MMM Group Limited

Stormwater Management Report

Costco Wholesale Corp.
Costco Kanata Gas Station
City of Kanata
10-10021-001-W01

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

MMM GROUP

February, 2012

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1.0 INTRODUCTION

1.1 BACKGROUND

MMM Group has been retained by Costco Wholesale Canada Limited to prepare a Stormwater Management Brief for a proposed Petroleum filling station at the existing site of their Kanata warehouse store. The proposed site is located on Silver Seven Drive in the City of Ottawa (former City of Kanata), as shown in Figure 1.

This stormwater management report addresses the stormwater related impacts of the proposed expansion and follows the City of Ottawa stormwater management guidelines. The initial Costco warehouse project documented Stormwater Management measures in a report prepared by R.V. Anderson Associates Ltd. in August, 2004. The report presented a strategy based on full flow control and quality treatment in an on-site wet pond facility installed on the north portion of the property behind the store's rear driveway.

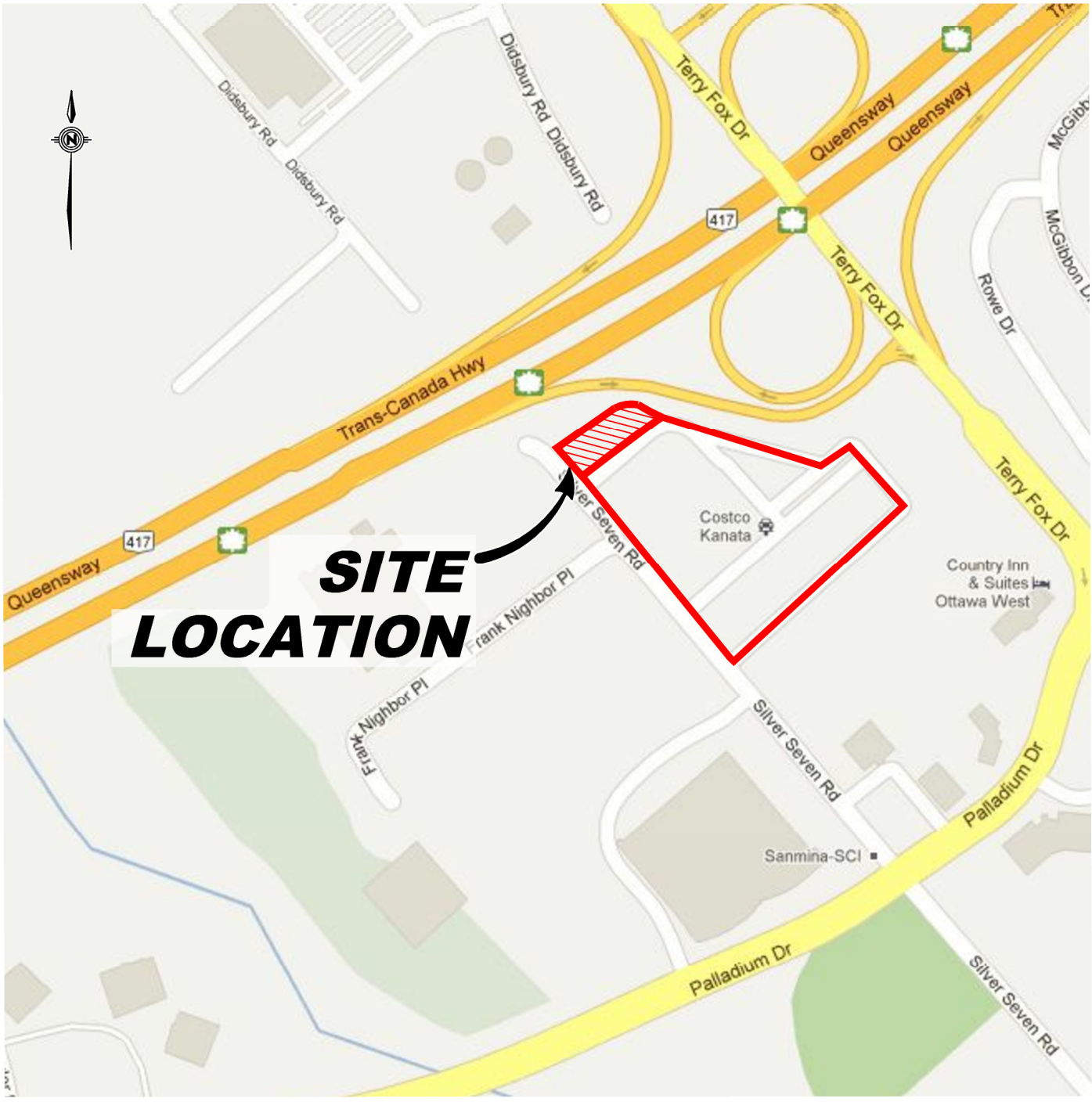
1.2 OBJECTIVES OF THE STORMWATER MANAGEMENT PLAN

The objectives of this stormwater management plan are as follows;

- Determine site specific stormwater management requirements for the project that replicate the functions documented in the original SWM report for the project;
- Establish the allowable release rate from the site;
- Determine feasible stormwater management practices for servicing the gas bar; and,
- Prepare a stormwater management report presenting results and recommendations of the study.

1.3 STORMWATER MANAGEMENT CRITERIA

Based on SWM guidelines of the City of Ottawa the following stormwater management criteria are to be satisfied. There is no stormwater management facility downstream of the site; therefore both stormwater quantity and quality controls are required for the proposed addition.



0 50 100 150 200 250m

CLIENT

COSTCO WHOLESALE CANADA LTD.

TITLE

SITE LOCATION

MMM GROUP
100 Commerce Valley Dr. W.
Thornhill, ON L3T 0A1
t. 905.882.1100
f. 905.882.1857
mmm@mmm.ca

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Date FEBRUARY 2012	Proj. No. 10-10021-001-W01	
Scale AS SHOWN	Figure No. 1	Gr.No. 010

FIGURE 1.dwg Site Location S:\14-41\10\10021-001-W01\ Feb 13, 2012 - 11:18arm

- 5 Yr. Post-development peak flow rates are to be controlled to a level consistent with a runoff coefficient of 0.2.

- Ensure that storm runoff draining to the site storm sewer is protected from contamination from hydrocarbon spills and;

- Water quality treatment for the entire Costco property must remain at "Normal" level (aka Level '2' treatment as defined in the site's original SWM report.

2.0 EXISTING CONDITIONS

2.1 GENERAL

The existing site has a stormwater management strategy implemented under the guidance of a report entitled "Stormwater management Report Costco - Kanata Proposed Big Box Store, City of Ottawa" prepared by R.V. Anderson Associates, Limited (Copy provided in appendix B). The site has been constructed according to guidance from the original SWM report with an onsite wet pond SWM facility.

The Costco Wholesale warehouse store site encompasses approximately 6.2 ha that currently consists of existing buildings and surrounding parking lot, and landscaped areas. The project site that will be modified under this proposal is an area of approximately 0.28 ha. The project site is the location of the on-site wet pond facility which will be filled and converted into the petroleum service area. The remainder of the site will remain unaffected by this project. Please see Figure 2.

2.2 ALLOWABLE FLOW CALCULATION

The Rational Method was used to calculate the total pre-development peak flow rate from the site.

Q = 2.778 C I A

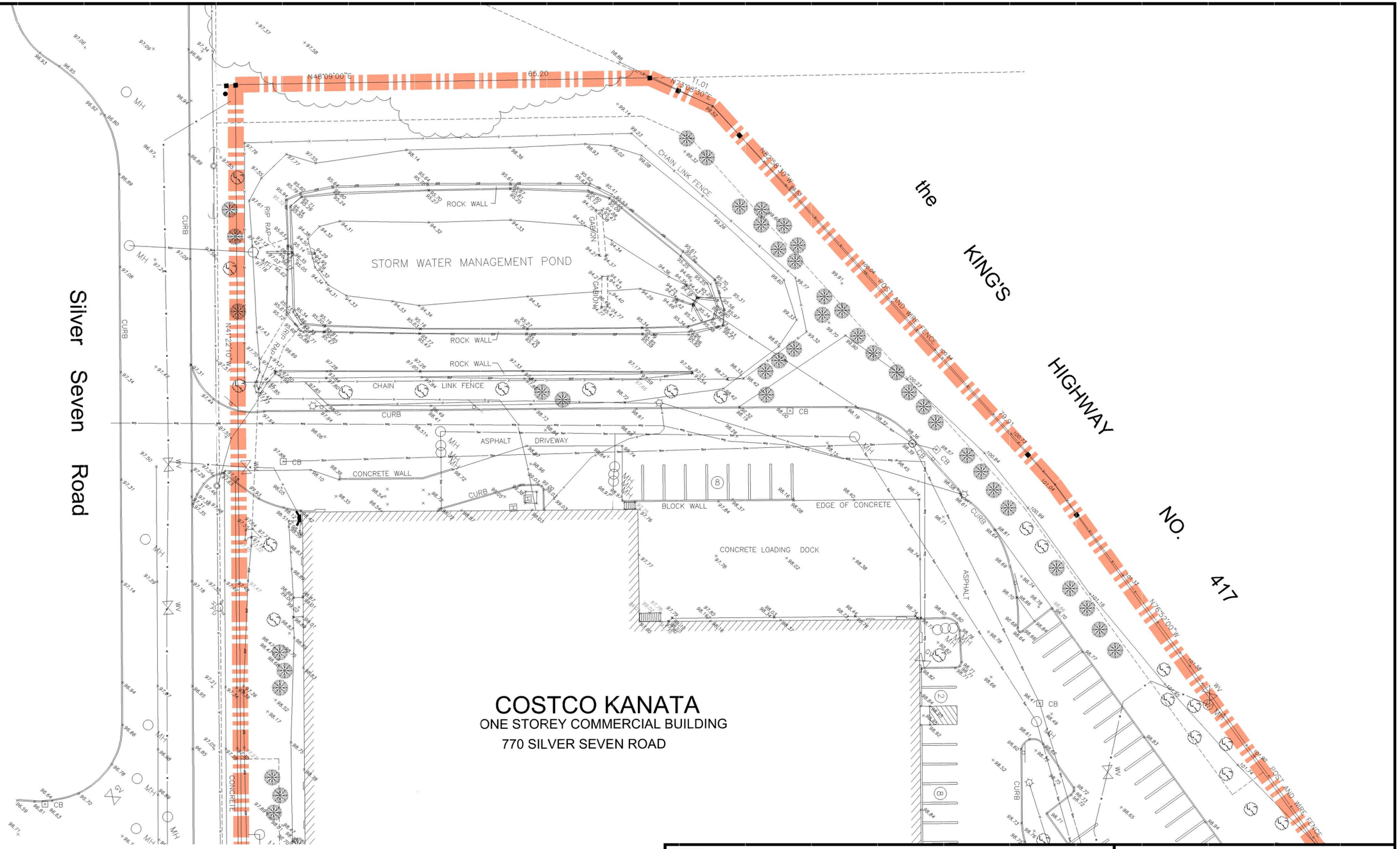
Where,

C = Runoff Coefficient
I = Rainfall Intensity (mm/h)
A = Area (ha)
Q = Flow rate (l/s)

The rainfall intensity was calculated using the following equation based on the design information for this project, which was obtained from City of Ottawa, as published in the original SWM Report:

$$I_5 = \frac{879}{t^{0.77}+2.8} \qquad I_{100} = \frac{1562.1}{(t+6)^{0.807}}$$

Where, I = intensity in mm/hr



COSTCO KANATA

ONE STOREY COMMERCIAL BUILDING

770 SILVER SEVEN ROAD

LEGEND

PROPERTY BOUNDARY

0 10 20 30 40m

CLIENT: COSTCO WHOLESALE CANADA LTD.

TITLE: COSTCO KANATA GAS BAR

EXISTING CONDITIONS

MMM GROUP
100 Commerce Valley Dr. W.
Thornhill, ON L3T 0A1
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Scale: AS SHOWN	Figure No.: 2 — Gr.No.: 013

FIGURE 2.dwg Layout1 S:\14-41\10\10021-001-W01\ Feb 13, 2012 - 3:05pm

Table 1 from section 5.0 of the original SWM report, identifying the site surface types is reproduced here along with the composite runoff coefficient for the site.

TABLE 1

Post Development Surface Drainage Areas			
Surface Type	Coefficient	Area (m^2)	Area x Coefficient
Asphalt	0.90	30476	27428.4
Roof	0.95	11859	11266.1
Stormwater Pond	0.00	2842	0
Landscaping or Natural	0.20	17005	3401
	Total	**62182**	**0.677 (composite coefficient)**

Section 5.3.2 of the original report utilized a time of concentration (t_c) of 20 minutes and calculated the allowable flow rate to the City's storm sewer system based on a coefficient of 0.2.

$$Q_{allowable} = 0.2 \times 68.45\, {}^{mm}/_{hr} \times 62182 m^2 \div 3600$$

$$Q_{allowable} = 236.46\, l/s$$

Due to the proposed pond solution in the original report, the peak flow rate from the pond facility was lowered below the allowable rate to provide for the MOE requirement of 24 hour detention for water quality events. As the pond facility is being replaced with an underground structure, the allowable rate has been calculated based on the storm sewer capacity and the above equation.

3.0 POST-DEVELOPMENT CONDITION

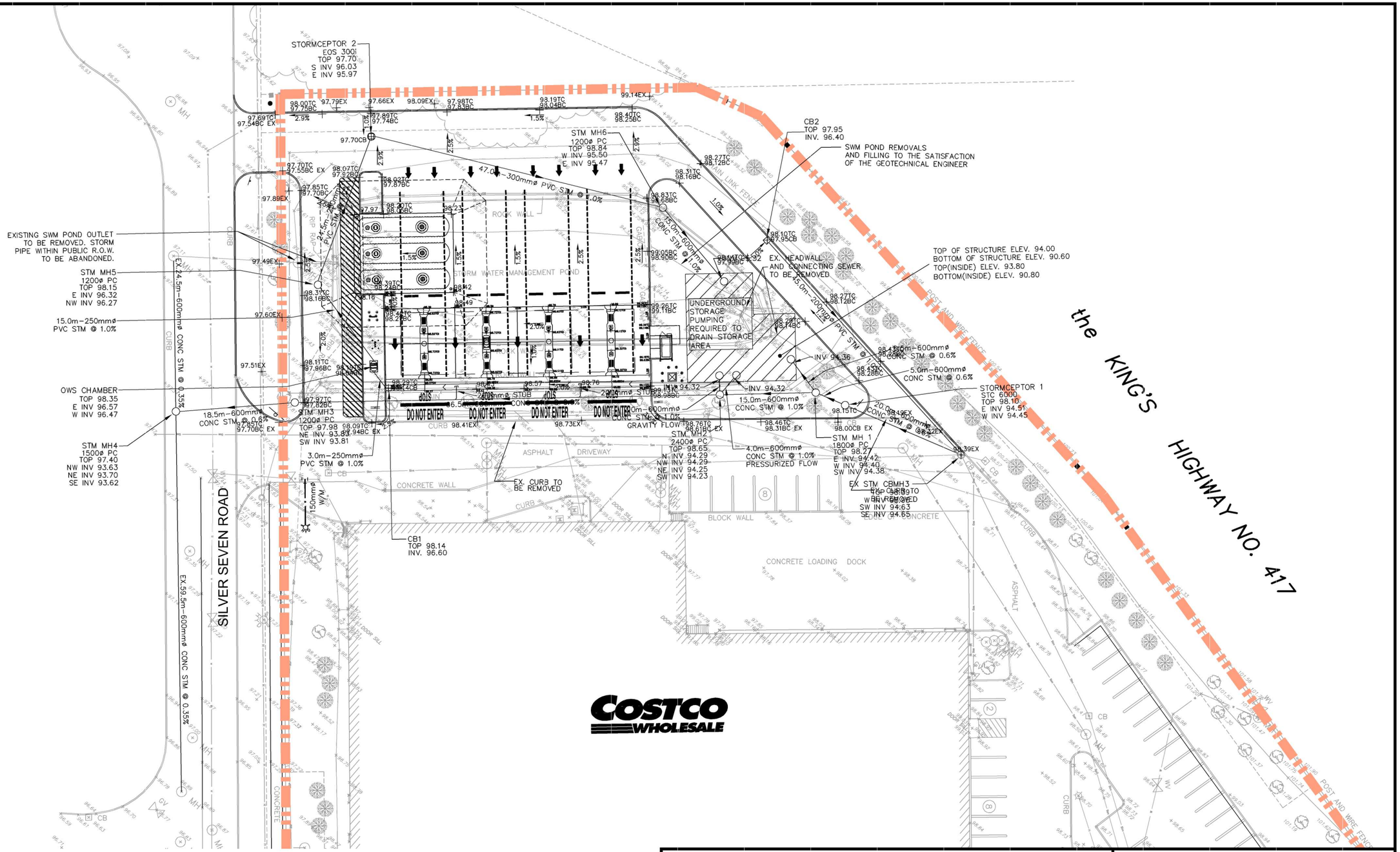
3.1 POST-DEVELOPMENT FLOW & WATER QUANTITY

The proposed development is a Gas Station in the northern area of the Costco property. The site is 0.28ha in area. The proposed development consists of gas bar canopy, asphalt paved area for the filling station and adjacent landscaped surfaces. Please see figure 3.

The current quantity control functions provided by the existing SWM pond will be replaced by an underground storage volume coupled with a pump solution calibrated to discharge a maximum flow rate to the downstream storm sewer system. The underground tank consists of a "StormTrap" precast concrete modular system (see appendix B) with a total storage volume of 649 m^3 in a 3.048 m tall chamber arrangement. Two pumps selected to discharge a maximum of 236 l/s will be installed to provide redundant capacity inside the storage tank. Under low flow conditions, the pumps will discharge at a lower rate until the tank approaches 50% full, at which time both pumps will switch on to their full design rate.

A hydrologic model utilizing the "HydroCad" software suite was utilized to determine the effectiveness of this strategy. The original SWM report utilized the Modified Rational Method to determine storage requirements in the pond. However, the Modified Rational Method is insufficient on its own to account for the behaviour of the pump strategy, so a modelling approach is required. The HydroCad package utilizes the Rational Method to determine the peak inflow rate, and then routes the resulting flows through the tank system and models the behaviour of the pump system, estimating flow rates to the storm sewer system and required storage. Modelling of an identical 5 year event from the original SWM report modified to account for the storage/pump strategy results in a maximum flow rate of 197 l/s and a utilized storage of 596 m^3 (of 679 m^3 available. Please see Appendix A for supporting calculations).

Major storm runoff will continue to be conveyed overland. The existing overland flow routes will be utilized to convey major storm runoff from the proposed gas bar area to Silver Seven Drive.



LEGEND

SITE BOUNDARY

0 10 20 30 40m

CLIENT

COSTCO WHOLESALE CANADA LTD.

TITLE

COSTCO KANATA GAS BAR

PROPOSED CONDITIONS

MMM GROUP
100 Commerce Valley Dr. W.
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FIGURE 3.dwg Layout1 S:\14-411\10\10021-001-W01\ Feb 14, 2012 - 9:13am

3.2 WATER QUALITY

The original SWM report documents a requirement to provide "Normal" level water quality treatment for discharge to off-site sewers, which was provided by settling action in the on-site pond. Due to the potential for hydrocarbon spill in the gas bar area, two separage OGS units are proposed for the site. The larger one, a Stormceptor Model STC 6000 (or approved equivalent) has been sized to address sediment loadings from the warehouse and parking areas. Separate treatment for the gas bar area will be provided by a Stormceptor Model EOS 300i. Sizing for both units is provided in Appendix A. Please note that the sediment removal performance for an STC 300 (as shown in the calculations) is identical to model EOS 300i. The EOS prefix represents (Extended Oil Storage) to accommodate the potential hydrocarbon spills from the filling area. Both units are capable of producing average annual removal of 70% TSS from their respective tributary areas. In addition, all drainage inlet points retain the sump volumes, pretreating runoff prior to collection and treatment in the SWM system.

4.0 CONCLUSIONS

A stormwater management report has been prepared for the proposed gas bar at the Kanata Costco warehouse in the City of Ottawa. The existing SWM pond that provided flow control, temporary detention storage and water quality treatment will be replaced with subsurface storage and active pump flow control, coupled with water quality treatment via Oil/Grit Separators. These facilities have been sized to replicate the features of the pond system, providing slightly better water quality treatment, extended oil storage for potential hydrocarbon spills, and flow control to the flow rates allowed by the City of Ottawa.

APPENDIX A
STORMWATER RUNOFF CALCULATIONS

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	13/02/2012
Project Name	Costco Kanata Gas Bar
Project Number	1010021-001-W01
Location	Kanata, ON

Designer Information

Company	MMM Group Ltd.
Contact	Steve van Haren, P.Eng., P.E.

Notes

N/A

Drainage Area

Total Area (ha)	5.93
Imperviousness (%)	71

The Stormceptor System model STC 6000 achieves the water quality objective removing 72% TSS for a Fine (organics, silts and sand) particle size distribution and 87% runoff volume.

Rainfall

Name	OTTAWA MACDONALD-CARTIER INT'L A
State	ON
ID	6000
Years of Records	1967 to 2003
Latitude	45°19'N
Longitude	75°40'W

Water Quality Objective

TSS Removal (%)	70
Runoff Volume (%)	80

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	38	32
STC 750	51	55
STC 1000	52	55
STC 1500	53	55
STC 2000	61	69
STC 3000	62	69
STC 4000	68	81
STC 5000	68	81
STC 6000	**72**	**87**
STC 9000	77	91
STC 10000	77	91
STC 14000	81	95

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

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Project Name	Costco Kanata Gas Bar
Project Number	1010021-001-W01
Location	Kanata, ON

Designer Information

Company	MMM Group Ltd.
Contact	Steve van Haren, P.Eng., P.E.

Notes

N/A

Drainage Area

Total Area (ha)	0.28
Imperviousness (%)	73

The Stormceptor System model STC 300 achieves the water quality objective removing 81% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	OTTAWA MACDONALD-CARTIER INT'L A
State	ON
ID	6000
Years of Records	1967 to 2003
Latitude	45°19'N
Longitude	75°40'W

Water Quality Objective

TSS Removal (%)	70
Runoff Volume (%)	80

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	**81**	**95**
STC 750	87	99
STC 1000	87	99
STC 1500	88	99
STC 2000	91	100
STC 3000	92	100
STC 4000	94	100
STC 5000	94	100
STC 6000	95	100
STC 9000	97	100
STC 10000	97	100
STC 14000	97	100

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

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Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
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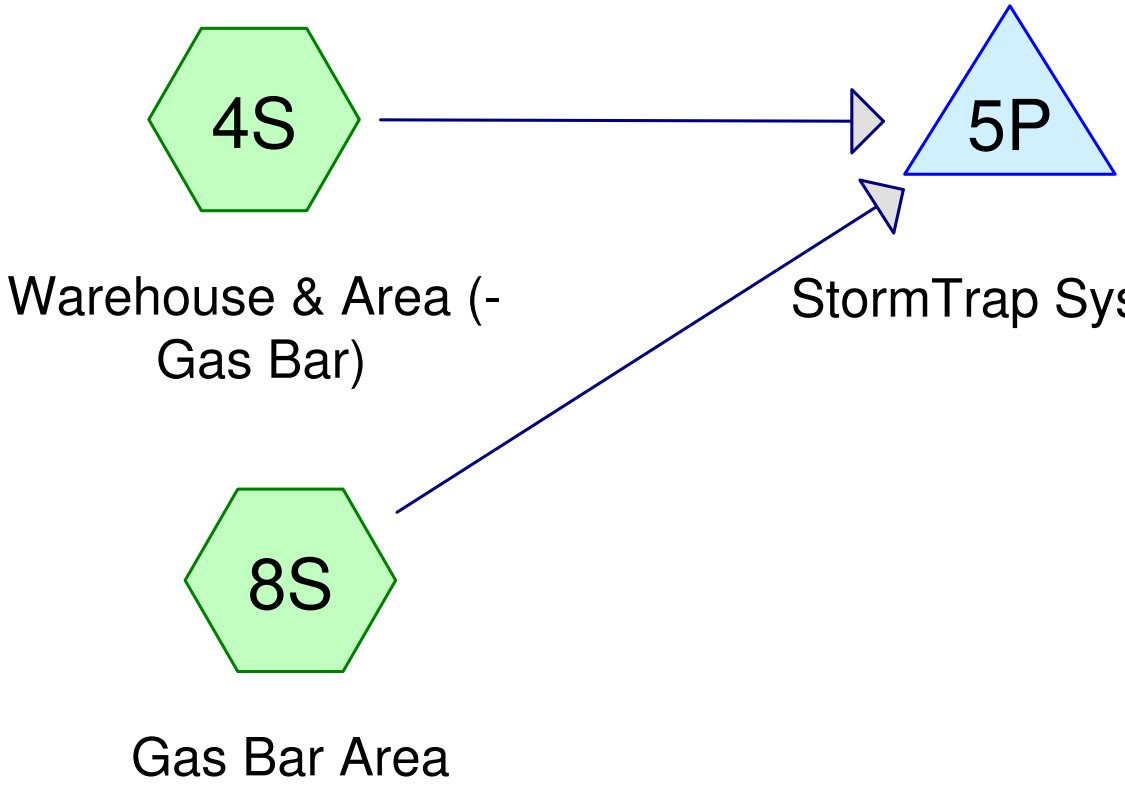


Subcat Reach Pond Link

Drainage Diagram for Costco Kanata - Pump Solution
Prepared by MMM Group Ltd., Printed 2/13/2012

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
1.7005	0.20	Landscaping or Natural (4S)
0.0762	0.25	Lanscape Area (8S)
3.0476	0.90	Asphalt (4S)
0.2080	0.90	Gas Bar (8S)
1.1859	0.95	Rooftop (4S)
6.2182		**TOTAL AREA**

Soil Listing (all nodes)

Area (hectares)	Soil Group	Subcatchment Numbers
0.0000	HSG A	
0.0000	HSG B	
0.0000	HSG C	
0.0000	HSG D	
6.2182	Other	4S, 8S
6.2182		**TOTAL AREA**

Time span=0.00-7.00 hrs, dt=0.01 hrs, 701 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 4S: Warehouse & Area Runoff Area=59,340.0 m² 19.98% Impervious Runoff Depth=16 mm
Tc=20.0 min C=0.71 Runoff=795 L/s 0.962 Ml

Subcatchment 8S: Gas Bar Area Runoff Area=2,842.0 m² 0.00% Impervious Runoff Depth=17 mm
Tc=5.0 min C=0.73 Runoff=39 L/s 0.047 Ml

Pond 5P: StormTrap System Peak Elev=94.587 m Storage=0.596 Ml Inflow=834 L/s 1.009 Ml
Outflow=197 L/s 1.009 Ml

Total Runoff Area = 6.2182 ha Runoff Volume = 1.009 Ml Average Runoff Depth = 16 mm
80.93% Pervious = 5.0323 ha 19.07% Impervious = 1.1859 ha

Summary for Subcatchment 4S: Warehouse & Area (- Gas Bar)

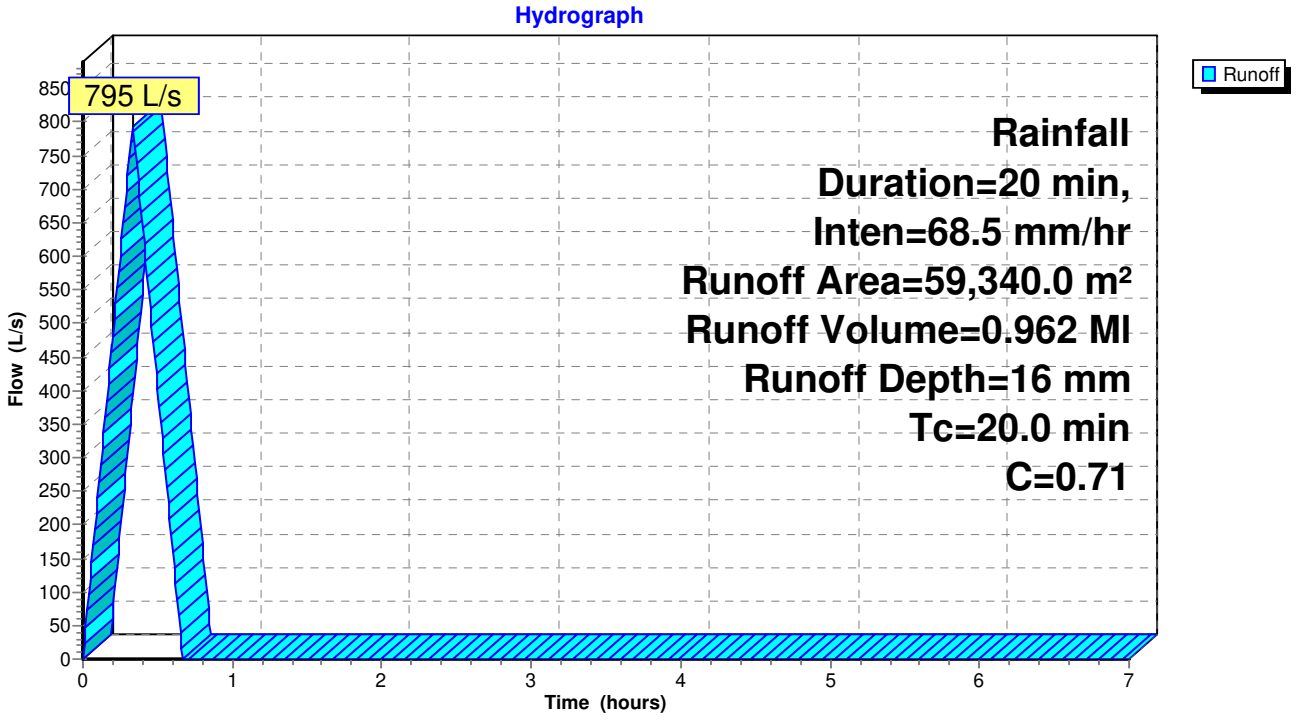
Runoff = 795 L/s @ 0.33 hrs, Volume= 0.962 Ml, Depth= 16 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-7.00 hrs, dt= 0.01 hrs
Rainfall Duration=20 min, Inten=68.5 mm/hr

Area (m²)	C	Description
30,476.0	0.90	Asphalt
11,859.0	0.95	Rooftop
17,005.0	0.20	Landscaping or Natural
59,340.0	0.71	Weighted Average
47,481.0		80.02% Pervious Area
11,859.0		19.98% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
20.0					**Direct Entry, Per Original SWM Report**

Subcatchment 4S: Warehouse & Area (- Gas Bar)



Summary for Subcatchment 8S: Gas Bar Area

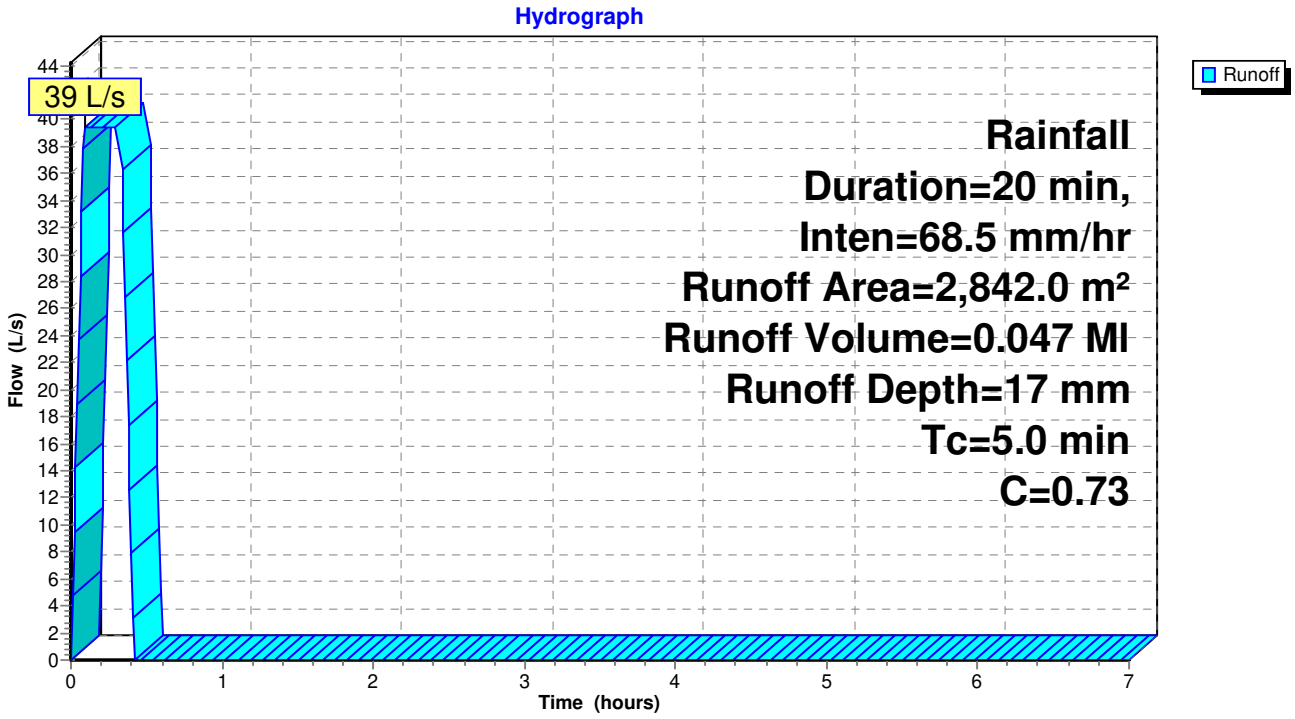
Runoff = 39 L/s @ 0.09 hrs, Volume= 0.047 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-7.00 hrs, dt= 0.01 hrs
Rainfall Duration=20 min, Inten=68.5 mm/hr

Area (m²)	C	Description
762.0	0.25	Lanscape Area
2,080.0	0.90	Gas Bar
2,842.0	0.73	Weighted Average
2,842.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 8S: Gas Bar Area



Summary for Pond 5P: StormTrap System

Inflow Area = 6.2182 ha, 19.07% Impervious, Inflow Depth = 16 mm
Inflow = 834 L/s @ 0.33 hrs, Volume= 1.009 Ml
Outflow = 197 L/s @ 0.08 hrs, Volume= 1.009 Ml, Atten= 76%, Lag= 0.0 min
Primary = 197 L/s @ 0.08 hrs, Volume= 1.009 Ml

Routing by Stor-Ind method, Time Span= 0.00-7.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 94.587 m @ 0.58 hrs Surf.Area= 0.0000 ha Storage= 0.596 Ml

Plug-Flow detention time= 25.6 min calculated for 1.008 Ml (100% of inflow)
Center-of-Mass det. time= 25.6 min (45.3 - 19.7)

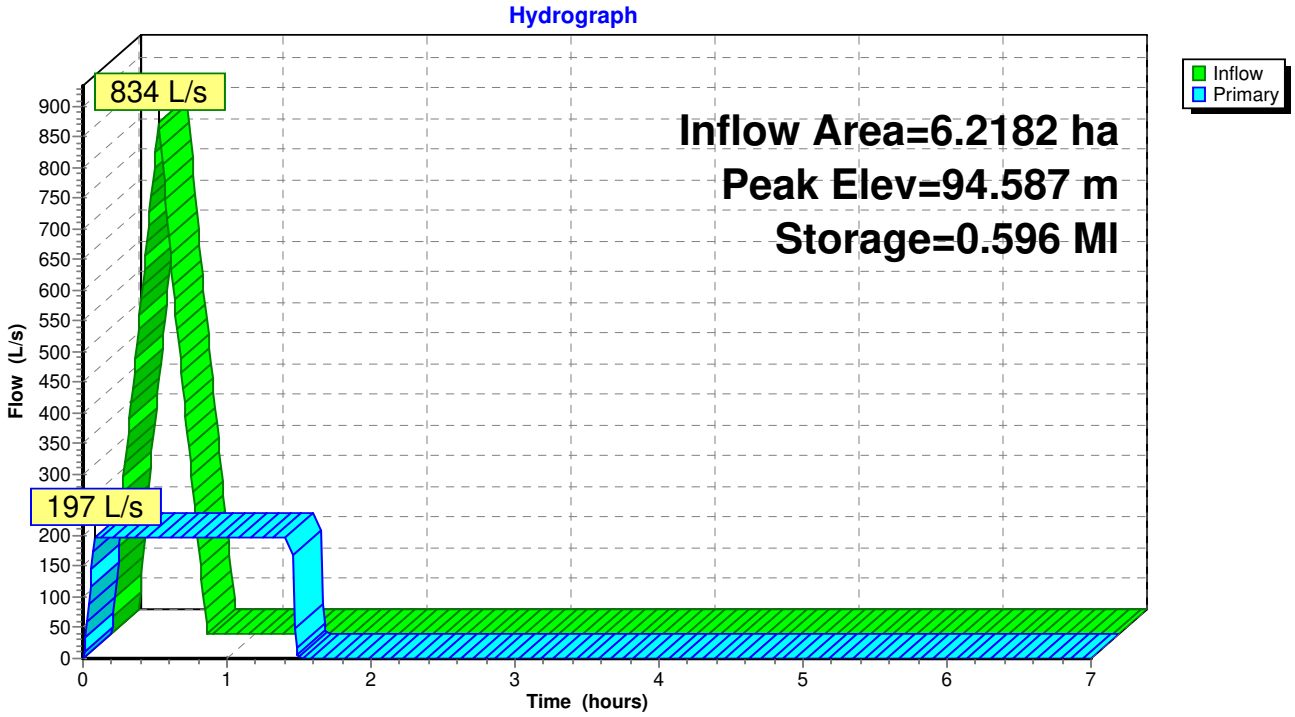
Volume	Invert	Avail.Storage	Storage Description
#1	91.912 m	0.679 Ml	**StormTrap 679 cu.m. DoubleTrap System** Listed below

Elevation (meters)	Cum.Store (Mega-liters)
91.912	0.000
94.960	0.679

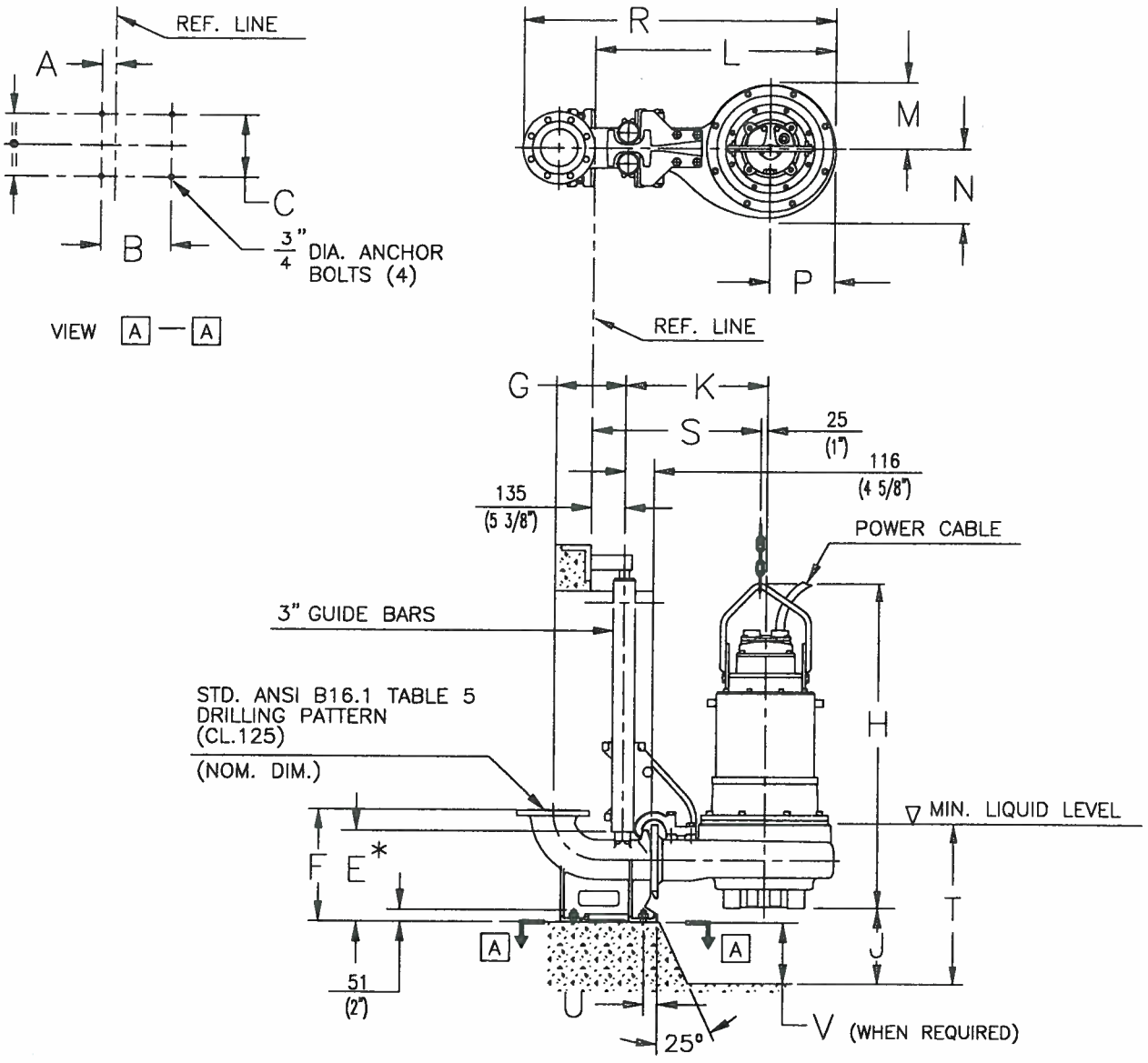
Device	Routing	Invert	Outlet Devices
#1	Primary	91.912 m	**Pump Discharges@94.320 m** 600 mm Diam. x 3.05 m Long Discharge, Hazen-Williams C= 130 Flow (l/min)= 0.0 1,500.0 3,000.0 4,500.0 6,000.0 7,500.0 9,000.0 10,500.0 11,820.0 Head (meters)= 10.500 10.000 9.500 9.250 9.000 8.650 8.300 7.900 7.548

Primary OutFlow Max=197 L/s @ 0.08 hrs HW=91.944 m (Free Discharge)
↑—**1=Pump** (Pump Controls 197 L/s)

Pond 5P: StormTrap System



APPENDIX B
SUPPORTING DOCUMENTATION

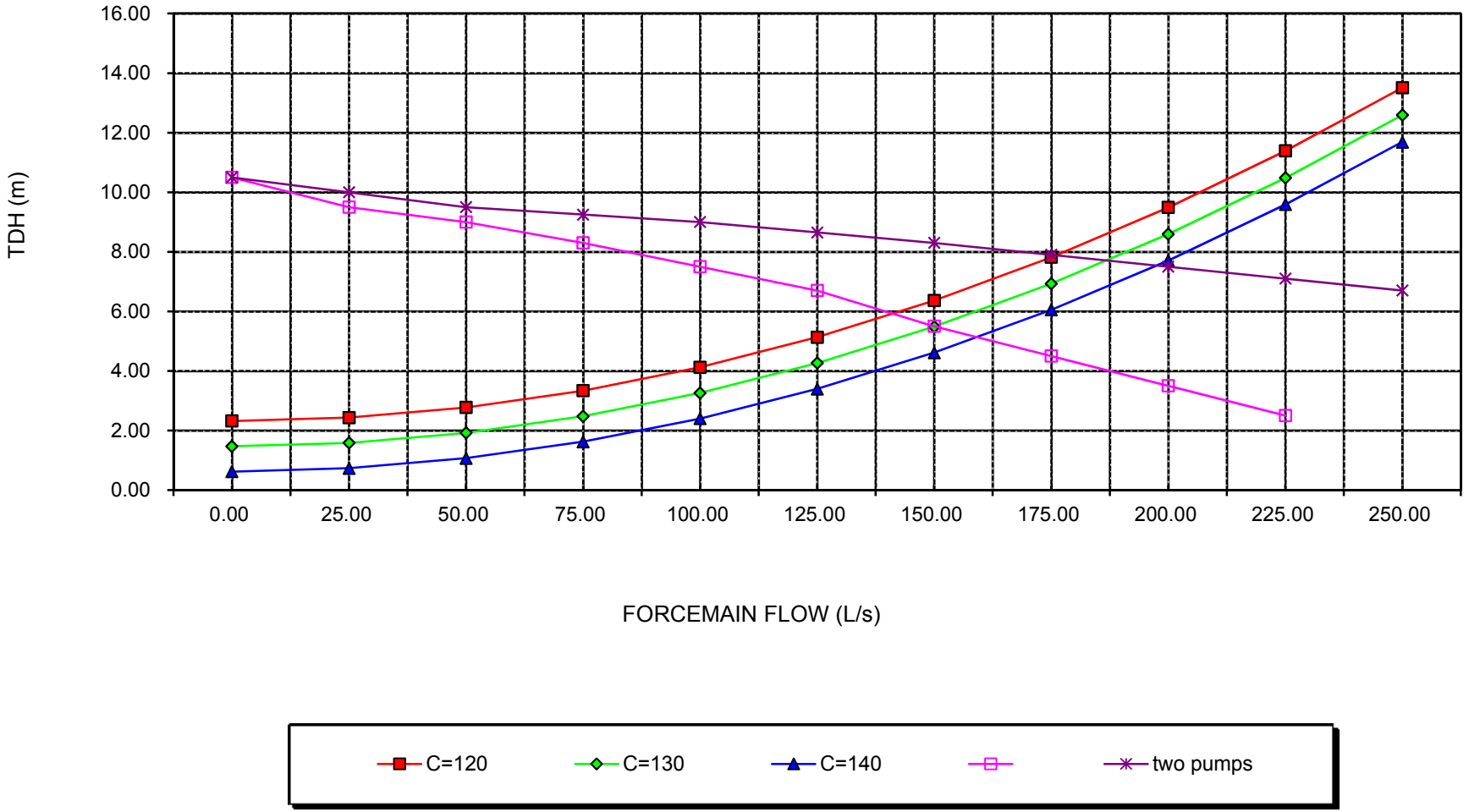


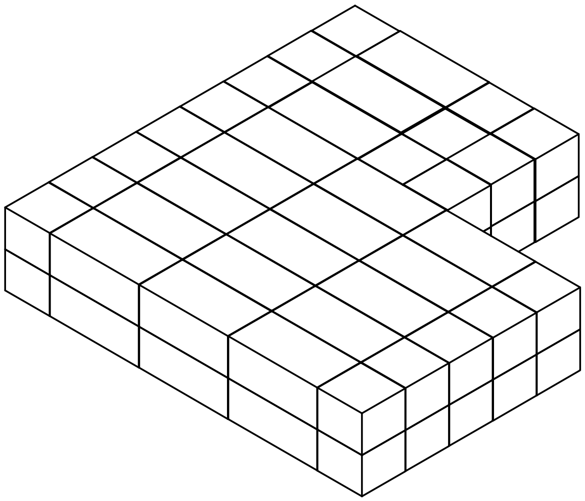
* DIM. TO ENDS OF GUIDE BARS.

(ALL DIMENSIONS SHOWN IN MILLIMETERS & INCHES)

Version	Nom. Dim.	Dimensional Chart																		Weight	
		A	B	C	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	Pump	Disch
MT	6"	59	280	210	330	450	279	1305	110	566	965	255	285	265	1255	676	445	55	50	520 kg	53 kg
		2 3/8"	11"	8 1/4"	13"	17 3/4"	11"	51 3/8"	4 3/8"	22 1/4"	38"	10"	11 1/4"	10 3/8"	49 3/8"	26 5/8"	17 1/2"	2 1/8"	2"	1147 lb	117 lb
	8"	89	280	210	350	450	309	1305	120	566	965	255	285	265	1310	676	450	55	50	520 kg	64 kg
		3 1/2"	11"	8 1/4"	13 3/4"	17 3/4"	12 1/8"	51 3/8"	4 3/4"	22 1/4"	38"	10"	11 1/4"	10 3/8"	51 5/8"	26 5/8"	17 3/4"	2 1/8"	2"	1147 lb	141 lb
LT	10"	309	500	210	400	450	359	1350	263	616	1100	295	410	350	1530	726	640	55	250	564 kg	98 kg
		12 1/8"	19 5/8"	8 1/4"	15 3/4"	17 3/4"	14 1/8"	53 1/8"	10 3/8"	24 1/4"	43 1/4"	11 5/8"	16 1/8"	13 3/4"	60 1/4"	28 5/8"	25 1/4"	2 1/8"	9 7/8"	1244 lb	216 lb
	12"	494	500	470	675	800	434	1350	288	616	1100	295	410	350	1645	726	665	75	0	564 kg	207 kg
		7 5/8"	19 5/8"	18 1/2"	26 5/8"	31 1/2"	17 1/8"	53 1/8"	11 3/8"	24 1/4"	43 1/4"	11 5/8"	16 1/8"	13 3/4"	64 3/4"	28 5/8"	26 1/8"	3"	0"	1244 lb	456 lb

System Head Curve





COSTCO

OTTAWA, ON

STORMTRAP® PATENTED

PRECAST CONCRETE MODULAR STORM WATER MANAGEMENT SYSTEMS

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JOB SITE INFORMATION	
DESCRIPTION	
JOB NAME:	COSTCO
JOB ADDRESS:	OTTAWA, ON
ENGINEERING CO:	MULVANNYG2 ARCHITECTURE
CONTACT NAME:	JEREMY GOECKERITZ
CONTACT PHONE:	
CONTACT FAX:	
STORM TRAP SUPPLIER:	STORMTRAP
CONTACT NAME:	BEN BURKHART
CONTACT PHONE:	815-941-4663
CONTACT FAX:	815-416-1100
WATER STORAGE REQ'D:	660 CUBIC METER
WATER STORAGE PROV:	679 CUBIC METER
UNIT HEADROOM:	3048 MM DOUBLETRAP
UNIT QUANTITY:	37 UNITS - 74 TOTAL PIECES

STORMTRAP® PATENTED

PRECAST CONCRETE MODULAR STORM WATER MANAGEMENT SYSTEMS
THIS STORMTRAP DESIGN MAY BE COVERED BY 1 OR MORE OF THE FOLLOWING U.S. PATENTS: NO. 6,991,402 B2, 7,160,058 B2, & 7,344,335 B2
CA PATENT NO. 2,45,609

2495 WEST BUNGALOW RD
MORRIS, IL 60450
P: 815-941-4663
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ENGINEER INFORMATION:

MULVANNYG2 ARCHITECTURE
8484 WESTPARK DRIVE
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PROJECT INFORMATION:

COSTCO
OTTAWA, ON
UNASSIGNED

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PRELIMINARY

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1	17-JAN-2012	ISSUED FOR PRELIMINARY	BB

SCALE:

NTS

SHEET TITLE:

COVER SHEET

SHEET NUMBER:

01

STORMTRAP INSTALLATION SPECIFICATION

1. STORMTRAP MODULES SHALL BE MANUFACTURED ACCORDING TO SHOP DRAWINGS APPROVED BY THE INSTALLING CONTRACTOR AND ENGINEER. THE SHOP DRAWINGS SHALL INDICATE SIZE AND LOCATION OF ROOF OPENINGS AND INLET/OUTLET PIPE OPENINGS.

2. STORMTRAP SHALL BE INSTALLED IN ACCORDANCE WITH ASTM C891-90, STANDARD PRACTICE FOR INSTALLATION OF UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES. THE FOLLOWING ADDITIONS AND/OR EXCEPTIONS SHALL APPLY:

   A. SPECIFICATIONS ON THE ENGINEER'S DRAWINGS SHALL TAKE PRECEDENCE.

   B. STORMTRAP MODULES SHALL BE PLACED ON A LEVEL, 152mm PAD OF 6mm COARSE AGGREGATE, THAT EXTENDS 610mm PAST THE OUTSIDE OF THE SYSTEM, PER ASTM C891-90, STANDARD PRACTICE FOR INSTALLATION OF UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES.

   C. THE STORMTRAP MODULES SHALL BE PLACED SUCH THAT THE MAXIMUM SPACE BETWEEN ADJACENT MODULES DOES NOT EXCEED 19mm. IF THE SPACE EXCEEDS 19mm, THE MODULES SHALL BE RESET WITH APPROPRIATE ADJUSTMENT MADE TO LINE AND GRADE TO BRING THE SPACE INTO SPECIFICATION.

   D. THE PERIMETER HORIZONTAL JOINT OF THE STORMTRAP MODULES SHALL BE SEALED WITH PREFORMED MASTIC JOINT SEALER ACCORDING TO ASTM C891-90, 8.8 AND 8.12.

   E. CONTRACTOR TO ARRRANGE FOR A STORMTRAP REPRESENTATIVE OR MANUFACURE'S REPSENTATIVE TO BE ON SITE WHEN THE POND LINER IS INSTALLED AT A MUTUALLY CONVIENT DATE.

   F. ALL EXTERIOR JOINTS BETWEEN ADJACENT STORMTRAP MODULES SHALL BE SEALED WITH 203mm PRE-FORMED, COLD-APPLIED, SELF-ADHERING ELASTOMERIC RESIN BONDED TO A WOVEN HIGHLY PUNCTURE RESISTANT POLYMER WRAP CONFORMING TO ASTM C891-90 AND SHALL BE 203mm INTEGRATED PRIMER SEALANT AS APPROVED BY STORMTRAP. THE ADHESIVE EXTERIOR JOINT WRAP SHALL BE INSTALLED ACCORDING TO THE FOLLOWING INSTALLATION INSTRUCTIONS:

      1. USE A BRUSH OR WET CLOTH TO THOROUGHLY CLEAN THE OUTSIDE SURFACE AT THE POINT WHERE THE JOINT WRAP IS TO BE APPLIED.

      2. A RELEASE PAPER PROTECTS THE ADHESIVE SEALANT SIDE OF THE JOINT WRAP. PLACE THE ADHESIVE TAPE (ADHESIVE SIDE DOWN) AROUND THE STRUCTURE, REMOVING THE RELEASE PAPER AS YOU GO. THE SURFACE MUST BE CLEAN AND DRY BEFORE THE JOINT WRAP IS APPLIED. PRESS THE JOINT WRAP FIRMLY AGAINST THE STORMTRAP MODULE SURFACE WHEN APPLYING. **NEVER** APPLY HEAT OR FIRE TOTHE JOINT WRAP OR POND LINER.

   G. THE FILL PLACED AROUND THE STORMTRAP UNITS MUST BE DEPOSITED ON BOTH SIDES AT THE SAME TIME AND TO APPROXIMATELY THE SAME ELEVATION. AT NO TIME SHALL THE FILL BEHIND ONE SIDE WALL BE MORE THAN 610mm HIGHER THAN THE FILL ON THE OPPOSITE SIDE. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR DENSITY OR OTHERWISE SPECIFIED BY ENGINEER. CARE SHALL BE TAKEN TO PREVENT ANY WEDGING ACTION AGAINST THE STRUCTURE, AND ALL SLOPES BOUNDING OR WITHIN THE AREA TO BE BACKFILLED MUST BE STEPPED OR SERRATED TO PREVENT WEDGE ACTION. (REFERENCE ARTICLE 502.10 I.D.O.T. S.S.R.B.C.) CARE SHALL ALSO BE TAKEN AS NOT TO DISRUPT THE JOINT WRAP FROM THE JOINT DURING THE BACK FILL PROCESS. BACKFILL MATERIAL NOT TO EXCEED 20 kN/cu M SOIL DENSITY OR 120 kG/M OF LATERAL SATURATED PRESSURE. BACKFILL TO CONSIST OF SAND APPROVED BY STORMTRAP AND SHALL CONFORM TO THE ABOVE DENSITY/LATERAL SATURATED PRESSURE REQUIREMENTS.

   H. CONTRACTOR IS RESPONSIBLE TO ENSURE THE STORMTRAP LINER IS UNDAMAGED AT TIME OF DELIVERY AND BEFORE PLACEMENT OF THE STORMTRAP UNITS. IT IS SOLELY THE INSTALLING CONTRACTOR'S RESPONSIBILITY TO TAKE ALL PRECAUTIONS BEFORE, DURING AND AFTER THE INSTALLATION OF THE SYSTEM TO PROTECT THE LINER FROM DAMAGE. THE CONTRACTOR MUST ENSURE THAT THE STORMTRAP LINER IS INSTALLED UNDAMAGED TO GUARANTEE THE WATER TIGHTNESS OF THE SYSTEM. THE INSTALLING CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION AND PROTECTION OF THE WATER PROOFING LINER AND ANCILLARY COMPONENTS SUCH THAT COMPLETED STORMTRAP SYSTEM MEETS THE PROJECT WATER TIGHTNESS SPECIFICATIONS.

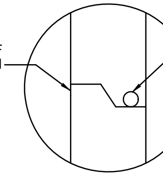
   I. LINER MUST BE TRANSPORTED, STORED AND INSTALLED IN TEMPS ABOVE 40° F.

CONTRACTOR SIGNATURE ______________________________

STORMTRAP SPECIFICATION

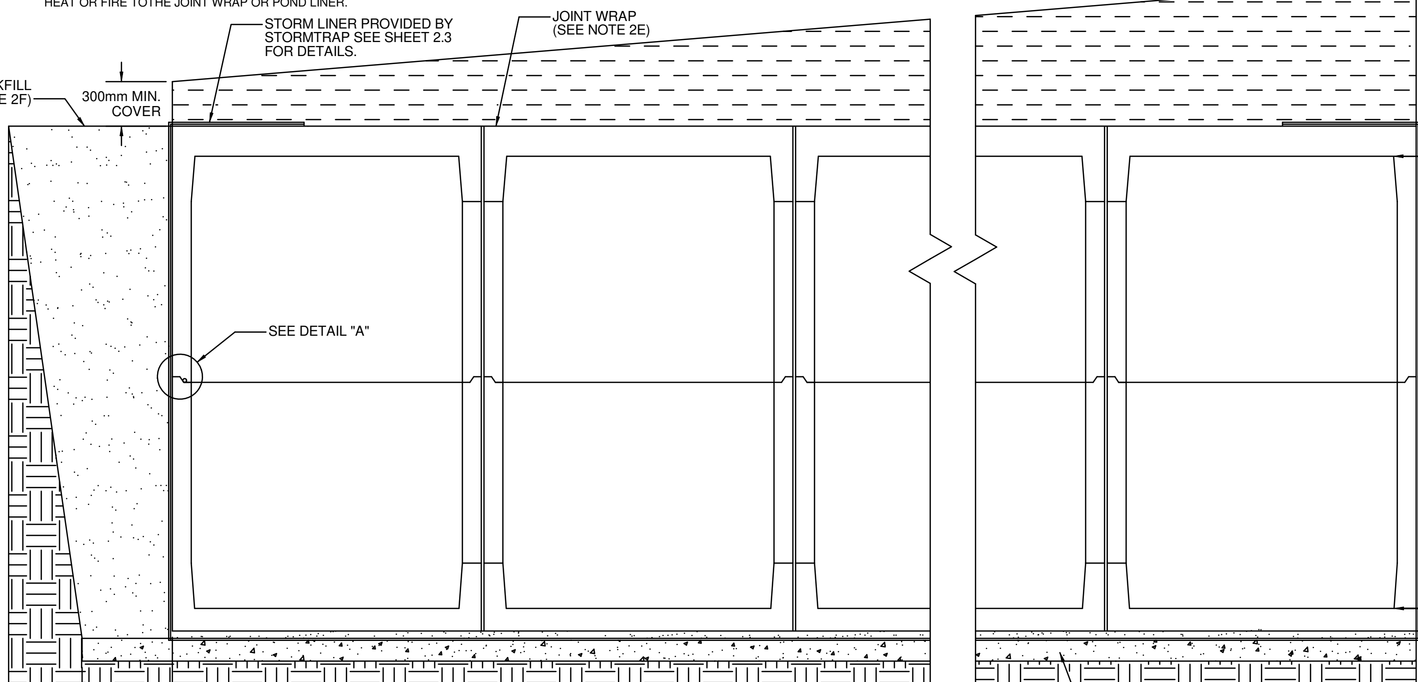
1. TOTAL COVER: MIN. 600mm MAX. 2700mm CONSULT STORMTRAP FOR ADDITIONAL COVER OPTIONS.
2. CONCRETE CHAMBER DESIGNED FOR CL 625 WHEEL LOAD. MINIMUM SOIL BEARING CAPACITY IS SLS = 100 KpA AND ULS = 150 KpA.
3. ALL DIMENSIONS AND SOIL CONDITIONS, INCLUDING BUT NOT LIMITED TO GROUNDWATER AND SOIL BEARING CAPACITY ARE TO BE VERIFIED IN THE FIELD BY OTHERS PRIOR TO STORMTRAP INSTALLATION.
4. FOR STRUCTURAL CALCULATIONS THE SOIL DENSITY IS ASSUMED TO BE 20 kN/cu M.
5. FOR STRUCTURAL AND FLOTATION CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW SYSTEM INVERT. IF WATER TABLE IS LESS DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.
6. THE POND LINER MUST BE STORED IN A HEATED SPACE WARMER THAN 10° CENTRIGADE, AND NOT INSTALLED IF THE TEMPERATURE IS LESS THAN10° CENTRIGADE.

EXTERIOR OF STORMTRAP SYSTEM



26mm Ø JOINT TAPE APPLIED AROUND THE PERIMETER OF THE SYSTEM ONLY

DETAIL "A"



3048 MM DOUBLETRAP

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DOUBLETRAP INSTALLATION SPECIFICATIONS

SHEET NUMBER:

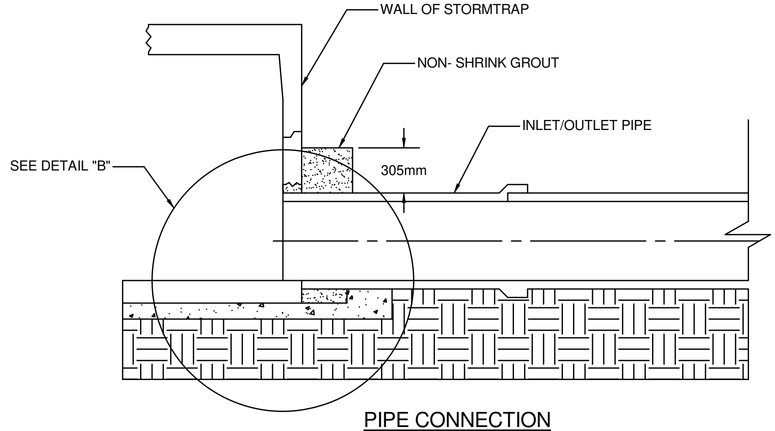
02

RECOMMENDED PIPE/RISER SPECIFICATION

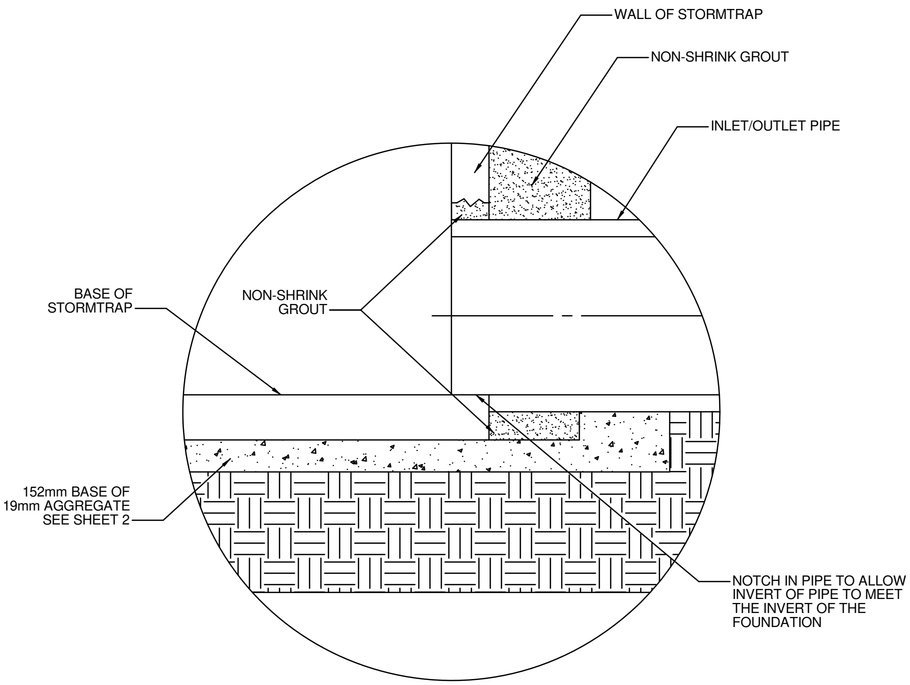
1. CONNECTING PIPES SHALL BE INSTALLED BY PLACING CONNECTING PIPE SO AS TO BREAK THE PLANE OF THE STORMTRAP WALL. A QUICK SETTING STRUCTURAL GRADE CONCRETE OR GROUT TO BE USED IN THE ANNULAR SPACE BETWEEN THE PIPE AND THE STORMTRAP. QUICK SETTING STRUCTURAL GRADE CONCRETE OR GROUT TO BE A MINIMUM OF 28 DAY COMPRESSIVE STRENGTH OF 20,500 kN/sq M. (ENGINEERS TYPICAL PIPE CONNECTION DETAIL SHALL TAKE PRECEDENCE)
2. ALL OPENINGS ARE PROVIDED BY STORMTRAP.

RECOMMENDED INSTALLATION INSTRUCTIONS

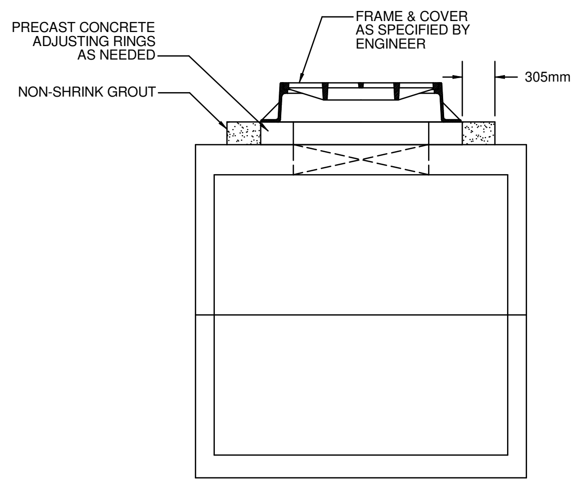
1. IF PIPE IS CUT, CARE SHOULD BE TAKEN TO PREVENT SHARP EDGES. BEVEL, CLEAN AND LIGHTLY LUBRICATE LEAD END OF PIPE TO BE INSERTED INTO STORMTRAP.
2. ALIGN CENTER OF PIPE TO CORRECT ELEVATION AND INSERT INTO OPENING. GROUT MAY BE REQUIRED TO BRING PIPE TO CORRECT ELEVATION.



PIPE CONNECTION



DETAIL "B"
CONNECTION DETAIL
(NOT TO SCALE)



RISER DETAIL

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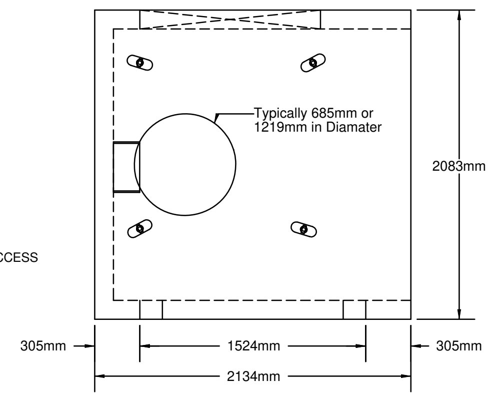
RECOMMENDED DOUBLETRAP INSTALLATION SPECIFICATIONS

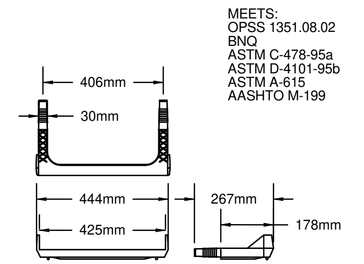
SHEET NUMBER:
2.1

RECOMMENDED
ACCESS OPENING SPECIFICATION

1. TYPICAL ACESS OPENING FOR THE STORMTRAP SYSTEM ARE 685MM FOR SYSTEMS WITH LESS THAN 450MM OF COVER, AND 1219MM OPENING FOR COVER GREATER THAN 450MM. MAXIMUM DIAMETER IS 1524 mm. ACCESS OPENINGS LARGER THAN 914mm IN DIAMETER NEED TO BE APPROVED BY STORMTRAP.
2. PLASTIC COATED STEEL STEPS PROVIDED BY STORMTRAP, ARE PRODUCED BY M.A. INDUSTRIES PART #PS3-PFC (SEE DETAIL TO THE RIGHT) ARE TO BE PLACED INSIDE ANY UNIT WHERE DEEMED NECESSARY. THE HIGHEST STEP IN THE UNIT IS TO BE PLACED A DISTANCE OF 305mm FROM THE INSIDE EDGE OF THE STORMTRAP UNITS. ALL ENSUING STEPS SHALL BE PLACED WITH A MINIMUM DISTANCE OF 406mm BETWEEN THEM. STEPS MAY BE MOVED OR ALTERED TO AVOID OPENINGS OR OTHER IRREGULARITIES IN THE UNIT.
3. STORMTRAP LIFTING INSERTS, PROVIDED WITHIN UNITS, MAY BE RELOCATED TO COINCIDE WITH THE ACCESS OPENING OR THE CENTER OF GRAVITY OF THE UNIT AS NEEDED.
4. STORMTRAP ACCESS OPENINGS MAY NOT INTERFERE WITH INLET AND/OR OUTLET OPENINGS
5. STORMTRAP ACCESS OPENINGS SHOULD BE LOCATED IN ORDER TO SATISFY THE APPROPRIATE MUNICIPAL REQUIREMENTS. STORMTRAP RECOMMENDS AT LEAST 1 ACCESS OPENING IN THE SYSTEM FOR MAINTENANCE.



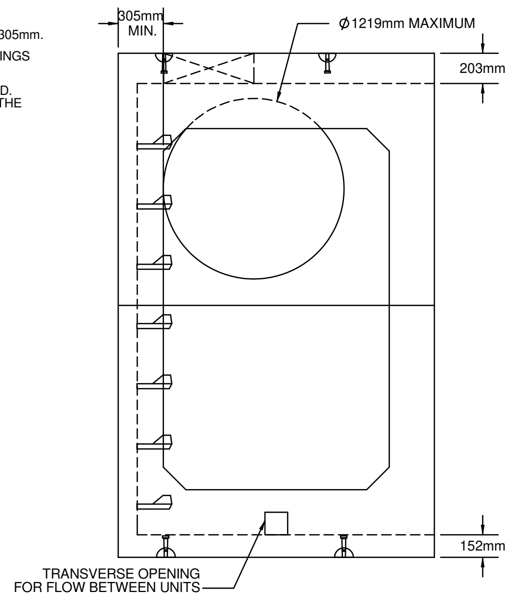
PLAN VIEW



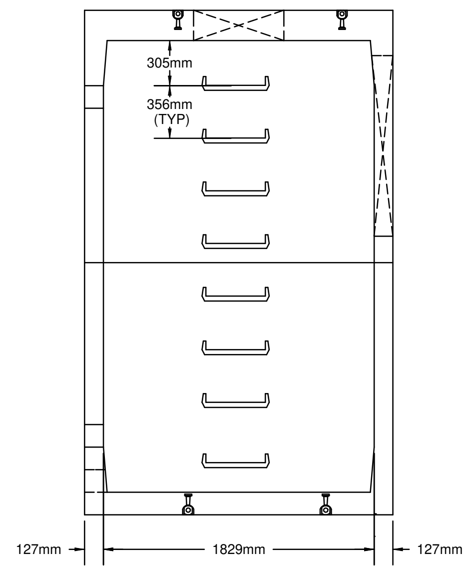
STAIR DETAIL

RECOMMENDED
PIPE OPENING SPECIFICATION

1. ALL OPENINGS MUST RETAIN AT LEAST 305mm OF CLEARANCE IN ALL DIRECTIONS FROM THE EDGE OF THE STORMTRAP UNITS.
2. MINIMUM DISTANCE FROM THE BASE OF THE ROOF SLAB SHALL BE NO LESS THAN 305mm.
3. PIPE OPENING SIZE SHALL NOT EXCEED 1219mm IN DIAMETER. LARGER PIPE OPENINGS MUST BE APPROVED BY STORMTRAP.
4. OPENINGS ARE NOT LIMITED TO THE ABOVE PARAMETERS BUT ARE RECOMMENDED. ANY OPENING NEEDED THAT DOES NOT FIT THE CRITERIA SHALL BE BROUGHT TO THE ATTENTION OF STORMTRAP FOR REVIEW.



ELEVATION VIEW



END VIEW

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RECOMMENDED
DOUBLETRAP
INSTALLATION
SPECIFICATIONS

SHEET NUMBER:

2.2

POND LINER & GEOFABRIC INSTALLATION NOTES

1. THE STONE AND SAND BEDDING SUBGRADE BELOW THE DOUBLETRAP UNITS MUST BE ABSOLUTELY AT SPECIFIED LINE AND GRADE TO AVOID STRETCHING OF THE LINER OVER VOIDS OR PUNCTURES FROM HIGH POINTS OR SHARP POINTS OF PRESSURE.
2. HANDLING AND PLACING OF THE LINER MUST BE DONE IN A WORKMANLIKE MANNER TO ENSURE THAT THE LINER IS NOT PUNCTURED THROUGHOUT THE INSTALLATION OF THE LINER, THE GEOFABRIC, THE STORMTRAP UNITS, AND THE BACKFILL PROCESS.
3. WHEN INSTALLING THE LINER, BOTH SIDES OF IT MUST BE COVERED WITH GEOFABRIC IN ORDER TO RESIST PUNCTURE AND TO ENSURE THE WATER TIGHTNESS OF THE SYSTEM.
   A. INSTALL THE 1ST LAYER OF GEOFABRIC ON THE SAND BEDDING. BE SURE THAT THERE IS A MINIMUM 457mm EXTRA TO FOLD ON TOP OF THE UNITS. REST FABRIC ON SIDES OF EXCAVATION WHILE INSTALLING THE SYSTEM.
   B. UNFOLD (IF REQUIRED) THE LINER TO ITS FULL WIDTH. (TAKE CAUTION AS TO CENTER THE LINER IN THE WIDTH WISE DIRECTION). THE LINER IS PREFORMED TO FIT THE STORMTRAP SYSTEM.
   C. UNROLL THE LINER TO ITS FULL LENGTH AND PLACE ON TOP OF THE GEOFABRIC. (AGAIN, TAKE CAUTION AS TO CENTER THE LINER IN THE LENGTH WISE DIRECTION).
   D. ENSURE THE LINER IS FLAT AND CENTERED TO ALLOW THE INSTALLATION OF THE 2ND LAYER OF GEOFABRIC.
   E. INSTALL THE 2ND LAYER OF GEOFABRIC ON THE POND LINER. BE SURE THAT THERE IS A MINIMUM 457MM EXTRA TO FOLD ON TOP OF THE UNITS. REST THE FABRIC, LINER, FABRIC ON THE SIDES OF THE EXCAVATION WHILE INSTALLING THE SYSTEM.
4. INSTALL DOUBLETRAP UNITS PER INSTALLATION SPECIFICATIONS ON SHEET 02, AS DISCUSSED IN PRE-INSTALLATION MEETING.
5. ONCE INSTALLATION OF DOUBLETRAP UNITS IS COMPLETE, THE LINER AND GEOFABRIC MUST BE LIFTED UP THE SIDES OF THE SYSTEM AND FOLDED OVER THE TOP OF THE SYSTEM TO A MINIMUM DISTANCE OF 457mm. CARE MUST BE TAKEN TO ELIMINATE GAPS AND VOIDS BETWEEN THE SYSTEM AND THE LINER. FOLD THE ENDS AND CORNERS AS IF WRAPPING A PARCEL.
6. ANY EXCESS LINER IS TO BE DRAPED OVER THE TOP OF THE UNITS AND TAPED TO THE UNITS WITH JOINT WRAP. (IF REQUIRED, INSTALL RAIN TARP ON TOP OF SYSTEM AND DRAPE OVER SIDES).

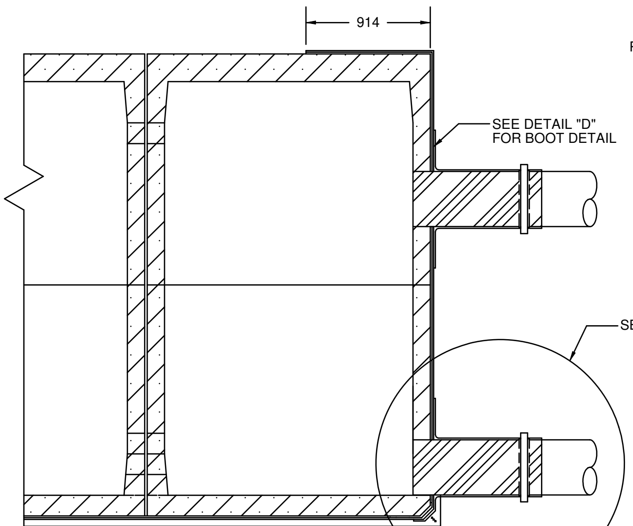
ENGINEERING AND CONSTRUCTION

NOTE: ALL PIPES ENTERING SYSTEM MUST BE SMOOTH (IE NO CORRUGATIONS) TO ENSURE PROPER SEAL WITH PIPE BOOT.

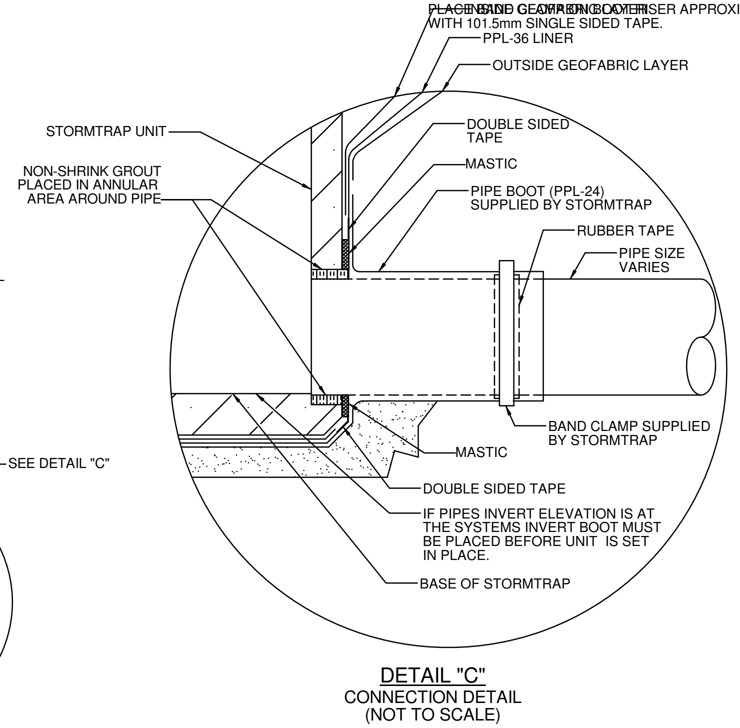
TYPICAL PIPE PENETRATION PROCEDURE

NOTE: IF THE PIPE OPENINGS ARE LOW IN THE EXTERIOR VERTICAL WALL OF THE STORMTRAP SYSTEM SUCH THAT THERE IS INSUFFICIENT WALL AREA BELOW THE PIPE OPENING FOR THE FLANGE OF THE BOOT TO BE APPLIED TO, THEN THE BOOT MUST BE APPLIED TO THE LINER PRIOR TO THE FINAL PLACING OF THE SUBJECT STORMTRAP UNITS AS IT WILL NEED TO WRAP AROUND THE BASE SURFACE OF THE STORMTRAP UNIT.

1. AFTER INSTALLATION OF THE LINER AND STORMTRAP UNITS, CAREFULLY CUT A HOLE THROUGH THE LINER AND GEOFABRIC AT THE HOLE LOCATIONS TO NO MORE THAN 25mm LARGER THAN THE OUTSIDE DIAMETER OF THE PIPE.
2. ENLARGE THE HOLE THROUGH THE INNER GEOFABRIC LAYER TO EXPOSE TO THE LINER AT LEAST 152mm OF BARE CONCRETE AROUND THE HOLE.
3. APPLY MASTIC TO THE 152mm AREA OF CONCRETE AROUND THE HOLE AND ADHERE THE LINER TO IT.
4. INSTALL PIPE SLIDE BOOT OVER PIPE AND PUSH AGAINST WALL.
5. CAREFULLY CUT BOOT FLANGE BASE SO THAT IT EXCEEDS THE CUT IN THE LINER BY 101.5mm TO 152mm IN ALL DIRECTIONS. MAKE THE FLANGE SQUARE. CUT A CORRESPONDING HOLE THOUGH THE OUTER LAYER OF GEOFABRIC TO EXPOSE THE LINER TO THE BOOT FLANGE.
6. CLEAN LINER AND FLANGE. USE WATER, MEK, XYLENE, ETC... DO NOT USE SOAP.
7. MARK A LINE AROUND FLANGE AND REMOVE BOOT.
8. PLACE 51mm WIDE DOUBLE SIDED TAPE ON LINER, SEE DETAIL "D". BE SURE TO OVERLAP AT CORNERS BY REMOVING THE FILM LAYER AT THE INTERSECTIONS. USE A RAG TO FIRMLY PRESS DOWN THE TAPE AND WORK OUT ANY WRINKLES.
9. REMOVE TOP FILM LAYER OF TAPE. REPLACE BOOT AND PRESS DOWN ON TO 51mm DOUBLE SIDED TAPE AND WORK OUT WRINKLES. ALL WRINKLES MUST BE REMOVED.
10. PLACE JOINT WRAP COMPLETELY OVER EDGE OF BOOT FLANGE, CENTERING ON THAT EDGE.
11. WRAP PIPE WITH ONE TO TWO LAYERS OF RUBBER TAPE AT LOCATION OF BAND CLAMP.
12. PLACE BAND CLAMP ON BOOT RISER APPROXIMATELY 25mm FROM TOP OF BOOT. TIGHTEN AND COVER WITH 101.5mm SINGLE SIDED TAPE.



PIPE CONNECTION



DETAIL "C"
CONNECTION DETAIL
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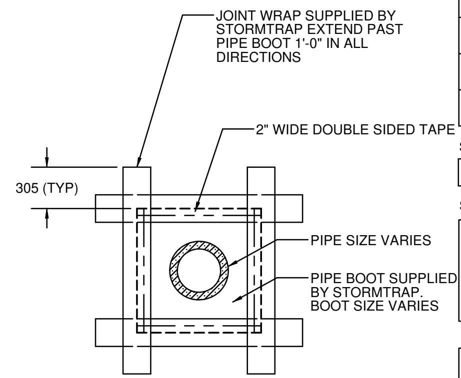

DETAIL "D"
TAPE CONNECTION DETAIL
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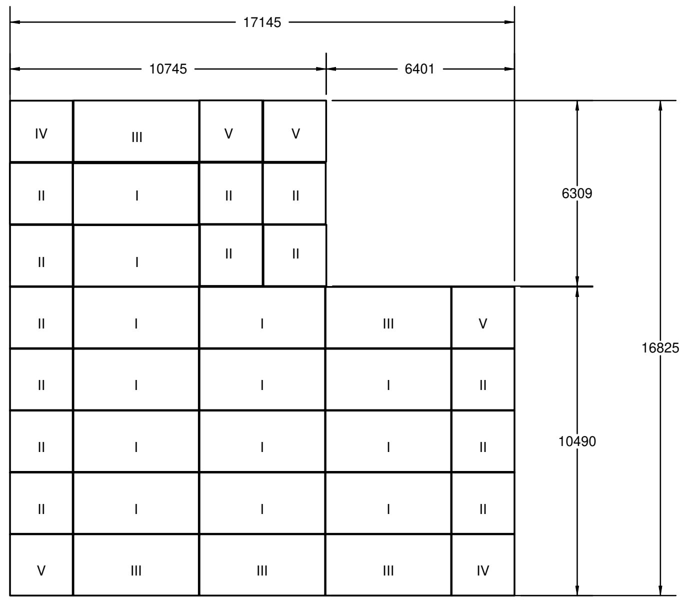
STORM LINER
DETAILS

SHEET NUMBER:

2.3

BILL OF MATERIALS

QTY.	PART NO.	DESCRIPTION
13	TYPE I	3048 MM DOUBLETRAP TYPE I
13	TYPE II	3048 MM DOUBLETRAP TYPE II
5	TYPE III	3048 MM DOUBLETRAP TYPE III
2	TYPE IV	3048 MM DOUBLETRAP TYPE IV
4	TYPE V	3048 MM DOUBLETRAP TYPE V
0	TYPE VI	3048 MM DOUBLETRAP TYPE VI
0	TYPE VII	3048 MM DOUBLETRAP TYPE VII
14	JOINT TAPE	JOINT TAPE - 4.42m PER ROLL
5	JOINT WRAP	JOINT WRAP - 45.75m PER ROLL



LAYOUT DETAIL

NOTES:

1. DIMENSION OF STORMTRAP SYSTEM ALLOW FOR A 19mm GAP BETWEEN EACH UNIT.
2. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY OTHERS.
3. SEE SHEET 2 FOR INSTALLATION SPECIFICATIONS.

DESIGN CRITERIA

INSIDE HEIGHT ELEVATION =

ALLOWABLE MIN GRADE = 0.153M

ALLOWABLE MAX GRADE =

SYSTEM INVERT =

STORMTRAP VOLUME = 679 C.M.

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CA PATENT NO. 2,45,609
2495 WEST BUNGALOW RD
MORRIS, IL 60450
P: 815-941-4663
F: 815-416-1100

ENGINEER INFORMATION:

MULVANNYG2 ARCHITECTURE

8484 WESTPARK DRIVE
MCLEAN, VA VA
Phone:
Fax:

PROJECT INFORMATION:

COSTCO

OTTAWA, ON

UNASSIGNED

CURRENT ISSUE DATE:

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1	17-JAN-2012	ISSUED FOR PRELIMINARY	BB

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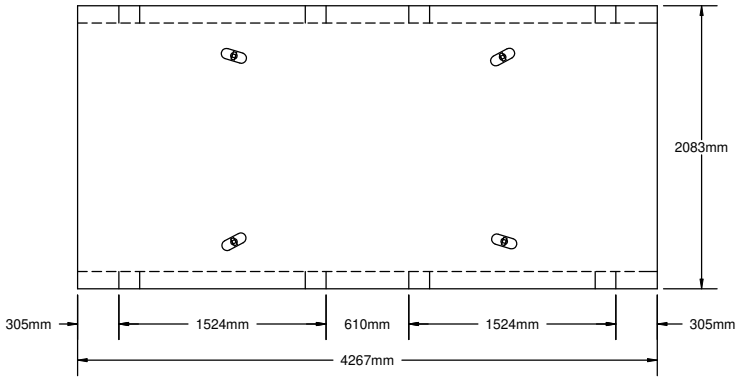
NTS

SHEET TITLE:

LAYOUT DETAIL

SHEET NUMBER:

03



PLAN VIEW

TYPE I UNITS			
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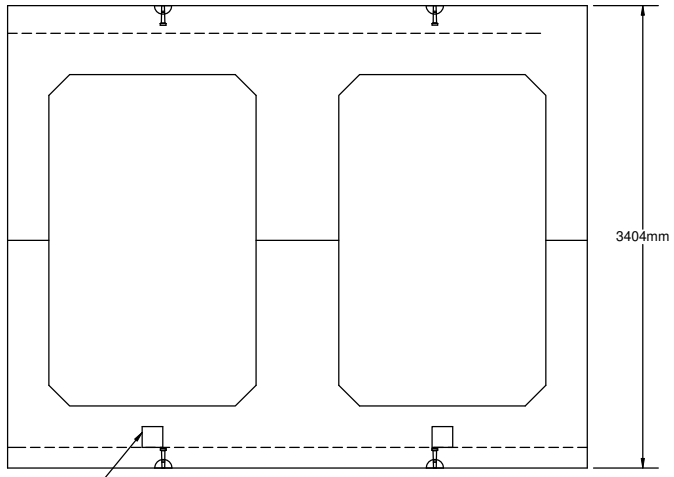
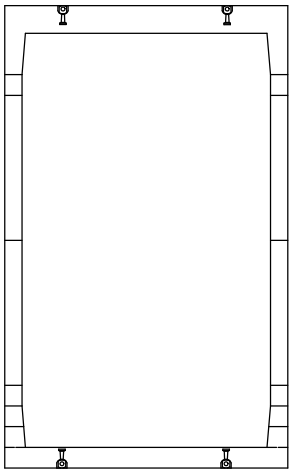


ELEVATION VIEW



SIDE VIEW

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3048 MM DOUBLETRAP
TYPE I

SHEET NUMBER:

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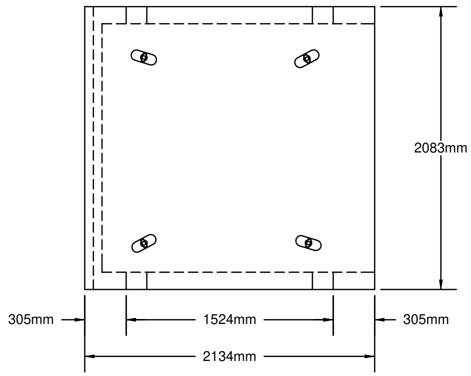

PLAN VIEW

TYPE II UNITS			
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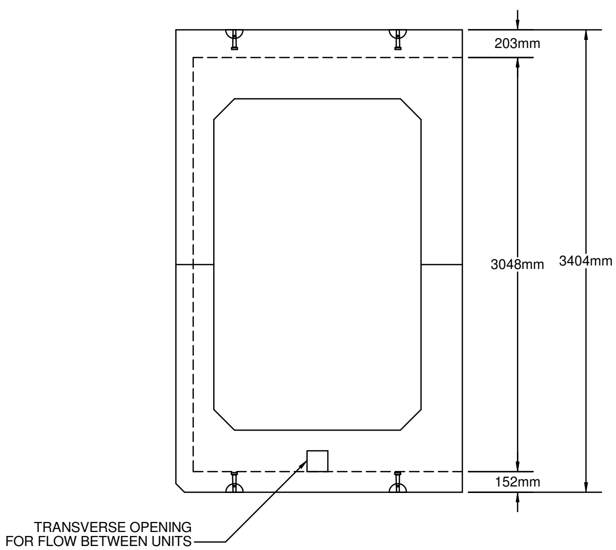
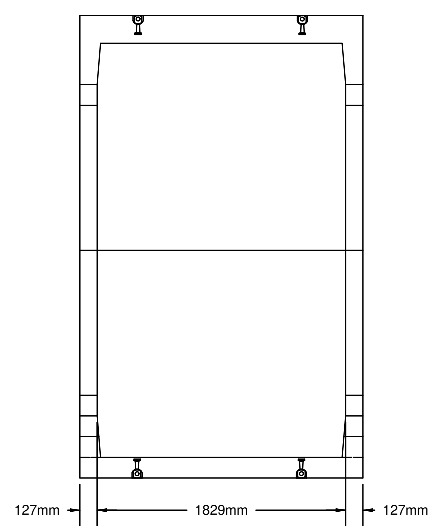


ELEVATION VIEW



SIDE VIEW

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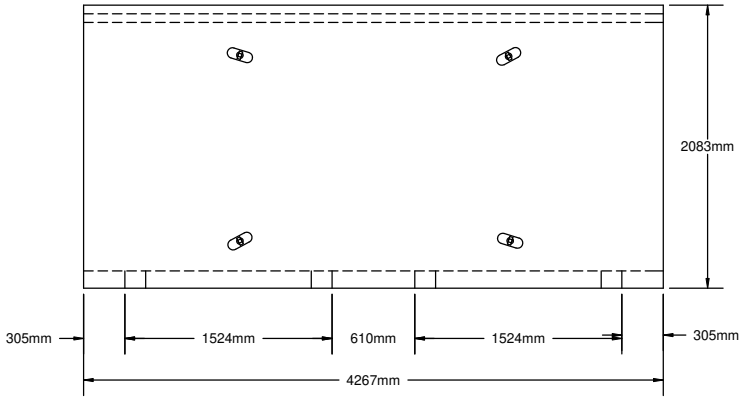

PLAN VIEW

TYPE III UNITS

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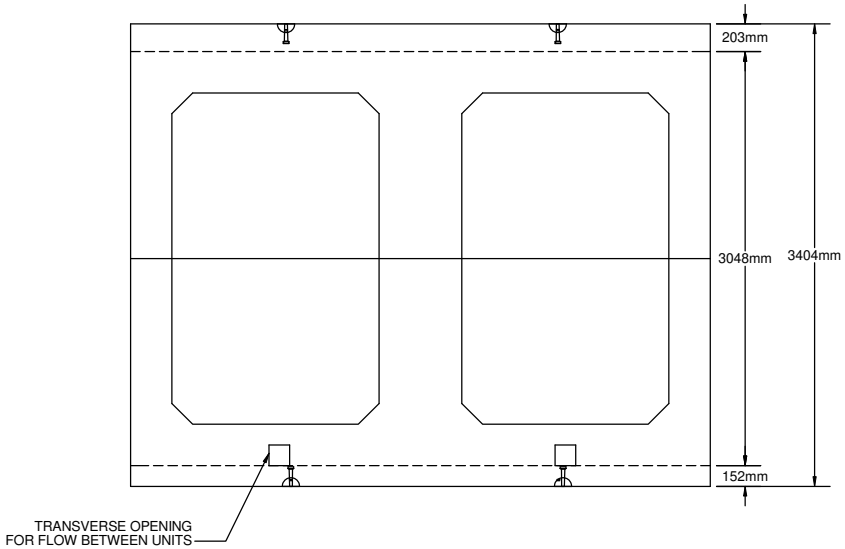
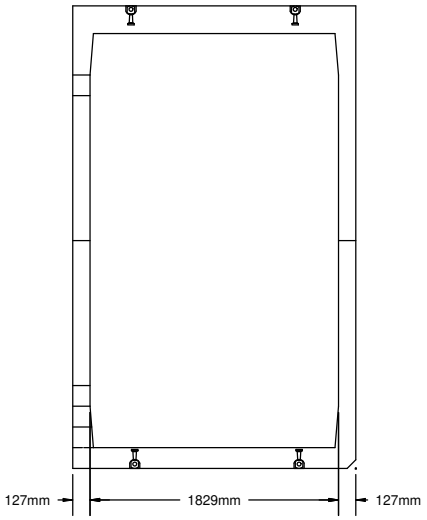


ELEVATION VIEW



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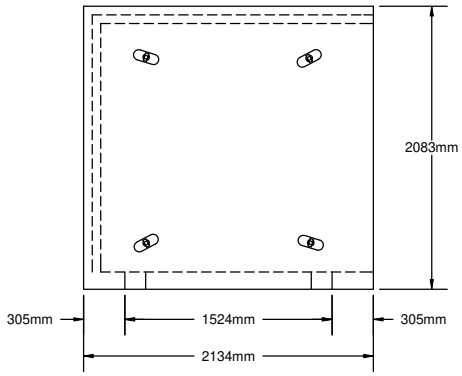

PLAN VIEW

TYPE IV UNITS

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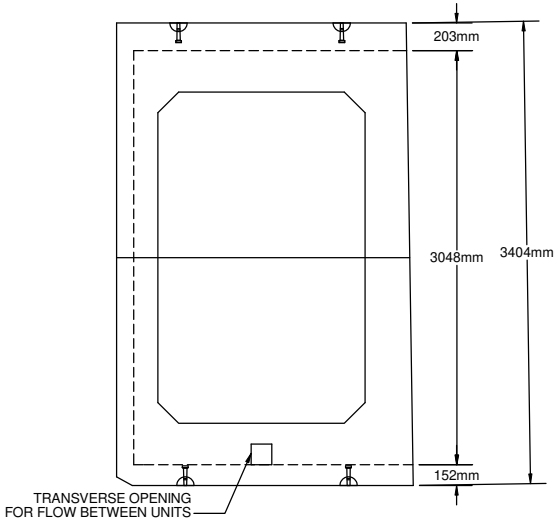
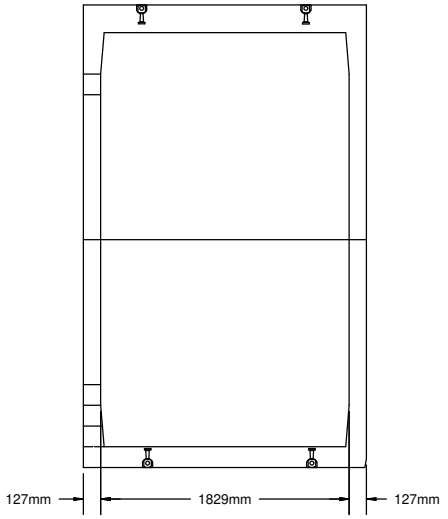


ELEVATION VIEW



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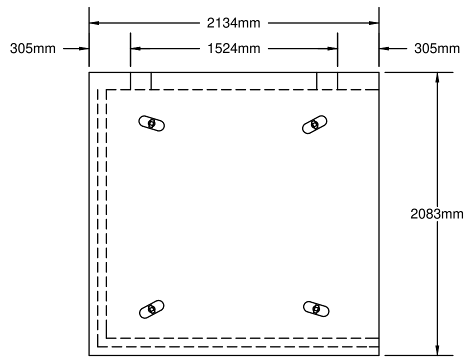

PLAN VIEW

TYPE V UNITS

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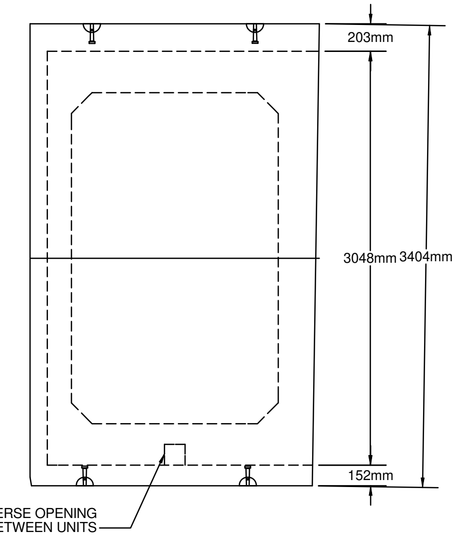

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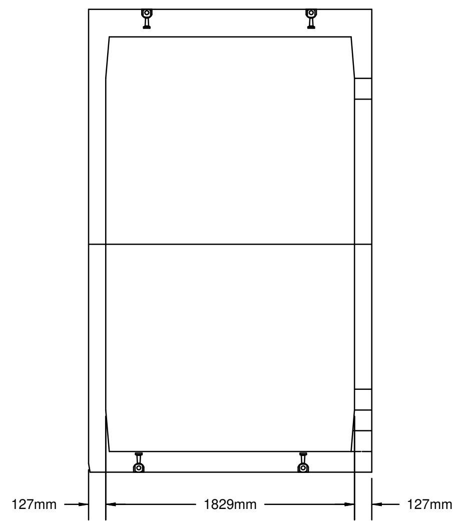

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STANDARD
3048 MM DOUBLETRAP
TYPE V

SHEET NUMBER:

08

STORMWATER MANAGEMENT REPORT
COSTCO – KANATA, CANADA
PROPOSED BIG BOX STORE

City of Ottawa

Prepared For:

Costco Wholesale
46000 Manekin Plaza
Sterling, Virgina
20166-6514

Submitted By:

R. V. Anderson Associates Limited
220 - 1750 Courtwood Crescent
Ottawa, Ontario
K2C 2B5

August 2004

RVA 5712

R.V. Anderson Associates Limited

1750 Courtwood Crescent Suite 220
Ottawa Ontario K2C 2B5 Canada
Tel (613) 226 1844 Fax (613) 226 8930
Web www.rvanderson.com

August 25, 2004

RVA 5712

Costco Wholesale
46000 Manekin Plaza
Sterling, VA
20166-6514

Attention: Jeffrey Ishida

Re: Costco Kanata

Attached is a copy of the storm water management report as submitted to the Ministry of the Environment of Ontario for the above noted project for your records.

Please note that three copies were sent directly to the City of Ottawa Infrastructure Approvals Branch to help speed up the approvals process. They will distribute the report to the Ministry of the Environment of Ontario.

If you have any questions on this please give me a call.

Yours very truly,

R. V. ANDERSON ASSOCIATES LIMITED

Gerald Bauer, P.Eng.
Project Manager

TABLE OF CONTENTS

1.0 INTRODUCTION

R.V. Anderson Associates Limited has been retained by Costco Wholesale to provide a General Plan of Services and Stormwater Management Report for the proposed wholesale commercial store, which is located in the City of Ottawa (former City of Kanata). This report will outline the proposed stormwater management measures and site services that will be implemented with the site to be in compliance with the City of Ottawa and Ministry of the Environment (MOE) requirements.

1.1 Site Location

The site is located at Silver Seven Road at Frank Nighbor Way in the City of Ottawa. Refer to Appendix A for the site location.

2.0 BACKGROUND

In discussions with City of Ottawa staff, the storm sewer and stormwater management requirements for the site were identified. The proposed development requires stormwater management for water quality since the site is located within the Carp River Watershed Area, as well as stormwater quantity control to an overall runoff coefficient of 0.20. The water quality treatment requirement is for Level 2 quality, which corresponds to 70% solids removal, also known as the MOE "Normal Protection" level. The MOE preferred requirement for wet ponds is 24-hour retention time for the 5-year storm event for solids removal, however a 12 hour retention time will be acceptable where minimum orifice conflicts are observed.

The site storm sewer will be discharged to the existing City storm sewer at the corner of Silver Seven Road and Frank Nighbor Way, which has been sized to accommodate the stormwater quantities that will discharge from the Costco site.

Part of the long term planning for the site was to have both it and the parcel of land south of it drain to the same outlet at the intersection of Silver Seven and Frank Nighbour Way. The development of the Costco site will land lock the parcel of land to the south. As such, a storm sewer is being built as part of this work in an easement to service the parcel. This will ensure that the other site will not be land locked when it develops at a future date. Appendix D shows the preliminary storm water calculations for the adjacent site (as done by Novatech Engineering). Appendix A also contains the legal plan by Annis O'Sullivan Vollebekk which shows the easements agreed upon by both land owners.

3.0 DESIGN CRITERIA

The following design criteria are proposed as a result of discussions with the City of Ottawa.

Peak Flow	-	5-year peak post-development flows controlled to a runoff coefficient of 0.2.
Calculated Method	-	Modified Rational Method using spreadsheet.
Storage Method	-	all storage for the site will be in a proposed stormwater pond. no rooftop storage will be used for proposed building. no significant surface ponding

Proposed Drainage	-	The proposed site storm sewer will be discharged to the existing 750mm diameter City storm sewer located under Frank Nighbor Way via the proposed 525mm diameter storm under Silver Seven Road
Coefficients of Runoff	-	Roof: C=0.95 Asphalt: C=0.90 Grass: C=0.20
Rainfall Intensities	-	City of Ottawa IDF rainfall curve for 5 and 100-year storms to generate the intensity formula as follows (See Appendix B for Storm Hyetographs):
Normal Water Quality	-	70% TSS

$$i_{5yr} = \frac{879}{T^{0.77} + 2.8} \quad \text{--equation (1)}$$

$$i_{100yr} = \frac{1562.1}{(T + 6)^{0.807}} \quad \text{--equation (2)}$$

where:
i – Rainfall intensity (mm/hr)
T – Time (min)

4.0 STORMWATER MANAGEMENT APPROACH

The stormwater management approach best suited to the site to achieve the overall runoff coefficient of 0.20 is based on the volume of storage required and the proposed site configuration, however it will be shown in this report that the water quality requirements will over rule the water quantity requirements. The bulk of the stormwater volume will be held in the stormwater pond north of the building.

For the purposes of this report, we have used a modified rational method approach. This method was selected considering the relatively small size of individual drainage areas for the site.

This approach involves considering the five-year storm as a three-hour storm event analyzed in five-minute time intervals. The rainfall intensity for each five-minute interval is calculated using RAIN, a program generally accepted in the industry. The RAIN program uses the City of Ottawa's rainfall curves to calculate the 3-hour rainfall Hyetograph and the accumulated rainfall. For the RAIN program outputs see Appendix B for the five-year and one hundred year storm events.

For each five-minute interval, an associated flow is calculated in a spreadsheet using the rational method:

$$Q = \frac{CIA}{3600} \quad \text{--equation (3)}$$

where:
Q = Flow (l/s)
C = Runoff Coefficient
I = Rainfall Intensity (mm/hr)
A = Area (m^2)

The flow contributing to storage is the post-development flow minus the allowable discharge rate. The quantity of storage is calculated by multiplying the flow contributing to storage by the five-minute time interval. The accumulated storage is summed for each five-minute time interval to determine the peak storage required.

The release rate of stormwater from the pond can be controlled by the provision of an Inlet Control Device (ICD), also known as an orifice plate, in the outlet of the downstream maintenance hole.

The orifice is selected to permit a peak post-development release rate that meets the City's allowable discharge rate. The orifice is sized according to the equation:

$$Q = C_d A (2gh)^{1/2}$$

Where,

C_d = 0.61 for a square edged orifice
h = head of water (m)
A = required orifice area (m^2)
g = 9.81 (m/s^2)

5.0 CALCULATIONS

Drawing SS-1 (Appendix A) shows the proposed building and site layout. The total area of the site is 62,182m^2. The following table identifies the breakdown by surface type for the site:

TABLE 1 POST DEVELOPMENT SURFACE DRAINAGE AREAS

SURFACE TYPE	Coefficient	AREA (m^2)
Asphalt	0.90	30476
Roof	0.95	11859
Storm Water Pond	0.00	2842
Landscaping or natural	0.20	17005
	Total	**62,182**

The following paragraph will outline the allowable runoff for quantity purposes, which will be overruled by the MOE requirements for quality, as outlined in further sections.

The allowable peak discharge rate for quantity for this site is equal to the 5-year peak development flow controlled to a runoff coefficient of 0.2 at a time of concentration of 20 minutes. Therefore the allowable peak discharge rate as per City of Ottawa's requirements from the site is:

Q_{ALL} = 0.20 x 68.45mm/hr x 62,182m^2 / 3600
Q_{ALL} = 236.5 l/s

5.1 Rooftop

The total area of the proposed rooftop is 11859m^2. The overall runoff coefficient for a roof surface is 0.95. Costco requirements do not allow rooftop storage therefore the roof will be allowed to drain uncontrolled thought roof drains and downspouts to the storm water pond.

Q_{Roof} = 0.95 x 68.45mm/hr x 11859m^2 / 3600
Q_{Roof} = 214.2 l/s

5.2 Asphalt and Landscaping

The total surface area of the site is 47481m^2, consisting of 30476m^2 of paved surface, and 17005m^2 of landscaped surface or natural vegetation. Drainage to the pond will be from catch basins located in the asphalt parking areas, and roof drains from the building, connected to the inlet of the pond. The water will be conveyed to the pond via an underground storm sewer system. The following table illustrates the ability of the main "trunk" storm sewer to convey the 5 year storm to the pond as calculated using the rational method in 20 minute increments:

TABLE 2 STORM SEWER CAPACITIES

FROM CBMH	TO CBMH	AREA (m^2)	CUMULATIVE FLOW (L/s)	CAPACITY (L/s)
#9	#8	8530	138.89	173.76
#8	#6	4075	201.84	283.76
#6	#5	15 050	438.16	443.80
#5	#4	3890	489.75	496.20
#4	#3	2020	515.27	516.40

Appendix E shows the calculations that this table is derived from.

5.3 STORM SEWER and STORMWATER MANAGEMENT

5.3.1 Stormwater Pond

The stormwater management approach best suited to the Costco Kanata site is site drainage to a stormwater pond sized to achieve both quantity and quality control, thereby meeting the City requirements; the site layout has the pond located at the northwest corner of the site. The outlet from the pond will use an Inlet Control Device (ICD) to achieve the peak flow allowable to restrict the runoff from the site. This runoff will be restricted to the lesser of either the City of Ottawa's design coefficient of 0.2 as described in section 5.3.2, or the MOE's requirement of 12 hour detention as described in section 5.3.3.

For the calculation of pond sizing in terms of stormwater quality, the MOE Stormwater Management Planning and Design Manual (March 2003) was used as a guideline.

5.3.2 Quantity Control

The total disturbed area of the site is 62182m^2, consisting of 11859m^2 of rooftop surface, 17005m^2 of grassed and similar surface, 30476m^2 of asphalt and similar surface and the stormwater pond sized at 2842, resulting in an overall runoff coefficient of:

$$c_{avg.} = [0.95(11859) + 0.20(17005) + 0.90(30476)] / 62182 = 0.67$$

Using the 5-year intensity with a time of concentration of 20 minutes, the proposed discharge will be limited to achieve an average runoff coefficient of 0.20 as per the City's requirements:

$Q_{Allowable}$ = 0.20 x 68.45mm/hr x 62182m^2 / 3600
$Q_{Allowable}$ = 236.46 l/s

This flow meets the City of Ottawa requirements for quantity; however, this flow is too large for the MOE requirement of 24-hour detention. As such, the Quality Control outlined in the following section will govern the discharge rate and the storage requirements that result from the discharge rate.

5.3.3 Quality Control

To achieve the total suspended solids removal required, Table 3.2 of the MOE manual indicates that the storage volume required for a wet pond for a site impervious level of 72% is 133 m^3/ha. Based on the total site area of 62182 m^2 (6.21 ha), the required pond volume is:

$Volume_{pond}$ = 133 m^3/ha * 6.21 ha = 826 m^3

Within the wet pond, the MOE manual recommends that the active storage volume comprises at least 40m^3/ha, with the remaining volume as the permanent pool.

Active Storage = 40 m^3/ha * 6.21 ha = 248 m^3
Permanent Pool = 826 – 248 = 578 m^3

This 826m^2 of storage will serve to meet the minimum required pond storage requirements for TSS removal; however, the MOE requires the 5-year storm to be held for a minimum of 12 hours.

Table 4.6 of the MOE guidelines suggest a minimum orifice size of 75mm, and for this site, an orifice of 100mm diameter has been selected, which is the preferred MOE criteria.

The discharge rate using a 100mm diameter orifice is calculated according to the following equation:

$$Q = C_dA \times (2gh)^{1/2}$$

where;
C_d = 0.61 for a square edge orifice
h = head of water (m)
A = required orifice area (m^2)

The following table identifies the characteristics of the proposed orifice to be used in order to attain the storage volumes outlined above. The orifice will be IPEX PVC ICD.

TABLE 3 CHARACTERISTICS OF PROPOSED ORIFICE							
STRUCTURE	INVERT (m)	MAXIMUM WATER LEVEL* (m)	PIPE SIZE (mm)	Q_{all} (L/s)	H (m)	A (m^2)	d (mm)
CBMH #1	93.82	95.16	525	24.56	1.34	.0079	100

* 5-Year Ponding Level.

This indicates that a plate having a round 100mm diameter orifice at the outlet of the 525mm diameter storm sewer will control the flow to 24.56 L/s as required given the constraints of the site. Though this flow will not retain the water for 24 hours, it will discharge from the pond over approximately 21 hours. Given this discharge rate, water will flow across the pool at a velocity of 0.001m/s over the 21 hours during a 5-year storm event, allowing settlement to occur.

Using this allowable discharge for the site, the resulting storage volume was computed, and Appendix C provides the volume output for the site drainage. The volume of storage required for the 5-year storm with 21-hour detention is 1663 m^3. This volume means a water height of 1.83m from the bottom, as outlined below and in section 5.3.4.

Therefore the design of the pond will accommodate a permanent pool of 578m^3 of storm water for quality measures, with active storage reaching 826m^3, and a 21-hour detention of 1663m^3 for the 5-year storm event. The following table outlines these critical depths and corresponding pond depths, as calculated using Land Development software, and confirmed using Microsoft Excel:

TABLE 4: VOLUME TO DEPTH RELATIONSHIPS			
VOLUME (m^3)	DEPTH (m)	ELEVATION (m)	REASON
590	1.0	94.46	Mean depth for permanent pool which meets minimum requirements of 578m^3
830	1.2	94.66	Meets the active storage depth requirement of 826m^3
1672	1.7	95.16	Meets the requirements for 21h detention of the 5 year storm of 1650m^3

Other factors will also aid in removal of solids prior to releasing the effluent into the City's sewer system. All of the catch basins and catch basin manholes on the site will have a sump, which will increase retention. As well, all of the pipes have been designed to have minimal slopes, which reduces the velocity, thereby aiding in removal. A gabion basket wall will be installed in the pond to the height of the permanent water level in order to further remove solids, and increase detention time in the pond. This wall will also serve to create a forebay area at the pond inlet.

The proposed grading for the site is designed in such a way that the 100-year storm event will be handled by overland flow routes (see drawing SG-1 in Appendix A). Water will be routed overland directly onto Silver Seven Drive, as per the overall land use plan by Novatech. The maximum ponding in the drainage basins will be 250mm. During the 100-year event, water will also escape the pond via overland flow towards the Silver Seven extension as shown on drawing SG-1.

5.3.4 Pond Layout

To achieve the volumes necessary for quantity and quality control, the approximate surface area required is approximately equivalent to a rectangle, which is 60m x 25m, with a small forebay area, separated by a gabion basket wall. The bottom elevation of the pond would be at approximately 93.46m in order to provide drainage throughout the site and conveyance through the site storm sewer system. The approximate elevation of the entranceway to the loading dock will be 97.73m, and approximately 99.0m along the north edge adjacent to Highway 417, therefore terracing will be necessary to accommodate the grade change between the pond and surrounding areas.

The permanent pool depth of the pond will be 1.0m, increasing to a depth of 1.7m for 21-hour detention of the 5 year storm event. The depths are based on a typical pond cross-section, with pond side slopes of 5:1 horizontal to vertical from the bottom to 3 meters beyond the permanent pool depth, to 3:1 from that point to match existing levels. Figure SG-1 in Appendix A shows a detail of the pond including the terracing which will be installed in order to meet the existing grades while avoiding encroachment onto the water main easement and the MTO setback.

The geotechnical report done by Jacques Whitford dated April 26, 2004 outlines some design requirements for the pond. The report states that the measured ground water level at the pond is 94.3m. This is at the same level as the permanent pool depth (94.26m), however because this measured water level was taken in the spring, it can be expected that the water level will drop during drier times of the year. As such, a synthetic pond lining system will be installed. The lining will be PVC, and will be buried under enough cover to meet the manufacturer's UV protection requirements, and to allow for vegetation. The lining must be provide a 100% seal.

6.0 EROSION AND SEDIMENT CONTROL

Erosion and sediment control measures (in accordance with the requirements of OPSS 577 – February 1996) consisting of both permanent and temporary measures shall be implemented prior to the commencement of construction activities to ensure that sediment is contained within the site. Permanent erosion control measures shall ensure that potential long-term and localized erosion problems are dealt with prior to their occurrence.

6.1 Temporary Sediment Control Measures

Filter fabric shall be installed under the frame of all proposed and existing catchbasins and storm manholes immediately adjacent to any disturbed areas prior to construction to prevent sediment from entering into the storm sewer system. The filter fabric shall remain in-place for the duration of construction activities and shall not be removed until such time as the landscaping has been established, and upon authorization by the Engineer.

7.0 CONCLUSION

The design of the stormwater management system serves to control the 5-year peak post-development flows for 21-hour detention. This on site storage is provided in a stormwater pond to control both quantity and quality. It will be the owners' responsibility to maintain the pond, the catch basins, maintenance holes, sewer pipes and inlet-control device in good working condition. There is no storage on the roof or in the parking lot.

We trust this stormwater management report complies with the City of Ottawa and Ministry of the Environment requirements and we look forward to receiving your approvals.

APPENDIX B

STORM HYETOGRAPHS

FIVE YEAR STORM - CITY OF OTTAWA

STORM HYETOGRAPH

A = 696 B = 4.0 C = 0.7295 R = 0.39

TIME (min)	INTENS. (mm/hr)	ACCUM. DEPTH (mm)	TIME (min)	INTENS (mm/hr)	ACCUM. DEPTH (mm)	TIME (min)	INTENS. (mm/hr)	ACCUM. DEPTH (mm)
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.08	4.7	0.4	0.00	0.0	0.0	0.00	0.0	0.0
0.17	5.0	0.8	0.00	0.0	0.0	0.00	0.0	0.0
0.25	5.4	1.3	0.00	0.0	0.0	0.00	0.0	0.0
0.33	5.8	1.8	0.00	0.0	0.0	0.00	0.0	0.0
0.42	6.3	2.3	0.00	0.0	0.0	0.00	0.0	0.0
0.50	7.0	2.9	0.00	0.0	0.0	0.00	0.0	0.0
0.58	7.8	3.5	0.00	0.0	0.0	0.00	0.0	0.0
0.67	8.8	4.2	0.00	0.0	0.0	0.00	0.0	0.0
0.75	10.2	5.1	0.00	0.0	0.0	0.00	0.0	0.0
0.83	12.4	6.1	0.00	0.0	0.0	0.00	0.0	0.0
0.92	15.9	7.5	0.00	0.0	0.0	0.00	0.0	0.0
1.00	23.2	9.4	0.00	0.0	0.0	0.00	0.0	0.0
1.08	47.4	13.3	0.00	0.0	0.0	0.00	0.0	0.0
1.17	140.1	25.0	0.00	0.0	0.0	0.00	0.0	0.0
1.25	55.2	29.6	0.00	0.0	0.0	0.00	0.0	0.0
1.33	30.9	32.2	0.00	0.0	0.0	0.00	0.0	0.0
1.42	21.9	34.0	0.00	0.0	0.0	0.00	0.0	0.0
1.50	17.2	35.5	0.00	0.0	0.0	0.00	0.0	0.0
1.58	14.3	36.6	0.00	0.0	0.0	0.00	0.0	0.0
1.67	12.3	37.7	0.00	0.0	0.0	0.00	0.0	0.0
1.75	10.9	38.6	0.00	0.0	0.0	0.00	0.0	0.0
1.83	9.7	39.4	0.00	0.0	0.0	0.00	0.0	0.0
1.92	8.9	40.1	0.00	0.0	0.0	0.00	0.0	0.0
2.00	8.2	40.8	0.00	0.0	0.0	0.00	0.0	0.0
2.08	7.6	41.4	0.00	0.0	0.0	0.00	0.0	0.0
2.17	7.1	42.0	0.00	0.0	0.0	0.00	0.0	0.0
2.25	6.6	42.6	0.00	0.0	0.0	0.00	0.0	0.0
2.33	6.3	43.1	0.00	0.0	0.0	0.00	0.0	0.0
2.42	5.9	43.6	0.00	0.0	0.0	0.00	0.0	0.0
2.50	5.6	44.1	0.00	0.0	0.0	0.00	0.0	0.0
2.58	5.4	44.5	0.00	0.0	0.0	0.00	0.0	0.0
2.67	5.2	44.9	0.00	0.0	0.0	0.00	0.0	0.0
2.75	4.9	45.4	0.00	0.0	0.0	0.00	0.0	0.0
2.83	4.8	45.8	0.00	0.0	0.0	0.00	0.0	0.0
2.92	4.6	46.1	0.00	0.0	0.0	0.00	0.0	0.0
3.00	0.0	46.1	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0

ONE HUNDRED YEAR STORM - CITY OF OTTAWA

STORM HYETOGRAPH

A = 1562 B = 6.0 C = 0.8070 R = 0.39

TIME (min)	INTENS. (mm/hr)	ACCUM. DEPTH (mm)	TIME (min)	INTENS (mm/hr)	ACCUM. DEPTH (mm)	TIME (min)	INTENS. (mm/hr)	ACCUM. DEPTH (mm)
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.08	5.4	0.5	0.00	0.0	0.0	0.00	0.0	0.0
0.17	5.9	0.9	0.00	0.0	0.0	0.00	0.0	0.0
0.25	6.4	1.5	0.00	0.0	0.0	0.00	0.0	0.0
0.33	6.9	2.1	0.00	0.0	0.0	0.00	0.0	0.0
0.42	7.7	2.7	0.00	0.0	0.0	0.00	0.0	0.0
0.50	8.6	3.4	0.00	0.0	0.0	0.00	0.0	0.0
0.58	9.7	4.2	0.00	0.0	0.0	0.00	0.0	0.0
0.67	11.3	5.2	0.00	0.0	0.0	0.00	0.0	0.0
0.75	13.6	6.3	0.00	0.0	0.0	0.00	0.0	0.0
0.83	17.1	7.7	0.00	0.0	0.0	0.00	0.0	0.0
0.92	23.2	9.6	0.00	0.0	0.0	0.00	0.0	0.0
1.00	36.1	12.7	0.00	0.0	0.0	0.00	0.0	0.0
1.08	80.1	19.3	0.00	0.0	0.0	0.00	0.0	0.0
1.17	225.6	38.1	0.00	0.0	0.0	0.00	0.0	0.0
1.25	94.1	46.0	0.00	0.0	0.0	0.00	0.0	0.0
1.33	50.2	50.2	0.00	0.0	0.0	0.00	0.0	0.0
1.42	33.8	53.0	0.00	0.0	0.0	0.00	0.0	0.0
1.50	25.4	55.1	0.00	0.0	0.0	0.00	0.0	0.0
1.58	20.3	56.8	0.00	0.0	0.0	0.00	0.0	0.0
1.67	17.0	58.2	0.00	0.0	0.0	0.00	0.0	0.0
1.75	14.6	59.4	0.00	0.0	0.0	0.00	0.0	0.0
1.83	12.8	60.5	0.00	0.0	0.0	0.00	0.0	0.0
1.92	11.4	61.4	0.00	0.0	0.0	0.00	0.0	0.0
2.00	10.3	62.3	0.00	0.0	0.0	0.00	0.0	0.0
2.08	9.5	63.1	0.00	0.0	0.0	0.00	0.0	0.0
2.17	8.7	63.8	0.00	0.0	0.0	0.00	0.0	0.0
2.25	8.1	64.5	0.00	0.0	0.0	0.00	0.0	0.0
2.33	7.6	65.1	0.00	0.0	0.0	0.00	0.0	0.0
2.42	7.1	65.7	0.00	0.0	0.0	0.00	0.0	0.0
2.50	6.7	66.3	0.00	0.0	0.0	0.00	0.0	0.0
2.58	6.3	66.8	0.00	0.0	0.0	0.00	0.0	0.0
2.67	6.0	67.3	0.00	0.0	0.0	0.00	0.0	0.0
2.75	5.7	67.8	0.00	0.0	0.0	0.00	0.0	0.0
2.83	5.5	68.2	0.00	0.0	0.0	0.00	0.0	0.0
2.92	5.2	68.6	0.00	0.0	0.0	0.00	0.0	0.0
3.00	0.0	68.6	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0
0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0

APPENDIX C

STORM EVENTS – STORAGE VOLUMES

Costco Kanata
5yr Storm Post-Development Flow

Proposed Surface

5 yr Peak Allow. Discharge (based on 20 minute time of concentration)	24.56 L/s

Elapsed time (min)	(s)	Intensity (mm/hr)	(mm/s)	Acc Depth (mm)	C	Area (m^2)	Flow (l/s)	Discharge (l/s)	Storage flow (l/s)	Storage volume (m^3)	Accumulated storage (m^3)	
0	0	0.00	0.0000	0.00	0.67	62182	0.00	0.00	0.00	0.00	0.00	
5	300	4.70	0.0013	0.39	0.67	62182	54.39	24.56	29.83	8.95	8.95	
10	600	5.00	0.0014	0.81	0.67	62182	57.86	24.56	33.30	9.99	18.94	
15	900	5.40	0.0015	1.26	0.67	62182	62.49	24.56	37.93	11.38	30.32	
20	1200	5.80	0.0016	1.74	0.67	62182	67.12	24.56	42.56	12.77	43.09	
25	1500	6.30	0.0018	2.27	0.67	62182	72.91	24.56	48.35	14.50	57.59	
30	1800	7.00	0.0019	2.85	0.67	62182	81.01	24.56	56.45	16.93	74.53	
35	2100	7.80	0.0022	3.50	0.67	62182	90.27	24.56	65.71	19.71	94.24	
40	2400	8.80	0.0024	4.23	0.67	62182	101.84	24.56	77.28	23.18	117.42	
45	2700	10.20	0.0028	5.08	0.67	62182	118.04	24.56	93.48	28.04	145.47	
50	3000	12.40	0.0034	6.12	0.67	62182	143.50	24.56	118.94	35.68	181.15	
55	3300	15.90	0.0044	7.44	0.67	62182	184.01	24.56	159.45	47.83	228.99	
60	3600	23.20	0.0064	9.38	0.67	62182	268.49	24.56	243.93	73.18	302.16	
65	3900	47.40	0.0132	13.33	0.67	62182	548.55	24.56	523.99	157.20	459.36	
70	4200	140.10	0.0389	25.00	0.67	62182	1621.34	24.56	1596.78	479.04	938.40	
75	4500	55.20	0.0153	29.60	0.67	62182	638.82	24.56	614.26	184.28	1122.67	
80	4800	30.90	0.0086	32.18	0.67	62182	357.60	24.56	333.04	99.91	1222.58	
85	5100	21.90	0.0061	34.00	0.67	62182	253.44	24.56	228.88	68.67	1291.25	
90	5400	17.20	0.0048	35.43	0.67	62182	199.05	24.56	174.49	52.35	1343.60	
95	5700	14.30	0.0040	36.63	0.67	62182	165.49	24.56	140.93	42.28	1385.88	
100	6000	12.30	0.0034	37.65	0.67	62182	142.34	24.56	117.78	35.34	1421.21	
105	6300	10.90	0.0030	38.56	0.67	62182	126.14	24.56	101.58	30.47	1451.69	
110	6600	9.70	0.0027	39.37	0.67	62182	112.26	24.56	87.70	26.31	1478.00	
115	6900	8.90	0.0025	40.11	0.67	62182	103.00	24.56	78.44	23.53	1501.53	
120	7200	8.20	0.0023	40.79	0.67	62182	94.90	24.56	70.34	21.10	1522.63	
125	7500	7.60	0.0021	41.43	0.67	62182	87.95	24.56	63.39	19.02	1541.65	
130	7800	7.10	0.0020	42.02	0.67	62182	82.17	24.56	57.61	17.28	1558.93	
135	8100	6.60	0.0018	42.57	0.67	62182	76.38	24.56	51.82	15.55	1574.47	
140	8400	6.30	0.0018	43.09	0.67	62182	72.91	24.56	48.35	14.50	1588.98	
145	8700	5.90	0.0016	43.58	0.67	62182	68.28	24.56	43.72	13.12	1602.09	
150	9000	5.60	0.0016	44.05	0.67	62182	64.81	24.56	40.25	12.07	1614.17	
155	9300	5.40	0.0015	44.50	0.67	62182	62.49	24.56	37.93	11.38	1625.55	
160	9600	5.20	0.0014	44.93	0.67	62182	60.18	24.56	35.62	10.69	1636.23	
165	9900	4.90	0.0014	45.34	0.67	62182	56.71	24.56	32.15	9.64	1645.88	
170	10200	4.80	0.0013	45.74	0.67	62182	55.55	24.56	30.99	9.30	1655.17	
175	10500	4.60	0.0013	46.13	0.67	62182	53.23	24.56	28.67	8.60	1663.78	-peak storage
180	10800	0.00	0.0000	46.13	0.67	62182	0.00	24.56	-24.56	-7.37	1656.41	

Costco Kanata
100 yr Storm Post-Development Flow

Proposed Surface

100 yr Peak Allow. Discharge	25.73 L/s
(based on 20 minute time of concentration)	

Elapsed time (min)	(s)	Intensity (mm/hr)	(mm/s)	Acc Depth (mm)	C	Area (m^2)	Flow (l/s)	Discharge (l/s)	Storage flow (l/s)	Storage volume (m^3)	Accumulated storage (m^3)	
0	0	0.00	0.0000	0.00	0.67	62182	0.00	0.00	0.00	0.00	0.00	
5	300	5.40	0.0015	0.45	0.67	62182	62.49	25.73	36.76	11.03	11.03	
10	600	5.90	0.0016	0.94	0.67	62182	68.28	25.73	42.55	12.76	23.79	
15	900	6.40	0.0018	1.48	0.67	62182	74.07	25.73	48.34	14.50	38.29	
20	1200	6.90	0.0019	2.05	0.67	62182	79.85	25.73	54.12	16.24	54.53	
25	1500	7.70	0.0021	2.69	0.67	62182	89.11	25.73	63.38	19.01	73.55	
30	1800	8.60	0.0024	3.41	0.67	62182	99.53	25.73	73.80	22.14	95.68	
35	2100	9.70	0.0027	4.22	0.67	62182	112.26	25.73	86.53	25.96	121.64	
40	2400	11.30	0.0031	5.16	0.67	62182	130.77	25.73	105.04	31.51	153.15	
45	2700	13.60	0.0038	6.29	0.67	62182	157.39	25.73	131.66	39.50	192.65	
50	3000	17.10	0.0048	7.72	0.67	62182	197.89	25.73	172.16	51.65	244.30	
55	3300	23.20	0.0064	9.65	0.67	62182	268.49	25.73	242.76	72.83	317.13	
60	3600	36.10	0.0100	12.66	0.67	62182	417.78	25.73	392.05	117.61	434.74	
65	3900	80.10	0.0223	19.33	0.67	62182	926.98	25.73	901.25	270.37	705.12	
70	4200	225.60	0.0627	38.13	0.67	62182	2610.81	25.73	2585.08	775.53	1480.64	
75	4500	94.10	0.0261	45.98	0.67	62182	1089.00	25.73	1063.27	318.98	1799.62	
80	4800	50.20	0.0139	50.16	0.67	62182	580.95	25.73	555.22	166.57	1966.19	
85	5100	33.80	0.0094	52.98	0.67	62182	391.16	25.73	365.43	109.63	2075.82	
90	5400	25.40	0.0071	55.09	0.67	62182	293.95	25.73	268.22	80.47	2156.28	
95	5700	20.30	0.0056	56.78	0.67	62182	234.93	25.73	209.20	62.76	2219.04	
100	6000	17.00	0.0047	58.20	0.67	62182	196.74	25.73	171.01	51.30	2270.34	
105	6300	14.60	0.0041	59.42	0.67	62182	168.96	25.73	143.23	42.97	2313.31	
110	6600	12.80	0.0036	60.48	0.67	62182	148.13	25.73	122.40	36.72	2350.04	
115	6900	11.40	0.0032	61.43	0.67	62182	131.93	25.73	106.20	31.86	2381.89	
120	7200	10.30	0.0029	62.29	0.67	62182	119.20	25.73	93.47	28.04	2409.94	
125	7500	9.50	0.0026	63.08	0.67	62182	109.94	25.73	84.21	25.26	2435.20	
130	7800	8.70	0.0024	63.81	0.67	62182	100.68	25.73	74.95	22.49	2457.68	
135	8100	8.10	0.0023	64.48	0.67	62182	93.74	25.73	68.01	20.40	2478.09	
140	8400	7.60	0.0021	65.12	0.67	62182	87.95	25.73	62.22	18.67	2496.75	
145	8700	7.10	0.0020	65.71	0.67	62182	82.17	25.73	56.44	16.93	2513.69	
150	9000	6.70	0.0019	66.27	0.67	62182	77.54	25.73	51.81	15.54	2529.23	
155	9300	6.30	0.0018	66.79	0.67	62182	72.91	25.73	47.18	14.15	2543.38	
160	9600	6.00	0.0017	67.29	0.67	62182	69.44	25.73	43.71	13.11	2556.49	
165	9900	5.70	0.0016	67.77	0.67	62182	65.96	25.73	40.23	12.07	2568.56	
170	10200	5.50	0.0015	68.23	0.67	62182	63.65	25.73	37.92	11.38	2579.94	
175	10500	5.20	0.0014	68.66	0.67	62182	60.18	25.73	34.45	10.33	2590.27	-peak storage
180	10800	0.00	0.0000	68.66	0.67	62182	0.00	25.73	-25.73	-7.72	2582.56	

APPENDIX D

CALCULATIONS FOR ADJACENT SITE

Natasha Baird

From: Scott MacKichan [s.mackichan@novatech-eng.com]
Sent: Tuesday, June 15, 2004 8:53 AM
To: tkealey@rvanderson.com
Cc: John Riddell
Subject: RE: Costco Kanata

Trevor

The time of concentration for the entire site was determined using the Airport Formula as follows:

$t_c = 3.26\ [(1.1 - C)\ L^{.5} / s^{0.33}]$ = 33.0 minutes

Where s = slope = 100 * (111-97.25)/321 = 4.28 %
C = run off coefficient = 0.2
L = total flow distance = 321 m

Determining rainfall intensity, $i = 879/(t_c^{0.77} + 2.8)$ = 50.04 mm/hr (Ottawa IDF)

Total flow from the site is:

$Q = 2.78\ CiA$ Where C = 0.2, i = 50.0 mm/hr, A = 10 ha

Q = 278 L/s or 27.8 L/s/ha

Site Area = 4.36ha (including widening)

Therefore Allowable Release = 121.20 L/s

Storm Sewer extension to Penreal site = 450mm dia @ 0.30% based on following Calculation

Manning Pipe Calculator
Given Input Data:
- Shape ..... Circular
- Solving for ..... Flowrate
- Diameter ..... 457.000 mm
- Depth ..... 457.000 mm
- Slope ..... 0.002 m/m
- Manning's n 0.0130

Computed Results:
- Flowrate ..... 132.868 lps
- Area 0.164 m2
- Wetted Area 0.164 m2
- Wetted Perimeter ..... 1435.708 mm
- Perimeter ..... 1435.708 mm
- Velocity ..... 0.810 mps
- Hydraulic Radius ..... 114.250 mm
- Percent Full ..... 100.000 %
- Full flow Flowrate ..... 132.868 lps
- Full flow velocity ..... 0.810 mps

Further to our discussions we understand that the legal agreement between Penreal and Costco has made provision for a stc sewer easement across the Costco property in favour of Penreal.

Scott MacKichan, P.Eng.
Project Manager
Novatech Engineering Consultants Ltd.

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-----Original Message-----
From: tkealey@rvanderson.com [mailto:tkealey@rvanderson.com]
Sent: Wednesday, June 09, 2004 3:20 PM
To: s.mackichan@novatech-eng.com
Subject: Costco Kanata

Hello Scott,

As part of our site plan application (specifically the storm water management) we have been asked to show how the Penreal site is able to outlet its storm water to the appropriate manhole at Frank Nighbour Way. We have shown them t plan to route the storm sewer along Silver Seven as given by Novatech which will be constructed as part of Costco's construction.

However, to ensure all requirements are being met, Troy Dunlop would like to see as part of our SWM report, a brief summary of the design numbers for the sewer coming from Penreal's site, such as the discharge rate/flow. Would you b able to send me a brief table outlining these numbers so we can include them in an appendix in our report?

Another item of interest to Troy Dunlop is a letter from the landowner stating that they are aware of the impositions being put on the site due to Costco, and that they are satisfied with the arrangement of having the storm sewer easement throu Costco's property, and that this will allow them to meet the future storm water management restrictions for the site. Can you let me know who I should contact at Penreal for this, or pass this request to that person I would appreciate it.

I will call you tomorrow to discuss these issues.

Regards,
Trevor Kealey, B. Eng.
Project Coordinator
R. V. Anderson Associates Limited
Email: tkealey@rvanderson.com
Tel: (613) 226-1844
Fax: (613) 226-8930

APPENDIX E

STORM SEWER CAPACITY CALCULATIONS

RATIONAL METHOD CALCULATIONS

Pipe	From	To	Incrememnt of Area	Total Area	Coefficient	A*c	Sum A*c	Increment of Time (min)	Total Time
1	CBMH #9	CBMH #8	8530	8530	0.9	7677	7677	1.71	21.71
2	CBMH #8	CBMH #6	4075	12605	0.9	3668	11345	0.60	22.31
3	CBMH #6	CBMH #5	15050	27655	0.9	13545	24890	0.39	22.70
4	CBMH #5	CBMH #4	3890	31545	0.9	3501	28391	0.76	23.46
5	CBMH #4	CBMH #3	2020	33565	0.9	1818	30209	0.43	23.89

Pipe	From	To	Rainfall Rate	Flow	Pipe Diameter	Grade %	Capacity	Velocity	Length
1	CBMH #9	CBMH #8	65.13	**138.89**	525	0.15	**173.76**	0.78	80.00
2	CBMH #8	CBMH #6	64.05	**201.84**	525	0.40	**283.76**	1.27	45.80
3	CBMH #6	CBMH #5	63.38	**438.16**	600	0.48	**443.8**	1.52	35.50
4	CBMH #5	CBMH #4	62.10	**489.75**	600	0.60	**496.2**	1.70	77.60
5	CBMH #4	CBMH #3	61.41	**515.27**	600	0.65	**516.4**	1.77	45.80