City of Hamilton

Drainage and Stormwater Management Report

Mohawk Roadway Widening, Municipal Class EA

Date: December 2019

Project Number B000941

Submitted by
CIMA Canada Inc.

415 Baseline Road West, 2nd Floor
Bowmanville, ON L1C 5M2
T 905 697 4464 F 905 697 0443
cima.ca

Contact

Ryan Cressman, P.Eng.
Ryan.Cressman@cima.ca
T 905 697-4464, 6927

Table of Contents

List of Appendices

1 Introduction

The City of Hamilton has retained CIMA+ to complete a Municipal Class Environmental Assessment (MCEA) for the widening of Mohawk Road between Lime Kiln Road and Filman Road. The study area extends for approximately 750 meters and has multiple outlets, draining into either Tiffany Creek or Ancaster Creek, which are both tributary to Spencer Creek and within the jurisdiction of the Hamilton Conservation Authority (HCA). General location of study area can be found in Appendix A, Figure 1.

The purpose of this report is to provide an assessment of existing and proposed conditions for roadway stormwater and drainage. The report identifies existing drainage constraints and issues, impacts to water quality and quantity, and a proposed stormwater management plan to mitigate the impacts due to the widening of Mohawk Road.

1.1 Background Documents

The following background drawings, studies and guidance documents were obtained as part of the SWM Study:

- Storm Drainage Policy, City of Hamilton, 2004;
- Stormwater Master Plan, City of Hamilton, 2007;
- Planning & Regulation Policies and Guidelines, Hamilton Conservation Authority, 2011;
- Ancaster Creek Subwatershed Stewardship Action Plan, Hamilton Conservation Authority, 2008;
- Tiffany Creek Subwatershed Stewardship Action Plan, Hamilton Conservation Authority, 2008;
- MOE's Stormwater Management Planning and Design Manual, March 2003;
- Low Impact Development Stormwater Management Planning and Design Guide, CVC, 2010;
- Comprehensive Development Guidelines and Financial Policies Manual, 2018.

1.2 Design Criteria

This section provides an overview of the SWM design criteria for the study area based on City of Hamilton and HCA guidelines.

1.2.1 City of Hamilton

The City of Hamilton has updated the Criteria and Guidelines for Stormwater Infrastructure Design as part of the Comprehensive Development Guidelines and Financial Policies Manual, 2018, which contains specific storm water management guidelines. The following is a summary of key design requirements:

- Rainfall intensity shall be based on the 5 year IDF relationship for the Mount Hope rainfall gauge;
- Initial time of concentration Tc shall be 10 minutes and the time for conveyance of storm flows shall be based on full pipe flow velocities;
- Runoff coefficient for single family residential is 0.50 – 0.65.

Lastly, where existing storm sewers are designed for a return event less than the 5 year standard, to prevent downstream surcharging, the proposed upstream storm sewer should not increase the level of surcharging downstream. Otherwise, hydraulic analysis should demonstrate that no negative impact on the receiving storm sewer system results from the proposed storm.

Water Quality

Within the City of Hamilton, the quality control criteria for both Ancaster and Tiffany Creek requires level 1 enhanced quality control. Water quality performance shall conform to Provincial requirements SWM planning and design Manual MOE, 2003.

1.2.2 Hamilton Conservation Authority

The Planning and Regulation Policies and Guidelines, 2011, developed by the HCA, contains specific storm water management guidelines. Excerpts of the report can be found in Appendix B.

Water Quantity

The HCA requires at minimum to control the pre- to post-development flows from the 2-year storm event up to the 100-year storm event (i.e. 2, 5, 10, 25, 50 and 100-year storms).

Water Quality

The HCA's water quality requirements are based on current watershed habitat classifications. As per the City of Hamilton guidelines, within the City of Hamilton, both Ancaster and Tiffany creek requires level 1 enhanced quality control.

1.2.3 Ministry of the Environment, Conservation and Parks (MECP)

Additional stormwater runoff from new pavement can impact receiving watercourse and flood conditions. Quality and quantity control measures to treat stormwater runoff should be considered for all new impervious areas and, where possible, existing surfaces. A Stormwater Management Plan should be prepared in accordance with the MOECC "Stormwater Management Planning and Design Manual" dated May 2003.

2 Existing Conditions Characterization

Mohawk Road is a 750 m two-lane arterial roadway extending from the off ramp of Highway 403 in the east to the intersection of Lime Kiln Road in the west. Generally, the existing roadway is a 2 lane rural cross-section with shallow ditching on both sides of the roadway, and no pedestrian sidewalks or active transportation trails.

From east to west, Mohawk Road tapers from a 3-lane road to a 2-lane road as the roadway leaves the Highway 403 off ramp and enters the residential area at Filman Road. From there and over the next 550 m, Mohawk Road is a rural cross section with gravel shoulders and storm ditches. Within this area of rural road cross section, Mohawk Road briefly expands to a 3-lane road to provide left turn lane access to Algonquin Avenue.

Towards the west end of the study area, between Cayuga Avenue and Lime Kiln Road, approximately 175 m of Mohawk Road has a half urban cross section, with the north side of Mohawk Road curbed and the south side with a gravel shoulder and ditches. At the intersection of Mohawk Road and Lime Kiln Road, Mohawk Road expands to a 3-lane road to provide for a left turning lane for the intersection.

To the west, Outlet 1, from Lime Kiln Road to Cayuga Avenue drains to Ancaster Creek. The remaining of the study area, both Outlets 2 & 3, drain to Tiffany Creek. Both Creek's combine downstream and drain to Spencer Creek within the jurisdiction of the Hamilton Conservation Authority (HCA).

The drainage characteristics of the site depend on many things, including the topography, local land use and the type of native soil. This section further describes the existing conditions drainage and SWM within the study area.

A map of existing drainage conditions can be found in Appendix A, Figure 3.

2.1 Existing Land Use

The area land use is mostly low density residential with the HWY 403 off ramp to the east of the study area, as well as a school and small grouping of high-density residential buildings on the west side of the study area.

2.2 Existing Surficial Soils

Soil groups in the area were taken from the Ontario Soil Survey Complex which was obtained from the Land Information Ontario database. The soil group that covers the entire study area and most of the drainage area is Grimsby Sandy Loam. This soil is categorized under hydraulic soil group A, characterized by well drained soils with low runoff potential and high infiltration rates even when wetted.

The remaining soil in the drainage area is Alberton Silt Loam, within hydraulic soil group B, characterized by soils with moderate runoff potential and moderate infiltration.

A soils map can be found in Appendix A.

2.3 Existing Minor Drainage System

Topography of the study area generally flows in a northerly direction. The study area has been delineated into 3 distinct drainage areas with three separate outlets. The catchment areas and outlets are described below and depicted in Appendix A. Both internal and external drainage areas have been discussed. External drainage areas are areas that are outside of the boundary of project work and whose stormwater quantity and quality will not be affected by the proposed works. Internal drainage areas are areas in which proposed work will directly impact the stormwater quality and quantity.

Catchment 1.0: The western portion of Mohawk Road, labelled Outlet 1, drains to the low point at the intersection of Mohawk Road and Lime Kiln Road. From there it enters the storm sewer through a 600 mm pipe @ 0.8% which drains north to the residential area on Longfield Crescent which outlets into Ancaster Creek.

Catchment 101 & 102 (External): The external areas drainage to Outlet 1 primarily consist of a park, forest area, school and high-density residential housing. The mixed use generally drains to the low point at the intersection of Mohawk Road and Lime Kiln Road through a combination of storm sewers and ditch's outletting to the same location as catchment 1.0 as described above.

Catchment 2.0: The central portion of Mohawk Road between Cayuga Avenue and Filman Road, labelled Outlet 2, drains to the center of the study area and into a residential storm sewer, flowing north into a 975 mm pipe, through a residential neighborhood and outletting into Tiffany Creek.

Catchment 201, 202 & 203 (External): The external areas draining to Outlet 2 are detached estate residential development areas with rural roadway and ditching. Specifically, catchment 201 is a 24 ha external catchment that drains to a 450 mm pipe on Hiawatha Boulevard flowing north through an easement into the same outlet as catchment 2.0 described above.

Catchment 3.0: A small portion of the intersection of Filman Road and Mohawk Road, as well as some roadway to the east of Filman Road, labelled Outlet 3, drain north and enter the same storm sewer as Catchment 2 through a 300 mm diameter pipe, through a residential neighbourhood and outletting into Tiffany Creek.

Catchment 301 (External): This external area is a small residential property draining to the same outlet as catchment 3.0, as described above.

2.4 Existing Major Drainage System

Mohawk Road has three poorly defined existing major drainage systems. Fundamentally, these systems convey flows to three (3) different outlets:

Catchment 1.0: The western portion of the study area, labelled Outlet 1, has an overland flow path which is conveyed by Lime Kiln Road north to Longfield Crescent and then west along Longfield Crescent to Ancaster Creek. The overland flow route has no defined flow route between homes from Longfield Crescent to Ancaster Creek, the receiving watercourse. This lack of a defined overland flow path poses potential flooding risks.

Catchment 101 & 102 (External): The external areas drainage has the same overland flow route as catchment 1.0, as described above.

Catchment 2.0: The central portion of the study area between Cayuga Avenue and Filman Road, labelled Outlet 2, has no clear overland flow route to Tiffany Creek, the receiving watercourse. This lack of a defined overland flow path poses potential flooding risks.

Catchment 201, 202 & 203 (External): The external areas drainage has the same overland flow route as catchment 2.0, as described above.

Catchment 3.0: The eastern portion of the study area, labelled Outlet 3, has an overland flow path that will convey water in a north easterly direction along Filman Road, spilling to Tiffany Creek at Highvalley Road.

Catchment 301 (External): The external areas drainage has the same overland flow route as catchment 3.0, as described above.

2.5 Existing Stormwater Infrastructure

There is no existing stormwater quantity or quality infrastructure (SWM Ponds, OGS, etc.) on Mohawk Road, however, the existing storm ditches provide a measure of quality and quantity control. The Falling Brook Estates storm drainage area plan identifies an oil grit separator (OGS) prior to outletting to the Banting's Pond, at Tiffany Creek. No record information was available to confirm the level of quality and quantity controls provided.

2.6 Existing Storm Sewer Assessment

The following is an overview of the background information collected, including design drawings, storm sewer design sheets, and drainage plans, as it relates to the capacity of the existing storm sewer system. The documents were obtained from City of Hamilton:

- Legacy Subdivision (25T-200403) Storm Sewer Design Sheets, A.J. Clarke and Associated Ltd., October 2013;
- Legacy Subdivision (25T-200403) Storm Drainage Area Plan, A.J. Clarke and Associated Ltd., July 2012;
- High Park Estates (Phase 1) Storm Sewer Easements, A.J. Clarke and Associates, May 1975;
- Falling Brook Estates as Constructed Storm Drainage Area Plan, A.J. Clarke and Associates, September 1987.

A review of existing subdivision drainage area plans found that the receiving storm sewers were not designed based on the current storm sewer criteria including runoff coefficients, time of concentration (Tc) and rainfall design storms. The design records show a runoff coefficient of 0.35, in comparison to Hamilton guidelines recommend using a coefficient of 0.5 to 0.65 for single family residential. Also, design records show an initial time of concentration of 15 minutes verses 10 minutes for the current design guidelines. Lastly, the original storm sewer was designed based on a 2 year design storm, instead of the 5 year design storm currently utilized. Table 1 below shows the differences between current and historic criteria.

Table 1: Historical vs. Current Storm Sewer Design Criteria

Criteria	Historic	Current
Time of Concentration (min)	15	10
Runoff Coefficients	0.35	0.50 - 0.65
Rainfall Design Storm	2-Year	5-Year

Intensity Duration Frequency (IDF) curve values for the study area were found based on the recommendations of the Comprehensive Development Guidelines, 2018. The Guidelines state that the IDF values from the Mount Hope rainfall data should be used for the design of storm sewers. The table of IDF parameters taken from the Mount Hope rainfall data can be found in Appendix C.

Time of Concentrations (Tc) for drainage areas were calculated based on the City of Hamilton's Comprehensive Development Guidelines, 2018. All internal drainage areas were given a Tc of 10 minutes. For external drainage areas, the guideline states that initial Tc's shall be given a value of 10 minutes, and that routing times shall be calculated assuming that the area would be fully urbanized in the future. The most probable route for storm sewers was assumed and a velocity of 2 m/sec was assumed. Table 2: below shows the values used in the calculations of Tc for each drainage area.

Table 2: Time of Concentration Calculations for Each Catchment

	Catchment 1	Catchment 2	Catchment 3
Length (m)	200	700	0
Time (min)	1.7	5.8	0
Initial Tc (min)	10.00	10.00	10.00
Tc (min)	11.67	15.83	10.00

An assessment of the storm sewer was completed based on the original design assumptions and compared to existing conditions based on Hamilton's current design standards.

For the original design, using coefficient of 0.35, time of concentration of 15 minutes and drainage area matching as-built records the 2-year sewer capacity at all the outlets are less than 100% capacity.

For existing conditions, based on current design standards, the existing storm sewer outlets exceed 200% capacity at Outlets 1 and 2 for the 5-year event based on 0.55 coefficient, 10-minute time of concentration and updated drainage areas based on CIMA's assessment.

The following table provides a summary of the results at each outlet:

Table 3: Summary of Storm Sewer Capacity

Outlet	Historical Design Records (2 Year)			Existing Conditions (5 Year)		
	Runoff Coefficients	Flow at Outlet (L/s)	Sewer Capacity (L/s)	Runoff Coefficients	Flow at Outlet (L/s)	Sewer Capacity (L/s)
Outlet 1	0.35	441	549 (80%)	0.60	1187	549 (216%)
Outlet 2	0.35	659	1585 (42%)	0.55	3283	1585 (207%)
Outlet 3	0.35	25	133 (19%)	0.61	75	133 (53%)

It can be concluded, based on current design standards, the existing receiving storm sewer at Outlet 1 and Outlet 2 will be surcharged during the 5-year storm event. The capacity of Outlet 3 is adequately sized for the 5 year storm event.

2.7 Existing Design Constraints and Issues

Based on the preceding sections, the following design constraints and issues have been identified outside the scope of the current project:

- The existing receiving storm sewers within the study area were originally sized for the 2-year event, and will surcharge during the 5-year storm event at Outlets 1 and 2;
- The existing receiving storm sewers, in particular, at Outlets 1 and 2 are within drainage easements through private residential homes;
- The condition of the existing receiving storm system is unknown; and

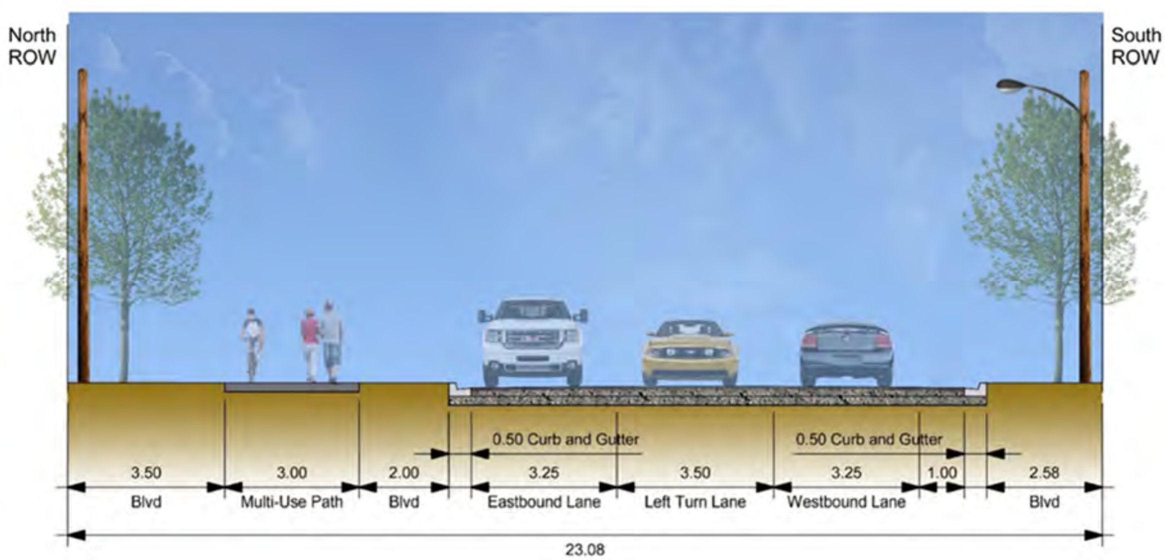
- Lack of overland flow route to the receiving system.

Bearing in mind the above noted design constraints and issues are outside the scope of this study, the City of Hamilton should further discuss the following recommendations:

- A CCTV inspection of existing storm sewers running through private property from Hiawatha Boulevard through to the parkland north of Deervalley Road to verify the condition of the existing receiving storm sewers at Outlet 2;
- A hydraulic capacity and grade line assessment of the existing receiving storm sewers should be considered;
- Undertake a broader stormwater study to investigate opportunities to improve the existing storm sewer, stormwater and drainage infrastructure downstream of Outlet 2 which could be implemented in conjunction with Mohawk Road.

3 Proposed Conditions

The proposed widening of Mohawk Road will have an urban cross section which results in a Right of Way (ROW) with 72% imperviousness including 3.0 m active transportation on north side, intermittent 1.5-1.8 m sidewalk on south side, 3.25 m westbound and eastbound lane and share 3.5 m turning lane. Mohawk Road will maintain this cross section as illustrated below throughout the study area.



Drainage concerns for the Mohawk Road widening may include flooding and water quality impacts. Typical impacts of roadway widenings are due to increases in impervious area and are characterized by higher flows in the existing roadway or trunk sewer systems and increased water quality degradation at the receiving watercourses.

The following section quantifies the impacts on stormwater runoff quantity and quality, evaluates methods of controlling changes to stormwater quantity and quality and provides a recommended stormwater management plan to mitigate the impacts associated with the roadway widening.

3.1 Runoff Parameters

Runoff coefficients for the internal drainage areas under existing and proposed conditions were calculated. Using ortho imagery, a weighted runoff coefficient for the area was calculated using runoff coefficients of 0.9 for impervious areas and 0.25 for pervious areas for both existing and proposed conditions.

The table below summarizes the change in impervious area between the existing and proposed Right of Way (ROW), as well as the existing and proposed weighted runoff coefficients.

Table 4: Changes in Impervious Areas – Existing vs. Proposed

Outlet	Total Area (ha)	Existing	Proposed	Existing	Proposed
		Area (ha) Impervious		Weighted Runoff Coefficient	
1	0.78	0.47	0.56	0.60	0.72
2	1.36	0.63	0.98	0.55	0.72
3*	0.24	0.13	0.13	0.61	0.61

Note: There was no change to Outlet 3 as the roadway at the intersection of Filman Road and Mohawk Road is already 3 lanes wide.

3.2 Proposed Impact Assessment

The following section provides an assessment of the impacts associated with the proposed widening of Mohawk Road.

3.2.1 Peak Flow Estimates

Peak flows were estimated using the rational method. Tables 5 summarizes the increase in flows for the 5-year event based on the increase in impervious area from existing vs proposed conditions. Total % increases were calculated at each outlet based on the combination of the existing internal and external catchment runoffs. Detail hydrology calculations are attached in Appendix C for all return events.

The increase inflow to Outlet 1 and Outlet 2 is respectively 2.1% and 1.6% increase in runoff. There will be no increases to Outlet 3. While this increase is a relatively small, the existing receiving storm sewer system is over 200% capacity because the receiving storm sewers were originally designed based on 2-year design event, 15-year Tc, and 0.35 runoff coefficient. A summary of the storm sewer capacity for existing conditions and proposed conditions is provided in Table 6, while detailed storm sewer sheets can be found in Appendix D.

Table 5: Summary of Existing vs. Proposed Runoff Increase by Outlet

Outlet	Internal & External Drainage Areas		Increase	Total % Increase
	Existing	Proposed	Change	
	Runoff (L/s)	Runoff (L/s)	Runoff (L/s)	Runoff (%)
1	1187	1212	25	2.1%
2	3283	3334	51	1.6%
3	75	75	0.0	0.0%

As per Hamilton guidelines, where existing storm sewers are designed for a return event less than the 5-year standard, to prevent downstream surcharging, the proposed storm sewer for Mohawk Road should not increase the level of surcharging downstream. Otherwise, hydraulic grade line calculations should demonstrate that no negative impact on the receiving storm sewer system results from the proposed storm.

Table 6: Summary of Storm Sewer Capacity by Outlet

Outlet	Existing Conditions (5-Year)			Proposed Conditions (5-Year)		
	Runoff Coefficients	Flow at Outlet (L/s)	Sewer Capacity (L/s)	Runoff Coefficients	Flow at Outlet (L/s)	Sewer Capacity (L/s)
Outlet 1	0.60	1187	549 (217%)	0.72	1212	549 (221%)
Outlet 2	0.55	3283	1585 (209%)	0.72	3334	1585 (212%)
Outlet 3	0.61	75	133 (56%)	0.61	75	133 (56%)

Therefore, it is recommended that stormwater quantity controls will be required to mitigate the impacts from the proposed roadway widening. Since Outlet 1 and Outlet 2 drain to separate creeks, both will need standalone quantity and quality control measures.

3.3 Proposed Stormwater Management Plan

3.3.1 Evaluation of Alternative Stormwater Solutions

An evaluation of alternative stormwater solutions including source controls, conveyance controls and end of pipe solutions was completed. The following best management practices were evaluated considering relative cost, construction feasibility and stormwater objectives:

- Permeable Pavement
- Curb Extension Bioretention
- Traditional SWM Facilities
- Oil Grit Separators
- Bioretention Swale or Planters
- Underground Storage

Table 7 below summarizes the alternative SWM solutions that were considered for the project. It was concluded that the combination of Oil Grit Separators (OGS) and underground storage would be the most feasible and effective SWM practice that could be applied to provide the required levels of retention, quality and quantity controls for the roadway widening. The following is a summary of the recommended SWM plan for each outlet.

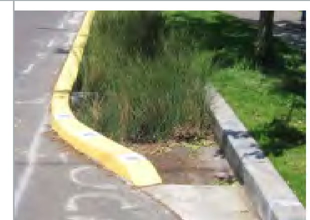
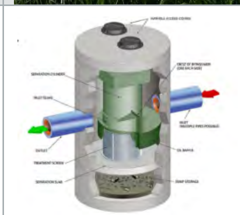
Catchment 1.0: The western portion of Mohawk Road is proposed to enter the existing storm sewers at Lime Kiln Road and Mohawk Road. Underground storage will be implemented to provide flow storage to reduce the runoff from the proposed roadway back to existing conditions. An Oil-Grit Separator (OGS) unit will be implemented before the entrance of the storage system to provide level 1 enhanced quality control for the roadway runoff.

Catchment 2.0: The central portion of Mohawk Road is proposed to enter the existing storm sewers as they cross Mohawk Road approximately 120 m to the east of green Ravine Drive. Underground storage will be implemented to provide flow storage to reduce the runoff from the proposed roadway back to existing conditions. An OGS unit will be implemented before the entrance of the storage system to provide level 1 enhanced quality control for the roadway runoff.

Catchment 3.0: No SWM is required as no increase to the amount of impervious area within catchment 3.0 are proposed.

The proposed layout for the proposed SWM facilities can be found in Appendix A.

Table 7: Evaluation of Alternative SWM Solutions

Stormwater Management Alternative	Relative Cost	Construction Feasibility	Likelihood of Achieving Stormwater Objectives	Constraints to Use	Illustration	
Permeable pavement in lay-by parking areas	HIGH	LOW	LOW	No parking areas are expected to be a feature of the proposed roads.		LID SWM Manual, CVC & TRCA, 2010
Curb extension bioretention	MODERATE	LOW	MODERATE	Will remove lane capacity-- suitable in traffic calming areas, but not expected to be a feature of the proposed major roads.		LID SWM Manual, CVC & TRCA, 2010
Traditional storm sewer/ curb and gutter design - conveyance to end-of-stormwater management facility	HIGH	MODERATE	HIGH	Requires sufficient space to implement SWM pond at outlet, which is not available for Outlet 1. Possibility for implementation within parkland north of study area for Outlet 2.		Ash Creek SWM Pond Town of Whitby
Oil-Grit Separators	LOW	HIGH	MODERATE	Provides quality control for proposed roadways at outlets. Requires the least amount of space and can be placed within the road ROW. Does not provide any quantity control.		CDS Technologies O/G Separator

Bio-retention swale	MODERATE	LOW	MODERATE	Requires excessive space in boulevard - constrained by right-of-way width, tree impacts and multiple driveway crossings.	 LID SWM Manual, CVC & TRCA, 2010
Bio-retention planters	HIGH	LOW	MODERATE	Requires space in boulevard - may be constrained by sidewalk / multiuse pathway and utilities. In 'main street' type setting, requires extensive landscaping and maintenance but can become a signature feature.	 LID SWM Manual, CVC & TRCA, 2010
Underground Storage	HIGH	HIGH	HIGH	Provides quantity control for roadway outlets. Requires the least amount of space and can be placed underground within the road. Utilization of an underground open bottom infiltration/retention stormwater storage system (as illustrated to the right), would provide both water quality and water retention benefits.	 Sustainable Technologies Evaluation Program, 2019

3.3.2 Proposed Stormwater Management System

The following section provides preliminary sizing details for the proposed stormwater management system.

Catchment 1.0: Roadway runoff will need to outlet into a Hydroworks HydroStorm 8 or equivalent in order to provide level 1 enhanced quality control for the proposed roadway expansion as per ETV certification. The OGS will outlet into underground storage with a volume of 43 m^3 to control the 100-year flow back to pre widening levels. The storage unit will then outlet into the existing storm sewer.

Catchment 2.0: Roadway runoff will need to outlet into a Hydroworks HydroStorm 10 or equivalent in order to provide level 1 enhanced quality control for the proposed roadway expansion as per ETV certification. The OGS will outlet into underground storage with a volume of 113 m^3 to control the 100-year flow back to existing conditions. The storage unit will then outlet into the existing storm sewer.

Catchment 3.0: No SWM is required as no increase to the amount of impervious area of catchment 3.0 are proposed.

As the soils in the study area are well draining, it is recommended that the underground storage units be open bottomed to provide a treatment train approach to quality control, as well as providing water retention. The increase in impervious area between existing and proposed conditions is 0.44 ha. Aiming for an infiltration amount of 5 mm, a total volume of 22 m^3 will need to be retained within the underground storage to infiltrate into the ground.

Calculations for infiltration amounts, underground storage and OGS unit sizing can be found in Appendix E.

3.3.3 Proposed Minor Drainage System

The study area will be urbanized with curb & gutters and stormwater will be captured with the implementation of storm sewers and catch basin infrastructure for the minor drainage system.

3.3.4 Proposed Major Drainage System

The proposed urban roadway will act as a major drainage path and will maintain the existing major drainage patterns as part of the proposed roadway widening to existing sag locations. The roadway was analyzed using the minimum road grade of 0.50% and maximum 100-year flow of 400 L/s. The roadway has capacity for 480 L/s of flow, and at the maximum flow the depth of flow shall be 0.11 m based on calculations presented in Appendix E.

4 Conclusions

The report has demonstrated the proposed widening of Mohawk Road may proceed in general conformance with the applicable City of Hamilton and Hamilton Region Conservation Authority criteria. The findings of this report are summarized as follows:

- Minor flows from the study area will be conveyed to three (3) separate existing outlet locations.
- Major flows from the study area will be conveyed to three (3) separate existing outlet locations.
- Quality control for Outlet 1 will be provided through the implementation of an OGS unit, providing level 1 enhanced quality control. Quantity control will be provided through the implementation of underground storage, designed to reduce the flows for storms 2-100 year back to existing levels.
- Quality control for Outlet 2 will be provided through the implementation of an OGS unit, providing level 1 enhanced quality control. Quantity control will be provided through the implementation of underground storage, designed to reduce the flows for storms 2-100 year back to existing levels.
- Open footed underground storage is recommended to provide a treatment train approach to quality control, as well as providing water retention.
- There are no proposed changes to the level of imperviousness of Catchment 3.0, and so no quality or quantity controls are required.

5 Recommendations

The City of Hamilton should further discuss the following recommendations:

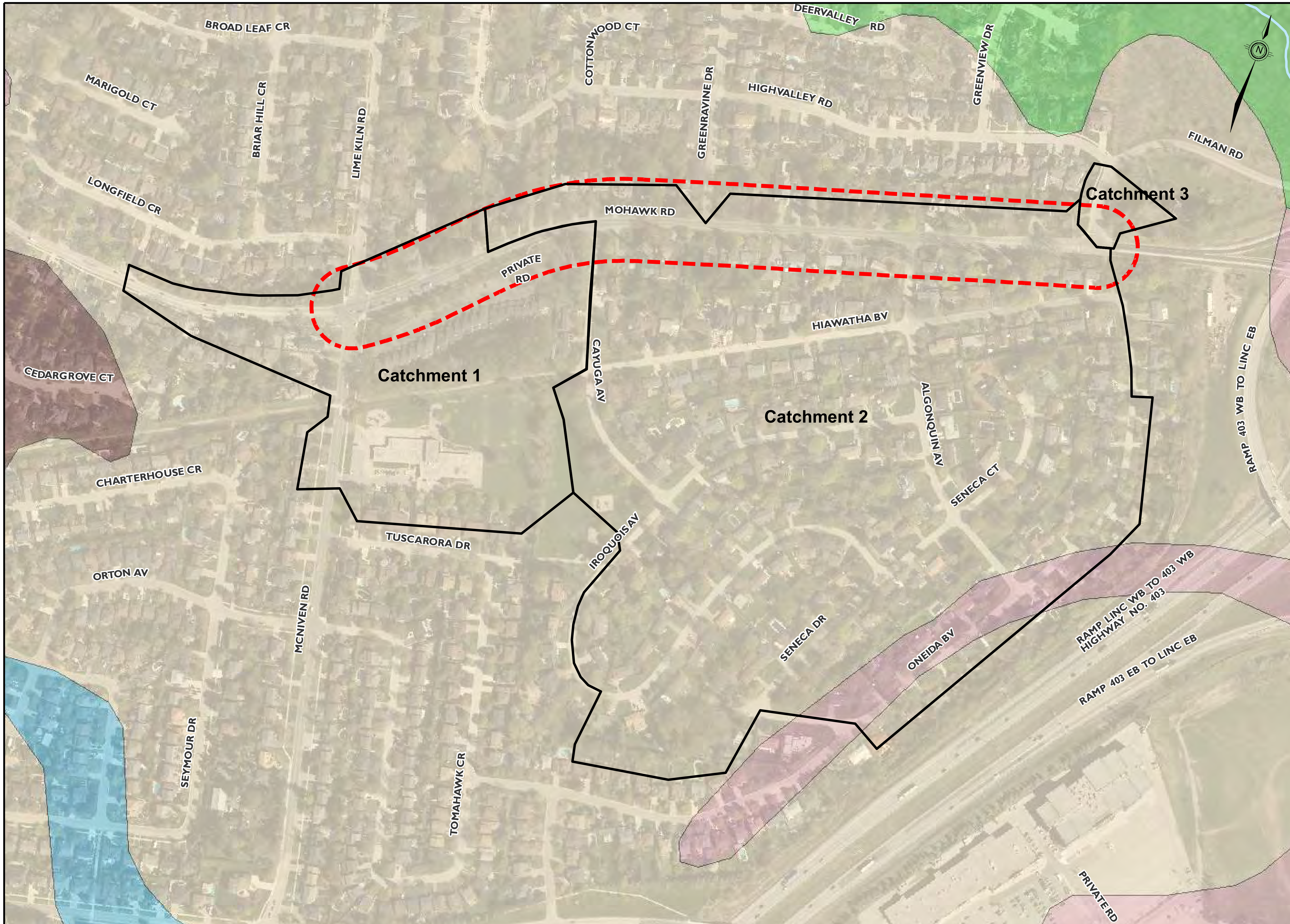
- A CCTV inspection of existing storm sewers running through private property from Hiawatha Boulevard through to the parkland north of Deervalley Road to verify the condition of the existing receiving storm sewers at Outlet 2.
- A hydraulic capacity and grade line investigation of the receiving storm sewers should be considered to ensure adequate capacity of existing storm sewers.
- Undertaking a broader stormwater study to investigate opportunities to improve the existing storm sewer, stormwater and drainage infrastructure downstream of Outlet 2.

A

Appendix A: Figures

- Figure 1: Study Area Map
- Figure 2: Soil Map
- Figure 3: Existing Drainage Map
- Figure 4: Proposed SWM Plan

CIMA+	CLIENT: Hamilton	SCALE: 50 25 0 50 100 150 200 250 meters 1:12,500	PROJECT NAME: ENVIRONMENTAL IMPACT STUDY -	PROJECT No: T000941		CLIENT FILE No: ---
				DRAFTER: S. ELLIOTT	DESIGNER ---	DRAWING No: FIG. 1
			SHEET TITLE: STUDY AREA MAP	APPROVER L. CYMBALY	APPROVER ---	
				DATE: 7/30/2018		SHEET No: 1 of 1



LEGEND

- Water Courses
- Existing Catchment Areas
- Study Area

Soil Survey, LIO

Soil Name:

- GRIMSBY SANDY LOAM
- ALBERTON SILT LOAM
- RAVINE
- TOLEDO SILT LOAM
- TUSCOLA SILT LOAM

DATA SOURCES:
Soil Survey from Land Informaiton Ontario, Soil Survey Complex, 2015

CLIENT

Hamilton

PROJECT NAME:

MOHAWK-ROUSSEAUX ROAD EA

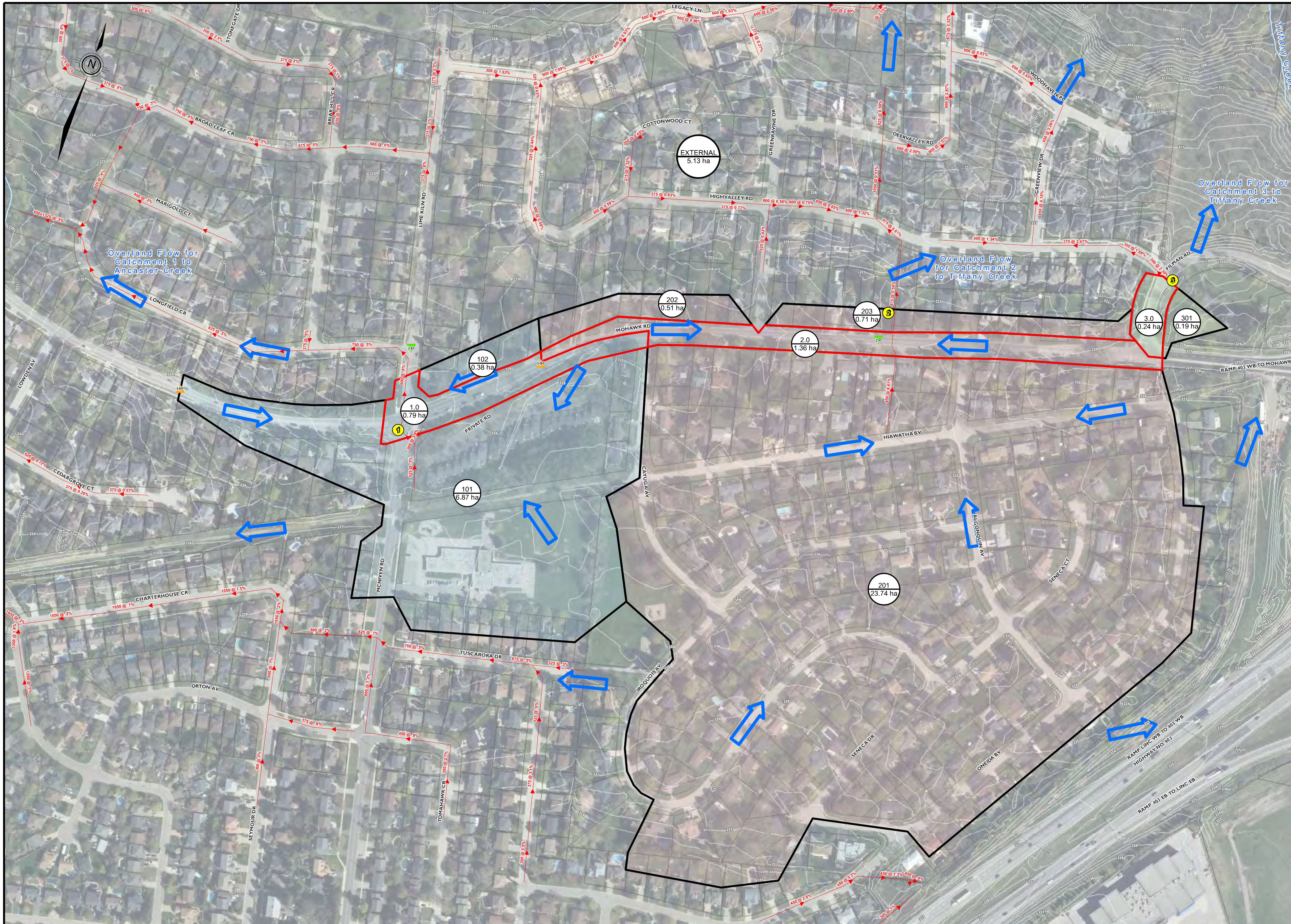
SHEET TITLE:

SOIL MAP

SUB TITILE:

SCALE: 0 15 30 60 90 120
Meters
1:3,500

PROJECT No: **B000941**		CLIENT FILE No:
DRAFTER: K. LUKAWIECKI	DESIGNER ---	DRAWING No: **Figure 2**
APPROVER R. CRESSMAN	APPROVER ---	
DATE: 5/14/2019		SHEET No: 1 of 1



LEGEND

- High Point
- Low Point
- Outlets
- Overland Flow
- Contours1m
- Existing Storm Sewers
- PROPERTY PARCEL

Drainage Areas

Drain to:

- Outlet 1
- Outlet 2
- Outlet 3

DATA SOURCES:
WATERCOURSE, CONTOURS, & ROAD NETWORK INFORMATION OBTAINED FROM LAND INFORMATION ONTARIO AND LICENSED UNDER THE OPEN GOVERNMENT LICENCE – ONTARIO.

CIMA+

CLIENT

Hamilton

PROJECT NAME:

MOHAWK-ROUSSEAUX ROAD EA

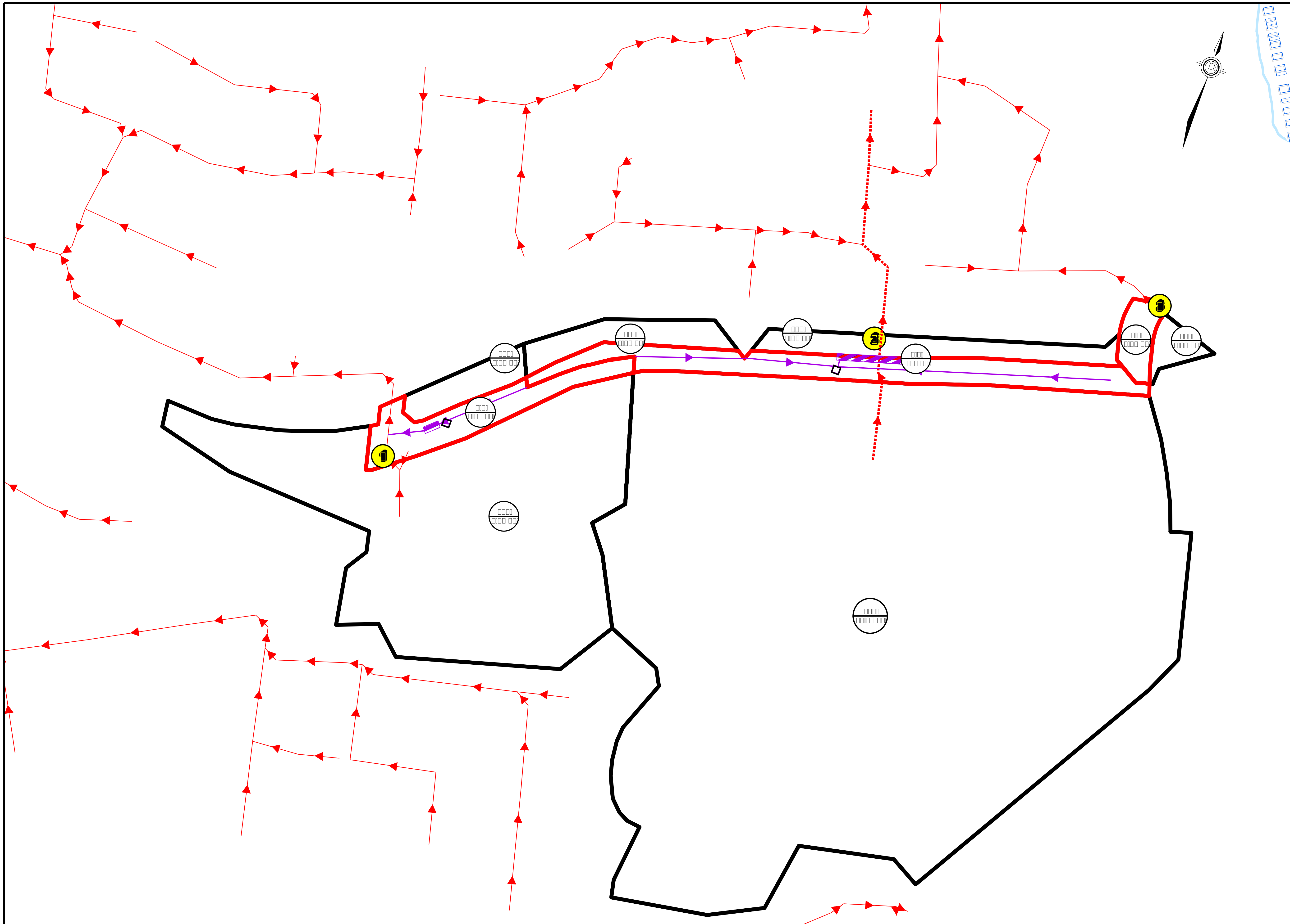
SHEET TITLE:

EXISTING CONDITIONS DRAINAGE MOSAIC

SCALE:

25 12.5 0 25 50 75 100
meters
1:1,750

PROJECT No: B000941	CLIENT FILE No:
DRAFTER: S. ELLIOTT / DESIGNER —	DRAWING No:
APPROVER R. CRESSMAN / APPROVER —	**Figure 3**
DATE: 7/15/2019	SHEET No: 1 of 1



E

Appendix E: Preliminary Sizing Calculations

- OGS Sizing Calculations
- Underground Storage Calculations
- Major Overland Flow Calculations

Hydroworks

Hydroworks Sizing Summary

12-04-2019

Recommended Size: HS 10

A HydroStorm HS 10 is recommended to provide 80 % annual TSS removal based on a drainage area of 1.36 (ha) with an imperviousness of 72 % and Toronto Bloor St., Ontario rainfall for the ETV Canada particle size distribution.

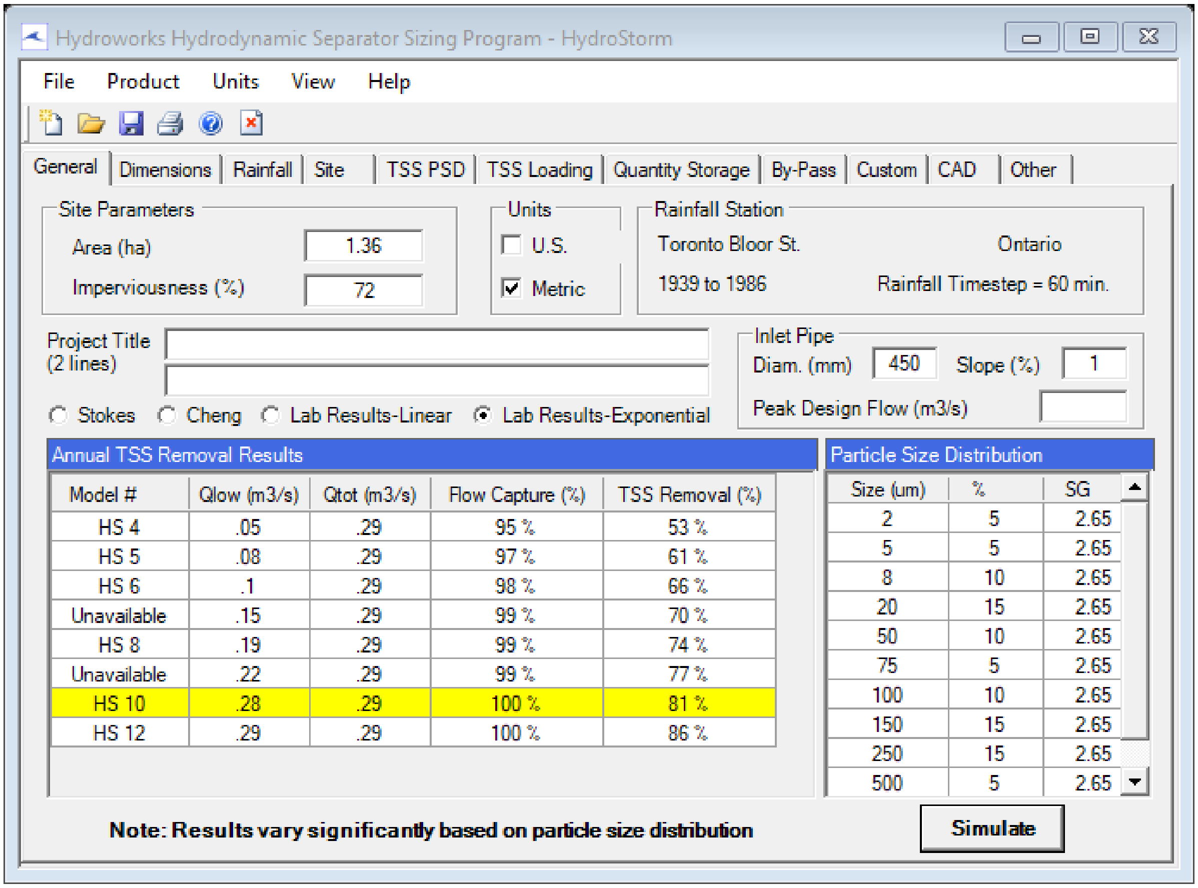
The recommended HydroStorm HS 10 treats 100 % of the annual runoff and provides 81 % annual TSS removal for the Toronto Bloor St. rainfall records and ETV Canada particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .3 (m3/s) for the given 450 (mm) pipe diameter at 1% slope. The headloss was calculated to be 170 (mm) based on a flow depth of 450 (mm) (full pipe flow).

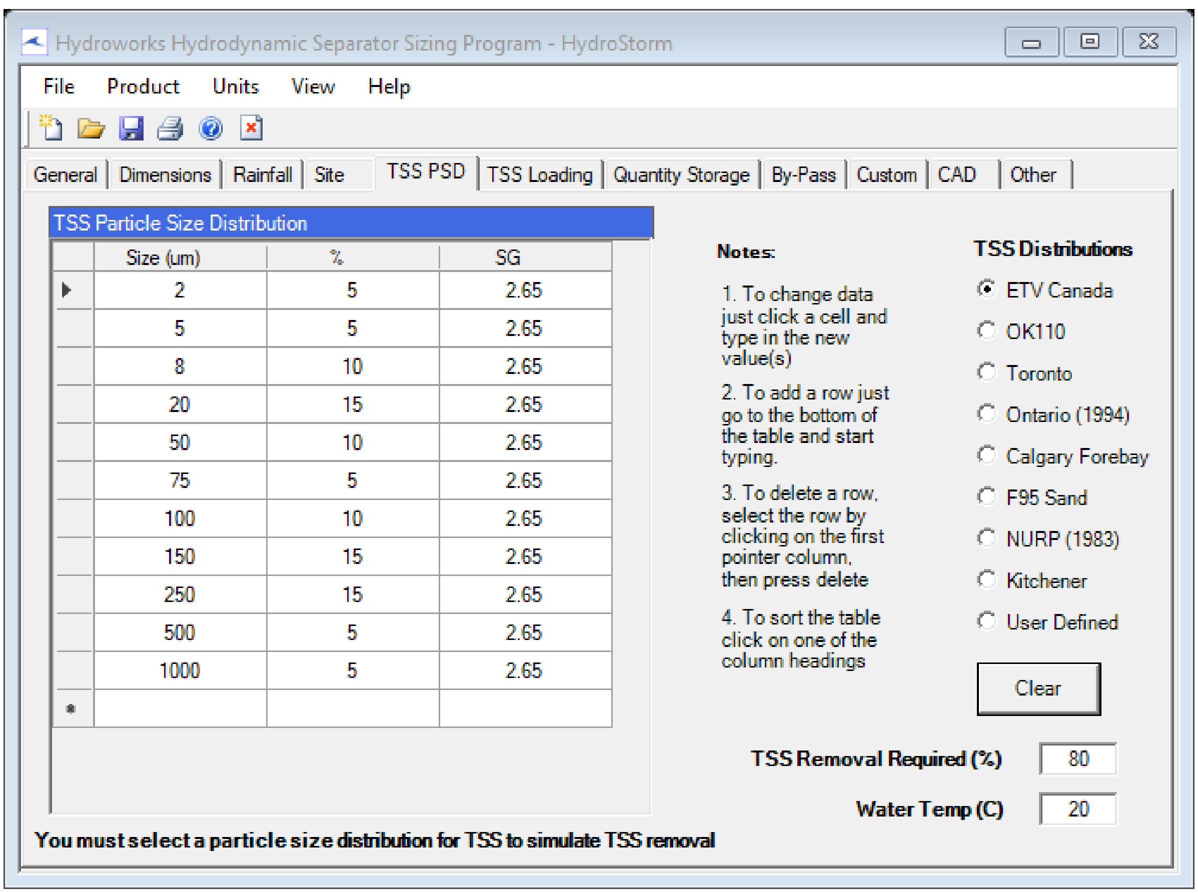
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

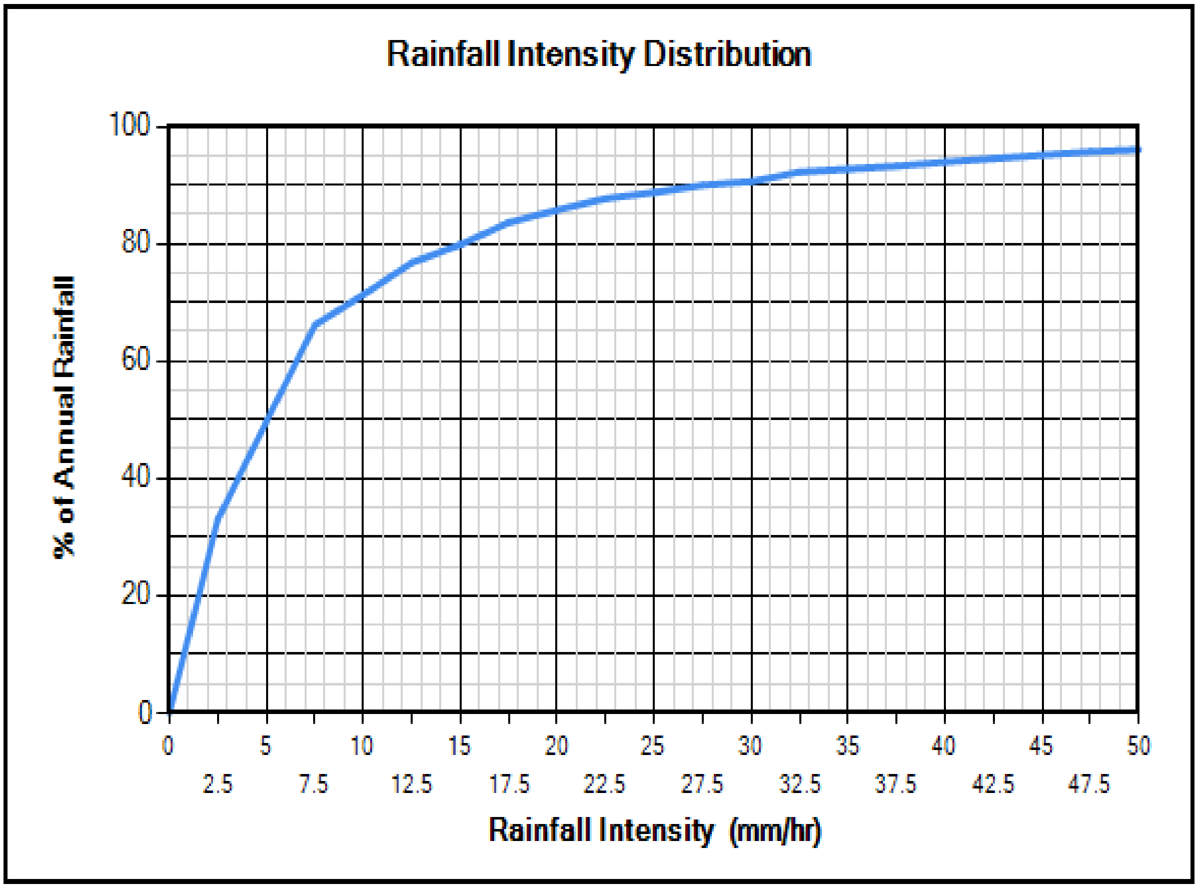
TSS Removal Sizing Summary



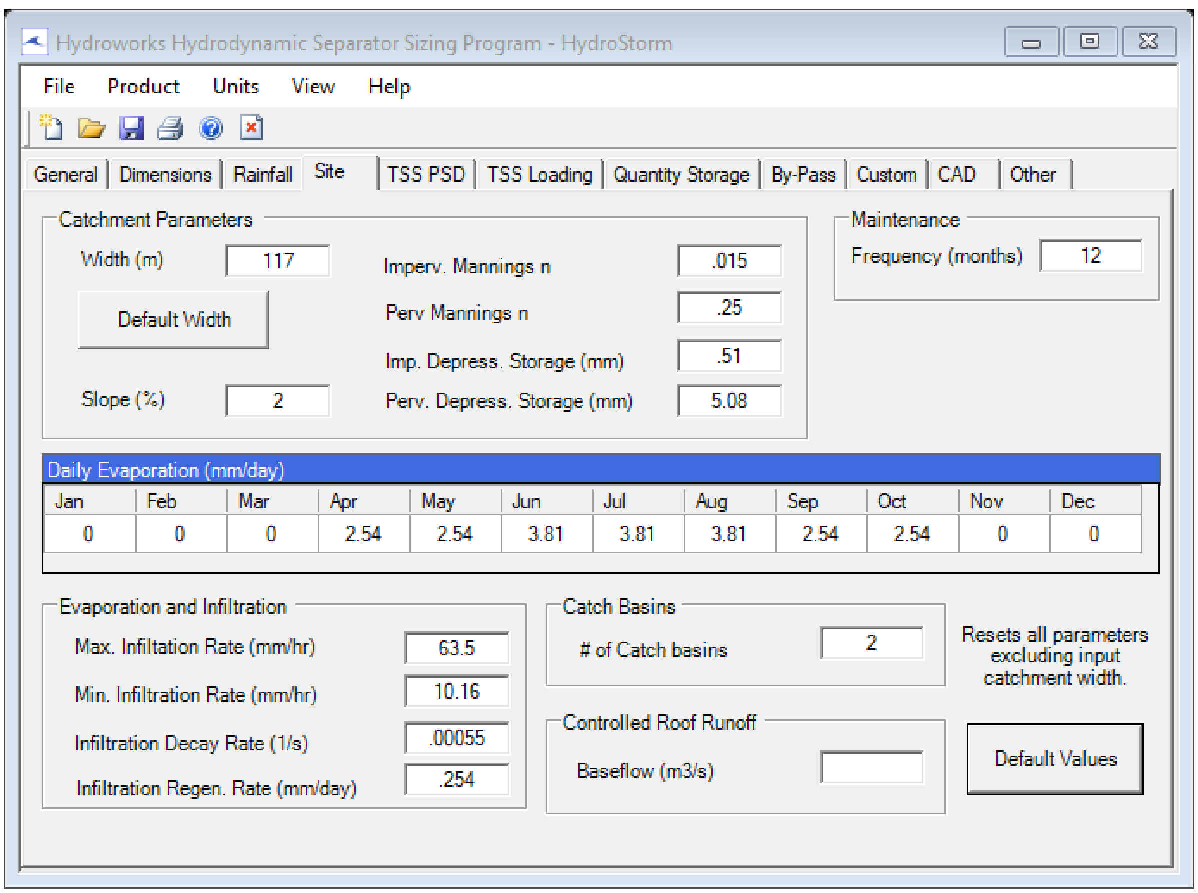
TSS Particle Size Distribution



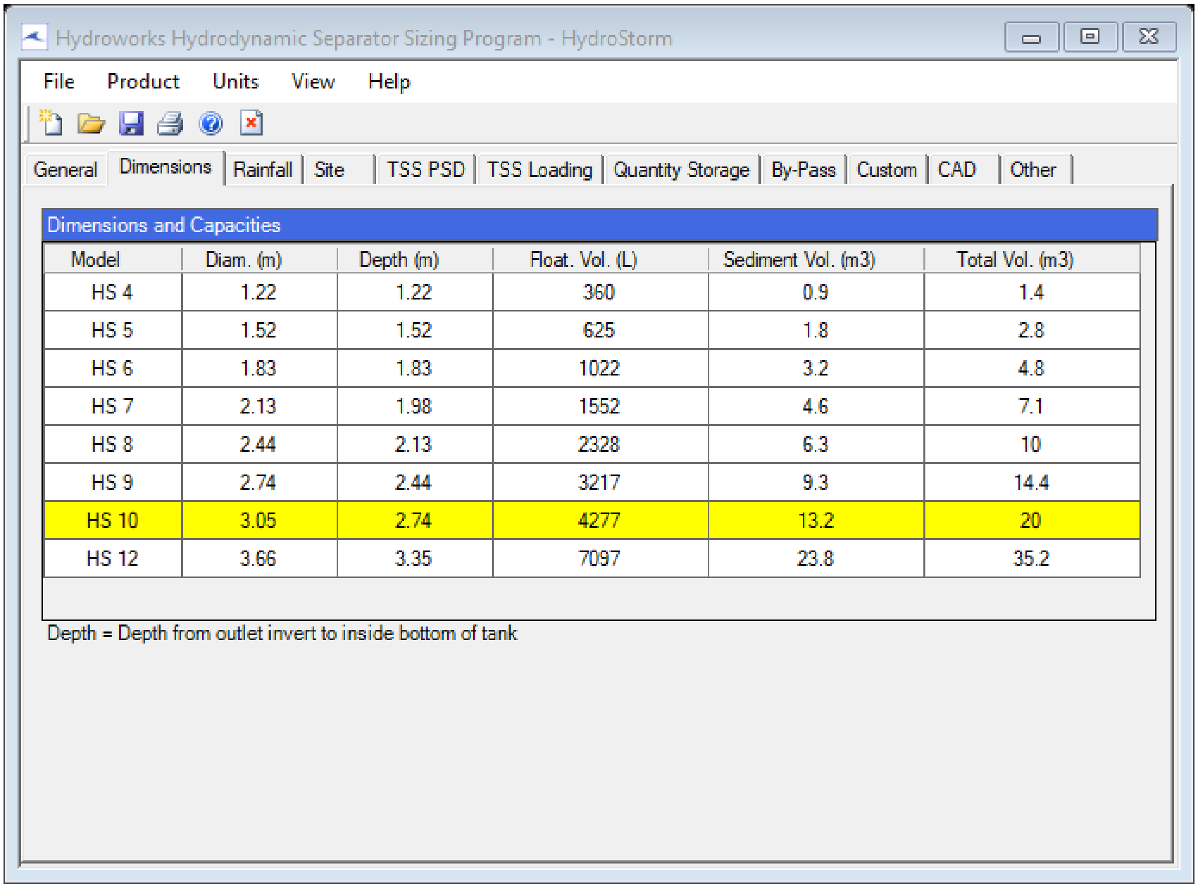
Rainfall Station - Toronto Bloor St., Ontario(1939 to 1986)



Site Physical Characteristics



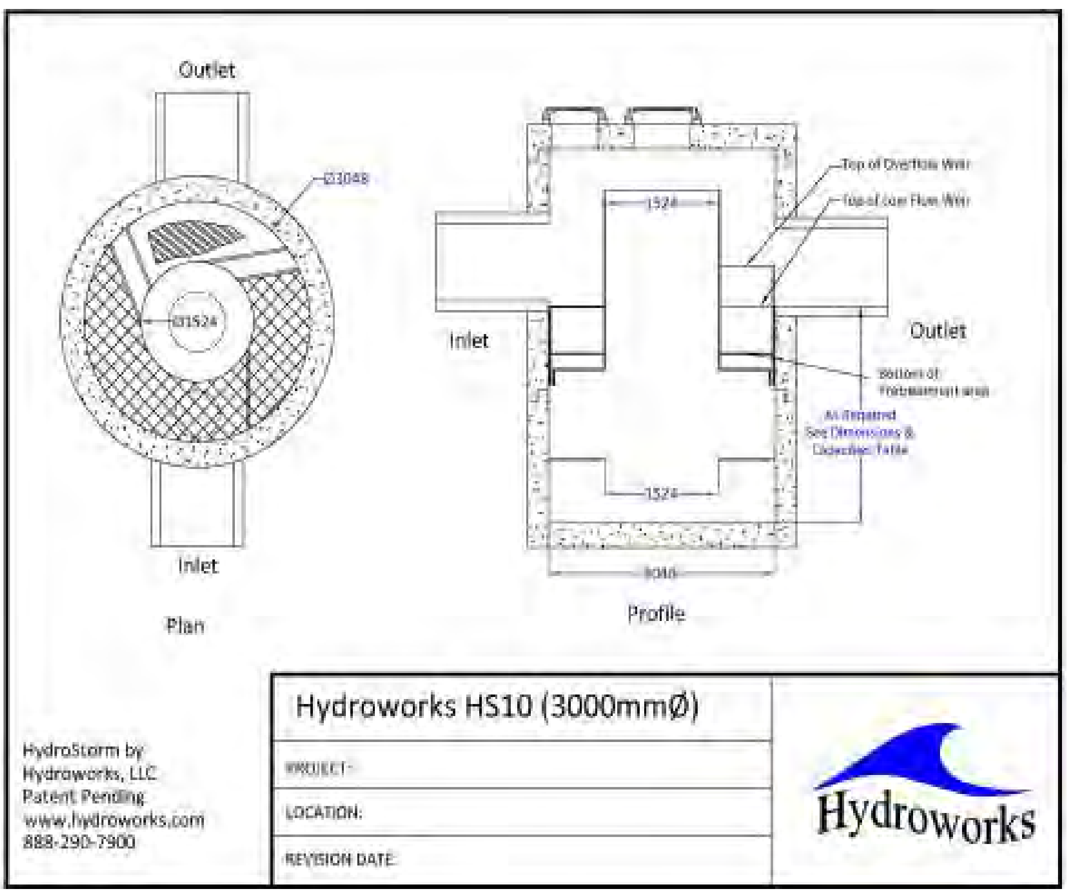
Dimensions And Capacities



Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	360	0.9	1.4
HS 5	1.52	1.52	625	1.8	2.8
HS 6	1.83	1.83	1022	3.2	4.8
HS 7	2.13	1.98	1552	4.6	7.1
HS 8	2.44	2.13	2328	6.3	10
HS 9	2.74	2.44	3217	9.3	14.4
HS 10	3.05	2.74	4277	13.2	20
HS 12	3.66	3.35	7097	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

Generic HS 10 CAD Drawing



Hydroworks Sizing Summary

12-04-2019

Recommended Size: HS 8

A HydroStorm HS 8 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.79 (ha) with an imperviousness of 72 % and Toronto Bloor St., Ontario rainfall for the ETV Canada particle size distribution.

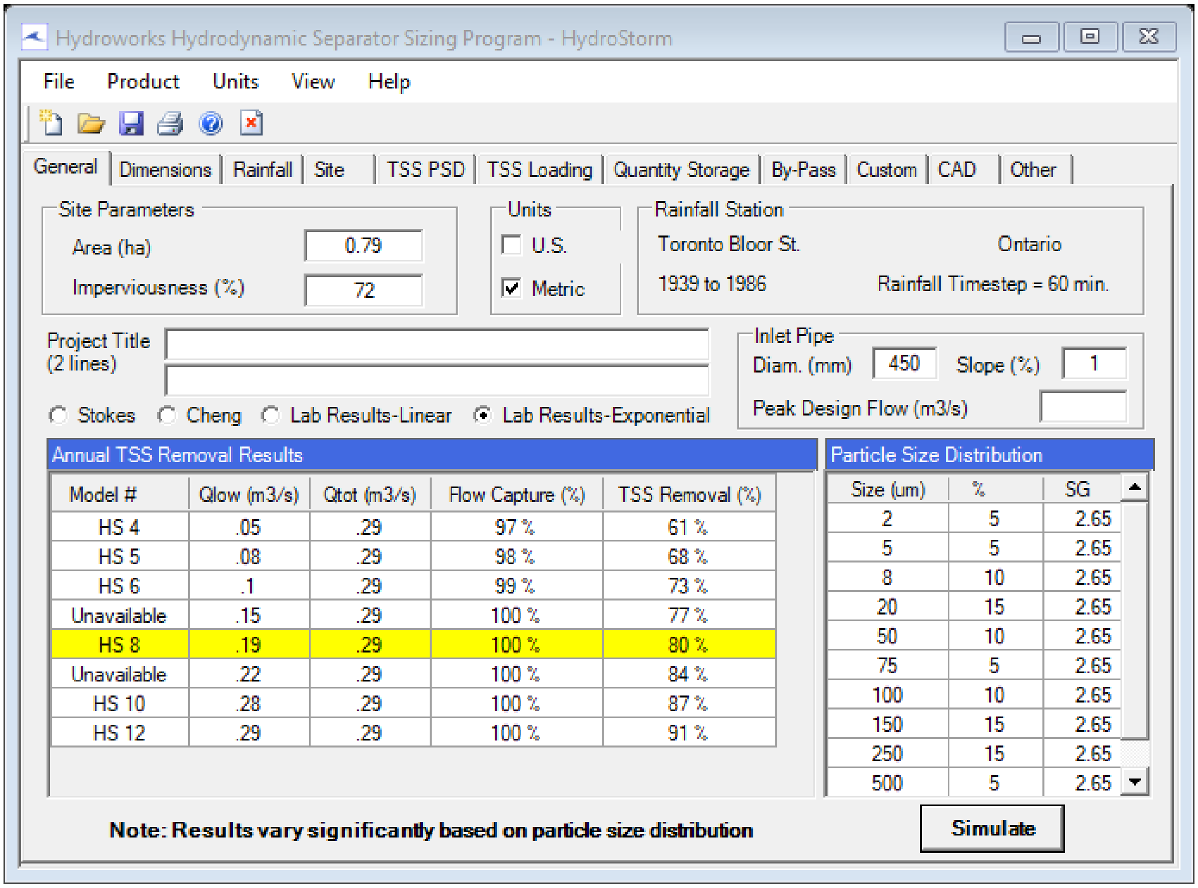
The recommended HydroStorm HS 8 treats 100 % of the annual runoff and provides 80 % annual TSS removal for the Toronto Bloor St. rainfall records and ETV Canada particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .3 (m3/s) for the given 450 (mm) pipe diameter at 1% slope. The headloss was calculated to be 170 (mm) based on a flow depth of 450 (mm) (full pipe flow).

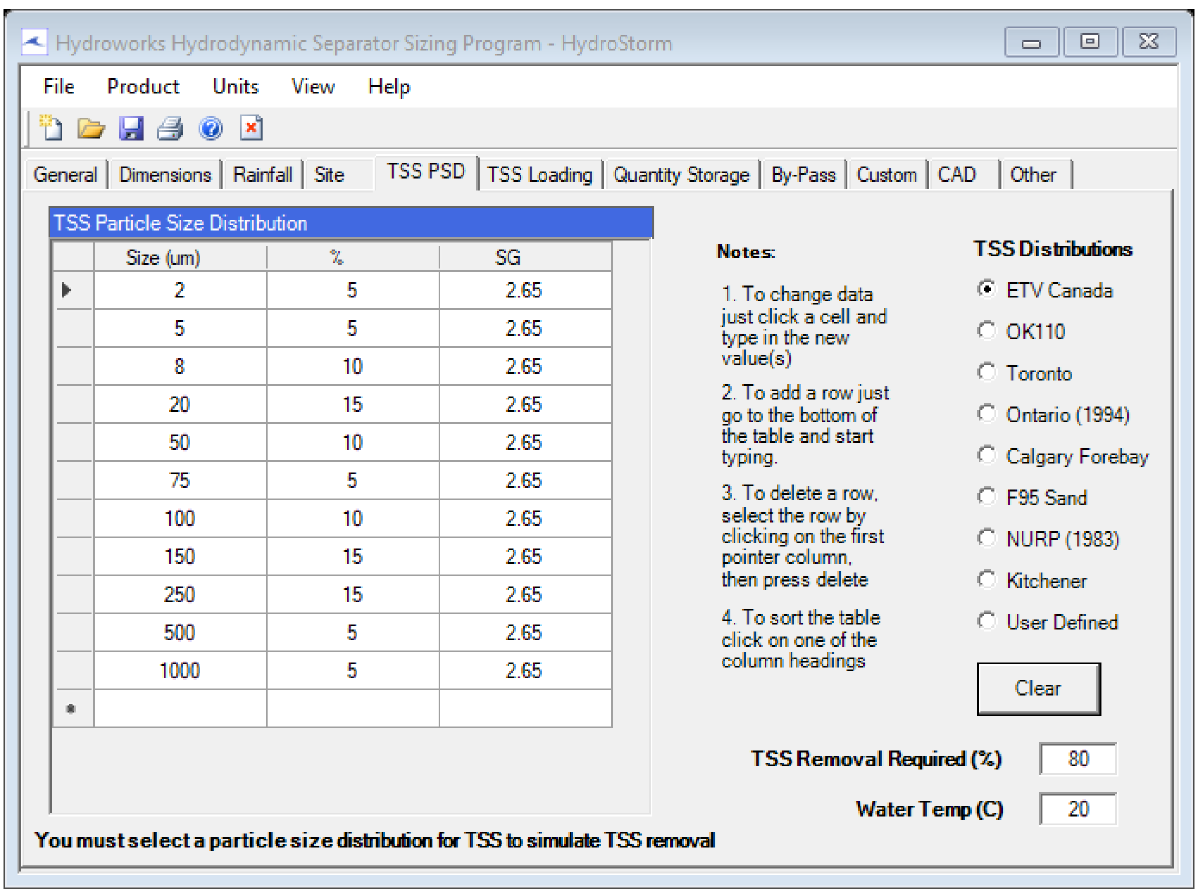
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

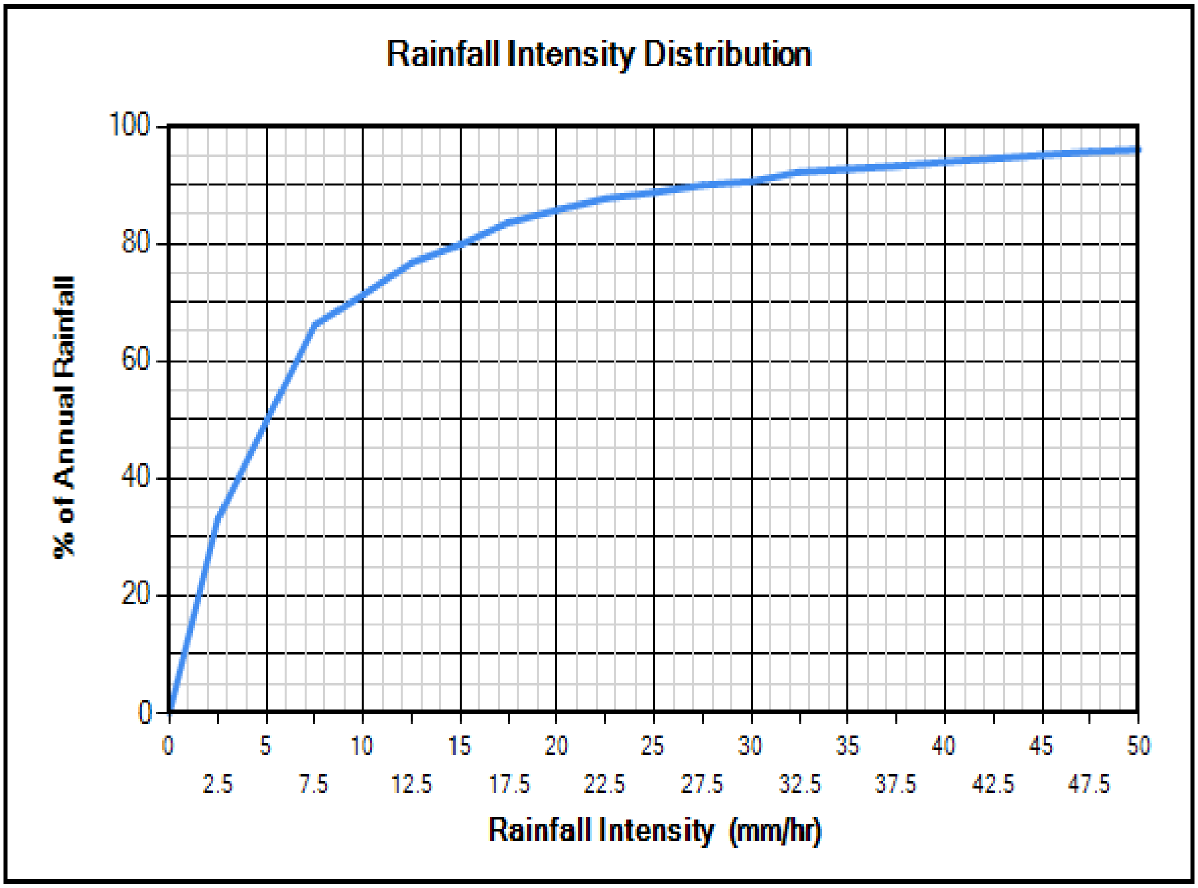
TSS Removal Sizing Summary



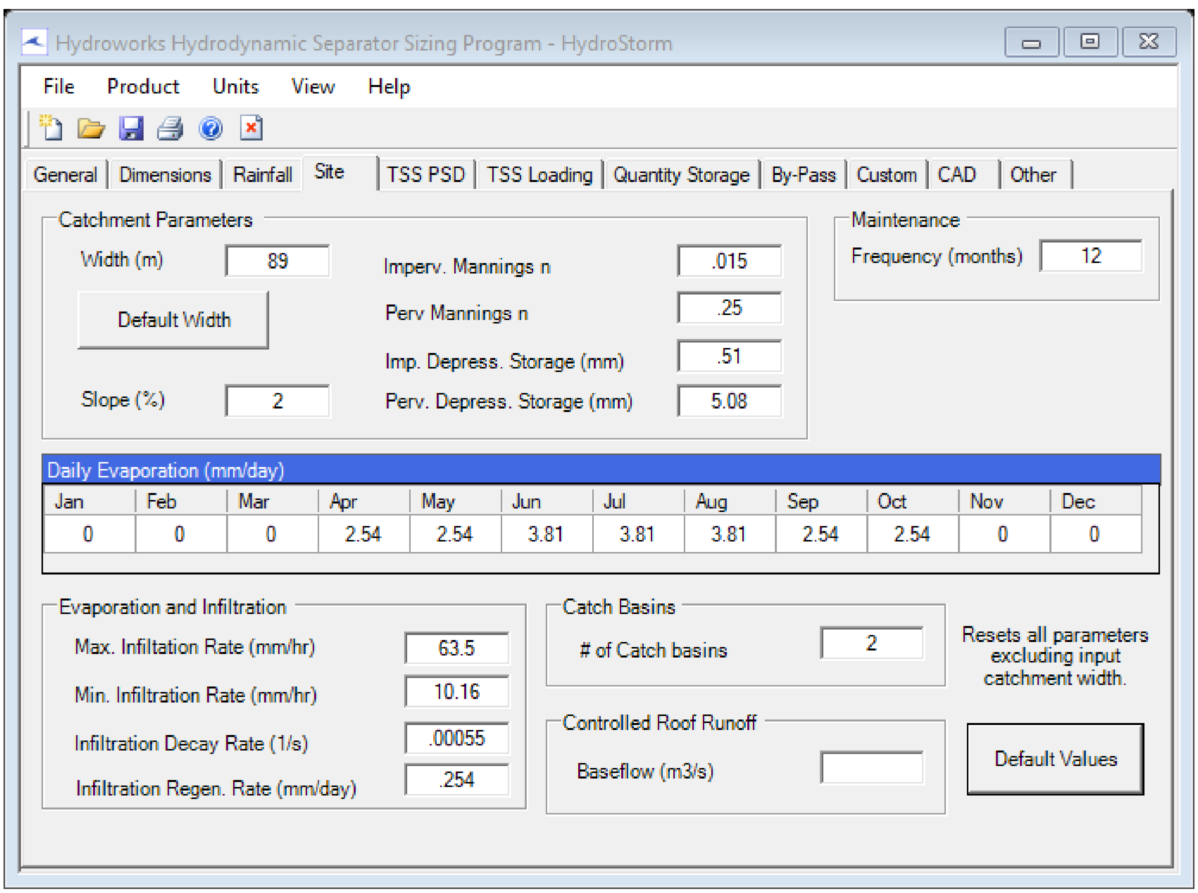
TSS Particle Size Distribution



Rainfall Station - Toronto Bloor St., Ontario(1939 to 1986)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	360	0.9	1.4
HS 5	1.52	1.52	625	1.8	2.8
HS 6	1.83	1.83	1022	3.2	4.8
HS 7	2.13	1.98	1552	4.6	7.1
HS 8	2.44	2.13	2328	6.3	10
HS 9	2.74	2.44	3217	9.3	14.4
HS 10	3.05	2.74	4277	13.2	20
HS 12	3.66	3.35	7097	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

Generic HS 8 CAD Drawing

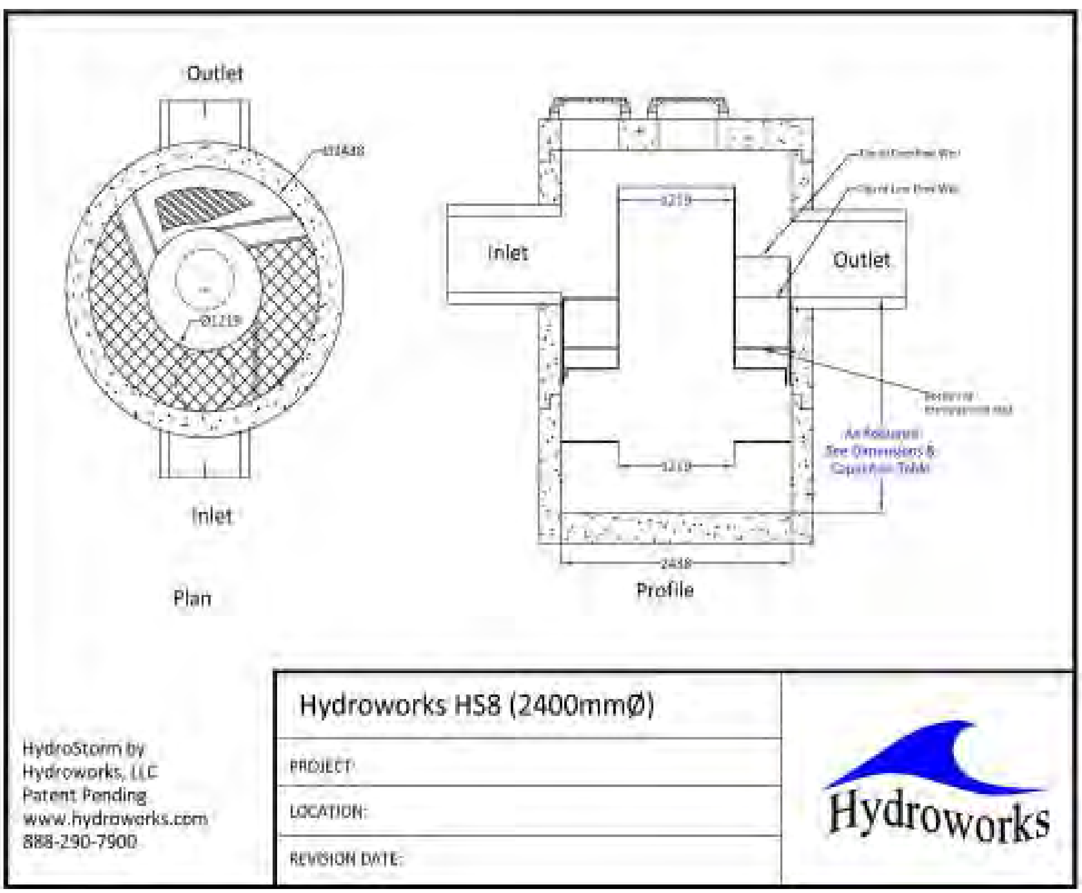


TABLE A2: STORMWATER MANAGEMENT ANALYSIS - 100 YR STORM

JOB NUMBER: C11-B00941
CLIENT: City of Hamilton
LOCATION: Ancaster, On

SITE INFORMATION FOR 100 YR RETURN PERIOD

	AREA (ha)	RUNOFF COEFFICIENT
Total Area	0.79	0.72

Allowable Release from the Site = 224

DETERMINATION OF NECESSARY STORAGE VOLUME TO CONTROL DRAINAGE TO 100 YEAR EXISTING STORM

Modified Rational Method used to determine storage volume:
Q=2.78 CiA

Time (min)	i=100yr (mm/hr)	Inflow (l/sec)	Accumulated Runoff (m3)	Allowable Discharge (1yr) (L/sec)	Allowable Release Volume (m3)	Required Storage (m3)
2	271.5	429	52	224	26.9	24.6
4	240.9	381	91	224	53.8	37.7
6	216.9	343	123	224	80.6	42.9
8	197.7	313	150	224	107.5	42.5
10	181.8	287	172	224	134.4	38.1
12	168.5	266	192	224	161.3	30.6

Conclusion: The maximum storage required to bring post to pre quantity controls is 43 m3 of underground storage

TABLE A2: STORMWATER MANAGEMENT ANALYSIS - 100 YR STORM

JOB NUMBER: C11-B00941
CLIENT: City of Hamilton
Ancaster, On

SITE INFORMATION FOR 100 YR RETURN PERIOD

	AREA (ha)	RUNOFF COEFFICIENT
Total Area	1.36	0.72

Allowable Release from the Site = 306

DETERMINATION OF NECESSARY STORAGE VOLUME TO CONTROL DRAINAGE TO 100 YEAR EXISTING STORM

Modified Rational Method used to determine storage volume:
Q=2.78 CiA

2	271.5	739	89	306	36.7	52.0
4	240.9	656	157	306	73.4	83.9
6	216.9	591	213	306	110.2	102.4
8	197.7	538	258	306	146.9	111.4
10	181.8	495	297	306	183.6	113.4
12	168.5	459	330	306	220.3	109.9

Conclusion: The maximum storage required to bring post to pre quantity controls is 113 m3 of underground storage

Major Drainage Capacity

Roadway Parameters	
Roughness coefficient	0.016
Slope %	0.00505
Elevation (m)	0.12
Discharge (m^3/s)	0.48
Capacity of Roadway (L/s)	480

Capacity Based on Max 100 Year Flow Within ROW	
Capacity of Roadway (L/s)	480
Max 100 Year Flow Within ROW (L/s)	400
Capacity of Roadway Utilized (%)	84%
Depth at Max 100 Year Flow (m)	0.11

Worksheet for Mohawk Road Major Road Drainage

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00505	m/m
Normal Depth	0.12	m

Section Definitions

Station (m)	Elevation (m)
0+00	0.12
0+00	0.00
0+06	0.12
0+12	0.00
0+12	0.12

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.12)	(0+12, 0.12)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	0.48	m^3/s
Elevation Range	0.00 to 0.12 m	
Flow Area	0.72	m^2
Wetted Perimeter	12.24	m
Hydraulic Radius	0.06	m
Top Width	12.00	m
Normal Depth	0.12	m
Critical Depth	0.11	m

Worksheet for Mohawk Road Major Road Drainage

Results

Critical Slope		0.00670	m/m
Velocity		0.67	m/s
Velocity Head		0.02	m
Specific Energy		0.14	m
Froude Number		0.88	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.12	m
Critical Depth	0.11	m
Channel Slope	0.00505	m/m
Critical Slope	0.00670	m/m

Worksheet for Mohawk Road Major Road Drainage

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00505	m/m
Discharge	0.40	m³/s
Section Definitions		

Station (m)	Elevation (m)
0+00	0.12
0+00	0.00
0+06	0.12
0+12	0.00
0+12	0.12

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.12)	(0+12, 0.12)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.11	m
Elevation Range	0.00 to 0.12 m	
Flow Area	0.62	m²
Wetted Perimeter	11.40	m
Hydraulic Radius	0.05	m
Top Width	11.17	m
Normal Depth	0.11	m
Critical Depth	0.11	m

Worksheet for Mohawk Road Major Road Drainage

Results

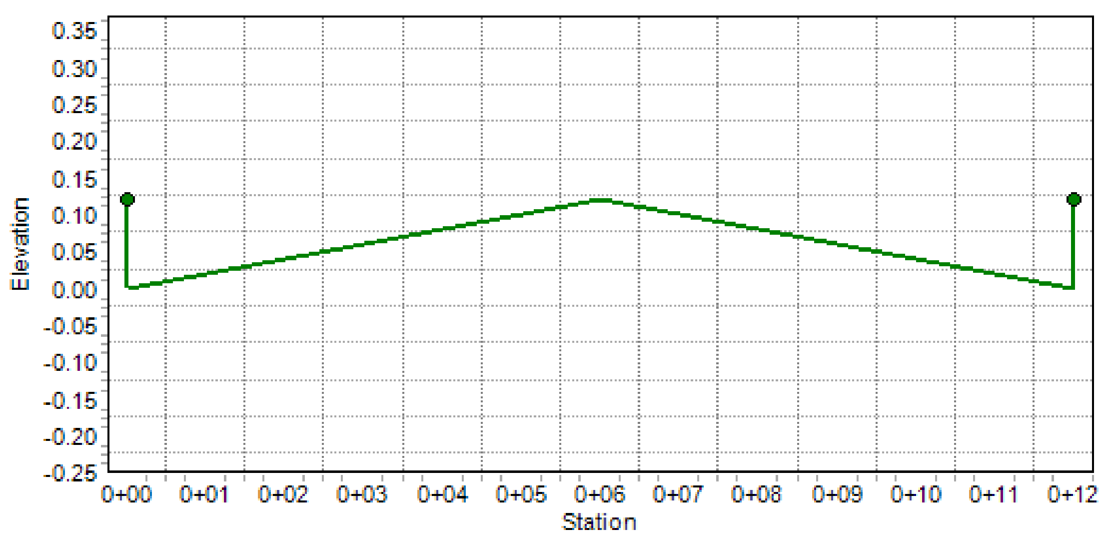
Critical Slope		0.00688	m/m
Velocity		0.64	m/s
Velocity Head		0.02	m
Specific Energy		0.13	m
Froude Number		0.87	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.11	m
Critical Depth	0.11	m
Channel Slope	0.00505	m/m
Critical Slope	0.00688	m/m



CIMA CANADA INC.
415 Baseline Road West, 2nd Floor
Bowmanville , ON L1C 5M2
T 905 697 4464 F 905 697 0443
cima.ca