

STORMWATER MANAGEMENT PLAN

WESTWOOD ESTATES (PHASE 3)

CITY OF PORT COLBORNE

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REFERENCES

1. Stormwater Management Planning and Design Manual
Ontario Ministry of Environment (March 2003)
2. Soils of the Regional Municipality of Niagara Soil Survey Report No. 60 of the Ontario
Institute of Pedology. (1989)

STORMWATER MANAGEMENT PLAN

WESTWOOD ESTATES (PHASE 3)

CITY OF PORT COLBORNE

1.0 INTRODUCTION

1.1 Study Area

The proposed residential development of Westwood Estates (Phase 3), is located within the remaining lands of the Westwood Estates Park Secondary Plan in City of Port Colborne. As shown on the enclosed Site Location Plan (Figure 1), the subject property is situated south of Stanley Street, east of Cement Plant Road, west of Olga Drive, and north of the Eagle Marsh Drain.

The study area is approximately 30.55 hectares and will consist of a mix of single detached dwellings, street townhouse dwellings, and a Block that can be developed as a future medium density residential site (Block 160). The site will include associated asphalt parking lot, concrete curb, catch basins, storm sewers, sanitary sewers, and watermain.

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 stormwater from the drainage area.
3. Investigate alternatives for controlling the quality of stormwater discharging from the site.
4. Establish the property requirements to construct a stormwater management facility for the Draft Plan of Subdivision.

1.3 Existing & Proposed Conditions

a) Existing Conditions

The site has historically been used as primarily agriculture land with one Provincially Significant Wetland (PSW) located in the south-east portion of the site.

The topography of the site is relatively flat with a general southerly slope towards the Eagle Marsh Drain. There is an existing drainage channel through the middle of the site, flowing from north to south providing a stormwater outlet for the previously constructed Phases of the Westwood Estates Subdivision (Phases 1 and 2). This drainage channel was constructed within the existing shallow bedrock levels present within the subject lands.

The soils within the subject lands, according to the Ontario Institute of Pedology, predominantly consist of Brooke soils, with 50-100 cm of variable textures over bedrock and an infiltration rate classified as “Poorly Drained”.

b) Proposed Conditions

The subject lands are approximately 30.55 hectares and will consist of a mix of single family residential dwellings, street town residential dwellings and a Block that can be developed as a future medium density residential site (Block 160). The site shall be provided with full municipal services including sanitary sewers, storm sewers and watermain with asphalt pavement, concrete curbs and gutters.

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 the City of Port Colborne, Regional Municipality of Niagara, Niagara Peninsula Conservation Authority (NPCA), and the Ministry of the Environment, Conservation and Parks (MECP), the following site-specific considerations were identified:

- Stormwater runoff from the development shall be collected and treated to an Enhanced (80% TSS removal) standard prior to discharge to the receiving watercourse (Eagle Marsh Drain); and,

- The subject lands are located immediately upstream of the Eagle Marsh Drain's ultimate outlet to Lake Erie. Detaining future peak stormwater flows on site will delay the stormwater peak from the site to match with the greater stormwater peak from the approximately 633 hectares of upstream lands within the Eagle Marsh Drain watershed per the NPCA's 2010 Floodplain Mapping Report for the Eagle Marsh Drain.
- The Regional Municipality of Niagara has requested that downstream erosion protection be provided prior to discharging to the Eagle Marsh Drain.

Based on the above and a review of the site-specific considerations, the following stormwater management criteria have been established for this site:

- Stormwater **quality** controls are to be provided to provide Enhanced Protection (80% TSS removal) in accordance with MECP guidelines prior to outletting to the Eagle Marsh Drain;
- Stormwater **quantity** controls are not required for stormwater flows discharging from the subject lands directly to the Eagle Marsh Drain; and,
- A permanent water elevation is present the Eagle Marsh Drain, which is maintained by the water elevation in Lake Erie. Therefore, downstream erosion effects are not anticipated in the Eagle Marsh Drain due to uncontrolled stormwater flows discharging from the subject lands in frequent storm events and it is not considered necessary to provide **downstream erosion protection** from proposed stormwater management facilities within the subject lands.

3.0 STORMWATER ANALYSIS

It is proposed to model existing and future flows with the MIDUSS modelling software. 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.

3.1 Design Storms

The 5 and 100 year design storm hyetographs w developed using a Chicago distribution based on City of Welland Intensity-Duration-Frequency (IDF) curves in accordance with City of Port Colborne standards. The 25mm design storm IDF curve parameters were derived 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	512.0	6.00	0.800
5 Year	830.0	7.30	0.777
100 Year	1020.0	4.70	0.731
$Intensity \text{ (mm/hr)} = \frac{a}{(t_d + b)^c}$			

3.2 Existing Conditions

As shown in Figure 2, existing stormwater flows from the subject lands are conveyed southerly to the Eagle Marsh Drain, and ultimately to Lake Erie.

The eastern portion of the site will drain southerly directly to the existing PSW on the south limit of the site prior to discharging to the Eagle Marsh Drain. This drainage area is shown as Drainage Area EX1 in Figure 2. The remaining portion of the site will drain to the Eagle Marsh Drain either the via existing Bedrock Channel located within the subject lands or the Cement Plan Road roadside ditches.

Flows discharging directly to the Eagle Marsh Drain will not require quantity controls due to the location of the subject lands within the Eagle Marsh Drain watershed. Delaying the discharge of future flows from the subject lands will result in matching the governing upstream peak within the respective watershed, increasing downstream water levels.

Future flows discharging directly the existing PSW are to be limited to existing levels.

To ensure existing flows at the southerly PSW are maintained at or below existing levels, Figure 2 shows the existing stormwater drainage area discharging to this PSW and Table 2 summarizes the hydrologic parameters used in the existing conditions MIDUSS model.

Table 2. Hydrologic Parameters for Existing Conditions								
Area No.	Area (ha)	Length (m)	Slope (%)	Manning – “n”		Soil Type	SCS CN	Percent Impervious
				Perv.	Imperv.			
EX1	11.20	273	1.0	0.25	0.015	C	77	1%
11.20		Total Area (ha)						

3.3 Proposed Conditions

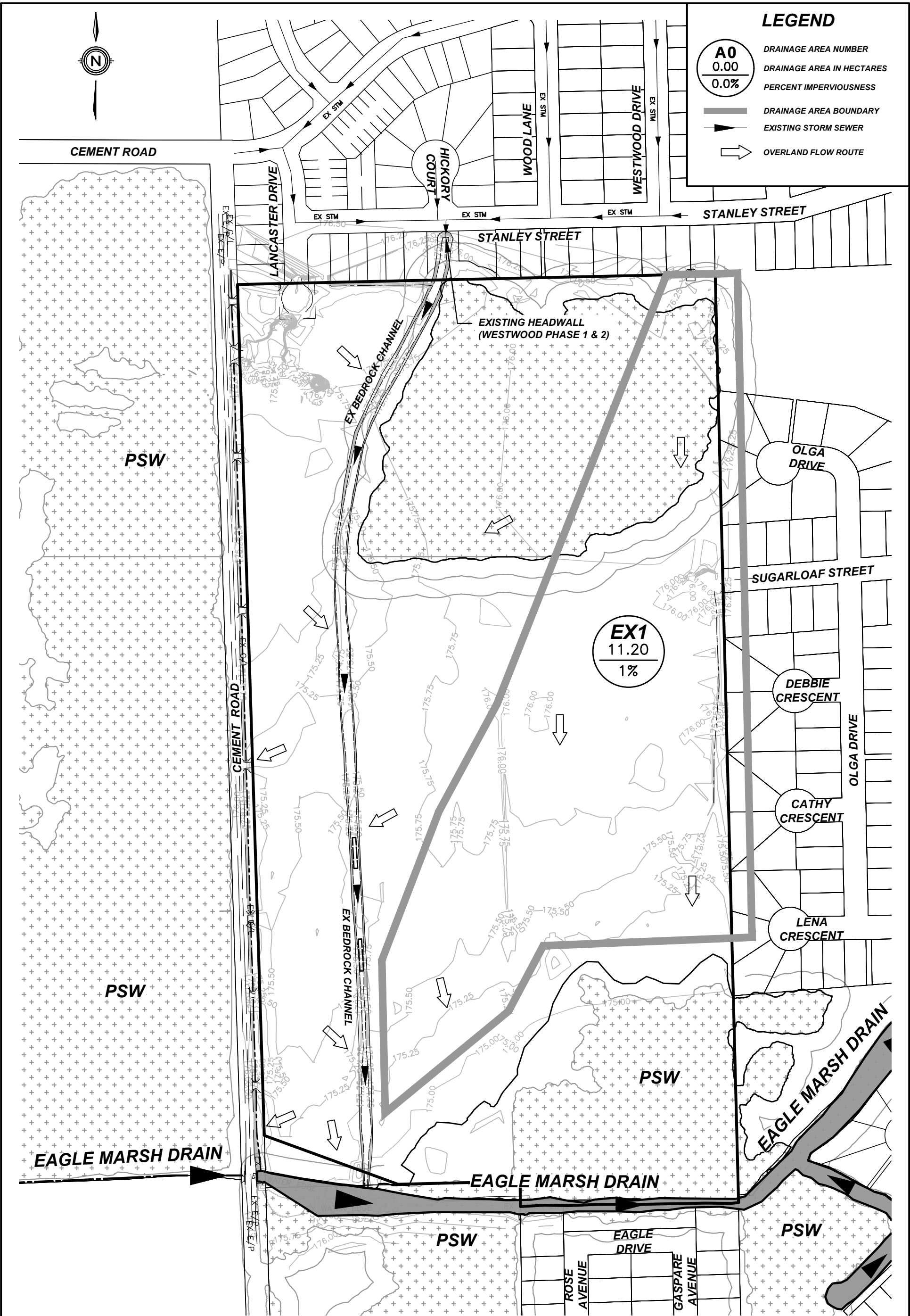
The future drainage areas for the proposed development, shown in Figure 3, were modelled to establish the stormwater future peak flows once development has been completed

Future Drainage Areas A1 and A2 have been modelled for the purposes of sediment forebay sizing and determining stormwater quality controls only.

Area A3 has been modelled to identify the future peak flows discharging to the southern PSW. Input parameters for the computer model are shown in Table 2.

Table 3. Hydrologic Parameters for Future Conditions								
Area No.	Area (ha)	Length (m)	Slope (%)	Manning – “n”		Soil Type	SCS CN	Percent Impervious
				Perv.	Imperv.			
A1	4.27	168	1.0	0.25	0.015	C	77	67%
A2	15.48	320	1.0	0.25	0.015	C	77	35%
A3	2.90	139	1.0	0.25	0.015	C	77	10%
24.04		Total Area (ha)						

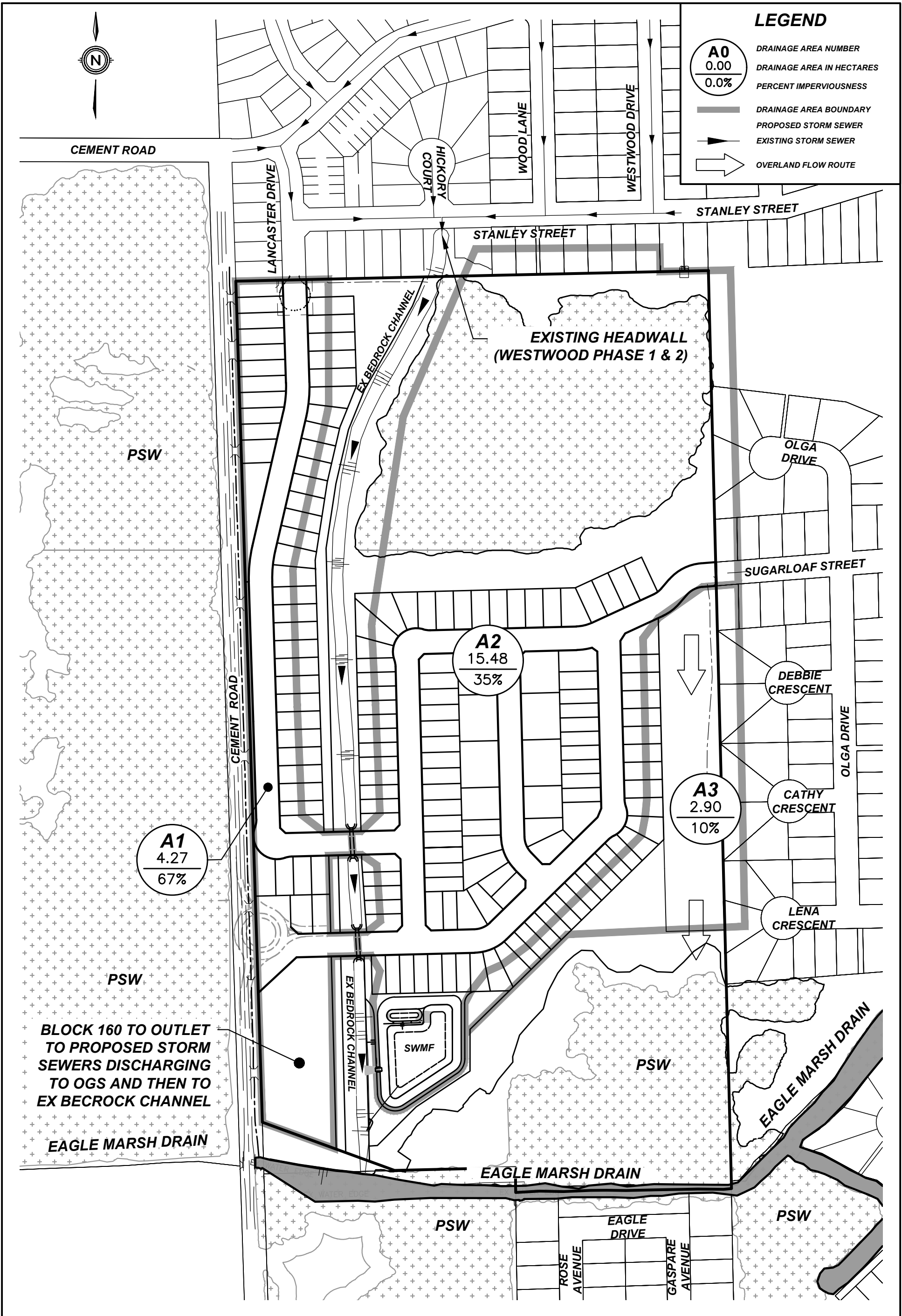
The detailed MIDUSS modelling output files have been enclosed in Appendix C for reference.



**UPPER CANADA
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ENGINEERS / PLANNERS

WESTWOOD ESTATES (PHASE 3)
CITY OF PORT COLBORNE
EXISTING STORM DRAINAGE AREAS
TO EXISTING PSW

DATE	2025-04-21
SCALE	1:3000 m
REF No.	2160
DWG No.	FIGURE 2



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. Wet facilities are effective practices for stormwater quality control for large drainage areas (>5 ha).

e) Other

Where the associated drainage areas are too small to support a permanent pool volume and available space are limited oil/grit separators can be very effective in providing quality protection.

Table 4. Evaluation of Stormwater Management Practices

Westwood Estates (Phase 3)	Criteria for Implementation of Stormwater Management Practices (SWMP)					Technical Effectiveness (10 high)	Recommend Implementation Yes / No	Comments
	Topography	Soils	Bedrock	Groundwater	Area			
Site Conditions	Flat ±1%	Variable ±15 mm/hr	Shallow	At Considerable Depth	± 4.27ha ± 15.48ha			
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	6	No	Very effective quality control
Other								
Oil/Grit Separator	nlc	nlc	nlc	nlc	<2 ha	8	Yes	Limited benefit/area too large

Reference: Stormwater Management Practices Planning and Design Manual - 2003
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.
- **An oil/grit separator** to provide stormwater quality controls in accordance with MECP guidelines.

5.0 STORMWATER MANAGEMENT PLAN

A MIDUSS model was created to assess future peak flows and stormwater volumes generated within the site. The proposed stormwater management facilities shall provide quality controls for future drainage areas 'A1' and 'A2'.

It is proposed to construct a stormwater management wet pond facility to provide stormwater management quality controls to MECP Enhanced levels (80% TSS Removal) prior to discharging to the Eagle Marsh Drain for the eastern portion of the subject lands.

To provide quality controls for the western portion of the subject lands, it is proposed to provide an Oil/Grit Separator prior to discharging to the Eagle Marsh Drain as the overall drainage areas is less than 5 hectares.

5.1 Existing PSW

A MIDUSS model has been prepared for existing and future conditions draining to the southern PSW shown in Figures 2 and 3 respectively. The peak flows under existing and future conditions are summarized in Table 5.

Table 5. Existing and Future Peak Flows Comparison - PSW		
Design Storm (Return Period)	Peak Flows (m ³ /s)	
	Existing	Future
5 Year	0.132	0.060
100 Year	0.408	0.150

As shown in Table 5, future flows are below existing conditions in the 5 and 100 year design storm events without controls. Therefore, quantity controls are not required.

Additionally, future flows from Drainage Area A3 will be comprised of rear yard drainage and the proposed Corridor Enhancement Area (Block 171), which contribute clean stormwater flows to the adjacent PSW. Therefore, stormwater quality controls will also not be required for this area prior to discharging to the adjacent PSW.

5.2 Proposed Wet Pond

5.2.1 Stormwater Quality Control

Based on Table 3.2 of SWMP & Design Manual, the water quality storage requirement is approximately 140 m³/ha for *Enhanced* protection for developments with 35% impervious areas. The drainage area contributing peak stormwater flows to facility A2 is 15.48 hectares. The storage volumes required for the proposed quality controls are shown in Table 9.

Table 6. Wet Pond - Stormwater Quality Volume Calculations	
Total Water Quality Volume = 15.48 ha x 140 m ³ /ha = 2,167 m ³	Reference: Table 3.2, SWMP & Design Manual (MECP 2003)
Permanent Pool Volume = 15.48 ha x 100 m ³ /ha = 1,548 m ³	Extended Detention Volume = 15.48 ha x 40 m ³ /ha = 619 m ³

5.2.2 Stormwater Management Facility Configuration

As shown in Figure 4, it is proposed to construct a two-stage control outlet for the proposed stormwater management facility. The first stage of control consists of a reverse slope pipe acting as a tubular control 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 provide an outlet for major storm events.

The proposed bottom elevation of the facility is 173.00 m, and the permanent pool water level is 174.20 m for a water depth of 1.2 metres. The configuration of the facility provides 2,958 m³ of permanent pool volume, which is more than the required 1,548 m³. The proposed top of pond is at an elevation of 175.70 m which provides a total active volume of 6,627 m³ with 5:1 side slopes.

Based on the configuration of the proposed facility, it was determined that a 135 mm diameter quality orifice at an invert of 174.20 m can provide 26 hours of detention for the 25mm design storm event, which complies with the minimum required drawdown time of 24 hours.

The proposed ditch inlet catchbasin will be constructed with the rim at an elevation of 174.95 which will provide an extended detention volume of 2,918 m³, which is greater than the minimum volume of 619 m³ specified in Table 6.

Stage-storage-discharge calculations have been prepared for this facility and are included in Appendix A for reference.

Major overland flows within the drainage area tributary to facility A2 will be directed to the Eagle Marsh Drain.

The proposed facility has a single storm sewer inlet. Therefore, a sediment forebay has been designed to minimize the transport of heavy sediments from the storm sewer outlet throughout the facility and localize maintenance activities. Calculations for the forebay sizing follow MECP guidelines and are shown in 12.

Table 7. SWM Facility– MECP Quality Requirements Comparison		
SWM Facility Characteristic	MECP Requirement	Provided by SWM Facility
Permanent Pool Volume (m ³) - <i>minimum</i>	1,548	2,958
Extended Detention Volume (m ³) – <i>minimum</i>	619	2,918
Total Quality + Detention Storage (m ³) – <i>minimum</i>	2,167	5,876
Facility Drawdown Time (hours) – <i>minimum</i>	24	26
Forebay Length (m) – <i>minimum</i>	15.49	24.00
Forebay Width (m) – <i>minimum</i>	1.94	4.00
Average Forebay Velocity (m/s) – <i>maximum</i>	0.15	0.07
Cleanout Frequency (years) - <i>minimum</i>	10	17

As shown in Table 7, the proposed stormwater management facility configuration satisfies the quality requirements outlined by the MECP for the 15.48 hectare drainage area.

Table 8. SWM Facility Characteristics				
Design Storm (Return Period)	Peak Flows (m³/s)		Maximum Elevation (m)	Maximum Volume (m³)
	Inflow	Outflow		
25 mm	0.485	0.012	174.48	1,079
5 Year	0.966	0.031	174.93	2,847

As shown in Table 18, the proposed stormwater management facility has adequate storage capacity to detain future 25mm and 5 year design storm flows to provide the required quality controls.

Table 9. Stormwater Management Facility Forebay Sizing			
a) Forebay Settling Length (MOE SWMP&D, Equation 4.5)			
$Settling\ Length = \sqrt{\left(\frac{r \times Q}{V_s}\right)}$	r =	6.0 :1	(Length:Width Ratio)
	Q _p =	0.012 m ³ /s	(25mm Storm Pond Discharge)
	V _s =	0.0003 m/s	(Settling Velocity)
Settling Length = 15.49 m			
b) Dispersion Length (MOE SWMP&D, Equation 4.6)			
$Dispersion\ Length = \frac{8 \times Q}{D \times V_f}$	Q =	0.966 m ³ /s	(5 Yr Stm Sew Design Inflow)
	D =	1.00 m	(Depth of Forebay)
	V _f =	0.5 m/s	(Desired Velocity)
Dispersion Length = 15.46 m			
c) Minimum Forebay Deep Zone Bottom Width (MOE SWMP&D), Equation 4.7)			
$Width = \frac{Min.\ Forebay\ Length}{8}$	15.49 m DI (minimum required length)		
	Width = 1.94 m (minimum required width)		
d) Average Velocity of Flow			
$Average\ Velocity = \frac{Q}{A}$	Q =	0.485 m ³ /s	(25mm Storm Design Inflow)
	A =	7.00 m ²	(Cross Sectional Area)
	D =	1.00 m	(Depth of Forebay)
	W =	4.00 m	(Proposed Bottom Width)
	SS =	3 :1	(Side Slopes - Minimum)
Average Velocity = 0.07 m/s			
Is this Acceptable? Yes (Maximum velocity of flow = 0.15 m/s)			
e) Cleanout Frequency			
Is this Acceptable? Yes	L =	24.0 m	(Proposed Bottom Length)
	ASL =	0.6 m ³ /ha	(Annual Sediment Loading)
	A =	15.48 ha	(Drainage Area)
	FRC =	80 %	(Facility Removal Efficiency)
	FV =	198.0 m ³	(Forebay Volume)
Cleanout Frequency = 17 Years			
Is this Acceptable? Yes (10 Year Minimum Cleanout Frequency)			

3.0m WIDE ASPHALT
MAINTENANCE ACCESS
ROUTE WITH CONNECTION
TO STREET 'A'

PROP STM SEWER

INLET HEADWALL
OPSD 804.040

DEPRESSION FOR
OVERFLOW
SPILLWAY (CREST
ELEVATION = 175.40)

DITCH INLET
OPSD 705.030
RIM: 174.95m

450Ø OUTLET PIPE

OUTLET HEADWALL
OPSD 804.030

24.0m LONG, 4.0m WIDE, 1.0m DEEP
SEDIMENT FOREBAY

1.2m DEEP
PERMANENT POOL
VOLUME = 2,958m³

1.5m DEEP ACTIVE
STORAGE
VOLUME = 6,627m³

135Ø REVERSE
SLOPE PIPE



**UPPER CANADA
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WESTWOOD ESTATES (PHASE 3)
CITY OF PORT COLBORNE
STORMWATER MANAGEMENT WET POND

DATE	2025-04-22
SCALE	1:750 m
REF No.	2160
DWG No.	FIGURE 4



PSW

5.3 Proposed Oil/Grit Separator

To improve the stormwater quality for the Drainage Area A1, an oil/grit MH system will be used to provide the required Enhance Quality Protection (80% TSS Removal) prior to discharging to the Eagle Marsh Drain.

The contributing drainage area to the proposed oil/grit separator is 4.24 hectares with an imperviousness of 67%. The modelling for a Hydroworks unit has indicated that an HD8 will provide 86% TSS removal and capture 100% of the stormwater flows. Therefore, the Hydroworks HD8 is proposed for this site to treat the stormwater flows from Drainage Area A1. Output calculations for the quality assessment can be found in Appendix B.

5.4 Regulated 100 Year Floodplain

The NPCA generated a 100 year floodplain for the Eagle Marsh Drain with a detailed HEC-RAS model. The HEC-RAS model includes detailed cross sections along the watercourse to determine the extents of the existing 100 year floodplain to the outlet at Lake Erie. The cross sections along the southern limit of the site and the existing 100 year floodplain are shown in Figure 5.

The construction of the Wet Pond will include earthworks within Block 164 of the proposed Draft Plan of Subdivision respectively, which can potentially impact the 100 year floodplain associated to the Eagle Marsh Drain.

In accordance with NPCA policies, no earthworks will occur within the adjacent regulated wetland or the associated 15m regulated Wetland Buffer (Block 161). Therefore, since the existing 100 year floodplain is completely contained within Block 161, the proposed lots along the boundary of this Block will not impact the existing 100 year floodplain.

To determine the impact of future grading works within Blocks 155 and 164, a “levee” was added to the HEC-RAS model at the southern limits of these Blocks to simulate future conditions, where the footprint of the floodplain will be reduced by the future pond banks. A comparison of the 100 year flood elevations modelled with and without the “levee” is shown in Table 13.

Table 10. Comparison of Existing and Future 100 Year Floodplain Elevations			
Cross-section ID	Flood Elevation (m)		
	Existing Conditions (without levee)	Future Conditions (with levee)	Change
1029.780	175.21	175.20	-0.01
1005.961	175.18	175.18	0
964.9745	175.13	175.13	0
917.2293	175.11	175.11	0
863.8885	175.07	175.07	0

As shown in the above table, there is no measurable impact on the existing 100 year floodplain elevations resulting from the construction of the proposed Wet Pond and future development. The 0.01m decrease at cross section 1029.780 is likely due to internal rounding and is considered within the margin of error associated to the model. Therefore, the proposed wet pond facility can be permitted to be constructed within the existing 100 year floodplain extent without negatively impacting neighbouring or upstream properties.

The existing and future HEC-RAS cross sections summarized above have been enclosed in Appendix D and E for reference.

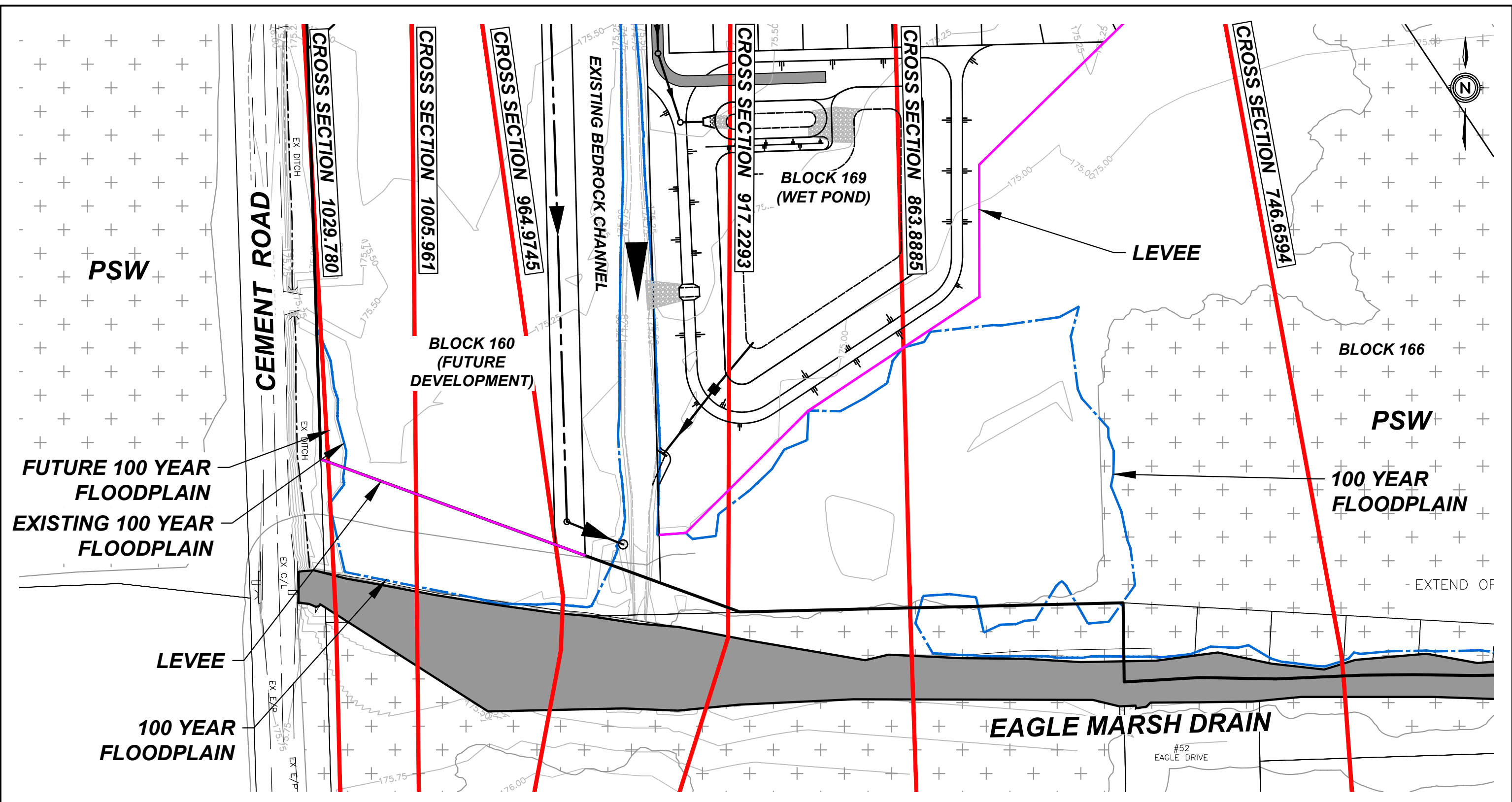
From the comments received from the City of Port Colborne's Engineering Peer Review consultant, it was indicated that there was a discrepancy between the 100 year floodplain extents provided within the NPCA's HEC-RAS model and the extents generated using the 100 year water surface elevations reported in Table 10 against the geodetic topographical data obtained by Upper Canada Consultants via on-site surveys using GPS equipment.

To address the Peer Review comments, additional topographical data within Block 161 was obtained and compared against the topographical data used by the NPCA to generated HEC-RAS model along the Eagle Marsh Drain.

It was determined that the NPCA topographical data requires an adjustment of approximately -0.14m is required to be comparative to the geodetic elevations obtained by Upper Canada Consultants.

Table 11 below summarizes the localized geodetic 100 year water surface elevations used to generate the associated 100 year floodplain extents shown on Figure 5.

Table 11. Adjusted Future 100 Year Floodplain Elevations		
Cross-section ID	Flood Elevation (m)	
	NPCA HEC-RAS Model	Localized Geodetic Floodplain Elevation
1029.780	175.20	175.06
1005.961	175.18	175.04
964.9745	175.13	174.99
917.2293	175.11	174.97
863.8885	175.07	174.93



WESTWOOD ESTATES (PHASE 3)
CITY OF PORT COLBORNE
HEC-RAS CROSS SECTION LOCATIONS

DATE	2025-04-22
SCALE	1:1000 m
REF No.	2160
DWG No.	FIGURE 5

6.0 SEDIMENT CONTROL

Sediment controls are required during construction. The proposed extended detention facility can be used for this purpose. Therefore, the proposed constructed wet pond facility should be constructed prior to the facility for sediment control during construction.

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

- Install silt control fencing along the limits of construction where overland flows will flow beyond the limits of the development or into downstream watercourse.
- 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.
- The Stormwater management facility be cleaned after construction prior to assumption by municipality.

7.0 STORMWATER MANAGEMENT FACILITY MAINTENANCE

7.1 Wet Pond

Maintenance is a necessary and important aspect of urban stormwater quality and quantity measures such as constructed wetlands. Many pollutants (i.e. 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 event. 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 clean-up, 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 is 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.

7.2 Oil/Grit Separator

The stormwater oil/grit separator, will require maintenance on an annual basis. The following is a summary of the maintenance activities required.

Regular inspections of the stormwater Maintenance Hole (MH) oil/grit interceptor will indicate whether maintenance is required or not. They should be made after every significant storm during the first two years of operation to ensure that it is functioning properly. This will translate into an average of six inspections per year. Points of regular inspections are as follows:

- a) Is there sediment in the separator sump? The level of sediment can be measured from the surface without entry into the oil/grit separator via a dipstick tube equipped with a ball valve (Sludge Judge) or with a graduated pole with a flat plate attached to the bottom.
- b) Is there oil in the separator sump? This can be checked from the surface by inserting a dipstick in the 150mm vent tube. The presence of oil is usually indicated by an oily sheen, frothing or unusual colouring. The separator should be cleaned in the event of a major spill contamination.
- c) Is there debris or trash at the inlet weir and drop pipe? This can be observed from the surface without entry into the separator. Clogging at the inlet drop pipe will cause stormwater to bypass the sedimentation section and continue downstream without treatment.
- d) Completion of the Inspection Report (a sample report is included in Appendix B for reference purposes). These reports will provide details about the operation and maintenance requirements for this type of stormwater quality device. After an evaluation period (usually 2 years) this information will be used to maximize efficiency and minimize the costs of operation and maintenance for the maintenance hole oil/grit separator.

Typically, stormwater MH oil/grit separators are cleaned out using vacuum pumping. No entry into the unit is required for maintenance. Cleaning should occur annually or whenever the accumulation reaches sediment storage specified by the manufacturer and after any major spills have occurred. Oil levels greater than 2.5 centimeters should be removed immediately by a licensed waste management firm.

Generally, the sediment removed from the separator 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. The Ministry of Environment, Conservation and Parks publishes sediment disposal guidelines which should be consulted for up-to-date information pertaining to the exact parameters and acceptable levels for the various disposal options. The preferred option is an off-site disposal, arranged by a licensed waste management firm.

The future owners of a Hydroworks facility are provided with an Owner's Manual upon installation, which explains the function, maintenance requirements and procedures for the facility with extensive use. It is recommended to follow the manufacturers instructions to allow the oil/grit separator to perform as intended.

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.
- The proposed wet pond facility will provide stormwater quality control, quantity control and erosion controls to the future Drainage Area A2 of the proposed development.
- The proposed Oil/Grit separator Hydroworks HD8 will provide stormwater quality control to the future Drainage Area A1 of the proposed development
- 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 the stormwater management wet pond facility be constructed to provide stormwater quality protection to MECP *Enhanced* Protection levels.
- That the Oil/Grit separator Hydroworks HD8 be constructed to provide stormwater quality protection to MECP *Enhanced* Protection levels.
- That additional lot level controls and vegetative stormwater management practices as described previously in this report be implemented.
- That the sediment during construction as described in this report be implemented.

Respectfully Submitted,

Prepared By:



Roberto A. Duarte, B. Eng.
April 21, 2025

Reviewed by:



Brendan Kapteyn, P.Eng.
April 21, 2025



Encl.

APPENDICES

APPENDIX A

Stormwater Management Facility Calculations (Wet Pond)

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, ON, L2W 1A3
PROJECT NAME: Westwood Estates (Phase 3)
PROJECT NO.: 2160

PROPOSED WET POND CALCULATIONS

Quality Requirements	Quality Orifice	Outlet Weir	Overflow Spillway	Outflow Pipe Orifice
Drainage Area (ha) = 15.48	Diameter (m) = 0.135	Perimeter Length (m) = 0.60	Length (m) = 2.50	Diameter (m) = 0.450
Enhanced (m3/ha) = 140 @ 35%	Cd = 0.63	Inlet Elevation (m) = 174.95	Slopes (X:1) = 3.00	Cd = 0.65
Perm Pool (m3/ha) = 100	Invert (m) = 174.20		Invert (m) = 175.40	Invert (m) = 174.20
Perm Pool Vol (m3) = 1,548	Pond Drawdown Time Calculation (MOE, 2003)			Obvert (m) = 174.65
Extended Det. Vol (m3) 619	25mm Design Storm Water Surface Elevation (m) = 174.48			Top of Pipe (m) = 174.75
Total Quality Volume = 2,167	MOE Equation 4.11 Drawdown Coefficient 'C2' = 1,380			
Water Level Elev. = 174.20 m	MOE Equation 4.11 Drawdown Coefficient 'C3' = 3,373			
	MOE Equation 4.11 Drawdown Time (h) = 26			

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)	Overflow Spillway (m ³ /s)	Total Outflow (m ³ /s)	Side Slope
173.00		-1.20	1,752			0							
	0.40			2,171	869								5:1
173.40		-0.80	2,171			869							
	0.40			2,389	955								5:1
173.80		-0.40	2,606			1,824							
	0.40			2,836	1,134								
174.20		0.00	3,066			2,958							
174.20		0.00	3,373				0	0.000	0.000	0.000	0.000	0.000	
	0.75			3,891	2,918								5:1
174.95		0.75	4,409			0	2,918	0.032	0.000	0.307	0.000	0.032	
	0.25			4,575	1,144								5:1
175.20		1.00	4,741			0	4,062	0.038	0.128	0.383	0.000	0.166	
	0.20			4,878	976								5:1
175.40		1.20	5,014			0	5,038	0.042	0.309	0.434	0.000	0.351	
	0.30			5,296	1,589								5:1
175.70		1.50	5,579			0	6,627	0.047	0.665	0.502	0.886	1.388	

Notes

1. Quality Orifice flow is the orifice controlling for the extended 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

Hydroworks Output Files
OGS Sample of Inspection Report



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```
#####
# Entry made to the Runoff Block, last updated by #
# Oregon State University, and Camp, Dresser and #
# McKee, Inc., March 2002. #
#####
# "And wherever water goes, amoebae go along for #
# the ride" Tom Robbins #
#####
```

```
Snowmelt parameter - ISNOW..... 0
Number of rain gages - NRGAG..... 1
Horton infiltration equation used - INFILM..... 2
Maximum infiltration volume is limited to RMAXINF input on subcatchment lines.
Infiltration volume regenerates during non rainfall periods.
Quality is simulated - KWALTY..... 1
IVAP is negative. Evaporation will be set to zero
during time steps with rainfall.
Read evaporation data on line(s) F1 (F2) - IVAP.. 1
Hour of day at start of storm - NHR..... 1
Minute of hour at start of storm - NMN..... 1
Time TZERO at start of storm (hours)..... 1.017
Use Metric units for I/O - METRIC..... 1
====> Ft-sec units used in all internal computations
Runoff input print control... 0
Runoff graph plot control... 1
Runoff output print control.. 0
Print headers every 50 lines - NOHEAD (0=yes, 1=no) 0
Print land use load percentages -LANDUPR (0=no, 1=yes) 0
Limit number of groundwater convergence messages to 10000 (if simulated)
Month, day, year of start of storm is: 1/ 1/1971
Wet time step length (seconds)..... 300.
Dry time step length (seconds)..... 900.
Wet/Dry time step length (seconds)... 450.
Simulation length is..... 20051231.0 Yr/Mo/Dy
Percent of impervious area with zero detention depth 25.0
Horton infiltration model being used
Rate for regeneration of infiltration = REGEN * DECAY
DECAY is read in for each subcatchment
REGEN = ..... 0.01000
```

```
*****
* Processed Precipitation will be read from file *
*****
```

```
#####
# Data Group F1 #
# Evaporation Rate (mm/day) #
#####
```

JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
0.00	0.00	0.00	2.54	2.54	3.81	3.81	3.81	2.54	2.54	0.00	0.00

```
*****
* CHANNEL AND PIPE DATA *
*****
```

Input equen umber	NAMEG: Channel ID #	Drains to NGTO:	Channel Type	Width (m)	Length (m)	Invert Slope (m/m)	L Side Slope (m/m)	R Side Slope (m/m)	Intial Depth (m)	Max Depth (m)	Mann- ings "N"	Full Flow (cms)
1	201	200	Dummy	0.0	0.0	0.0000	0.0000	0.0000	0.0	0.0	0.0000	0.00E+00

```
*****
* SUBCATCHMENT DATA *
*****
```

NOTE. SEE LATER TABLE FOR OPTIONAL SUBCATCHMENT PARAMETERS

SUBCATCH- MENT NO.	CHANNEL OR INLET	WIDTH (M)	AREA (HA)	PERCENT IMPERV.	SLOPE (M/M)	RESISTANCE IMPERV.	FACTOR PERV.	DEPRES. IMPERV.	STORAGE(MM) PERV.	INFILTRATION RATE(MM/HR) MAXIMUM MINIMUM	DECAY RATE (1/SEC)	GAGE NO.	MAXIMUM VOLUME (MM)	
1	300	200	168.00	4.24	67.00	0.0100	0.015	0.250	0.510	5.080	63.50	10.16	0.00055	1 101.60000

```
TOTAL NUMBER OF SUBCATCHMENTS... 1
TOTAL TRIBUTARY AREA (HECTARES). 4.24
IMPERVIOUS AREA (HECTARES)..... 2.84
PERVIOUS AREA (HECTARES)..... 1.40
TOTAL WIDTH (METERS)..... 168.00
PERCENT IMPERVIOUSNESS..... 67.00
```

```
*****
* GROUNDWATER INPUT DATA *
*****
```

SUB- CATCH NUMBER	CHANNEL OR INLET	===== E L E V A T I O N S =====	===== F L O W C O N S T A N T S =====
		GROUND (M) BOTTOM (M) STAGE (M) BC (M) TW (M) A1 (MM/HR-M^B1) B1 A2 (MM/HR-M^B2) B2 A3 (MM/HR-M^A2)	
0	602	3.05 0.00 0.00 0.61 0.61	3.484E-04 2.600 0.000E+00 1.000 0.00E+00

```
*****
* GROUNDWATER INPUT DATA (CONTINUED) *
*****
```

SUBCAT. NO.	SATURATED HYDRAULIC CONDUCTIVITY (mm/hr)	WILTING POINT	FIELD CAPACITY	INITIAL MOISTURE	MAX. DEEP PERCOLATION (mm/hr)	PERCOLATION PARAMETERS HCO PCO	E T P A R A M E T E R S DEPTH OF ET TO UPPER ZONE (m)	FRACTION OF ET TO UPPER ZONE
0	.4000	127.000	.1500	.3000	.3000	5.080E-02 10.00 4.57	4.27	0.350



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* Arrangement of Subcatchments and Channel/Pipes *

* See second subcatchment output table for connectivity *
* of subcatchment to subcatchment flows. *

Channel
or Pipe
201 No Tributary Channel/Pipes
No Tributary Subareas.....

INLET
200 Tributary Channel/Pipes... 201
Tributary Subareas..... 300

* Hydrographs will be stored for the following 1 INLETS *

200

Quality Simulation #

General Quality Control Data Groups #
#####

Description	Variable	Value
Number of quality constituents.....	NQS.....	1
Number of land uses.....	JLAND.....	1
Standard catchbasin volume.....	CBVOL.....	1.22 cubic meters
Erosion is not simulated.....	IROS.....	0
DRY DAYS PRIOR TO START OF STORM...	DRYDAY.....	3.00 DAYS
DRY DAYS REQUIRED TO RECHARGE CATCHBASIN CONCENTRATION TO INITIAL VALUES.....	DRYBSN.....	5.00 DAYS
DUST AND DIRT STREET SWEEPING EFFICIENCY.....	REFFDD.....	0.300
DAY OF YEAR ON WHICH STREET SWEEPING BEGINS.....	KLNBGN.....	120
DAY OF YEAR ON WHICH STREET SWEEPING ENDS.....	KLNEND.....	270

Land use data on data group J2 #
#####

AND USE LNAME)	BUILDUP EQUATION TYPE (METHOD)	FUNCTIONAL DEPENDENCE OF BUILDUP PARAMETER(JACGUT)	LIMITING BUILDUP QUANTITY (DDLIM)	BUILDUP POWER (DDPOW)	BUILDUP COEFF. (DDFACT)	CLEANING INTERVAL IN DAYS (CLFREQ)	AVAIL. FACTOR FRACTION (AVSWP)	DAYS SINCE LAST SWEEPING (DSLCL)
Urban De	EXPONENTIAL(1)	AREA(1)	2.802E+01	0.500	67.250	30.000	0.300	30.000

Constituent data on data group J3 #
#####

Constituent units.....	Total Su mg/l
Type of units.....	0
KALC.....	2
Type of buildup calc.....	EXPONENTIAL(2)
KWASH.....	0
Type of washoff calc.....	POWER EXPONEN.(0)
KACGUT.....	1
Dependence of buildup...	AREA(1)
LINKUP.....	0
Linkage to snowmelt.....	NO SNOW LINKAGE
Buildup param 1 (QFACT1).	28.020
Buildup param 2 (QFACT2).	0.500
Buildup param 3 (QFACT3).	67.250
Buildup param 4 (QFACT4).	0.000
Buildup param 5 (QFACT5).	0.000
Washoff power (WASHPO)...	1.100
Washoff coef. (RCOEF)...	0.086
Init catchb conc (CBFACT)	100.000
Precip. conc. (CONCRN)...	0.000
Street sweep effc (REFF)	0.300
Remove fraction (REMOVE).	0.000
1st order QDECAY, 1/day..	0.000
Land use number.....	1

* Constant Groundwater Quality Concentration(s) *

Total Susp has a concentration of.. 0.0000 mg/l

* REMOVAL FRACTIONS FOR SELECTED CHANNEL/PIPES *
* FROM J7 LINES *

CHANNEL/ PIPE	CONSTITUENT Total Susp
201	0.000



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* Subcatchment surface quality on data group L1 *

	Land No.	Land Usage	Land Use No.	Total Gutter Length Km	Number of Catch- Basins	Input Loading load/ha Total Su
1	300	Urban De	1	0.29	10.00	0.0E+00
Totals (Loads in kg or other)				0.29	10.00	0.0E+00

* DATA GROUP M1 *

TOTAL NUMBER OF PRINTED GUTTERS/INLETS...NPRNT.. 1
NUMBER OF TIME STEPS BETWEEN PRINTINGS...INTERV.. 0
STARTING AND STOPPING PRINTOUT DATES..... 0 0

* DATA GROUP M3 *

CHANNEL/INLET PRINT DATA GROUPS..... -200

* Rainfall from Nat. Weather Serv. file *
* in units of hundredths of an inch *

WESTWOOD ESTATES (PHASE 3)
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Rainfall Station St. Catharines A
State/Province Ontario

Rainfall Depth Summary (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1971.	31.	0.	0.	0.	0.	0.	126.	93.	52.	60.	29.	0.	391.
1972.	0.	0.	0.	47.	65.	100.	39.	115.	63.	90.	1.	0.	521.
1973.	0.	0.	0.	103.	77.	71.	53.	29.	63.	139.	0.	0.	534.
1974.	0.	0.	0.	67.	105.	62.	50.	31.	74.	37.	110.	0.	536.
1975.	0.	0.	0.	0.	0.	94.	78.	76.	73.	56.	59.	6.	442.
1976.	0.	0.	0.	119.	136.	87.	101.	60.	72.	73.	13.	1.	662.
1977.	0.	0.	0.	94.	29.	69.	57.	150.	230.	71.	0.	1.	701.
1978.	0.	0.	0.	72.	43.	72.	43.	86.	156.	95.	0.	0.	567.
1979.	0.	0.	0.	84.	92.	33.	91.	88.	84.	129.	71.	0.	673.
1980.	0.	0.	0.	81.	39.	122.	60.	32.	79.	96.	45.	0.	554.
1981.	0.	0.	0.	91.	71.	106.	122.	61.	123.	91.	84.	0.	749.
1982.	0.	0.	0.	28.	65.	97.	36.	66.	82.	25.	143.	0.	544.
1983.	0.	0.	0.	78.	100.	65.	55.	106.	75.	122.	92.	0.	694.
1984.	0.	0.	0.	31.	113.	136.	19.	51.	144.	24.	44.	0.	562.
1985.	0.	0.	67.	32.	52.	64.	40.	94.	42.	109.	0.	1.	501.
1986.	0.	0.	0.	93.	113.	60.	85.	83.	98.	80.	43.	65.	719.
1987.	0.	2.	11.	77.	42.	80.	122.	97.	99.	71.	94.	34.	730.
1988.	0.	0.	41.	71.	42.	21.	110.	82.	70.	68.	75.	5.	585.
1989.	0.	0.	13.	63.	137.	108.	36.	45.	89.	73.	84.	0.	647.
1990.	0.	2.	38.	99.	124.	44.	68.	95.	56.	112.	96.	0.	735.
1991.	0.	0.	86.	124.	67.	31.	85.	57.	79.	64.	61.	28.	682.
1992.	0.	0.	29.	127.	56.	92.	185.	116.	77.	47.	103.	38.	869.
1993.	3.	0.	7.	83.	56.	86.	32.	61.	71.	92.	80.	38.	610.
1994.	0.	0.	44.	88.	105.	124.	48.	77.	117.	15.	0.	15.	633.
1995.	112.	23.	16.	48.	37.	60.	123.	66.	8.	137.	94.	0.	724.
1998.	0.	0.	0.	0.	51.	54.	64.	29.	9.	0.	1.	0.	207.
1999.	0.	0.	0.	79.	59.	35.	61.	58.	116.	78.	0.	0.	487.
2000.	0.	0.	0.	123.	134.	216.	51.	0.	0.	0.	10.	0.	534.
2001.	0.	0.	0.	56.	88.	45.	25.	30.	81.	129.	0.	0.	454.
2002.	0.	0.	0.	73.	104.	64.	53.	49.	52.	65.	8.	0.	468.
2003.	0.	0.	0.	10.	163.	77.	81.	64.	67.	73.	2.	0.	537.
2004.	0.	0.	0.	131.	126.	99.	115.	40.	88.	17.	0.	0.	616.
2005.	0.	0.	0.	38.	42.	78.	53.	120.	112.	0.	0.	0.	443.

Total Rainfall Depth for Simulation Period 19310. (mm)

Rainfall Intensity Analysis (mm/hr)

(mm/hr)	(#)	(%)	(mm)	(%)
2.50	21481	74.6	6454.	33.4
5.00	3585	12.4	3088.	16.0
7.50	1973	6.8	2886.	14.9
10.00	575	2.0	1233.	6.4
12.50	389	1.4	1070.	5.5
15.00	194	0.7	660.	3.4
17.50	210	0.7	846.	4.4
20.00	66	0.2	306.	1.6
22.50	92	0.3	487.	2.5
25.00	39	0.1	232.	1.2
27.50	37	0.1	246.	1.3
30.00	34	0.1	245.	1.3
32.50	29	0.1	228.	1.2
35.00	5	0.0	42.	0.2
37.50	10	0.0	90.	0.5
40.00	10	0.0	97.	0.5
42.50	12	0.0	124.	0.6
45.00	9	0.0	99.	0.5
47.50	1	0.0	12.	0.1
50.00	3	0.0	37.	0.2
>50.00	49	0.2	829.	4.3

Total # of Intensities 28803



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Daily Rainfall Depth Analysis (mm)

(mm)	(#)	(%)	(mm)	(%)
2.50	1077	38.9	1247.	6.5
5.00	507	18.3	1850.	9.6
7.50	326	11.8	2006.	10.4
10.00	226	8.2	1958.	10.1
12.50	150	5.4	1672.	8.7
15.00	111	4.0	1495.	7.7
17.50	100	3.6	1620.	8.4
20.00	67	2.4	1260.	6.5
22.50	45	1.6	958.	5.0
25.00	37	1.3	881.	4.6
27.50	23	0.8	609.	3.2
30.00	20	0.7	575.	3.0
32.50	20	0.7	631.	3.3
35.00	12	0.4	405.	2.1
37.50	8	0.3	290.	1.5
40.00	9	0.3	350.	1.8
42.50	4	0.1	165.	0.9
45.00	4	0.1	173.	0.9
47.50	2	0.1	91.	0.5
50.00	4	0.1	192.	1.0
>50.00	15	0.5	882.	4.6

Total # Days with Rain 2767

* End of time step DO-loop in Runoff *

Final Date (Mo/Day/Year) = 1/ 1/2006
Total number of time steps = 2056986
Final Julian Date = 2006001
Final time of day = 1. seconds.
Final time of day = 0.00 hours.
Final running time = 306816.0000 hours.
Final running time = 12784.0000 days.

* Extrapolation Summary for Watersheds *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of OVERLND Calls *

Subcatch	# Steps	# Calls	Subcatch	# Steps	# Calls	Subcatch	# Steps	# Calls
300	6293855	1676669						

* Extrapolation Summary for Channel/Pipes *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of GUTNR Calls *

Chan/Pipe	# Steps	# Calls	Chan/Pipe	# Steps	# Calls	Chan/Pipe	# Steps	# Calls
201	0	0						

* Continuity Check for Surface Water *

	cubic meters	Millimeters over Total Basin
Total Precipitation (Rain plus Snow)	816726.	19263.
Total Infiltration	268855.	6341.
Total Evaporation	66314.	1564.
Surface Runoff from Watersheds	483432.	11402.
Total Water remaining in Surface Storage	0.	0.
Infiltration over the Pervious Area...	268855.	19215.

Infiltration + Evaporation + Surface Runoff + Snow removal + Water remaining in Surface Storage + Water remaining in Snow Cover.....	818600.	19307.
Total Precipitation + Initial Storage.	816726.	19263.

The error in continuity is calculated as

* Precipitation + Initial Snow Cover *
* - Infiltration - *
*Evaporation - Snow removal - *
*Surface Runoff from Watersheds - *
*Water in Surface Storage - *
*Water remaining in Snow Cover *

* Precipitation + Initial Snow Cover *

Error..... -0.230 Percent

* Continuity Check for Channel/Pipes *

	cubic meters	Millimeters over Total Basin
Initial Channel/Pipe Storage.....	0.	0.
Final Channel/Pipe Storage.....	0.	0.
Surface Runoff from Watersheds.....	483432.	11402.
Baseflow.....	0.	0.
Groundwater Subsurface Inflow.....	0.	0.
Evaporation Loss from Channels.....	0.	0.
Channel/Pipe/Inlet Outflow.....	483432.	11402.
Initial Storage + Inflow.....	483432.	11402.
Final Storage + Outflow.....	483432.	11402.



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```
*****
* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
*   Initial Channel/Pipe Storage           *
*   -----                               *
*   Final Storage + Outflow + Evaporation *
*****
Error..... 0.000 Percent
```

```
*****
* Continuity Check for Subsurface Water *
*****
```

	cubic meters	Millimeters over Subsurface Basin
Total Infiltration	0.	0.
Total Upper Zone ET	0.	0.
Total Lower Zone ET	0.	0.
Total Groundwater flow	0.	0.
Total Deep percolation	0.	0.
Initial Subsurface Storage	38769.	914.
Final Subsurface Storage	38769.	914.
Upper Zone ET over Pervious Area	0.	0.
Lower Zone ET over Pervious Area	0.	0.

```
*****
* Infiltration + Initial Storage - Final *
* Storage - Upper and Lower Zone ET - *
* Groundwater Flow - Deep Percolation *
*   -----                               *
*   Infiltration + Initial Storage       *
*****
Error ..... 0.000 Percent
```

SUMMARY STATISTICS FOR SUBCATCHMENTS

=====

SUBCATCH- MENT NO.	GUTTER OR INLET NO.	AREA (HA)	PERCENT IMPER.	TOTAL SIMULATED RAINFALL (MM)	PERVIOUS AREA			IMPERVIOUS AREA			TOTAL SUBCATCHMENT AREA		
					TOTAL RUNOFF DEPTH (MM)	TOTAL LOSSES (MM)	PEAK RATE (CMS)	TOTAL RUNOFF DEPTH (MM)	PEAK RATE (CMS)	TOTAL RUNOFF DEPTH (MM)	PEAK RATE (CMS)	PEAK UNIT RUNOFF (MM/HR)	
300	200	4.24	67.01	9262.47	43.839	*****	0.170	16991.297	1.488	11398.636	1.658	141.913	

*** NOTE *** IMPERVIOUS AREA STATISTICS AGGREGATE IMPERVIOUS AREAS WITH AND WITHOUT DEPRESSION STORAGE

SUMMARY STATISTICS FOR CHANNEL/PIPES

=====

CHANNEL NUMBER	FULL FLOW (CMS)	FULL VELOCITY (M/S)	FULL DEPTH (M)	MAXIMUM COMPUTED INFLOW (CMS)	MAXIMUM COMPUTED OUTFLOW (CMS)	MAXIMUM COMPUTED DEPTH (M)	MAXIMUM COMPUTED VELOCITY (M/S)	TIME OF OCCURRENCE DAY HR.	LENGTH OF SURCHARGE (HOUR)	MAXIMUM SURCHARGE VOLUME (CU-M)	RATIO OF MAX. TO FULL FLOW	RATIO OF MAX. DEPTH TO FULL DEPTH
201				0.00				1/ 0/1900	0.00			
200				1.66				8/14/1972	14.25			

TOTAL NUMBER OF CHANNELS/PIPES = 2

*** NOTE *** THE MAXIMUM FLOWS AND DEPTHS ARE CALCULATED AT THE END OF THE TIME INTERVAL

```
#####
# Runoff Quality Summary Page #
# If NDIM = 0 Units for: loads mass rates #
# METRIC = 1 lb lb/sec #
# METRIC = 2 kg kg/sec #
# If NDIM = 1 Loads are in units of quantity #
# and mass rates are quantity/sec #
# If NDIM = 2 loads are in units of concentration #
# times volume and mass rates have units#
# of concentration times volume/second #
#####
```

Total Su NDIM = 0
METRIC = 2

Total Su

Inputs

```
-----
1. INITIAL SURFACE LOAD..... 92.
2. TOTAL SURFACE BUILDUP..... 67421.
3. INITIAL CATCHBASIN LOAD.... 1.
4. TOTAL CATCHBASIN LOAD..... 0.
5. TOTAL CATCHBASIN AND
   SURFACE BUILDUP (2+4)..... 67421.
```

Remaining Loads

```
-----
6. LOAD REMAINING ON SURFACE... 37.
7. REMAINING IN CATCHBASINS... 0.
8. REMAINING IN CHANNEL/PIPES.. 0.
```

Removals

```
-----
9. STREET SWEEPING REMOVAL.... 6235.
10. NET SURFACE BUILDUP (2-9)... 61186.
11. SURFACE WASHOFF..... 61132.
12. CATCHBASIN WASHOFF..... 0.
```



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13. TOTAL WASHOFF (11+12)..... 61132.
14. LOAD FROM OTHER CONSTITUENTS 0.
15. PRECIPITATION LOAD..... 0.
15a. SUM SURFACE LOAD (13+14+15).. 61132.
16. TOTAL GROUNDWATER LOAD..... 0.
16a. TOTAL I/I LOAD..... 0.
17. NET SUBCATCHMENT LOAD
(15a-15b-15c-15d+16+16a).... 61132.
>>Removal in channel/pipes (17a, 17b):
17a. REMOVE BY BMP FRACTION..... 0.
17b. REMOVE BY 1st ORDER DECAY... 0.
18. TOTAL LOAD TO INLETS..... 61132.
19. FLOW WT'D AVE. CONCENTRATION mg/l
(INLET LOAD/TOTAL FLOW)..... 127.

Percentages

20. STREET SWEEPING (9/2)..... 9.
21. SURFACE WASHOFF (11/2)..... 91.
22. NET SURFACE WASHOFF(11/10).. 100.
23. WASHOFF/SUBCAT LOAD(11/17).. 100.
24. SURFACE WASHOFF/INLET LOAD
(11/18)..... 100.
25. CATCHBASIN WASHOFF/
SUBCATCHMENT LOAD (12/17)... 0.
26. CATCHBASIN WASHOFF/
INLET LOAD (12/18)..... 0.
27. OTHER CONSTITUENT LOAD/
SUBCATCHMENT LOAD (14/17)... 0.
28. INSOLUBLE FRACTION/
INLET LOAD (14/18)..... 0.
29. PRECIPITATION/
SUBCATCHMENT LOAD (15/17)... 0.
30. PRECIPITATION/
INLET LOAD (15/18)..... 0.
31. GROUNDWATER LOAD/
SUBCATCHMENT LOAD (16/17)... 0.
32. GROUNDWATER LOAD/
INLET LOAD (16/18)..... 0.
32a. INFILTRATION/INFLOW LOAD/
SUBCATCHMENT LOAD (16a/17).. 0.
32b. INFILTRATION/INFLOW LOAD/
INLET LOAD (16a/18)..... 0.
32c. CH/PIPE BMP FRACTION REMOVAL/
SUBCATCHMENT LOAD (17a/17).. 0.
32d. CH/PIPE 1st ORDER DECAY REMOVAL/
SUBCATCHMENT LOAD (17b/17).. 0.
33. INLET LOAD SUMMATION ERROR
(18+8+6a+17a+17b-17)/17..... 0.

CAUTION. Due to method of quality routing (Users Manual, Appendix IX)
quality routing through channel/pipes is sensitive to the time step.
Large "Inlet Load Summation Errors" may result.
These can be reduced by adjusting the time step(s).
Note: surface accumulation during dry time steps at end of simulation is
not included in totals. Buildup is only performed at beginning of
wet steps or for street cleaning.

* TSS Particle Size Distribution *

Diameter % Specific Settling Velocity Critical Peclet
(um) Gravity (m/s) Number

20. 20.0 2.65 0.000267 0.080977
60. 20.0 2.65 0.002319 0.160673
150. 20.0 2.65 0.012234 0.284537
400. 20.0 2.65 0.047806 0.524584
2000. 20.0 2.65 0.180097 1.431405

* Summary of TSS Removal *

TSS Removal based on Lab Performance Curve

Model #	Low Q Treated (cms)	High Q Treated (cms)	Runoff Treated (%)	TSS Removed (%)
Unavailabl	0.481	0.481	99.6	47.6
HD 4	0.481	0.481	99.6	58.1
HD 5	0.481	0.481	99.6	68.4
HD 6	0.481	0.481	99.6	76.8
Unavailabl	0.481	0.481	99.6	82.4
HD 8	0.481	0.481	99.6	86.1
HD 10	0.481	0.481	99.6	91.1
HD 12	0.481	0.481	99.6	94.0

* Summary of Annual Flow Treatmnet & TSS Removal *



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HD 8 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	50284.	49494.	1214.	1010.	204.	2.	98.4	83.1
1972.	64276.	60532.	1601.	1387.	214.	47.	94.2	84.1
1973.	64114.	64114.	1707.	1468.	239.	0.	100.0	86.0
1974.	65468.	65095.	1778.	1598.	180.	8.	99.4	89.5
1975.	55801.	55662.	1563.	1330.	233.	2.	99.8	85.0
1976.	83005.	82232.	1975.	1712.	264.	18.	99.1	85.9
1977.	88836.	87891.	1926.	1571.	356.	16.	98.9	80.9
1978.	71022.	71022.	1840.	1549.	292.	0.	100.0	84.1
1979.	84990.	84379.	2052.	1762.	290.	11.	99.3	85.4
1980.	68201.	68201.	1954.	1676.	278.	0.	100.0	85.8
1981.	94641.	94641.	2169.	1923.	246.	0.	100.0	88.7
1982.	66720.	66720.	1759.	1572.	187.	0.	100.0	89.4
1983.	88099.	87917.	2275.	1965.	310.	5.	99.8	86.2
1984.	70722.	70722.	1752.	1496.	256.	0.	100.0	85.4
1985.	61465.	61465.	1703.	1495.	208.	0.	100.0	87.8
1986.	90001.	90001.	2354.	2080.	274.	0.	100.0	88.3
1987.	93138.	92812.	2373.	2045.	328.	4.	99.7	86.0
1988.	74397.	74397.	1961.	1734.	227.	0.	100.0	88.4
1989.	82489.	82489.	1906.	1674.	232.	0.	100.0	87.8
1990.	93462.	93462.	2446.	2170.	276.	0.	100.0	88.7
1991.	87550.	87550.	2245.	1951.	295.	0.	100.0	86.9
1992.	111355.	111355.	2667.	2262.	405.	0.	100.0	84.8
1993.	75329.	75329.	2171.	1958.	213.	0.	100.0	90.2
1994.	80571.	79645.	1818.	1488.	329.	15.	98.9	81.2
1995.	94158.	94137.	2199.	1835.	364.	1.	100.0	83.4
1998.	23585.	23585.	810.	707.	103.	0.	100.0	87.3
1999.	58910.	58910.	1687.	1450.	237.	0.	100.0	85.9
2000.	68693.	68693.	1502.	1202.	300.	0.	100.0	80.0
2001.	53800.	53800.	1363.	1243.	120.	0.	100.0	91.2
2002.	55986.	55986.	1603.	1423.	180.	0.	100.0	88.8
2003.	63847.	63847.	1649.	1414.	235.	0.	100.0	85.8
2004.	76838.	76838.	1720.	1471.	249.	0.	100.0	85.5
2005.	55197.	54823.	1309.	1047.	262.	2.	99.3	79.8

* Summary of Quantity and Quality Results at *
* Location 200 INFlow in cms. *
* Values are instantaneous at indicated time step *

WESTWOOD ESTATES (PHASE 3)
Copyright Hydroworks, LLC, 2022

Date Mo/Da/Year	Time Hr:Min	Flow cum/s	Total Su mg/l
-----	-----	-----	-----
Flow wtd means.....		0.001	127.
Flow wtd std devs..		0.009	64.
Maximum value.....		1.658	292.
Minimum value.....		0.000	0.
Total loads.....		483262.	61168.
		Cub-Met	KILOGRAM

====> Runoff simulation ended normally.

====> SWMM 4.4 simulation ended normally.
Always check output file for possible warning messages.

* SWMM 4.4 Simulation Date and Time Summary *

* Starting Date... March 18, 2025 *
* Time... 13: 4:14.240 *
* Ending Date... March 18, 2025 *
* Time... 13: 4:17.895 *
* Elapsed Time... 0.061 minutes. *
* Elapsed Time... 3.655 seconds. *



SAMPLE INSPECTION REPORT

Owner:

Location:

Manhole Oil/Grit Separator:

Type of Inspection

☐ Monthly

☐ Annually

☐ Special

Inlet/Outlet Information

Inlet

Outlet

Clear of Debris

☐ Yes

☐ No

☐ Yes

☐ No

Build Up of Sediment

☐ Yes

☐ No

☐ Yes

☐ No

Action Taken:

Sediment Tank Information

A. Manhole Sump Depth:

± m from cover rim (to be as-constructed verified)

B. Measurement from Rim
to Sediment Level

m

C. Depth of Sediment:

m (A - B)

Note:

If the measured depth of sediment is greater than **200mm** then sediment removal is required.

Presence of Contaminants

Oil

☐ Yes

☐ No

Depth

m

Foam

☐ Yes

☐ No

Depth

m

Action Taken:

Name of Regulatory Agency

Telephone No.:

Transaction No.:

Name of Licensed Waste Management Collector

Telephone No.:

Transaction No.:

Owner Notification

☐ Yes

☐ No

Other:

Time:

Date:

Name of Inspector:

Signed:

Date:

APPENDIX C
MIDUSS Output Files

Stormwater Management Plan

Westwood Estates (Phase 3), City of Port Colborne

Existing Conditions

```
Output File (4.7) EXSWM.OUT    opened 2025-04-21  10:17
Units used are defined by G =   9.810
      24  144    10.000 are MAXDT MAXHYD & DTMIN values
Licensee: UPPER CANADA CONSULTANTS
35  COMMENT
3   line(s) of comment
WESTWOOD PHASE 3, CITY OF PORT COLBORNE
STORMWATER MANAGEMENT PLAN
*** EXISTING CONDITIONS ***
14  START
1   1=Zero; 2=Define
35  COMMENT
3   line(s) of comment
*****
** 5YR DESIGN STORM EVENT **
*****
2   STORM
1   1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
830.000 Coefficient a
7.300 Constant b (min)
.777 Exponent c
.450 Fraction to peak r
240.000 Duration ó 240 min
45.874 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
1.000 ID No.6 99999
11.200 Area in hectares
273.000 Length (PERV) metres
1.000 Gradient (%)
1.000 Per cent Impervious
273.000 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
.132 .000 .000 .000 c.m/s
.280 .886 .286 C perv/imperv/total
15  ADD RUNOFF .132 .132 .000 .000 c.m/s
14  START
1   1=Zero; 2=Define
35  COMMENT
3   line(s) of comment
*****
** 100YR DESIGN STORM EVENT **
*****
2   STORM
1   1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
1020.000 Coefficient a
4.700 Constant b (min)
.731 Exponent c
.450 Fraction to peak r
240.000 Duration ó 240 min
73.203 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
1.000 ID No.6 99999
11.200 Area in hectares
273.000 Length (PERV) metres
1.000 Gradient (%)
1.000 Per cent Impervious
273.000 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
.408 .000 .000 .000 c.m/s
.416 .918 .421 C perv/imperv/total
15  ADD RUNOFF .408 .408 .000 .000 c.m/s
```

Stormwater Management Plan

Westwood Estates (Phase 3), City of Port Colborne

Future Conditions

Output File (4.7) SWM.OUT opened 2025-04-22 10:31
Units used are defined by G = 9.810
24 144 10.000 are MAXDT MAXHYD & DTMIN values
Licensee: UPPER CANADA CONSULTANTS

35 COMMENT
3 line(s) of comment
WESTWOOD PHASE 3, CITY OF PORT COLBORNE
STORMWATER MANAGEMENT PLAN
TURE CONDITIONS ***
14 START

35 1 1=Zero; 2=Define
COMMENT
3 line(s) of comment

** 25mm MECP 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
.450 Fraction to peak r
210.000 Duration 240 min
24.309 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

35 COMMENT
1 line(s) of comment
*** FROM WET POND TO OUTLET ***

4 CATCHMENT
2.000 ID No. 99999
15.480 Area in hectares
320.000 Length (PERV) metres
1.000 Gradient (%)
35.000 Per cent Impervious
320.000 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
.485 .000 .000 .000 c.m/s
.124 .800 .361 C perv/imperv/total

15 ADD RUNOFF
.485 .485 .000 .000 c.m/s

27 HYDROGRAPH DISPLAY
4 is # of Hyeto/Hydrograph chosen
Volume = .1354987E+04 c.m

10 POND
5 Depth - Discharge - Volume sets
174.200 .000 .0
174.950 .0320 2918.0
175.200 .166 4062.0
175.400 .351 5038.0
175.700 1.388 6627.0
Peak Outflow = .012 c.m/s
Maximum Depth = 174.477 metres
Maximum Storage = 1079. c.m
.485 .485 .012 .000 c.m/s

14 START
1 1=Zero; 2=Define

35 COMMENT
3 line(s) of comment

** 5YR DESIGN STORM EVENT **

2 STORM
1 1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
830.000 Coefficient a
7.300 Constant b (min)
.777 Exponent c
.450 Fraction to peak r
240.000 Duration 240 min
45.874 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

35 COMMENT
1 line(s) of comment
*** FROM OGS TO OUTLET ***

4 CATCHMENT
1.000 ID No. 99999
4.270 Area in hectares
168.000 Length (PERV) metres
1.000 Gradient (%)
67.000 Per cent Impervious
168.000 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
.484 .000 .012 .000 c.m/s
.280 .872 .676 C perv/imperv/total

15 ADD RUNOFF
.484 .484 .012 .000 c.m/s

14 START
1 1=Zero; 2=Define

35 COMMENT
1 line(s) of comment
*** FROM WET POND TO OUTLET ***

4 CATCHMENT
2.000 ID No. 99999
15.480 Area in hectares
320.000 Length (PERV) metres
1.000 Gradient (%)
35.000 Per cent Impervious
320.000 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
.966 .000 .012 .000 c.m/s
.280 .881 .490 C perv/imperv/total

15 ADD RUNOFF
.966 .966 .012 .000 c.m/s

27 HYDROGRAPH DISPLAY
4 is # of Hyeto/Hydrograph chosen
Volume = .3480572E+04 c.m

10 POND
5 Depth - Discharge - Volume sets
174.200 .000 .0
174.950 .0320 2918.0
175.200 .166 4062.0
175.400 .351 5038.0
175.700 1.388 6627.0
Peak Outflow = .031 c.m/s
Maximum Depth = 174.932 metres
Maximum Storage = 2847. c.m
.966 .966 .031 .000 c.m/s

14 START
1 1=Zero; 2=Define

35 COMMENT
1 line(s) of comment
*** FROM A3 TO PSW ***

4 CATCHMENT
3.000 ID No. 99999
2.900 Area in hectares
139.000 Length (PERV) metres
1.000 Gradient (%)
10.000 Per cent Impervious
139.000 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
.060 .000 .031 .000 c.m/s
.280 .864 .338 C perv/imperv/total

15 ADD RUNOFF
.060 .060 .031 .000 c.m/s

14 START
1 1=Zero; 2=Define

35 COMMENT
3 line(s) of comment

** 100YR DESIGN STORM EVENT **

2 STORM
1 1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
1020.000 Coefficient a
4.700 Constant b (min)
.731 Exponent c
.450 Fraction to peak r
240.000 Duration 240 min
73.203 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

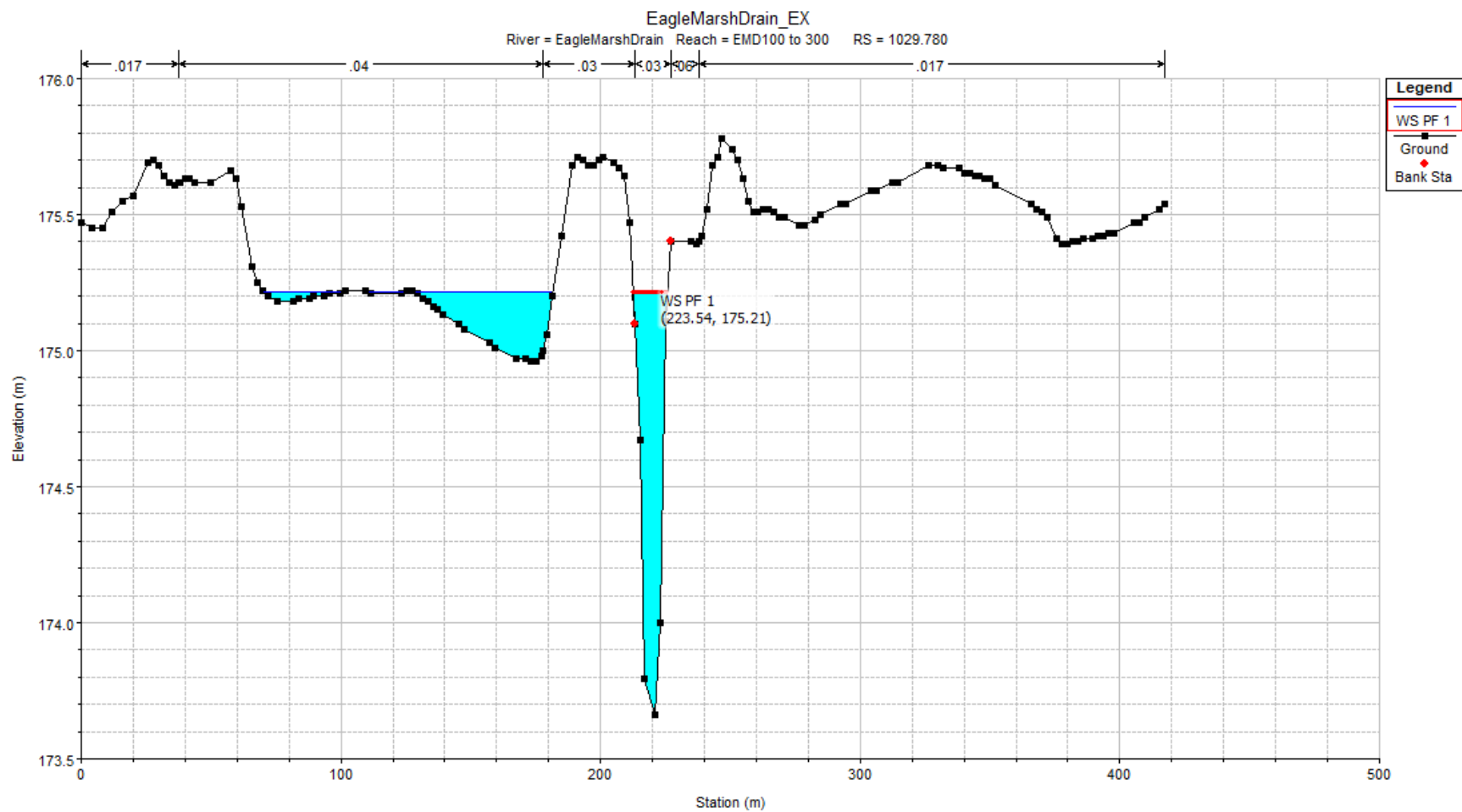
35 COMMENT
1 line(s) of comment
*** FROM A3 TO PSW ***

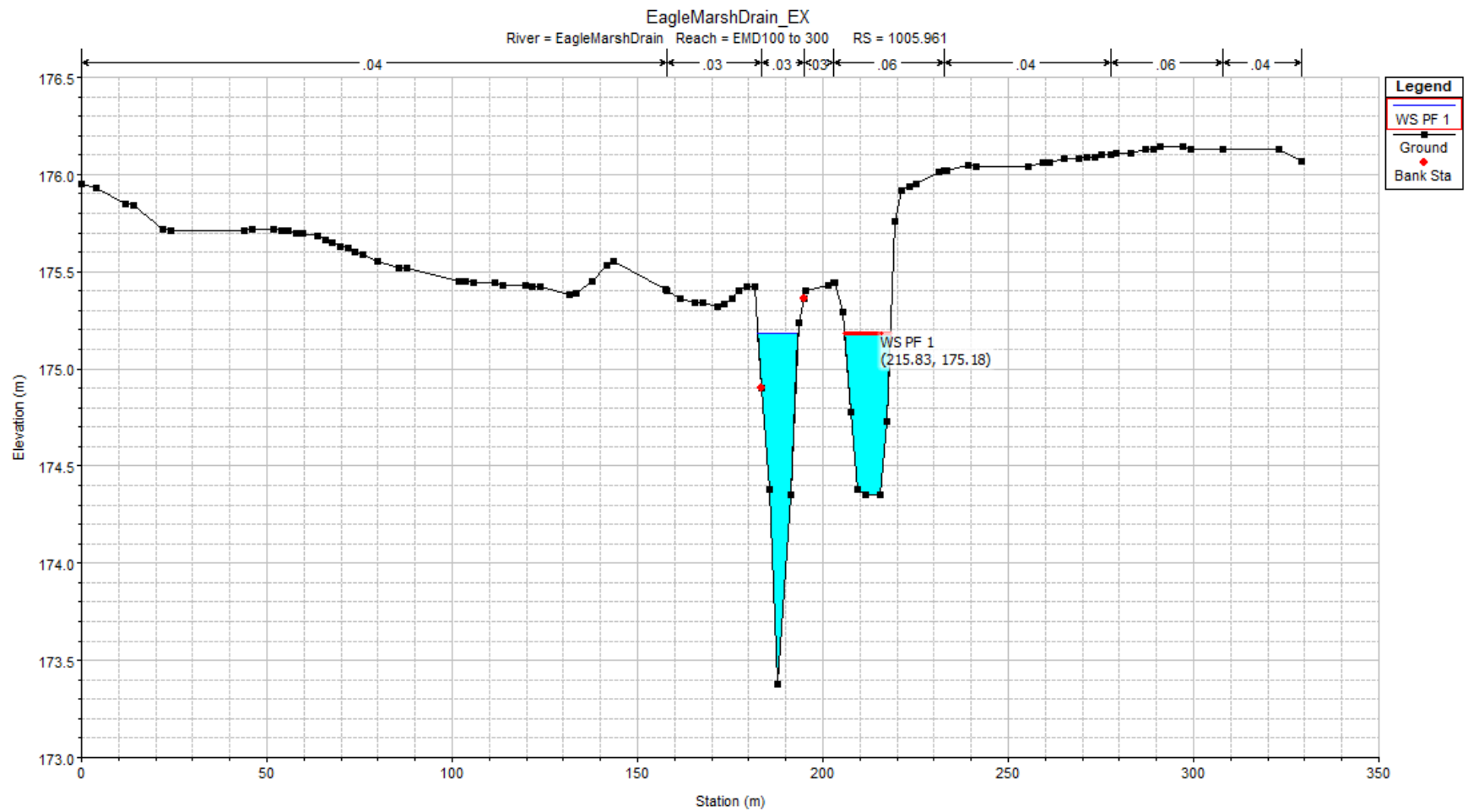
4 CATCHMENT
3.000 ID No. 99999
2.900 Area in hectares
139.000 Length (PERV) metres
1.000 Gradient (%)
10.000 Per cent Impervious
139.000 Length (IMPERV)
.000 %Imp. with Zero Dpth
1 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
.250 Manning "n"
77.000 SCS Curve No or C
.100 Ia/S Coefficient
7.587 Initial Abstraction
1 Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
.150 .000 .031 .000 c.m/s
.415 .914 .465 C perv/imperv/total

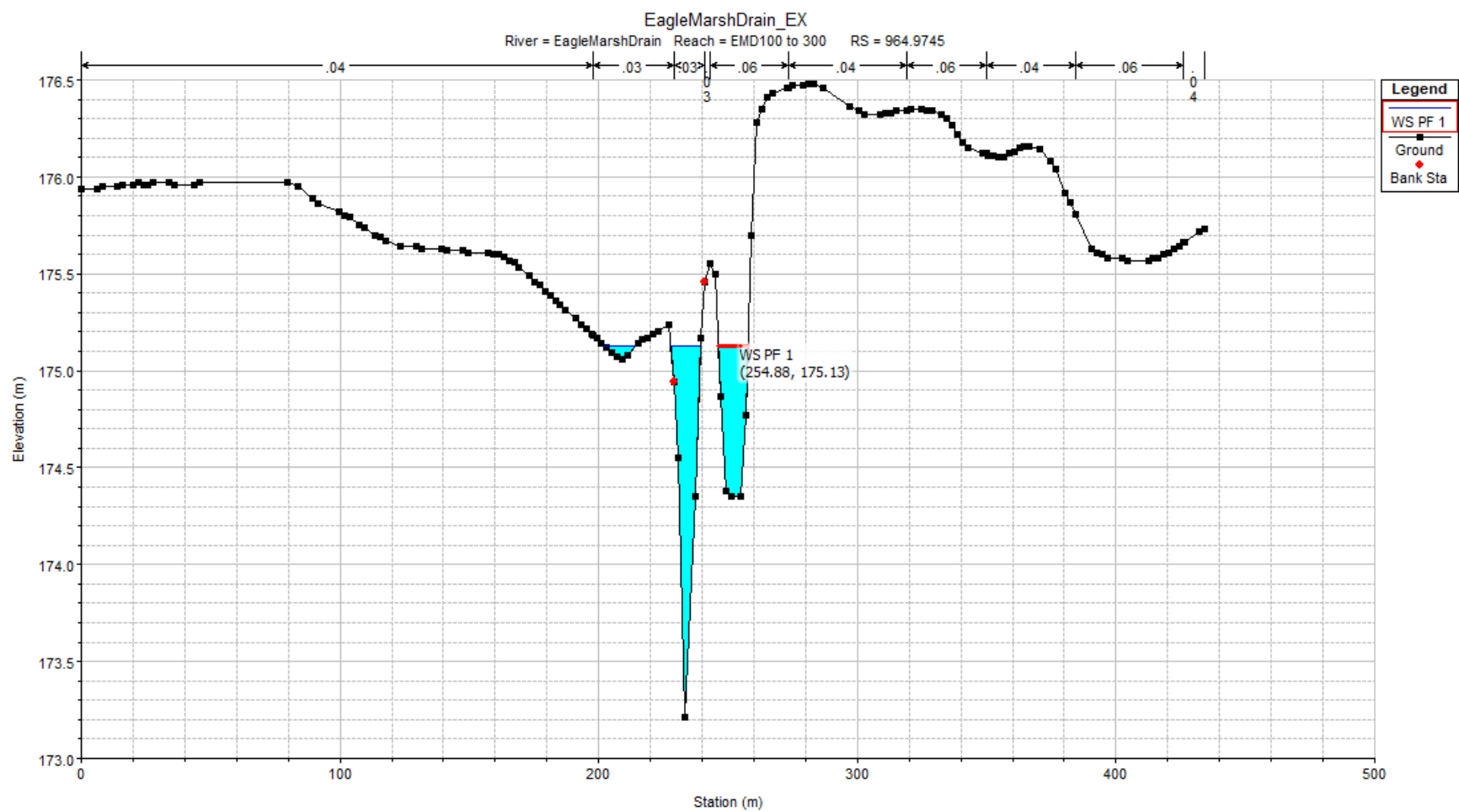
15 ADD RUNOFF
.150 .150 .031 .000 c.m/s

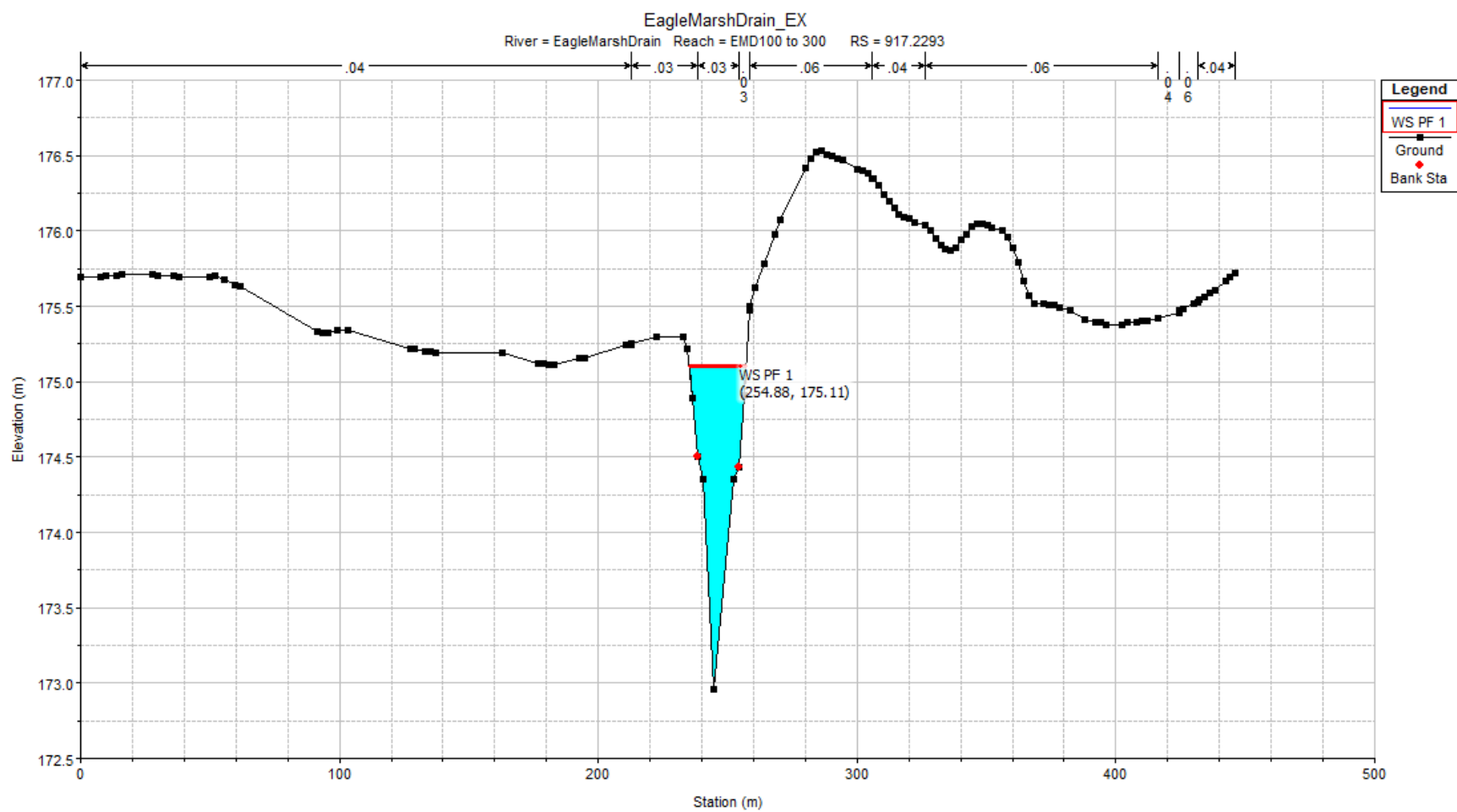
APPENDIX D

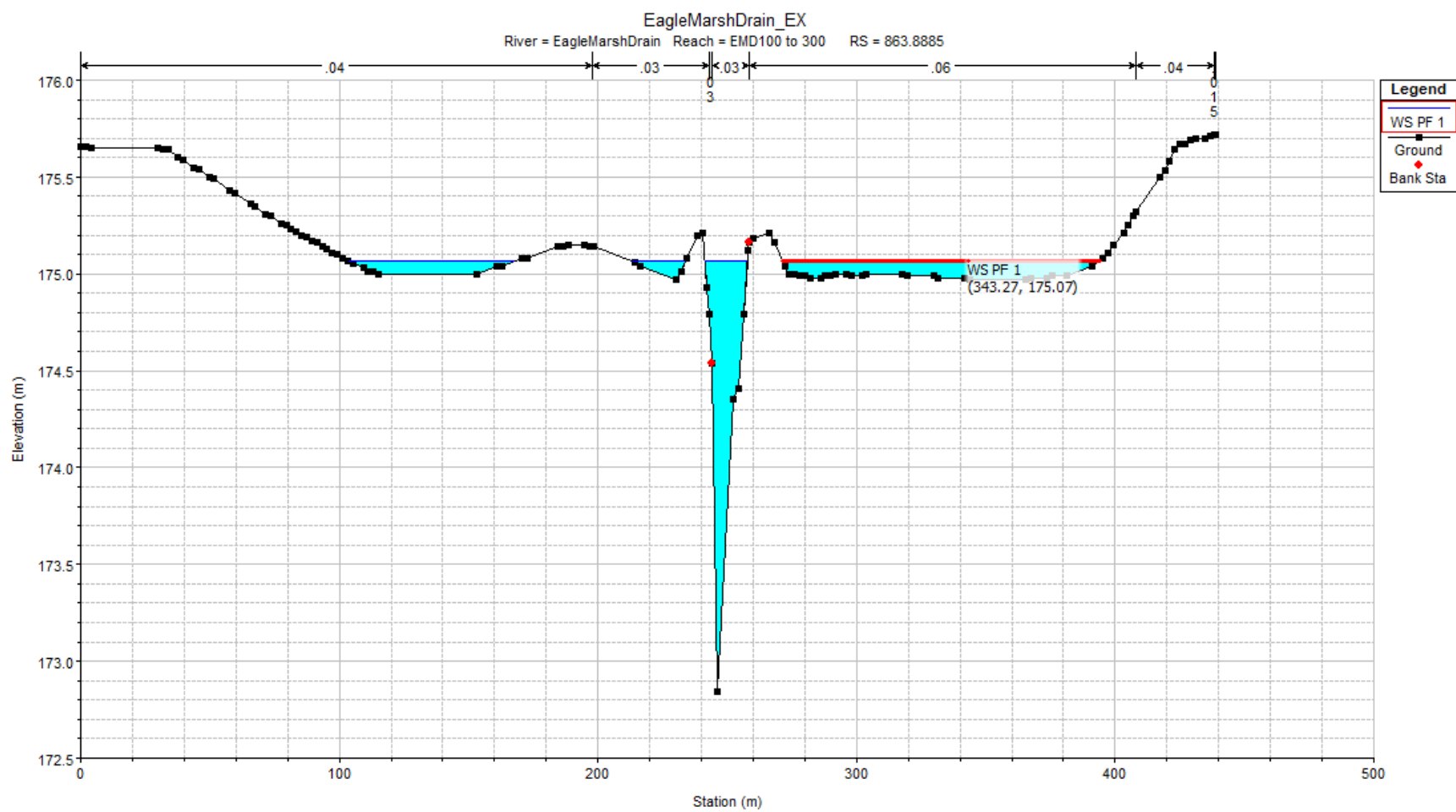
Existing HEC-RAS Cross Sections (without Levee)











APPENDIX E

Future HEC-RAS Cross Sections (with Levee)

