Drainage and Stormwater Management Report

Teston Road Improvements Class Environmental Assessment Study
From 250 m West of Pine Valley Drive to Kleinburg Summit Way

City of Vaughan
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1 Introduction

The City of Vaughan is undertaking a Schedule 'B' Class Environmental Assessment (EA) Study to review the transportation improvements along Teston Road from 250 m west of Pine Valley Drive to Kleinburg Summit Way. HDR has been retained by the City of Vaughan to conduct the Teston Road Improvements Class EA Study. Within the study limits, Teston Road is currently a two-lane rural major collector roadway with one driving lane in each direction.

This Drainage and Stormwater Management Report has been prepared in support of the Class EA Study and complies with the Ministry of the Environment, Conservation and Parks (MECP), Toronto and Region Conservation Authority (TRCA), Region of York, and the City of Vaughan's Policies and Standards. The study limits are illustrated in **Figure 1-1**.

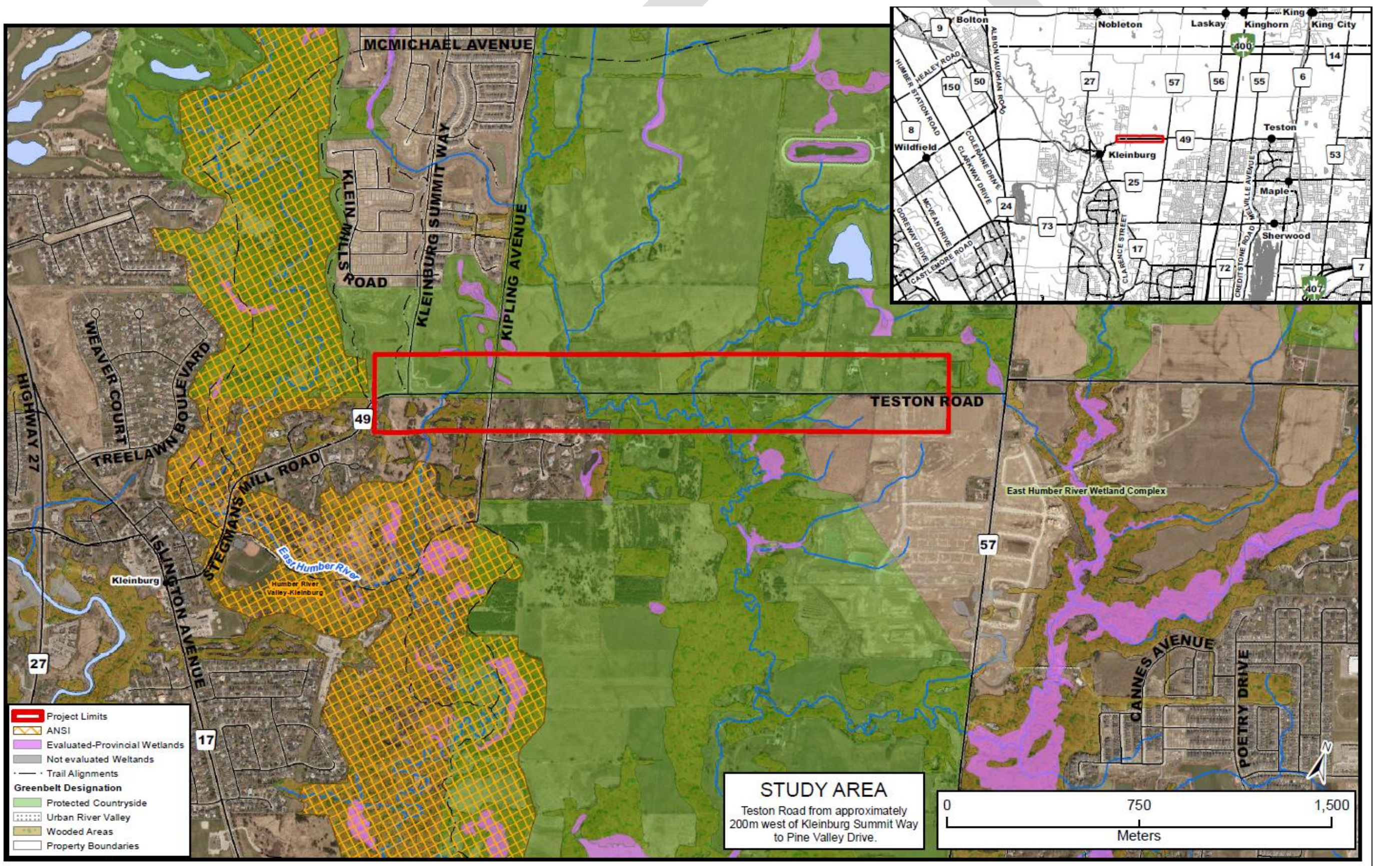


Figure 1-1. Study Area

The objective of the Drainage and Stormwater Management Report is to:

- Review available drainage information for existing conditions, including storm drainage area plans, reports and previous studies, plan-and-profile drawings and hydraulic and hydrologic models;

- Identify and evaluate existing drainage patterns and transverse culvert and bridge locations;
- Identify the existing stormwater and drainage conditions in the study area, including sensitive areas and issues;
- Establish design criteria for stormwater management to meet the requirements of the various authoritative bodies;
- Identify potential stormwater runoff quality and quantity impacts to the receiving watercourses/ storm sewer system resulting from changes to the roadway cross-section (i.e. increased pavement area); and
- Propose an appropriate drainage system, transverse culvert and bridge upgrades, and a stormwater management strategy in conjunction with the proposed road widening to mitigate any potential impact.

1.1 Background information

In preparation of the Teston Road Environmental Assessment Drainage and Stormwater Management Report, the following documents were obtained and reviewed:

1. Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Practices Planning and Design Manual, March 2003;
2. Ministry of Transportation (MTO) Highway Drainage Design Standards, January 2008;
3. Toronto and Region Conservation Authority (TRCA) Stormwater Management Criteria, August 2012;
4. Humber River Hydrology Update Final Report, prepared by Civica Infrastructure Ltd., April 2018;
5. Toronto and Region Conservation Authority (TRCA) and Credit Valley Conservation (CVC) Low Impact Development Stormwater Management Planning and Design Guide, 2010;
6. Sustainable Technologies Evaluation Program (STEP) Low Impact Development Stormwater Management (LID SWM) Planning and Design Guide, 2020;
7. City of Vaughan, Engineering Design Criteria & Standard Drawings, Section 1.3 Municipal Infrastructure – Stormwater Management System, December 2020;
8. York Region Road Design Guidelines, December 2020;
9. Draft Fluvial Geomorphological Assessment, Teston Road Environmental Assessment (between 250 metres west of Pine Valley Drive and Kleinburg Summit Way), prepared by Matrix Solutions Inc., February 2021;
10. Natural Heritage Report, Teston Road from 250 m West of Pine Valley Drive to Kleinburg Summit Way, prepared by LGL Ltd., March 2022;
11. Draft Geotechnical Report, Teston Road Improvements 250 m West of Pine Valley Drive to Kleinburg Summit Way, prepared by Terraprobe Inc., February 2022;

12. Kleinburg Summit Master Environmental Servicing Plan for Block 55 East, City of Vaughan, prepared by SCS Consulting Group Ltd., June 2014;
13. Culvert Inspection Report, prepared by Keystone Bridge Management Corporation, 2018;
14. Zzen-Lindvest Residential Subdivision Final Stormwater Management Report, prepared by Urban Ecosystems Ltd., June 2017; and
15. Zzen-Lindvest Residential Subdivision Teston Road Drawings, City of Vaughan, prepared by Urban Ecosystems Ltd., February 2021.

2 Existing Drainage Conditions

2.1 Watershed and Subwatershed

The study corridor is located within the East Humber River watershed. The Toronto and Region Conservation Authority (TRCA) has jurisdiction with respect to drainage and stormwater management of the East Humber River Watershed. The study corridor crosses a tributary of East Humber River, Purpleville Creek, and two (2) tributaries of Purpleville Creek.

2.2 Land Use

The area surrounding the study corridor mainly consists of residential properties and open space on both sides of the roadway. New residential subdivision developments are currently under construction on the north-west side of the Teston Road and Kipling Avenue intersection, and the south-west side of the Teston Road and Pine Valley Drive intersection (Zzen-Lindvest Residential Subdivision).

2.3 Hydrogeological Conditions

Preliminary geotechnical and hydrogeological investigations were conducted by Terraprobe Inc. in December 2021. A field investigation program was carried out between December 8 and 13, 2021, and consisted of drilling and sampling a total of sixteen (16) boreholes. Groundwater levels were measured using a 50 mm diameter standpipe piezometer on January 6 and 31, 2022.

The borehole investigation showed that along Teston Road, the subsurface stratigraphy generally consisted of a pavement structure or topsoil overlying compact sandy gravel, firm to stiff silty clay, and loose silty sand. The native overburden deposits consist of firm to hard silty clay to clayey silt till, loose to compact silt and sand to sand and silt, compact silt, and firm to stiff silty clay.

The estimated hydraulic conductivity ranged from 1×10^{-8} m/s to 1×10^{-5} m/s. As a conservative approach, the lowest hydraulic conductivity of 1×10^{-8} m/s was used for sizing of the Low Impact Development (LID) measures. This hydraulic conductivity approximately corresponds to an infiltration rate of 12 mm/hr, as per Table C1 in Appendix C of the CVC/TRCA LID SWM Planning and Design Guide (2010). A safety correction factor of 3.0 was applied to estimate the soil infiltration rate at the base of the proposed LID measures. Accordingly, a percolation rate of 4.0 mm/hr was considered for the native soil.

Measured groundwater levels in the standpipe piezometers near Crossings C-1, C-2, and C-3 during the investigation ranged from 1.4 m to 5.8 m below the ground surface (elevations ranging from 199.7 m to 202.2 m). During the detailed design stage, in-situ infiltration rate measurements should be completed at all proposed LID locations to confirm the soil infiltration rates and groundwater levels.

2.4 Existing Drainage Pattern

Within most of the study limits, Teston Road has a rural cross-section and is drained by roadside ditches. The ditches convey flows to the four (4) watercourse crossings along the corridor.

As part of the Zzen-Lindvest Residential Subdivision development, Teston Road has been reconstructed from 260 m west of Ballantyne Boulevard to the east end of the study limits. From 260 m to 100 m west of Ballantyne Boulevard, Teston Road has a rural cross-section on the north side and curb and gutter along the south side. From 100 m west of Ballantyne Boulevard to the east end of the study limits, Teston Road has an urban cross-section on both sides of the road. The existing storm sewers drain to various municipal systems constructed as part of the Zzen-Lindvest Residential Subdivision.

Based on the Zzen-Lindvest Residential Subdivision Final Stormwater Management Report prepared by Urban Ecosystems Limited (June 2017), the Teston Road right-of-way from 260 m west of Ballantyne Boulevard to the east end of the study limits has already been accounted for in the stormwater management strategy.

Refer to the Drainage Plans in **Appendix A** for additional details. **Table 2-1** summarizes the approximate locations and areas for each of the drainage areas.

Table 2-1. Summary of Existing Drainage Areas

Drainage Area ID	Description	Drainage Area (ha)	From Station	To Station	Discharge Location
A-1	Kleinburg Summit Way to 120 m east of Kipling Avenue	0.92	1+000	1+500	Tributary of East Humber River (Crossing 1)
A-2	120 m east of Kipling Avenue to 460 m east of Kipling Avenue	0.52	1+500	1+850	Purpleville Creek (Crossing 2)
A-3	460 m east of Kipling Avenue to 650 m east of Kipling Avenue	0.31	1+850	2+040	Roadside ditches (ultimate outfall to Purpleville Creek)
A-4	650 m east of Kipling Avenue to 410 m west of Ballantyne Boulevard	0.91	2+040	2+590	Tributary of Purpleville Creek (Crossing 3)
A-5	410 m west of Ballantyne Boulevard to 200 m (south side) / 80 m (north side) west of Ballantyne Boulevard	0.24	2+590	2+790 (South)/ 2+900 (North)	Tributary of Purpleville Creek (Crossing 4)
A-6	200 m (south side) / 80 m (north side) west of Ballantyne Boulevard to 30 m east of Ballantyne Boulevard	0.55	2+790 (South)/ 2+900 (North)	3+020	Proposed storm sewer system by Zzen-Lindvest Residential Subdivision (ultimate condition) [1]
A-7	30 m east of Ballantyne Boulevard to 240 m west of Pine Valley Drive	0.25	3+020	3+160	Existing storm sewer system by Zzen-Lindvest Residential Subdivision on Ballantyne Boulevard

[1] At the time of preparation of this Drainage and SWM Report, the proposed storm sewer by the Zzen-Lindvest Residential Subdivision has not yet been constructed, and flows within this catchment are directed through a quality control unit and discharge to the Tributary of Purpleville Creek (Crossing 4) in the interim condition

Since there is no watercourse crossing within Drainage Area A-3, flows ponding at the low point within this catchment will ultimately discharge towards the south to Purpleville Creek.

2.4.1 External Areas

Existing catchment areas and outlet locations along the corridor are identified in the Drainage Plans (**Appendix A**). Based on the existing roadway profile, external flows from the roadway and ditches west of Kleinburg Summit Way contribute to the flows in Drainage Area A-1 and ultimately discharge to Crossing 1. External areas contributing to the watercourse crossings within the study corridor were also delineated as part of the Humber River Hydrology Update (Civica Infrastructure, 2018).

As part of detailed design, a continuous flow path should be provided for any external drainage that enters the Teston Road right-of-way to convey external drainage to its respective outlet.

2.5 Aquatic Resources

According to the Natural Heritage Report prepared by LGL Ltd. (LGL, 2022), Crossing 1 is classified as coolwater indirect fish habitat, Crossing 2 and Crossing 3 are classified as coldwater-coolwater direct fish habitat, and Crossing 4 is classified as coldwater-coolwater indirect fish habitat. Crossings 2 and 3 are identified as potential seasonal Redside Dace habitat and are therefore considered regulated habitat for aquatic Species At Risk (SAR). The study area is also located within the general regulation limits of the TRCA, and the proposed works will require permitting under Ontario Regulation 166/06.

2.6 Transverse Culvert Crossings

Under existing conditions, there are four (4) transverse culvert crossings of Teston Road, which are a tributary of East Humber River, Purpleville Creek, and two (2) tributaries of Purpleville Creek. Crossings 2 and 3 are regulated by the TRCA. There is also an existing 1.8 m span and 0.8 m rise concrete box culvert immediately west of Crossing C-1 that receives flow from the existing stormwater management pond servicing the subdivision north of Teston Road. To accommodate the proposed works, this culvert will be extended by 3.0 m on the south side. Since this culvert is only receiving flow from the existing stormwater management pond, this culvert has been excluded from the hydrologic and hydraulic analysis. **Table 2-2** summarizes the size, type, and location of the culvert structures. Refer to the Drainage Plans provided in **Appendix A** for additional details.

Table 2-2. Summary of Transverse Culvert Crossings

Crossing ID	Watercourse Crossing	Location of Crossing	Culvert Description	Crossing Length (m)
C-1	Tributary of East Humber River	180 m west of Kipling Avenue	0.9 m diameter circular CSP	15.9
C-2	Purpleville Creek	360 m east of Kipling Avenue	3.0 m span x 1.0 m rise concrete box	8.4

Table 2-2. Summary of Transverse Culvert Crossings

Crossing ID	Watercourse Crossing	Location of Crossing	Culvert Description	Crossing Length (m)
C-3	Tributary of Purpleville Creek	790 m east of Kipling Avenue	2.4 m diameter circular CSP	18.4
C-4	Tributary of Purpleville Creek	670 m west of Pine Valley Drive	0.75 m diameter circular CSP	15.1

A Culvert Inspection Report (Keystone Bridge Management Corp., 2018) indicated that the concrete box culvert at Crossing C-2 has significant damage and is overdue for replacement. Additional existing condition assessments were not conducted as part of this study for the transverse crossings.

2.6.1 Assessment Criteria

In view of the proposed improvements, a hydraulic assessment of the existing transverse crossings within the Teston Road EA study corridor were undertaken in accordance with the Ontario Ministry of Transportation's Highway Drainage Design Standards (2008).

Design Flows

Based on the MTO Drainage Standard WC-1, the design flow for structures crossing Rural Arterial & Collector roadways with spans less than 6.0 m is the 25-year flow. For structures with spans greater than 6.0 m, the design flow is the 50-year flow. The Check Flow for Rural Arterial and Collector roadways is specified as 115% of the 100-year flow.

Freeboard

The minimum required freeboard for culvert crossings of Rural Arterial and Collector roadways is specified as 1.0 m between the design high water level and the edge of the travelled lane as per the MTO Drainage Standard WC-7.

As per the MTO Drainage Standard WC-7, the upstream water level generated by the Check Flow shall not exceed the elevation of the edge of the traveled lane.

Clearance

For open footing culverts, a minimum clearance of 0.3 m between the design high water level and the top of the culvert opening is specified as per MTO Drainage Standard WC-7. For closed footing culverts with a maximum diameter or rise of 3.0 m on Freeways, Arterials, and Collector roadways a maximum ratio of flood depth to the diameter or rise of the culvert (HW/D) of 1.5 is specified as per WC-7.

Minimum Culvert Sizes

The minimum culvert size for an entrance culvert is 500 mm diameter and the minimum culvert size for roadway crossings is 800 mm diameter as per the York Region Road Design Guidelines.

2.6.2 Hydraulic Assessment of Existing Transverse Crossings

A hydraulic analysis was conducted for the crossings within the study corridor to assess their hydraulic capacity under the existing conditions. An Estimated HEC-RAS hydraulic model for Purpleville Creek was obtained from the Toronto and Region Conservation Authority (TRCA) and updated with the latest available survey data for Crossing 2 and Crossing 3. Hydraulic models were not available for Crossing 1 and Crossing 4, and HY-8 hydraulic models were developed for the analysis of these crossings.

<u>Design Flows</u>

For Crossing 1, the design flows were obtained from the Kleinburg Summit Master Environmental Servicing Plan for Block 55 East (SCS Consulting Group Ltd., 2014), under post-development conditions for the 6 hour storm. Excerpts from the report are included in **Appendix B**.

For Crossing 2 and Crossing 3, the design flows were obtained from the Visual OTTHYMO model from the Humber River Hydrology Update Final Report (Civica Infrastructure Ltd., 2018). The Visual OTTHYMO model schematic and output is provided in **Appendix B**.

For Crossing 4, the peak flows at this crossing were calculated using a Visual OTTHYMO hydrologic model, taking the larger of the peak flows from the 6-hour and 12-hour design storms. The Drainage Area Plan and associated calculations are included in **Appendix B**. Using the catchments from the Humber River Hydrology Update Visual OTTHYMO model (Civica Infrastructure Ltd., 2018), the drainage area north of Teston Road draining to Crossing 4 was determined to be 21.5 ha. The runoff coefficient was estimated to be 0.4, using aerial maps and based on runoff coefficients for the local soil type, which was determined from the Land Information Ontario Soil Survey Complex and the MTO Drainage Design Manual. The Airport Method was used to calculate the time of concentration and corresponding time to peak, which was calculated to be 0.6 hours. The parameters were input into the Humber River Hydrology Update Visual OTTHYMO model to calculate the peak flow rates for the various storm events.

It is recommended that during detailed design, the assessment results be reviewed and verified to confirm any changes to the land-use and associated hydrologic information that may affect the peak flow presented in this Class EA study. A summary table of the storm design peak flows of the transverse crossing is presented in **Table 2-3**.

Table 2-3. Design Peak Flow for Transverse Crossings

Crossing ID	Watercourse Crossing	Peak Flow (m^3/s)		
		25-year Storm	50-year Storm	Regional Storm/ Check Flow
C-1	Tributary of East Humber River	0.98	1.20	1.64[2]
C-2	Purpleville Creek	2.14	2.60	22.03
C-3	Tributary of Purpleville Creek	0.47	0.57	3.63
C-4 [1]	Tributary of Purpleville Creek	0.24	0.30	0.41[2]

[1] Derived from Humber River Hydrology Update VO, 21.5 ha catchment area, peak flow from the 6-hr design storm
[2] Check Flow equal to 115% of the 100-yr storm, according to WC-1 of the MTO Highway Drainage Design Standards (2008)

Hydraulic Assessment

For Crossings C-1 and C-4, the hydraulic analysis was completed using a HY-8 hydraulic model, utilizing the culvert information (size, length, invert elevations and road elevation) obtained from the record drawings and the survey data. For Crossing C-2 and C-3, the HEC-RAS model for Purpleville Creek obtained from the TRCA was reviewed and updated to reflect the existing crossing conditions based on the available survey data completed for this EA study and used to conduct the hydraulic assessment. As part of the update to the hydraulic model, cross-sections upstream and downstream of the Teston Road crossing, as well as the driveway culvert downstream of the crossing, were included.

As per the MTO Highway Drainage Design Standards, hydraulic capacities were assessed based on the 25-year storm event peak flow for structure with spans less than 6.0 m, and the 50-year design storm event peak flow for structure with spans greater than 6.0 m to determine the available freeboard and clearance.

Table 2-4 summarizes the hydraulic analysis results for the transverse crossings along the study corridor. All hydraulic assessment output files are provided in **Appendix C**.

Table 2-4. Hydraulic Analysis Results for Transverse Culverts (Existing Condition)

Crossing ID	U/S Invert (m)	D/S Invert (m)	Length (m)	Road Elev. (m)	Water Surface Elev. (m)			Free-board (m)	HW/D	Remarks
					25-yr	50-yr	Reg./ Check Flow			
C-1	203.99	203.72	15.9	205.44	204.99	205.20	205.50[1]	0.45	1.11	Does not meet MTO freeboard criteria. Check Flow overtops road.
C-2	201.95	201.91	8.4	203.58	202.77	202.83	203.65	0.81	0.82	Does not meet MTO freeboard criterion. Regional overtops road
C-3	199.05	198.97	18.4	202.51	200.02	200.06	200.81	2.49	0.18	Meets MTO freeboard and clearance criteria.
C-4	215.76	215.33	15.1	217.88	216.20	216.26	216.37[1]	1.68	0.59	Meets MTO freeboard and clearance criteria.

[1] Check Flow equal to 115% of the 100-yr storm, according to WC-1 of the MTO Highway Drainage Design Standards (2008)

The results presented in **Table 2-4** indicate that Crossing C-1 does not meet MTO freeboard criterion, and the water surface level generated by the Check Flow overtops Teston Road by approximately 0.06 m. Crossing C-2 also does not meet MTO freeboard criterion, and the water surface level generated by the Regional storm overtops Teston Road with a depth of approximately 0.07 m. Crossing C-3 and C-4 meet MTO freeboard and clearance criteria and no overtopping occurs under Check Flow/Regional storm event condition.

3 Proposed Drainage Condition

3.1 Roadway Drainage System

The preferred alternative design concept for Teston Road improvements from 250 m West of Pine Valley Drive to Kleinburg Summit recommends urbanization of the existing two-lane roadway (one lane in each direction), and the addition of a sidewalk on one side of the road and cycle tracks on both sides of the road. The design concept also includes intersection improvements at the Kleinburg Summit Way and Kipling Avenue intersections.

The roadway profile is modified in the proposed conditions to address vertical alignment geometric deficiencies and accommodate larger culvert crossings. The roadway profile will be raised at the sag near Crossing C-1 and raised over Crossing C-2, and the high point in the profile 100 m east of Crossing C-2 will be removed. Overall, the existing drainage patterns and discharge locations will not be altered as per the proposed roadway improvements, with the exception of the removed high point 100 m east of Crossing C-2, where major flows in the roadway will flow in an easterly direction towards the low point at Station 1+900.

As part of the Zzen-Lindvest Residential Subdivision development in the south-west corner of the Teston Road and Pine Valley Drive intersection, the roadway urbanization in Drainage Areas A-6 (south side only) and A-7 was already completed at the time of preparation of this Drainage and Stormwater Management Report. The design for this segment of Teston Road by the developer included a 3.0 m multi-use path on the south side of the road. Accordingly, the pavement area analysis for Drainage Areas A-6 and A-7 in the Teston Road EA only accounts for the increase in impervious area from the original design of a 3.0 m multi-use path on one side, to the proposed 1.8 m sidewalk on one side and 1.8 m cycle tracks on both sides with the 0.8 m buffer.

Runoff from Drainage Areas A-6 and A-7 discharge to the stormwater management system constructed by the developer, and these areas are accounted for in the design of the stormwater management wet pond. The Drainage Area Plan from the Zzen-Lindvest Residential Subdivision, prepared by Urban Ecosystems Limited (June 2017) is included in **Appendix F**. Accordingly, no additional stormwater management measures are proposed for these catchments within the Teston Road right-of-way as part of this study.

3.1.1 Minor Drainage System

The overall drainage pattern will generally be consistent with the existing conditions. To accommodate the proposed roadway urbanization, the proposed roadway runoff will be collected by a series of catchbasins and will be conveyed by curb and gutter and storm sewers to the existing drainage outlet locations. The storm sewer system for the ultimate roadway configuration is to be designed for a 5-year storm event and shall not surcharge during any storm return frequency event up to and including the 100-year return frequency level, as per the City of Vaughan Engineering Design Criteria (City of Vaughan, 2020). The combined design of the storm sewer and overland flow system must be capable of handling a 100 year return storm without surcharging the minor system. For the storm sewer discharge locations, refer to the Drainage Plans in

Appendix A. A summary listing the right-of-way drainage area characteristics is provided in **Table 2-1**.

As part of the Zzen-Lindvest Residential Subdivision development, a new storm sewer system has been constructed from 260 m west of Ballantyne Boulevard to the east end of the study limits. The proposed storm sewers draining the north side of Teston Road east of Crossing C-4 (within Drainage Area A-6) will tie into the receiving storm sewer system constructed as part of the Zzen-Lindvest Residential Subdivision development. As shown on the Zzen-Lindvest Residential Subdivision Drainage Area Plan provided in **Appendix F**, this area is already included within the Zzen-Lindvest Residential Subdivision storm sewer system, and will receive water quality and water quantity control in the downstream stormwater management wet pond. Further discussion regarding the stormwater management plan is provided in **Section 4**.

3.1.2 Major Drainage System

The roadway design should ensure that the major system runoff up to the 100-year storm event can be safely conveyed to the outfall locations. Roadways may be used for major system overland flow conveyance during the greater of the 100-year return frequency or Regional storm, subject to the flow depth constraints indicated in the City of Vaughan Engineering Design Criteria. The maximum depth of ponding is 0.10 m above the crown of road and the water level up to the right-of-way. To address the climate change controls, the maximum depth of ponding for the August 19, 2005 storm event is 0.3 m above the gutter line and the water level should be retained within the right-of-way. Major system inlets will capture the greater of the 100-year and Regional flows and direct it to the appropriate outfalls. A spread analysis should be completed at the detailed design stage to ensure that the ponding at low points does not exceed the above criteria.

For major system flow route details, refer to the Drainage Plans in **Appendix A**.

3.2 Transverse Culvert Crossings

There are four (4) watercourse crossings within the study corridor. The proposed size, structure, and locations of each crossing was determined based on the existing condition assessment, natural heritage considerations, fluvial geomorphologic assessments, proposed roadway geometry, grading impacts, and hydraulic performance, with the objective of improving the drainage condition at each crossing, accommodating wildlife crossings, and addressing any existing deficiencies. A summary of the recommended approach for upgrades at each watercourse crossing is provided in **Table 3-1**.

Table 3-1. Transverse Culvert Crossing Recommendations

Crossing ID	Watercourse Crossing	Location	Recommendations for Watercourse Crossing Upgrades
C-1	Tributary of East Humber River	180 m west of Kipling Avenue	Replace existing 0.9 m diameter CSP culvert with a 4.267 m span x 1.525 m rise concrete open footing culvert
C-2	Purpleville Creek	360 m east of Kipling Avenue	Replace existing 3.0 m span x 1.0 m rise concrete box culvert with a 12.192 m span x 1.525 m rise concrete open footing culvert
C-3	Tributary of Purpleville Creek	790 m east of Kipling Avenue	Replace existing 2.4 m diameter CSP culvert with a 4.877 m span x 1.830 m rise concrete open footing culvert
C-4	Tributary of Purpleville Creek	670 m west of Pine Valley Drive	Extend existing 0.75 m diameter CSP culvert

3.2.1 Hydraulic Assessment of Proposed Transverse Crossings

Under proposed conditions, the drainage boundary and design peak flow values for the transverse crossings are considered to remain unchanged compared to the existing conditions. The increase in the pavement area as a result of the Teston Road improvements is negligible in comparison to the large external drainage areas contributing to each watercourse crossing location. Therefore, the design peak flows based on the current land use conditions were used to assess the hydraulic performance of the proposed crossings.

The hydraulic assessment for the proposed crossings is based on the preliminary proposed horizontal road design and vertical centerline profile design. Note that the proposed inverts of the crossing culverts are to be confirmed during detailed design to accommodate the road design and the roadside ditch grading. Hydraulic analysis results for proposed conditions are provided in **Table 3-2**. Hydraulic model output files are provided in **Appendix C**.

Crossing C-1 (Tributary of East Humber River)

To improve the hydraulic capacity at the crossing, the existing culvert is proposed to be replaced with a 4.267 m span x 1.525 m rise concrete open footing culvert.

The hydraulic assessment of the proposed Crossing C-1 completed using a HY-8 hydraulic model indicates that under proposed conditions for the design (25-year) storm event, the freeboard will be 2.32 m, and the Check Flow will not overtop the roadway.

Crossing C-2 (Purpleville Creek)

To accommodate wildlife passage and improve the hydraulic capacity at the crossing, the existing culvert is proposed to be replaced with a 12.192 m span x 1.525 m rise concrete open footing culvert, and the roadway profile is proposed to be raised to ensure sufficient cover for the culvert at this crossing. The existing 800 mm CSP at this location, which is a drainage culvert, is proposed to be removed as well.

The hydraulic assessment of the proposed Crossing C-2 completed using the updated Purpleville Creek HEC-RAS hydraulic model indicates that under proposed conditions for the design (50-year) storm event, the freeboard will be 1.05 m, and the Regional storm will not overtop the roadway. Additional coordination with the City of Vaughan and TRCA shall be carried out to finalize the detail design of the culvert and to minimize impacts to the watercourse.

<u>Crossing C-3 (Tributary to Purpleville Creek)</u>

To accommodate wildlife passage, the existing culvert is proposed to be replaced with a 4.877 m span x 1.830 m rise concrete open footing culvert.

The hydraulic assessment of the proposed Crossing C-3 completed using the updated Purpleville Creek HEC-RAS hydraulic model indicates that under proposed conditions for the design (25-year) storm event, the freeboard will be 2.71 m, and the Regional storm will not overtop the roadway. Additional coordination with the City of Vaughan and TRCA shall be carried out to finalize the detail design of the culvert and to minimize impacts to the watercourse.

<u>Crossing C-4 (Tributary to Purpleville Creek)</u>

To accommodate roadway platform widening, the existing culvert is proposed to be extended. The hydraulic assessment of the proposed culvert extension at Crossing C-4 completed using a HY-8 hydraulic model indicates that under proposed conditions for the design (25-year) storm event, the freeboard will be 1.63 m, and the Check Flow will not overtop the roadway.

Table 3-2. Hydraulic Analysis Results for Transverse Culverts (Proposed Condition)

Crossing ID	U/S Invert (m)	D/S Invert (m)	Length (m)	Road Elev. (m)	Water Surface Elev. (m)			Free-board (m)	Clearance (m) / HW/D	Remarks
					25-yr	50-yr	Reg./Check			
C-1	204.15	203.42	28.9	206.74	204.42	204.46	204.53[1]	2.32	0.53	Meets MTO criteria.
C-2	202.31	202.25	26.0	203.80	202.72	202.75	203.38	1.05	1.03	Meets MTO criteria.
C-3	199.74	199.67	17.2	202.65	199.94	199.96	200.30	2.71	1.56	Meets MTO criteria.
C-4	215.817	215.23	20.57	217.88	216.25	216.31	216.43[1]	1.63	0.58[2]	Meets MTO criteria.

[1] Check Flow equal to 115% of the 100-yr storm, according to WC-1 of the MTO Highway Drainage Design Standards (2008)
[2] HW/D

4 Stormwater Management Plan

The stormwater management plan for the study area within the Humber River watershed shall be developed to comply with the Toronto and Region Conservation Authority (TRCA) Stormwater Management Criteria, MECP Stormwater Management Guidelines, Humber River Hydrology Update Final Report (TRCA, 2018), York Region Road Design Guidelines, and City of Vaughan Engineering Design Criteria.

4.1 Water Quality Control

Watercourses within the TRCA's jurisdiction are classified as requiring an "Enhanced" level of protection, which equates to 80% Total Suspended Solids (TSS) removal.

Stormwater management (water quality) measures within the study limits will be designed to provide "Enhanced" water quality treatment, as a minimum, for the increased pavement area as a result of roadway extension/widening/improvements. Opportunities to treat the entire pavement area are to be investigated in the detailed design stage.

4.2 Water Quantity Control

Watercourse Crossings

According to the TRCA Stormwater Management Criteria (TRCA, 2012), for catchments discharging to the main branch of the East Humber River, post-development peak flows are to be controlled to pre-development levels for the 2- to 100-year design storm events. For catchments discharging to Purpleville Creek, which is located within Sub Basin 19A, unit flow rates are provided for the 2- to 100-year design storm events. However, given the limited space within the ROW for linear infrastructure, it will be difficult to satisfy the unit flow criteria; therefore, a best efforts approach to provide sufficient storage to attenuate the post-development peak flow to the pre-development level for all design storms is recommended.

Storm Sewer Systems

For locations where the runoff discharges into an existing system, the minor system design storm (5-year storm) peak flows must be controlled to the existing peak flows, for which the receiving system was designed. The receiving storm sewer systems within the project limits are City of Vaughan systems, which would have been designed based on a 5-year storm.

4.3 Water Balance and Erosion Control

The TRCA criterion for water balance and erosion control requires retention of 5 mm of rainfall. This criterion is applicable to increased pavement area as a result of roadway extension/widening/improvements. Opportunities to provide water balance for the entire pavement area are to be investigated in the detailed design stage.

4.4 Pavement Area Analysis

A pavement area analysis was performed to determine the increase in impervious surface. It was determined that the proposed roadway improvements will result in a 1.40 hectare, or 69.0% increase, in pavement area within the Teston Road study corridor. The increase pavement area within the corridor is primarily attributed to the proposed cycle tracks, sidewalk, and 0.8 m buffer between the curb and the active transportation facilities. The pavement area analysis results are summarized in **Table 4-1**.

Table 4-1. Pavement Area Analysis

Existing	Proposed			Increase in Pavement Area (ha)	Percent Increase
Pavement Area (ha)	Roadway Pavement Area (ha)	Cycle Track, Sidewalk, and Buffer Area (ha)	Total Pavement Area (ha)		
2.02	1.91	1.51	3.42	1.40	69.0%

4.5 Stormwater Best Management Practice Options

Various Best Management Practices (BMPs) for stormwater management were reviewed and assessed for their applicability on this project. Due to the nature of this facility (i.e. linear transportation corridor) and the limited space within the roadway right-of-way, exfiltration systems under the cycle tracks parallel to storm sewers are proposed for quality treatment, erosion control, and water balance.

To provide quantity control at locations discharging to the watercourses to meet TRCA criteria, online storage pipes are proposed.

Since the increase in pavement area within the corridor is primarily attributed to the proposed cycle tracks and sidewalk, the use of permeable material (e.g. permeable pavement, permeable concrete) for the active transportation facilities as well as the buffer between them and the roadway could be considered as an alternative to exfiltration systems and online storage pipes. Since these are not heavy load bearing surfaces, the use of permeable pavement will not impact the functionality of the proposed design. Accordingly, there would be a negligible increase in pavement area, and no additional quantity or quality control would be required. Additional details and specifications for the permeable material are to be included in the detailed design stage.

The Stormwater Management plan has been prepared under the assumption that the active transportation facilities and buffer between the curb and active transportation facilities will be impervious, and exfiltration systems and online storage pipes will be required to mitigate the impacts of increased runoff.

4.5.1 Exfiltration Systems

Exfiltration Systems are linear conveyance facilities parallel to storm sewers, which consist of a trench lined with geotextile fabric and clean granular fill (50 mm clear stone) and include a perforated inlet pipe connected to the upstream catchbasin or manhole. In addition to removing TSS particles and providing water balance through infiltration, the granular filter within the trench reduces water temperature impact and enhances stream base flows through groundwater recharge. It also contributes to controlling downstream erosion by reducing flow velocities.

The design criteria specified in the SWM Planning and Design Guide (MECP, 2003) and LID SWM Planning and Design Guide (STEP, 2020) were applied to determine the depth and footprint area for the trenches. The maximum allowable depth of the stone reservoir can be calculated using the following formula:

$$d_{r\ max} = i * t_s / V_r$$

where *i* is the infiltration rate of the native soils, which was estimated to be 4.0 mm/hr within the project limits based on the Hydrogeological Investigation (**Section 2.3**); t_s is time to drain, which is recommended to be 48 hours; and V_r is void space ratio of the aggregate used, which is typically 0.4 for clear stone. Accordingly, the maximum allowable depth of the reservoir can be calculated to be d_{max} = 480 mm.

For this project, 1.4 m wide by 0.4 m deep trenches are proposed with a 0.2 m perforated inlet pipe. Conceptual plan and profiles of the proposed exfiltration systems are provided in **Appendix D**. The footprint area of the trenches can be calculated using the following formula:

$$A_f = WQV / (d_c * V_r)$$

where *WQV* is the required water quality volume to meet the 'Enhanced' level protection (80% TSS removal), which is determined based on the contributing drainage area and the imperviousness using Table 3.2 of the SWM Planning and Design Manual (MECP, 2003); d_c is the depth of the trench, and V_r is the void space ratio for the gravel storage layer, which is typically 0.4. The stone reservoir within the trench will retain water to meet the water balance and erosion control targets. Additionally, the ratio of the impervious drainage area to footprint area of the infiltration trench should be between 5:1 and 20:1 to limit the rate of accumulation of fine sediments and thereby prevent clogging.

The bottom of the trench should be one (1) metre above the seasonally high groundwater table. According to the Hydrogeological Investigation (**Section 2.3**), the groundwater table ranges from 1.4 to 5.8 m below the ground surface where LID measures are generally proposed along the corridor. Due to the raise in roadway profile west of Crossing C-2, which is the location with the lowest separation, this should provide adequate separation under proposed conditions between the groundwater table and the bottom of the proposed facilities. LID measures could also be implemented in areas with high groundwater to exclusively provide quality control, but the facilities should be lined with an impermeable liner if adequate separation cannot be obtained. Further investigation should be completed during the detail design stage to confirm adequate separation from the proposed facilities at each location and to determine the percolation rate of the native soils using in-situ infiltration testing to ensure the maximum allowable depth of the reservoir is not exceeded.

The exfiltration systems are proposed for all the catchments within the study corridor, since runoff entering the proposed storm sewer system discharges directly into the watercourses. In addition to providing 'Enhanced' level protection (80% TSS removal), the provided storage volume within the trenches includes the volume required to retain the first 5 mm of rainfall to meet the TRCA water balance and erosion control target. Pre-treatment of the runoff directed to the infiltration trenches using catchbasin inserts (e.g. CB Shield) is recommended.

Drainage Areas A-2, A-3, and A-4 are discharging to potential Redside Dace contributing habitat. Accordingly, 100% of the pavement areas are proposed to be treated due to the sensitivity of the receiving watercourse. Overall, the exfiltration systems are designed to provide water quality treatment for pavement areas exceeding the total increase in pavement area across the study corridor.

Table 4-2 lists the details of the exfiltration systems proposed along the Teston Road corridor. For locations of the proposed trenches, refer to the Drainage Plans provided in **Appendix A**. Detailed calculations are provided in **Appendix E**.

Table 4-2. Summary of Proposed Water Quality Treatment Strategy

Drainage Area ID	Proposed Pavement Area (ha)	Additional Pavement Area (ha)	Req'd Water Quality Volume (m^3)	Req'd Water Balance Storage[1] (m^3)	Proposed Length (m)	Treated Pave-ment Area[2] (m^2)	Provided Storage Volume (m^3)
A-1	0.89	0.34	10	17	140	0.34	31
A-2	0.50	0.24	22	25	185	0.50	41
A-3	0.28	0.13	13	14	120	0.28	27
A-4	0.79	0.40	36	39	340	0.79	76
A-5	0.22	0.11	3	5	80	0.11	18
A-6	0.51	0.12	4	6	-	-	-
A-7	0.24	0.06	2	3	-	-	-
Total	**3.42**	**1.40**	**90**	**109**	**865**	**2.01**	**194**

[1] Based on the retention of the first 5 mm of rainfall
[2] Area considered to be receiving water quality treatment

Through the proposed water quality treatment strategy, a total of 2.01 ha of pavement area is considered to receive water quality control through the use of the exfiltration systems. A total of 194 m^3 of water balance and water quality/erosion control storage volume is proposed using the trenches, which exceeds the required storage volumes based on MECP and TRCA criteria. During detailed design, the location and performance characteristics of the exfiltration systems will need to be confirmed to ensure that all design criteria can be met.

4.5.2 Online Storage Pipes

For quantity control for catchments discharging to the Main Branch of the East Humber River (Drainage Area A-1), TRCA requires post-development peak flows to be controlled to pre-development levels for the full range of storm events. The required storage is considered as the largest of the storage required to control the peak flow from all storm events, up to the 100-year storm event, to the existing levels, and can be provided as a combination of underground storage and surface ponding.

For catchments discharging to Purpleville Creek (Drainage Areas A-2 to A-5), and for catchments discharging to the existing City of Vaughan Zzen-Lindvest Residential Subdivision storm system sewers (Drainage Areas A-6 to A-7), due to the linear nature of the corridor and limited space for stormwater management facilities within the right-of-way, the unitary flow rates established as part of the TRCA Stormwater Management Criteria (2012) cannot be met. Therefore, a best-efforts approach is proposed for Drainage Areas A-2 to A-5 by controlling post-development peak flows for the 2-year to 100-year events to existing levels. For Drainage Areas A-6 and A-7, construction of the roadway and Teston Road storm sewer system have already been completed by the Zzen-Lindvest Residential Subdivision developer. The Teston Road right-of-way has already been accounted for in the sizing of the developer stormwater management wet pond, and quantity control is provided to meet the unitary flow rates established as part of the TRCA Stormwater Management Criteria (2012). Accordingly, no additional quantity control measures are required for Drainage Areas A-6 and A-7. The Drainage Area Plan from the Zzen-Lindvest Residential Subdivision, prepared by Urban Ecosystems Limited (June 2017) is included in **Appendix F**.

The required storage volumes to achieve the quantity control targets for each catchment are summarized in **Table 4-3**. Online storage pipes are proposed and shall be designed in combination with surface ponding to provide the required storage in the detailed design stage. Detailed calculations are provided in **Appendix E**.

Table 4-3. Summary of Proposed Water Quantity Treatment Strategy

Drainage Area ID	Drainage Area (ha)	Existing Pavement Area (ha)	Additional Pavement Area (ha)	Required Storage [1] (m^3)
A-1	0.92	0.55	0.34	64
A-2	0.52	0.26	0.24	46
A-3	0.31	0.14	0.13	25
A-4	0.91	0.39	0.40	75
A-5	0.24	0.11	0.11	21
A-6[2]	0.55	0.39	0.12	0
A-7[2]	0.25	0.19	0.06	0
Total	**3.70**	**2.02**	**1.40**	**230**

[1] Based on controlling up to 100-year storm
[2] Quantity control will be provided by the Zzen-Lindvest Residential Subdivision stormwater management facility

Through the proposed water quantity control strategy, a total of 230 m^3 of storage volume will be provided to attenuate peak flows to existing levels. During detailed design, the location, pipe sizing, and orifice sizing of the online storage pipes will need to be determined to ensure that the water quantity control criteria can be met. Storage volume calculations with a minute-by-minute time step are also to be provided for review by TRCA during detailed design.

4.5.3 Supplemental BMP Measures

Through discussions with TRCA, opportunities to implement supplemental stormwater best management practice (BMP) measures to augment the treatment proposed by the exfiltration systems using a treatment train approach, including measures to mitigate water temperature impacts, are to be considered in the detail design stage.

The supplemental BMP measures shall be designed based on the site conditions and further geotechnical and hydrogeological investigations undertaken during the next phase of design. Any low impact development measures shall meet the design criteria as per the Low Impact Development Stormwater Management Planning and Design Guide (STEP, 2020).

A list of potential LID measures and BMP's to support the treatment train approach that may be considered for implementation within the study corridor during the detailed design is provided as follows:

Bioretention Systems

Bioretention systems allow for stormwater filtration, infiltration, and evapotranspiration from tree and vegetative plantings.

For roadway applications, these can take the form of sub-surface modular units that are filled with lightly compacted soil within a trench situated beneath the roadway boulevards. The trench unit consists of a filter bed, which is a mixture of sand, fines, and organic material to support vegetation and promote evapotranspiration by allowing surface runoff to route through a surface inlet or a subsurface distribution pipe via gravity within the trench. Soil filtration, bioremediation, and evapotranspiration will occur as water filtrates through the soil from the perforated distribution pipe.

Since trees require water to sustain their health and allow for growth, the concept of integrating stormwater runoff from the right-of-ways and discharging the runoff directly into the soil trench systems has the following advantages:

- Boulevard landscaping (trees) will receive a supply of rainwater during every rainfall event, thus sustaining their health;
- Stormwater runoff from the roadways could potentially see significant detention within the soil trench systems, which will result in runoff reduction;
- Water quality treatment will be achieved since stormwater can be routed through the trench's soil and tree root matrix, thus creating a subsurface bioretention system; and
- For smaller rainfall events, the soil trenches can provide (in the long-term) for complete capture of the runoff through infiltration, root uptake, and evapotranspiration.

Vegetated Filter Strips

Vegetated filter strips operate through a combination of sedimentation and infiltration. Shallow flows are routed over grassed areas, which allow the filter strips to function by slowing down the runoff velocity and filter out suspended sediment and associated pollutants and allowing infiltration into underlying soils. Filter strips are applicable where there are low, flat vegetated areas that will allow runoff to disperse over a wide area.

Vegetative filter strips should be considered to provide additional water quality control in series with the exfiltration systems as a treatment train system.

Plunge Pools

Plunge pools are designated depression areas at the base of storm outfalls to prevent scouring and erosion due to the high velocity of the flow at the outfall pipe locations. The plunge pool also functions as a level spreader that reduces the concentrated flow from the outfall and spreads the flow onto a natural vegetated floodplain area.

Plunge pools should be considered at the storm outfall locations to disperse the energy of the flow.

4.6 Erosion and Sediment Control during Construction

Erosion and sediment control measures should be implemented and monitored through the construction period. Construction activities should be conducted during periods that are least likely to result in in-stream impacts to fish habitat.

Detailed erosion and sediment control plans will be required as part of the detail design component for all phases of the construction. The erosion and sediment control plans will be subject to review and approval by the various external agencies involved in the project, including the TRCA.

During construction, disturbances to watercourse riparian vegetation should be minimized. If riparian vegetation is removed or disturbed, erosion and sediment control measures such as silt fences, rock flow check dams and sedimentation ponds should be utilized to provide a maximum protection of local and downstream aquatic resources. These measures should be maintained during construction and until disturbed areas have been stabilized with seed and mulch. Additionally, topsoil should not be stockpiled close to the watercourses and water should not be withdrawn from these sensitive streams for construction purposes.

The site engineer and contractor will be responsible for delineating work areas and ensuring that erosion and sediment control measures are functional. In addition, the engineer will ensure that provisions related to fisheries and watercourse protection is met and that any required fish habitat compensation measures are implemented in accordance with the terms and conditions of the Fisheries Act Authorization.

4.7 Stormwater Management Plan Summary

The proposed stormwater management plan for the project has been developed by examining the opportunities and constraints within the entire study corridor. Runoff from the paved roadway area will be conveyed to the proposed exfiltration and roadway storm sewer systems and discharge to the existing watercourses within the study limits. As per **Section 4.3**, the pavement area will increase by 1.40 ha due to the additional cycle tracks and sidewalk. Enhanced level water quality, water balance, and erosion control treatment will be considered to be provided for 2.01 ha of pavement area, exceeding the MECP requirement of providing treatment to the increased pavement area. The stormwater management plan for this project is presented on the Drainage Plans in **Appendix A**. **Table 4-4** provides a summary of the water quality treatment and quantity control strategies proposed to mitigate the increase in impervious surface within the project limits from the cycle tracks and sidewalk.

Table 4-4. Summary of Stormwater Management Plan

Drainage Area ID	Existing Pavement Area (ha)	Additional Pavement Area (ha)	Pavement Area Considered to Receive Quality Treatment (ha)	Quality Storage Volume Provided (m^3)	Quantity Control Storage Required[2] (m^3)
A-1	0.55	0.34	0.34	31	64
A-2[1]	0.26	0.24	0.50	41	46
A-3[1]	0.14	0.13	0.28	27	25
A-4[1]	0.39	0.40	0.79	76	75
A-5[1]	0.11	0.11	0.11	18	21
A-6[3]	0.39	0.12	0.00	0	0
A-7[3]	0.19	0.06	0.00	0	0
Total	**2.02**	**1.40**	**2.01**	**194**	**230**

[1] Total pavement area is treated to meet MECP requirements of treating the overall increased pavement area in the corridor
[2] Based on controlling up to 100-year storm
[3] Quality and Quantity control provided by Zzen-Lindvest Residential Subdivision stormwater management facility

5 Conclusions

The Teston Road corridor from 250 m west of Pine Valley Drive to Kleinburg Summit Way is proposed to be urbanized with the addition of cycle tracks on both sides of the road and a sidewalk on the south side of the road. The proposed design will include a new subsurface road drainage system, consisting of storm sewer systems with catchbasins along the curb lines to convey stormwater runoff to the various outfall locations along the corridor.

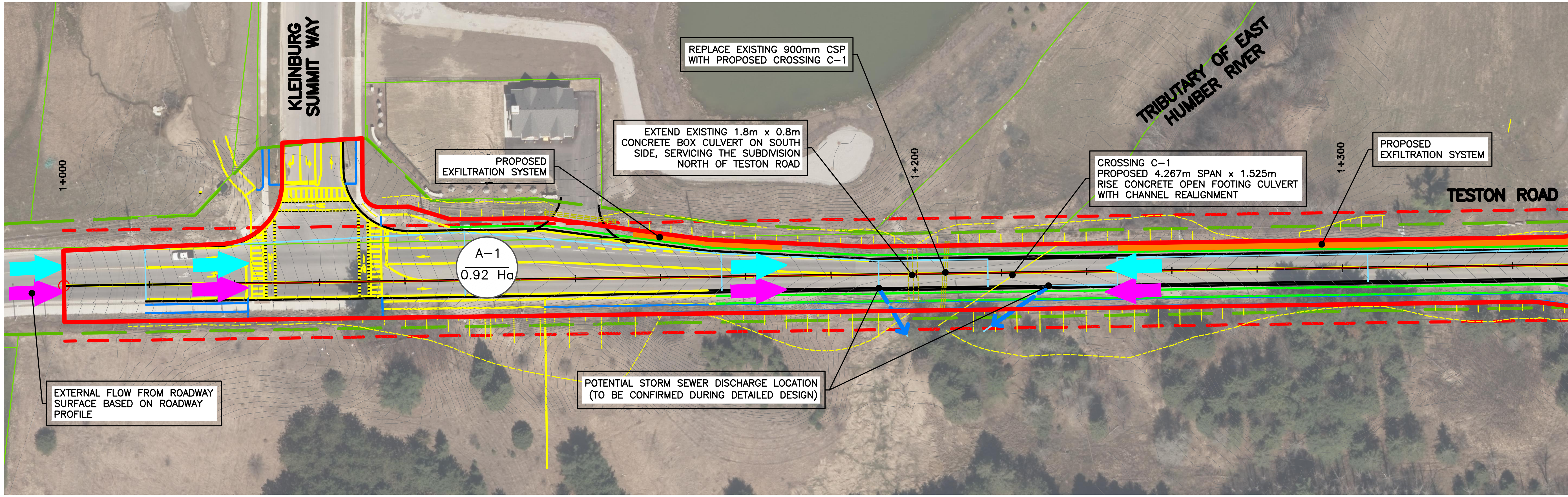
The study area is within the area regulated by the TRCA, and four (4) watercourse crossings are located within the project limits. Hydraulic analyses were completed for the existing and proposed conditions at the watercourse crossings to ensure that the proposed structures will not negatively impact the upstream flood levels and if feasible, will meet the requirements of the MTO Highway Drainage Design Standards.

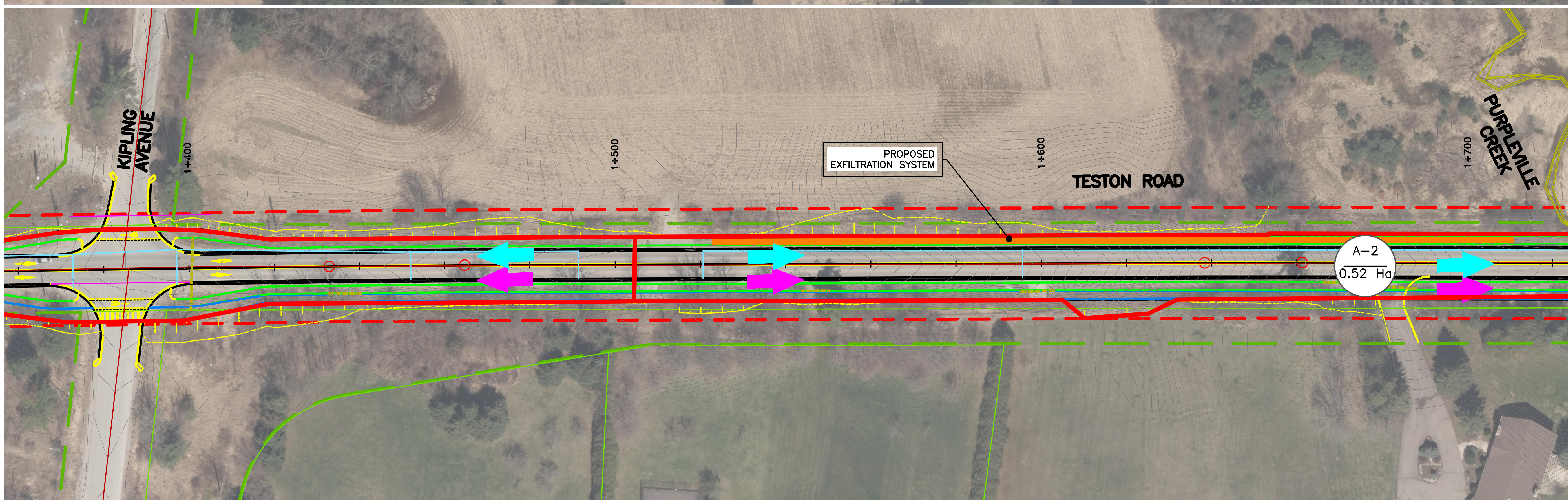
The East Humber River culvert crossing (Crossing C-1) does not meet MTO hydraulic criteria and is proposed to be replaced with a 4.267 m span x 1.5225 m rise concrete open footing culvert. The Purpleville Creek culvert crossing (Crossing C-2) does not meet MTO hydraulic criteria and is currently overtopped under the Regional storm event and is proposed to be replaced with a 12.192 m span x 1.525 m rise concrete open footing culvert. The two Tributary of Purpleville Creek Crossings (Crossing C-3 and C-4) currently meet MTO hydraulic criteria. C-3 will be replaced with a 4.877 m span x 1.830 m rise concrete open footing culvert to accommodate wildlife passage, and the existing 750 mm diameter CSP culvert at C-4 will be extended to accommodate the proposed improvements. A detailed hydraulic assessment should be conducted during detail design to confirm the hydraulic impacts in consideration with the proposed downstream channel improvement works.

Stormwater best management practices, including catchbasin inserts, exfiltration systems, and online storage pipes, are proposed to provide stormwater quality treatment, water balance, erosion control, and quantity control of the increased runoff from the right-of-way. The proposed road improvements will result in a 1.40 ha increase in pavement area. As part of the SWM strategy, a total of 2.01 ha of pavement area will be considered to receive quality treatment through the proposed exfiltration systems, which exceeds the MECP requirement of providing treatment to the increased pavement area. The exfiltration systems will provide a total 194 m^3 of storage volume for water balance and quality and erosion control, which exceeds the required volumes determined by the MECP and TRCA. Quantity control will be provided through the proposed online storage pipes to control various storm events peak flows rates to their existing levels. Opportunities to implement supplemental BMP measures to provide additional water quality control, water temperature mitigation, and support a treatment train approach may be considered during the next phases of design in series with the proposed measures to enhance the overall water quality objectives.

Appendix A: Drainage Area Plans

METRIC





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LEGEND

PROPOSED R.O.W.
EXISTING R.O.W.
EXISTING WATERCOURSE CROSSING
PROPOSED CATCHMENT BOUNDARY
STORM SEWER SYSTEM OUTLET

GRADING
CL EXISTING ALIGNMENT
CL PROPOSED ALIGNMENT
PROPOSED EXFILTRATION SYSTEM
EXISTING STORM SEWER
CONCEPTUAL STORM SEWER LAYOUT

A / xx Ha — DRAINAGE AREA

EXISTING OVERLAND FLOW DIRECTION

PROPOSED OVERLAND FLOW DIRECTION

HDR

TESTON ROAD
(W OF PINE VALLEY TO KLEINBURG SUMMIT)
ENVIRONMENTAL ASSESSMENT
DRAINAGE PLAN
STA. 1+000 TO 1+730

SHEET NO.
DP-01

MAY, 2023

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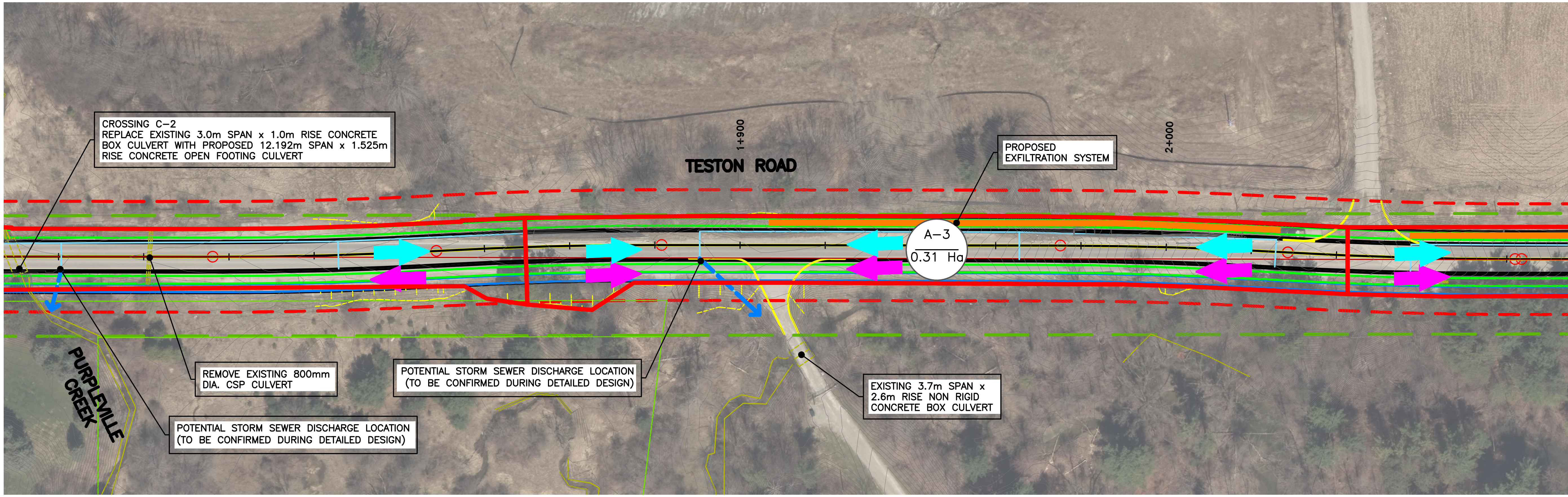

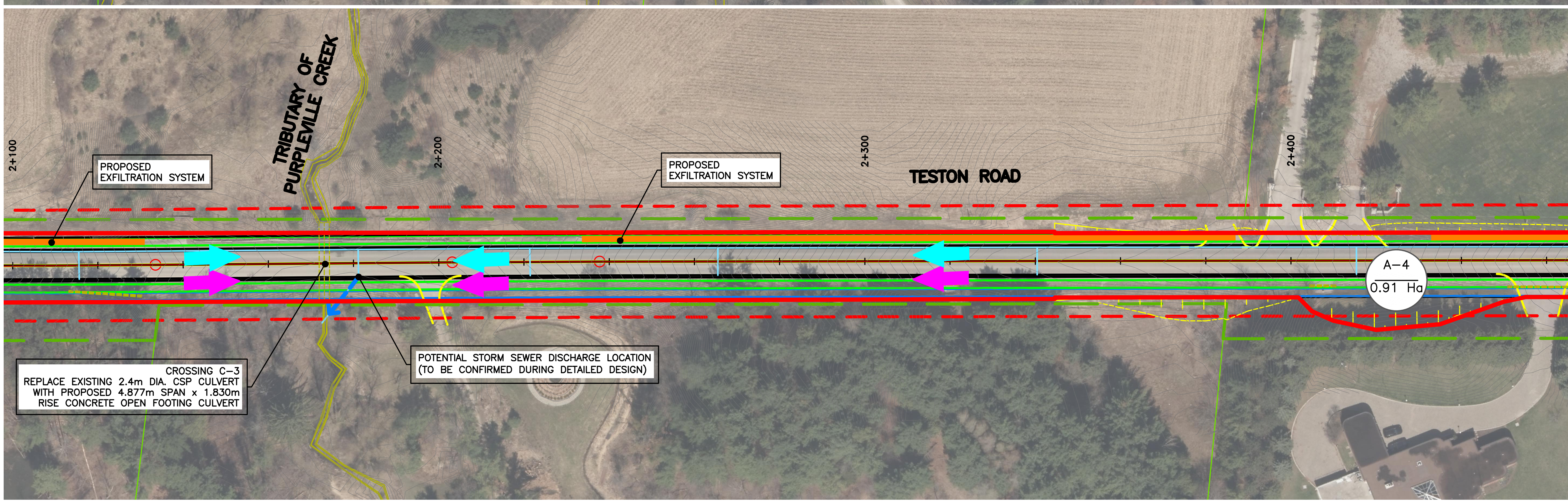

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LEGEND

PROPOSED R.O.W.
EXISTING R.O.W.
EXISTING WATERCOURSE CROSSING
PROPOSED CATCHMENT BOUNDARY
STORM SEWER SYSTEM OUTLET

GRADING
CL EXISTING ALIGNMENT
CL PROPOSED ALIGNMENT
PROPOSED EXFILTRATION SYSTEM
EXISTING STORM SEWER
CONCEPTUAL STORM SEWER LAYOUT

A / xx Ha — DRAINAGE AREA

EXISTING OVERLAND FLOW DIRECTION

PROPOSED OVERLAND FLOW DIRECTION

HDR

TESTON ROAD
(W OF PINE VALLEY TO KLEINBURG SUMMIT)
ENVIRONMENTAL ASSESSMENT
DRAINAGE PLAN
STA. 1+730 TO 2+470

SHEET NO.
DP–02

MAY, 2023

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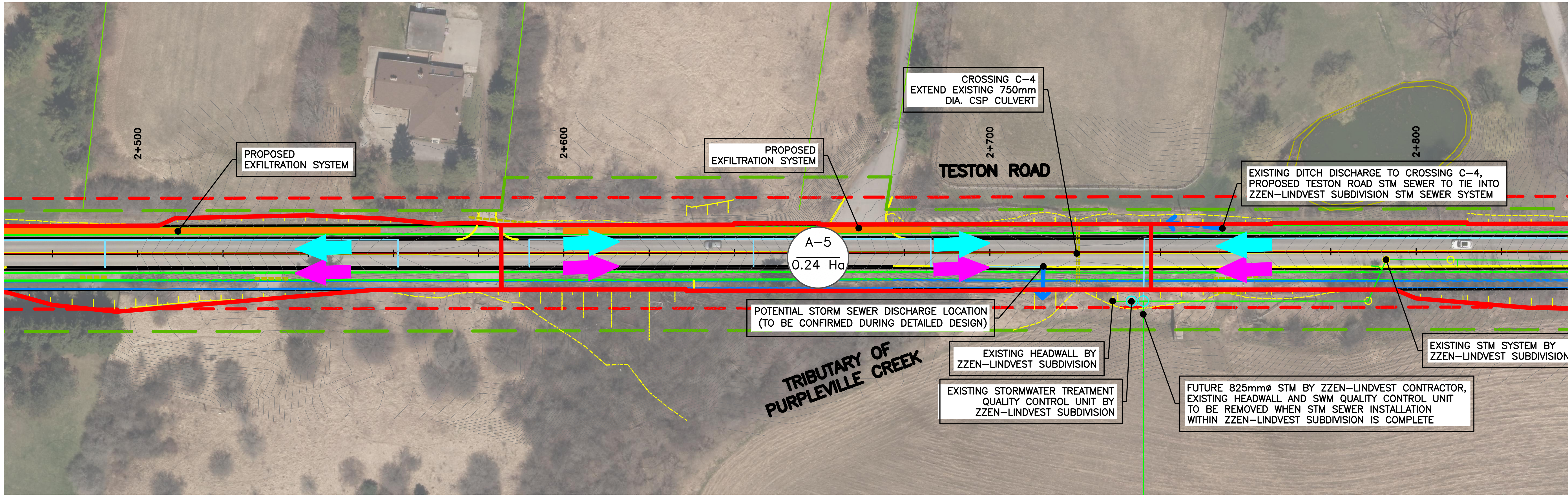

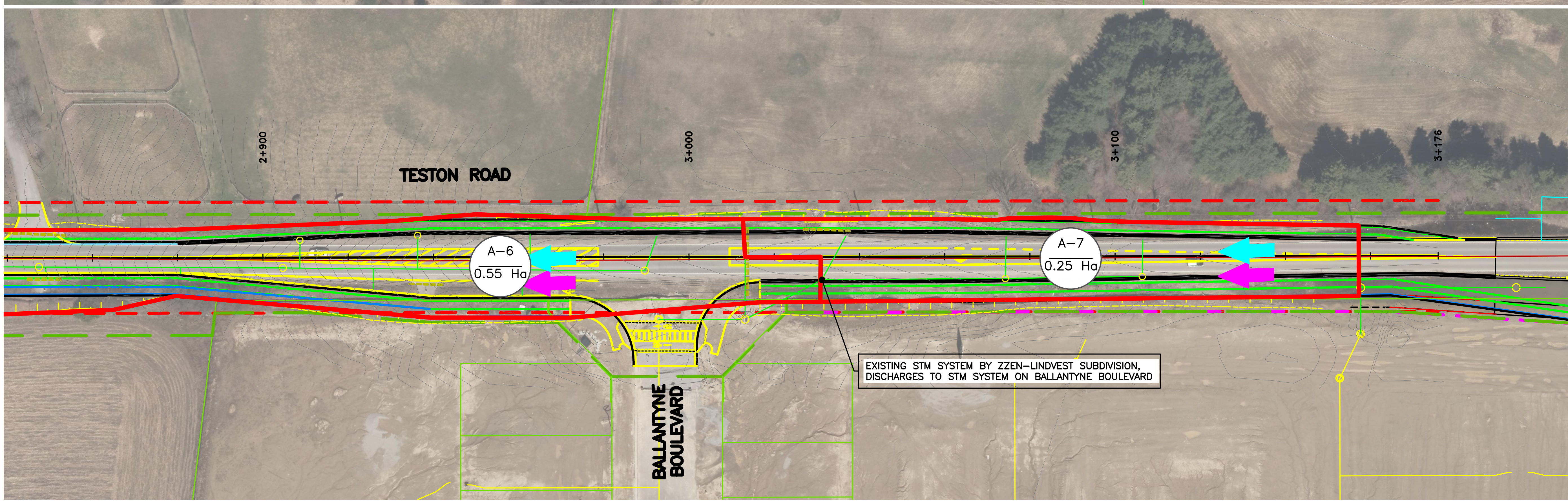

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LEGEND

- PROPOSED R.O.W.
- EXISTING R.O.W.
- EXISTING WATERCOURSE CROSSING
- PROPOSED CATCHMENT BOUNDARY
- STORM SEWER SYSTEM OUTLET
- GRADING
- CL EXISTING ALIGNMENT
- CL PROPOSED ALIGNMENT
- PROPOSED EXFILTRATION SYSTEM
- EXISTING STORM SEWER
- CONCEPTUAL STORM SEWER LAYOUT
- A / xx Ha — DRAINAGE AREA
- EXISTING OVERLAND FLOW DIRECTION
- PROPOSED OVERLAND FLOW DIRECTION

HDR

TESTON ROAD
(W OF PINE VALLEY TO KLEINBURG SUMMIT)
ENVIRONMENTAL ASSESSMENT
DRAINAGE PLAN
STA. 2+470 TO 3+200

SHEET NO.
DP–03

MAY, 2023

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Appendix B: Hydrologic Analysis

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(289) 695-4600

VAUGHAN

Kleinburg SUMMIT

MASTER ENVIRONMENTAL SERVICING PLAN

BLOCK 55 EAST

THE KIPLING AVENUE COMMUNITY

July 2013, Revised January 2014, Final June 2014

SCS consulting group ltd

Table B7.6: Summary of Pre and Post-Development Flows at Feature C Upstream of Teston Road – Option A

Pond 5 – Option A				
Return Period Storm	Feature C Upstream of Teston Road (Node JC1)		Feature C Upstream of Teston Road (Node JC1)	
	PRE 12 Hour AES	POST 12 Hour AES	PRE 6 Hour AES	POST 6 Hour AES
2 Year	0.21	0.14	0.26	0.18
5 Year	0.53	0.32	0.71	0.45
10 Year	0.78	0.47	1.07	0.66
25 Year	1.10	0.64	1.56	0.94
50 Year	1.33	0.78	1.93	1.15
100 Year	1.55	0.90	2.30	1.38

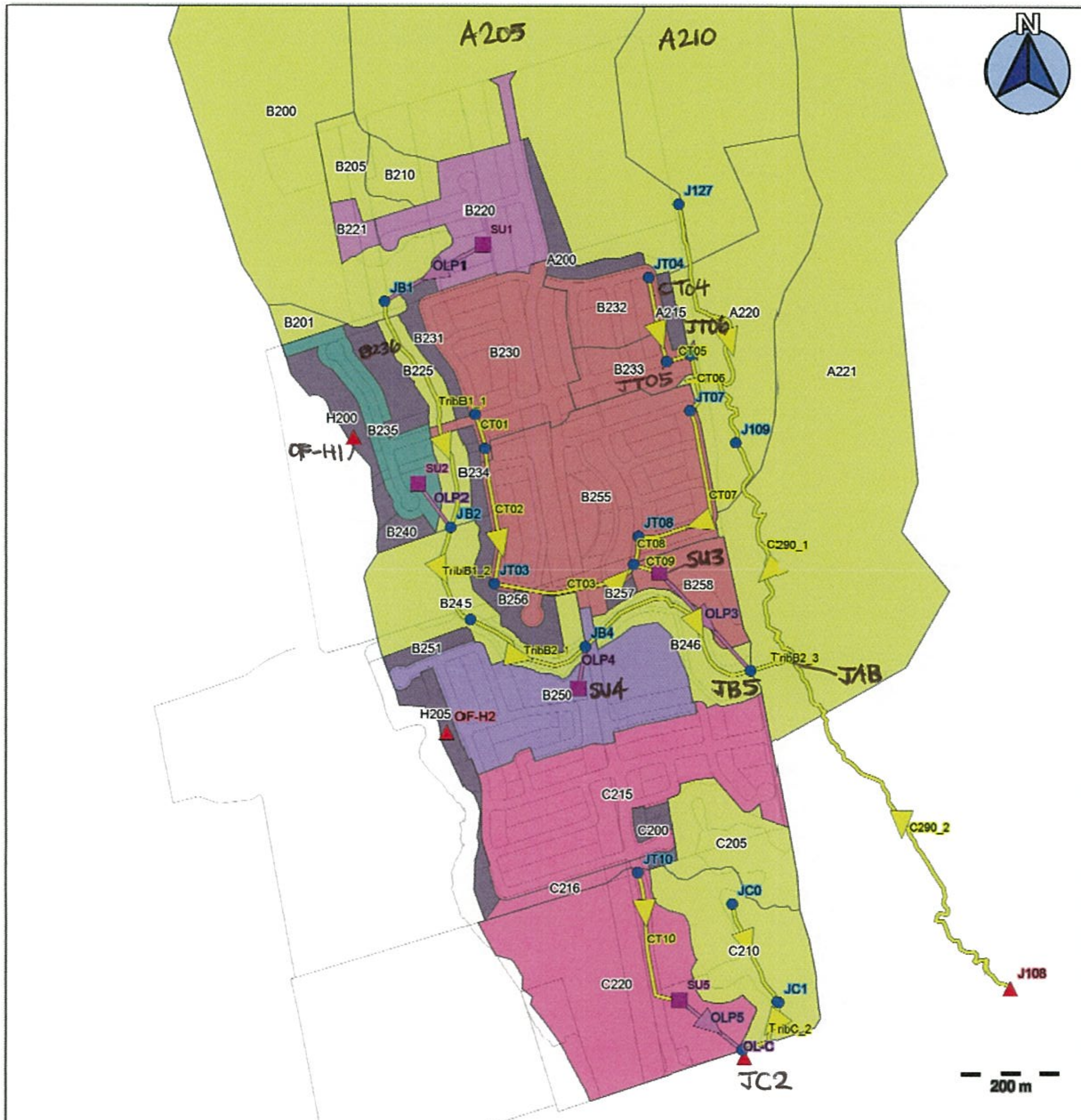
Table B7.7: Summary of Pre and Post-Development Flows at Feature C Downstream of Teston Road – Option A

Pond 5 – Option A				
Return Period Storm	Feature C Downstream of Teston Road (Node JC2)		Feature C Downstream of Teston Road (Node JC2)	
	PRE 12 Hour AES	POST 12 Hour AES	PRE 6 Hour AES	POST 6 Hour AES
2 Year	0.40	0.38	0.49	0.43
5 Year	1.08	1.14	1.43	1.29
10 Year	1.62	1.68	2.18	2.04
25 Year	2.30	2.31	3.20	2.97
50 Year	2.80	2.77	3.98	3.67
100 Year	3.28	2.89	4.77	4.08

Table B7.8: Summary of Pre and Post-Development Flows at Feature C Upstream of Teston Road – Option B

Pond 5 – Option B				
Return Period Storm	Feature C Upstream of Teston Road (Node JC1)		Feature C Upstream of Teston Road (Node JC1)	
	PRE 12 Hour AES	POST 12 Hour AES	PRE 6 Hour AES	POST 6 Hour AES
2 Year	0.21	0.15	0.25	0.19
5 Year	0.53	0.34	0.71	0.47
10 Year	0.78	0.49	1.07	0.69
25 Year	1.09	0.67	1.55	0.98
50 Year	1.33	0.81	1.92	1.20
100 Year	1.55	0.95	2.29	1.43

Flows used for Crossing 1
Hydrologic Analysis



LEGEND

- Junctions (Nodes, MHs)
- Outfalls
- Storages (Ponds)
- Conduits (Channels, Pipes)

Subcatchments

- Tag = UNC (Uncontrolled)
- Tag = EXT (External)
- Tag = P3 (Pond 3)
- Tag = P5 (Pond 5B)
- Tag = P1 (Pond 1)
- Tag = P4 (Pond 4)
- Tag = P2 (Pond 2)

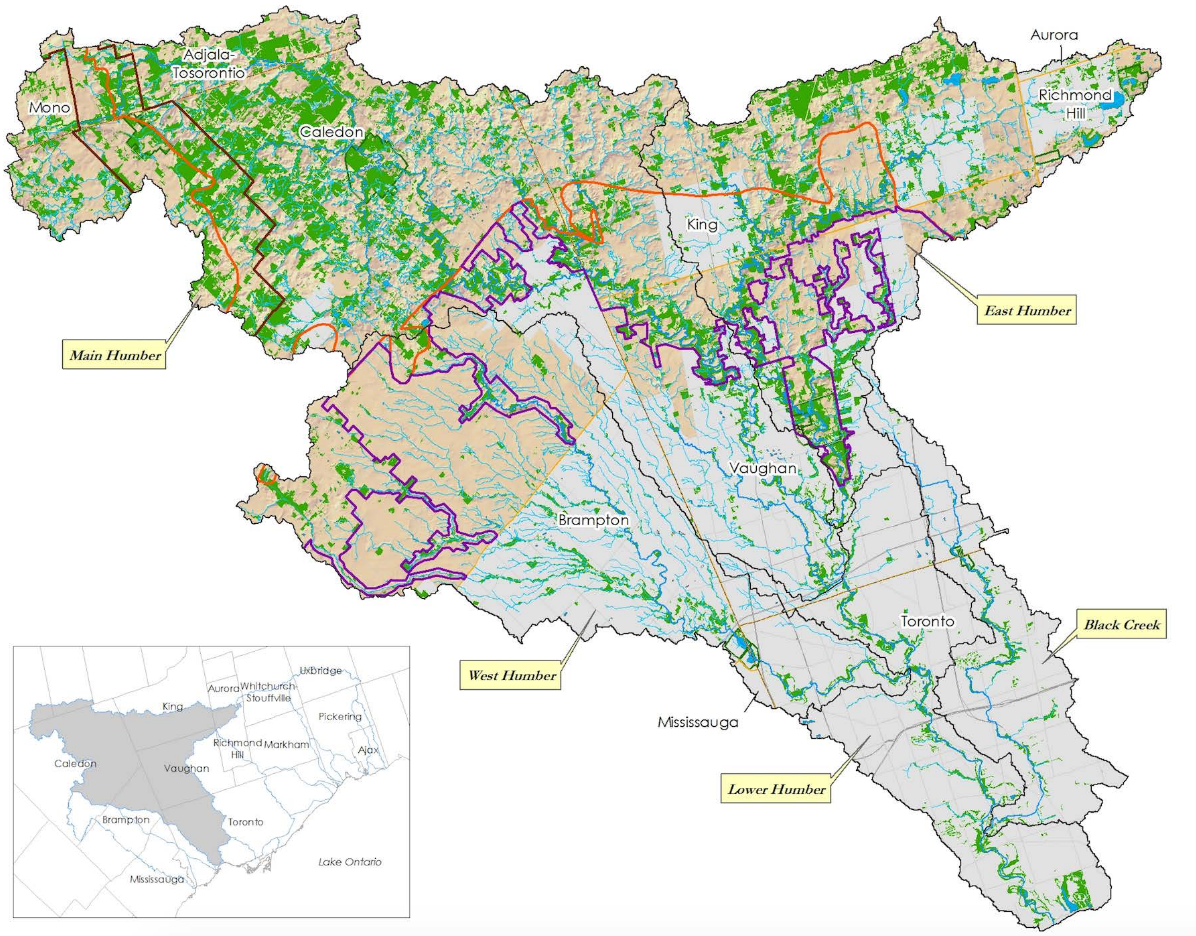
1506-blockplanJan2014

POST-DEVELOPMENT
OPTION B SCHEMATIC

April 2018

Prepared for: Toronto and Region Conservation Authority (TRCA)

Final Report:
Humber River Hydrology Update



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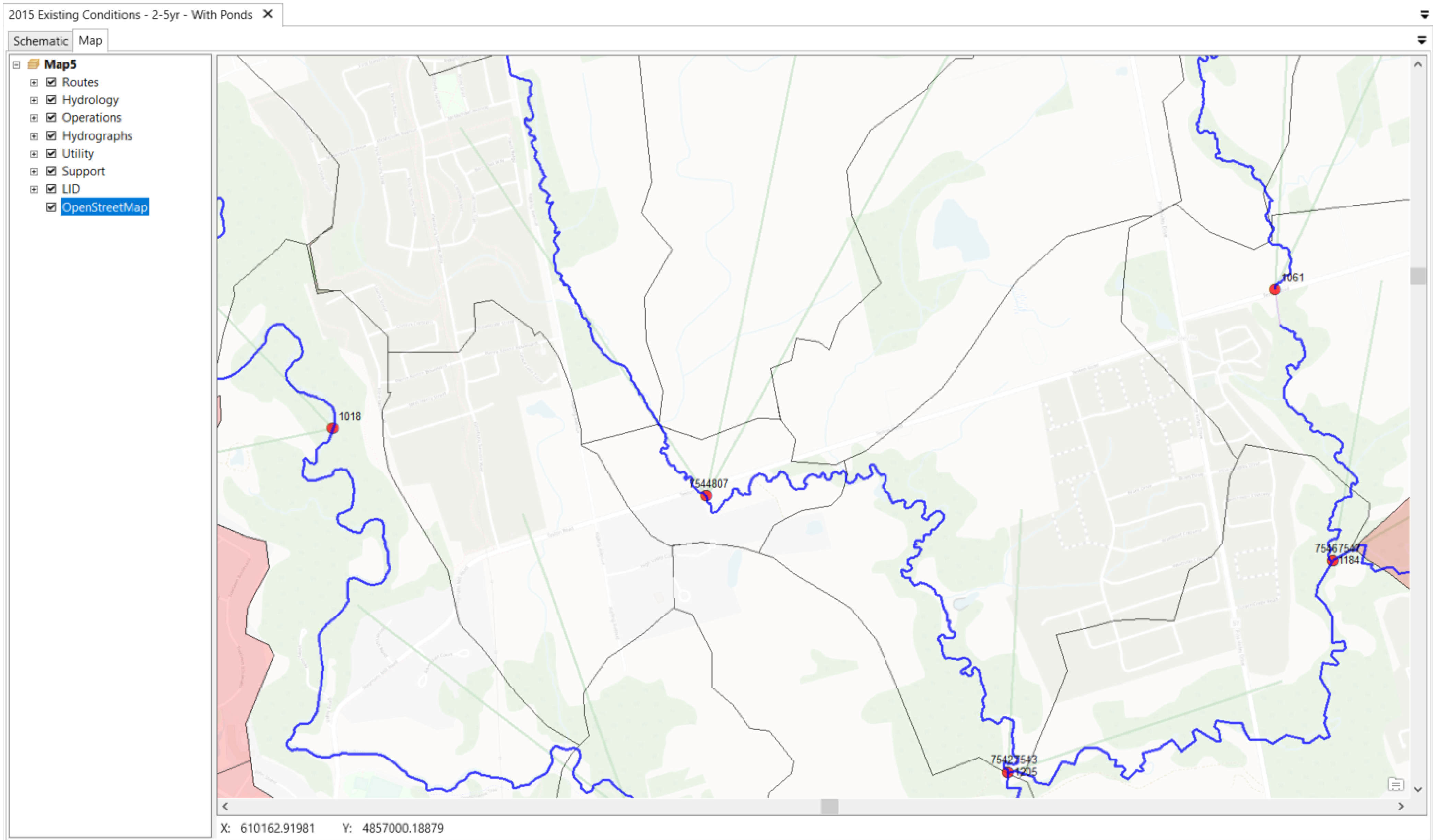
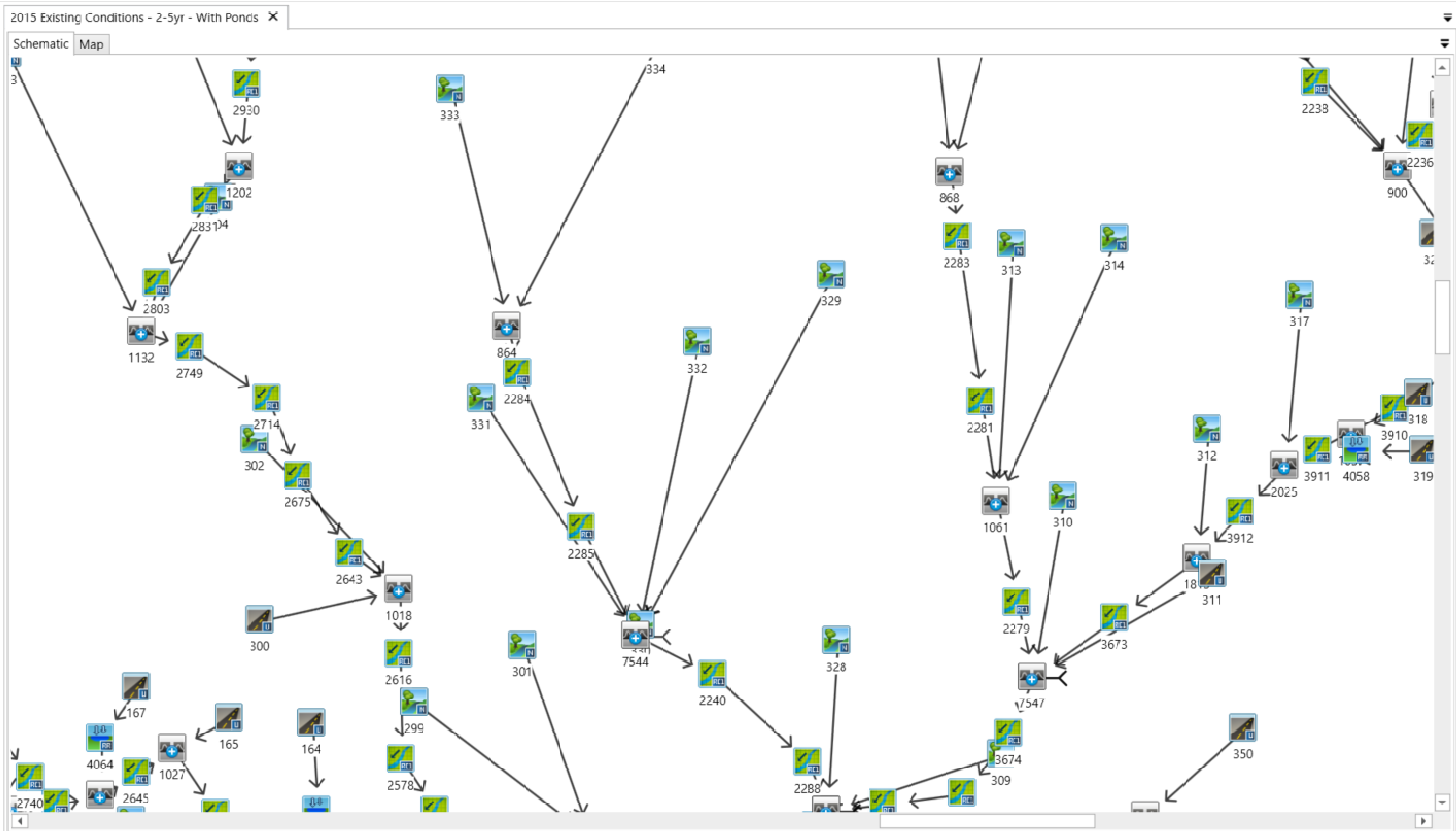
Crossing 2 and 3
Visual OTTHYMO Catchments



Crossing 2 and 3
Visual OTTHYMO Schematic



Crossing 2 and 3, 12-hour Storm
Visual OTTHYMO Outputs

```
*******************************
** SIMULATION:2yr-12hr       **
*******************************

-------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   0.346    12.50     5.85
      + ID2= 2 (  0330):    23.23   0.027     8.25     3.58
        ===================================================
        ID = 3 (  7544):   440.05   0.363    12.00     5.73

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

-------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   0.363    12.00     5.73
      + ID2= 2 (  0331):   159.69   0.126    10.75     4.74
        ===================================================
        ID = 1 (  7544):   599.74   0.487    11.67     5.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

-------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  7544):   599.74   0.487    11.67     5.47
      + ID2= 2 (  0332):   191.39   0.155    12.17     5.85
        ===================================================
        ID = 3 (  7544):   791.13   0.642    11.75     5.56
```

Crossing 2, 2-Year 12-hour Storm

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

-------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
```

Crossing 3, 2-Year 12-hour Storm

```
        ID1= 1 (  0329):   219.14   0.143    13.00     6.03
      + ID2= 2 (  7544):   791.13   0.642    11.75     5.56
        ===================================================
        ID = 3 (  0807):  1010.27   0.783    12.17     5.67

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
*******************************
** SIMULATION:5yr-12hr       **
*******************************

-------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   0.621    12.25    10.52
      + ID2= 2 (  0330):    23.23   0.049     8.25     6.59
        ===================================================
        ID = 3 (  7544):   440.05   0.654    11.75    10.31

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

-------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
-------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   0.654    11.75    10.31
      + ID2= 2 (  0331):   159.69   0.229    10.50     8.62
        ===================================================
        ID = 1 (  7544):   599.74   0.881    11.42     9.86

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

-------------------
```

```
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  7544):   599.74   0.881    11.42     9.86
      + ID2= 2 (  0332):   191.39   0.278    11.83    10.51
        ==================================================
        ID = 3 (  7544):   791.13   1.158    11.50    10.02

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

Crossing 2, 5-Year 12-hour Storm

```
--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0329):   219.14   0.256    12.92    10.81
      + ID2= 2 (  7544):   791.13   1.158    11.50    10.02
        ==================================================
        ID = 3 (  0807):  1010.27   1.410    11.83    10.20

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

Crossing 3, 5-Year 12-hour Storm

```
*******************************
** SIMULATION:100yr-12hr      **
*******************************

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   1.647    11.92    27.85
      + ID2= 2 (  0330):    23.23   0.139     8.00    18.53
        ===================================================
        ID = 3 (  7544):   440.05   1.740    11.42    27.36

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   1.740    11.42    27.36
      + ID2= 2 (  0331):   159.69   0.627    10.25    23.49
        ===================================================
        ID = 1 (  7544):   599.74   2.361    11.08    26.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  7544):   599.74   2.361    11.08    26.33
      + ID2= 2 (  0332):   191.39   0.736    11.42    27.83
        ===================================================
        ID = 3 (  7544):   791.13   3.097    11.17    26.70
```

Crossing 2, 100-Year 12-hour Storm

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0329):   219.14   0.674    12.75    28.49
      + ID2= 2 (  7544):   791.13   3.097    11.17    26.70
        ===================================================
        ID = 3 (  0807):  1010.27   3.757    11.42    27.12
```

Crossing 3, 100-Year 12-hour Storm

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
*******************************
** SIMULATION:10yr-12hr       **
*******************************

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   0.839    12.17    14.20
      + ID2= 2 (  0330):    23.23   0.068     8.25     9.05
        ===================================================
        ID = 3 (  7544):   440.05   0.884    11.67    13.93

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   0.884    11.67    13.93
      + ID2= 2 (  0331):   159.69   0.313    10.42    11.74
        ===================================================
        ID = 1 (  7544):   599.74   1.193    11.33    13.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
```

```
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 1 (  7544):   599.74   1.193    11.33    13.35
     + ID2= 2 (  0332):   191.39   0.375    11.67    14.19
       ===============================================
       ID = 3 (  7544):   791.13   1.568    11.42    13.55
```

Crossing 2, 10-Year 12-hour Storm

```
    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 1 (  0329):   219.14   0.345    12.83    14.58
     + ID2= 2 (  7544):   791.13   1.568    11.42    13.55
       ===============================================
       ID = 3 (  0807):  1010.27   1.906    11.75    13.79
```

Crossing 3, 10-Year 12-hour Storm

```
    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------
********************************
** SIMULATION:25yr-12hr       **
********************************

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 1 (  2285):   416.82   1.142    12.00    19.33
     + ID2= 2 (  0330):    23.23   0.094     8.17    12.54
       ===============================================
       ID = 3 (  7544):   440.05   1.205    11.50    18.97

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 3 (  7544):   440.05   1.205    11.50    18.97
     + ID2= 2 (  0331):   159.69   0.430    10.33    16.11
       ===============================================
       ID = 1 (  7544):   599.74   1.630    11.25    18.21

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 1 (  7544):   599.74   1.630    11.25    18.21
     + ID2= 2 (  0332):   191.39   0.511    11.58    19.31
       ===============================================
       ID = 3 (  7544):   791.13   2.141    11.25    18.48
```

Crossing 2, 25-Year 12-hour Storm

```
    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
       ID1= 1 (  0329):   219.14   0.468    12.75    19.81
     + ID2= 2 (  7544):   791.13   2.141    11.25    18.48
       ===============================================
       ID = 3 (  0807):  1010.27   2.600    11.58    18.79
```

Crossing 3, 25-Year 12-hour Storm

```
    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------
********************************
** SIMULATION:50yr-12hr       **
********************************

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   1.387    11.92    23.47
      + ID2= 2 (  0330):    23.23   0.116     8.08    15.43
        ===================================================
        ID = 3 (  7544):   440.05   1.464    11.42    23.04

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   1.464    11.42    23.04
      + ID2= 2 (  0331):   159.69   0.525    10.33    19.68
        ===================================================
        ID = 1 (  7544):   599.74   1.984    11.17    22.15

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  7544):   599.74   1.984    11.17    22.15
      + ID2= 2 (  0332):   191.39   0.620    11.50    23.45
        ===================================================
        ID = 3 (  7544):   791.13   2.604    11.25    22.47
```

Crossing 2, 50-Year 12-hour Storm

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0329):   219.14   0.568    12.75    24.03
      + ID2= 2 (  7544):   791.13   2.604    11.25    22.47
        ===================================================
        ID = 3 (  0807):  1010.27   3.161    11.50    22.83
```

Crossing 3, 50-Year 12-hour Storm

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------
```

```
*******************************
** SIMULATION:Hazel1000       **
*******************************

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  2285):   416.82   9.122    14.42   151.77
      + ID2= 2 (  0330):    23.23   1.003    12.00   129.39
        ===============================================
        ID = 3 (  7544):   440.05   9.879    14.00   150.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   440.05   9.879    14.00   150.59
      + ID2= 2 (  0332):   191.39   4.074    14.08   151.61
        ===============================================
        ID = 1 (  7544):   631.44  13.954    14.00   150.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  7544):   631.44  13.954    14.00   150.95
      + ID2= 2 (  7637):    97.14  12.925    10.00   173.85
        ===============================================
        ID = 3 (  7544):   728.58  19.656    11.00   154.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  7544)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  7544):   728.58  19.656    11.00   154.00
      + ID2= 2 (  7638):    62.39   2.643    12.08   147.15
        ===============================================
        ID = 1 (  7544):   790.97  22.029    11.00   153.46    Crossing 2, Regional Storm

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0807)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0329):   219.14   3.629    15.42   153.03    Crossing 3, Regional Storm
      + ID2= 2 (  7544):   790.97  22.029    11.00   153.46
        ===============================================
        ID = 3 (  0807):  1010.11  24.603    11.00   153.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------
```

Project	Teston Class EA, City of Vaughan			
Date	2-Jun-22	No.	--	Page
By	J. Look	Checked	S. Sadek	

Stormwater Management Calculations

Crossing C-4 Hydrologic Analysis

VO Parameters		
Parameter	**Value**	**Comments**
Culvert Catchment Area (ha)	21.459	Area in Catchment 20.01 (NHYD 328) north of Teston Road
Catchment Type	NASHYD	
CN	60*	From TRCA VO Model, Catchment 20.01
IA	10	From TRCA VO Model, Catchment 20.01
N	1.5	From TRCA VO Model, Catchment 20.01

Time to Peak Calculation (Airport Method)		
Parameter	**Value**	**Comments**
Soil Type	Clay/Clay Loam	Source: Soil Survey Complex
C, runoff coeff	0.4	Based on MTO Part 4 Table 1.07
L, catchment length (m)	730	Determined from satellite imagery and contours
Sw, catchment slope (%)	1.51	Determined from satellite imagery and contours
A, catchment area (ha)	21.459	
tc (minutes)	53.854	
tp (hours)	0.601	

Results		
Storm Event	**6 Hour AES**	**12 hour AES**
2-Year	0.058	0.066
5-Year	0.118	0.122
10-Year	0.166	0.167
25-Year	0.237	0.23
50-Year	0.295	0.282
100-Year	0.358	0.337

Note: 6-hour flow rates used as a conservative approach, due to the larger flow rates in the major storm events.

VO Hydrology Output: Crossing 4

```
 **************************************************
 ** SIMULATION:10 Year 12 Hour AES (Bloor, TRCA) **
 **************************************************

 --------------------
 |    READ STORM    |     Filename: C:\Users\JLook\AppD
 |                  |               ata\Local\Temp\
 |                  |               4a18b056-16a0-40dd-b965-edb2c32052b5\95b28b57
 | Ptotal= 62.71 mm |     Comments: 10 Year 12 Hour AES (Bloor, TRCA)
 --------------------
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.25    0.00 |  3.50   10.66 |   6.75    4.39 | 10.00    0.63
                  0.50    0.63 |  3.75   10.66 |   7.00    4.39 | 10.25    0.63
                  0.75    0.63 |  4.00   10.66 |   7.25    4.39 | 10.50    0.63
                  1.00    0.63 |  4.25   10.66 |   7.50    2.51 | 10.75    0.63
                  1.25    0.63 |  4.50   28.84 |   7.75    2.51 | 11.00    0.63
                  1.50    0.63 |  4.75   28.84 |   8.00    2.51 | 11.25    0.63
                  1.75    0.63 |  5.00   28.84 |   8.25    2.51 | 11.50    0.63
                  2.00    0.63 |  5.25   28.84 |   8.50    1.25 | 11.75    0.63
                  2.25    0.63 |  5.50    8.15 |   8.75    1.25 | 12.00    0.63
                  2.50    3.76 |  5.75    8.15 |   9.00    1.25 | 12.25    0.63
                  2.75    3.76 |  6.00    8.15 |   9.25    1.25 |
                  3.00    3.76 |  6.25    8.15 |   9.50    0.63 |
                  3.25    3.76 |  6.50    4.39 |   9.75    0.63 |

 ------------------------------------------------------------------------------

 --------------------
 | CALIB            |
 | NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
 |ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
 --------------------   U.H. Tp(hrs)=   0.60

          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 3.167    3.76 | 6.250    8.15 |  9.33    0.63
                 0.167    0.00 | 3.250    3.76 | 6.333    4.39 |  9.42    0.63
                 0.250    0.00 | 3.333   10.66 | 6.417    4.39 |  9.50    0.63
                 0.333    0.63 | 3.417   10.66 | 6.500    4.39 |  9.58    0.63
                 0.417    0.63 | 3.500   10.66 | 6.583    4.39 |  9.67    0.63
                 0.500    0.63 | 3.583   10.66 | 6.667    4.39 |  9.75    0.63
                 0.583    0.63 | 3.667   10.66 | 6.750    4.39 |  9.83    0.63
                 0.667    0.63 | 3.750   10.66 | 6.833    4.39 |  9.92    0.63
                 0.750    0.63 | 3.833   10.66 | 6.917    4.39 | 10.00    0.63
                 0.833    0.63 | 3.917   10.66 | 7.000    4.39 | 10.08    0.63
                 0.917    0.63 | 4.000   10.66 | 7.083    4.39 | 10.17    0.63
                 1.000    0.63 | 4.083   10.66 | 7.167    4.39 | 10.25    0.63
                 1.083    0.63 | 4.167   10.66 | 7.250    4.39 | 10.33    0.63
                 1.167    0.63 | 4.250   10.66 | 7.333    2.51 | 10.42    0.63
                 1.250    0.63 | 4.333   28.84 | 7.417    2.51 | 10.50    0.63
                 1.333    0.63 | 4.417   28.84 | 7.500    2.51 | 10.58    0.63
                 1.417    0.63 | 4.500   28.84 | 7.583    2.51 | 10.67    0.63
                 1.500    0.63 | 4.583   28.84 | 7.667    2.51 | 10.75    0.63
                 1.583    0.63 | 4.667   28.84 | 7.750    2.51 | 10.83    0.63
                 1.667    0.63 | 4.750   28.84 | 7.833    2.51 | 10.92    0.63
                 1.750    0.63 | 4.833   28.84 | 7.917    2.51 | 11.00    0.63
                 1.833    0.63 | 4.917   28.84 | 8.000    2.51 | 11.08    0.63
                 1.917    0.63 | 5.000   28.84 | 8.083    2.51 | 11.17    0.63
                 2.000    0.63 | 5.083   28.84 | 8.167    2.51 | 11.25    0.63
                 2.083    0.63 | 5.167   28.84 | 8.250    2.51 | 11.33    0.63
                 2.167    0.63 | 5.250   28.84 | 8.333    1.25 | 11.42    0.63
                 2.250    0.63 | 5.333    8.15 | 8.417    1.25 | 11.50    0.63
                 2.333    3.76 | 5.417    8.15 | 8.500    1.25 | 11.58    0.63
                 2.417    3.76 | 5.500    8.15 | 8.583    1.25 | 11.67    0.63
                 2.500    3.76 | 5.583    8.15 | 8.667    1.25 | 11.75    0.63
                 2.583    3.76 | 5.667    8.15 | 8.750    1.25 | 11.83    0.63
                 2.667    3.76 | 5.750    8.15 | 8.833    1.25 | 11.92    0.63
                 2.750    3.76 | 5.833    8.15 | 8.917    1.25 | 12.00    0.63
                 2.833    3.76 | 5.917    8.15 | 9.000    1.25 | 12.08    0.63
                 2.917    3.76 | 6.000    8.15 | 9.083    1.25 | 12.17    0.63
                 3.000    3.76 | 6.083    8.15 | 9.167    1.25 | 12.25    0.63
                 3.083    3.76 | 6.167    8.15 | 9.250    1.25 |

      Unit Hyd Qpeak  (cms)=   0.611
```

```
      PEAK FLOW       (cms)=   0.167 (i)
      TIME TO PEAK    (hrs)=   6.250
      RUNOFF VOLUME    (mm)=  12.459
      TOTAL RAINFALL   (mm)=  62.710
      RUNOFF COEFFICIENT   =   0.199

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ------------------------------------------------------------------------------
 *************************************************
 ** SIMULATION:10 Year 6 Hour AES (Bloor, TRCA) **
 *************************************************

 --------------------
 |    READ STORM    |     Filename: C:\Users\JLook\AppD
 |                  |               ata\Local\Temp\
 |                  |               4a18b056-16a0-40dd-b965-edb2c32052b5\5ae43f37
 | Ptotal= 55.69 mm |     Comments: 10 Year 6 Hour AES (Bloor, TRCA)
 --------------------
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.25    0.00 |  2.00   18.94 |   3.75    7.80 |  5.50    1.11
                  0.50    1.11 |  2.25   18.94 |   4.00    4.46 |  5.75    1.11
                  0.75    1.11 |  2.50   51.24 |   4.25    4.46 |  6.00    1.11
                  1.00    1.11 |  2.75   51.24 |   4.50    2.23 |  6.25    1.11
                  1.25    1.11 |  3.00   14.48 |   4.75    2.23 |
                  1.50    6.68 |  3.25   14.48 |   5.00    1.11 |
                  1.75    6.68 |  3.50    7.80 |   5.25    1.11 |

 ------------------------------------------------------------------------------

 --------------------
 | CALIB            |
 | NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
 |ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
 --------------------   U.H. Tp(hrs)=   0.60

          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 1.667    6.68 | 3.250   14.48 |  4.83    1.11
                 0.167    0.00 | 1.750    6.68 | 3.333    7.80 |  4.92    1.11
                 0.250    0.00 | 1.833   18.94 | 3.417    7.80 |  5.00    1.11
                 0.333    1.11 | 1.917   18.94 | 3.500    7.80 |  5.08    1.11
                 0.417    1.11 | 2.000   18.94 | 3.583    7.80 |  5.17    1.11
                 0.500    1.11 | 2.083   18.94 | 3.667    7.80 |  5.25    1.11
                 0.583    1.11 | 2.167   18.94 | 3.750    7.80 |  5.33    1.11
                 0.667    1.11 | 2.250   18.94 | 3.833    4.46 |  5.42    1.11
                 0.750    1.11 | 2.333   51.24 | 3.917    4.46 |  5.50    1.11
                 0.833    1.11 | 2.417   51.24 | 4.000    4.46 |  5.58    1.11
                 0.917    1.11 | 2.500   51.24 | 4.083    4.46 |  5.67    1.11
                 1.000    1.11 | 2.583   51.24 | 4.167    4.46 |  5.75    1.11
                 1.083    1.11 | 2.667   51.24 | 4.250    4.46 |  5.83    1.11
                 1.167    1.11 | 2.750   51.24 | 4.333    2.23 |  5.92    1.11
                 1.250    1.11 | 2.833   14.48 | 4.417    2.23 |  6.00    1.11
                 1.333    6.68 | 2.917   14.48 | 4.500    2.23 |  6.08    1.11
                 1.417    6.68 | 3.000   14.48 | 4.583    2.23 |  6.17    1.11
                 1.500    6.68 | 3.083   14.48 | 4.667    2.23 |  6.25    1.11
                 1.583    6.68 | 3.167   14.48 | 4.750    2.23 |

      Unit Hyd Qpeak  (cms)=   0.611

      PEAK FLOW       (cms)=   0.166 (i)
      TIME TO PEAK    (hrs)=   3.833
      RUNOFF VOLUME    (mm)=   9.667
      TOTAL RAINFALL   (mm)=  55.690
      RUNOFF COEFFICIENT   =   0.174

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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 ***************************************************
 ** SIMULATION:100 Year 12 Hour AES (Bloor, TRCA) **
 ***************************************************

 --------------------
 |    READ STORM    |     Filename: C:\Users\JLook\AppD
```

```
|                  |             ata\Local\Temp\
|                  |             4a18b056-16a0-40dd-b965-edb2c32052b5\1acac372
| Ptotal= 88.54 mm |    Comments: 100 Year 12 Hour AES (Bloor, TRCA)
--------------------
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.25    0.00 |  3.50   15.05 |  6.75    6.20 | 10.00    0.89
                0.50    0.89 |  3.75   15.05 |  7.00    6.20 | 10.25    0.89
                0.75    0.89 |  4.00   15.05 |  7.25    6.20 | 10.50    0.89
                1.00    0.89 |  4.25   15.05 |  7.50    3.54 | 10.75    0.89
                1.25    0.89 |  4.50   40.71 |  7.75    3.54 | 11.00    0.89
                1.50    0.89 |  4.75   40.71 |  8.00    3.54 | 11.25    0.89
                1.75    0.89 |  5.00   40.71 |  8.25    3.54 | 11.50    0.89
                2.00    0.89 |  5.25   40.71 |  8.50    1.77 | 11.75    0.89
                2.25    0.89 |  5.50   11.51 |  8.75    1.77 | 12.00    0.89
                2.50    5.31 |  5.75   11.51 |  9.00    1.77 | 12.25    0.89
                2.75    5.31 |  6.00   11.51 |  9.25    1.77 |
                3.00    5.31 |  6.25   11.51 |  9.50    0.89 |
                3.25    5.31 |  6.50    6.20 |  9.75    0.89 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    0.00 | 3.167    5.31 | 6.250   11.51 |  9.33    0.89
               0.167    0.00 | 3.250    5.31 | 6.333    6.20 |  9.42    0.89
               0.250    0.00 | 3.333   15.05 | 6.417    6.20 |  9.50    0.89
               0.333    0.89 | 3.417   15.05 | 6.500    6.20 |  9.58    0.89
               0.417    0.89 | 3.500   15.05 | 6.583    6.20 |  9.67    0.89
               0.500    0.89 | 3.583   15.05 | 6.667    6.20 |  9.75    0.89
               0.583    0.89 | 3.667   15.05 | 6.750    6.20 |  9.83    0.89
               0.667    0.89 | 3.750   15.05 | 6.833    6.20 |  9.92    0.89
               0.750    0.89 | 3.833   15.05 | 6.917    6.20 | 10.00    0.89
               0.833    0.89 | 3.917   15.05 | 7.000    6.20 | 10.08    0.89
               0.917    0.89 | 4.000   15.05 | 7.083    6.20 | 10.17    0.89
               1.000    0.89 | 4.083   15.05 | 7.167    6.20 | 10.25    0.89
               1.083    0.89 | 4.167   15.05 | 7.250    6.20 | 10.33    0.89
               1.167    0.89 | 4.250   15.05 | 7.333    3.54 | 10.42    0.89
               1.250    0.89 | 4.333   40.71 | 7.417    3.54 | 10.50    0.89
               1.333    0.89 | 4.417   40.71 | 7.500    3.54 | 10.58    0.89
               1.417    0.89 | 4.500   40.71 | 7.583    3.54 | 10.67    0.89
               1.500    0.89 | 4.583   40.71 | 7.667    3.54 | 10.75    0.89
               1.583    0.89 | 4.667   40.71 | 7.750    3.54 | 10.83    0.89
               1.667    0.89 | 4.750   40.71 | 7.833    3.54 | 10.92    0.89
               1.750    0.89 | 4.833   40.71 | 7.917    3.54 | 11.00    0.89
               1.833    0.89 | 4.917   40.71 | 8.000    3.54 | 11.08    0.89
               1.917    0.89 | 5.000   40.71 | 8.083    3.54 | 11.17    0.89
               2.000    0.89 | 5.083   40.71 | 8.167    3.54 | 11.25    0.89
               2.083    0.89 | 5.167   40.71 | 8.250    3.54 | 11.33    0.89
               2.167    0.89 | 5.250   40.71 | 8.333    1.77 | 11.42    0.89
               2.250    0.89 | 5.333   11.51 | 8.417    1.77 | 11.50    0.89
               2.333    5.31 | 5.417   11.51 | 8.500    1.77 | 11.58    0.89
               2.417    5.31 | 5.500   11.51 | 8.583    1.77 | 11.67    0.89
               2.500    5.31 | 5.583   11.51 | 8.667    1.77 | 11.75    0.89
               2.583    5.31 | 5.667   11.51 | 8.750    1.77 | 11.83    0.89
               2.667    5.31 | 5.750   11.51 | 8.833    1.77 | 11.92    0.89
               2.750    5.31 | 5.833   11.51 | 8.917    1.77 | 12.00    0.89
               2.833    5.31 | 5.917   11.51 | 9.000    1.77 | 12.08    0.89
               2.917    5.31 | 6.000   11.51 | 9.083    1.77 | 12.17    0.89
               3.000    5.31 | 6.083   11.51 | 9.167    1.77 | 12.25    0.89
               3.083    5.31 | 6.167   11.51 | 9.250    1.77 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.337 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  24.780
     TOTAL RAINFALL   (mm)=  88.540
     RUNOFF COEFFICIENT   =   0.280
```

```
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
**************************************************
** SIMULATION:100 Year 6 Hour AES (Bloor, TRCA) **
**************************************************

--------------------
|    READ STORM    |    Filename: C:\Users\JLook\AppD
|                  |              ata\Local\Temp\
|                  |              4a18b056-16a0-40dd-b965-edb2c32052b5\1b711ac5
| Ptotal= 80.31 mm |    Comments: 100 Year 6 Hour AES (Bloor, TRCA)
--------------------
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.25    0.00 |  2.00   27.30 |  3.75   11.24 |  5.50    1.61
                0.50    1.61 |  2.25   27.30 |  4.00    6.42 |  5.75    1.61
                0.75    1.61 |  2.50   73.88 |  4.25    6.42 |  6.00    1.61
                1.00    1.61 |  2.75   73.88 |  4.50    3.21 |  6.25    1.61
                1.25    1.61 |  3.00   20.88 |  4.75    3.21 |
                1.50    9.64 |  3.25   20.88 |  5.00    1.61 |
                1.75    9.64 |  3.50   11.24 |  5.25    1.61 |

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    0.00 | 1.667    9.64 | 3.250   20.88 |  4.83    1.61
               0.167    0.00 | 1.750    9.64 | 3.333   11.24 |  4.92    1.61
               0.250    0.00 | 1.833   27.30 | 3.417   11.24 |  5.00    1.61
               0.333    1.61 | 1.917   27.30 | 3.500   11.24 |  5.08    1.61
               0.417    1.61 | 2.000   27.30 | 3.583   11.24 |  5.17    1.61
               0.500    1.61 | 2.083   27.30 | 3.667   11.24 |  5.25    1.61
               0.583    1.61 | 2.167   27.30 | 3.750   11.24 |  5.33    1.61
               0.667    1.61 | 2.250   27.30 | 3.833    6.42 |  5.42    1.61
               0.750    1.61 | 2.333   73.88 | 3.917    6.42 |  5.50    1.61
               0.833    1.61 | 2.417   73.88 | 4.000    6.42 |  5.58    1.61
               0.917    1.61 | 2.500   73.88 | 4.083    6.42 |  5.67    1.61
               1.000    1.61 | 2.583   73.88 | 4.167    6.42 |  5.75    1.61
               1.083    1.61 | 2.667   73.88 | 4.250    6.42 |  5.83    1.61
               1.167    1.61 | 2.750   73.88 | 4.333    3.21 |  5.92    1.61
               1.250    1.61 | 2.833   20.88 | 4.417    3.21 |  6.00    1.61
               1.333    9.64 | 2.917   20.88 | 4.500    3.21 |  6.08    1.61
               1.417    9.64 | 3.000   20.88 | 4.583    3.21 |  6.17    1.61
               1.500    9.64 | 3.083   20.88 | 4.667    3.21 |  6.25    1.61
               1.583    9.64 | 3.167   20.88 | 4.750    3.21 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.358 (i)
     TIME TO PEAK    (hrs)=   3.750
     RUNOFF VOLUME    (mm)=  20.541
     TOTAL RAINFALL   (mm)=  80.310
     RUNOFF COEFFICIENT   =   0.256

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
*************************************************
** SIMULATION:2 Year 12 Hour AES (Bloor, TRCA) **
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--------------------
|    READ STORM    |    Filename: C:\Users\JLook\AppD
|                  |              ata\Local\Temp\
|                  |              4a18b056-16a0-40dd-b965-edb2c32052b5\45c934b0
| Ptotal= 42.00 mm |    Comments: 2 Year 12 Hour AES (Bloor, TRCA)
--------------------
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
```

```
                 0.25    0.00 |  3.50    7.14 |  6.75    2.94 | 10.00    0.42
                 0.50    0.42 |  3.75    7.14 |  7.00    2.94 | 10.25    0.42
                 0.75    0.42 |  4.00    7.14 |  7.25    2.94 | 10.50    0.42
                 1.00    0.42 |  4.25    7.14 |  7.50    1.68 | 10.75    0.42
                 1.25    0.42 |  4.50   19.32 |  7.75    1.68 | 11.00    0.42
                 1.50    0.42 |  4.75   19.32 |  8.00    1.68 | 11.25    0.42
                 1.75    0.42 |  5.00   19.32 |  8.25    1.68 | 11.50    0.42
                 2.00    0.42 |  5.25   19.32 |  8.50    0.84 | 11.75    0.42
                 2.25    0.42 |  5.50    5.46 |  8.75    0.84 | 12.00    0.42
                 2.50    2.52 |  5.75    5.46 |  9.00    0.84 | 12.25    0.42
                 2.75    2.52 |  6.00    5.46 |  9.25    0.84 |
                 3.00    2.52 |  6.25    5.46 |  9.50    0.42 |
                 3.25    2.52 |  6.50    2.94 |  9.75    0.42 |

-------------------------------------------------------------------------------

--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    2.52 | 6.250    5.46 |   9.33    0.42
                0.167    0.00 | 3.250    2.52 | 6.333    2.94 |   9.42    0.42
                0.250    0.00 | 3.333    7.14 | 6.417    2.94 |   9.50    0.42
                0.333    0.42 | 3.417    7.14 | 6.500    2.94 |   9.58    0.42
                0.417    0.42 | 3.500    7.14 | 6.583    2.94 |   9.67    0.42
                0.500    0.42 | 3.583    7.14 | 6.667    2.94 |   9.75    0.42
                0.583    0.42 | 3.667    7.14 | 6.750    2.94 |   9.83    0.42
                0.667    0.42 | 3.750    7.14 | 6.833    2.94 |   9.92    0.42
                0.750    0.42 | 3.833    7.14 | 6.917    2.94 |  10.00    0.42
                0.833    0.42 | 3.917    7.14 | 7.000    2.94 |  10.08    0.42
                0.917    0.42 | 4.000    7.14 | 7.083    2.94 |  10.17    0.42
                1.000    0.42 | 4.083    7.14 | 7.167    2.94 |  10.25    0.42
                1.083    0.42 | 4.167    7.14 | 7.250    2.94 |  10.33    0.42
                1.167    0.42 | 4.250    7.14 | 7.333    1.68 |  10.42    0.42
                1.250    0.42 | 4.333   19.32 | 7.417    1.68 |  10.50    0.42
                1.333    0.42 | 4.417   19.32 | 7.500    1.68 |  10.58    0.42
                1.417    0.42 | 4.500   19.32 | 7.583    1.68 |  10.67    0.42
                1.500    0.42 | 4.583   19.32 | 7.667    1.68 |  10.75    0.42
                1.583    0.42 | 4.667   19.32 | 7.750    1.68 |  10.83    0.42
                1.667    0.42 | 4.750   19.32 | 7.833    1.68 |  10.92    0.42
                1.750    0.42 | 4.833   19.32 | 7.917    1.68 |  11.00    0.42
                1.833    0.42 | 4.917   19.32 | 8.000    1.68 |  11.08    0.42
                1.917    0.42 | 5.000   19.32 | 8.083    1.68 |  11.17    0.42
                2.000    0.42 | 5.083   19.32 | 8.167    1.68 |  11.25    0.42
                2.083    0.42 | 5.167   19.32 | 8.250    1.68 |  11.33    0.42
                2.167    0.42 | 5.250   19.32 | 8.333    0.84 |  11.42    0.42
                2.250    0.42 | 5.333    5.46 | 8.417    0.84 |  11.50    0.42
                2.333    2.52 | 5.417    5.46 | 8.500    0.84 |  11.58    0.42
                2.417    2.52 | 5.500    5.46 | 8.583    0.84 |  11.67    0.42
                2.500    2.52 | 5.583    5.46 | 8.667    0.84 |  11.75    0.42
                2.583    2.52 | 5.667    5.46 | 8.750    0.84 |  11.83    0.42
                2.667    2.52 | 5.750    5.46 | 8.833    0.84 |  11.92    0.42
                2.750    2.52 | 5.833    5.46 | 8.917    0.84 |  12.00    0.42
                2.833    2.52 | 5.917    5.46 | 9.000    0.84 |  12.08    0.42
                2.917    2.52 | 6.000    5.46 | 9.083    0.84 |  12.17    0.42
                3.000    2.52 | 6.083    5.46 | 9.167    0.84 |  12.25    0.42
                3.083    2.52 | 6.167    5.46 | 9.250    0.84 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.066 (i)
     TIME TO PEAK    (hrs)=   6.333
     RUNOFF VOLUME    (mm)=   5.064
     TOTAL RAINFALL   (mm)=  42.000
     RUNOFF COEFFICIENT   =   0.121

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
************************************************
** SIMULATION:2 Year 6 Hour AES (Bloor, TRCA) **
************************************************
```

```
--------------------
|    READ STORM     |    Filename: C:\Users\JLook\AppD
|                   |              ata\Local\Temp\
|                   |              4a18b056-16a0-40dd-b965-edb2c32052b5\8bc384cc
| Ptotal= 36.00 mm |    Comments: 2 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  2.00   12.24 |  3.75    5.04 |  5.50    0.72
                 0.50    0.72 |  2.25   12.24 |  4.00    2.88 |  5.75    0.72
                 0.75    0.72 |  2.50   33.12 |  4.25    2.88 |  6.00    0.72
                 1.00    0.72 |  2.75   33.12 |  4.50    1.44 |  6.25    0.72
                 1.25    0.72 |  3.00    9.36 |  4.75    1.44 |
                 1.50    4.32 |  3.25    9.36 |  5.00    0.72 |
                 1.75    4.32 |  3.50    5.04 |  5.25    0.72 |

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| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 1.667    4.32 | 3.250    9.36 |   4.83    0.72
                0.167    0.00 | 1.750    4.32 | 3.333    5.04 |   4.92    0.72
                0.250    0.00 | 1.833   12.24 | 3.417    5.04 |   5.00    0.72
                0.333    0.72 | 1.917   12.24 | 3.500    5.04 |   5.08    0.72
                0.417    0.72 | 2.000   12.24 | 3.583    5.04 |   5.17    0.72
                0.500    0.72 | 2.083   12.24 | 3.667    5.04 |   5.25    0.72
                0.583    0.72 | 2.167   12.24 | 3.750    5.04 |   5.33    0.72
                0.667    0.72 | 2.250   12.24 | 3.833    2.88 |   5.42    0.72
                0.750    0.72 | 2.333   33.12 | 3.917    2.88 |   5.50    0.72
                0.833    0.72 | 2.417   33.12 | 4.000    2.88 |   5.58    0.72
                0.917    0.72 | 2.500   33.12 | 4.083    2.88 |   5.67    0.72
                1.000    0.72 | 2.583   33.12 | 4.167    2.88 |   5.75    0.72
                1.083    0.72 | 2.667   33.12 | 4.250    2.88 |   5.83    0.72
                1.167    0.72 | 2.750   33.12 | 4.333    1.44 |   5.92    0.72
                1.250    0.72 | 2.833    9.36 | 4.417    1.44 |   6.00    0.72
                1.333    4.32 | 2.917    9.36 | 4.500    1.44 |   6.08    0.72
                1.417    4.32 | 3.000    9.36 | 4.583    1.44 |   6.17    0.72
                1.500    4.32 | 3.083    9.36 | 4.667    1.44 |   6.25    0.72
                1.583    4.32 | 3.167    9.36 | 4.750    1.44 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.058 (i)
     TIME TO PEAK    (hrs)=   3.917
     RUNOFF VOLUME    (mm)=   3.446
     TOTAL RAINFALL   (mm)=  36.000
     RUNOFF COEFFICIENT   =   0.096

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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*************************************************
** SIMULATION:25 Year 12 Hour AES (Bloor, TRCA) **
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--------------------
|    READ STORM     |    Filename: C:\Users\JLook\AppD
|                   |              ata\Local\Temp\
|                   |              4a18b056-16a0-40dd-b965-edb2c32052b5\226d24bc
| Ptotal= 73.10 mm |    Comments: 25 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50   12.43 |  6.75    5.12 | 10.00    0.73
                 0.50    0.73 |  3.75   12.43 |  7.00    5.12 | 10.25    0.73
                 0.75    0.73 |  4.00   12.43 |  7.25    5.12 | 10.50    0.73
                 1.00    0.73 |  4.25   12.43 |  7.50    2.92 | 10.75    0.73
                 1.25    0.73 |  4.50   33.63 |  7.75    2.92 | 11.00    0.73
                 1.50    0.73 |  4.75   33.63 |  8.00    2.92 | 11.25    0.73
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                1.75    0.73 |  5.00   33.63 |  8.25    2.92 | 11.50    0.73
                2.00    0.73 |  5.25   33.63 |  8.50    1.46 | 11.75    0.73
                2.25    0.73 |  5.50    9.50 |  8.75    1.46 | 12.00    0.73
                2.50    4.39 |  5.75    9.50 |  9.00    1.46 | 12.25    0.73
                2.75    4.39 |  6.00    9.50 |  9.25    1.46 |
                3.00    4.39 |  6.25    9.50 |  9.50    0.73 |
                3.25    4.39 |  6.50    5.12 |  9.75    0.73 |

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--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                           ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    4.39 | 6.250    9.50 |  9.33    0.73
                0.167    0.00 | 3.250    4.39 | 6.333    5.12 |  9.42    0.73
                0.250    0.00 | 3.333   12.43 | 6.417    5.12 |  9.50    0.73
                0.333    0.73 | 3.417   12.43 | 6.500    5.12 |  9.58    0.73
                0.417    0.73 | 3.500   12.43 | 6.583    5.12 |  9.67    0.73
                0.500    0.73 | 3.583   12.43 | 6.667    5.12 |  9.75    0.73
                0.583    0.73 | 3.667   12.43 | 6.750    5.12 |  9.83    0.73
                0.667    0.73 | 3.750   12.43 | 6.833    5.12 |  9.92    0.73
                0.750    0.73 | 3.833   12.43 | 6.917    5.12 | 10.00    0.73
                0.833    0.73 | 3.917   12.43 | 7.000    5.12 | 10.08    0.73
                0.917    0.73 | 4.000   12.43 | 7.083    5.12 | 10.17    0.73
                1.000    0.73 | 4.083   12.43 | 7.167    5.12 | 10.25    0.73
                1.083    0.73 | 4.167   12.43 | 7.250    5.12 | 10.33    0.73
                1.167    0.73 | 4.250   12.43 | 7.333    2.92 | 10.42    0.73
                1.250    0.73 | 4.333   33.63 | 7.417    2.92 | 10.50    0.73
                1.333    0.73 | 4.417   33.63 | 7.500    2.92 | 10.58    0.73
                1.417    0.73 | 4.500   33.63 | 7.583    2.92 | 10.67    0.73
                1.500    0.73 | 4.583   33.63 | 7.667    2.92 | 10.75    0.73
                1.583    0.73 | 4.667   33.63 | 7.750    2.92 | 10.83    0.73
                1.667    0.73 | 4.750   33.63 | 7.833    2.92 | 10.92    0.73
                1.750    0.73 | 4.833   33.63 | 7.917    2.92 | 11.00    0.73
                1.833    0.73 | 4.917   33.63 | 8.000    2.92 | 11.08    0.73
                1.917    0.73 | 5.000   33.63 | 8.083    2.92 | 11.17    0.73
                2.000    0.73 | 5.083   33.63 | 8.167    2.92 | 11.25    0.73
                2.083    0.73 | 5.167   33.63 | 8.250    2.92 | 11.33    0.73
                2.167    0.73 | 5.250   33.63 | 8.333    1.46 | 11.42    0.73
                2.250    0.73 | 5.333    9.50 | 8.417    1.46 | 11.50    0.73
                2.333    4.39 | 5.417    9.50 | 8.500    1.46 | 11.58    0.73
                2.417    4.39 | 5.500    9.50 | 8.583    1.46 | 11.67    0.73
                2.500    4.39 | 5.583    9.50 | 8.667    1.46 | 11.75    0.73
                2.583    4.39 | 5.667    9.50 | 8.750    1.46 | 11.83    0.73
                2.667    4.39 | 5.750    9.50 | 8.833    1.46 | 11.92    0.73
                2.750    4.39 | 5.833    9.50 | 8.917    1.46 | 12.00    0.73
                2.833    4.39 | 5.917    9.50 | 9.000    1.46 | 12.08    0.73
                2.917    4.39 | 6.000    9.50 | 9.083    1.46 | 12.17    0.73
                3.000    4.39 | 6.083    9.50 | 9.167    1.46 | 12.25    0.73
                3.083    4.39 | 6.167    9.50 | 9.250    1.46 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.230 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  17.057
     TOTAL RAINFALL   (mm)=  73.100
     RUNOFF COEFFICIENT   =   0.233

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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************************************************
** SIMULATION:25 Year 6 Hour AES (Bloor, TRCA) **
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--------------------
|    READ STORM     |    Filename: C:\Users\JLook\AppD
|                   |              ata\Local\Temp\
|                   |              4a18b056-16a0-40dd-b965-edb2c32052b5\32249b7f
| Ptotal= 65.59 mm  |    Comments: 25 Year 6 Hour AES (Bloor, TRCA)
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--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  2.00   22.30 |  3.75    9.18 |  5.50    1.31
                 0.50    1.31 |  2.25   22.30 |  4.00    5.25 |  5.75    1.31
                 0.75    1.31 |  2.50   60.35 |  4.25    5.25 |  6.00    1.31
                 1.00    1.31 |  2.75   60.35 |  4.50    2.62 |  6.25    1.31
                 1.25    1.31 |  3.00   17.06 |  4.75    2.62 |
                 1.50    7.87 |  3.25   17.06 |  5.00    1.31 |
                 1.75    7.87 |  3.50    9.18 |  5.25    1.31 |

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--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                           ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 1.667    7.87 | 3.250   17.06 |  4.83    1.31
                0.167    0.00 | 1.750    7.87 | 3.333    9.18 |  4.92    1.31
                0.250    0.00 | 1.833   22.30 | 3.417    9.18 |  5.00    1.31
                0.333    1.31 | 1.917   22.30 | 3.500    9.18 |  5.08    1.31
                0.417    1.31 | 2.000   22.30 | 3.583    9.18 |  5.17    1.31
                0.500    1.31 | 2.083   22.30 | 3.667    9.18 |  5.25    1.31
                0.583    1.31 | 2.167   22.30 | 3.750    9.18 |  5.33    1.31
                0.667    1.31 | 2.250   22.30 | 3.833    5.25 |  5.42    1.31
                0.750    1.31 | 2.333   60.35 | 3.917    5.25 |  5.50    1.31
                0.833    1.31 | 2.417   60.35 | 4.000    5.25 |  5.58    1.31
                0.917    1.31 | 2.500   60.35 | 4.083    5.25 |  5.67    1.31
                1.000    1.31 | 2.583   60.35 | 4.167    5.25 |  5.75    1.31
                1.083    1.31 | 2.667   60.35 | 4.250    5.25 |  5.83    1.31
                1.167    1.31 | 2.750   60.35 | 4.333    2.62 |  5.92    1.31
                1.250    1.31 | 2.833   17.06 | 4.417    2.62 |  6.00    1.31
                1.333    7.87 | 2.917   17.06 | 4.500    2.62 |  6.08    1.31
                1.417    7.87 | 3.000   17.06 | 4.583    2.62 |  6.17    1.31
                1.500    7.87 | 3.083   17.06 | 4.667    2.62 |  6.25    1.31
                1.583    7.87 | 3.167   17.06 | 4.750    2.62 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.237 (i)
     TIME TO PEAK    (hrs)=   3.750
     RUNOFF VOLUME    (mm)=  13.680
     TOTAL RAINFALL   (mm)=  65.590
     RUNOFF COEFFICIENT   =   0.209

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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************************************************
** SIMULATION:5 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM     |    Filename: C:\Users\JLook\AppD
|                   |              ata\Local\Temp\
|                   |              4a18b056-16a0-40dd-b965-edb2c32052b5\a76371a0
| Ptotal= 54.38 mm  |    Comments: 5 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50    9.25 |  6.75    3.81 | 10.00    0.54
                 0.50    0.54 |  3.75    9.25 |  7.00    3.81 | 10.25    0.54
                 0.75    0.54 |  4.00    9.25 |  7.25    3.81 | 10.50    0.54
                 1.00    0.54 |  4.25    9.25 |  7.50    2.18 | 10.75    0.54
                 1.25    0.54 |  4.50   25.02 |  7.75    2.18 | 11.00    0.54
                 1.50    0.54 |  4.75   25.02 |  8.00    2.18 | 11.25    0.54
                 1.75    0.54 |  5.00   25.02 |  8.25    2.18 | 11.50    0.54
                 2.00    0.54 |  5.25   25.02 |  8.50    1.09 | 11.75    0.54
                 2.25    0.54 |  5.50    7.07 |  8.75    1.09 | 12.00    0.54
                 2.50    3.26 |  5.75    7.07 |  9.00    1.09 | 12.25    0.54
                 2.75    3.26 |  6.00    7.07 |  9.25    1.09 |
                 3.00    3.26 |  6.25    7.07 |  9.50    0.54 |
```

```
              3.25    3.26 |  6.50    3.81 |  9.75    0.54 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                         ---- TRANSFORMED HYETOGRAPH ----
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.083    0.00 | 3.167    3.26 | 6.250    7.07 |  9.33    0.54
             0.167    0.00 | 3.250    3.26 | 6.333    3.81 |  9.42    0.54
             0.250    0.00 | 3.333    9.25 | 6.417    3.81 |  9.50    0.54
             0.333    0.54 | 3.417    9.25 | 6.500    3.81 |  9.58    0.54
             0.417    0.54 | 3.500    9.25 | 6.583    3.81 |  9.67    0.54
             0.500    0.54 | 3.583    9.25 | 6.667    3.81 |  9.75    0.54
             0.583    0.54 | 3.667    9.25 | 6.750    3.81 |  9.83    0.54
             0.667    0.54 | 3.750    9.25 | 6.833    3.81 |  9.92    0.54
             0.750    0.54 | 3.833    9.25 | 6.917    3.81 | 10.00    0.54
             0.833    0.54 | 3.917    9.25 | 7.000    3.81 | 10.08    0.54
             0.917    0.54 | 4.000    9.25 | 7.083    3.81 | 10.17    0.54
             1.000    0.54 | 4.083    9.25 | 7.167    3.81 | 10.25    0.54
             1.083    0.54 | 4.167    9.25 | 7.250    3.81 | 10.33    0.54
             1.167    0.54 | 4.250    9.25 | 7.333    2.18 | 10.42    0.54
             1.250    0.54 | 4.333   25.02 | 7.417    2.18 | 10.50    0.54
             1.333    0.54 | 4.417   25.02 | 7.500    2.18 | 10.58    0.54
             1.417    0.54 | 4.500   25.02 | 7.583    2.18 | 10.67    0.54
             1.500    0.54 | 4.583   25.02 | 7.667    2.18 | 10.75    0.54
             1.583    0.54 | 4.667   25.02 | 7.750    2.18 | 10.83    0.54
             1.667    0.54 | 4.750   25.02 | 7.833    2.18 | 10.92    0.54
             1.750    0.54 | 4.833   25.02 | 7.917    2.18 | 11.00    0.54
             1.833    0.54 | 4.917   25.02 | 8.000    2.18 | 11.08    0.54
             1.917    0.54 | 5.000   25.02 | 8.083    2.18 | 11.17    0.54
             2.000    0.54 | 5.083   25.02 | 8.167    2.18 | 11.25    0.54
             2.083    0.54 | 5.167   25.02 | 8.250    2.18 | 11.33    0.54
             2.167    0.54 | 5.250   25.02 | 8.333    1.09 | 11.42    0.54
             2.250    0.54 | 5.333    7.07 | 8.417    1.09 | 11.50    0.54
             2.333    3.26 | 5.417    7.07 | 8.500    1.09 | 11.58    0.54
             2.417    3.26 | 5.500    7.07 | 8.583    1.09 | 11.67    0.54
             2.500    3.26 | 5.583    7.07 | 8.667    1.09 | 11.75    0.54
             2.583    3.26 | 5.667    7.07 | 8.750    1.09 | 11.83    0.54
             2.667    3.26 | 5.750    7.07 | 8.833    1.09 | 11.92    0.54
             2.750    3.26 | 5.833    7.07 | 8.917    1.09 | 12.00    0.54
             2.833    3.26 | 5.917    7.07 | 9.000    1.09 | 12.08    0.54
             2.917    3.26 | 6.000    7.07 | 9.083    1.09 | 12.17    0.54
             3.000    3.26 | 6.083    7.07 | 9.167    1.09 | 12.25    0.54
             3.083    3.26 | 6.167    7.07 | 9.250    1.09 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.122 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=   9.177
     TOTAL RAINFALL   (mm)=  54.380
     RUNOFF COEFFICIENT   =   0.169

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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************************************************
** SIMULATION:5 Year 6 Hour AES (Bloor, TRCA) **
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--------------------
|    READ STORM    |    Filename: C:\Users\JLook\AppD
|                  |              ata\Local\Temp\
|                  |              4a18b056-16a0-40dd-b965-edb2c32052b5\5cce2708
| Ptotal= 47.81 mm |    Comments: 5 Year 6 Hour AES (Bloor, TRCA)
--------------------
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
              0.25    0.00 |  2.00   16.25 |  3.75    6.69 |  5.50    0.96
              0.50    0.96 |  2.25   16.25 |  4.00    3.82 |  5.75    0.96
              0.75    0.96 |  2.50   43.98 |  4.25    3.82 |  6.00    0.96
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```
              1.00    0.96 |  2.75   43.98 |  4.50    1.91 |  6.25    0.96
              1.25    0.96 |  3.00   12.43 |  4.75    1.91 |
              1.50    5.74 |  3.25   12.43 |  5.00    0.96 |
              1.75    5.74 |  3.50    6.69 |  5.25    0.96 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                         ---- TRANSFORMED HYETOGRAPH ----
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.083    0.00 | 1.667    5.74 | 3.250   12.43 |  4.83    0.96
             0.167    0.00 | 1.750    5.74 | 3.333    6.69 |  4.92    0.96
             0.250    0.00 | 1.833   16.25 | 3.417    6.69 |  5.00    0.96
             0.333    0.96 | 1.917   16.25 | 3.500    6.69 |  5.08    0.96
             0.417    0.96 | 2.000   16.25 | 3.583    6.69 |  5.17    0.96
             0.500    0.96 | 2.083   16.25 | 3.667    6.69 |  5.25    0.96
             0.583    0.96 | 2.167   16.25 | 3.750    6.69 |  5.33    0.96
             0.667    0.96 | 2.250   16.25 | 3.833    3.82 |  5.42    0.96
             0.750    0.96 | 2.333   43.98 | 3.917    3.82 |  5.50    0.96
             0.833    0.96 | 2.417   43.98 | 4.000    3.82 |  5.58    0.96
             0.917    0.96 | 2.500   43.98 | 4.083    3.82 |  5.67    0.96
             1.000    0.96 | 2.583   43.98 | 4.167    3.82 |  5.75    0.96
             1.083    0.96 | 2.667   43.98 | 4.250    3.82 |  5.83    0.96
             1.167    0.96 | 2.750   43.98 | 4.333    1.91 |  5.92    0.96
             1.250    0.96 | 2.833   12.43 | 4.417    1.91 |  6.00    0.96
             1.333    5.74 | 2.917   12.43 | 4.500    1.91 |  6.08    0.96
             1.417    5.74 | 3.000   12.43 | 4.583    1.91 |  6.17    0.96
             1.500    5.74 | 3.083   12.43 | 4.667    1.91 |  6.25    0.96
             1.583    5.74 | 3.167   12.43 | 4.750    1.91 |

     Unit Hyd Qpeak  (cms)=   0.611

     PEAK FLOW       (cms)=   0.118 (i)
     TIME TO PEAK    (hrs)=   3.833
     RUNOFF VOLUME    (mm)=   6.872
     TOTAL RAINFALL   (mm)=  47.810
     RUNOFF COEFFICIENT   =   0.144

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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**************************************************
** SIMULATION:50 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\JLook\AppD
|                  |              ata\Local\Temp\
|                  |              4a18b056-16a0-40dd-b965-edb2c32052b5\79b149f4
| Ptotal= 80.82 mm |    Comments: 50 Year 12 Hour AES (Bloor, TRCA)
--------------------
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
              0.25    0.00 |  3.50   13.74 |  6.75    5.66 | 10.00    0.81
              0.50    0.81 |  3.75   13.74 |  7.00    5.66 | 10.25    0.81
              0.75    0.81 |  4.00   13.74 |  7.25    5.66 | 10.50    0.81
              1.00    0.81 |  4.25   13.74 |  7.50    3.23 | 10.75    0.81
              1.25    0.81 |  4.50   37.17 |  7.75    3.23 | 11.00    0.81
              1.50    0.81 |  4.75   37.17 |  8.00    3.23 | 11.25    0.81
              1.75    0.81 |  5.00   37.17 |  8.25    3.23 | 11.50    0.81
              2.00    0.81 |  5.25   37.17 |  8.50    1.62 | 11.75    0.81
              2.25    0.81 |  5.50   10.50 |  8.75    1.62 | 12.00    0.81
              2.50    4.85 |  5.75   10.50 |  9.00    1.62 | 12.25    0.81
              2.75    4.85 |  6.00   10.50 |  9.25    1.62 |
              3.00    4.85 |  6.25   10.50 |  9.50    0.81 |
              3.25    4.85 |  6.50    5.66 |  9.75    0.81 |

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| CALIB            |
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| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60
```

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.167	4.85	6.250	10.50	9.33	0.81
0.167	0.00	3.250	4.85	6.333	5.66	9.42	0.81
0.250	0.00	3.333	13.74	6.417	5.66	9.50	0.81
0.333	0.81	3.417	13.74	6.500	5.66	9.58	0.81
0.417	0.81	3.500	13.74	6.583	5.66	9.67	0.81
0.500	0.81	3.583	13.74	6.667	5.66	9.75	0.81
0.583	0.81	3.667	13.74	6.750	5.66	9.83	0.81
0.667	0.81	3.750	13.74	6.833	5.66	9.92	0.81
0.750	0.81	3.833	13.74	6.917	5.66	10.00	0.81
0.833	0.81	3.917	13.74	7.000	5.66	10.08	0.81
0.917	0.81	4.000	13.74	7.083	5.66	10.17	0.81
1.000	0.81	4.083	13.74	7.167	5.66	10.25	0.81
1.083	0.81	4.167	13.74	7.250	5.66	10.33	0.81
1.167	0.81	4.250	13.74	7.333	3.23	10.42	0.81
1.250	0.81	4.333	37.17	7.417	3.23	10.50	0.81
1.333	0.81	4.417	37.17	7.500	3.23	10.58	0.81
1.417	0.81	4.500	37.17	7.583	3.23	10.67	0.81
1.500	0.81	4.583	37.17	7.667	3.23	10.75	0.81
1.583	0.81	4.667	37.17	7.750	3.23	10.83	0.81
1.667	0.81	4.750	37.17	7.833	3.23	10.92	0.81
1.750	0.81	4.833	37.17	7.917	3.23	11.00	0.81
1.833	0.81	4.917	37.17	8.000	3.23	11.08	0.81
1.917	0.81	5.000	37.17	8.083	3.23	11.17	0.81
2.000	0.81	5.083	37.17	8.167	3.23	11.25	0.81
2.083	0.81	5.167	37.17	8.250	3.23	11.33	0.81
2.167	0.81	5.250	37.17	8.333	1.62	11.42	0.81
2.250	0.81	5.333	10.50	8.417	1.62	11.50	0.81
2.333	4.85	5.417	10.50	8.500	1.62	11.58	0.81
2.417	4.85	5.500	10.50	8.583	1.62	11.67	0.81
2.500	4.85	5.583	10.50	8.667	1.62	11.75	0.81
2.583	4.85	5.667	10.50	8.750	1.62	11.83	0.81
2.667	4.85	5.750	10.50	8.833	1.62	11.92	0.81
2.750	4.85	5.833	10.50	8.917	1.62	12.00	0.81
2.833	4.85	5.917	10.50	9.000	1.62	12.08	0.81
2.917	4.85	6.000	10.50	9.083	1.62	12.17	0.81
3.000	4.85	6.083	10.50	9.167	1.62	12.25	0.81
3.083	4.85	6.167	10.50	9.250	1.62		

```
Unit Hyd Qpeak  (cms)=   0.611

PEAK FLOW       (cms)=   0.282 (i)
TIME TO PEAK    (hrs)=   6.250
RUNOFF VOLUME    (mm)=  20.795
TOTAL RAINFALL   (mm)=  80.820
RUNOFF COEFFICIENT   =   0.257

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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**************************************************
** SIMULATION:50 Year 6 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\JLook\AppD
|                  |              ata\Local\Temp\
|                  |              4a18b056-16a0-40dd-b965-edb2c32052b5\b94c634c
| Ptotal= 73.00 mm |    Comments: 50 Year 6 Hour AES (Bloor, TRCA)
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	0.00	2.00	24.82	3.75	10.22	5.50	1.46
0.50	1.46	2.25	24.82	4.00	5.84	5.75	1.46
0.75	1.46	2.50	67.16	4.25	5.84	6.00	1.46
1.00	1.46	2.75	67.16	4.50	2.92	6.25	1.46
1.25	1.46	3.00	18.98	4.75	2.92		
1.50	8.76	3.25	18.98	5.00	1.46		
1.75	8.76	3.50	10.22	5.25	1.46		

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```
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=  21.46   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  10.00   # of Linear Res.(N)= 1.50
--------------------   U.H. Tp(hrs)=   0.60
```

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	1.667	8.76	3.250	18.98	4.83	1.46
0.167	0.00	1.750	8.76	3.333	10.22	4.92	1.46
0.250	0.00	1.833	24.82	3.417	10.22	5.00	1.46
0.333	1.46	1.917	24.82	3.500	10.22	5.08	1.46
0.417	1.46	2.000	24.82	3.583	10.22	5.17	1.46
0.500	1.46	2.083	24.82	3.667	10.22	5.25	1.46
0.583	1.46	2.167	24.82	3.750	10.22	5.33	1.46
0.667	1.46	2.250	24.82	3.833	5.84	5.42	1.46
0.750	1.46	2.333	67.16	3.917	5.84	5.50	1.46
0.833	1.46	2.417	67.16	4.000	5.84	5.58	1.46
0.917	1.46	2.500	67.16	4.083	5.84	5.67	1.46
1.000	1.46	2.583	67.16	4.167	5.84	5.75	1.46
1.083	1.46	2.667	67.16	4.250	5.84	5.83	1.46
1.167	1.46	2.750	67.16	4.333	2.92	5.92	1.46
1.250	1.46	2.833	18.98	4.417	2.92	6.00	1.46
1.333	8.76	2.917	18.98	4.500	2.92	6.08	1.46
1.417	8.76	3.000	18.98	4.583	2.92	6.17	1.46
1.500	8.76	3.083	18.98	4.667	2.92	6.25	1.46
1.583	8.76	3.167	18.98	4.750	2.92		

```
Unit Hyd Qpeak  (cms)=   0.611

PEAK FLOW       (cms)=   0.295 (i)
TIME TO PEAK    (hrs)=   3.750
RUNOFF VOLUME    (mm)=  17.010
TOTAL RAINFALL   (mm)=  73.000
RUNOFF COEFFICIENT   =   0.233

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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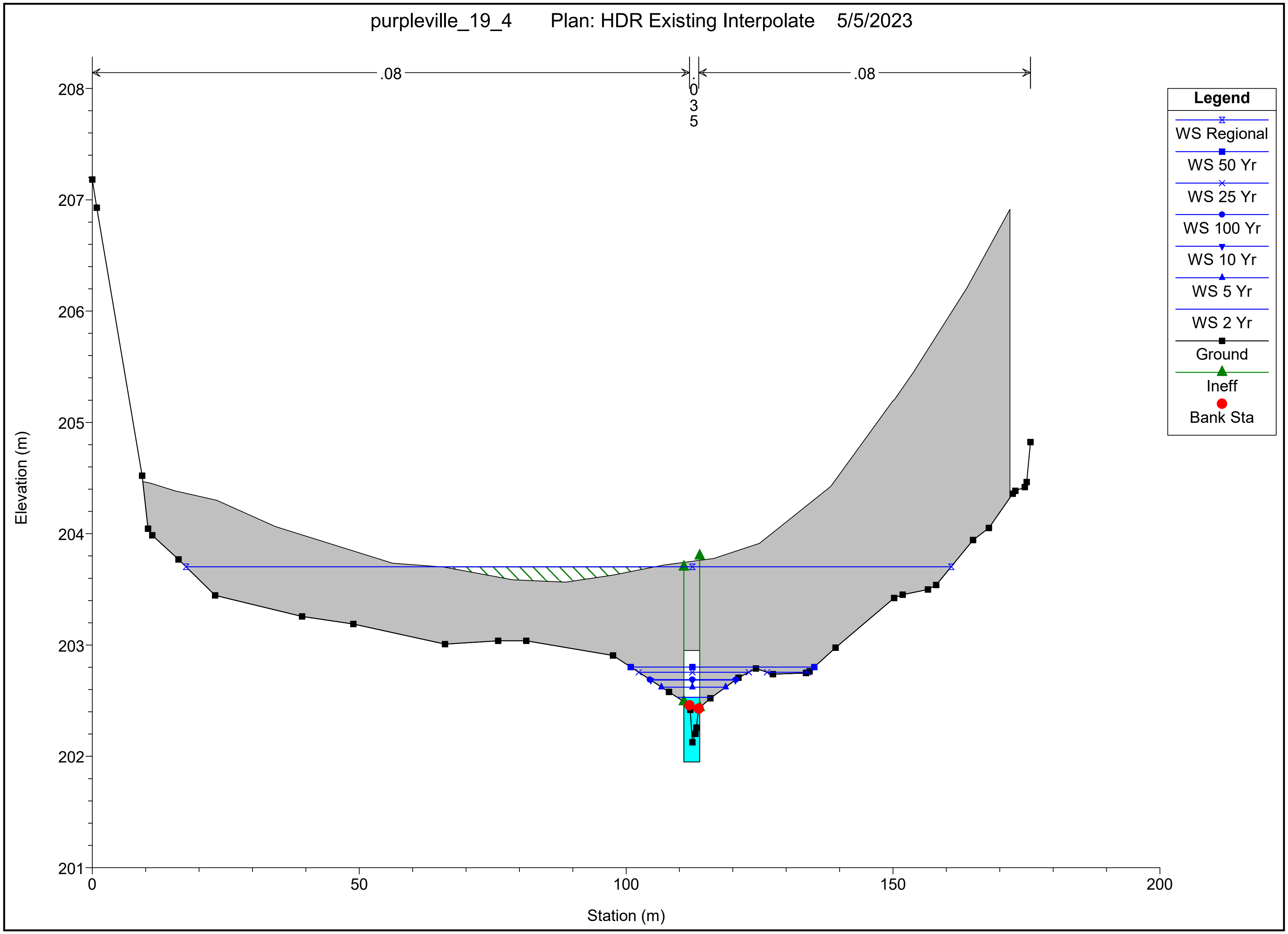
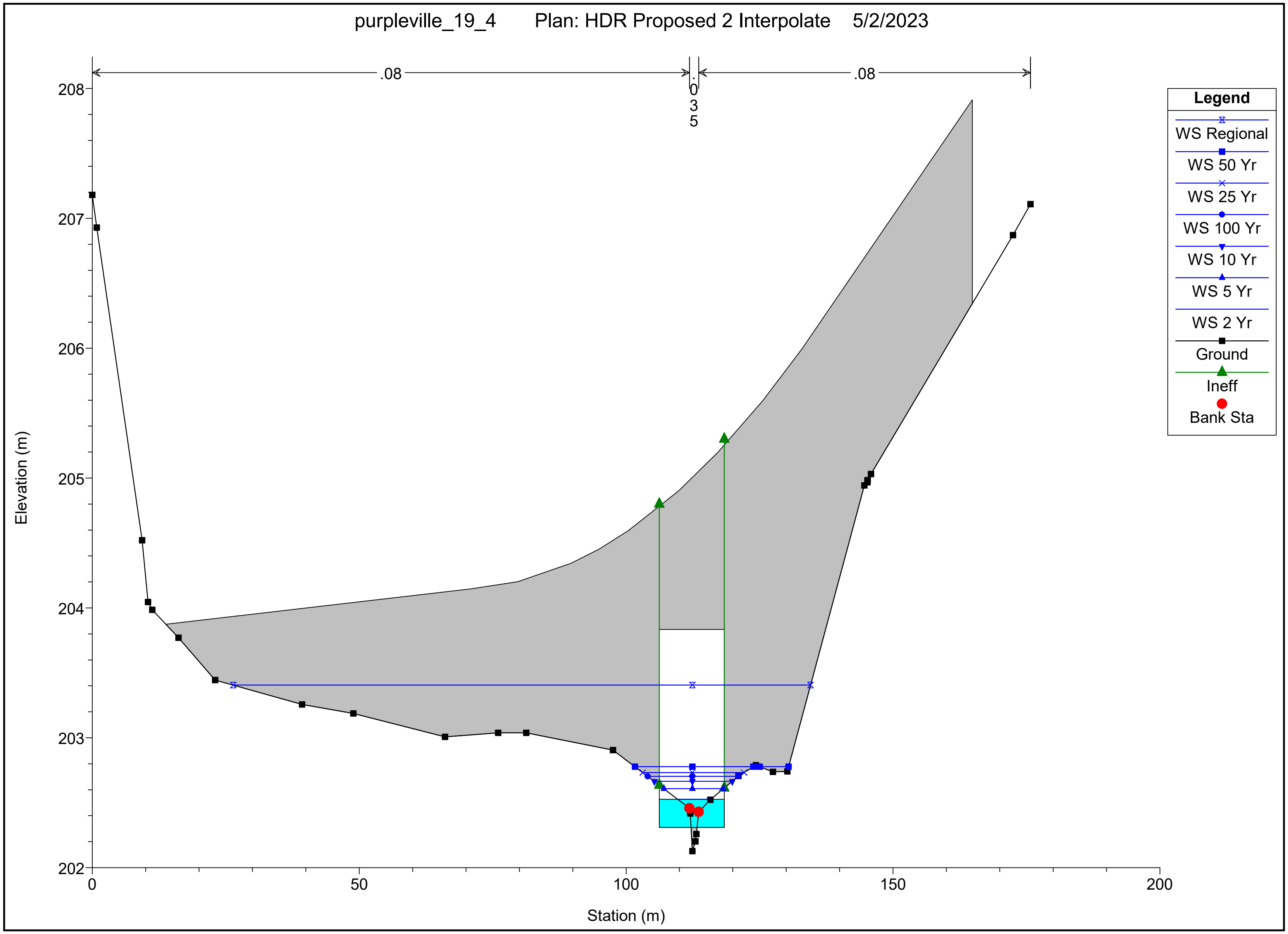
Appendix C: Hydraulic Model Output

HEC-RAS Cross Section - Crossing 2 Existing Conditions



HEC-RAS Cross Section - Crossing 2 Proposed Conditions

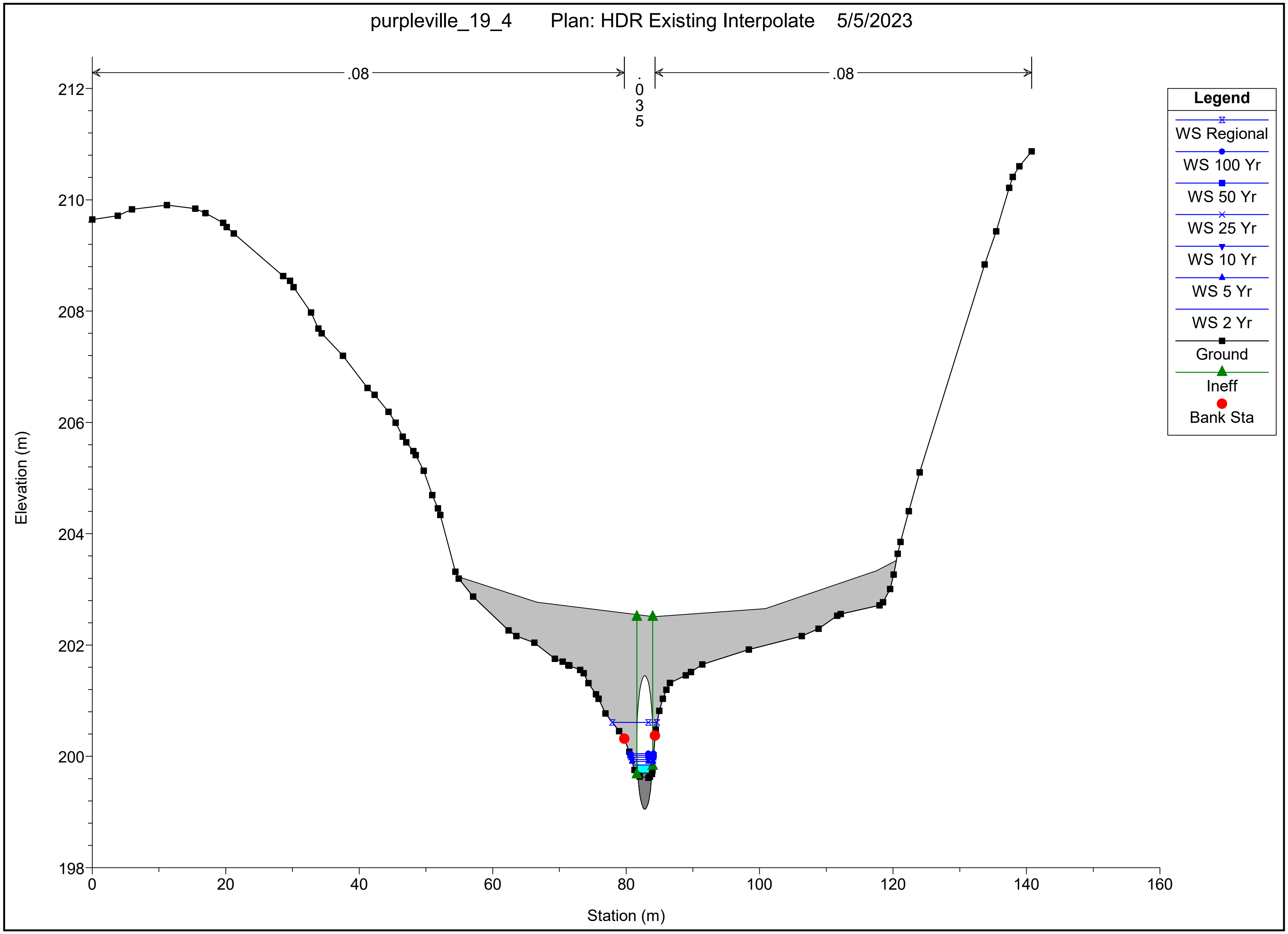


HEC-RAS Output - Crossing 2

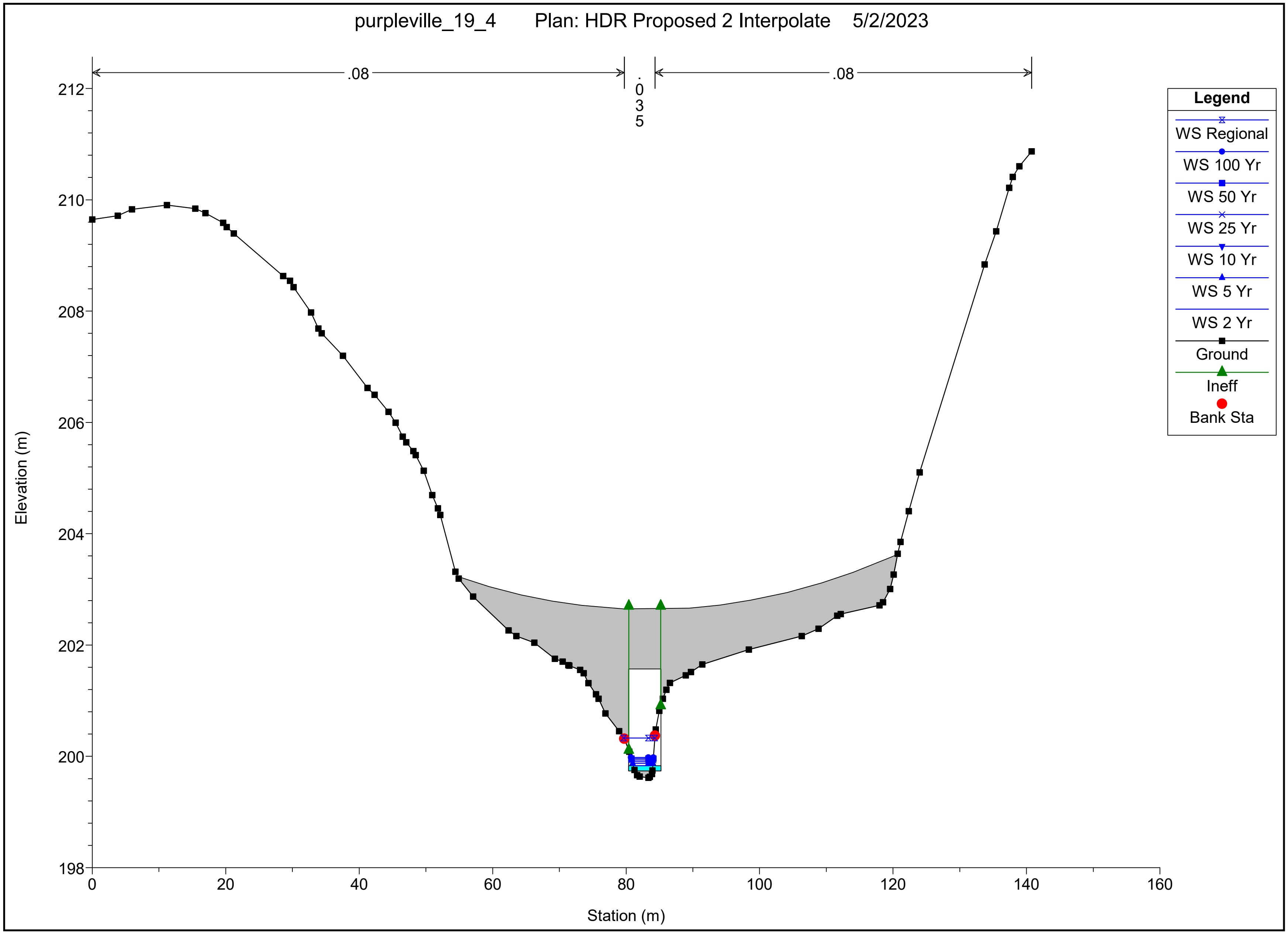
HEC-RAS River: purplevile19_6 Reach: 19.6 lower

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
19.6 lower	846.3868	2 Yr	HDR Pr 2 Interp	0.64	202.59	202.82		202.82	0.001754	0.15	4.30	28.25	0.12
19.6 lower	846.3868	2 Yr	HDR Ex Interp	0.64	202.59	202.83		202.83	0.001580	0.14	4.46	28.57	0.12
19.6 lower	846.3868	5 Yr	HDR Pr 2 Interp	1.16	202.59	202.89		202.89	0.001898	0.18	6.29	32.05	0.13
19.6 lower	846.3868	5 Yr	HDR Ex Interp	1.16	202.59	202.93		202.93	0.001135	0.15	7.54	34.19	0.10
19.6 lower	846.3868	10 Yr	HDR Pr 2 Interp	1.57	202.59	202.93		202.93	0.001903	0.20	7.78	34.58	0.14
19.6 lower	846.3868	10 Yr	HDR Ex Interp	1.57	202.59	203.00		203.00	0.000921	0.15	10.14	38.96	0.10
19.6 lower	846.3868	25 Yr	HDR Pr 2 Interp	2.14	202.59	202.98		202.99	0.001949	0.22	9.69	38.25	0.14
19.6 lower	846.3868	25 Yr	HDR Ex Interp	2.14	202.59	203.09		203.09	0.000675	0.15	13.98	43.17	0.09
19.6 lower	846.3868	50 Yr	HDR Pr 2 Interp	2.60	202.59	203.02		203.03	0.001911	0.23	11.19	40.33	0.14
19.6 lower	846.3868	50 Yr	HDR Ex Interp	2.60	202.59	203.16		203.17	0.000547	0.15	17.35	47.26	0.08
19.6 lower	846.3868	100 Yr	HDR Pr 2 Interp	3.10	202.59	203.06		203.06	0.001831	0.24	12.79	42.00	0.14
19.6 lower	846.3868	100 Yr	HDR Ex Interp	3.10	202.59	203.25		203.25	0.000454	0.14	21.40	53.34	0.07
19.6 lower	846.3868	Regional	HDR Pr 2 Interp	22.03	202.59	203.90		203.91	0.000884	0.34	65.52	75.98	0.12
19.6 lower	846.3868	Regional	HDR Ex Interp	22.03	202.59	206.14		206.14	0.000013	0.09	250.30	92.78	0.02
19.6 lower	793.89	2 Yr	HDR Pr 2 Interp	0.64	202.13	202.53	202.53	202.61	0.014721	1.34	0.64	6.33	0.84
19.6 lower	793.89	2 Yr	HDR Ex Interp	0.64	202.13	202.52	202.52	202.62	0.018341	1.45	0.49	5.66	0.93
19.6 lower	793.89	5 Yr	HDR Pr 2 Interp	1.16	202.13	202.64	202.64	202.71	0.009921	1.39	1.66	12.83	0.73
19.6 lower	793.89	5 Yr	HDR Ex Interp	1.16	202.13	202.62	202.62	202.77	0.016860	1.75	0.80	11.86	0.94
19.6 lower	793.89	10 Yr	HDR Pr 2 Interp	1.57	202.13	202.67	202.67	202.76	0.010758	1.54	2.12	15.09	0.77
19.6 lower	793.89	10 Yr	HDR Ex Interp	1.57	202.13	202.68	202.68	202.86	0.016565	1.95	1.00	15.83	0.96
19.6 lower	793.89	25 Yr	HDR Pr 2 Interp	2.14	202.13	202.72	202.72	202.81	0.011497	1.71	2.67	17.94	0.81
19.6 lower	793.89	25 Yr	HDR Ex Interp	2.14	202.13	202.77	202.77	202.98	0.016167	2.17	1.24	30.12	0.98
19.6 lower	793.89	50 Yr	HDR Pr 2 Interp	2.60	202.13	202.75	202.75	202.85	0.012202	1.83	3.03	23.36	0.85
19.6 lower	793.89	50 Yr	HDR Ex Interp	2.60	202.13	202.83	202.83	203.07	0.015899	2.32	1.42	35.67	0.99
19.6 lower	793.89	100 Yr	HDR Pr 2 Interp	3.10	202.13	202.77	202.77	202.89	0.013621	2.00	3.31	26.64	0.90
19.6 lower	793.89	100 Yr	HDR Ex Interp	3.10	202.13	202.88	202.88	203.15	0.015851	2.47	1.59	38.82	1.00
19.6 lower	793.89	Regional	HDR Pr 2 Interp	22.03	202.13	203.38	203.38	203.78	0.020024	4.13	10.80	106.15	1.25
19.6 lower	793.89	Regional	HDR Ex Interp	22.03	202.13	203.65	203.65	205.91	0.047473	7.32	3.88	141.19	1.99
19.6 lower	780.41			Culvert									
19.6 lower	752.78	2 Yr	HDR Pr 2 Interp	0.64	201.92	202.52		202.52	0.000242	0.23	2.84	7.65	0.12
19.6 lower	752.78	2 Yr	HDR Ex Interp	0.64	201.92	202.53		202.53	0.000551	0.42	1.52	13.74	0.19
19.6 lower	752.78	5 Yr	HDR Pr 2 Interp	1.16	201.92	202.60		202.60	0.000452	0.33	3.47	8.29	0.16
19.6 lower	752.78	5 Yr	HDR Ex Interp	1.16	201.92	202.61		202.63	0.001064	0.65	1.77	19.80	0.27
19.6 lower	752.78	10 Yr	HDR Pr 2 Interp	1.57	201.92	202.65		202.66	0.000586	0.40	3.93	8.73	0.19
19.6 lower	752.78	10 Yr	HDR Ex Interp	1.57	201.92	202.67		202.70	0.001425	0.80	1.95	21.73	0.32
19.6 lower	752.78	25 Yr	HDR Pr 2 Interp	2.14	201.92	202.71		202.73	0.000743	0.47	4.52	9.26	0.22
19.6 lower	752.78	25 Yr	HDR Ex Interp	2.14	201.92	202.73		202.78	0.001953	1.00	2.14	22.30	0.38
19.6 lower	752.78	50 Yr	HDR Pr 2 Interp	2.60	201.92	202.76		202.77	0.000845	0.53	4.92	9.61	0.23
19.6 lower	752.78	50 Yr	HDR Ex Interp	2.60	201.92	202.77		202.84	0.002396	1.15	2.26	22.66	0.42
19.6 lower	752.78	100 Yr	HDR Pr 2 Interp	3.10	201.92	202.65		202.68	0.002294	0.79	3.92	8.72	0.38
19.6 lower	752.78	100 Yr	HDR Ex Interp	3.10	201.92	202.59		202.76	0.008810	1.82	1.70	18.76	0.77
19.6 lower	752.78	Regional	HDR Pr 2 Interp	22.03	201.92	203.07	203.07	203.46	0.013591	2.77	7.94	12.13	1.00
19.6 lower	752.78	Regional	HDR Ex Interp	22.03	201.92	203.84	203.84	204.00	0.011050	1.99	19.49	67.55	0.86
19.6 lower	725.1825	2 Yr	HDR Pr 2 Interp	0.64	202.21	202.47	202.43	202.50	0.009053	0.74	0.87	6.16	0.62
19.6 lower	725.1825	2 Yr	HDR Ex Interp	0.64	202.21	202.47	202.43	202.50	0.009472	0.75	0.86	6.13	0.64
19.6 lower	725.1825	5 Yr	HDR Pr 2 Interp	1.16	202.21	202.51	202.48	202.56	0.015139	1.05	1.11	6.78	0.83
19.6 lower	725.1825	5 Yr	HDR Ex Interp	1.16	202.21	202.50	202.48	202.56	0.017634	1.10	1.05	6.63	0.89
19.6 lower	725.1825	10 Yr	HDR Pr 2 Interp	1.57	202.21	202.53	202.52	202.61	0.018843	1.23	1.27	7.19	0.93
19.6 lower	725.1825	10 Yr	HDR Ex Interp	1.57	202.21	202.52	202.52	202.61	0.021747	1.30	1.21	7.04	1.00
19.6 lower	725.1825	25 Yr	HDR Pr 2 Interp	2.14	202.21	202.57	202.57	202.67	0.021193	1.40	1.53	7.78	1.01
19.6 lower	725.1825	25 Yr	HDR Ex Interp	2.14	202.21	202.57	202.57	202.67	0.021193	1.40	1.53	7.78	1.01
19.6 lower	725.1825	50 Yr	HDR Pr 2 Interp	2.60	202.21	202.60	202.60	202.71	0.020002	1.45	1.80	8.35	0.99
19.6 lower	725.1825	50 Yr	HDR Ex Interp	2.60	202.21	202.60	202.60	202.71	0.020002	1.45	1.80	8.35	0.99
19.6 lower	725.1825	100 Yr	HDR Pr 2 Interp	3.10	202.21	202.62	202.62	202.62	0.001679	0.44	14.47	69.81	0.29
19.6 lower	725.1825	100 Yr	HDR Ex Interp	3.10	202.21	202.62	202.62	202.62	0.001679	0.44	14.47	69.81	0.29
19.6 lower	725.1825	Regional	HDR Pr 2 Interp	22.03	202.21	203.03	202.67	203.04	0.002417	0.97	46.48	85.96	0.41
19.6 lower	725.1825	Regional	HDR Ex Interp	22.03	202.21	203.03	202.67	203.05	0.002406	0.96	46.55	85.97	0.41

HEC-RAS Cross Section - Crossing 3 Existing Conditions



HEC-RAS Cross Section - Crossing 3 Proposed Conditions



HEC-RAS Output - Crossing 3

HEC-RAS River: purplevile19_5 Reach: 19.5

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
19.5	115.18	2 Yr	HDR Pr 2 Interp	0.14	199.59	199.84		199.87	0.011753	0.75	0.19	1.48	0.67
19.5	115.18	2 Yr	HDR Ex Interp	0.14	199.59	199.86		199.88	0.006972	0.63	0.23	1.56	0.53
19.5	115.18	5 Yr	HDR Pr 2 Interp	0.26	199.59	199.88		199.93	0.015963	1.00	0.26	1.62	0.81
19.5	115.18	5 Yr	HDR Ex Interp	0.26	199.59	199.93		199.96	0.006993	0.75	0.34	1.79	0.55
19.5	115.18	10 Yr	HDR Pr 2 Interp	0.35	199.59	199.91	199.89	199.98	0.018770	1.16	0.30	1.71	0.89
19.5	115.18	10 Yr	HDR Ex Interp	0.35	199.59	199.97		200.01	0.007151	0.82	0.42	1.95	0.56
19.5	115.18	25 Yr	HDR Pr 2 Interp	0.47	199.59	199.93	199.93	200.03	0.023525	1.37	0.34	1.79	1.00
19.5	115.18	25 Yr	HDR Ex Interp	0.47	199.59	200.03		200.07	0.007099	0.89	0.53	2.17	0.57
19.5	115.18	50 Yr	HDR Pr 2 Interp	0.57	199.59	199.96	199.96	200.07	0.023262	1.44	0.39	1.90	1.01
19.5	115.18	50 Yr	HDR Ex Interp	0.57	199.59	200.07		200.11	0.006886	0.92	0.62	2.32	0.57
19.5	115.18	100 Yr	HDR Pr 2 Interp	0.67	199.59	199.99	199.99	200.10	0.022732	1.50	0.45	2.01	1.01
19.5	115.18	100 Yr	HDR Ex Interp	0.67	199.59	200.10		200.15	0.006596	0.95	0.71	2.45	0.57
19.5	115.18	Regional	HDR Pr 2 Interp	3.63	199.59	200.44	200.44	200.68	0.012911	2.17	2.05	6.62	0.89
19.5	115.18	Regional	HDR Ex Interp	3.63	199.59	200.87		200.91	0.001506	1.06	5.53	9.27	0.33
19.5	106.37	2 Yr	HDR Pr 2 Interp	0.14	199.61	199.84	199.71	199.84	0.000987	0.28	0.52	2.93	0.21
19.5	106.37	2 Yr	HDR Ex Interp	0.14	199.61	199.86	199.71	199.86	0.000692	0.27	0.53	3.01	0.18
19.5	106.37	5 Yr	HDR Pr 2 Interp	0.26	199.61	199.88	199.74	199.89	0.001620	0.40	0.65	3.06	0.28
19.5	106.37	5 Yr	HDR Ex Interp	0.26	199.61	199.93	199.74	199.94	0.000900	0.37	0.70	3.21	0.22
19.5	106.37	10 Yr	HDR Pr 2 Interp	0.35	199.61	199.90	199.77	199.92	0.002055	0.47	0.73	3.14	0.31
19.5	106.37	10 Yr	HDR Ex Interp	0.35	199.61	199.97	199.77	199.98	0.001036	0.43	0.80	3.34	0.24
19.5	106.37	25 Yr	HDR Pr 2 Interp	0.47	199.61	199.94	199.79	199.95	0.002609	0.57	0.83	3.23	0.36
19.5	106.37	25 Yr	HDR Ex Interp	0.47	199.61	200.02	199.80	200.04	0.001176	0.51	0.92	3.49	0.26
19.5	106.37	50 Yr	HDR Pr 2 Interp	0.57	199.61	199.96	199.81	199.98	0.003049	0.64	0.90	3.29	0.39
19.5	106.37	50 Yr	HDR Ex Interp	0.57	199.61	200.06	199.82	200.08	0.001263	0.56	1.02	3.61	0.28
19.5	106.37	100 Yr	HDR Pr 2 Interp	0.67	199.61	199.98	199.83	200.00	0.003481	0.70	0.96	3.35	0.42
19.5	106.37	100 Yr	HDR Ex Interp	0.67	199.61	200.10	199.84	200.12	0.001337	0.61	1.10	3.74	0.29
19.5	106.37	Regional	HDR Pr 2 Interp	3.63	199.61	200.30	200.19	200.44	0.008807	1.69	2.15	4.51	0.72
19.5	106.37	Regional	HDR Ex Interp	3.63	199.61	200.81	200.25	200.89	0.001738	1.29	2.80	8.20	0.38
19.5	101			Culvert									
19.5	76.92	2 Yr	HDR Pr 2 Interp	0.14	199.58	199.79	199.76	199.80	0.012807	0.61	0.23	2.82	0.67
19.5	76.92	2 Yr	HDR Ex Interp	0.14	199.58	199.78	199.76	199.81	0.013572	0.76	0.19	2.70	0.72
19.5	76.92	5 Yr	HDR Pr 2 Interp	0.26	199.58	199.83	199.80	199.85	0.013058	0.70	0.36	4.21	0.70
19.5	76.92	5 Yr	HDR Ex Interp	0.26	199.58	199.83	199.80	199.87	0.016164	0.88	0.29	4.39	0.80
19.5	76.92	10 Yr	HDR Pr 2 Interp	0.35	199.58	199.85	199.82	199.88	0.013163	0.76	0.45	5.00	0.72
19.5	76.92	10 Yr	HDR Ex Interp	0.35	199.58	199.85	199.84	199.91	0.017157	1.01	0.34	5.10	0.85
19.5	76.92	25 Yr	HDR Pr 2 Interp	0.47	199.58	199.88	199.85	199.91	0.013423	0.83	0.56	5.88	0.74
19.5	76.92	25 Yr	HDR Ex Interp	0.47	199.58	199.88	199.87	199.95	0.018731	1.17	0.40	5.92	0.91
19.5	76.92	50 Yr	HDR Pr 2 Interp	0.57	199.58	199.89	199.87	199.93	0.013798	0.89	0.64	6.49	0.76
19.5	76.92	50 Yr	HDR Ex Interp	0.57	199.58	199.89	199.89	199.98	0.020461	1.30	0.44	6.46	0.97
19.5	76.92	100 Yr	HDR Pr 2 Interp	0.67	199.58	199.91	199.88	199.96	0.014120	0.94	0.72	7.02	0.78
19.5	76.92	100 Yr	HDR Ex Interp	0.67	199.58	199.91	199.91	200.01	0.021441	1.41	0.48	7.02	1.01
19.5	76.92	Regional	HDR Pr 2 Interp	3.63	199.58	200.15	200.15	200.34	0.016753	1.93	1.88	13.29	1.00
19.5	76.92	Regional	HDR Ex Interp	3.63	199.58	200.33	200.33	200.63	0.014539	2.46	1.48	17.84	1.00
19.5	68.18	2 Yr	HDR Pr 2 Interp	0.14	199.40	199.60	199.60	199.64	0.028139	0.93	0.15	1.72	1.00
19.5	68.18	2 Yr	HDR Ex Interp	0.14	199.40	199.60	199.60	199.64	0.028139	0.93	0.15	1.72	1.00
19.5	68.18	5 Yr	HDR Pr 2 Interp	0.26	199.40	199.65	199.65	199.69	0.027230	0.93	0.28	3.12	0.99
19.5	68.18	5 Yr	HDR Ex Interp	0.26	199.40	199.65	199.65	199.69	0.027230	0.93	0.28	3.12	0.99
19.5	68.18	10 Yr	HDR Pr 2 Interp	0.35	199.40	199.67	199.67	199.72	0.026729	0.98	0.35	3.62	1.00
19.5	68.18	10 Yr	HDR Ex Interp	0.35	199.40	199.67	199.67	199.72	0.026729	0.98	0.35	3.62	1.00
19.5	68.18	25 Yr	HDR Pr 2 Interp	0.47	199.40	199.70	199.70	199.75	0.026127	1.04	0.45	4.18	1.01
19.5	68.18	25 Yr	HDR Ex Interp	0.47	199.40	199.70	199.70	199.75	0.026127	1.04	0.45	4.18	1.01
19.5	68.18	50 Yr	HDR Pr 2 Interp	0.57	199.40	199.71	199.71	199.77	0.025373	1.07	0.53	4.59	1.00
19.5	68.18	50 Yr	HDR Ex Interp	0.57	199.40	199.71	199.71	199.77	0.025373	1.07	0.53	4.59	1.00
19.5	68.18	100 Yr	HDR Pr 2 Interp	0.67	199.40	199.73	199.73	199.79	0.024738	1.11	0.61	5.02	1.00
19.5	68.18	100 Yr	HDR Ex Interp	0.67	199.40	199.73	199.73	199.79	0.024738	1.11	0.61	5.02	1.00
19.5	68.18	Regional	HDR Pr 2 Interp	3.63	199.40	199.98	199.98	200.12	0.014689	1.72	2.74	12.54	0.92
19.5	68.18	Regional	HDR Ex Interp	3.63	199.40	199.98	199.98	200.12	0.014689	1.72	2.74	12.54	0.92

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Crossing 1 Existing

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Culvert 1: CSP Discharge (cms)	Roadway Discharge (cms)	Iterations
204.35	2-Yr	0.19	0.19	0.00	1
204.59	5-Yr	0.47	0.47	0.00	1
204.76	10-Yr	0.69	0.69	0.00	1
204.99	25-Yr	0.98	0.98	0.00	1
205.20	50-Yr	1.20	1.20	0.00	1
205.45	100-Yr	1.43	1.43	0.00	18
205.50	Check	1.64	1.47	0.17	8
205.44	Overtopping	1.42	1.42	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1 Existing

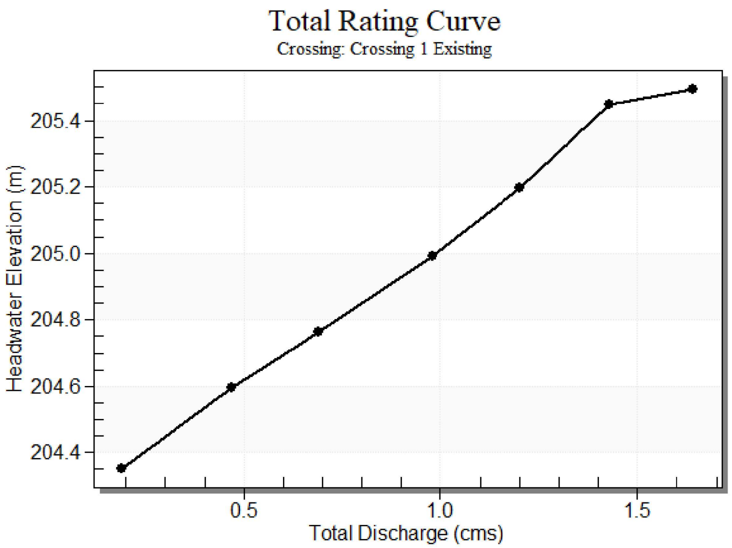


Table 2 - Culvert Summary Table: Culvert 1: CSP

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
2-Yr	0.19	0.19	204.35	0.364	0.0*	1-S2n	0.228	0.249	0.228	0.217	1.444
5-Yr	0.47	0.47	204.59	0.604	0.218	1-S2n	0.368	0.398	0.368	0.339	1.858
10-Yr	0.69	0.69	204.76	0.772	0.408	1-S2n	0.458	0.486	0.458	0.407	2.050
25-Yr	0.98	0.98	204.99	1.003	0.702	5-S2n	0.575	0.584	0.575	0.479	2.218
50-Yr	1.20	1.20	205.20	1.206	1.208	7-M2c	0.674	0.648	0.648	0.526	2.446
100-Yr	1.43	1.43	205.45	1.457	1.354	7-M2c	0.900	0.706	0.706	0.569	2.669
Check	1.64	1.47	205.50	1.505	1.390	7-M2c	0.900	0.715	0.715	0.605	2.709

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 203.99 m,   Outlet Elevation (invert): 203.72 m

Culvert Length: 15.90 m,   Culvert Slope: 0.0170

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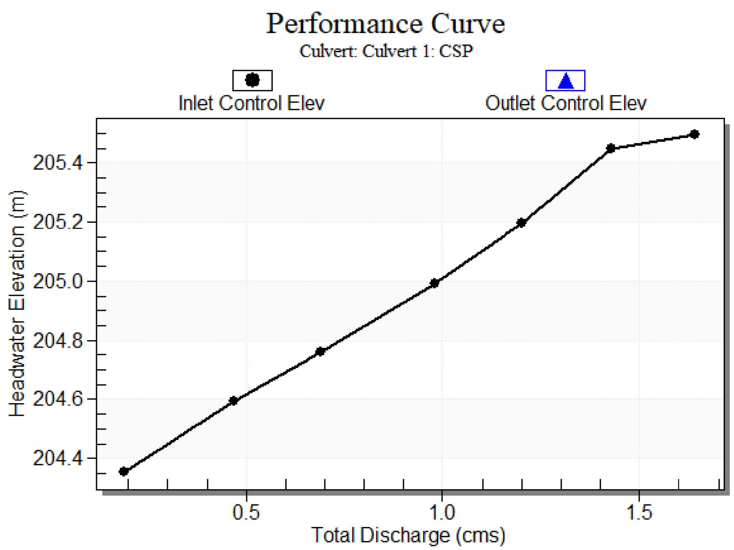
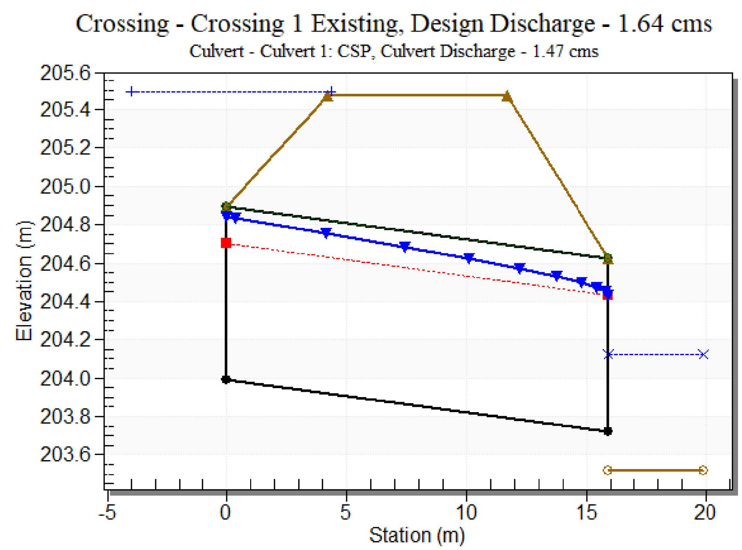
Culvert Performance Curve Plot: Culvert 1: CSP



Water Surface Profile Plot for Culvert: Culvert 1: CSP



Site Data - Culvert 1: CSP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 203.99 m

Outlet Station: 15.90 m

Outlet Elevation: 203.72 m

Number of Barrels: 1

Culvert Data Summary - Culvert 1: CSP

Barrel Shape: Circular

Barrel Diameter: 900.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing 1 Existing)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.19	203.74	0.22	0.57	10.62	0.46
0.47	203.86	0.34	0.72	16.63	0.49
0.69	203.93	0.41	0.80	19.96	0.50
0.98	204.00	0.48	0.87	23.49	0.51
1.20	204.05	0.53	0.92	25.76	0.52
1.43	204.09	0.57	0.96	27.88	0.52
1.64	204.12	0.60	1.00	29.65	0.53

Tailwater Channel Data - Crossing 1 Existing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 0.90 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0350

Channel Invert Elevation: 203.52 m

Roadway Data for Crossing: Crossing 1 Existing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 7.50 m

HY-8 Output: Crossing 1 Proposed

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 4 - Summary of Culvert Flows at Crossing: Crossing 1 Proposed

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
204.27	2-Yr	0.19	0.19	0.00	1
204.31	5-Yr	0.47	0.47	0.00	1
204.36	10-Yr	0.69	0.69	0.00	1
204.42	25-Yr	0.98	0.98	0.00	1
204.46	50-Yr	1.20	1.20	0.00	1
204.50	100-Yr	1.43	1.43	0.00	1
204.53	Check	1.64	1.64	0.00	1
206.74	Overtopping	19.91	19.91	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1 Proposed

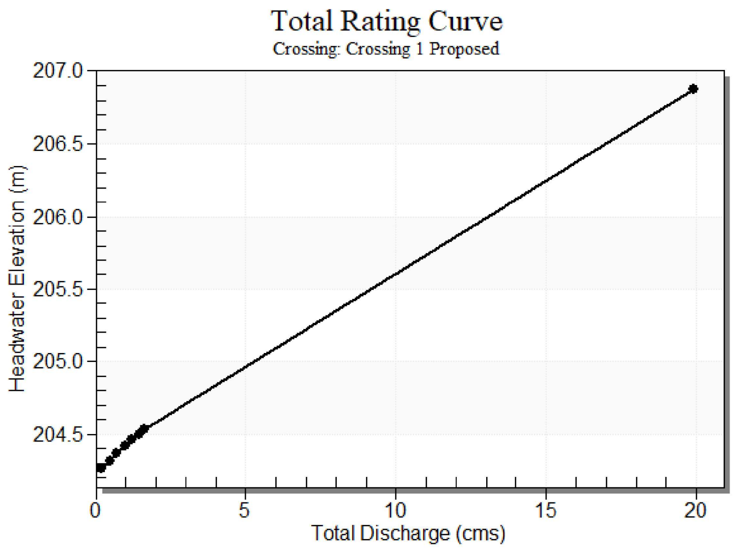


Table 5 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
2-Yr	0.19	0.19	204.27	0.086	0.114	3-M1t	0.059	0.057	0.247	0.248	0.180
5-Yr	0.47	0.47	204.31	0.160	0.0*	1-S2n	0.104	0.104	0.104	0.349	1.033
10-Yr	0.69	0.69	204.36	0.213	0.0*	1-S2n	0.131	0.136	0.131	0.403	1.198
25-Yr	0.98	0.98	204.42	0.270	0.0*	1-JS1t	0.163	0.173	0.459	0.460	0.488
50-Yr	1.20	1.20	204.46	0.309	0.0*	1-JS1t	0.184	0.198	0.495	0.496	0.554
100-Yr	1.43	1.43	204.50	0.347	0.0*	1-S2n	0.205	0.223	0.205	0.530	1.592
Check	1.64	1.64	204.53	0.380	0.0*	1-JS1t	0.223	0.244	0.557	0.558	0.673

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 204.15 m,   Outlet Elevation (invert): 203.42 m

Culvert Length: 28.94 m,   Culvert Slope: 0.0252

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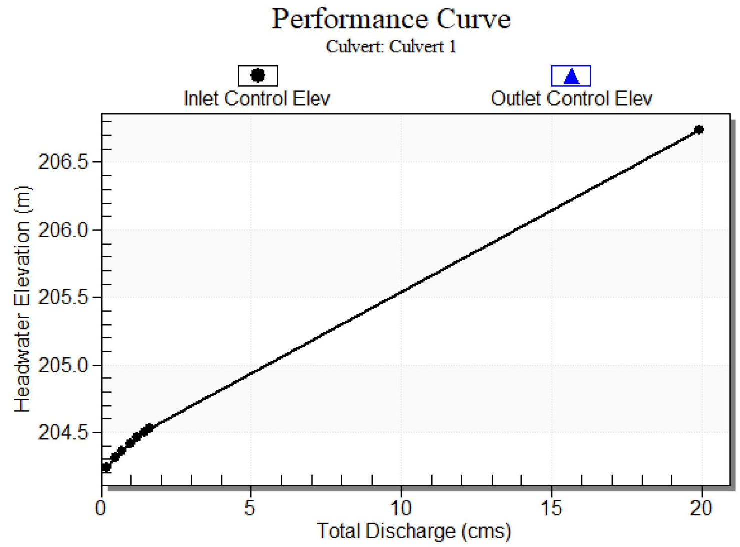
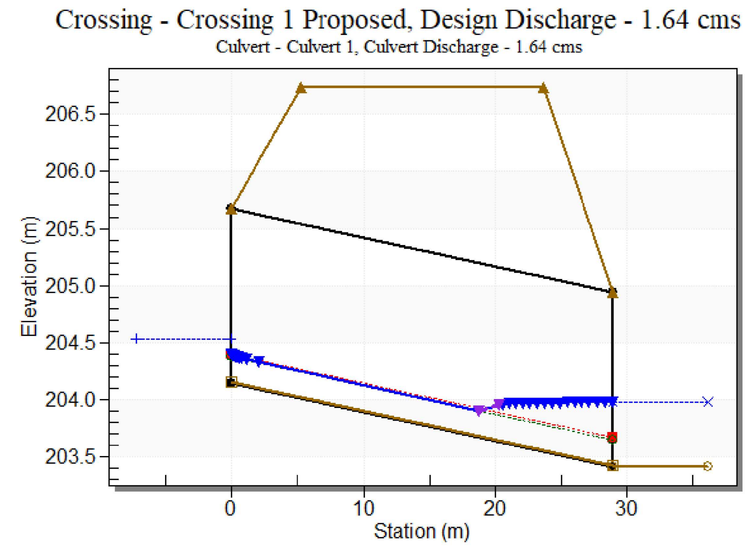
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

- Site Data Option: Culvert Invert Data
- Inlet Station: 0.00 m
- Inlet Elevation: 204.15 m
- Outlet Station: 28.93 m
- Outlet Elevation: 203.42 m
- Number of Barrels: 1

Culvert Data Summary - Culvert 1

- Barrel Shape: User Defined
- Barrel Span: 4267.00 mm
- Barrel Rise: 1525.00 mm
- Barrel Material: Concrete
- Embedment: 1.00 mm
- Barrel Manning's n: 0.0130 (top and sides)
- Manning's n: 0.0350 (bottom)
- Culvert Type: Straight
- Inlet Configuration: Thin Edge Projecting
- Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing 1 Proposed)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.19	203.67	0.25	1.03	54.32	0.93
0.47	203.77	0.35	1.29	76.28	0.98
0.69	203.82	0.40	1.42	88.10	1.01
0.98	203.88	0.46	1.55	100.49	1.03
1.20	203.92	0.50	1.63	108.41	1.04
1.43	203.95	0.53	1.70	115.78	1.05
1.64	203.98	0.56	1.76	121.89	1.06

Tailwater Channel Data - Crossing 1 Proposed

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0223

Channel Manning's n: 0.0350

Channel Invert Elevation: 203.42 m

Roadway Data for Crossing: Crossing 1 Proposed

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 m

Crest Elevation: 206.74 m

Roadway Surface: Paved

Roadway Top Width: 18.46 m

HY-8 Output: Crossing 4 Existing

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 7 - Summary of Culvert Flows at Crossing: Crossing 4 Existing

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
215.96	2-Yr	0.06	0.06	0.00	1
216.06	5-Yr	0.12	0.12	0.00	1
216.12	10-Yr	0.17	0.17	0.00	1
216.20	25-Yr	0.24	0.24	0.00	1
216.26	50-Yr	0.30	0.30	0.00	1
216.32	100-Yr	0.36	0.36	0.00	1
216.37	Check	0.41	0.41	0.00	1
217.88	Overtopping	1.35	1.35	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 4 Existing

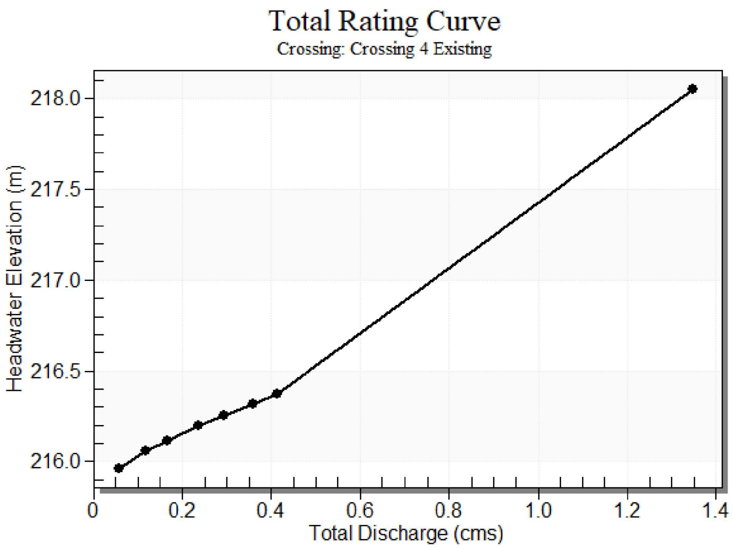


Table 8 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
2-Yr	0.06	0.06	215.96	0.205	0.0*	1-S2n	0.118	0.142	0.122	0.125	1.201
5-Yr	0.12	0.12	216.06	0.297	0.0*	1-S2n	0.168	0.204	0.168	0.182	1.551
10-Yr	0.17	0.17	216.12	0.356	0.0*	1-S2n	0.199	0.244	0.199	0.216	1.705
25-Yr	0.24	0.24	216.20	0.435	0.0*	1-S2n	0.239	0.293	0.239	0.257	1.884
50-Yr	0.30	0.30	216.26	0.496	0.0*	1-S2n	0.269	0.330	0.269	0.286	1.999
100-Yr	0.36	0.36	216.32	0.560	0.052	1-S2n	0.299	0.366	0.299	0.313	2.109
Check	0.41	0.41	216.37	0.613	0.117	1-S2n	0.323	0.393	0.323	0.335	2.187

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 215.76 m,   Outlet Elevation (invert): 215.33 m

Culvert Length: 15.08 m,   Culvert Slope: 0.0285

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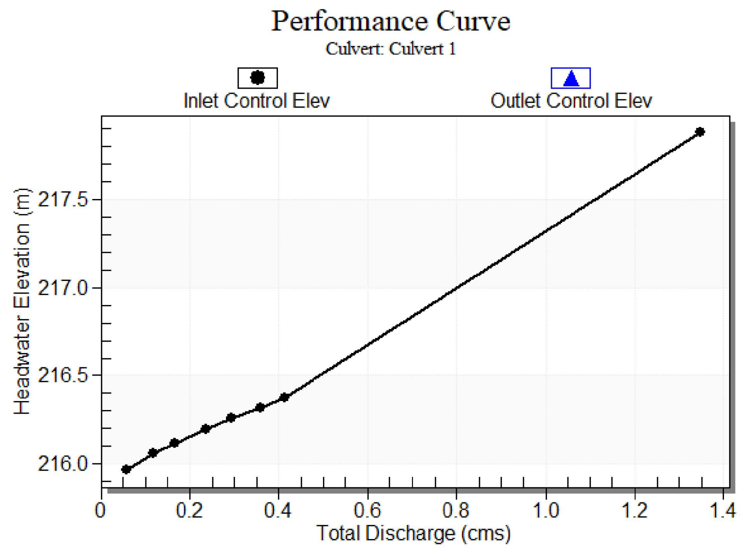
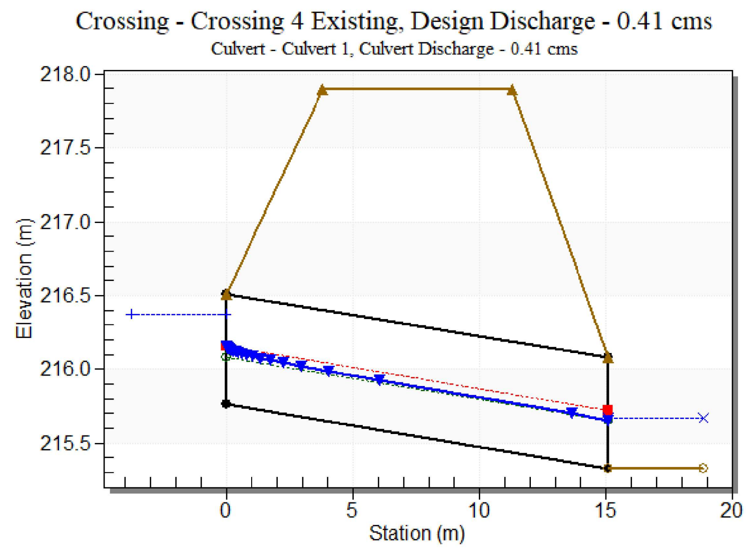
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 215.76 m

Outlet Station: 15.07 m

Outlet Elevation: 215.33 m

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 750.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: Crossing 4 Existing)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.06	215.46	0.13	0.41	6.15	0.43
0.12	215.51	0.18	0.50	8.90	0.45
0.17	215.55	0.22	0.55	10.57	0.46
0.24	215.59	0.26	0.61	12.59	0.47
0.30	215.62	0.29	0.64	14.00	0.48
0.36	215.64	0.31	0.68	15.35	0.48
0.41	215.66	0.33	0.70	16.40	0.49

Tailwater Channel Data - Crossing 4 Existing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 0.75 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0350

Channel Invert Elevation: 215.33 m

Roadway Data for Crossing: Crossing 4 Existing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 7.50 m

HY-8 Output: Crossing 4 Proposed

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 10 - Summary of Culvert Flows at Crossing: Crossing 4 Proposed

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Culvert 1: CSP Extension Discharge (cms)	Roadway Discharge (cms)	Iterations
216.02	2-Year	0.06	0.06	0.00	1
216.11	5-Year	0.12	0.12	0.00	1
216.17	10-Year	0.17	0.17	0.00	1
216.25	25-Year	0.24	0.24	0.00	1
216.31	50-Year	0.30	0.30	0.00	1
216.38	100-Year	0.36	0.36	0.00	1
216.43	Check	0.41	0.41	0.00	1
217.93	Overtopping	1.34	1.34	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 4 Proposed

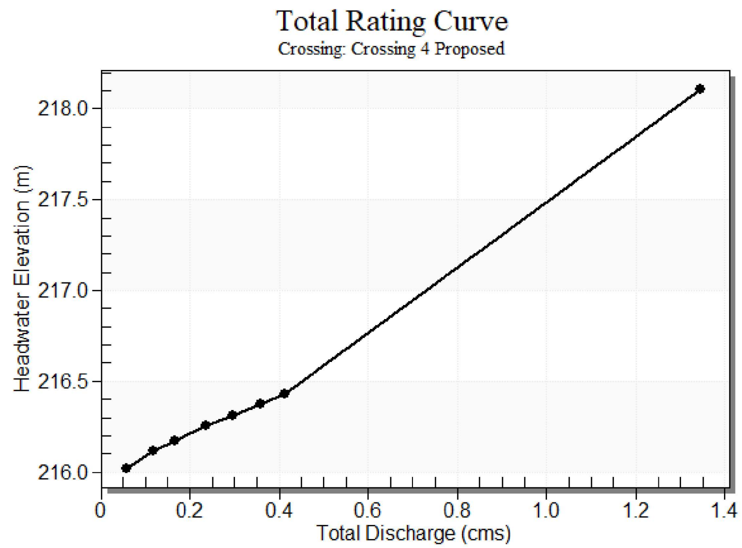


Table 11 - Culvert Summary Table: Culvert 1: CSP Extension

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
2-Year	0.06	0.06	216.02	0.205	0.0*	1-S2n	0.118	0.142	0.122	0.125	1.202
5-Year	0.12	0.12	216.11	0.297	0.0*	1-S2n	0.168	0.204	0.168	0.182	1.551
10-Year	0.17	0.17	216.17	0.356	0.0*	1-S2n	0.199	0.244	0.199	0.216	1.705
25-Year	0.24	0.24	216.25	0.435	0.0*	1-S2n	0.239	0.293	0.239	0.257	1.884
50-Year	0.30	0.30	216.31	0.496	0.0*	1-S2n	0.269	0.330	0.269	0.286	1.999
100-Year	0.36	0.36	216.38	0.560	0.0*	1-S2n	0.299	0.366	0.299	0.313	2.109
Check	0.41	0.41	216.43	0.613	0.0*	1-S2n	0.323	0.393	0.323	0.335	2.187

* Full Flow Headwater elevation is below inlet invert.

****

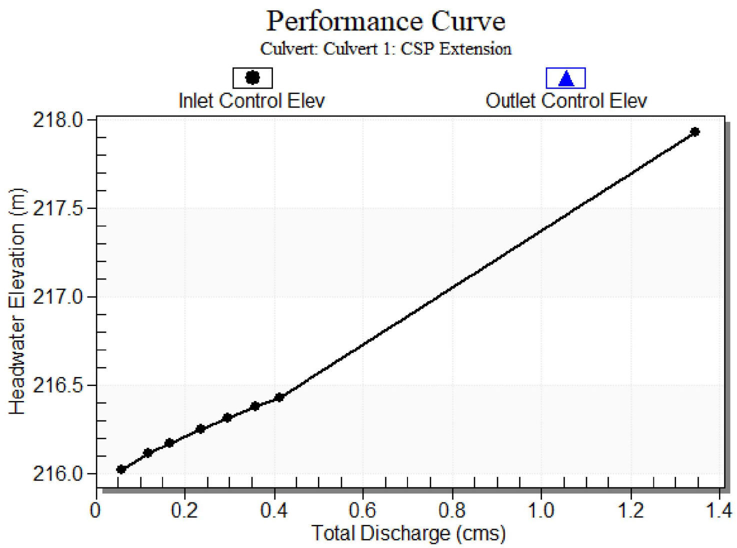
Straight Culvert

Inlet Elevation (invert): 215.82 m,   Outlet Elevation (invert): 215.23 m

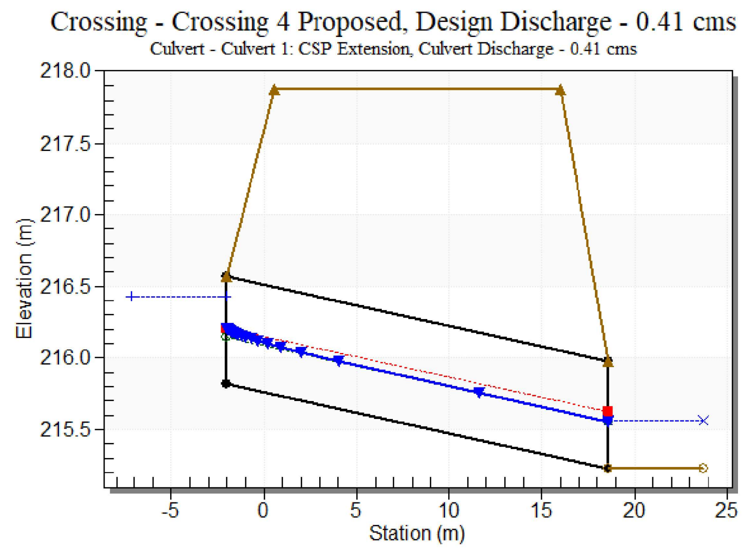
Culvert Length: 20.58 m,   Culvert Slope: 0.0285

****

Culvert Performance Curve Plot: Culvert 1: CSP Extension



Water Surface Profile Plot for Culvert: Culvert 1: CSP Extension



Site Data - Culvert 1: CSP Extension

Site Data Option: Culvert Invert Data

Inlet Station: -2.00 m

Inlet Elevation: 215.82 m

Outlet Station: 18.57 m

Outlet Elevation: 215.23 m

Number of Barrels: 1

Culvert Data Summary - Culvert 1: CSP Extension

Barrel Shape: Circular

Barrel Diameter: 750.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: Crossing 4 Proposed)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.06	215.36	0.13	0.41	6.15	0.43
0.12	215.41	0.18	0.50	8.90	0.45
0.17	215.45	0.22	0.55	10.57	0.46
0.24	215.49	0.26	0.61	12.59	0.47
0.30	215.52	0.29	0.64	14.00	0.48
0.36	215.54	0.31	0.68	15.35	0.48
0.41	215.56	0.33	0.70	16.40	0.49

Tailwater Channel Data - Crossing 4 Proposed

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 0.75 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0350

Channel Invert Elevation: 215.23 m

Roadway Data for Crossing: Crossing 4 Proposed

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

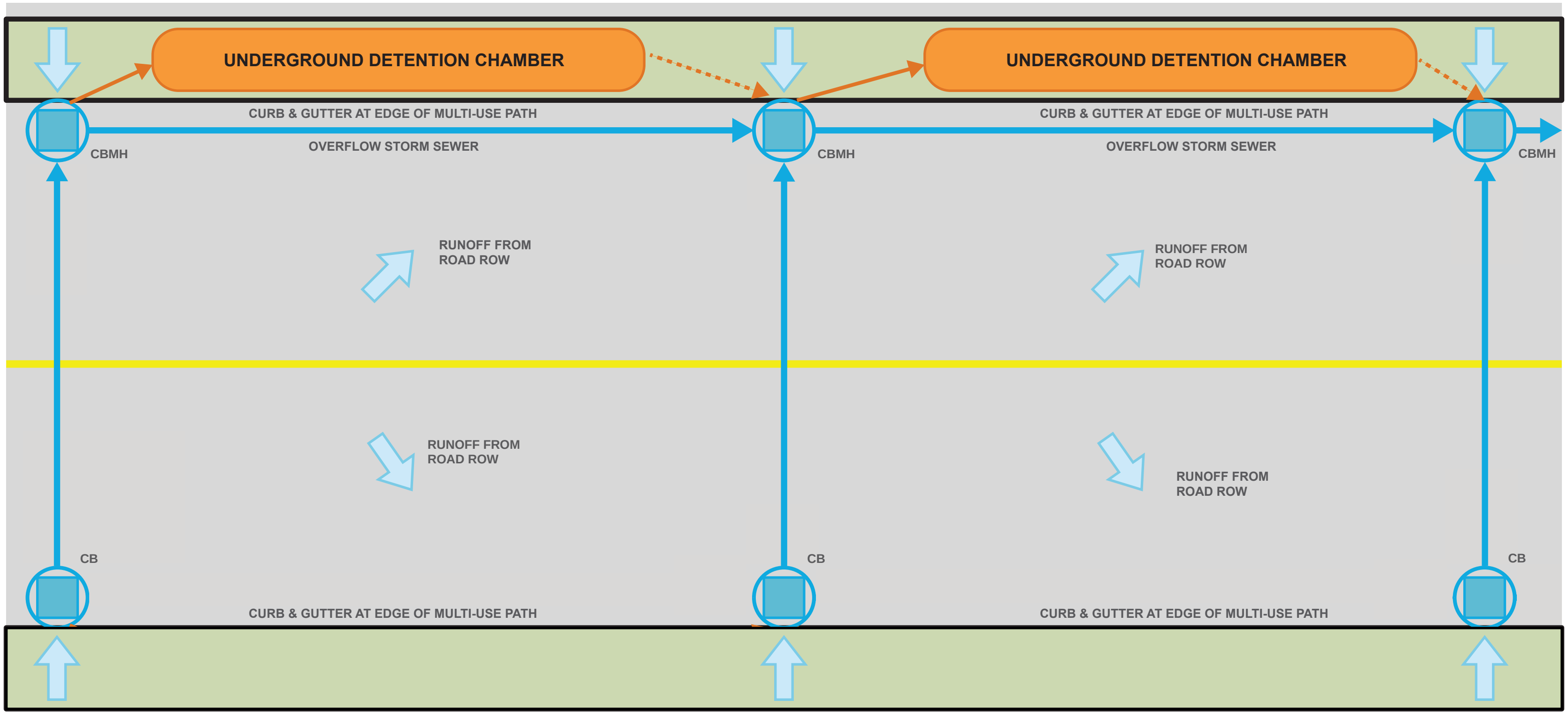
Roadway Surface: Paved

Roadway Top Width: 15.50 m

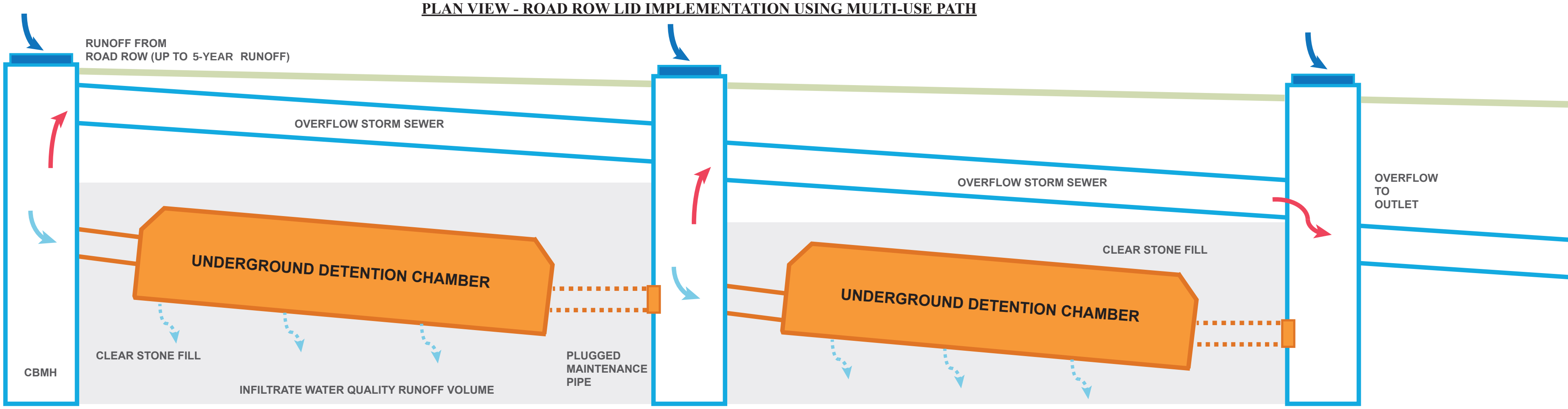
Appendix D: Exfiltration System Schematic

100 York Boulevard, Suite 300, Richmond Hill, ON, CA L4B 1J8
(289) 695-4600
hdrinc.com

SCHEMATIC OF LINEAR LID FEATURE (UNDERGROUND DETENTION) - FIGURE NOT TO SCALE



PLAN VIEW - ROAD ROW LID IMPLEMENTATION USING MULTI-USE PATH



PROFILE VIEW - SUB-SURFACE INFRASTRUCTURE

Appendix E: Stormwater Management Calculations

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Stormwater Management Calculations

TABLE 01
QUALITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	Drainage Area (ha)	Existing			Proposed			Increased Paved Area (ha)	Contributing Pavement Area (ha)	Required Treatment Volume[1] (m^3)	Water Balance Storage[3] (m^3)	Total Required Storage (m^3)	Required Exfil. Trench Area[2] (m^2)	Required Exfil. Trench Length (m)	Exfil. Trench Width (m)	Proposed Exfil. Trench Length (m)	Provided Water Balance Storage Volume (m3)	Provided Water Quality and Erosion Control Storage Volume (m^3)	Discharge Location
		Paved Area (ha)	% Impervious	Req. Volume (m^3)	Paved Area (ha)	% Impervious	Req. Volume (m^3)												
A1	0.92	0.55	60%	29.51	0.89	96%	39.75	0.34	0.34	10	17	17	170	121	1.4	140	31	31	Tributary of East Humber River (Crossing 1)
A2	0.52	0.26	49%	15.07	0.50	95%	22.45	0.24	0.50	22	25	25	250	179	1.4	185	41	41	Purpleville Creek (Crossing 2)
A3	0.31	0.14	45%	8.70	0.28	88%	12.72	0.13	0.28	13	14	14	138	98	1.4	120	27	27	Roadside ditches (ultimate outfall to Purpleville Creek)
A4	0.91	0.39	43%	24.50	0.79	87%	36.45	0.40	0.79	36	39	39	393	281	1.4	340	76	76	Tributary of Purpleville Creek (Crossing 3)
A5	0.24	0.11	46%	6.60	0.22	93%	9.89	0.11	0.11	3	5	5	55	39	1.4	80	18	18	Tributary of Purpleville Creek (Crossing 4)
A6	0.55	0.39	71%	19.43	0.51	93%	22.95	0.12	0.00	4	6	6	58	42	1.4	0	0	0	Proposed storm sewer system by Zzen-Lindvest Subdivision (no additional quality/quantity req'd)
A7	0.25	0.19	77%	9.14	0.24	99%	10.83	0.06	0.00	2	3	3	28	20	1.4	0	0	0	Existing storm sewer system by Zzen-Lindvest Subdivision on Ballantyne Blvd (no additional quality/quantity req'd)
Total	**3.70**	**2.02**			**3.42**			**1.40**	**2.01**	**90**	**109**	**109**	**1092**	**780**		**865**	**194**	**194**	

[1] From Table 3.2 of MOE SWM Planning and Design Manual (2003)
[2] 5% of the contributing pavement area
[3] Based on TRCA target of 5 mm retention

MOE Table 3.2

Impervious Level (%)	W.Q. Storage Vol. (m^3/ha)
35%	25
55%	30
70%	35
85%	40

Exfiltration Trench Dimensions

Hydraulic Conductivity =	1.00E-06 cm/s
Infiltration Rate, i =	12 mm/hr
Safety Factor =	3
Infilt. With Safety Factor	4.0 mm/hr
d_p =	0 mm
t_s =	48 hr
V_r =	0.4
$d_{r\ max}$ =	480 mm
d_r =	0.4 m
Perforated Pipe	0.00 m
$d_{filter} = d_{f\ minimum}$	0.00 m
$d_{pea\ gravel}$ =	0 m
d_{total} =	0.40 m

LID SWM GUIDE Table C1

Kfs cm/s	T min/cm	1/T mm/hr
0.1	2	300
0.01	4	150
0.001	8	75
0.0001	12	50
0.00001	20	30
0.000001	50	12

Note:
Kfs: Hydraulic Conductivity
T: Percolation Time
1/T: Infiltration Rate

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Stormwater Management Calculations

TABLE 02
QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	Existing			Proposed			Increased Paved Area (ha)	5-Year			100-Year			Humber River Unit Flow Rates (TRCA, 2012)		Remarks
	Drainage Area (ha)	Paved Area (ha)	Runoff Coefficient	Drainage Area (ha)	Paved Area (ha)	Runoff Coefficient		Existing Flow (m3/s)	Uncontrolled Proposed Flow (m3/s)	Req'd Storage Vol. (m^3)	Existing Flow (m3/s)	Uncontrolled Proposed Flow (m3/s)	Req'd Storage Vol. (m^3)	Req'd Storage Vol. (m^3) based on 5-Year	Req'd Storage Vol. (m^3) based on 100-Year	
A1	0.92	0.55	0.64	0.92	0.89	0.88	0.34	0.22	0.31	35	0.40	0.56	64	-	-	Tributary of East Humber River (Crossing 1)
A2	0.52	0.26	0.57	0.52	0.50	0.87	0.24	0.11	0.17	25	0.20	0.31	46	152	246	Purpleville Creek (Crossing 2)
A3	0.31	0.14	0.54	0.31	0.28	0.82	0.13	0.07	0.10	14	0.12	0.18	25	84	135	Roadside ditches (ultimate outfall to Purpleville Creek)
A4	0.91	0.39	0.53	0.91	0.79	0.81	0.40	0.18	0.28	41	0.33	0.51	75	245	397	Tributary of Purpleville Creek (Crossing 3)
A5	0.24	0.11	0.55	0.24	0.22	0.85	0.11	0.05	0.08	11	0.09	0.14	21	65	105	Tributary of Purpleville Creek (Crossing 4)
A6	0.55	0.39	0.71	0.55	0.51	0.85	0.12	0.15	0.18	12	0.27	0.32	22	154	250	Proposed storm sewer system by Zzen-Lindvest Subdivision (no additional quality/quantity req'd)
A7	0.25	0.19	0.75	0.25	0.24	0.90	0.06	0.07	0.08	6	0.13	0.15	11	73	117	Existing storm sewer system by Zzen-Lindvest Subdivision on Ballantyne Blvd (no additional quality/quantity req'd)
Total	3.70	2.02		3.70	3.42		1.40			127			230			
										Excludes A6, A7			Excludes A6, A7			

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Stormwater Management Calculations

TABLE 03
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A1**	
Existing Drainage Area	0.92	ha
Existing Pavement Area	0.55	ha
Existing Runoff Coefficient	0.64	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.92	ha
Proposed Pavement Area	0.89	ha
Proposed Runoff Coefficient	0.88	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
2-yr	647.7	4	0.784	1	98.84	161.46
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**224.08**
10-yr	1021	3	0.7870	1	166.73	272.37
25-yr	1100	2	0.7760	1	199.94	326.62
50-yr	1488	3	0.8030	1	234.21	382.60
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**404.73**

Peak Flow Control Requirement
Discharging to Crossing C-1 (Tributary to East Humber)

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	308.31	129.49	94.11	35.37
8	127.97	287.62	138.06	107.56	30.50
9	120.05	269.83	145.71	121.00	24.70
10	113.16	254.33	152.60	134.45	18.15
11	107.10	240.71	158.87	147.89	10.98
12	101.72	228.63	164.61	161.34	3.27
13	96.92	217.83	169.91	174.78	0.00
14	92.60	208.12	174.82	188.23	0.00
15	88.69	199.33	179.39	201.67	0.00
20	73.60	165.43	198.51	268.90	0.00
60	33.65	75.63	272.26	806.69	0.00
100	22.84	51.34	308.01	1344.48	0.00
120	19.85	44.61	321.21	1613.37	0.00
360	8.40	18.89	408.04	4840.12	0.00
720	4.86	10.91	471.44	9680.24	0.00
1440	2.80	6.29	543.49	19360.48	0.00
Required Storage Volume:			**35.37**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	556.86	233.88	169.99	63.89
8	230.70	518.52	248.89	194.27	54.62
9	216.04	485.58	262.21	218.56	43.65
10	203.31	456.95	274.17	242.84	31.33
11	192.12	431.81	285.00	267.12	17.87
12	182.22	409.55	294.88	291.41	3.47
13	173.38	389.69	303.96	315.69	0.00
14	165.44	371.85	312.35	339.98	0.00
15	158.27	355.72	320.15	364.26	0.00
20	130.68	293.71	352.45	485.68	0.00
60	58.47	131.41	473.07	1457.04	0.00
100	39.27	88.25	529.51	2428.40	0.00
120	33.99	76.40	550.07	2914.08	0.00
360	14.06	31.59	682.40	8742.24	0.00
720	8.00	17.98	776.58	17484.48	0.00
1440	4.54	10.21	881.78	34968.96	0.00
Required Storage Volume:			**63.89**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.31**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.22**	m^3/s	5 Year Existing Flow
Required Storage Volume	**35.37**	m^3	
Uncontrolled Discharge Flow Rate	**0.56**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.40**	m^3/s	100 Year Existing Flow
Required Storage Volume	**63.89**	m^3	

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Stormwater Management Calculations

TABLE 04
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A2**	
Existing Drainage Area	0.52	ha
Existing Pavement Area	0.26	ha
Existing Runoff Coefficient	0.57	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.52	ha
Proposed Pavement Area	0.50	ha
Proposed Runoff Coefficient	0.87	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
2-yr	647.7	4	0.784	1	98.84	81.70
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**113.38**
10-yr	1021	3	0.7870	1	166.73	137.82
25-yr	1100	2	0.7760	1	199.94	165.27
50-yr	1488	3	0.8030	1	234.21	193.59
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**204.79**

Peak Flow Control Requirement
Discharging to Crossing C-2 (Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	174.04	73.10	47.62	25.47
8	127.97	162.36	77.93	54.42	23.51
9	120.05	152.32	82.25	61.23	21.02
10	113.16	143.57	86.14	68.03	18.11
11	107.10	135.88	89.68	74.83	14.85
12	101.72	129.06	92.92	81.64	11.29
13	96.92	122.96	95.91	88.44	7.47
14	92.60	117.48	98.68	95.24	3.44
15	88.69	112.52	101.27	102.04	0.00
20	73.60	93.38	112.06	136.06	0.00
60	33.65	42.69	153.69	408.18	0.00
100	22.84	28.98	173.87	680.30	0.00
120	19.85	25.18	181.32	816.36	0.00
360	8.40	10.66	230.34	2449.07	0.00
720	4.86	6.16	266.12	4898.15	0.00
1440	2.80	3.55	306.80	9796.30	0.00
Required Storage Volume:			**25.47**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	314.35	132.03	86.01	46.01
8	230.70	292.70	140.50	98.30	42.19
9	216.04	274.10	148.02	110.59	37.43
10	203.31	257.94	154.77	122.88	31.89
11	192.12	243.76	160.88	135.16	25.72
12	182.22	231.19	166.46	147.45	19.01
13	173.38	219.98	171.58	159.74	11.85
14	165.44	209.91	176.32	172.03	4.30
15	158.27	200.80	180.72	184.31	0.00
20	130.68	165.80	198.96	245.75	0.00
60	58.47	74.18	267.04	737.25	0.00
100	39.27	49.82	298.91	1228.76	0.00
120	33.99	43.13	310.51	1474.51	0.00
360	14.06	17.83	385.21	4423.53	0.00
720	8.00	10.15	438.38	8847.05	0.00
1440	4.54	5.76	497.76	17694.10	0.00
Required Storage Volume:			**46.01**	**m^3**	

Required Storage Summary			
Uncontrolled Discharge Flow Rate	**0.17**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.11**	m^3/s	5 Year Existing Flow
Required Storage Volume	**25.47**	m^3	
Uncontrolled Discharge Flow Rate	**0.31**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.20**	m^3/s	100 Year Existing Flow
Required Storage Volume	**46.01**	m^3	

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Stormwater Management Calculations

TABLE 05

DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A2**	
Existing Drainage Area	0.52	ha
Existing Pavement Area	0.26	ha
Existing Runoff Coefficient	0.57	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.52	ha
Proposed Pavement Area	0.50	ha
Proposed Runoff Coefficient	0.87	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E

Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	4.89
5-yr	**7.89**
10-yr	9.88
25-yr	12.49
50-yr	14.69
100-yr	17.06

Peak Flow Control Requirement

Discharging to Crossing C-2 (Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	174.04	73.10	1.74	71.36
15	88.69	112.52	101.27	3.73	97.54
20	73.60	93.38	112.06	4.97	107.09
25	63.29	80.29	120.44	6.21	114.23
30	55.74	70.72	127.30	7.45	119.85
40	45.38	57.57	138.17	9.94	128.23
50	38.53	48.89	146.67	12.42	134.25
60	33.65	42.69	153.69	14.90	138.79
70	29.97	38.02	159.69	17.39	142.30
80	27.08	34.36	164.94	19.87	145.07
90	24.76	31.41	169.63	22.36	147.28
100	22.84	28.98	173.87	24.84	149.03
120	19.85	25.18	181.32	29.81	151.52
360	8.40	10.66	230.34	89.42	140.92
720	4.86	6.16	266.12	178.84	87.28
1440	2.80	3.55	306.80	357.68	0.00
Required Storage Volume:			**151.52**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	314.35	132.03	3.76	128.27
15	158.27	200.80	180.72	8.05	172.67
20	130.68	165.80	198.96	10.74	188.22
25	111.89	141.97	212.95	13.42	199.52
30	98.21	124.61	224.29	16.11	208.18
40	79.50	100.86	242.06	21.48	220.58
50	67.21	85.27	255.80	26.85	228.96
60	58.47	74.18	267.04	32.22	234.83
70	51.90	65.85	276.59	37.59	239.00
80	46.78	59.35	284.89	42.96	241.94
90	42.66	54.12	292.27	48.33	243.94
100	39.27	49.82	298.91	53.70	245.21
120	33.99	43.13	310.51	64.44	246.07
360	14.06	17.83	385.21	193.31	191.90
720	8.00	10.15	438.38	386.62	51.76
1440	4.54	5.76	497.76	773.24	0.00
Required Storage Volume:			**246.07**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.17**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.004**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**151.52**	m^3	
Uncontrolled Discharge Flow Rate	**0.31**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.009**	m^3/s	100 Year Unit Flows
Required Storage Volume	**246.07**	m^3	

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Stormwater Management Calculations

TABLE 06
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A3**	
Existing Drainage Area	0.31	ha
Existing Pavement Area	0.14	ha
Existing Runoff Coefficient	0.54	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.31	ha
Proposed Pavement Area	0.28	ha
Proposed Runoff Coefficient	0.82	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$				Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
	A	B	C	C_f		
2-yr	647.7	4	0.784	1	98.84	46.98
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**65.20**
10-yr	1021	3	0.7870	1	166.73	79.25
25-yr	1100	2	0.7760	1	199.94	95.03
50-yr	1488	3	0.8030	1	234.21	111.32
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**117.76**

Peak Flow Control Requirement
Discharging to Purpleville Creek

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	98.31	41.29	27.38	13.91
8	127.97	91.72	44.02	31.29	12.73
9	120.05	86.04	46.46	35.21	11.26
10	113.16	81.10	48.66	39.12	9.54
11	107.10	76.76	50.66	43.03	7.63
12	101.72	72.90	52.49	46.94	5.55
13	96.92	69.46	54.18	50.85	3.33
14	92.60	66.36	55.74	54.76	0.98
15	88.69	63.56	57.20	58.68	0.00
20	73.60	52.75	63.30	78.23	0.00
60	33.65	24.12	86.82	234.70	0.00
100	22.84	16.37	98.22	391.17	0.00
120	19.85	14.23	102.43	469.41	0.00
360	8.40	6.02	130.11	1408.22	0.00
720	4.86	3.48	150.33	2816.44	0.00
1440	2.80	2.01	173.31	5632.88	0.00
Required Storage Volume:			**13.91**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	177.57	74.58	49.46	25.12
8	230.70	165.34	79.36	56.52	22.84
9	216.04	154.84	83.61	63.59	20.02
10	203.31	145.71	87.43	70.65	16.77
11	192.12	137.69	90.88	77.72	13.16
12	182.22	130.60	94.03	84.78	9.25
13	173.38	124.26	96.93	91.85	5.08
14	165.44	118.57	99.60	98.92	0.69
15	158.27	113.43	102.09	105.98	0.00
20	130.68	93.66	112.39	141.31	0.00
60	58.47	41.90	150.85	423.92	0.00
100	39.27	28.14	168.85	706.54	0.00
120	33.99	24.36	175.40	847.84	0.00
360	14.06	10.07	217.60	2543.53	0.00
720	8.00	5.73	247.63	5087.06	0.00
1440	4.54	3.25	281.18	10174.12	0.00
Required Storage Volume:			**25.12**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.10**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.07**	m^3/s	5 Year Existing Flow
Required Storage Volume	**13.91**	m^3	
Uncontrolled Discharge Flow Rate	**0.18**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.12**	m^3/s	100 Year Existing Flow
Required Storage Volume	**25.12**	m^3	

Stormwater Management Calculations

TABLE 07
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A3**	
Existing Drainage Area	0.31	ha
Existing Pavement Area	0.14	ha
Existing Runoff Coefficient	0.54	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.31	ha
Proposed Pavement Area	0.28	ha
Proposed Runoff Coefficient	0.82	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E
Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	5.15
5-yr	**8.32**
10-yr	10.41
25-yr	13.15
50-yr	15.47
100-yr	17.98

Peak Flow Control Requirement
Discharging to Purpleville Creek

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	98.31	41.29	1.10	40.19
15	88.69	63.56	57.20	2.35	54.85
20	73.60	52.75	63.30	3.14	60.16
25	63.29	45.36	68.03	3.92	64.11
30	55.74	39.95	71.91	4.71	67.20
40	45.38	32.52	78.05	6.28	71.77
50	38.53	27.62	82.85	7.84	75.01
60	33.65	24.12	86.82	9.41	77.40
70	29.97	21.48	90.21	10.98	79.22
80	27.08	19.41	93.17	12.55	80.62
90	24.76	17.75	95.82	14.12	81.70
100	22.84	16.37	98.22	15.69	82.53
120	19.85	14.23	102.43	18.83	83.60
360	8.40	6.02	130.11	56.48	73.63
720	4.86	3.48	150.33	112.97	37.36
1440	2.80	2.01	173.31	225.93	0.00
Required Storage Volume:			**83.60**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	177.57	74.58	2.37	72.21
15	158.27	113.43	102.09	5.09	97.00
20	130.68	93.66	112.39	6.78	105.61
25	111.89	80.19	120.29	8.48	111.81
30	98.21	70.39	126.70	10.17	116.52
40	79.50	56.97	136.74	13.56	123.17
50	67.21	48.17	144.50	16.96	127.54
60	58.47	41.90	150.85	20.35	130.50
70	51.90	37.20	156.24	23.74	132.50
80	46.78	33.53	160.93	27.13	133.80
90	42.66	30.57	165.10	30.52	134.58
100	39.27	28.14	168.85	33.91	134.94
120	33.99	24.36	175.40	40.69	134.71
360	14.06	10.07	217.60	122.08	95.52
720	8.00	5.73	247.63	244.16	3.48
1440	4.54	3.25	281.18	488.31	0.00
Required Storage Volume:			**134.94**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.10**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.003**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**83.60**	m^3	
Uncontrolled Discharge Flow Rate	**0.18**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.006**	m^3/s	100 Year Unit Flows
Required Storage Volume	**134.94**	m^3	

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Stormwater Management Calculations

TABLE 08
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A4**	
Existing Drainage Area	0.91	ha
Existing Pavement Area	0.39	ha
Existing Runoff Coefficient	0.53	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.91	ha
Proposed Pavement Area	0.79	ha
Proposed Runoff Coefficient	0.81	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$				Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
	A	B	C	C_f		
2-yr	647.7	4	0.784	1	98.84	131.99
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**183.18**
10-yr	1021	3	0.7870	1	166.73	222.66
25-yr	1100	2	0.7760	1	199.94	267.00
50-yr	1488	3	0.8030	1	234.21	312.77
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**330.86**

Peak Flow Control Requirement
Discharging to Crossing C-3 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	281.49	118.22	76.94	41.29
8	127.97	262.60	126.05	87.93	38.12
9	120.05	246.36	133.03	98.92	34.11
10	113.16	232.21	139.33	109.91	29.42
11	107.10	219.77	145.05	120.90	24.15
12	101.72	208.74	150.29	131.89	18.40
13	96.92	198.88	155.13	142.88	12.24
14	92.60	190.01	159.61	153.87	5.74
15	88.69	181.99	163.79	164.86	0.00
20	73.60	151.04	181.24	219.82	0.00
60	33.65	69.05	248.58	659.45	0.00
100	22.84	46.87	281.22	1099.09	0.00
120	19.85	40.73	293.27	1318.90	0.00
360	8.40	17.25	372.55	3956.71	0.00
720	4.86	9.96	430.43	7913.43	0.00
1440	2.80	5.74	496.21	15826.86	0.00
Required Storage Volume:			**41.29**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	508.42	213.54	138.96	74.57
8	230.70	473.41	227.24	158.81	68.42
9	216.04	443.34	239.40	178.67	60.74
10	203.31	417.20	250.32	198.52	51.80
11	192.12	394.25	260.20	218.37	41.84
12	182.22	373.93	269.23	238.22	31.01
13	173.38	355.79	277.52	258.07	19.45
14	165.44	339.50	285.18	277.92	7.26
15	158.27	324.78	292.30	297.78	0.00
20	130.68	268.16	321.79	397.03	0.00
60	58.47	119.98	431.92	1191.10	0.00
100	39.27	80.57	483.45	1985.17	0.00
120	33.99	69.75	502.22	2382.21	0.00
360	14.06	28.84	623.04	7146.63	0.00
720	8.00	16.41	709.03	14293.26	0.00
1440	4.54	9.32	805.07	28586.51	0.00
Required Storage Volume:			**74.57**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.28**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.18**	m^3/s	5 Year Existing Flow
Required Storage Volume	**41.29**	m^3	
Uncontrolled Discharge Flow Rate	**0.51**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.33**	m^3/s	100 Year Existing Flow
Required Storage Volume	**74.57**	m^3	

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Stormwater Management Calculations

TABLE 09
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A4**	
Existing Drainage Area	0.91	ha
Existing Pavement Area	0.39	ha
Existing Runoff Coefficient	0.53	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.91	ha
Proposed Pavement Area	0.79	ha
Proposed Runoff Coefficient	0.81	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E
Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	4.62
5-yr	**7.44**
10-yr	9.31
25-yr	11.78
50-yr	13.85
100-yr	16.08

Peak Flow Control Requirement
Discharging to Crossing C-3 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	281.49	118.22	2.84	115.39
15	88.69	181.99	163.79	6.08	157.71
20	73.60	151.04	181.24	8.11	173.13
25	63.29	129.87	194.80	10.14	184.66
30	55.74	114.38	205.89	12.16	193.73
40	45.38	93.11	223.47	16.22	207.26
50	38.53	79.07	237.22	20.27	216.95
60	33.65	69.05	248.58	24.33	224.25
70	29.97	61.50	258.28	28.38	229.90
80	27.08	55.58	266.78	32.43	234.35
90	24.76	50.81	274.36	36.49	237.88
100	22.84	46.87	281.22	40.54	240.68
120	19.85	40.73	293.27	48.65	244.62
360	8.40	17.25	372.55	145.95	226.60
720	4.86	9.96	430.43	291.90	138.53
1440	2.80	5.74	496.21	583.81	0.00
Required Storage Volume:			**244.62**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	508.42	213.54	6.14	207.40
15	158.27	324.78	292.30	13.15	279.15
20	130.68	268.16	321.79	17.53	304.26
25	111.89	229.61	344.42	21.92	322.51
30	98.21	201.54	362.77	26.30	336.47
40	79.50	163.13	391.51	35.07	356.45
50	67.21	137.91	413.74	43.83	369.90
60	58.47	119.98	431.92	52.60	379.32
70	51.90	106.51	447.35	61.37	385.98
80	46.78	96.00	460.78	70.13	390.65
90	42.66	87.54	472.71	78.90	393.81
100	39.27	80.57	483.45	87.66	395.78
120	33.99	69.75	502.22	105.20	397.02
360	14.06	28.84	623.04	315.59	307.45
720	8.00	16.41	709.03	631.18	77.84
1440	4.54	9.32	805.07	1262.37	0.00
Required Storage Volume:			**397.02**	**m^3**	

Required Storage Summary			
Uncontrolled Discharge Flow Rate	**0.28**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.007**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**244.62**	m^3	
Uncontrolled Discharge Flow Rate	**0.51**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.015**	m^3/s	100 Year Unit Flows
Required Storage Volume	**397.02**	m^3	

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Stormwater Management Calculations

TABLE 10
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A5**	
Existing Drainage Area	0.24	ha
Existing Pavement Area	0.11	ha
Existing Runoff Coefficient	0.55	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.24	ha
Proposed Pavement Area	0.22	ha
Proposed Runoff Coefficient	0.85	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$				Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
	A	B	C	C_f		
2-yr	647.7	4	0.784	1	98.84	35.70
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**49.55**
10-yr	1021	3	0.7870	1	166.73	60.23
25-yr	1100	2	0.7760	1	199.94	72.22
50-yr	1488	3	0.8030	1	234.21	84.60
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**89.50**

Peak Flow Control Requirement
Discharging to Crossing C-4 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	76.59	32.17	20.81	11.36
8	127.97	71.45	34.30	23.78	10.51
9	120.05	67.03	36.20	26.76	9.44
10	113.16	63.18	37.91	29.73	8.18
11	107.10	59.80	39.47	32.70	6.76
12	101.72	56.80	40.89	35.68	5.22
13	96.92	54.11	42.21	38.65	3.56
14	92.60	51.70	43.43	41.62	1.81
15	88.69	49.52	44.57	44.59	0.00
20	73.60	41.10	49.32	59.46	0.00
60	33.65	18.79	67.64	178.38	0.00
100	22.84	12.75	76.52	297.29	0.00
120	19.85	11.08	79.80	356.75	0.00
360	8.40	4.69	101.37	1070.26	0.00
720	4.86	2.71	117.12	2140.52	0.00
1440	2.80	1.56	135.02	4281.04	0.00
Required Storage Volume:			**11.36**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	138.34	58.10	37.59	20.51
8	230.70	128.81	61.83	42.96	18.87
9	216.04	120.63	65.14	48.33	16.81
10	203.31	113.52	68.11	53.70	14.41
11	192.12	107.27	70.80	59.07	11.73
12	182.22	101.74	73.26	64.44	8.82
13	173.38	96.81	75.51	69.81	5.71
14	165.44	92.38	77.60	75.18	2.42
15	158.27	88.37	79.53	80.55	0.00
20	130.68	72.97	87.56	107.39	0.00
60	58.47	32.65	117.52	322.18	0.00
100	39.27	21.92	131.54	536.97	0.00
120	33.99	18.98	136.65	644.37	0.00
360	14.06	7.85	169.53	1933.11	0.00
720	8.00	4.47	192.92	3866.21	0.00
1440	4.54	2.54	219.06	7732.43	0.00
Required Storage Volume:			**20.51**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.08**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.05**	m^3/s	5 Year Existing Flow
Required Storage Volume	**11.36**	m^3	
Uncontrolled Discharge Flow Rate	**0.14**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.09**	m^3/s	100 Year Existing Flow
Required Storage Volume	**20.51**	m^3	

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Stormwater Management Calculations

TABLE 11
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A5**	
Existing Drainage Area	0.24	ha
Existing Pavement Area	0.11	ha
Existing Runoff Coefficient	0.55	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.24	ha
Proposed Pavement Area	0.22	ha
Proposed Runoff Coefficient	0.85	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E
Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	5.29
5-yr	**8.56**
10-yr	10.70
25-yr	13.53
50-yr	15.92
100-yr	18.49

Peak Flow Control Requirement
Discharging to Crossing C-4 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	76.59	32.17	0.85	31.32
15	88.69	49.52	44.57	1.81	42.75
20	73.60	41.10	49.32	2.42	46.90
25	63.29	35.34	53.00	3.02	49.98
30	55.74	31.12	56.02	3.62	52.40
40	45.38	25.34	60.81	4.83	55.97
50	38.53	21.52	64.55	6.04	58.51
60	33.65	18.79	67.64	7.25	60.39
70	29.97	16.73	70.28	8.46	61.82
80	27.08	15.12	72.59	9.67	62.93
90	24.76	13.82	74.65	10.87	63.78
100	22.84	12.75	76.52	12.08	64.44
120	19.85	11.08	79.80	14.50	65.30
360	8.40	4.69	101.37	43.49	57.88
720	4.86	2.71	117.12	86.99	30.13
1440	2.80	1.56	135.02	173.97	0.00
Required Storage Volume:			**65.30**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	138.34	58.10	1.83	56.28
15	158.27	88.37	79.53	3.92	75.62
20	130.68	72.97	87.56	5.22	82.34
25	111.89	62.48	93.72	6.53	87.19
30	98.21	54.84	98.71	7.83	90.87
40	79.50	44.39	106.53	10.44	96.09
50	67.21	37.53	112.58	13.05	99.52
60	58.47	32.65	117.52	15.67	101.86
70	51.90	28.98	121.72	18.28	103.45
80	46.78	26.12	125.38	20.89	104.49
90	42.66	23.82	128.62	23.50	105.12
100	39.27	21.92	131.54	26.11	105.44
120	33.99	18.98	136.65	31.33	105.32
360	14.06	7.85	169.53	93.99	75.53
720	8.00	4.47	192.92	187.99	4.94
1440	4.54	2.54	219.06	375.98	0.00
Required Storage Volume:			**105.44**	**m^3**	

Required Storage Summary			
Uncontrolled Discharge Flow Rate	**0.08**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.002**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**65.30**	m^3	
Uncontrolled Discharge Flow Rate	**0.14**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.004**	m^3/s	100 Year Unit Flows
Required Storage Volume	**105.44**	m^3	

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Stormwater Management Calculations

TABLE 12
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A6**	
Existing Drainage Area	0.55	ha
Existing Pavement Area	0.39	ha
Existing Runoff Coefficient	0.71	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.55	ha
Proposed Pavement Area	0.51	ha
Proposed Runoff Coefficient	0.85	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$				Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
	A	B	C	C_f		
2-yr	647.7	4	0.784	1	98.84	107.20
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**148.77**
10-yr	1021	3	0.7870	1	166.73	180.84
25-yr	1100	2	0.7760	1	199.94	216.85
50-yr	1488	3	0.8030	1	234.21	254.02
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**268.71**

Peak Flow Control Requirement

Discharging to Storm Sewer by Country Wide Subdivision (Discharging to Crossing C-4 (Tributary of Purpleville Creek) under interim conditions)

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	177.70	74.63	62.48	12.15
8	127.97	165.78	79.57	71.41	8.16
9	120.05	155.52	83.98	80.34	3.64
10	113.16	146.59	87.95	89.26	0.00
11	107.10	138.74	91.57	98.19	0.00
12	101.72	131.77	94.88	107.12	0.00
13	96.92	125.55	97.93	116.04	0.00
14	92.60	119.95	100.76	124.97	0.00
15	88.69	114.89	103.40	133.90	0.00
20	73.60	95.35	114.42	178.53	0.00
60	33.65	43.59	156.92	535.58	0.00
100	22.84	29.59	177.53	892.64	0.00
120	19.85	25.71	185.14	1071.17	0.00
360	8.40	10.89	235.19	3213.50	0.00
720	4.86	6.29	271.73	6427.00	0.00
1440	2.80	3.63	313.25	12854.00	0.00
Required Storage Volume:			**12.15**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	320.96	134.80	112.86	21.94
8	230.70	298.86	143.45	128.98	14.47
9	216.04	279.87	151.13	145.11	6.03
10	203.31	263.37	158.02	161.23	0.00
11	192.12	248.89	164.26	177.35	0.00
12	182.22	236.06	169.96	193.47	0.00
13	173.38	224.61	175.19	209.60	0.00
14	165.44	214.32	180.03	225.72	0.00
15	158.27	205.03	184.53	241.84	0.00
20	130.68	169.29	203.14	322.46	0.00
60	58.47	75.74	272.67	967.37	0.00
100	39.27	50.87	305.20	1612.29	0.00
120	33.99	44.03	317.05	1934.74	0.00
360	14.06	18.21	393.32	5804.23	0.00
720	8.00	10.36	447.60	11608.46	0.00
1440	4.54	5.88	508.23	23216.93	0.00
Required Storage Volume:			**21.94**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.18**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.15**	m^3/s	5 Year Existing Flow
Required Storage Volume	**12.15**	m^3	
Uncontrolled Discharge Flow Rate	**0.32**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.27**	m^3/s	100 Year Existing Flow
Required Storage Volume	**21.94**	m^3	

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Stormwater Management Calculations

TABLE 13
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A6**	
Existing Drainage Area	0.55	ha
Existing Pavement Area	0.39	ha
Existing Runoff Coefficient	0.71	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.55	ha
Proposed Pavement Area	0.51	ha
Proposed Runoff Coefficient	0.85	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E
Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	4.87
5-yr	**7.86**
10-yr	9.84
25-yr	12.44
50-yr	14.62
100-yr	16.99

Peak Flow Control Requirement
Discharging to Crossing C-4 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	177.70	74.63	1.80	72.83
15	88.69	114.89	103.40	3.87	99.53
20	73.60	95.35	114.42	5.16	109.26
25	63.29	81.98	122.97	6.45	116.53
30	55.74	72.21	129.98	7.73	122.24
40	45.38	58.78	141.08	10.31	130.76
50	38.53	49.92	149.76	12.89	136.87
60	33.65	43.59	156.92	15.47	141.45
70	29.97	38.82	163.05	18.05	145.00
80	27.08	35.09	168.42	20.63	147.79
90	24.76	32.07	173.20	23.20	150.00
100	22.84	29.59	177.53	25.78	151.75
120	19.85	25.71	185.14	30.94	154.20
360	8.40	10.89	235.19	92.82	142.37
720	4.86	6.29	271.73	185.63	86.09
1440	2.80	3.63	313.25	371.26	0.00
Required Storage Volume:			**154.20**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	320.96	134.80	3.90	130.90
15	158.27	205.03	184.53	8.36	176.17
20	130.68	169.29	203.14	11.15	192.00
25	111.89	144.95	217.43	13.93	203.50
30	98.21	127.23	229.01	16.72	212.29
40	79.50	102.98	247.16	22.29	224.86
50	67.21	87.06	261.19	27.87	233.32
60	58.47	75.74	272.67	33.44	239.22
70	51.90	67.24	282.41	39.02	243.39
80	46.78	60.60	290.89	44.59	246.30
90	42.66	55.26	298.42	50.16	248.25
100	39.27	50.87	305.20	55.74	249.46
120	33.99	44.03	317.05	66.88	250.16
360	14.06	18.21	393.32	200.65	192.67
720	8.00	10.36	447.60	401.30	46.30
1440	4.54	5.88	508.23	802.60	0.00
Required Storage Volume:			**250.16**	**m^3**	

Required Storage Summary			
Uncontrolled Discharge Flow Rate	**0.18**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.004**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**154.20**	m^3	
Uncontrolled Discharge Flow Rate	**0.32**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.009**	m^3/s	100 Year Unit Flows
Required Storage Volume	**250.16**	m^3	

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Stormwater Management Calculations

TABLE 14
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A7**	
Existing Drainage Area	0.25	ha
Existing Pavement Area	0.19	ha
Existing Runoff Coefficient	0.75	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.25	ha
Proposed Pavement Area	0.24	ha
Proposed Runoff Coefficient	0.90	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Existing and Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)	Allowable Release Rate (L/s)
2-yr	647.7	4	0.784	1	98.84	50.58
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**	**70.20**
10-yr	1021	3	0.7870	1	166.73	85.33
25-yr	1100	2	0.7760	1	199.94	102.32
50-yr	1488	3	0.8030	1	234.21	119.86
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**	**126.80**

Peak Flow Control Requirement
Discharging to Existing Storm Sewer on Ballantyne Boulevard

Storage Volume Calculation - 5 Year Post to 5 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	84.08	35.31	29.48	5.83
8	127.97	78.44	37.65	33.70	3.96
9	120.05	73.59	39.74	37.91	1.83
10	113.16	69.36	41.62	42.12	0.00
11	107.10	65.65	43.33	46.33	0.00
12	101.72	62.35	44.89	50.54	0.00
13	96.92	59.41	46.34	54.76	0.00
14	92.60	56.76	47.68	58.97	0.00
15	88.69	54.36	48.92	63.18	0.00
20	73.60	45.12	54.14	84.24	0.00
60	33.65	20.63	74.25	252.72	0.00
100	22.84	14.00	84.00	421.20	0.00
120	19.85	12.17	87.60	505.44	0.00
360	8.40	5.15	111.28	1516.33	0.00
720	4.86	2.98	128.57	3032.66	0.00
1440	2.80	1.72	148.22	6065.32	0.00
Required Storage Volume:			**5.83**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Pre

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	151.87	63.78	53.25	10.53
8	230.70	141.41	67.88	60.86	7.01
9	216.04	132.43	71.51	68.47	3.04
10	203.31	124.62	74.77	76.08	0.00
11	192.12	117.76	77.72	83.69	0.00
12	182.22	111.69	80.42	91.29	0.00
13	173.38	106.28	82.90	98.90	0.00
14	165.44	101.41	85.18	106.51	0.00
15	158.27	97.01	87.31	114.12	0.00
20	130.68	80.10	96.12	152.16	0.00
60	58.47	35.84	129.02	456.47	0.00
100	39.27	24.07	144.41	760.78	0.00
120	33.99	20.84	150.01	912.93	0.00
360	14.06	8.62	186.10	2738.80	0.00
720	8.00	4.90	211.79	5477.60	0.00
1440	4.54	2.78	240.48	10955.19	0.00
Required Storage Volume:			**10.53**	**m^3**	

Required Storage Summary

Uncontrolled Discharge Flow Rate	**0.08**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.07**	m^3/s	5 Year Existing Flow
Required Storage Volume	**5.83**	m^3	
Uncontrolled Discharge Flow Rate	**0.15**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.13**	m^3/s	100 Year Existing Flow
Required Storage Volume	**10.53**	m^3	

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Stormwater Management Calculations

TABLE 15
DRAINAGE AREA QUANTITY CONTROL REQUIREMENT CALCULATION

Drainage Area ID	**A7**	
Existing Drainage Area	0.25	ha
Existing Pavement Area	0.19	ha
Existing Runoff Coefficient	0.75	*Assume pavement C = 0.9, landscaped C = 0.25*
Proposed Drainage Area	0.25	ha
Proposed Pavement Area	0.24	ha
Proposed Runoff Coefficient	0.90	*Assume pavement C = 0.9, landscaped C = 0.25*
Time of Concentration	7	minute

Proposed - City of Vaughan Rainfall Parameters

Return Period	IDF Parameters (City of Vaughan) $i = C_f \times A / (Tc + B)^C$ A	B	C	C_f	Rainfall Intensity (mm/hr)
2-yr	647.7	4	0.784	1	98.84
5-yr	**929.6**	**4**	**0.7980**	**1**	**137.17**
10-yr	1021	3	0.7870	1	166.73
25-yr	1100	2	0.7760	1	199.94
50-yr	1488	3	0.8030	1	234.21
100-yr	**1770**	**4**	**0.8200**	**1**	**247.76**

Humber River SWM Quantity Control Release Rates

Equation E
Sub-Basin 19A

Return Period	Unit Flow Rates (L/s/ha)
2-yr	5.27
5-yr	**8.52**
10-yr	10.66
25-yr	13.47
50-yr	15.85
100-yr	18.41

Peak Flow Control Requirement
Discharging to Crossing C-4 (Tributary of Purpleville Creek)

Storage Volume Calculation - 5 Year Post to 5 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	137.17	84.08	35.31	0.88	34.43
15	88.69	54.36	48.92	1.89	47.04
20	73.60	45.12	54.14	2.52	51.62
25	63.29	38.79	58.19	3.14	55.04
30	55.74	34.17	61.50	3.77	57.73
40	45.38	27.81	66.75	5.03	61.72
50	38.53	23.62	70.86	6.29	64.57
60	33.65	20.63	74.25	7.55	66.70
70	29.97	18.37	77.15	8.80	68.35
80	27.08	16.60	79.69	10.06	69.63
90	24.76	15.18	81.95	11.32	70.63
100	22.84	14.00	84.00	12.58	71.43
120	19.85	12.17	87.60	15.09	72.51
360	8.40	5.15	111.28	45.28	66.01
720	4.86	2.98	128.57	90.55	38.02
1440	2.80	1.72	148.22	181.10	0.00
Required Storage Volume:			**72.51**	**m^3**	

Storage Volume Calculation - 100 Year Post to 100 Year Unit Flows

Time (minutes)	Rainfall Intensity (mm/hr)	Peak Flow (L/s)	Storm Runoff Volume (m^3)	Ex. Discharge Flow Vol. (m^3)	Required Storage Volume (m^3)
7	247.76	151.87	63.78	1.90	61.88
15	158.27	97.01	87.31	4.08	83.23
20	130.68	80.10	96.12	5.44	90.68
25	111.89	68.59	102.88	6.79	96.09
30	98.21	60.20	108.36	8.15	100.21
40	79.50	48.73	116.95	10.87	106.07
50	67.21	41.19	123.58	13.59	110.00
60	58.47	35.84	129.02	16.31	112.71
70	51.90	31.82	133.62	19.03	114.60
80	46.78	28.67	137.64	21.74	115.89
90	42.66	26.15	141.20	24.46	116.74
100	39.27	24.07	144.41	27.18	117.23
120	33.99	20.84	150.01	32.62	117.40
360	14.06	8.62	186.10	97.85	88.26
720	8.00	4.90	211.79	195.69	16.10
1440	4.54	2.78	240.48	391.39	0.00
Required Storage Volume:			**117.40**	**m^3**	

Required Storage Summary			
Uncontrolled Discharge Flow Rate	**0.08**	m^3/s	5 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.002**	m^3/s	5 Year Unit Flow Flows
Required Storage Volume	**72.51**	m^3	
Uncontrolled Discharge Flow Rate	**0.15**	m^3/s	100 Year Proposed Conditions
Controlled Discharge Flow Rate	**0.005**	m^3/s	100 Year Unit Flows
Required Storage Volume	**117.40**	m^3	

Appendix F: Excerpt from the Zzen-Lindvest Residential Subdivision Final Stormwater Management Report by Urban Ecosystems Limited (June, 2017)

100 York Boulevard, Suite 300, Richmond Hill, ON, CA L4B 1J8
(289) 695-4600

FINAL STORMWATER MANAGEMENT REPORT

ZZEN-LINDVEST RESIDENTIAL SUBDIVISION

PART OF LOTS 24 & 25, CONCESSION 7

CITY OF VAUGHAN, ONTARIO

06011.300
JUNE 23, 2017

7050 Weston Road, Suite 705 Woodbridge, Ontario L4L 8G7
Telephone (905) 856-0629 Fax: (905) 856-0698
uel@urbanecosystems.com


0.80Ha
AREA502
2.03Ha
AREA103
0.93Ha
AREA102
TESTON ROAD (REGIONAL ROAD No. 49)
TESTON RD.
70m OF AVAILABILE
INFILTRATION TRENCH
(30m REQUIRED)
4.80 Ha
AREA101
10.87Ha
AREA501
0.55Ha
AREA1114
OPEN SPACE BUFFER
VISTA
STREET 7
STREET 8
STREET 9
STREET 10
STREET 1
STREET 5
STREET 4
STREET 3
STREET 2
SCHOOL
BLOCK 395
10.56 Ha
AREA201
2.42 Ha
AREA202
PARK
BLOCK 394
2.18 Ha
AREA203
0.56 Ha
AREA204
PINE VALLEY DRIVE
FUTURE LOCATION OF
INFILTRATION TRENCH
(230m AVAILABLE)
(130m REQUIRED)
1.41Ha
AREA1113
BLOCK393
OPEN SPACE
VALLEY
STREET 11
STREET 12
10.09 Ha
AREA301
6.07 Ha
SEE DWG FIG. 2.1-B
ZZEN-LINDVEST
RESIDENTIAL SUBDIVISION
URBAN ECOSYSTEMS LIMITED
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WOODBRIDGE, ONTARIO L4L 8G7
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UEL
POST DEVELOPMENT DRAINAGE
AREA PLAN
DATE
MARCH 2017
PROJECT No.
06011
FIGURE
FIGURE 2.1-A

ZZEN / LINDVEST SUBDIVISION
GENERAL SERVICING

ZZEN-LINDVEST
RESIDENTIAL SUBDIVISION

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POST DEVELOPMENT DRAINAGE
AREA PLAN

DATE	PROJECT No.	FIGURE
MARCH 2017	06011	FIGURE 2.1-B