STORMWATER MANAGEMENT PLAN

STONEBRIDGE VILLAGE SUBDIVISION

CITY OF PORT COLBORNE

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REFERENCES

1. Stormwater Management Planning and Design Manual
   Ontario Ministry of Environment (March 2003)

STORMWATER MANAGEMENT PLAN

STONEBRIDGE VILLAGE SUBDIVISION

CITY OF PORT COLBORNE

1.0 INTRODUCTION

1.1 Study Area

The proposed residential development is located in the City of Port Colborne as part of Lot 31 and Concession 3. As shown on the enclosed Site Location Plan (Figure 1), the subject property is situated west of West Side Road (Highway 58), north of Barrick Road and south/east of the Biederman Municipal Drain.

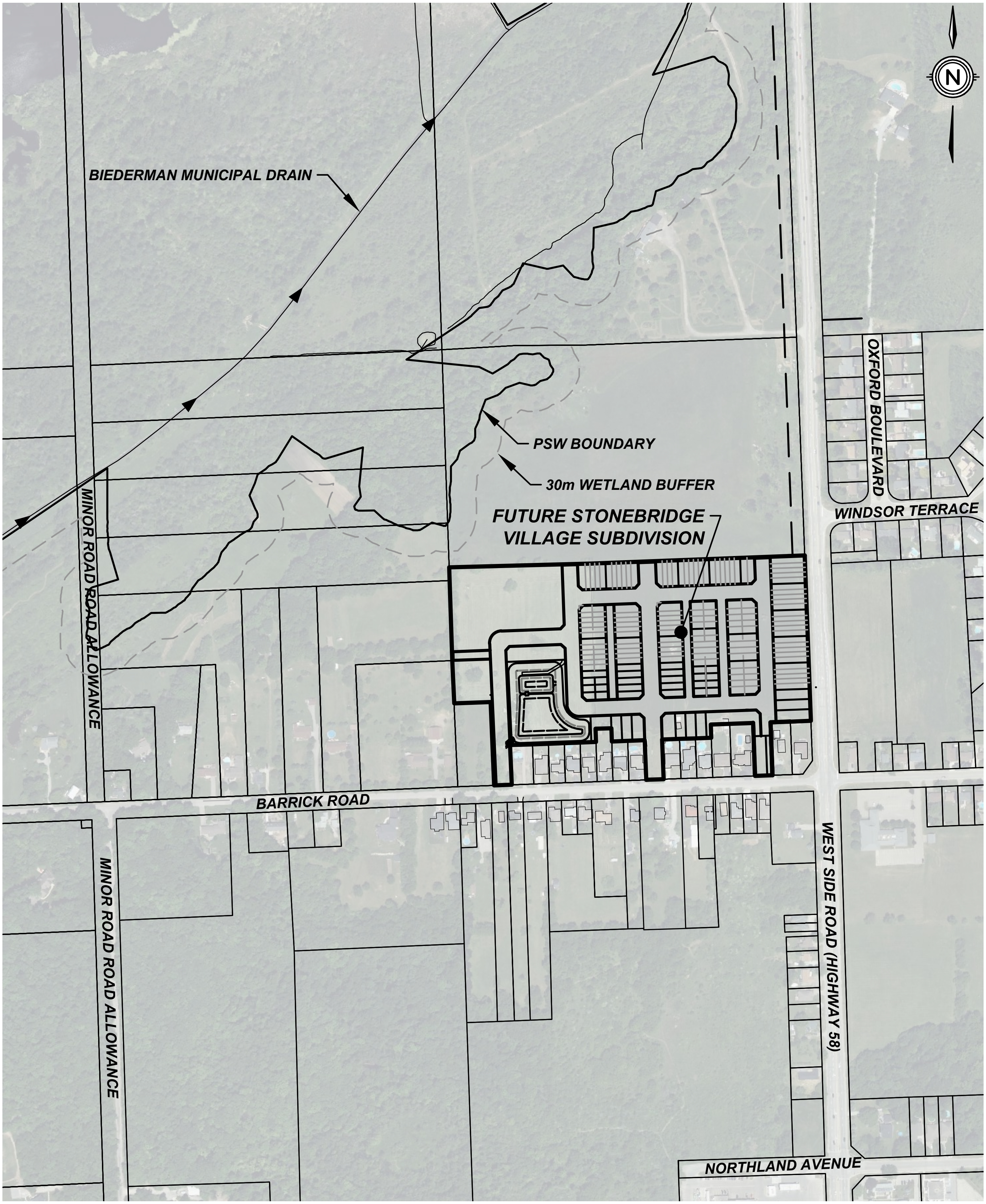
The 8.34-hectare property is bound by West Side Road (Highway 58) to the east, existing agricultural lands to the north and residential lands to the south and west. The proposed development will include two roadway entrances to Barrick Road, a park block, a Stormwater Management (SWM) Facility block, as well as two separate condo blocks. The current development plan will result in a residential subdivision consisting of a total of 385 residential units and has been designed to allow for future development expansion to the available vacant agricultural lands north of the site.

The drainage areas contributing to the Stormwater Management (SWM) Plan consist of the development site, as well as the available development area to the north. All stormwater flows from the proposed development site are ultimately conveyed to the Biederman Municipal Drain north-west of the property, however flows are conveyed there through four (4) separate paths as outlined further in this report. The intention of this Stormwater Management Plan is to prove and outline an overall stormwater management model for the entire development area consisting of Stonebridge Village as well as the outlined available northern development lands.

1.2 Objectives

The objectives of this study are as follows:

1. Establish specific criteria for the management of stormwater from this site.
2. Determine the impact of development on the stormwater peak flow & volume of from this site.
3. Investigate alternatives for controlling the quantity and quality of stormwater from this site.
4. Recommend a comprehensive plan for the management of stormwater during and after construction.



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STONEBRIDGE VILLAGE

CITY OF PORT COLBORNE

SITE LOCATION PLAN

DATE	2024–03–04
SCALE	1:6,000 m
REF No.	2300
DWG No.	FIGURE 1

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1.3 Existing & Proposed Conditions

a) <u>Existing Conditions</u>

Historically, the proposed development site has always been utilized for agricultural purposes, though recently has remained vacant lands. The 8.34-hectare property is limited by residential properties/Barrick Road to the south, West Side Road (Highway 58) to the east, and vacant agricultural lands to the north.

The vast majority of stormwater flows from the development site are conveyed south towards Barrick Road under existing conditions, then flowing west before ultimately discharging to the Biederman Drain. However as discussed previously, it is expected that future residential development will occur within the lands to the north, connecting to the proposed development. As such, the available development area north of the site has been included in the proposed SWM Plan for Barrick Road Subdivision.

The native soils within the development site have been characterized as Silty Clay via borehole information provided from a preliminary geotechnical analysis conducted by Niagara Testing & Inspection (NTIL). Seven boreholes were conducted (including 5 monitoring wells) noting that bedrock was found approximately 0.5 – 1.1m beneath the existing grade across the site.

b) <u>Proposed Conditions</u>

The development property is 8.34 hectares and will result in the construction of 2 condominium blocks (157 units), with various single detached/semi/townhouse areas for a total of 341 residential units. The current layout accounts for expected additional single-detached dwellings along the south limits, increasing the fully developed layout to 348 units. The site shall be provided with full municipal services including sanitary sewers, storm sewers and watermain with asphalt pavement, concrete curbs and gutters. The proposed SWM plan discusses the proposed development under fully developed conditions.

2.0 STORMWATER MANAGEMENT CRITERIA

New developments are required to provide stormwater management in accordance with provincial and municipal policies including:

- Stormwater Quality Guidelines for New Development (MECP/MNRF, May 1991)
- Stormwater Management Planning and Design Manual (MECP, March 2003)

Based on the comments and outstanding policies from various agencies (City of Port Colborne, Regional Municipality of Niagara, Niagara Peninsula Conservation Authority (NPCA), and the Ministry of the Environment, Conservation and Parks (MECP), and others) the following site-specific considerations were identified:

- The receiving watercourse, Biederman Drain has been identified by the Ministry of Natural Resources watercourse evaluation as a **Type 2** (*Important*) fish habitat. Based on this fish habitat, the corresponding MECP level of protection for stormwater management quality practices on all new developments shall be *Normal*.

- The site outlets to the Biederman Drain which contain lands that would be negatively impacted by increased flooding levels, and, therefore, stormwater quantity control is considered necessary to maintain the downstream peak water elevations.

Based on the above policies and site-specific considerations, the following stormwater management criteria have been established for this site.

- Stormwater **quality** controls are to be provided for the internal storm system of the Rosedale Subdivision development according to MECP guidelines. It is proposed to provide Normal Protection (70% TSS removal) to the stormwater before discharging to the Biederman Drain.

- Stormwater **quantity** controls are to be provided for the outlet to limit the proposed development peak flows from the 2, 5, 10, 25, 50- and 100-year storm events to existing peak flow levels

3.0 STORMWATER ANALYSIS

A stormwater analysis has been conducted by Upper Canada Consultants as part of the design of the Barrick Subdivision development using the MIDUSS computer modelling program. A new stormwater analysis was conducted to represent the existing and future conditions to the Biederman Drain.

This program was selected because it is applicable to an urban drainage area like the study area, it is relatively easy to use and modify for the proposed drainage conditions and control facilities, and it readily allows for the use of design storm hyetographs for the various return periods being investigated.

Copies of the current model output files are enclosed in Appendix B.

3.1 Design Storms

Design storm hyetographs were developed using a Chicago distribution based on the Ministry of Transportation's Intensity-Duration-Frequency curves for the subject area in Port Colborne. Hyetographs for the 25mm, 2, 5, 10, 25, 50- and 100-year events were developed using a 4-hour Chicago distribution. Table 1 summarizes the rainfall data.

Table 1. Rainfall Data

Design Storm (Return Period)	Chicago Distribution Parameters		
	a	**b**	**c**
25mm	512.000	6.00	0.800
2 Year	397.149	0.0	0.699
5 Year	524.867	0.0	0.699
10 Year	608.845	0.0	0.699
25 Year	715.568	0.0	0.699
50 Year	794.298	0.0	0.699
100 Year	871.279	0.0	0.699

$$Intensity\ (mm/hr) = \frac{a}{(t_d + b)^c}$$

3.2 Existing Conditions

Existing conditions were modelled to establish peak stormwater flows and volumes prior to any development within this site. The existing drainage areas for this subwatershed (shown on Figure 2) were determined from field investigations and a combination of recent topographic surveys and Ontario LIDAR data. Stormwater from all drainage areas outlined on Figure 2 are ultimately directed to the Biederman Drain, however the drainage areas have been delineated based on their immediate stormwater outlets from the site. It should be noted that the entire development area considered as part of this SWM Plan was included in the Biederman Drain watershed area as noted in the Spriet Associates Municipal Drain Report (January 12, 2023).

Drainage Area EX10 represents the area directing stormwater to the Barrick Road road allowance (Outlet A). Outlet A consists of a series of ditches and storm sewers currently directing stormwater flows westerly on Barrick Road, to a tributary watercourse conveying flows north between #805 & #825 Barrick Road, prior to ultimate discharge to the Biederman Drain. This drainage area consists largely of the proposed Stonebridge Village Subdivision lands as well as a portion of the property to the north.

Stormwater flows from Drainage Area EX20 are conveyed overland via sheet flow to north-westerly to Outlet B. Stormwater Outlet B consists of the Provincially Significant Wetland (PSW) as part of the Wainfleet Bog Wetland Complex, with all stormwater flows conveyed to the Biederman Drain approximately 200m north-west. These lands consist of a large portion of the northerly agricultural lands as well as the existing residential dwelling/driveway located at municipal address #503 West Side Road.

Drainage Area EX30 consists of the agricultural lands on the north development area directing stormwater flows to a 1.2m x 0.9m concrete box culvert (Outlet C) crossing West Side Road (Highway 58). Stormwater flows from this area are currently directed easterly across Oxford Boulevard and then northerly through the future Rosedale Subdivision/Meadow Heights Subdivision Development Area prior to ultimately being discharged to the Biederman Drain. This identical area has been included in the Stormwater Management Plan for the previously named downstream subdivisions within their calculations.

Lastly, Drainage Area EX40 consists of lands within the delineated future northerly development lands discharging stormwater flows directly to the West Side Road (Highway 58) road allowance (Outlet D), continuing northerly within the MTO road allowance before discharging to the Biederman Drain. These lands consist of the cleared, though undeveloped, front yard of the existing residential dwelling at #503 West Side Road.

Input parameters for the computer model for the existing conditions are shown in Table 2. Table 3 shows the stormwater peak flows and volumes generated by the various design storm events. A Weighted Impervious Calculation Sheet has been included in Appendix A for the existing drainage area conditions.

3.3 Proposed Conditions

It is proposed to construct a Stormwater Management Wet Pond Facility to provide the necessary quantity and quality controls for stormwater flows discharging from the development area under fully developed conditions. As stated previously, the available development lands as part of the two properties north of the Stonebridge Village development have been included in this SWM Plan as they are both included within the urban boundary of Port Colborne and are expected to be developed in the future. Without proper planning, these northern properties will not have a suitable proper stormwater outlet, and as such, have been included in the calculations within this report.

The future drainage areas for the proposed development, shown in Figure 3, were modelled to establish the stormwater peak flows and volumes once development has been completed at the proposed site. Input parameters for the computer model with the proposed development conditions are shown in Table 2.

Table 2. Hydrologic Parameters

Area No.	Area (ha)	Length (m)	Slope (%)	SCS CN	Percent Impervious
Existing Conditions					
EX10	11.26	300	1.0	77	3.0%
EX20	5.13	100	1.0	77	1.9%
EX30	3.44	100	2.0	77	0.5%
EX40	0.48	30	1.0	77	0.5%
	20.31	**Total Area**			
Future Conditions					
A1	19.41	450	1.0	77	70.0
A2	0.88	20	1.0	77	28.6
	20.31	**Total Area**			

As outlined within the Proposed Overall Storm Drainage Area Plan in Figure 3, the modelling for this SWM Plan has been conducted to allow the vast majority of stormwater flows from the overall development area to be conveyed to the proposed SWM Facility. As stormwater flows from Drainage Area EX20 are currently conveying stormwater flows to the existing PSW area as part of Outlet B, this SWM Plan is obligated to continue to discharge stormwater flows to these lands at a similar rate, and not completely remove this source of stormwater from the PSW lands. Therefore, Drainage Area A20 has been delineated representing the expected rear yard area from single family dwellings conveying stormwater flows to the PSW lands via sheet flow. As these would be rear-yards and a non-significant source of TSS, quality controls would not be required for this area.

To remain conservative, the lands as part of Drainage Areas EX30 and EX40 have been included in the modelling for this SWM Facility. As the northern lands are outside of the Stonebridge Village development area, they will remain untouched and are still expected to drain to their current outlets until such time that development occurs. However, all expected future development lands north of the site not included in Drainage Area A20 have been included in sizing the proposed SWM Facility, and no future flows have been modelled to drain to Outlets C and D under future conditions. This may change under future development applications for these northern lands.

As the proposed Stonebridge Village development consists of mainly townhouses with an additional mix of apartments, single detached dwellings as well as park area, an imperviousness of 70% has been utilized for the entire development area as it is expected these land densities will remain consistent within future development on the northern lands.

As stated previously, the stormwater infrastructure on Barrick Road consists of a series of ditches, culverts and storm sewers, ultimately conveying stormwater flows to a tributary flowing north between #805 and #825 Barrick Road to the Biederman Drain. As part of the proposed SWM Plan, a stormwater system will be constructed on Barrick Road to provide a suitable stormwater outlet for the SWM Facility. The system will be constructed from the west development entrance and continue westerly to the Minor Road road allowance, before directing flows north within the road allowance.

As part of the preliminary design of the internal subdivision storm sewer system, the vast majority of stormwater flows from the northern lands have been included as discharging to the storm sewer on at the northern limit of Street ‘D’. Therefore, cost sharing will be required for the northern lands for: the downstream storm sewers to the SWM Facility, the SWM Facility itself, and the downstream stormwater system to the ultimate Biederman Drain outlet. It is also expected that cost sharing will occur with the City of Port Colborne to construct the stormwater system on Barrick Road/Minor Road to the Biederman Drain.

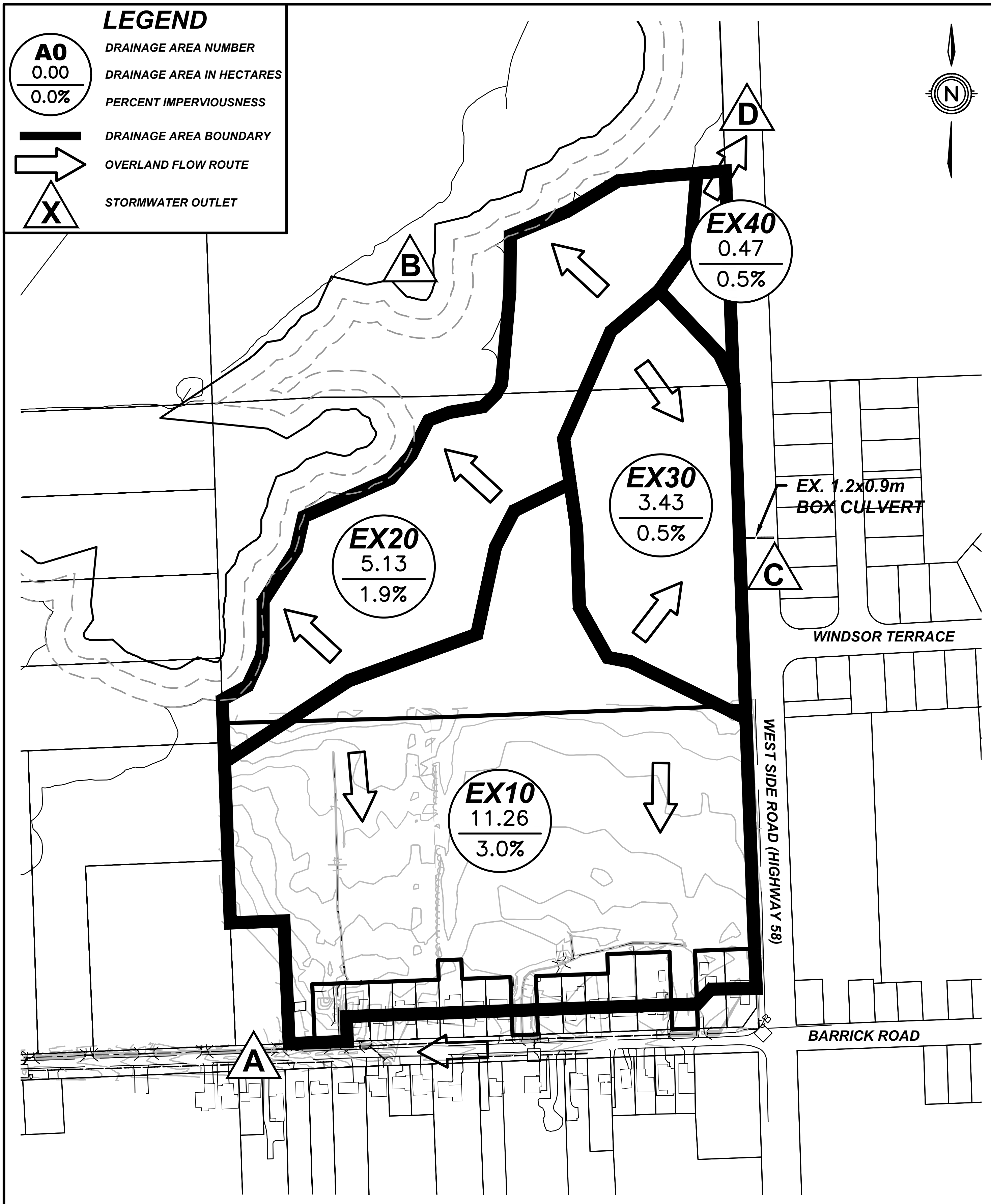
The peak stormwater flows and volumes have been calculated and outlined in Table 3 below for various stormwater outlets depicted in Figures 2 and 3 under existing and fully developed conditions for the 2, 5, 20, 25, 50- and 100-year design storm events.

Stated previously, Table 3 shows no stormwater flows have been modelled to discharge to outlets ‘C’ or ‘D’ for the northern development lands, though this may change under future development applications. Peak stormwater flows discharging to Outlet B via sheet flow will be maintained during the 2-year event and reduced under larger storm events. However, stormwater flows being directed to Outlet A (Barrick Road road allowance) will be significantly increased during all storm events under proposed conditions and therefore, stormwater quantity controls will be required.

Table 3. Peak Flow and Volume for Future Development Conditions

Outlet	Peak Flow (L/s)			Volume (m^3)		
	Existing	Future*	Change	Existing	Future*	Change
2 Year Design Storm Event						
A	56	1,737	+3,002%	866	4,398	+3,532
B	43	43	-	382	116	-266
C	32	0	-100%	245	0	-245
D	7	0	-100%	34	0	-34
5 Year Design Storm Event						
A	129	2,444	+1,795%	1517	6,149	+4,632
B	96	64	-33%	675	177	-498
C	74	0	-100%	439	0	-439
D	14	0	-100%	61	0	-61
10 Year Design Storm Event						
A	188	2904	+1,445%	2004	7,371	+5,367
B	146	79	-46%	895	221	-674
C	108	0	-100%	586	0	-586
D	20	0	-100%	82	0	-82
25 Year Design Storm Event						
A	288	3,480	+1,108%	2677	8,995	+6,328
B	211	96	-55%	1198	279	-919
C	178	0	-100%	787	0	-787
D	31	0	-100%	109	0	-109
50 Year Design Storm Event						
A	366	3,897	+965%	3203	10,198	+6,995
B	271	113	-58%	1440	323	-1117
C	224	0	-100%	948	0	-948
D	41	0	-100%	132	0	-132
100 Year Design Storm Event						
A	477	4,300	+801%	3743	11,379	+7,636
B	345	131	-61%	1682	368	-1,314
C	272	0	-100%	1109	0	-1109
D	58	0	-100%	155	0	-155

Stormwater Outlets are as follows:
Outlet A – Barrick Road
Outlet B – Forested Lands Northwest of the Development
Outlet C – Existing Box Culvert Crossing West Side Road (Highway 58)
Outlet D – West Side Road (Highway 58) Road Allowance



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CITY OF PORT COLBORNE

EXISTING OVERALL STORM DRAINAGE AREA PLAN

DATE	2024-03-25
SCALE	1:4000 m
REF No.	2300
DWG No.	FIGURE 2

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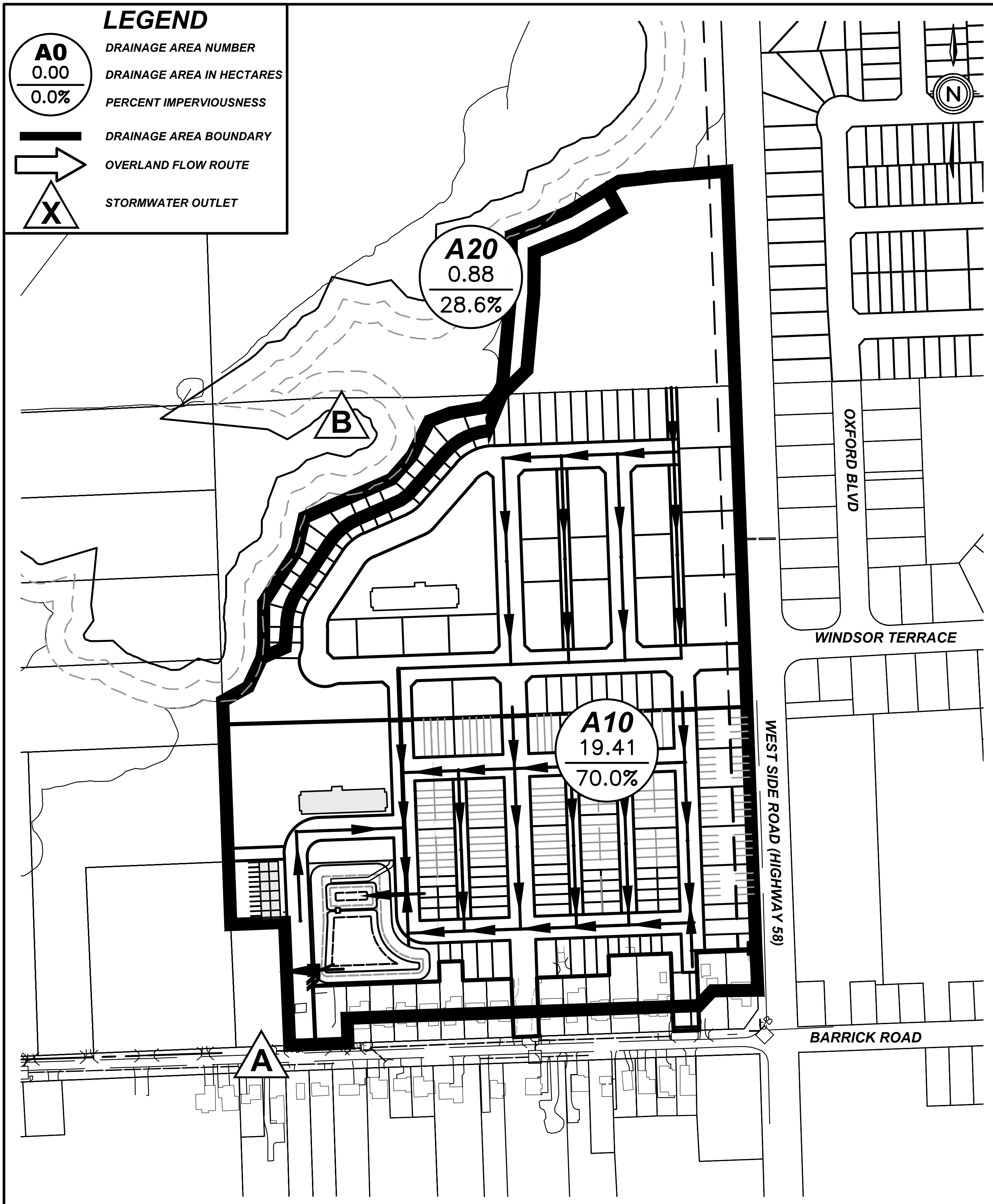

UPPER CANADA CONSULTANTS *ENGINEERS / PLANNERS*	**STONEBRIDGE VILLAGE** **CITY OF PORT COLBORNE** **FUTURE OVERALL STORM DRAINAGE AREA PLAN**

DATE	2024-03-25
SCALE	1:4000 m
REF No.	2300
DWG No.	FIGURE 3

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4.0 STORMWATER MANAGEMENT ALTERNATIVES

4.1 Screening of Stormwater Management Alternatives

A variety of stormwater management alternatives are available to control the quality of stormwater, most of which are described in the Stormwater Management Planning and Design Manual (MECP, March 2003). Alternatives for the proposed and ultimate developments were considered in the following broad categories: lot level, vegetative, infiltration, and end-of-pipe controls. General comments on each category are provided below. Individual alternatives for the proposed development are listed in Table 4 with comments on their effectiveness and applicability to the proposed outlet.

a) Lot Level Controls

Lot level controls are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

b) Vegetative Alternatives

Vegetative stormwater management practices are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

c) Infiltration Alternatives

Where soils are suitable, infiltration techniques can be very effective in providing quantity and quality control. However, the very small amount of surface area on this site dedicated to permeable surfaces such as greenspace and landscaping make this an impractical option. Therefore, infiltration techniques will not be considered for this development.

d) End-of-Pipe Alternatives

Surface storage techniques can be very effective in providing quality and quantity control. Dry facilities are effective practices for stormwater erosion and flood control for large drainage areas.

Wet facilities are effective practices for stormwater erosion, quality and quantity control for large drainage areas.

Table 4. Evaluation of Stormwater Management Practices

Stonebridge Village Subdivision	Criteria for Implementation of Stormwater Management Practices (SWMP)					Technical Effectiveness (10 high)	Recommend Implementation Yes / No	Comments
	Topography	**Soils**	**Bedrock**	**Groundwater**	**Area**			
Site Conditions	***Variable 1 to 3%***	***Silty Clay <10mm/hr***	***At Considerable Depth***	***At Considerable Depth***	***± 19.4ha***			
Lot Level Controls								
Lot Grading	<5%	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Leaders to Surface	nlc	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Ldrs.to Soakaway Pits	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	6	No	Unsuitable site conditions
Sump Pump Fdtn. Drains	nlc	nlc	nlc	nlc	nlc	2	Yes	Suitable site conditions
Vegetative								
Grassed Swales	< 5 %	nlc	nlc	nlc	nlc	7	Yes	Quality/quantity benefits
Filter Strips(Veg. Buffer)	< 10 %	nlc	nlc	>.5m Below Bottom	< 2 ha	5	No	Unsuitable site conditions
Infiltration								
Infiltration Basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 5 ha	2	No	Unsuitable site conditions
Infiltration Trench	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 2 ha	4	No	Unsuitable site conditions
Rear Yard Infiltration	< 2.0 %	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	7	No	Unsuitable site conditions
Perforated Pipes	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	4	No	Unsuitable site conditions
Pervious Catch basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	3	No	Unsuitable site conditions
Sand Filters	nlc	nlc	nlc	>.5m Below Bottom	< 5 ha	5	No	High maintenance/poor aesthetics
Surface Storage								
Dry Ponds	nlc	nlc	nlc	nlc	> 5 ha	7	No	No quality control
Wet Ponds	nlc	nlc	nlc	nlc	> 5 ha	9	Yes	Very effective quality control
Wetlands	nlc	nlc	nlc	nlc	> 5 ha	10	No	Very effective quality control
Other								
Oil/Grit Separator	nlc	nlc	nlc	nlc	<2 ha	3	No	Limited benefit/area too large

Reference: Stormwater Management Practices Planning and Design Manual - 1994
nlc - No Limiting Criteria

4.2 Selection of Stormwater Management Alternatives

Stormwater management alternatives were screened based on technical effectiveness, physical suitability for this site, and their ability to meet the stormwater management criteria established for proposed and future development areas. The following stormwater management alternatives are recommended for implementation on the proposed development:

- **Lot grading** to be kept as flat as practical in order to slow down stormwater and encourage infiltration.

- **Roof leaders to be discharged to the ground surface** in order to slow down stormwater and encourage infiltration.

- **Grassed swales** to be used to collect rear lot drainage. Grassed swales tend to filter sediments and slow down the rate of stormwater.

- A **wet pond facility** to be constructed to provide stormwater quality enhancement for frequent storms.

5.0 STORMWATER MANAGEMENT PLAN

As part of the Stormwater Management Plan for this development, an internal storm sewer system will be constructed within the subdivision to convey stormwater flows up to and including the 5-year design storm event to the proposed SWM Facility. The overall grading design for the roadway system will direct overland stormwater flows, unable to enter the storm sewer system, during major storm events to the SWM Facility.

A MIDUSS model was created to assess existing, future and ultimate development peak flows and stormwater volumes generated by the proposed subdivision. The stormwater management facility was sized according to MECP Guidelines (MECP, March 2003) as follows:

5.1 Proposed Stormwater Management Facility

5.1.1 Stormwater Quality Control

The stormwater drainage outlet for the proposed development is Biederman Municipal Drain, which has been identified by the Ministry of Natural Resources watercourse evaluation as a **Type 2** fish habitat. Based on this fish habitat, the corresponding MECP level of protection for stormwater management quality practices on all new developments shall be *Normal*. It is proposed to provide Normal (70% TSS removals) Protection quality controls prior to discharge to the Biederman Drain.

Based on Table 3.2 of SWMP & Design Manual, the water quality storage requirement is approximately 130m^3/ha for *Normal* protection for developments with 70% impervious areas. The drainage area requiring stormwater quality improvement draining to the proposed facility is 19.41 hectares. The storage volumes required for this proposed facility are shown in Table 5.

Table 5. Stormwater Quality Volume Calculations	
Total Water Quality Volume = 19.41 ha x 130 m^3/ha = 2,523 m^3	Reference: Table 3.2, SWMP & Design Manual (MECP 2003)
Permanent Pool Volume = 19.41 ha x 90 m^3/ha = 1,747 m^3	**Extended Detention Volume** = 19.41 ha x 40 m^3/ha = 776 m^3

5.1.2 Stormwater Quantity Control

As shown in the previous Table 3, stormwater management quantity controls are required to reduce the peak flows from the development area to existing conditions for up to and including the 100-year design storm event. The stormwater peak flows from the proposed development shall be reduced to the existing levels by providing stormwater quantity storage within the wet pond facility. It is proposed to construct a control structure outlet to reduce the peak stormwater flows discharging from the proposed facility.

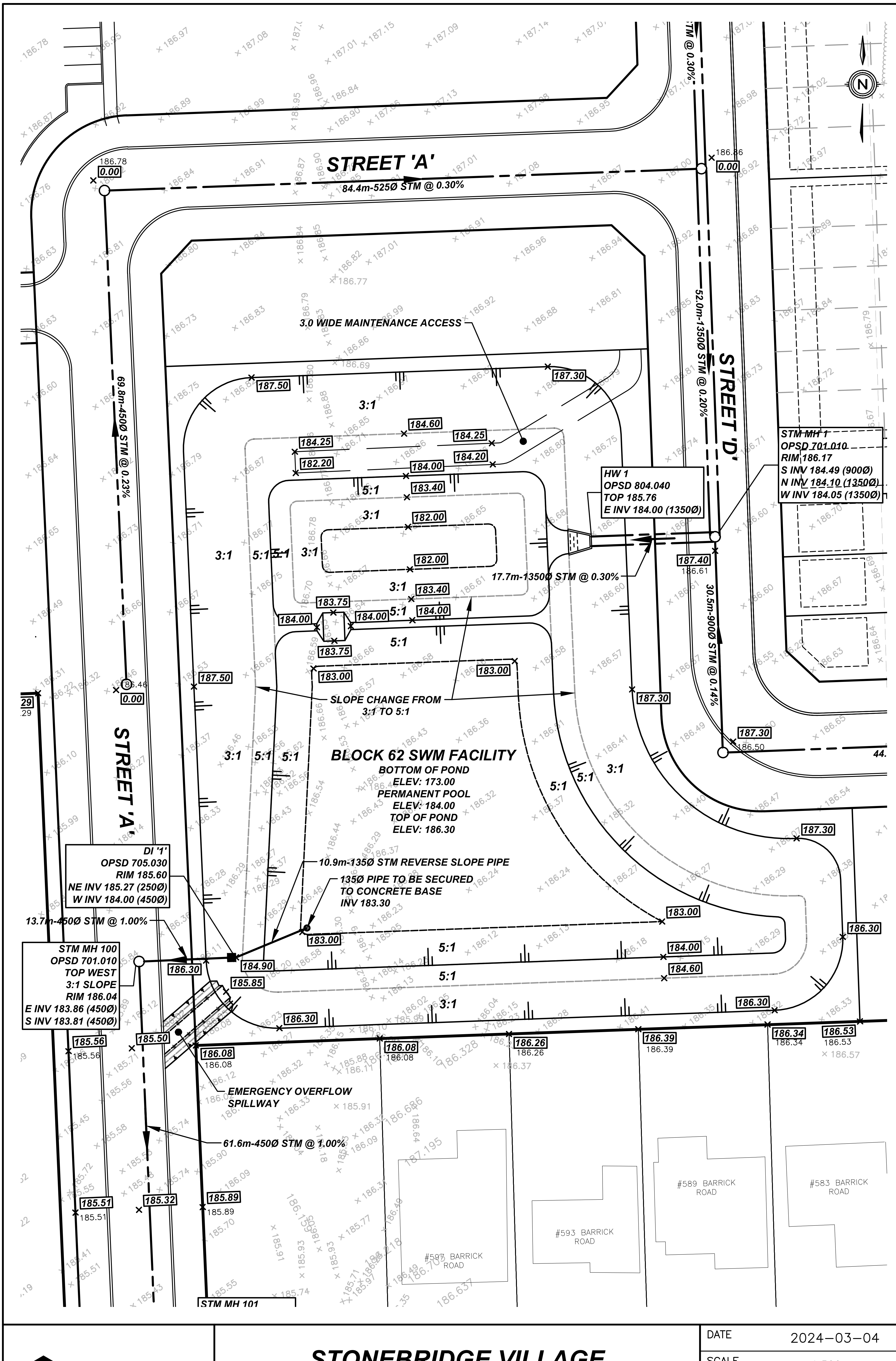
5.1.3 Stormwater Management Facility Configuration

As seen within the Proposed Stormwater Management Facility detail (Figure 5), the layout is providing a single sewer outlet from the SWM Facility to the storm sewer on Street ‘A’ directing flows to the proposed storm sewer on Barrick Road.

It is proposed to construct a three-stage outlet for the proposed stormwater management facility. The first stage of control consists of a reverse slope pipe acting as a 133mm (5”) diameter orifice to provide the required quality controls. The second stage of control consists of a ditch inlet catch basin and outlet pipe which provides an outlet for flows exceeding the extended detention volume. An emergency spillway will complete the third stage, providing an outlet for flows exceeding the capacity of the ditch inlet catch basin and outlet pipe during extreme storm events.

The proposed effective bottom elevation of the facility is 183.00m, and the permanent pool water level is 184.00m for a water depth of 1.0 metre. The configuration of the facility provides 1,805 m^3 of permanent pool volume, which is more than the required 1,747m^3. The proposed top of pond is at an elevation of 186.30m which provides a total active volume of approximately 10,235m^3.

The proposed facility has a single storm sewer inlet, therefore, the sediment forebay was designed to minimize the transport of heavy sediment from the storm sewer outlet throughout the facility and localize maintenance activities. Calculations for the forebay sizing follow MECP guidelines and are shown in Table 6.



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STORMWATER MANAGEMENT FACILITY DETAIL

DATE	2024–03–04
SCALE	1:500 m
REF No.	2300
DWG No.	FIGURE 4

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Table 6. Stormwater Management Facility Forebay Sizing

a) Forebay Settling Length (MOECC SWMP&D, Equation 4.5)

$$Settling\ Length = \sqrt{\frac{r * Q_p}{V_s}}$$

r =	4.1	:1	(Length:Width Ratio)
Q_p =	0.038	m^3/s	(25mm Storm Pond Discharge)
V_s =	0.0003	m/s	(Settling Velocity)

Settling Length = **22.74 m**

b) Dispersion Length (MOECC SWMP&D, Equation 4.6)

$$Dispersion\ Length = \frac{8 * Q}{D * V_f}$$

Q =	2.444	m^3/s	(5 Yr Stm Sew Design Inflow)
D =	2.00	m	(Depth of Forebay)
V_f =	0.5	m/s	(Desired Velocity)

Dispersion Length = **19.55 m**

c) Minimum Forebay Deep Zone Bottom Width (MOECC SWMP&D, Equation 4.7)

$$Width = \frac{Dispersion\ Length}{8}$$

Minimum Forebay Length from Equations 3.3 and 3.4

22.74 m (minimum required length)

Width = **2.84 m** (minimum required width)

d) Average Velocity of Flow

$$Average\ Velocity = \frac{Q}{A}$$

Q =	1.014	m^3/s	(Quality Design Inflow)
A =	24.00	m^2	(Cross Sectional Area)
D =	2.00	m	(Depth of Forebay)
W =	6.00	m	(Proposed Bottom Width)
S =	3	:1	(Side slopes - minimum)

Average Velocity = **0.04 m/s**

Is this Acceptable? **Yes** (Maximum velocity of flow = 0.15 m/s)

e) Cleanout Frequency

Is this Acceptable? **Yes**

L =	24.5	m	(Proposed Bottom Length)
ASL =	2.8	m^3/ha	(Annual Sediment Loading)
A =	19.41	ha	(Drainage Area)
FRC =	70	%	(Facility Removal Efficiency)
FV =	804.0	m^3	(Forebay Volume)

Cleanout Frequency = **10.4 years**

Is this Acceptable? **Yes** (10 year minimum cleanout frequency)

Based on the configuration of the proposed facility, it was determined that a 133mm (5”) diameter quality orifice shall provide 41.9 hours of detention (24-hour minimum required duration of detention). The rim elevation for the proposed ditch inlet catch basin is 184.90m and will provide an extended detention volume of 3,482m^3, which is more than the required 776m^3.

The outflow pipe from the stormwater management facility is to be 450mm in diameter and will convey the stormwater flows from the ditch inlet to a storm sewer on Street ‘A’ discharging flows to the proposed Barrick Road Stormwater System. During extreme storm events greater than the 100-year event, stormwater flows will crest over an emergency overflow spillway located at the south west corner of the facility, and be directed to the Street ‘A’ road allowance continuing towards Barrick Road. The grade of Barrick Road will direct major overland stormwater flows easterly, and therefore, no stormwater flows will be conveyed to the MTO road allowance as part of the proposed Stormwater Management Plan.

Table 7 summarizes the peak inflows and outflows for the Stormwater Management Facility along with corresponding pond elevations. A stage-storage-discharge relationship was determined for the facility and is included in Appendix A for reference purposes.

Table 7. Stormwater Management Facility Characteristics

Design Storm	Peak Flows (L/s)			Maximum Elevation (m)	Maximum Storage (m3)
	Existing Outflow	Future Inflow	Future Outflow		
25mm	-	1,014	29	184.66	2,461
2 Year	56	1,737	52	184.96	3,732
5 Year	129	2,444	128	185.19	4,804
10 Year	188	2,904	147	185.36	5,626
25 Year	288	3,480	148	185.64	7,027
50 Year	366	3,897	159	185.86	8,127
100 Year	477	4,300	289	185.97	8,719

Therefore, peak stormwater flows to Outlet A will be reduced during all storm events from existing conditions. As the 25mm design storm is only modelled for stormwater quality purposes, an existing peak flow rate has not been provided.

Based on the MIDUSS model, Table 7 shows the maximum wet pond elevation of 185.97m, and an active storage volume of 8,719m^3 for the 100-year design storm event. approximately 0.33m of free board will be provided by the stormwater management facility during the 100-year design storm event.

The stormwater sewer system immediately downstream of the SWM facility outlet will be designed to convey peak stormwater flows up to and including the 5-year event. During the 5-year event, the SWM facility will discharge approximately 128L/s to the downstream stormwater system according to the MIDUSS Modelling. As part of the design of this storm sewer, a conservatively increased flow allocation from the Stonebridge Village SWM Facility of 130L/s will be included to ensure sufficient capacity is provided.

During events greater than the 5-year storm event, it has been conservatively assumed that storm sewers can accommodate flow at an additional 15% on top of their full flow capacity due to surcharged conditions. Therefore, for the purpose of modelling the SWM facility, a maximum discharge rate of 148.4L/s (129L/s + 15%) has been utilized for flows being discharged at the outlet pipe. Additional outflow capacity is included once stormwater flows within the SWM facility reach the minor spillway elevation of 185.80m.

6.0 SEDIMENT AND EROSION CONTROL

Sediment and erosion controls are required during all construction phases of this development to limit the transport of sediment into Bartlett Creek.

The following additional erosion and sediment controls will also be implemented during construction:

- Install silt control fencing along the limits of construction of the development to collect sediment in overland flows before discharging to downstream systems. The silt control fence installed along east end of site will be installed along the wetland buffer to act as the limit of construction.

- Re-vegetate disturbed areas as soon as possible after grading works have been completed.

- Lot grading and siltation controls plans will be provided with sediment and erosion control measures to the appropriate agencies for approval during the final design stage.

7.0 STORMWATER MANAGEMENT FACILITY MAINTENANCE

7.1 Wetpond Facility

Maintenance is a necessary and important aspect of urban stormwater quality and quantity measures such as constructed wetlands. Many pollutants (ie. nutrients, metals, bacteria, etc.) bind to sediment and therefore removal of sediment on a scheduled basis is required.

The wet pond for this development is subject to frequent wetting and deposition of sediments as a result of frequent low intensity storm events. The purpose of the wet pond is to improve post development sediment and contaminant loadings by detaining the 'first flush' flow for a 24-hour period. For the initial operation period of the stormwater management facility, the required frequency of maintenance is not definitively known and many of the maintenance tasks will be performed on an 'as required' basis. For example, during the home construction phase of the development there will be a greater potential for increased maintenance frequency, which depends on the effectiveness of sediment and erosion control techniques employed.

Inspections of the wet pond will indicate whether or not maintenance is required. Inspections should be made after every significant storm during the first two years of operation or until all development is completed to ensure the wet pond is functioning properly. This may translate into an average of six inspections per year. Once all building activity is finalized, inspections shall be performed annually. The following points should be addressed during inspections of the facility.

a) Standing water above the inlet storm sewer invert a day or more after a storm may indicate a blockage in the reverse slope pipe or orifice. The blockage may be caused by trash or sediment and a visual inspection would be required to determine the cause.

b) The vegetation around the wet pond should be inspected to ensure its function and aesthetics. Visual inspections will indicate whether replacement of plantings are required. A decline in vegetation habitat may indicate that other aspects of the constructed wet pond are operating improperly, such as the detention times may be inadequate or excessive.

c) The accumulation of sediment and debris at the wet pond inlet sediment forebay or around the high water line of the wet pond should be inspected. This will indicate the need for sediment removal or debris clean up.

d) The wet pond has been created by excavating a detention area. The integrity of the embankments should be periodically checked to ensure that it remains watertight and the side slopes have not sloughed.

Grass cutting is a maintenance activity that is done solely for aesthetic purposes. It is recommended that grass cutting be eliminated. It should be noted that municipal by-laws may require regular grass maintenance for weed control.

Trash removal is an integral part of maintenance and an annual cleanup, usually in the spring, is a minimum requirement. After this, trash removal is performed as required basis on observation of trash build-up during inspections.

To ensure long term effectiveness, the sediment that accumulates in the forebay area should be removed periodically to ensure that sediment in not deposited throughout the facility. For sediment removal operations, typical grading/excavating equipment should be used to remove sediment from the inlet forebay and detention areas. Care should be taken to ensure that limited damage occurs to existing vegetation and habitat.

Generally, the sediment which is removed from the detention pond will not be contaminated to the point that it would be classified as hazardous waste. However, the sediment should be tested to determine the disposal options.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, the following conclusions are offered:

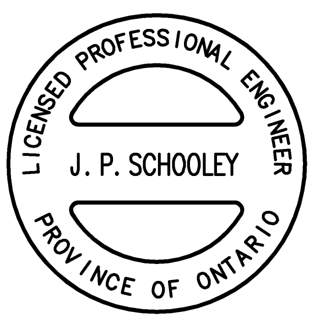
- Infiltration techniques are not suitable for this site as the primary control facility due to the low soil infiltration rates and the large drainage area for this development.
- The proposed stormwater management facilities will provide stormwater quality and quantity controls for the approximately 19.41 hectare catchment area.
- Various lot level vegetative stormwater management practices can be implemented to enhance stormwater quality.
- This report was prepared in accordance with the provincial guidelines contained in "Stormwater Management Planning and Design Manual, March 2003".

The above conclusions lead to the following recommendations:

- That the stormwater management criteria established in this report be accepted.
- That a stormwater management wet pond facility be constructed to provide stormwater quality protection to MECP *Normal* Protection levels and quantity controls as outlined in this report.
- That additional lot level controls and vegetative stormwater management practices as described previously in this report be implemented.

Prepared By:

Kurt Tiessen, E.I.T.
March 28, 2024



Reviewed By:

Jason Schooley, P.Eng.

APPENDICES

APPENDIX A

Weighted Impervious Calculation Sheet
Stormwater Management Facility Calculations

Weighted Imperviousness Percentage Calculation Worksheet

Project Name: Barrick Road Subdivision
Project Number: 2300
Date: March 2024
Person: K.Tiessen

EX10 - EXISTING CONDITIONS

	Footprint	*% Impervious*	*Effective Impervious Area*
Buildings	2324.6 m^2	100%	2324.6 m^2
Concrete/Asphalt/Granular Driveways	1190.9 m^2	80%	952.7 m^2
Landscape/Greenspace	109116.7 m^2	0.1%	109.1 m^2
TOTAL CATCHMENT IMPERVIOUS AREAS			3,386 m^2
TOTAL CATCHMENT AREA			112,632 m^2
		EFFECTIVE WEIGHTED CATCHMENT % IMPERVIOUS	**3.0 %**
		RUNOFF COEFFICIENT	**0.22**

EX20 - EXISTING CONDITIONS

	Footprint	*% Impervious*	*Effective Impervious Area*
Buildings	91.3 m^2	100%	91.3 m^2
Granular Driveways	1160.5 m^2	70%	812.4 m^2
Landscape/Greenspace	50008.2 m^2	0.1%	50.0 m^2
TOTAL CATCHMENT IMPERVIOUS AREAS			954 m^2
TOTAL CATCHMENT AREA			51,260 m^2
		EFFECTIVE WEIGHTED CATCHMENT % IMPERVIOUS	**1.9 %**
		RUNOFF COEFFICIENT	**0.21**

Upper Canada Consultants
30 HANNOVER DRIVE, UNIT 3
St. Catharines, Ontario L2W 1A3 **DATE: MARCH 2024**
PROJECT NAME: STONEBRIDGE VILLAGE SUBDIVISION
PROJECT NO.: 2300

STORMWATER MANAGEMENT FACILITY WETPOND

Quality Requirements
Drainage Area (ha) = 19.41
Normal (m^3/ha) = 130 (@ 70%)
Perm Pool (m^3/ha) = 90
Perm Pool Vol (m^3) = 1,747
Active Vol (m^3) 776
Perm. Pool Elev. = 184.00 m

Quality Orifice
Diameter (m) = 0.133
Cd = 0.63
Invert (m) = 184.00
5" Ring-Tite PVC DR28

Ditch Inlet Weir
Length (m) = 0.60
Width (m) = 0.60
Grate Slope (X:1) = 4
Inlet Elevation (m) = 184.90
Cd = 1.84

Outflow Pipe Orifice
Diameter (m) = 0.450
Cd = 0.63
Invert (m) = 184.00
Overt (m) = 184.45

Overflow Spillway
Minor Length (m) = 2.00
Slopes (X:1) = 2.00
Minor Invert (m) = 185.85
Major Length (m) = 4.00
Major Invert (m) = 186.00

MOE Equation 4.10 Drawdown Coefficient 'C2' = 1,623
MOE Equation 4.10 Drawdown Coefficient 'C3' = 3,175
MOE Equation 4.10 Drawdown Time (h) = **41.9**

Elevation	Increment Depth (m)	Active Depth (m)	Surface Area (m^2)	Average Surface Area (m^2)	Increment Volume (m^3)	Permanent Volume (m^3)	Active Volume (m^3)	Quality Orifice (m^3/s)	Ditch Inlet (m^3/s)	Max Pipe Orifice (m^3/s)	Max Outflow (5yr+15%) (m^3/s)	Overflow Spillway (m^3/s)	Total Outflow (m^3/s)	Average Discharge (m^3/s)	Side Slope (H:V)
183.00		-1.00	**1,335**			0					*5yr flow = 129 L/s*				BOTTOM
	0.40			1,509	604										3:1
183.40		-0.60	1,684			604									
	0.60			2,003	1,202										5:1
184.00		0.00	**2,322**			1,805									PERM
	0.00			2,740	0										
184.00		0.00	3,158				0.0	0.000	0.000	0.00	0.00	0.00	0.000		PERM
	0.30			3,428	1,028									0.015	5:1
184.30		0.30	3,698				1028.3	0.018	0.000	0.000	0.148	0.000	0.0178		
	0.30			3,915	1,174									0.023	3:1
184.60		0.60	4,132				2202.7	0.028	0.000	0.243	0.148	0.000	0.0277		
	0.30			4,266	1,280									0.031	3:1
184.90		0.90	4,399				3482.4	0.035	0.000	0.344	0.148	0.000	0.0349		
	0.35			4,559	1,596									0.092	3:1
185.25		1.25	4,718				5077.9	0.042	0.114	0.433	0.148	0.000	0.1484		
	0.60			4,999	2,999									0.148	3:1
185.85		1.85	5,280				8077.3	0.051	0.511	0.553	0.148	0.000	0.1484		
	0.15			5,352	803									0.236	3:1
186.00		2.00	5,424				8880.1	0.054	0.637	0.579	0.148	0.176	0.3242		
	0.30			5,569	1,671									0.972	3:1
186.30		2.30	5,715				10550.9	0.058	0.914	0.628	0.148	1.471	1.6197		

Notes
1. Quality Orifice flow is the orifice controlling for the 24 hour detention period and uses an orifice formula.
2. Pipe Orifice flow is calcuated using an orifice formula on the pipe from the ditch inlet to the outlet and uses the total head on the orifice.
3. Overflow Weir flow is calculated using a trapezondial weir to convey outflow for less frequent storms through the embankment with an emergency spillway.
4. Total Outflow is calculated by adding the Overflow Spillway with the lowest of Quality Orifice plus Ditch Inlet or Max Pipe Orifice.

APPENDIX B

MIDUSS Output Files

Existing Conditions

```
         Output File (4.7) EX.OUT      opened 2024-02-09  10:42
         Units used are defined by G =    9.810
             24   144    10.000        are MAXDT MAXHYD & DTMIN values
         Licensee: UPPER CANADA CONSULTANTS
   35    COMMENT
        4     line(s) of comment
         PROJECT NAME: BARRICK SUBDIVISION
         PROJECT NO.:  2300
         STORMWATER MANAGEMENT ANALYSIS JULY 2023
         EXISTING CONDITIONS
   14    START
        1     1=Zero; 2=Define
   35    COMMENT
        3     line(s) of comment
         ****************************
         ** 25mm DESIGN STORM EVENT **
         ****************************
    2    STORM
             1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       512.000      Coefficient  a
         6.000      Constant  b    (min)
          .800      Exponent  c
          .400      Fraction to peak  r
       240.000      Duration ó  240 min
                 25.036 mm     Total depth
    3    IMPERVIOUS
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .013      Manning "n"
        98.000      SCS Curve No or C
          .100      Ia/S Coefficient
          .518      Initial Abstraction
    4    CATCHMENT
        10.000      ID No.ó 99999
        11.260      Area in hectares
       300.000      Length (PERV) metres
         1.000      Gradient (%)
         3.000      Per cent Impervious
       300.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .032       .000       .000       .000 c.m/s
              .130       .797       .150     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .4237393E+03 c.m
   14    START
        1     1=Zero; 2=Define
   35    COMMENT
        3     line(s) of comment
         *********************************
         * MTO 2 YEAR DESIGN STORM EVENT *
         *********************************
    2    STORM
             1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       397.149      Coefficient  a
          .000      Constant  b    (min)
          .699      Exponent  c
          .450      Fraction to peak  r
       240.000      Duration ó  240 min
                 34.451 mm     Total depth
    3    IMPERVIOUS
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015      Manning "n"
        98.000      SCS Curve No or C
          .100      Ia/S Coefficient
          .518      Initial Abstraction
    4    CATCHMENT
        10.000      ID No.ó 99999
        11.260      Area in hectares
       300.000      Length (PERV) metres
         1.000      Gradient (%)
         3.000      Per cent Impervious
       300.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .056       .000       .000       .000 c.m/s
              .204       .849       .223     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .8657618E+03 c.m
    4    CATCHMENT
        20.000      ID No.ó 99999
         5.130      Area in hectares
       100.000      Length (PERV) metres
         1.000      Gradient (%)
         1.900      Per cent Impervious
       100.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .043       .000       .000       .000 c.m/s
              .204       .838       .216     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
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         Volume  =  .3815630E+03 c.m
    4    CATCHMENT
        30.000      ID No.ó 99999
         3.440      Area in hectares
       100.000      Length (PERV) metres
         2.000      Gradient (%)
          .500      Per cent Impervious
       100.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .032       .000       .000       .000 c.m/s
              .204       .847       .207     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .2453878E+03 c.m
    4    CATCHMENT
        40.000      ID No.ó 99999
          .480      Area in hectares
        30.000      Length (PERV) metres
         1.000      Gradient (%)
          .500      Per cent Impervious
        30.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .007       .000       .000       .000 c.m/s
              .203       .839       .206     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .3414280E+02 c.m
   14    START
        1     1=Zero; 2=Define
   35    COMMENT
        3     line(s) of comment
         *********************************
         * MTO 5 YEAR DESIGN STORM EVENT *
         *********************************
    2    STORM
             1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       524.867      Coefficient  a
          .000      Constant  b    (min)
          .699      Exponent  c
          .450      Fraction to peak  r
       240.000      Duration ó  240 min
                 45.530 mm     Total depth
    3    IMPERVIOUS
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015      Manning "n"
        98.000      SCS Curve No or C
          .100      Ia/S Coefficient
          .518      Initial Abstraction
    4    CATCHMENT
        10.000      ID No.ó 99999
        11.260      Area in hectares
       300.000      Length (PERV) metres
         1.000      Gradient (%)
         3.000      Per cent Impervious
       300.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .129       .000       .000       .000 c.m/s
              .278       .884       .296     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
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         Volume  =  .1517193E+04 c.m
    4    CATCHMENT
        20.000      ID No.ó 99999
         5.130      Area in hectares
       100.000      Length (PERV) metres
         1.000      Gradient (%)
         1.900      Per cent Impervious
       100.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .096       .000       .000       .000 c.m/s
              .278       .876       .289     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .6748363E+03 c.m
    4    CATCHMENT
        30.000      ID No.ó 99999
         3.440      Area in hectares
       100.000      Length (PERV) metres
         2.000      Gradient (%)
          .500      Per cent Impervious
       100.000      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        77.000      SCS Curve No or C
          .100      Ia/S Coefficient
         7.587      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .074       .000       .000       .000 c.m/s
              .278       .880       .281     C perv/imperv/total
   27    HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .4396343E+03 c.m
    4    CATCHMENT
        40.000      ID No.ó 99999
          .480      Area in hectares
        30.000      Length (PERV) metres
         1.000      Gradient (%)
          .500      Per cent Impervious
```

```
        30.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .014       .000       .000       .000 c.m/s
                .277       .865       .280     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .6120665E+02 c.m
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         *********************************
         * MTO 10 YEAR DESIGN STORM EVENT *
         *********************************
   2     STORM
             1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       608.845     Coefficient  a
          .000     Constant  b    (min)
          .699     Exponent  c
          .450     Fraction to peak  r
       240.000     Duration ó  240 min
                52.815 mm     Total depth
   3     IMPERVIOUS
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015     Manning "n"
        98.000     SCS Curve No or C
          .100     Ia/S Coefficient
          .518     Initial Abstraction
   4     CATCHMENT
        10.000     ID No.ó 99999
        11.260     Area in hectares
       300.000     Length (PERV) metres
         1.000     Gradient (%)
         3.000     Per cent Impervious
       300.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .188       .000       .000       .000 c.m/s
                .320       .897       .337     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .2004478E+04 c.m
   4     CATCHMENT
        20.000     ID No.ó 99999
         5.130     Area in hectares
       100.000     Length (PERV) metres
         1.000     Gradient (%)
         1.900     Per cent Impervious
       100.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .146       .000       .000       .000 c.m/s
                .319       .892       .330     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .8946319E+03 c.m
   4     CATCHMENT
        30.000     ID No.ó 99999
         3.440     Area in hectares
       100.000     Length (PERV) metres
         2.000     Gradient (%)
          .500     Per cent Impervious
       100.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .108       .000       .000       .000 c.m/s
                .320       .894       .322     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .5859025E+03 c.m
   4     CATCHMENT
        40.000     ID No.ó 99999
          .480     Area in hectares
        30.000     Length (PERV) metres
         1.000     Gradient (%)
          .500     Per cent Impervious
        30.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .020       .000       .000       .000 c.m/s
                .319       .876       .322     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .8161620E+02 c.m
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         *********************************
         * MTO 25 YEAR DESIGN STORM EVENT *
         *********************************
   2     STORM
             1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       715.568     Coefficient  a
          .000     Constant  b    (min)
          .699     Exponent  c
          .450     Fraction to peak  r
       240.000     Duration ó  240 min
                62.073 mm     Total depth
   3     IMPERVIOUS
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015     Manning "n"
        98.000     SCS Curve No or C
          .100     Ia/S Coefficient
          .518     Initial Abstraction
   4     CATCHMENT
        10.000     ID No.ó 99999
        11.260     Area in hectares
       300.000     Length (PERV) metres
         1.000     Gradient (%)
         3.000     Per cent Impervious
       300.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .288       .000       .000       .000 c.m/s
                .367       .911       .383     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .2677228E+04 c.m
   4     CATCHMENT
        20.000     ID No.ó 99999
         5.130     Area in hectares
       100.000     Length (PERV) metres
         1.000     Gradient (%)
         1.900     Per cent Impervious
       100.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .211       .000       .000       .000 c.m/s
                .366       .908       .376     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .1197842E+04 c.m
   4     CATCHMENT
        30.000     ID No.ó 99999
         3.440     Area in hectares
       100.000     Length (PERV) metres
         2.000     Gradient (%)
          .500     Per cent Impervious
       100.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .178       .000       .000       .000 c.m/s
                .366       .904       .369     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .7870166E+03 c.m
   4     CATCHMENT
        40.000     ID No.ó 99999
          .480     Area in hectares
        30.000     Length (PERV) metres
         1.000     Gradient (%)
          .500     Per cent Impervious
        30.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        77.000     SCS Curve No or C
          .100     Ia/S Coefficient
         7.587     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .031       .000       .000       .000 c.m/s
                .365       .886       .368     C perv/imperv/total
  27     HYDROGRAPH DISPLAY
        4     is # of Hyeto/Hydrograph chosen
         Volume  =  .1095012E+03 c.m
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         *********************************
         * MTO 50 YEAR DESIGN STORM EVENT *
         *********************************
   2     STORM
             1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       794.298     Coefficient  a
          .000     Constant  b    (min)
          .699     Exponent  c
          .450     Fraction to peak  r
       240.000     Duration ó  240 min
                68.903 mm     Total depth
   3     IMPERVIOUS
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015     Manning "n"
        98.000     SCS Curve No or C
          .100     Ia/S Coefficient
          .518     Initial Abstraction
   4     CATCHMENT
        10.000     ID No.ó 99999
        11.260     Area in hectares
       300.000     Length (PERV) metres
         1.000     Gradient (%)
         3.000     Per cent Impervious
```

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      300.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .366       .000       .000       .000 c.m/s
               .397       .917       .413     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .3203910E+04 c.m
  4    CATCHMENT
       20.000      ID No.ó 99999
        5.130      Area in hectares
      100.000      Length (PERV) metres
        1.000      Gradient (%)
        1.900      Per cent Impervious
      100.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .271       .000       .000       .000 c.m/s
               .398       .916       .408     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .1440367E+04 c.m
  4    CATCHMENT
       30.000      ID No.ó 99999
        3.440      Area in hectares
      100.000      Length (PERV) metres
        2.000      Gradient (%)
         .500      Per cent Impervious
      100.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .224       .000       .000       .000 c.m/s
               .398       .910       .400     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .9483638E+03 c.m
  4    CATCHMENT
       40.000      ID No.ó 99999
         .480      Area in hectares
       30.000      Length (PERV) metres
        1.000      Gradient (%)
         .500      Per cent Impervious
       30.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .041       .000       .000       .000 c.m/s
               .397       .891       .400     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .1321806E+03 c.m
 14    START
       1     1=Zero; 2=Define
 35    COMMENT
       3     line(s) of comment
        ***********************************
        * MTO 100 YEAR DESIGN STORM EVENT *
        ***********************************
  2    STORM
            1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      871.279      Coefficient  a
         .000      Constant  b    (min)
         .699      Exponent  c
         .450      Fraction to peak  r
      240.000      Duration ó  240 min
                 75.581 mm     Total depth
  3    IMPERVIOUS
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015      Manning "n"
       98.000      SCS Curve No or C
         .100      Ia/S Coefficient
         .518      Initial Abstraction
  4    CATCHMENT
       10.000      ID No.ó 99999
       11.260      Area in hectares
      300.000      Length (PERV) metres
        1.000      Gradient (%)
        3.000      Per cent Impervious
      300.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .477       .000       .000       .000 c.m/s
               .425       .922       .440     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .3743332E+04 c.m
  4    CATCHMENT
       20.000      ID No.ó 99999
        5.130      Area in hectares
      100.000      Length (PERV) metres
        1.000      Gradient (%)
        1.900      Per cent Impervious
      100.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .345       .000       .000       .000 c.m/s
               .424       .923       .434     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .1682262E+04 c.m
  4    CATCHMENT
       30.000      ID No.ó 99999
        3.440      Area in hectares
      100.000      Length (PERV) metres
        2.000      Gradient (%)
         .500      Per cent Impervious
      100.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .272       .000       .000       .000 c.m/s
               .424       .915       .427     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .1109006E+04 c.m
  4    CATCHMENT
       40.000      ID No.ó 99999
         .480      Area in hectares
       30.000      Length (PERV) metres
        1.000      Gradient (%)
         .500      Per cent Impervious
       30.000      Length (IMPERV)
         .000      %Imp. with Zero Dpth
            1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250      Manning "n"
       77.000      SCS Curve No or C
         .100      Ia/S Coefficient
        7.587      Initial Abstraction
            1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .058       .000       .000       .000 c.m/s
               .424       .896       .427     C perv/imperv/total
 27    HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .1548541E+03 c.m
 20    MANUAL
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Future Conditions – WITH SWM

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          Output File (4.7) SWM.OUT      opened 2024-03-04  13:12
          Units used are defined by G =     9.810
              24   144    10.000        are MAXDT MAXHYD & DTMIN values
          Licensee: UPPER CANADA CONSULTANTS
   35     COMMENT
         4     line(s) of comment
          PROJECT NAME: BARRICK SUBDIVISION
          PROJECT NO.:  2300
          STORMWATER MANAGEMENT ANALYSIS JULY 2023
          PROPOSED CONDITIONS
   14     START
         1     1=Zero; 2=Define
   35     COMMENT
         3     line(s) of comment
          *****************************
          ** 25MM DESIGN STORM EVENT **
          *****************************
    2     STORM
              1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
        512.000      Coefficient  a
          6.000      Constant  b    (min)
           .800      Exponent  c
           .400      Fraction to peak  r
        240.000      Duration ó  240 min
                   25.036 mm     Total depth
    3     IMPERVIOUS
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .013      Manning "n"
         98.000      SCS Curve No or C
           .100      Ia/S Coefficient
           .518      Initial Abstraction
    4     CATCHMENT
         10.000      ID No.ó 99999
         19.410      Area in hectares
        450.000      Length (PERV) metres
          1.000      Gradient (%)
         70.000      Per cent Impervious
        450.000      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         77.000      SCS Curve No or C
           .100      Ia/S Coefficient
          7.587      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                1.014       .000       .000       .000 c.m/s
                 .130       .807       .604     C perv/imperv/total
   15     ADD RUNOFF
                1.014      1.014       .000       .000 c.m/s
   27     HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .2925692E+04 c.m
   10     POND
         8 Depth - Discharge - Volume sets
          184.000        .000          .0
          184.300       .0178      1028.3
          184.600       .0277      2202.7
          184.900       .0349      3482.4
          185.250        .147      5077.9
          185.850        .148      8077.3
          186.000        .324      8880.1
          186.300       1.899     10550.9
          Peak Outflow    =      .029 c.m/s
          Maximum Depth   =   184.661 metres
          Maximum Storage =     2461. c.m
                1.014      1.014       .029       .000 c.m/s
   14     START
         1     1=Zero; 2=Define
   35     COMMENT
         3     line(s) of comment
          *********************************
          * MTO 2 YEAR DESIGN STORM EVENT *
          *********************************
    2     STORM
              1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
        397.149      Coefficient  a
           .000      Constant  b    (min)
           .699      Exponent  c
           .450      Fraction to peak  r
        240.000      Duration ó  240 min
                   34.451 mm     Total depth
    3     IMPERVIOUS
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .015      Manning "n"
         98.000      SCS Curve No or C
           .100      Ia/S Coefficient
           .518      Initial Abstraction
    4     CATCHMENT
         20.000      ID No.ó 99999
           .880      Area in hectares
         20.000      Length (PERV) metres
          1.000      Gradient (%)
         28.600      Per cent Impervious
         20.000      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         77.000      SCS Curve No or C
           .100      Ia/S Coefficient
          7.587      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                 .043       .000       .029       .000 c.m/s
                 .203       .828       .382     C perv/imperv/total
   27     HYDROGRAPH DISPLAY
         4     is # of Hyeto/Hydrograph chosen
          Volume  =  .1157704E+03 c.m
    4     CATCHMENT
          1.000      ID No.ó 99999
         19.410      Area in hectares
        450.000      Length (PERV) metres
          1.000      Gradient (%)
         70.000      Per cent Impervious
        450.000      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         77.000      SCS Curve No or C
           .100      Ia/S Coefficient
          7.587      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                1.737       .000       .029       .000 c.m/s
                 .204       .853       .658     C perv/imperv/total
   15     ADD RUNOFF
                1.737      1.737       .029       .000 c.m/s
   27     HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .4398207E+04 c.m
   10     POND
         8 Depth - Discharge - Volume sets
          184.000        .000          .0
          184.300       .0178      1028.3
          184.600       .0277      2202.7
          184.900       .0349      3482.4
          185.250        .147      5077.9
          185.850        .148      8077.3
          186.000        .324      8880.1
          186.300       1.899     10550.9
          Peak Outflow    =      .052 c.m/s
          Maximum Depth   =   184.955 metres
          Maximum Storage =     3732. c.m
                1.737      1.737       .052       .000 c.m/s
   14     START
         1     1=Zero; 2=Define
   35     COMMENT
         3     line(s) of comment
          *********************************
          * MTO 5 YEAR DESIGN STORM EVENT *
          *********************************
    2     STORM
              1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
        524.867      Coefficient  a
           .000      Constant  b    (min)
           .699      Exponent  c
           .450      Fraction to peak  r
        240.000      Duration ó  240 min
                   45.530 mm     Total depth
    3     IMPERVIOUS
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .015      Manning "n"
         98.000      SCS Curve No or C
           .100      Ia/S Coefficient
           .518      Initial Abstraction
    4     CATCHMENT
         20.000      ID No.ó 99999
           .880      Area in hectares
         20.000      Length (PERV) metres
          1.000      Gradient (%)
         28.600      Per cent Impervious
         20.000      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         77.000      SCS Curve No or C
           .100      Ia/S Coefficient
          7.587      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                 .064       .000       .052       .000 c.m/s
                 .276       .853       .441     C perv/imperv/total
   27     HYDROGRAPH DISPLAY
         4     is # of Hyeto/Hydrograph chosen
          Volume  =  .1767936E+03 c.m
    4     CATCHMENT
          1.000      ID No.ó 99999
         19.410      Area in hectares
        450.000      Length (PERV) metres
          1.000      Gradient (%)
         70.000      Per cent Impervious
        450.000      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         77.000      SCS Curve No or C
           .100      Ia/S Coefficient
          7.587      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                2.444       .000       .052       .000 c.m/s
                 .278       .875       .696     C perv/imperv/total
   15     ADD RUNOFF
                2.444      2.444       .052       .000 c.m/s
   27     HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .6149111E+04 c.m
   10     POND
         8 Depth - Discharge - Volume sets
          184.000        .000          .0
          184.300       .0178      1028.3
          184.600       .0277      2202.7
          184.900       .0349      3482.4
          185.250        .147      5077.9
          185.850        .148      8077.3
          186.000        .324      8880.1
          186.300       1.899     10550.9
          Peak Outflow    =      .128 c.m/s
          Maximum Depth   =   185.190 metres
          Maximum Storage =     4804. c.m
                2.444      2.444       .128       .000 c.m/s
   14     START
         1     1=Zero; 2=Define
   35     COMMENT
         3     line(s) of comment
          **********************************
          * MTO 10 YEAR DESIGN STORM EVENT *
          **********************************
    2     STORM
              1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
        608.845      Coefficient  a
           .000      Constant  b    (min)
           .699      Exponent  c
           .450      Fraction to peak  r
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      240.000     Duration ó  240 min
               52.815 mm     Total depth
 3     IMPERVIOUS
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015      Manning "n"
      98.000      SCS Curve No or C
        .100      Ia/S Coefficient
        .518      Initial Abstraction
 4     CATCHMENT
      20.000      ID No.ó 99999
        .880      Area in hectares
      20.000      Length (PERV) metres
       1.000      Gradient (%)
      28.600      Per cent Impervious
      20.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
           .079       .000       .128       .000 c.m/s
           .319       .864       .475     C perv/imperv/total
27     HYDROGRAPH DISPLAY
    4     is # of Hyeto/Hydrograph chosen
     Volume  =  .2207980E+03 c.m
 4     CATCHMENT
       1.000      ID No.ó 99999
      19.410      Area in hectares
     450.000      Length (PERV) metres
       1.000      Gradient (%)
      70.000      Per cent Impervious
     450.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
          2.904       .000       .128       .000 c.m/s
           .320       .890       .719     C perv/imperv/total
15     ADD RUNOFF
          2.904      2.904       .128       .000 c.m/s
27     HYDROGRAPH DISPLAY
    5     is # of Hyeto/Hydrograph chosen
     Volume  =  .7370755E+04 c.m
10     POND
    8 Depth - Discharge - Volume sets
     184.000        .000         .0
     184.300       .0178      1028.3
     184.600       .0277      2202.7
     184.900       .0349      3482.4
     185.250        .147      5077.9
     185.850        .148      8077.3
     186.000        .324      8880.1
     186.300       1.899     10550.9
     Peak Outflow    =      .147 c.m/s
     Maximum Depth   =   185.360 metres
     Maximum Storage =     5626. c.m
          2.904      2.904       .147       .000 c.m/s
14     START
    1     1=Zero; 2=Define
35     COMMENT
    3     line(s) of comment
     *********************************
     * MTO 25 YEAR DESIGN STORM EVENT *
     *********************************
 2     STORM
          1       1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
     715.568      Coefficient  a
        .000      Constant  b    (min)
        .699      Exponent  c
        .450      Fraction to peak  r
     240.000      Duration ó  240 min
               62.073 mm     Total depth
 3     IMPERVIOUS
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015      Manning "n"
      98.000      SCS Curve No or C
        .100      Ia/S Coefficient
        .518      Initial Abstraction
 4     CATCHMENT
      20.000      ID No.ó 99999
        .880      Area in hectares
      20.000      Length (PERV) metres
       1.000      Gradient (%)
      28.600      Per cent Impervious
      20.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
           .096       .000       .147       .000 c.m/s
           .365       .875       .511     C perv/imperv/total
27     HYDROGRAPH DISPLAY
    4     is # of Hyeto/Hydrograph chosen
     Volume  =  .2789290E+03 c.m
 4     CATCHMENT
       1.000      ID No.ó 99999
      19.410      Area in hectares
     450.000      Length (PERV) metres
       1.000      Gradient (%)
      70.000      Per cent Impervious
     450.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
          3.480       .000       .147       .000 c.m/s
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           .367       .909       .747     C perv/imperv/total
15     ADD RUNOFF
          3.480      3.480       .147       .000 c.m/s
27     HYDROGRAPH DISPLAY
    5     is # of Hyeto/Hydrograph chosen
     Volume  =  .8994581E+04 c.m
10     POND
    8 Depth - Discharge - Volume sets
     184.000        .000         .0
     184.300       .0178      1028.3
     184.600       .0277      2202.7
     184.900       .0349      3482.4
     185.250        .147      5077.9
     185.850        .148      8077.3
     186.000        .324      8880.1
     186.300       1.899     10550.9
     Peak Outflow    =      .148 c.m/s
     Maximum Depth   =   185.640 metres
     Maximum Storage =     7027. c.m
          3.480      3.480       .148       .000 c.m/s
14     START
    1     1=Zero; 2=Define
35     COMMENT
    3     line(s) of comment
     *********************************
     * MTO 50 YEAR DESIGN STORM EVENT *
     *********************************
 2     STORM
          1       1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
     794.298      Coefficient  a
        .000      Constant  b    (min)
        .699      Exponent  c
        .450      Fraction to peak  r
     240.000      Duration ó  240 min
               68.903 mm     Total depth
 3     IMPERVIOUS
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015      Manning "n"
      98.000      SCS Curve No or C
        .100      Ia/S Coefficient
        .518      Initial Abstraction
 4     CATCHMENT
      20.000      ID No.ó 99999
        .880      Area in hectares
      20.000      Length (PERV) metres
       1.000      Gradient (%)
      28.600      Per cent Impervious
      20.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
           .113       .000       .148       .000 c.m/s
           .392       .881       .532     C perv/imperv/total
27     HYDROGRAPH DISPLAY
    4     is # of Hyeto/Hydrograph chosen
     Volume  =  .3227145E+03 c.m
 4     CATCHMENT
       1.000      ID No.ó 99999
      19.410      Area in hectares
     450.000      Length (PERV) metres
       1.000      Gradient (%)
      70.000      Per cent Impervious
     450.000      Length (IMPERV)
        .000      %Imp. with Zero Dpth
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250      Manning "n"
      77.000      SCS Curve No or C
        .100      Ia/S Coefficient
       7.587      Initial Abstraction
          1       Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
          3.897       .000       .148       .000 c.m/s
           .397       .919       .763     C perv/imperv/total
15     ADD RUNOFF
          3.897      3.897       .148       .000 c.m/s
27     HYDROGRAPH DISPLAY
    5     is # of Hyeto/Hydrograph chosen
     Volume  =  .1019831E+05 c.m
10     POND
    8 Depth - Discharge - Volume sets
     184.000        .000         .0
     184.300       .0178      1028.3
     184.600       .0277      2202.7
     184.900       .0349      3482.4
     185.250        .147      5077.9
     185.850        .148      8077.3
     186.000        .324      8880.1
     186.300       1.899     10550.9
     Peak Outflow    =      .159 c.m/s
     Maximum Depth   =   185.859 metres
     Maximum Storage =     8127. c.m
          3.897      3.897       .159       .000 c.m/s
14     START
    1     1=Zero; 2=Define
35     COMMENT
    3     line(s) of comment
     **********************************
     * MTO 100 YEAR DESIGN STORM EVENT *
     **********************************
 2     STORM
          1       1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
     871.279      Coefficient  a
        .000      Constant  b    (min)
        .699      Exponent  c
        .450      Fraction to peak  r
     240.000      Duration ó  240 min
               75.581 mm     Total depth
 3     IMPERVIOUS
          1       Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015      Manning "n"
      98.000      SCS Curve No or C
        .100      Ia/S Coefficient
        .518      Initial Abstraction
 4     CATCHMENT
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       20.000     ID No.ó 99999
         .880     Area in hectares
       20.000     Length (PERV) metres
        1.000     Gradient (%)
       28.600     Per cent Impervious
       20.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       77.000     SCS Curve No or C
         .100     Ia/S Coefficient
        7.587     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .131       .000       .159       .000 c.m/s
               .421       .886       .554     C perv/imperv/total
 27     HYDROGRAPH DISPLAY
       4     is # of Hyeto/Hydrograph chosen
        Volume  =  .3683710E+03 c.m
  4     CATCHMENT
        1.000     ID No.ó 99999
       19.410     Area in hectares
      450.000     Length (PERV) metres
        1.000     Gradient (%)
       70.000     Per cent Impervious
      450.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       77.000     SCS Curve No or C
         .100     Ia/S Coefficient
        7.587     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              4.300       .000       .159       .000 c.m/s
               .425       .926       .776     C perv/imperv/total
 15     ADD RUNOFF
              4.300      4.300       .159       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .1137934E+05 c.m
 10     POND
       8 Depth - Discharge - Volume sets
        184.000        .000          .0
        184.300       .0178      1028.3
        184.600       .0277      2202.7
        184.900       .0349      3482.4
        185.250        .147      5077.9
        185.850        .148      8077.3
        186.000        .324      8880.1
        186.300       1.899     10550.9
        Peak Outflow    =      .289 c.m/s
        Maximum Depth   =   185.970 metres
        Maximum Storage =     8719. c.m
              4.300      4.300       .289       .000 c.m/s
 20     MANUAL
```