%	0.0%	0.3%	0.0%	-0.3%
Reach_1019	0.30	0.0%	0.1%	0.0%	-0.1%	0.0%	0.3%	0.0%	-0.3%
Subbasin_135	0.30	0.0%	0.1%	0.0%	-0.1%	0.0%	0.2%	0.0%	-0.3%
Junction_120	0.60	0.0%	0.1%	0.0%	-0.1%	0.0%	0.2%	0.0%	-0.3%
Reach_1020	0.60	0.0%	0.1%	0.0%	-0.1%	0.0%	0.2%	0.0%	-0.3%
Subbasin_137	0.30	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	-0.1%
OutflowDurham	0.90	0.0%	0.1%	0.0%	-0.1%	0.1%	0.2%	0.0%	-0.2%
Junction_121	349.90	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.8%	-1.7%	-1.8%
Reach_1021	349.90	0.1%	0.1%	-0.1%	-0.1%	1.7%	1.8%	-1.7%	-1.9%
Subbasin_138	4.90	0.0%	0.1%	0.0%	0.0%	0.1%	0.4%	-0.1%	-0.4%
Sink-1	354.80	0.1%	0.1%	-0.1%	-0.1%	1.6%	1.8%	-1.6%	-1.8%
	Maximum	0.2%	0.2%	0.0%	0.0%	2.8%	2.9%	0.0%	-0.1%
	Minimum	0.0%	0.0%	-0.2%	-0.1%	0.0%	0.2%	-2.7%	-2.9%

Appendix B4

Single Station Frequency Analysis

Linear Regression Analysis

Project No: 5591
Project Name: Durham FPM
Designed/Checked By: SO/MC
Date: 18-Dec-23

Linear Regression Analysis Flow Data

Flow Data					
Max Instantaneous			Max Daily		
Year	MM--DD	MAX Flow (m^3/s)	Year	MM--DD	MAX Flow (m3/s)
1977	03--15	126	1977	03--15	104
1978	04--13	80.1	1978	04--13	77
1979	04--15	91.6	1979	04--15	81.6
1980	03--21	70.6	1980	03--21	32.3
1981	02--22	97.7	1981	02--22	92.6
1982	04--18	87.1	1982	04--18	84.1
1983	03--08	22.1	1983	03--08	21.1
1984	12--30	81.2	1984	12--30	73.5
1987	03--26	41.7	1987	03--26	39.6
1988	03--27	42.1	1988	03--27	40
1990	03--13	108	1990	03--14	86.9
1992	11--14	54.1	1992	11--14	49.5
1993	01--05	61.5	1993	01--05	54.9
1994	04--04	27.2	1994	04--05	24.3
1995	11--12	31.9	1995	11--12	30.6
1996	01--19	62.6	1996	01--20	49.2
1998	03--28	78.7	1998	03--28	65.5
2005	04--01	63.7	2005	04--02	45
2007	03--27	53.2	2007	03--27	50.9
2012	03--14	42.9	2012	03--14	40
2014	04--14	73	2014	04--14	63.5
2015	04--11	30.1	2015	04--11	29.3
2016	04--01	88.6	2016	04--01	85.9
2017	02--25	56.4	2017	02--25	53.7
2018	02--21	124	2018	02--21	104
2021	03--12	61	2021	03--13	48.6

Single Station Frequency Analysis Data	1

Project No: 5591
Project Name: Durham FPM
Designed/Checked By: SO/MC
Date: 18-Dec-23

Single Station Frequency Analysis Flow Data

Flow Data					
Max Instantaneous			Max Daily		
Year	MM--DD	MAX Flow (m^3/s)	Year	MM--DD	MAX Flow (m3/s)
1977	03--15	126	1977	03--15	104
1978	04--13	80.1	1978	04--13	77
1979	04--15	91.6	1979	04--15	81.6
1980	03--21	70.6	1980	03--21	32.3
1981	02--22	97.7	1981	02--22	92.6
1982	04--18	87.1	1982	04--18	84.1
1983	03--08	22.1	1983	03--08	21.1
1984	12--30	81.2	1984	12--30	73.5
1985	04--06	51	1985	03--30	46.5
1987	03--26	41.7	1987	03--26	39.6
1988	03--27	42.1	1988	03--27	40
1989	03--29	129.0	1989	03--29	115
1990	03--13	108	1990	03--14	86.9
1991	03--29	68.4	1991	04--10	61.7
1992	11--14	54.1	1992	11--14	49.5
1993	01--05	61.5	1993	01--05	54.9
1994	04--04	27.2	1994	04--05	24.3
1995	11--12	31.9	1995	11--12	30.6
1996	01--19	62.6	1996	01--20	49.2
1998	03--28	78.7	1998	03--28	65.5
2005	04--01	63.7	2005	04--02	45
2006	03--14	90.8	2006	03--14	80
2007	03--27	53.2	2007	03--27	50.9
2008	12--29	94.9	2008	12--29	83.8
2009	02--13	57.6	2009	02--13	49.6
2010	03--15	61.4	2010	03--15	53.1
2011	03--19	37.7	2011	03--19	31.4
2012	03--14	42.9	2012	03--14	40
2014	04--14	73	2014	04--14	63.5
2015	04--11	30.1	2015	04--11	29.3
2016	04--01	88.6	2016	04--01	85.9
2017	02--25	56.4	2017	02--25	53.7
2018	02--21	124	2018	02--21	104
2019	03--16	53.0	2019	03--16	45.4
2020	03--30	41.9	2020	01--12	37.8
2021	03--12	61	2021	03--13	48.6

Estimated

Station Frequency Analysis for Saugeen River

Project No: 23-5591
Project Name: Durham Creek FPM
Designed/Checked By: SO/MC
Date: December 12, 2023

Hydrologic Properties of Catchment Area

Catchment Name	Saugeen River
Catchment Area	347.3 km^2
Hydrology Model Catchment ID	-

Hydrometric (Gauging Station) Data

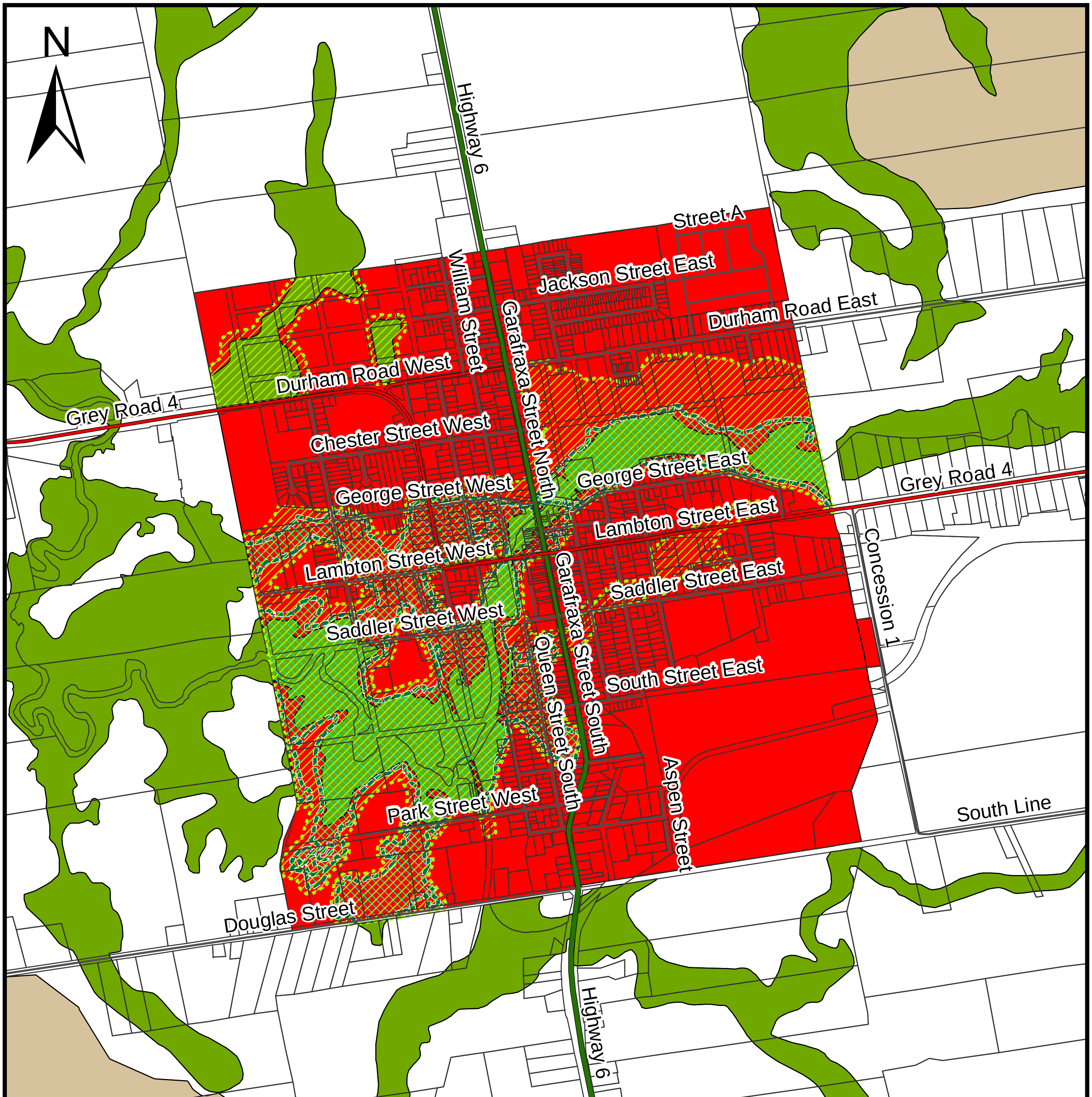
Station Number	Station Name	Period of Record	Drainage Area (km^2)	Source
02FC016	SAUGEEN RIVER ABOVE DURHAM	44	311.4	Water Survey of Canada
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

HEC-SSP Results

Percent Chance Exceedance	Return Period (years)	Probability	Peak Flow (cms)					
			02FC016					
50	2	0.5	62.2					
20	5	0.2	90.3					
10	10	0.1	109.8					
4	25	0.04	135.1					
2	50	0.02	154.6					
1	100	0.01	174.4					
0.1	1000	0.001	244.7					

Appendix B5

Official Plan and Zoning



LEGEND

- Provincial Highway
- County Road
- Local Road
- Seasonal Road
- Agricultural
- Special Agricultural
- Rural
- Primary Settlement Area
- Secondary Settlement Area
- Inland Lakes and Shoreline Settlement Area
- Regulated Area
- Flood Fringe
- Recreational Resort Settlement Area
- Sunset Strip Settlement Area
- Industrial Business Park Settlement Area
- Space Extensive Industrial and Commercial
- Niagara Escarpment Plan Boundary **
- Niagara Escarpment Development Control Area
- Escarpment Natural Area
- Escarpment Recreation Area
- Hazard Lands
- Provincially Significant Wetlands
- Hurricane Hazel Flood Event Standard

*** certain settlement areas within the Niagara Escarpment Plan Boundary may be subject to Development Control.*

THE COUNTY OF GREY OFFICIAL PLAN

SECONDARY SCHEDULE

Land Use Types

MAP 3I

DURHAM

SCALE 1:20 000

INTERACTIVE MAP: geo.grey.ca
DOWNLOAD PDF: grey.ca/planning-development

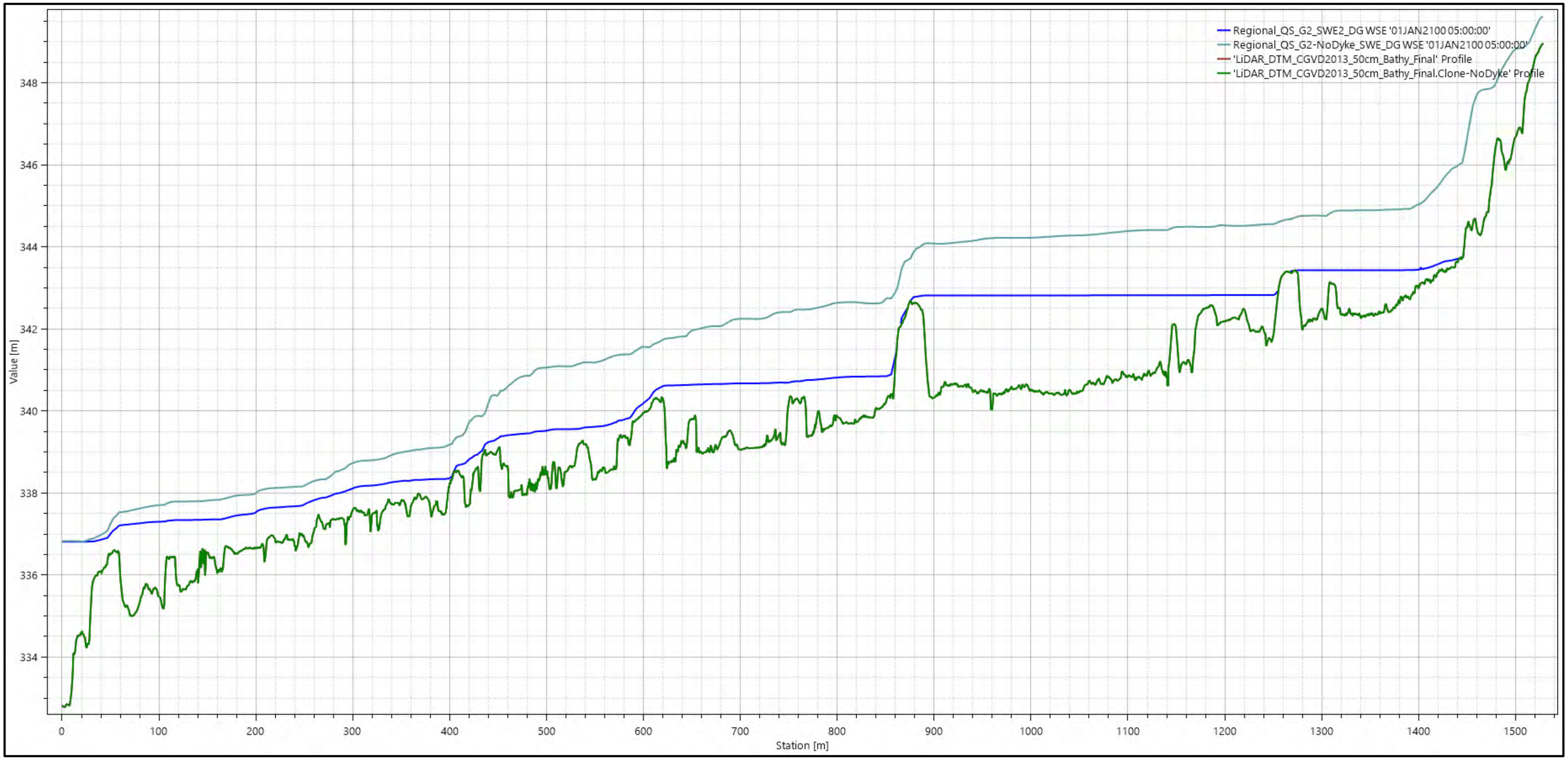
GR_OP_SecSched_Map3IDurhamX11.mxd

This map is for illustrative purposes only. Do not rely on this map as being a precise indicator of routes, location of features or surveying purposes. This map may contain cartographical errors or omissions.

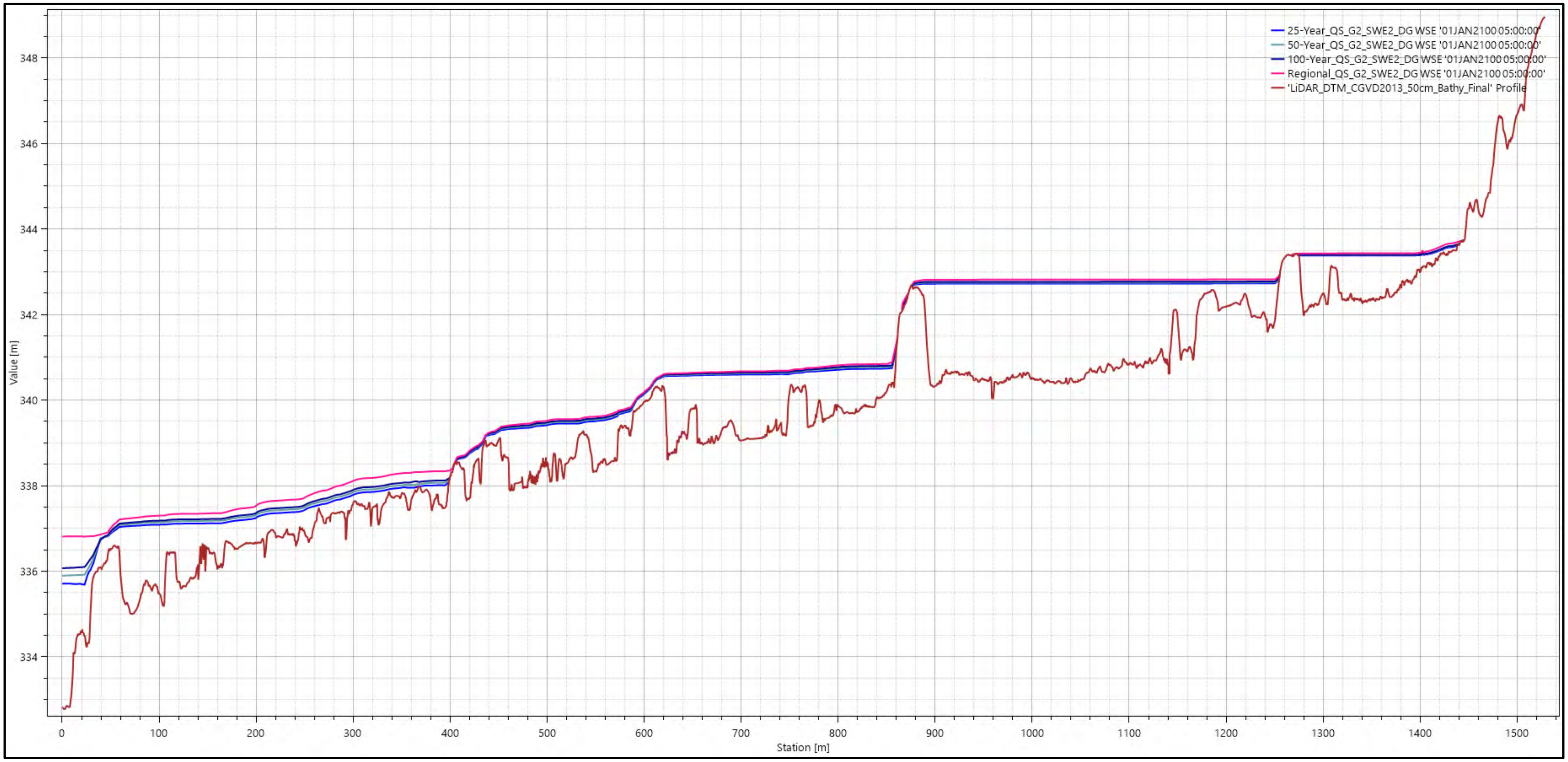
Appendix C

Hydraulic Study

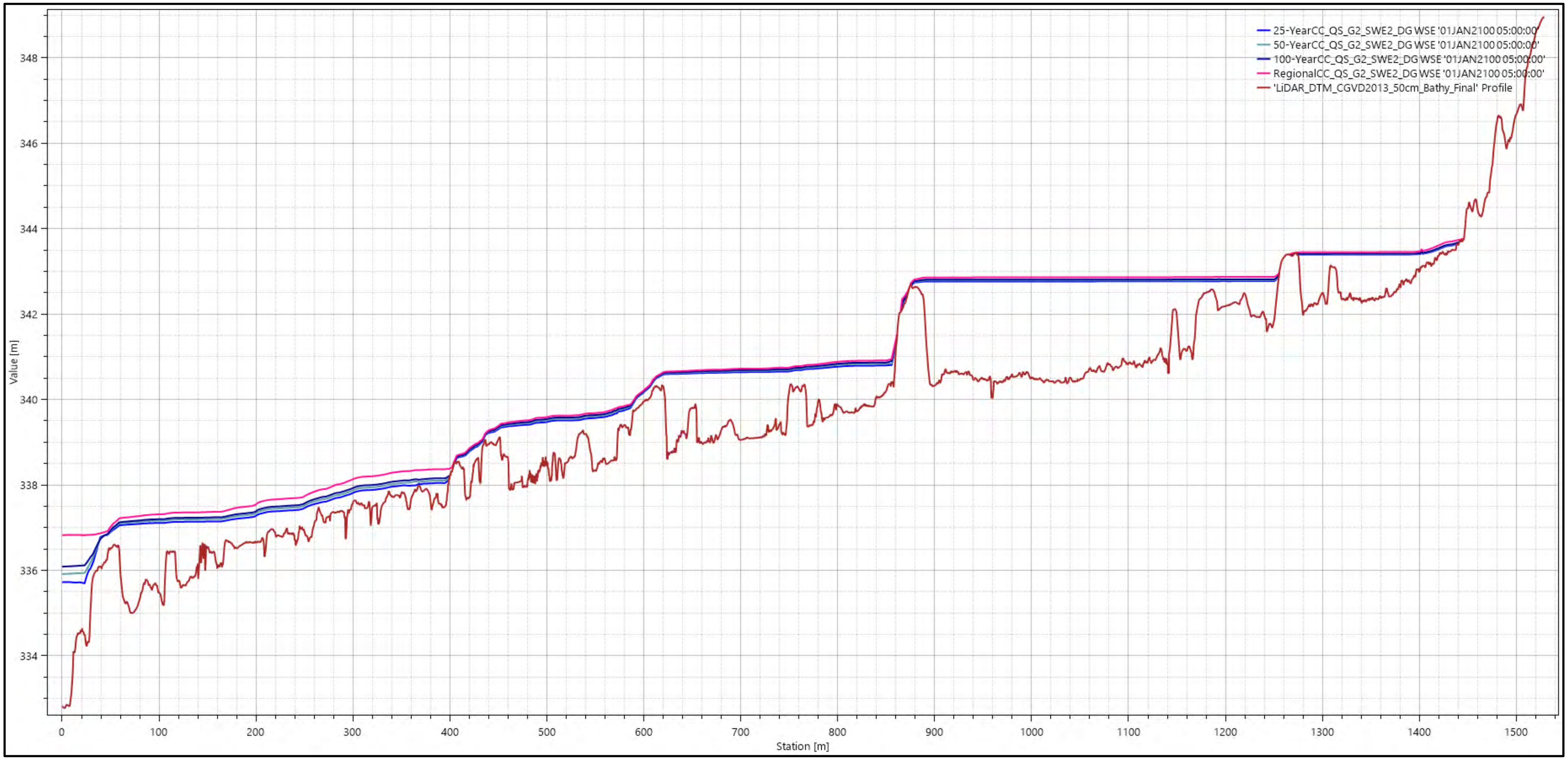
Profile Along Durham Creek Showing Hurricane Hazel and Hurricane Hazel with Saugeen River Spill Results



Profile Along Durham Creek Showing 25-Year, 50-Year, 100-Year, and Hurricane Hazel Results



Profile Along Durham Creek Showing 50-Year, 100-Year, and Hurricane Hazel Climate Change Results



Appendix D

Floodplain Mapping

Legend

- Extent of Study Area
- Existing SVCA Saugeen River Floodline
- Hurricane Hazel Floodway
- Hurricane Hazel Flood Fringe
- Contours (1m)
- Contours (5m)

0 15 30 60 90 120
Meters

True North

NAD83 UTM
Zone 17 North

CGVD 2013

Scales:

ANSI D (Full Size)
(22x34): 1:1500

1:1,500

1 cm = 15 m

2D Flow Area Flood Elevation Labelling

× 100.00 (1.00)
101.00 (1.01)

- Hurricane Hazel Water Surface Elevation (m)
- Hurricane Hazel Flood Depth (m)
- Hurricane Hazel with Saugeen Spill Flood Depth (m)
- Hurricane Hazel with Saugeen Spill Water Surface Elevation (m)

Revisions

No.	Description	By	Date
0	DRAFT FLOOD HAZARD MAPS	DG	02/26/24
1	FINAL FLOOD HAZARD MAPS	DG	03/01/24

Notes:

1. Modeled in ArcMap 10.7, HEC-RAS Version 6.4.1 (2D Flow Regime).
2. All units are metric and in meters unless otherwise specified.
3. Aerial imagery from SWOOP 2020.
4. Contours derrived from 2022 LiDAR DTM (DEDSFM Huron-Georgian Bay Project).
5. The LiDAR DTM base data is from the DEDSFM Huron-Georgian Bay 2022 project which has a 8.5 cm non-vegetated vertical accuracy and a 10.06 cm vegetated vertical accuracy which conforms to Level 1 Risk Criteria outlined in MNRF Technical Bulletin Flooding Hazards: Data Survey and Mapping Specification 2023.
6. This Flood Hazard Map is for Durham Creek only. The Flood Hazard Limits for the Saugeen River remain as per the 1991 Flood Hazard Mapping.

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03-01-2024
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West Grey

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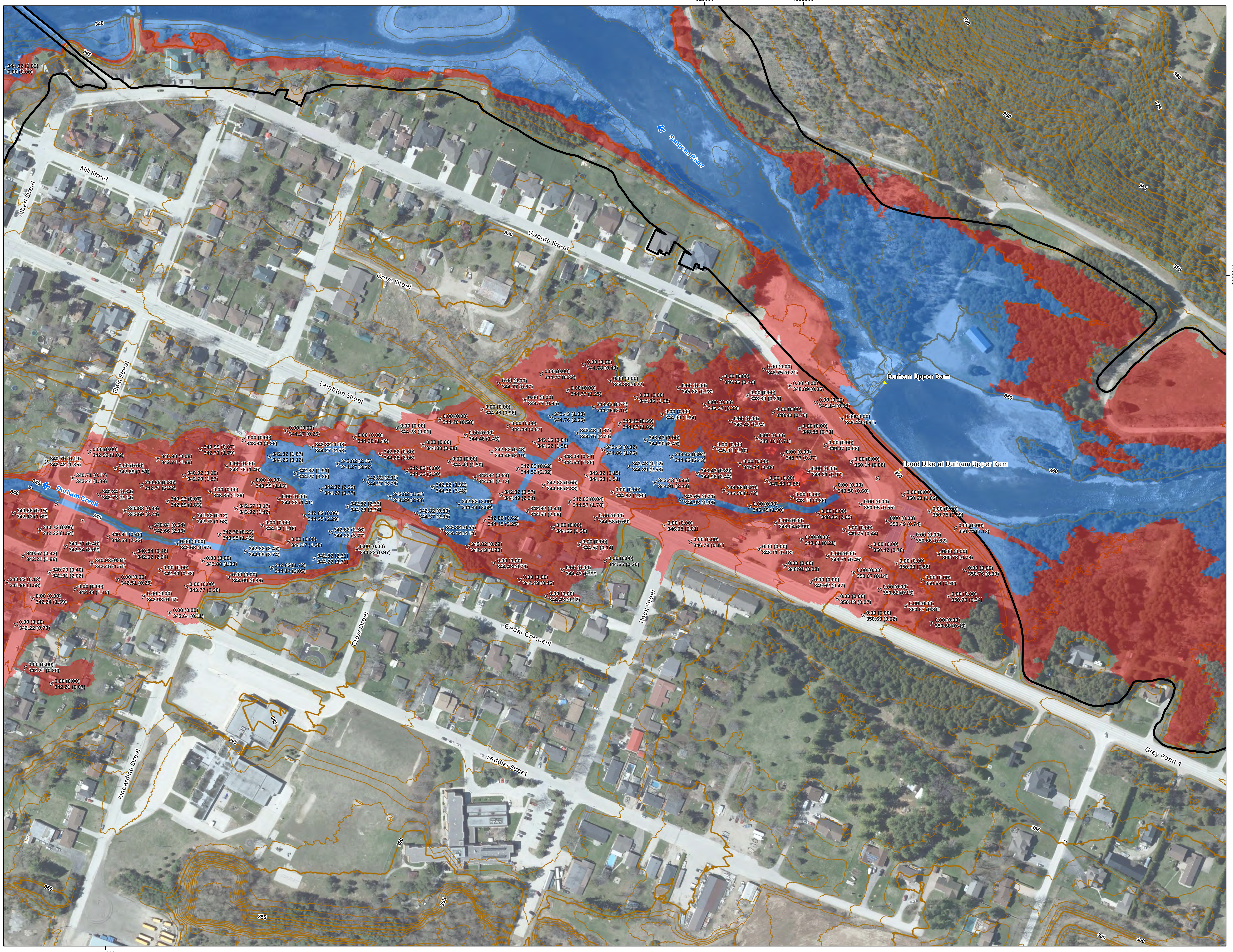
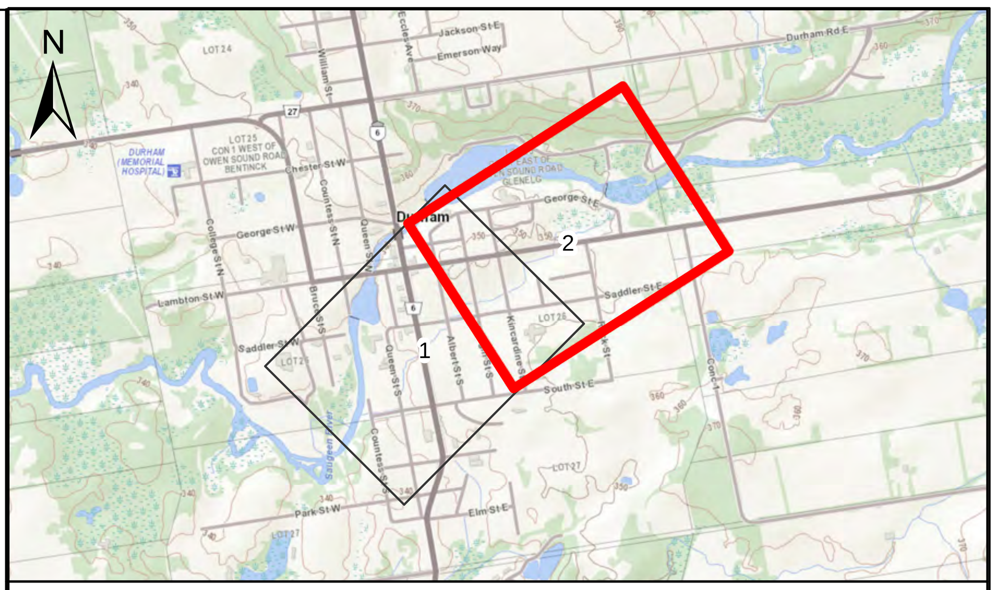
Engineer: MC	
Designed By: MC	
Checked By: DG	
Date: 03/01/24	
Project No. 23-5591	
Map File No. Draft FPM	

Durham Creek Flood Hazard Mapping

Saugeen Valley Conservation Authority
Municipality of West Grey

Hurricane Hazel Map Sheet 1





Legend

- Extent of Study Area
- Existing SVCA Saugeen River Floodline
- Hurricane Hazel Floodway
- Hurricane Hazel Flood Fringe
- Contours (1m)
- Contours (5m)

True North

NAD83 UTM Zone 17 North

CGVD 2013

Scales:

ANSI D (Full Size) (22x34): 1:1500

0 15 30 60 90 120

Meters

1:1,500

1 cm = 15 m

2D Flow Area Flood Elevation Labelling

100.00 (1.00)
101.00 (1.01)

- Hurricane Hazel Water Surface Elevation (m)
- Hurricane Hazel Flood Depth (m)
- Hurricane Hazel with Saugeen Spill Flood Depth (m)
- Hurricane Hazel with Saugeen Spill Water Surface Elevation (m)

Revisions

No.	Description	By	Date
0	DRAFT FLOOD HAZARD MAPS	DG	02/26/24
1	FINAL FLOOD HAZARD MAPS	DG	03/01/24

Notes:

1. Modeled in ArcMap 10.7, HEC-RAS Version 6.4.1 (2D Flow Regime).
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3. Aerial imagery from SWOOP 2020.
4. Contours derived from 2022 LiDAR DTM (DEDSFM Huron-Georgian Bay Project).
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Designed By: MC

Checked By: DG

Date: 03/01/24

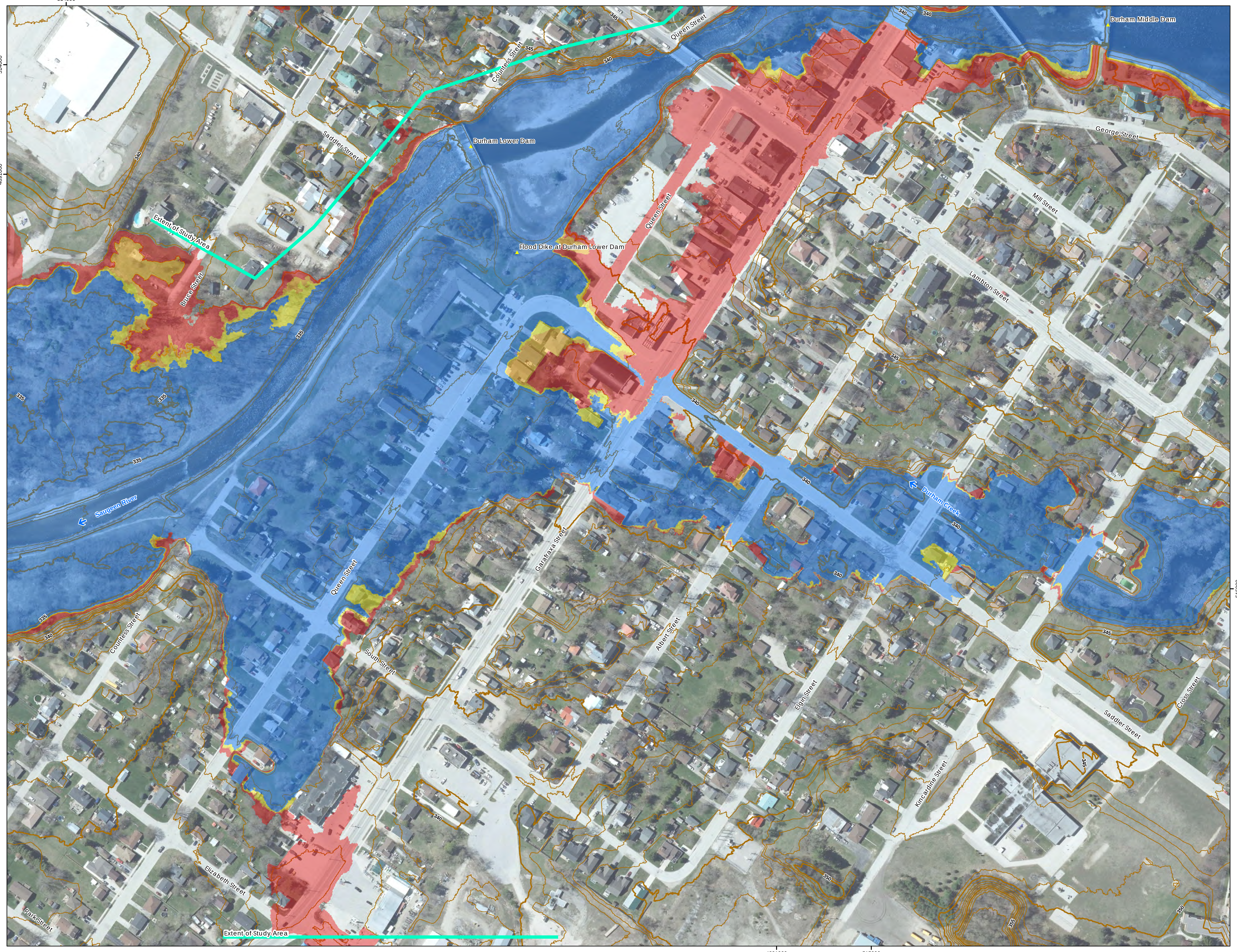
Project No. 23-5591

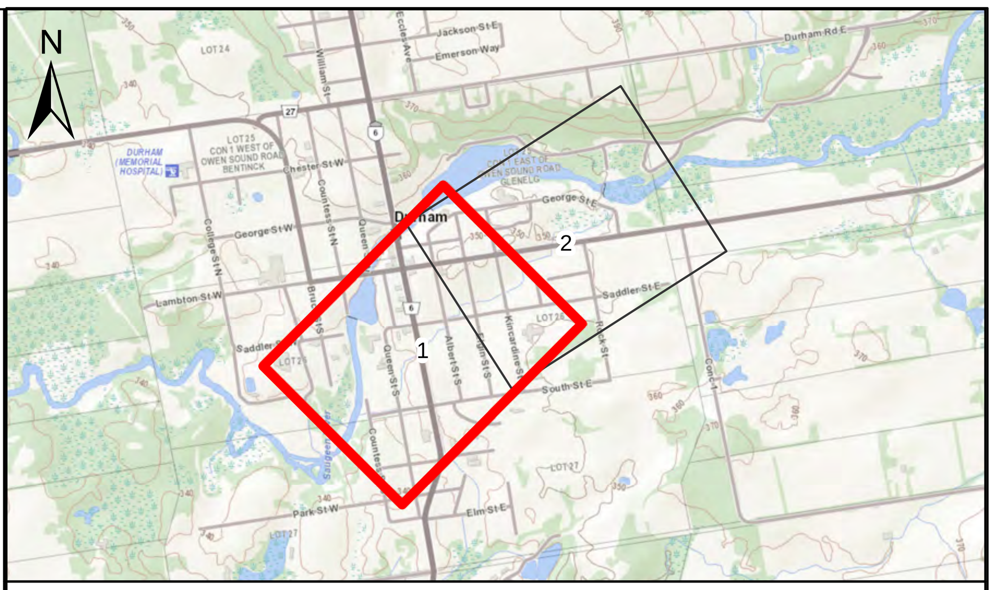
Map File No. Draft FPM

Durham Creek Flood Hazard Mapping

Saugeen Valley Conservation Authority
Municipality of West Grey

Hurricane Hazel Map Sheet 2





Legend

- Extent of Study Area
- 25-Year Inundation Boundary
- 50-Year Inundation Boundary
- 100-Year Inundation Boundary
- Regional Inudation Boundary
- Contours (1m)
- Contours (5m)

True North

NAD83 UTM
Zone 17 North

CGVD 2013

Scales:

ANSI D (Full Size)
(22x34): 1:1500

0 15 30 60 90 120
Meters

1:1,500

1 cm = 15 m

Revisions

No.	Description	By	Date
0	DRAFT FLOOD RISK MAPS	DG	02/27/24
1	FINAL FLOOD RISK MAPS	DG	03/01/24

Notes:

1. Modeled in ArcMap 10.7, HEC-RAS Version 6.4.1 (2D Flow Regime).
2. All units are metric and in meters unless otherwise specified.
3. Aerial imagery from SWOOP 2020.
4. Contours derrived from 2022 LiDAR DTM (DEDSFM Huron-Georgian Bay Project).
5. The LiDAR DTM base data is from the DEDSFM Huron-Georgian Bay 2022 project which has a 8.5 cm non-vegetated vertical accuracy and a 10.06 cm vegetated vertical accuracy which conforms to Level 1 Risk Criteria outlined in MNRF Technical Bulletin Flooding Hazards: Data Survey and Mapping Specification 2023.
6. This Flood Hazard Map is for Durham Creek only. The Flood Hazard Limits for the Saugeen River remain as per the 1991 Flood Hazard Mapping.

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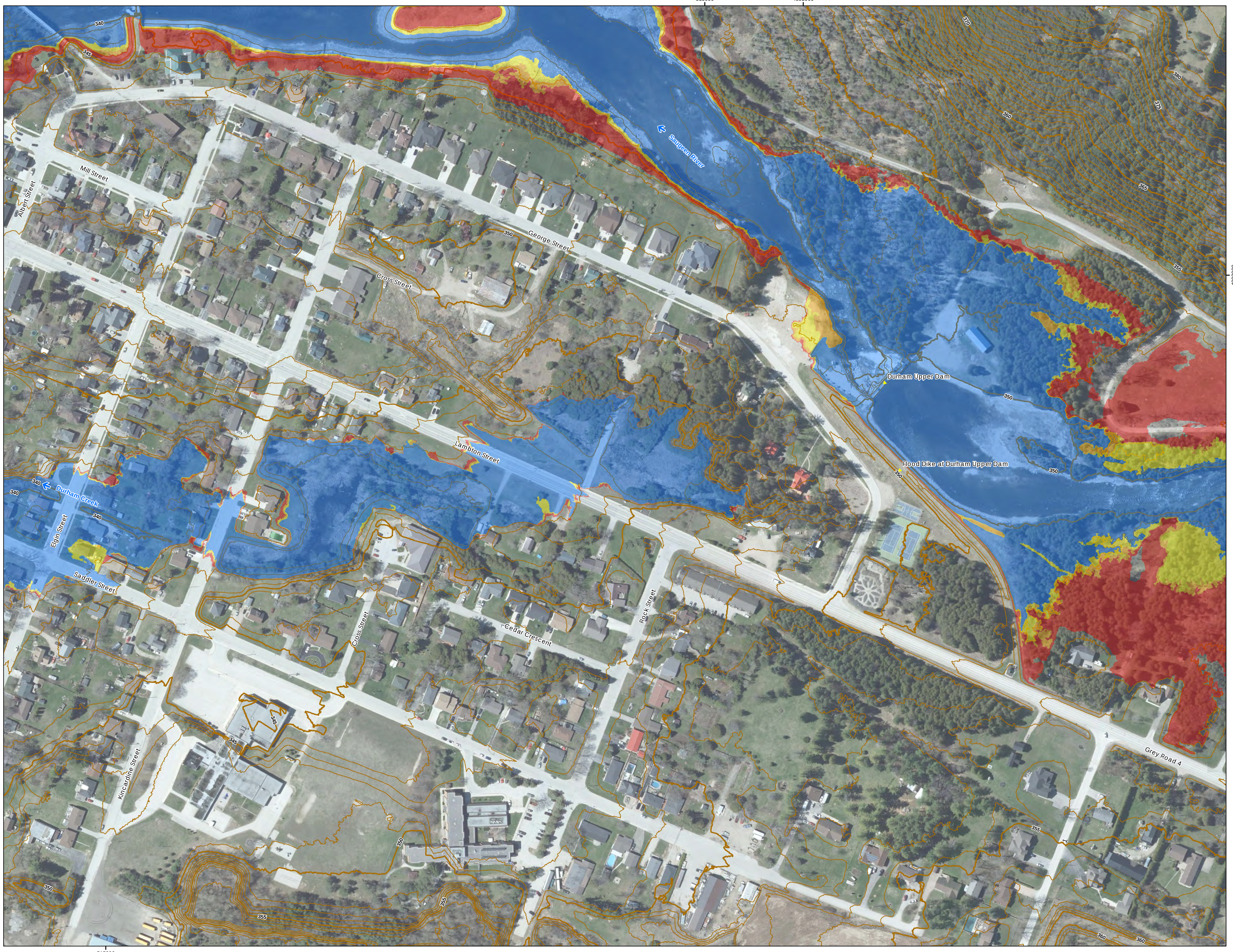
E. wills@dmwills.com

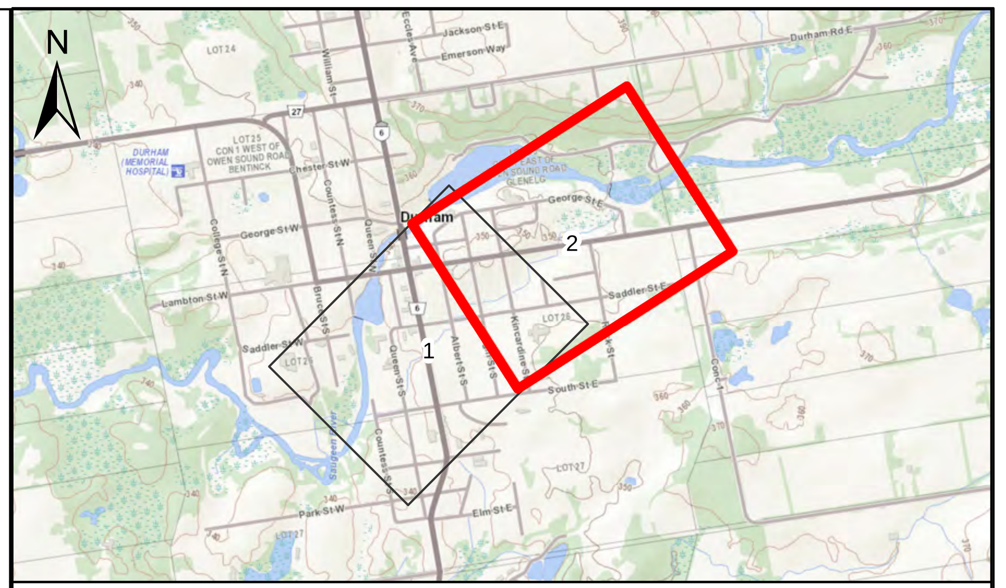
Engineer: MC
Designed By: MC
Checked By: DG
Date: 03/01/24
Project No. 23-5591
Map File No. Draft FPM

Durham Creek Flood Hazard Mapping

Saugeen Valley Conservation Authority
Municipality of West Grey

Flood Risk Map Sheet 1





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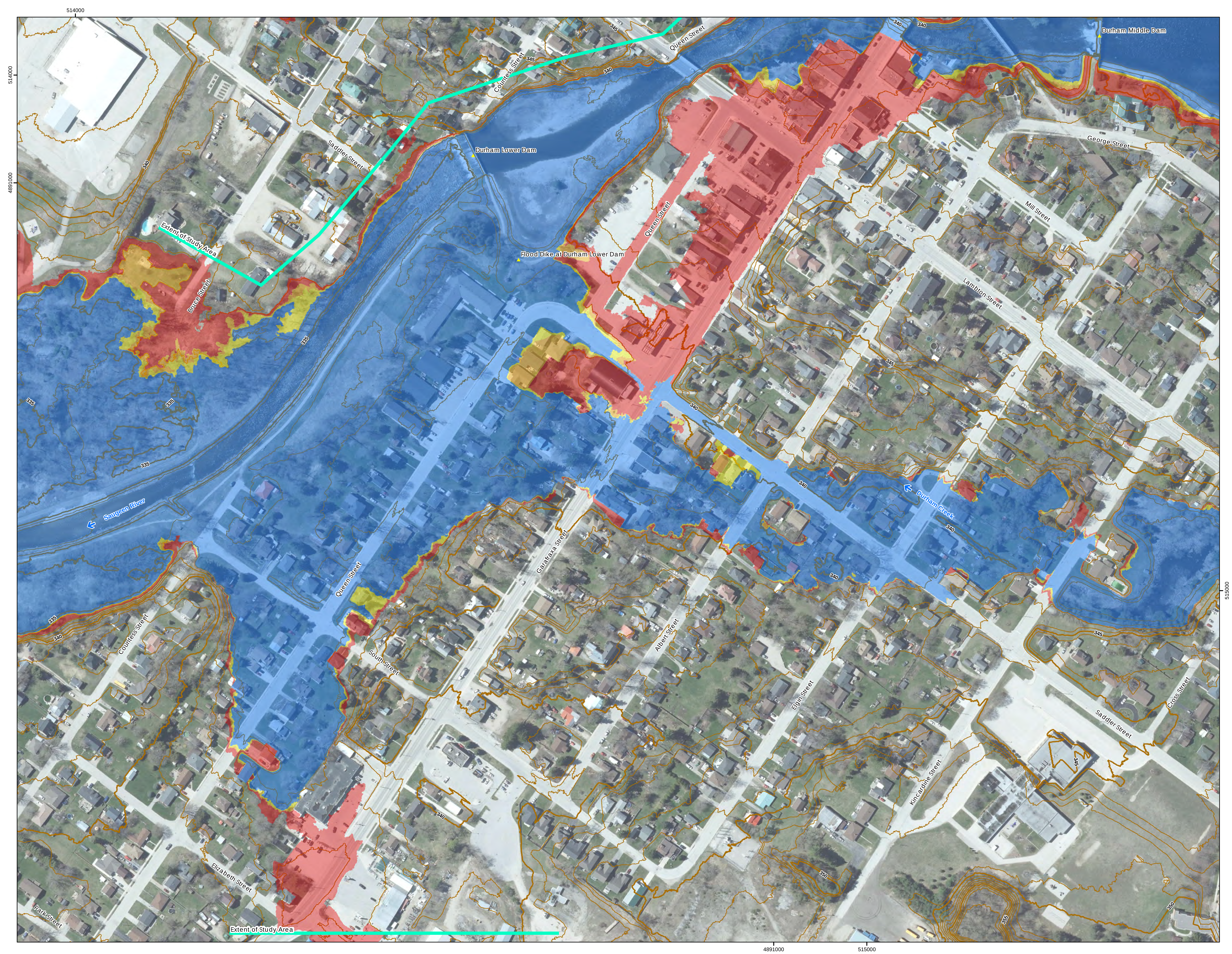

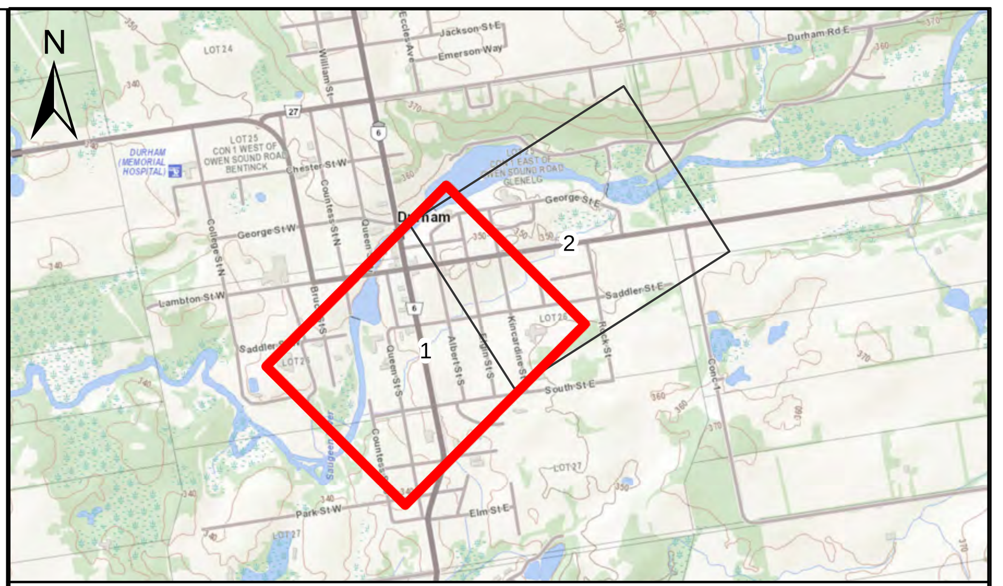

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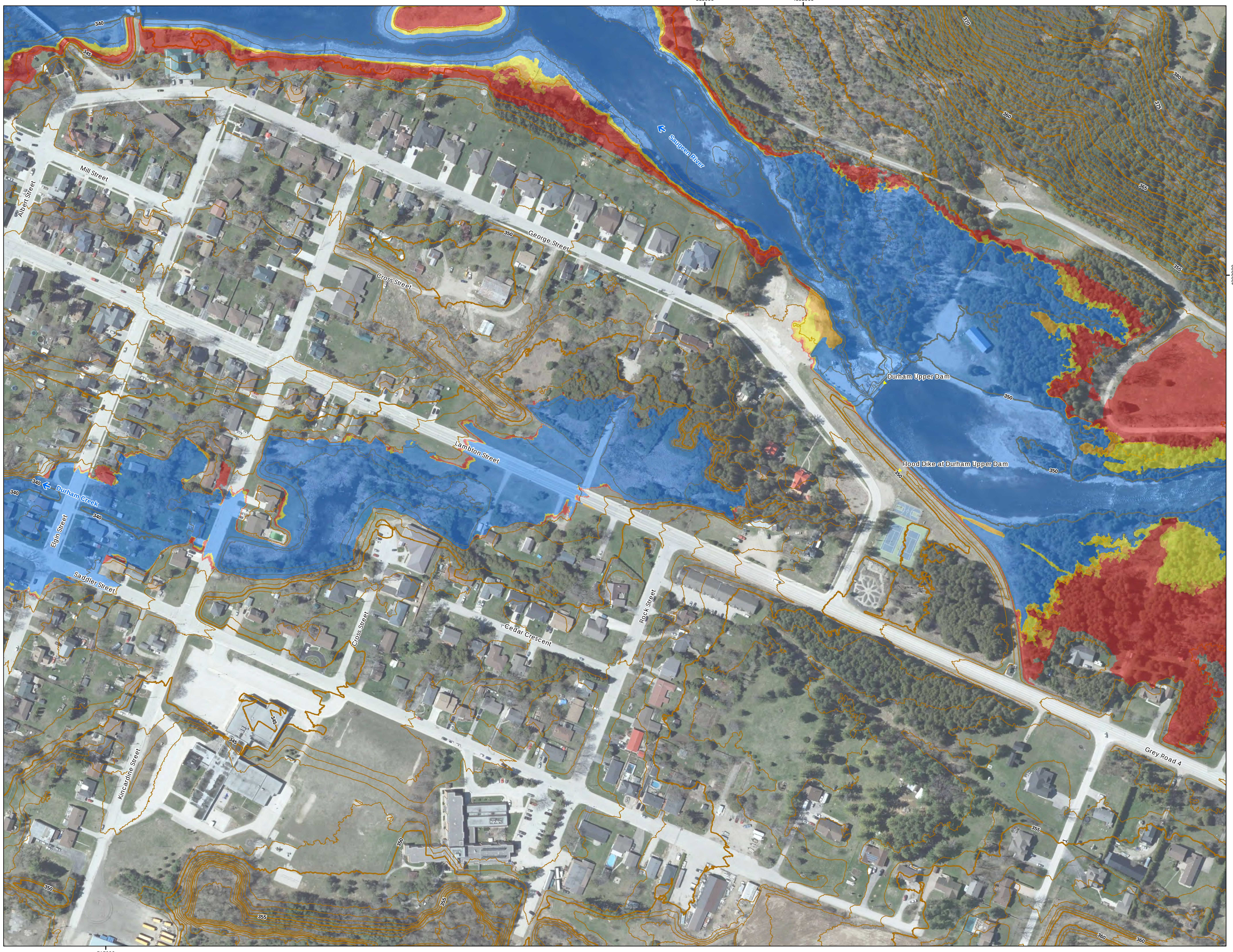
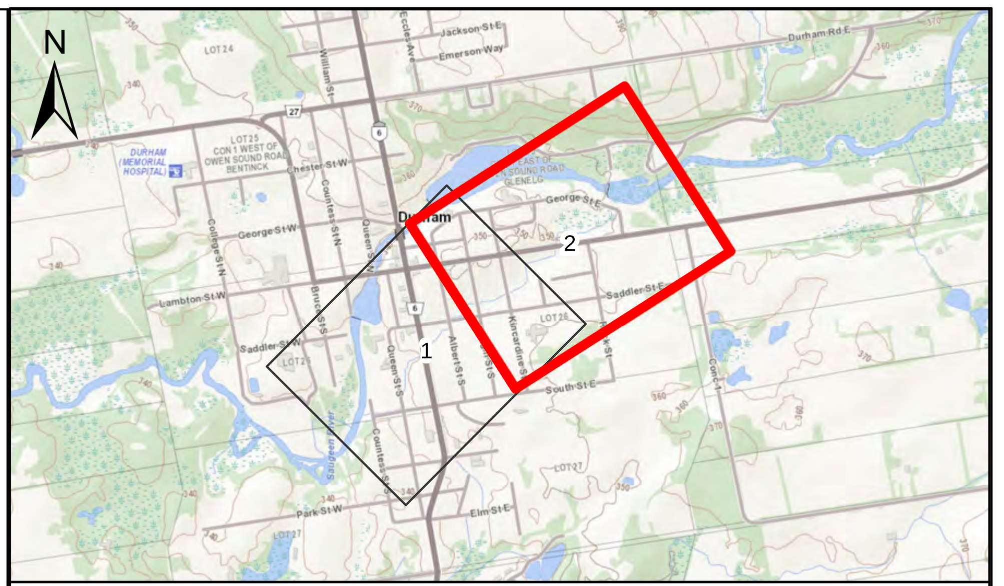
Durham Creek Flood Hazard Mapping

Saugeen Valley Conservation Authority
Municipality of West Grey

Climate Change Flood Risk Map Sheet 1





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Municipality of West Grey

Climate Change Flood Risk Map Sheet 2

Saugeen CONSERVATION

Durham Creek Floodplain Mapping

Overview of 2023/24 Flood Hazard Identification Mapping Program Project

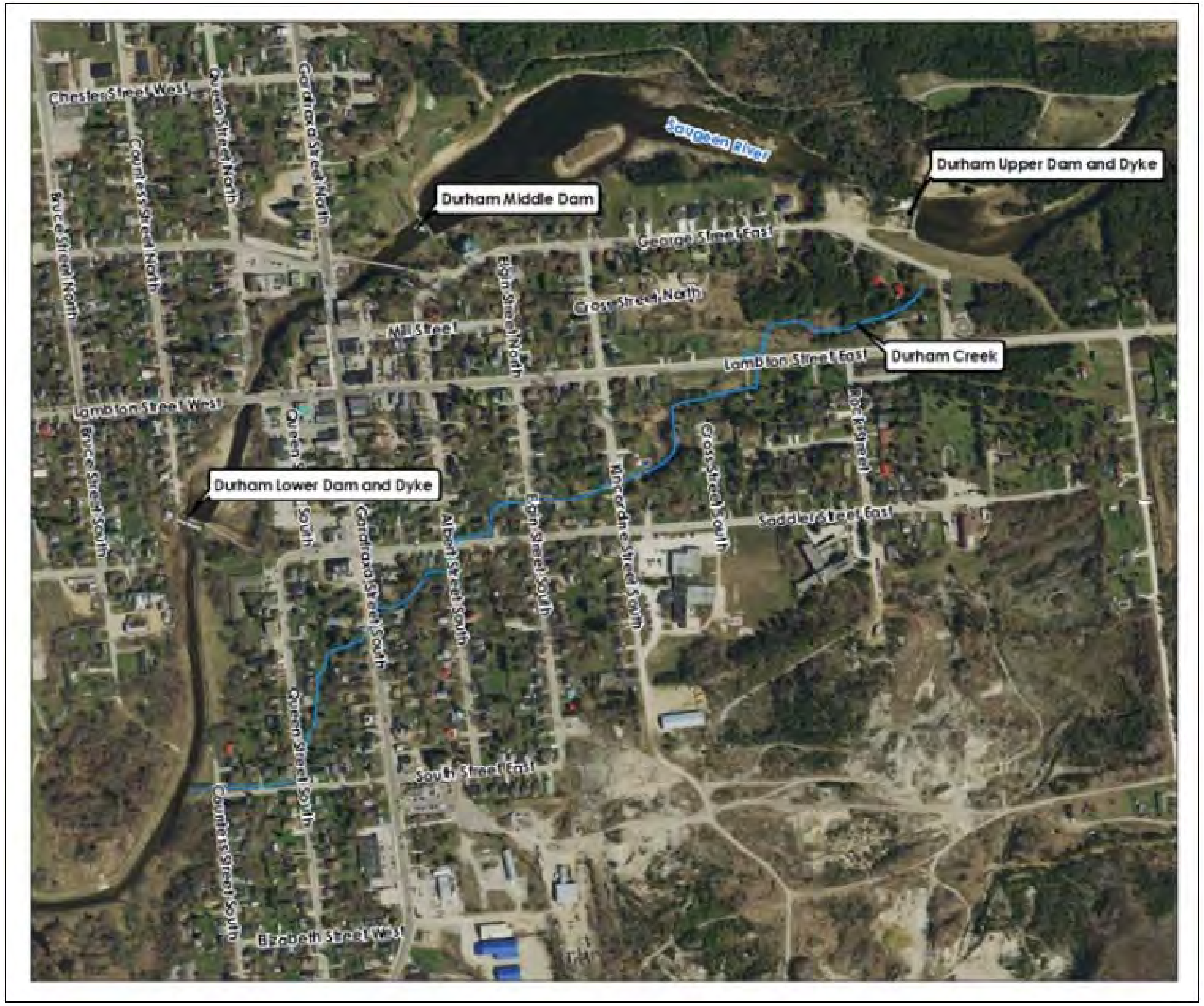
Matt Armstrong
Manager, Environmental Planning and Regulations
Saugeen Valley Conservation Authority

March 18, 2025

FHIMP Overview

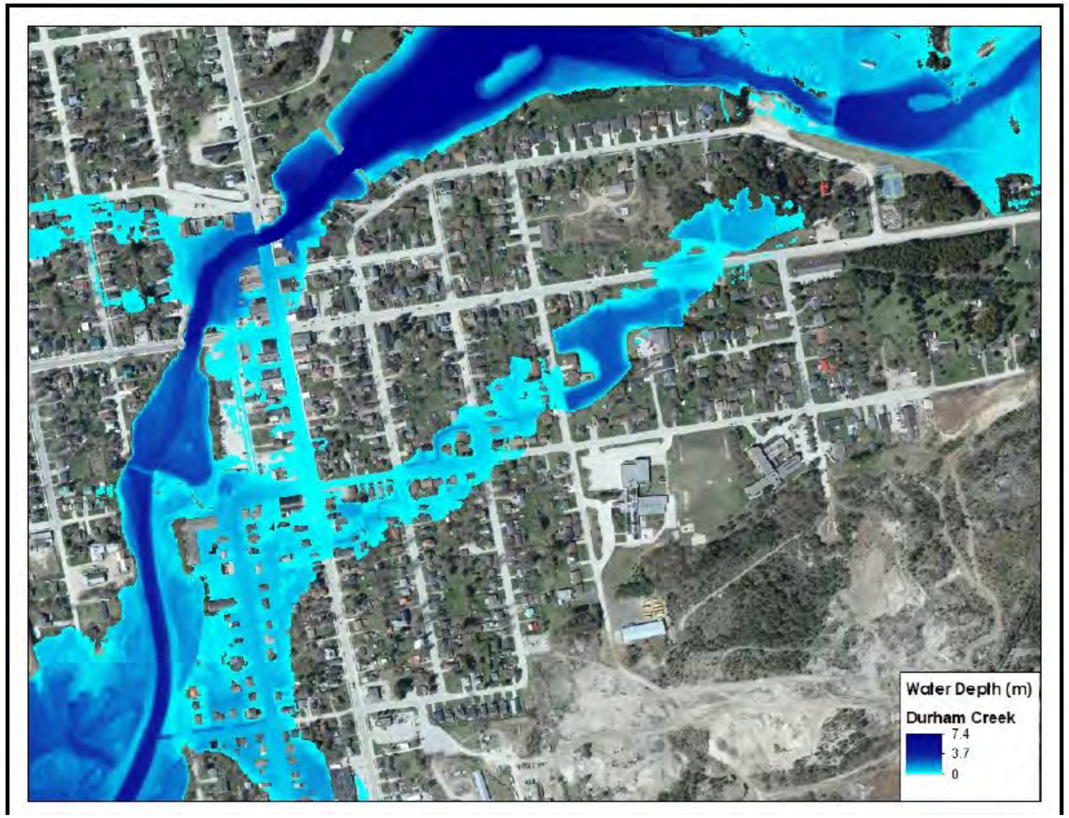
- In January 2022, Natural Resources Canada launched the Flood Hazard Identification and Mapping Program (FHIMP)
- Up to 50% matched federal funding to provinces and territories for eligible flood mapping projects (until 2028)
- SVCA partnered with West Grey, Huron-Kinloss, and Saugeen Shores to have updated or new floodplain mapping produced
- Durham Creek was identified as a priority area for West Grey

Durham Creek

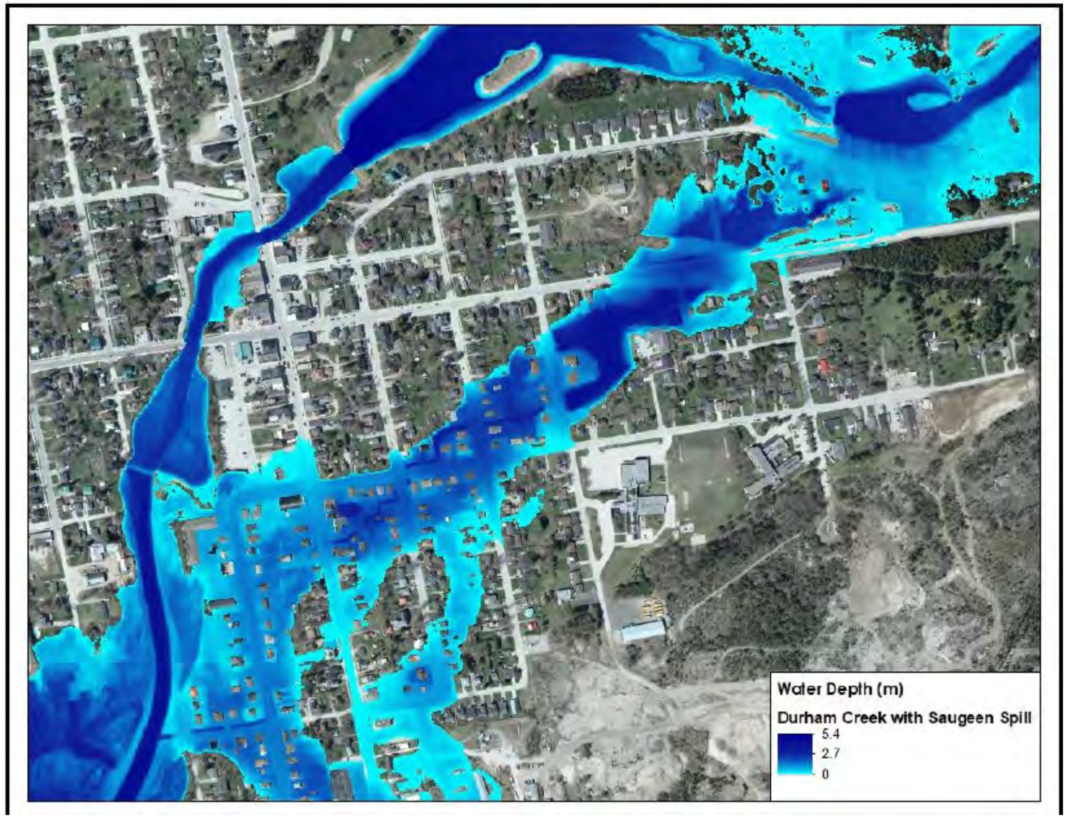


- Durham Creek flows through the east side of Durham, outlets to Saugeen River below Lower Dam
- No previous engineered floodplain mapping for Durham Creek
- DM Wills Associates Ltd. created hydrologic and hydraulic models to produce floodplain mapping
- Saugeen River influences Durham Creek Floodplain and was also modelled

Hydraulic Model Results

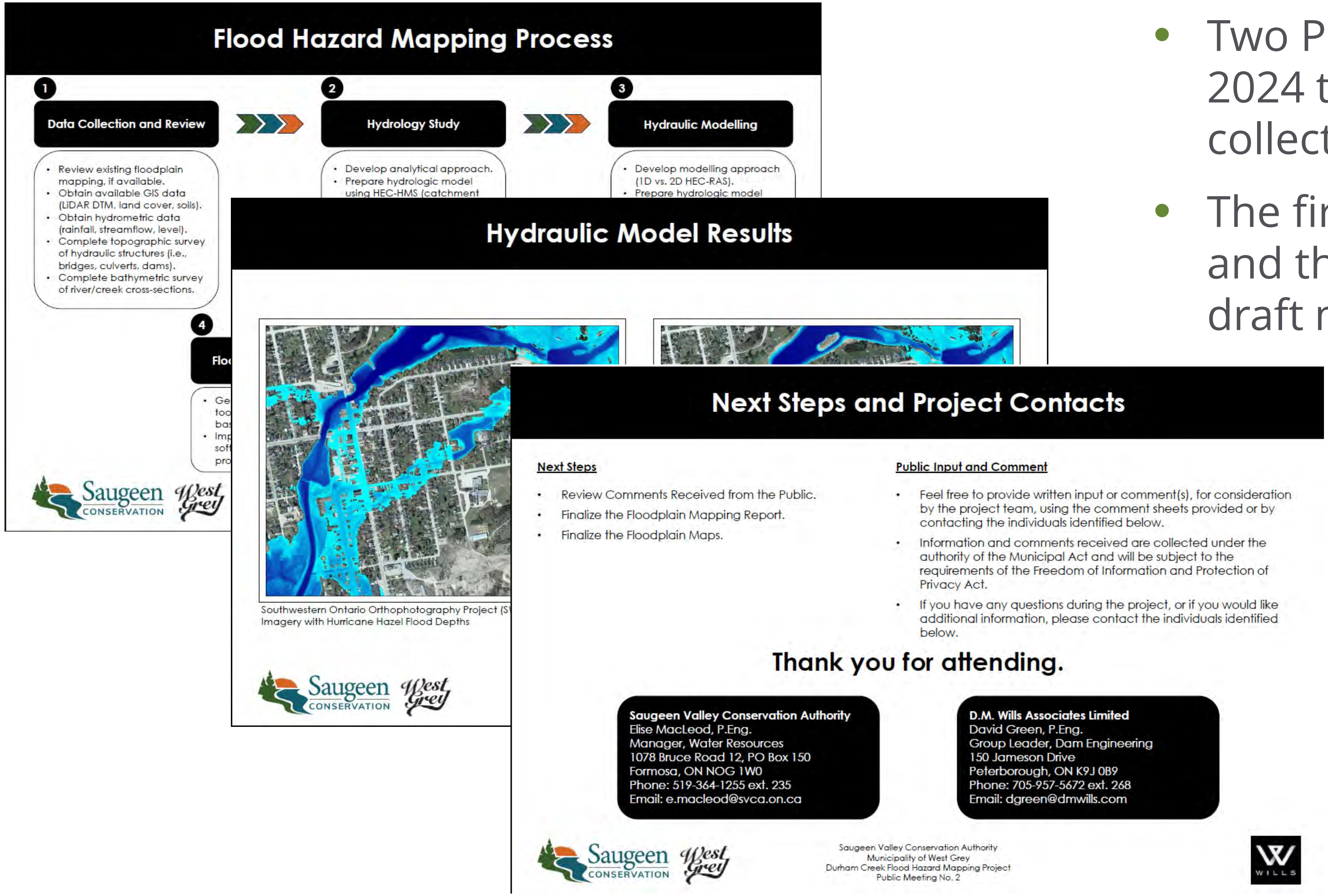


Floodplain without spill from Saugeen River at Upper Durham Dam



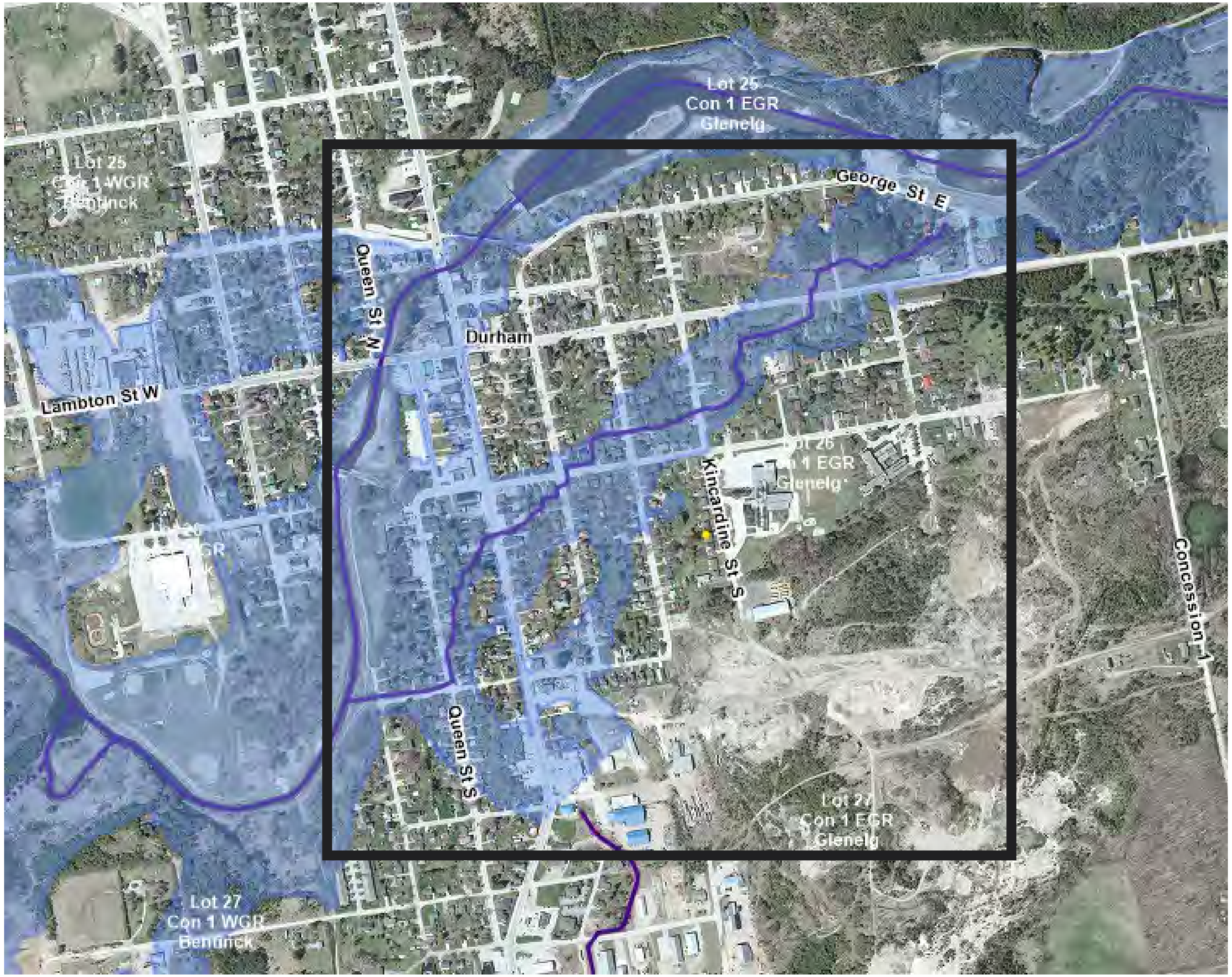
Floodplain with spill from Saugeen River at Upper Durham Dam

Public Information Centres (PICs)

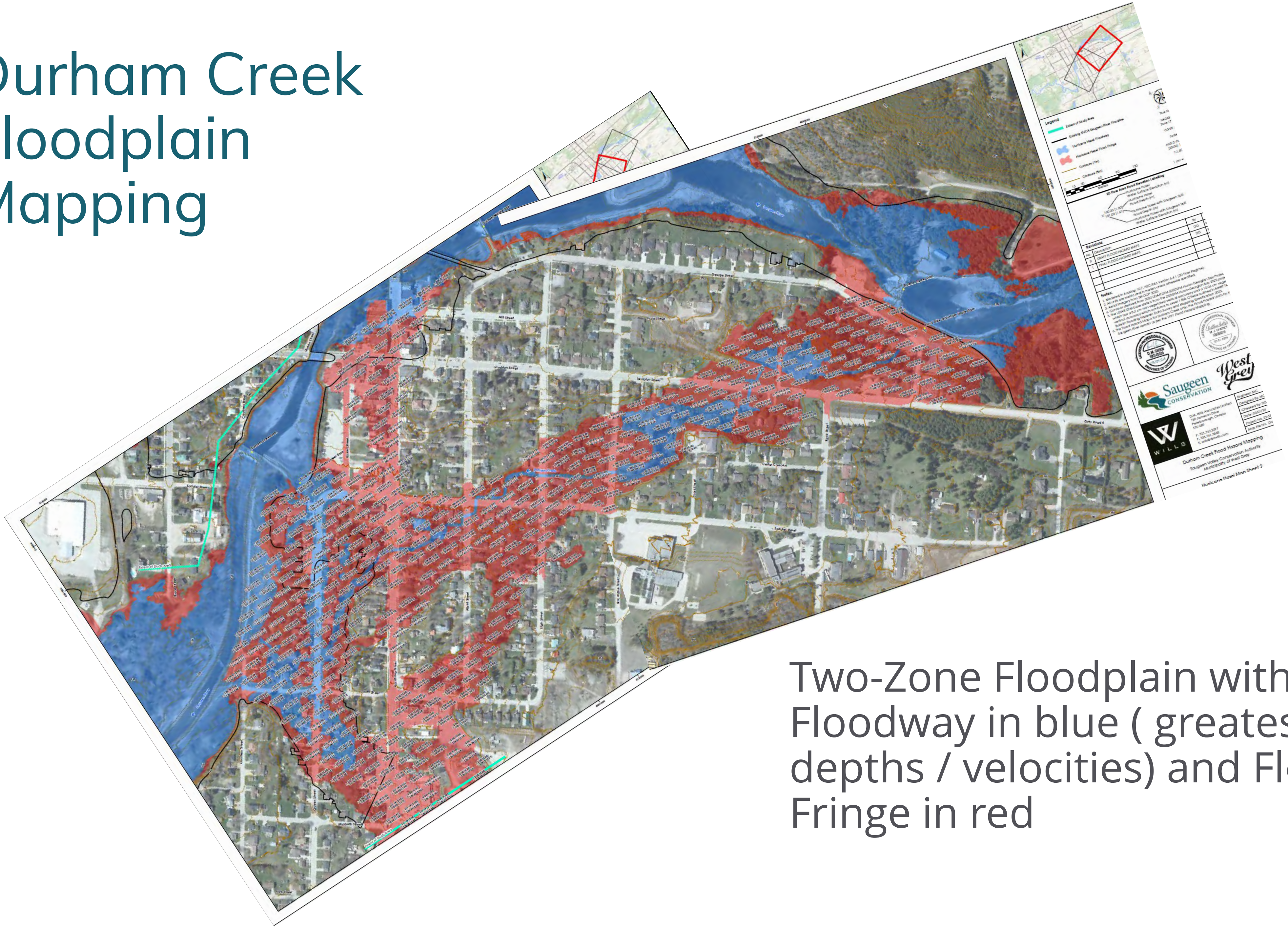


- Two PICs were held in 2023 & 2024 to educate residents and collect feedback
- The first PIC introduced FHIMP and the second presented draft mapping results

Durham Floodplain Mapping



Durham Creek Floodplain Mapping



Two-Zone Floodplain with Floodway in blue (greatest depths / velocities) and Flood Fringe in red

Report Recommendations

1) SVCA and the Municipality of West Grey update the floodplain mapping for the Saugeen River and then consider updates to their Two-Zone floodplain planning policies and development approvals processes for both Durham Creek and the Saugeen River together.

2) Given the potential significant impacts of a failure of the dike at the Durham Upper Dam, the SVCA and Municipality of West Grey should consider the development of an Emergency Preparedness and Response Plan (EPRP) for the structure.


Saugeen
CONSERVATION
Thank you.