QUEENSWOOD UNITED CHURCH

360 KENNEDY LANE EAST
STORMWATER MANAGEMENT REPORT

NOVEMBER 30, 2021

360 KENNEDY LANE EAST

STORMWATER MANAGEMENT REPORT

QUEENSWOOD UNITED CURCH

1ST SUBMISSION

PROJECT NO.: 211-12127-00
CLIENT REF:
DATE: NOVEMBER 30, 2021

WSP
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REVISION HISTORY

FIRST ISSUE

November 30th, 2021	Draft SWM Report			
Prepared by	Reviewed by	Approved By		
MO	AJ	AJ		

SIGNATURES

PREPARED BY

November 30th, 2021

Meaghan O'Neill
Designer, Water Resources

APPROVED[1] BY

Ayham Jadallah, M.Eng., P.Eng.
Project Engineer, Water Resources

November 30th, 2021

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CONTRIBUTORS

CLIENT

Oueenswood United Church.

WSP

Water Resources, Designer	Meaghan O'Neill
Water Resources, Project Engineer	Ayham Jadallah

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FIGURES

APPENDICES

1 INTRODUCTION

1.1 SCOPE

WSP Canada Inc. was retained by Queenswood United Church to prepare a Stormwater Management (SWM) report for the proposed development at 360 Kennedy Lane in Ottawa, Ontario. This SWM report examines the potential water quality and quantity impacts of the proposed residential development and summarizes how each will be addressed in accordance with applicable guidelines.

1.2 SITE LOCATION

The site of the proposed development is located at 360 Kennedy Lane East, Ottawa, Ontario. The subject site is bounded by Queenwood United Church to the north, Queenwood Ridge Park to the east and south, and residential homes along Mountainside Crescent to the west. The site is accessed via Kennedy Lane East on the north-east end of the property. The site location is shown in Figure 1.

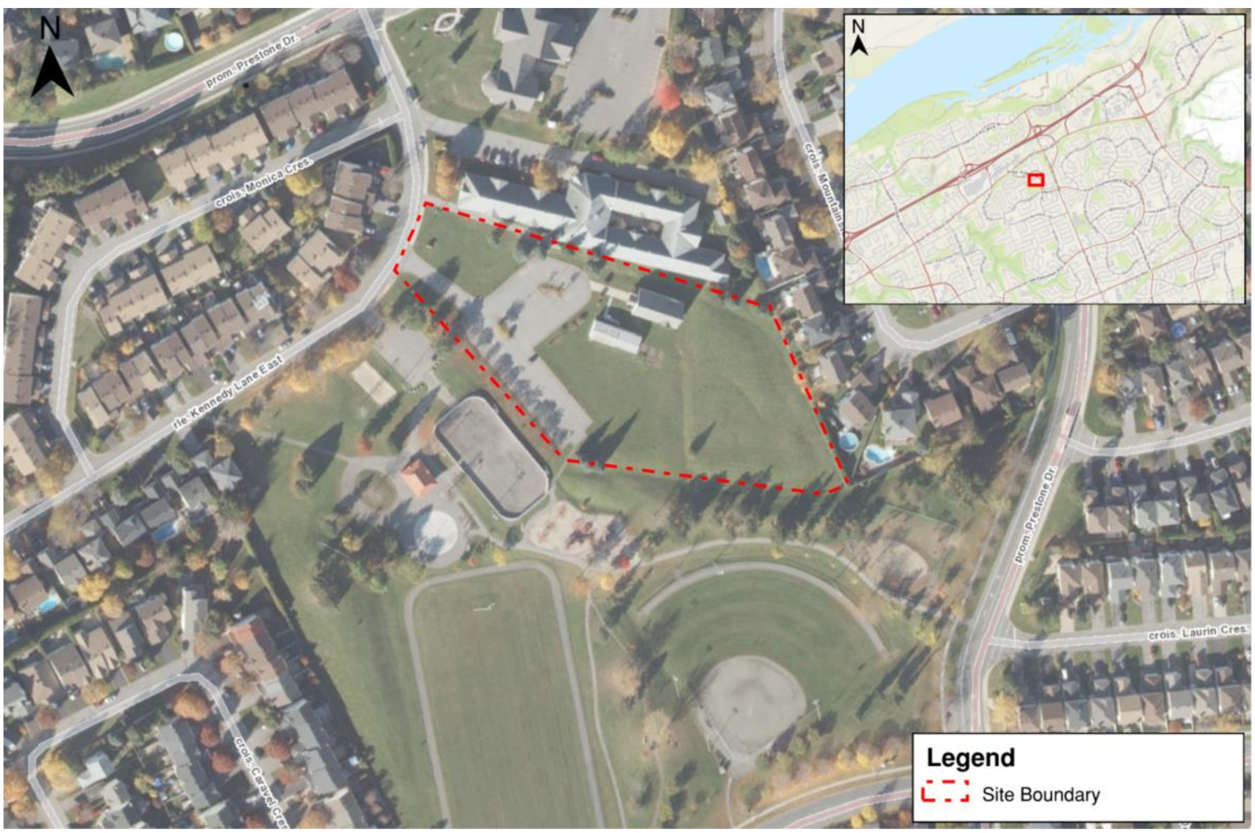


Figure 1: Site Location

1.3 STORMWATER MANAGEMENT PLAN OBJECTIVES

The objectives of the stormwater management plan are as follows:

- → Collect and review background information
- → Determine the site-specific stormwater management requirements to ensure that the proposals are in conformance with the applicable Provincial, Municipal and Conservation Authority stormwater management and development guidelines.
- → Evaluate various stormwater management practices that meet the applicable SWM and development requirements and recommend a preferred strategy.
- → Prepare a stormwater management report documenting the strategy along with the technical information necessary for the justification and sizing of the proposed stormwater management facilities.

1.4 DESIGN CRITERIA

Design criteria were obtained through the Site Plan Pre-Application Consultation Notes provided by the City of Ottawa on May 19th, 2021 (pre consultation notes in **Appendix A**). Criteria for 360 Kennedy Lane East are as follows:

- → **Stormwater Quantity-** control the 100-year post-development flows to the pre-development levels for the 5-year storm events. Allowable runoff coefficient (C) shall be the lesser of the pre-development conditions to a maximum of 0.5.
- → **Storm Quality-** enhanced level of protection per the Rideau Valley Conservation Authority (RVCA) is required (80% TSS Removal).

2 PRE-DEVELOPMENT CONDITIONS

2.1 GENERAL

The subject site is a 1.22 ha parcel of land comprised of primarily landscaped grass area, with an impervious paved parking area and two small building structures. Vehicular access to the site is via an entrance off of Kennedy Lane East. Existing drainage patterns for the site were determined using topographic survey information and arial imagery. Under pre-development conditions the entire 1.22 ha site ultimately discharges to the 900 mm concrete storm sewer on Kennedy Lane East. The pre-development imperviousness and runoff coefficient was determined using the PCSWMM area weighting tool. The existing conditions drainage area and runoff coefficient is summarized in Table 1, existing conditions drainage mosaic and land use figure are shown in Exhibit 1 and Exhibit 2 found in **Appendix B**.

Table 1: Existing Drainage Areas

AREA ID	AREA (HA)	IMPERVIOUS AREA (HA)	IMPERVIOUSNESS (%)	RUNOFF COEFFICENT
EX-001	1.22	0.34	28	0.37

2.2 RAINFALL INFORMATION

The rainfall intensity is calculated in accordance with Section 5.4.2 of the Ottawa Sewer Design Guidelines (October, 2012):

$$i = \left[\frac{A}{(Td + C)^B}\right]$$

Where;

- A, B, C = regression constants for each return period (defined in section 5.4.2)
- i = rainfall intensity (mm/hour)
- Td = storm duration (minutes)

The IDF parameters/regression constants are per the Ottawa Sewer Design Guidelines (October, 2012).

2.3 ALLOWABLE FLOW RATES

As noted in section 1.4, relevant policies from the OSDG for a re-development and the Site Plan Pre-Application Consultation notes require the 100-year post-development discharge rate from the site be controlled to the pre-development levels for the 5-year storm event, where pre-development conditions are analyzed using the lesser of the actual runoff coefficient and a runoff coefficient of 0.5. As previously discussed, under existing conditions the subject site has a runoff coefficient on 0.37 and therefore the actual runoff coefficient was used for existing conditions analysis.

PCSWMM was used to evaluate pre-development peak flow rates. Detailed model output can be found in **Appendix C**.

Table 2: Pre-Development Peak Flow Rate

AREA ID	PEAK FLOW RATE (m^3/s)					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
EX-001	0.08	0.12	0.16	0.22	0.26	0.31

3 POST-DEVELOPMENT CONDITIONS

3.1 GENERAL

The proposed Kennedy Lane E project is a residential development in Ottawa. Post development conditions drainage areas and runoff coefficients are shown in on Exhibit 3 in **Appendix B** and summarized in Table 3.

The proposed development includes the construction of 84 stacked residential units on the approximately 1.22 ha parcel of land. Vehicular access to the site will be via the one existing entrance off of Kennedy Lane E. Similar to existing conditions, all stormwater runoff will ultimately discharge via one outlet to the 900 mm concrete sewer on Kennedy Lane E.

An estimated area breakdown for the new layout is provided in Table 3.

Table 3: Area Breakdown

CATCHMENT ID	AREA (ha)	% COVERAGE OF PROJECT AREA	RUNOFF COEFFICIENT
Controlled Drainage Areas			
S-001	0.082	6.7%	0.83
S-002	0.047	3.8%	0.84
S-003	0.077	6.3%	0.72
S-004	0.036	2.9%	0.78
S-005	0.028	2.3%	0.70
S-006	0.062	5.1%	0.71
S-007	0.123	10.0%	0.66
S-008	0.126	10.3%	0.74
S-009	0.105	8.6%	0.77
S-010	0.114	9.3%	0.49
S-011	0.098	8.0%	0.53
S-012	0.051	4.2%	0.83
S-013	0.079	6.5%	0.84
S-014	0.113	9.2%	0.40
Un-Controlled Drainage Areas			
S-015	0.056	4.6%	0.40
S-016	0.006	0.5%	0.20
S-017	0.021	1.7%	0.83
TOTAL PROJECT AREA	1.22	100%	0.66

3.2 WATER QUANTITY

As noted previously, it is required that the 100-year post-development discharge rate from the site not exceed the 5-year pre-development level. As shown in Table 2, this means the 100-year post development flow must be controlled to 0.12 m^3/s or less.

Proposed features to achieve these targets include;

- → Surface storage with inlet control devices (ICDs) (HYDROVEX VHV or equivalent)
- → Stormtech (or equivalent) subsurface storage chambers with ICDs on outlets (HYDROVEX VHV or equivalent).

PCSWMM software was used to model the behaviour of the proposed SWM system. Storage areas were defined using storage nodes with the appropriate stage-storage relationships. Outflow controls from each storage node were defined using the appropriate Hydrovex VHV head-discharge curve at catchbasin lead pipes. Specified Hydrovex models are shown in Table 4.

Table 4: Catchbasin Outflow Control

LOCATION	ICD
CB01	150-VHV-2
CB04	200-VHV-2
CB06	75-VHV-1
Tank A	75-VHV-1
Tank B	75-VHV-1
Tank C	75-VHV-1
Tank D	75-VHV-1
Tank F	75-VHV-1
Tank G	75-VHV-1

A summary of modeling results is provided in Table 5 and detailed modelling output is included in **Appendix C**.

Table 5: Summary of PCSWMM Modelling Results

	RETURN PERIOD					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Peak Discharge Rate (m^3/s)	0.044	0.067	0.081	0.097	0.11	0.12
Storage Utilized in Tank A (m^3)	12.90	18.72	22.64	27.73	31.67	35.76
Storage Utilized in Tank B (m^3)	9.71	14.72	18.13	22.69	26.21	29.81
Storage Utilized in Tank C (m^3)	35.34	52.71	65.69	83.17	96.63	110.60
Storage Utilized in Tank D (m^3)	16.61*	24.21*	29.37*	36.23*	41.50*	43.69*
Storage Utilized in Tank F (m^3)	42.78	62.69	76.24	94.23	108	122.20
Storage Utilized in Tank G (m^3)	15.95	23.72	29.00	35.98	41.34	46.87

**Includes surface storage* – maximum underground storage 42 m^3

To avoid risk of flooding to the proposed homes, surface ponding has only been proposed where sufficient freeboard is provided between the 100-year ponding elevation and the finish floor elevation of surrounding homes, all other storage will be provided via underground storage as summarized in Table 5. To determine peak surface ponding depths at catchbasin locations, reference has been made to model output at each respective storage node where surface storage is utilized. Ponding depths have been simulated in the model by routing runoff from the contributing sub-catchment area to a storage node defined with a stage-storage relationship describing the ponding volume available on the surface (based on proposed grading), and with outflow controlled by a stage-discharge rating curve based on a standard 600 mm square CB grate (per City of Ottawa standards) with a Hydrovex VHV ICD on the CB lead.

As shown in Table 6, the model results provide maximum ponding elevation and volume at each location, maximum anticipated extents of ponding are shown on the Civil Grading Plan C04.

Table 6: Summary of Surface Ponding Analysis

AREA ID	LOCATION	INVERT (M)	100-YEAR ELEV. (M)	HEAD (M)	Q_{100} (L/SEC)	MAX VOLUME (M^3)
S-009	CB07	85.27	87.53	2.26	5.3	1.69
S-010	CB01	84.21	87.15	2.94	35.6	1.29
S-011	CB04	84.11	87.15	3.04	61.3	1.21
S-012	CB06	85.32	87.72	2.40	5.3	12.33

3.3 WATER QUALITY

As outlined in Section 1.4, it is required that post development runoff be treated to achieve 80% TSS removal.

Proposed features to achieve these targets include;

- → Suitably sized oil and grit separator (OGS) unit (FDC-3HC or equivalent)
- → Stormtech Isolator Row Plus
- → Grass swales

As noted previously, a single outlet location into the Kennedy Lane East sewer is proposed. A suitably sized OGS unit is proposed to achieve a minimum 80% TSS removal. Hydro First Defense (FDC-3HC, or equivalent) is proposed to meet the requirements, details on the proposed unit can be found in **Appendix D**.

The majority of roadway and parking lot runoff will be routed to one of six proposed underground Stormtech (or equivalent) storage units. The units are proposed to include a Stormtech Isolator Row Plus filtration devices to further improve the water quality through a treatment train approach. ETV Canada testing on Stormtech Isolator Row Plus units verified the filtration device is capable of achieving an average 82% TSS removal.

It is assumed that the runoff from pervious rear yard areas will be free of typical sediment-generating activities and therefore runoff will leave them effectively unchanged and can be considered clean for the purposes of water quality assessment. Additionally, it should be noted that runoff from the rear yards along the property line of the site will be captured and conveyed towards the outlet (and OGS) via grass swales. Grass swales are vegetated open channels that convey, treat and attenuate stormwater runoff.

4 CONCLUSIONS

A stormwater management report has been prepared to support the proposed development at 360 Kennedy Lane East in the City of Ottawa. The key points are summarized below.

WATER QUALITY

An OGS unit (Hydro First Defense FD-3HC, or equivalent) is proposed at the outlet to the Kennedey Lane East Sewer meet MOE Enhanced treatment standards (80% TSS removal). In addition, the enhanced grass swales will provide additional quality control.

WATER QUANTITY

Runoff will be controlled on the surface using ICDs on catch basin lead pipes and the outlet of the proposed underground chambers.

APPENDIX

A

PRE-CONSULTATION MEETING MINUTES AND TECHNICAL COMMENTS

Site Plan Pre- Application Consultation Notes

Date: Wednesday, May 19, 2021
Site Location: 360 Kennedy Lane E
Type of Development: ☒ **Residential (**☒ **townhomes,** ☒ **stacked,** ☐ **singles,**
☐ **apartments),** ☐ **Office Space,** ☐ **Commercial,** ☐ **Retail,** ☐ **Institutional,**
☐ **Industrial, Other:** N/A

Infrastructure

Water

Existing public services:

- Kennedy Lane E – 203mm DI

Watermain Frontage Fees to be paid ($190.00 per metre) on Woodroffe Avenue ☐ **Yes** ☒ **No**

Boundary conditions:
Civil consultant must request boundary conditions from the City's assigned Project Manager prior to first submission.

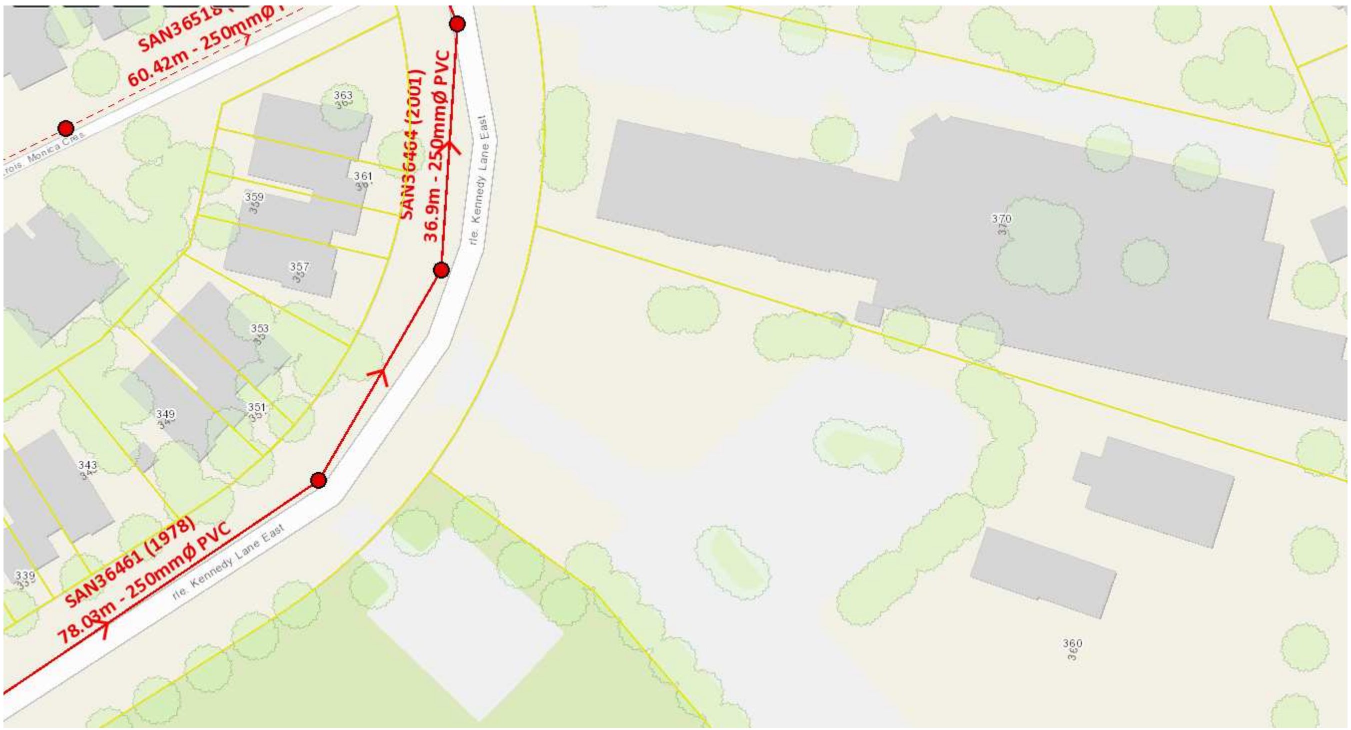
- Water boundary condition requests must include the location of the service(s) and the expected loads required by the proposed developments. Please provide all the following information:
    - Location of service(s)
    - Type of development and the amount of fire flow required (as per FUS, 1999)
    - Average daily demand: ___ L/s
    - Maximum daily demand: ___ L/s
    - Maximum hourly daily demand: ___ L/s
- Fire protection (Fire demand, Hydrant Locations)
- Please submit sanitary demands with the water boundary conditions

General comments

- Service areas with a basic demand greater than 50 m^3/day shall be connected with a minimum of two water services, separated by an isolation valve, to avoid creation of vulnerable service area.
- A District Metering Area Chamber (DMA) is required for new services 150mm or greater in diameter.

Sanitary Sewer

Existing public services:
- Kennedy Lane E – 250mm PVC

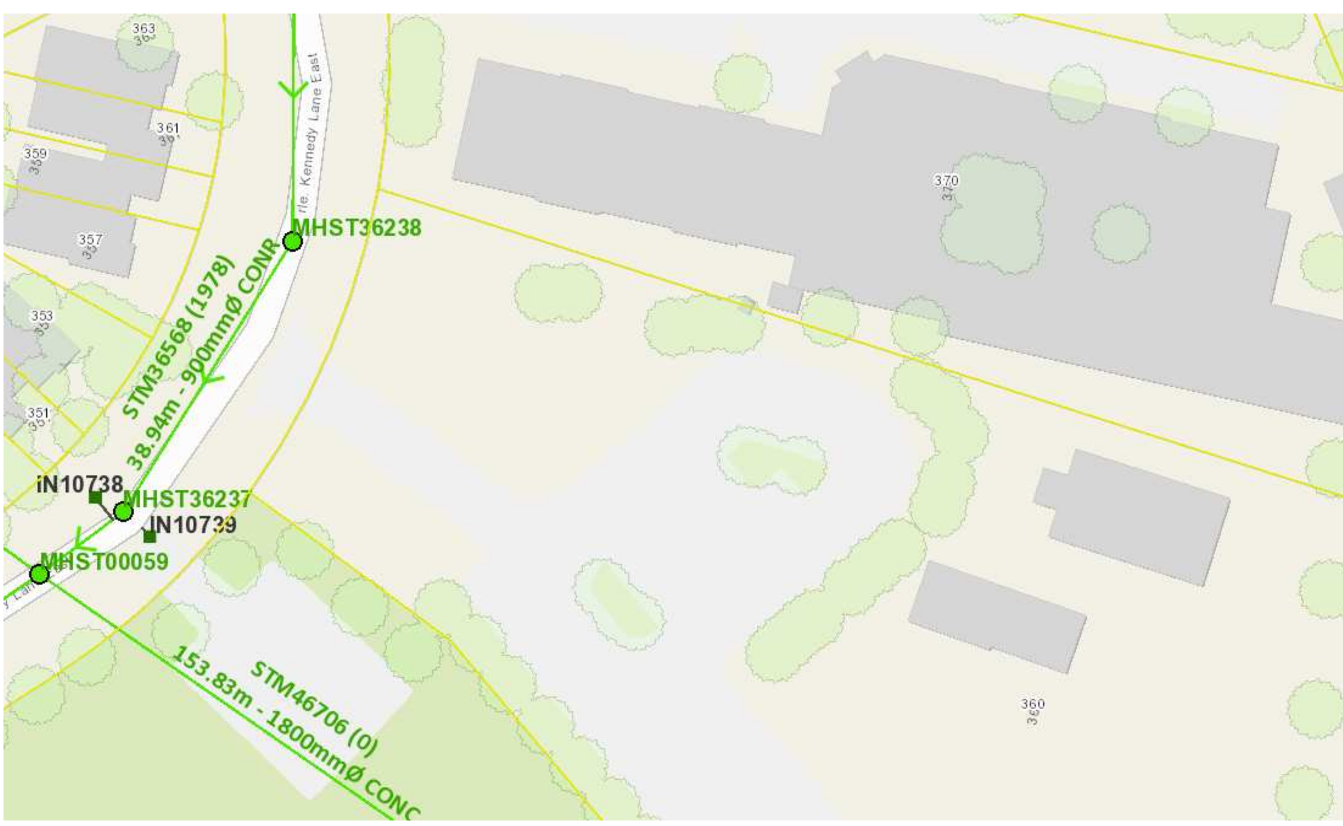


Is a monitoring manhole required on private property? ☒ **Yes** ☐ **No**

General comments
- Please submit sanitary demands with the water boundary conditions
- For infill developments within older neighbourhoods there is not an allotment for the sanitary capacity. As part of the rezoning application the consultant is required to demonstrate that there is sufficient capacity in the pipe network and system for the proposed sanitary demands.

Storm Sewer

Existing public services:
- Kennedy Lane E – 900mm Conc R



Stormwater Management

Quality Control:

- Rideau Valley Conservation Authority to confirm quality control requirements.

Quantity Control:

- LID features are strongly encouraged as the development is going from mostly pervious to impervious.
- Time of concentration (Tc): Tc = pre-development; maximum Tc = 10 min
- Allowable run-off coefficient: 0.5
- Allowable flowrate: Allowable flowrate: Control the 100-year storm events to the 5-year storm event.

Ministry of Environment, Conservation and Parks (MECEP)

All development applications should be considered for an Environmental Compliance Approval, under MECP regulations.

a. Consultants are required to determines if an approval for sewage works under Section 53 of OWRA is required.
b. ECA applications are required to be submitted online through the MECP portal. A business account required to submit ECA application. For more information visit https://www.ontario.ca/page/environmental-compliance-approval
c. If the consultants determines the site does not meet the definition of industrial site the consultant may request the MECP to exempt the works. The following information must be provided to the City Project Manager:
   (i) is designed to service one lot or parcel of land;
   (ii) discharges into a storm sewer that is not a combined sewer;
   (iii) does not service industrial land or a structure located on industrial land; and
   (iv) is not located on industrial land.

NOTE: Site Plan Approval, or Draft Approval, is required before any Ministry of the Environment and Climate Change (MOECC) application is sent

General Service Design Comments

- Existing sewers or watermains that are not reused must be decommissioned as per City Standards.
- The City of Ottawa Standard Detail Drawings should be referenced where possible for all work within the Public Right-of-Way.

Other

Capital Works Projects within proximity to application? ☐ **Yes** ☒ **No**

References and Resources

- As per section 53 of the Professional Engineers Act, O. Reg 941/40, R.S.O. 1990, all documents prepared by engineers must be signed and dated on the seal.
- All required plans & reports are to be provided in *.pdf format (at application submission and for any, and all, re-submissions)
- Please find relevant City of Ottawa Links to Preparing Studies and Plans below: https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#standards-policies-and-guidelines
- To request City of Ottawa plan(s) or report information please contact the City of Ottawa Information Centre:
  InformationCentre@ottawa.ca<mailto:InformationCentre@ottawa.ca>
  (613) 580-2424 ext. 44455
- geoOttawa
  http://maps.ottawa.ca/geoOttawa/

SITE PLAN APPLICATION – Municipal servicing

For information on preparing required studies and plans refer to:
http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans

S/A	Number of copies	ENGINEERING		S/A	Number of copies
S		1. Site Servicing Plan	2. Site Servicing Report	S	
S		3. Grade Control and Drainage Plan	4. Geotechnical Study Alternatively, existing report with memo providing recommendations for works based on current geotechnical guidelines.	S	
		5. Composite Utility Plan	6. Groundwater Impact Study		
		7. Servicing Options Report	8. Wellhead Protection Study		
		9. Community Transportation Study and/or Transportation Impact Study / Brief	10. Erosion and Sediment Control Plan / Brief	S	
S		11. Storm water Management Report	12. Hydro-geological and Terrain Analysis		
		13. Water main Analysis	14. Noise / Vibration Study	S	
		15. Roadway Modification Design Plan	16. Confederation Line Proximity Study		

It is important to note that the need for additional studies and plans may result during application review. If following the submission of your application, it is determined that material that is not identified in this checklist is required to achieve complete application status, in accordance with the Planning Act and Official Plan requirements, City Planning will notify you of outstanding material required within the required 30 day period. Mandatory pre-application consultation will not shorten the City's standard processing timelines, or guarantee that an application will be approved. It is intended to help educate and inform the applicant about submission requirements as well as municipal processes, policies, and key issues in advance of submitting a formal development application. This list is valid for one year following the meeting date. If the application is not submitted within this timeframe the applicant must again pre-consult with the City.

Notes:

4. Geotechnical Study / Slope Stability Study – required as per Official Plan section 4.8.3. All site plan applications need to demonstrate the soils are suitable for development. A Slope Stability Study may be required with unique circumstances (Schedule K or topography may define slope stability concerns).

10. Erosion and Sediment Control Plan – required with all site plan applications as per Official Plan section 4.7.3.

11. Stormwater Management Report/Brief - required with all site plan applications as per Official Plan section 4.7.6.

REZONING APPLICATION – Municipal servicing

For information on preparing required studies and plans refer to:
http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans

S/A	Number of copies	ENGINEERING		S/A	Number of copies
S		1. Site Servicing Plan	2. Site Servicing Report	S	
S		3. Grade Control and Drainage Plan	4. Geotechnical Study Alternatively, existing report with memo providing recommendations for works based on current geotechnical guidelines.	S	
		5. Composite Utility Plan	6. Groundwater Impact Study		
		7. Servicing Options Report	8. Wellhead Protection Study		
		9. Community Transportation Study and/or Transportation Impact Study / Brief	10. Erosion and Sediment Control Plan / Brief	S	
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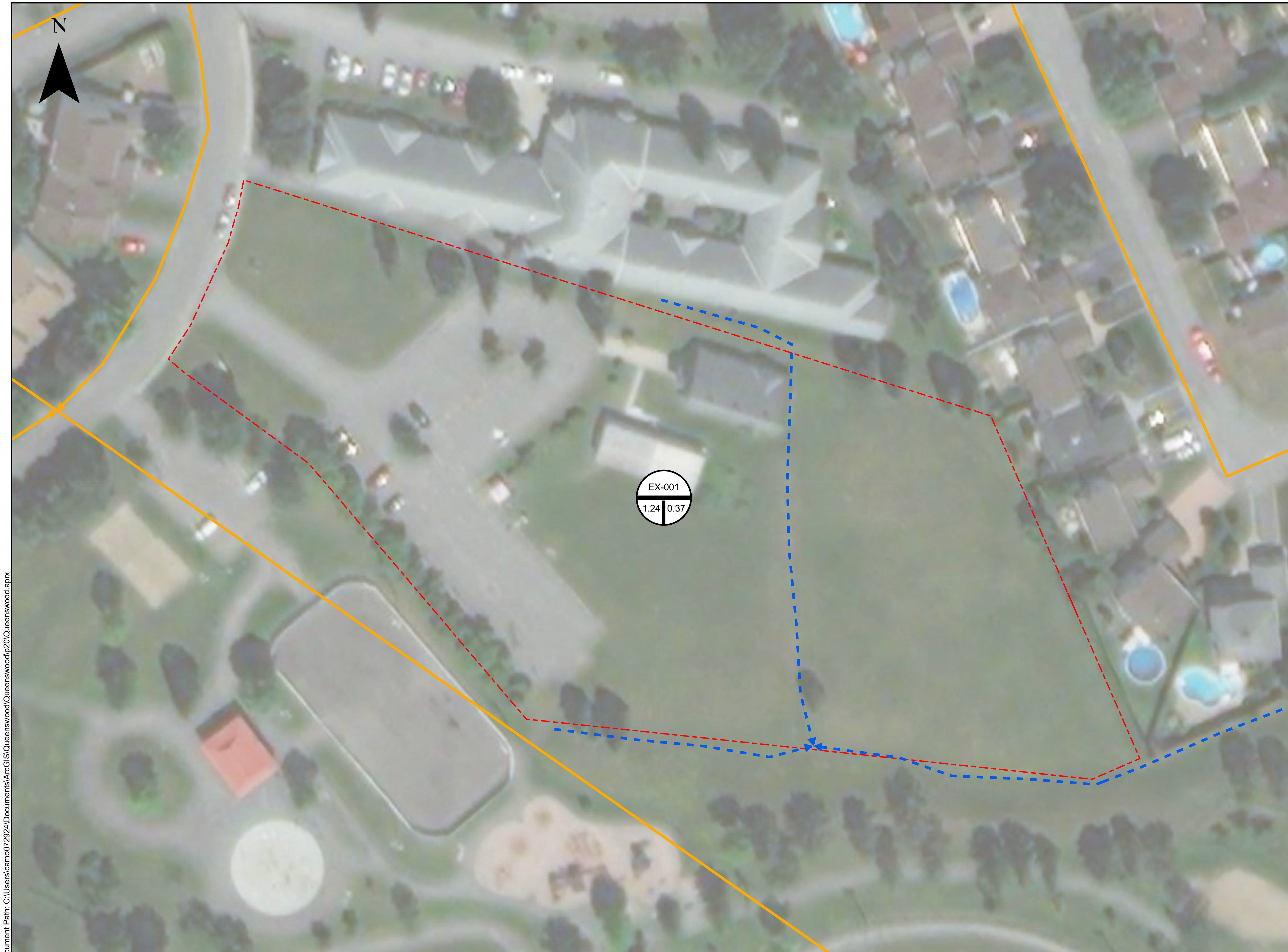
11. Stormwater Management Report/Brief - required with all site plan applications as per Official Plan section 4.7.6.

APPENDIX

B EXHIBITS



CLIENT

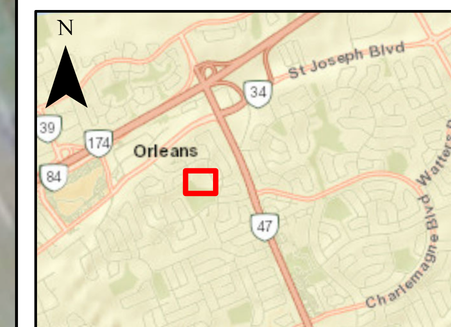
QUEENSWOOD UNITED CHURCH

PROJECT

360 KENNEDY LANE EAST DEVELOPMENT

TITLE

EXHIBIT 1
EXISTING CONDITIONS
DRAINAGE MOSAIC



LEGEND

- Existing Swale
- Existing Storm
- Drainage Area

Subcatchment ID | Area (ha) | Runoff C

0 0.01 0.01 km

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CHECKED BY MH

November 2021

NAD 1983 MTM 9

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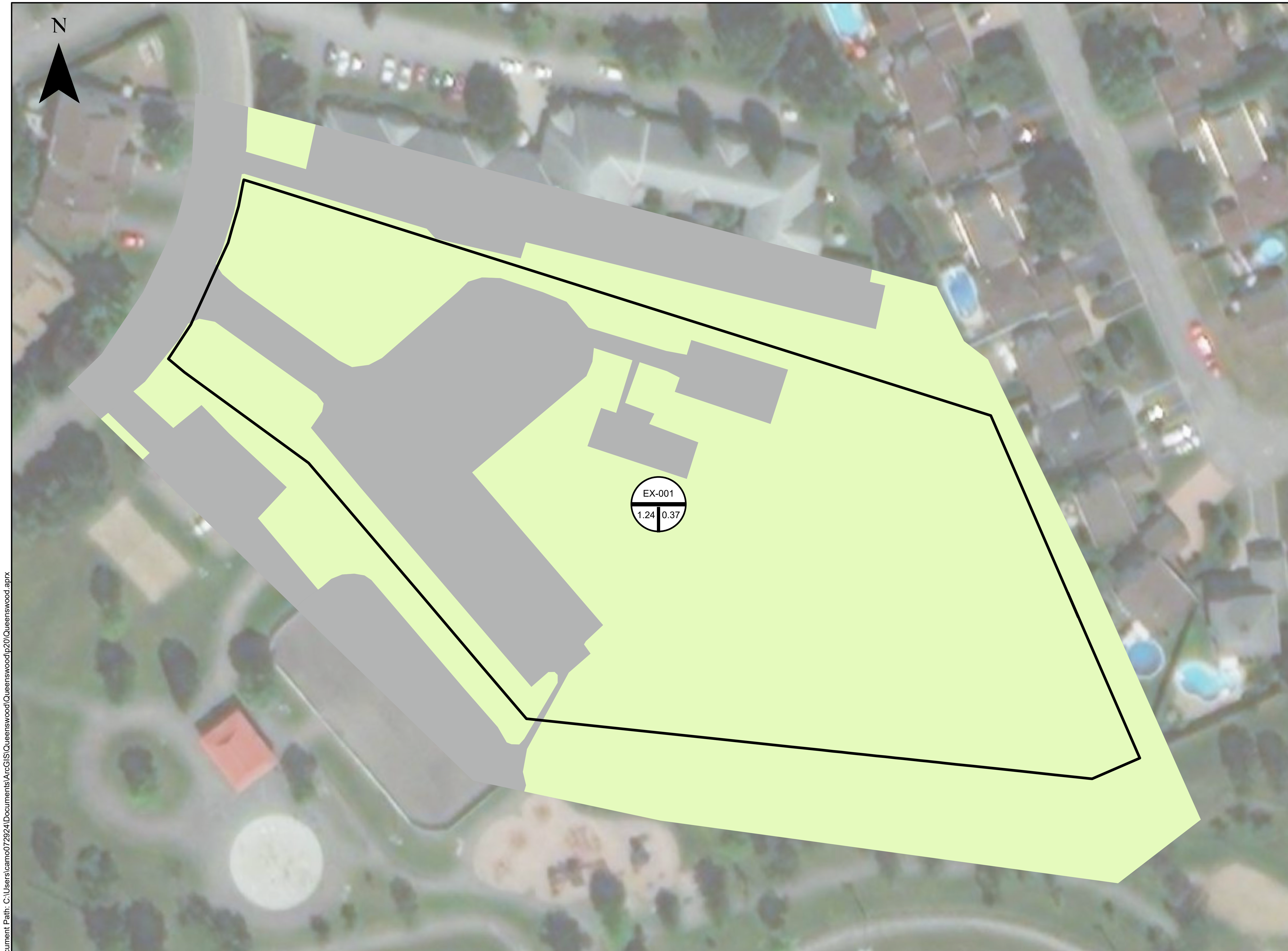
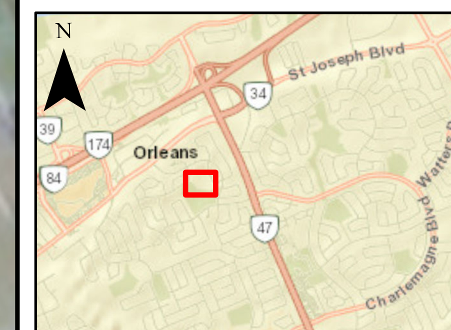


CLIENT
QUEENSWOOD UNITED CHURCH

PROJECT
360 KENNEDY LANE EAST DEVELOPMENT

TITLE
EXHIBIT 2
EXISTING CONDITIONS
LAND USE



LEGEND

Drainage Area

Land Use

Impervious

Pervious

Subcatchment ID
Area (ha) | Runoff C

0 0.01 0.01 km

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November 2021
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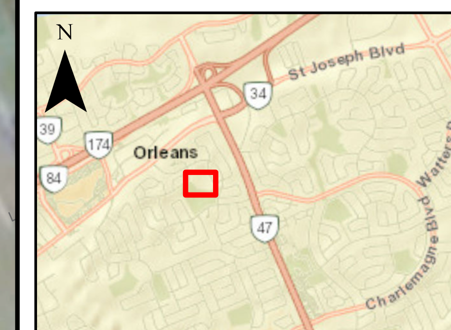
CLIENT
QUEENSWOOD UNITED CHURCH

PROJECT
360 KENNEDY LANE EAST DEVELOPMENT

TITLE
EXHIBIT 3
PROPOSED CONDITIONS
DRAINAGE MOSAIC



LEGEND

- OGS
- Proposed Storm
- Proposed Swale
- Existing Storm

Drainage Areas

- S-001
- S-002
- S-003
- S-004
- S-005
- S-006
- S-007
- S-008
- S-009
- S-010
- S-011
- S-012
- S-013
- S-014
- S-015
- S-016
- S-017

Subcatchment ID
Area (ha) | Runoff C

0 0.01 0.01 km

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CHECKED BY AH
November 2021
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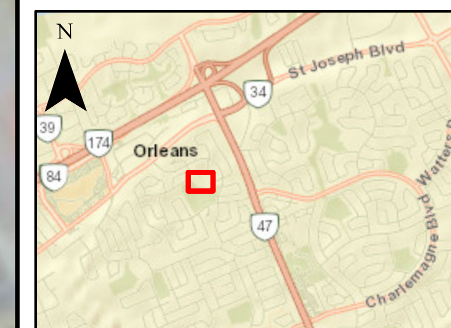
QUEENSWOOD UNITED CHURCH

PROJECT
360 KENNEDY LANE EAST DEVELOPMENT

TITLE
EXHIBIT 4
PROPOSED CONDITIONS
LAND USE



LEGEND

Drainage Areas

Land Use

Impervious

Pervious

Subcatchment ID
Area (ha) | Runoff C

0 0.01 0.01 km

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NAD 1983 MTM 9
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APPENDIX

C

CALCULATIONS & PCSWMM OUTPUT

5-Year Pre-Development

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------


*************
Element Count
*************
Number of rain gages ...... 16
Number of subcatchments ... 2
Number of nodes ........... 1
Number of links ........... 0
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval
------------------------------------------------------------------------
100yr_3hr_Chicago    100yr_3hr_Chicago              INTENSITY   10 min.
100yr_3hr_Chicago_Climate_Change 100yr_3hr_Chicago_Increase_20percent INTENSITY   10 min.
100yr_6hr_Chicago    100yr_6hr_Chicago              INTENSITY   10 min.
100yr_6hr_Chicago_Climate_Change 100yr_6hr_Chicago_Increase_20percent INTENSITY   10 min.
10yr_3hr_Chicago     10yr_3hr_Chicago               INTENSITY   10 min.
10yr_6hr_Chicago     10yr_6hr_Chicago               INTENSITY   10 min.
25mm_3hr_Chicago     25mm_3hr_Chicago               INTENSITY   10 min.
25mm_4hr_Chicago     25mm_4hr_Chicago               INTENSITY   10 min.
25yr_3hr_Chicago     25yr_3hr_Chicago               INTENSITY   10 min.
25yr_6hr_Chicago     25yr_6hr_Chicago               INTENSITY   10 min.
2yr_3hr_Chicago      2yr_3hr_Chicago                INTENSITY   10 min.
2yr_6hr_Chicago      2yr_6hr_Chicago                INTENSITY   10 min.
50yr_3hr_Chicago     50yr_3hr_Chicago               INTENSITY   10 min.
50yr_6hr_Chicago     50yr_6hr_Chicago               INTENSITY   10 min.
5yr_3hr_Chicago      5yr_3hr_Chicago                INTENSITY   10 min.
5yr_6hr_Chicago      5yr_6hr_Chicago                INTENSITY   10 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
S1_1                       0.51     68.63      6.56    7.7320 5yr_3hr_Chicago      OF1
S1_2                       0.72     60.33     43.95    3.4980 5yr_3hr_Chicago      OF1


************
Node Summary
************
                                           Invert      Max.    Ponded    External
Name                 Type                   Elev.     Depth      Area    Inflow
-------------------------------------------------------------------------------
OF1                  OUTFALL                83.72      0.00       0.0


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Starting Date ............ 11/10/2013 00:00:00
Ending Date .............. 11/10/2013 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.053        42.514
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.035        28.029
Surface Runoff ...........         0.018        14.194
Final Storage ............         0.001         0.449
Continuity Error (%) .....        -0.373


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.018         0.176
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.018         0.176
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Subcatchment Runoff Summary
***************************

------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm    10^6 ltr      CMS
------------------------------------------------------------------------------------------------------------
S1_1                     42.51       0.00       0.00      36.36       6.17        0.03     0.02   0.145
S1_2                     42.51       0.00       0.00      22.11      19.90        0.14     0.10   0.468


Analysis begun on:  Mon Nov 29 16:03:21 2021
Analysis ended on:  Mon Nov 29 16:03:21 2021
Total elapsed time: < 1 sec
```

100-Year Post Development

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
Element Count
****

Number of rain gages 16
Number of subcatchments ... 17
Number of nodes 33
Number of links 32
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_3hr_Chicago	100yr_3hr_Chicago	INTENSITY	10 min.
100yr_3hr_Chicago_Climate_Change	100yr_3hr_Chicago_Increase_20percent	INTENSITY	10 min.
100yr_6hr_Chicago	100yr_6hr_Chicago	INTENSITY	10 min.
100yr_6hr_Chicago_Climate_Change	100yr_6hr_Chicago_Increase_20percent	INTENSITY	10 min.
10yr_3hr_Chicago	10yr_3hr_Chicago	INTENSITY	10 min.
10yr_6hr_Chicago	10yr_6hr_Chicago	INTENSITY	10 min.
25mm_3hr_Chicago	25mm_3hr_Chicago	INTENSITY	10 min.
25mm_4hr_Chicago	25mm_4hr_Chicago	INTENSITY	10 min.
25yr_3hr_Chicago	25yr_3hr_Chicago	INTENSITY	10 min.
25yr_6hr_Chicago	25yr_6hr_Chicago	INTENSITY	10 min.
2yr_3hr_Chicago	2yr_3hr_Chicago	INTENSITY	10 min.
2yr_6hr_Chicago	2yr_6hr_Chicago	INTENSITY	10 min.
50yr_3hr_Chicago	50yr_3hr_Chicago	INTENSITY	10 min.
50yr_6hr_Chicago	50yr_6hr_Chicago	INTENSITY	10 min.
5yr_3hr_Chicago	5yr_3hr_Chicago	INTENSITY	10 min.
5yr_6hr_Chicago	5yr_6hr_Chicago	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S-001	0.08	40.24	90.16	2.9480	100yr_3hr_Chicago	CB012
S-002	0.05	24.89	92.17	2.6160	100yr_3hr_Chicago	CB011
S-003	0.08	38.07	79.02	2.6610	100yr_3hr_Chicago	CB010
S-004	0.04	14.42	92.79	2.6880	100yr_3hr_Chicago	CB08
S-005	0.03	24.00	85.78	3.6100	100yr_3hr_Chicago	CB014
S-006	0.06	34.00	75.03	2.8970	100yr_3hr_Chicago	CB02
S-007	0.12	46.60	79.01	2.7540	100yr_3hr_Chicago	CB03
S-008	0.13	46.67	78.52	2.2900	100yr_3hr_Chicago	CB05
S-009	0.11	40.72	83.90	2.6420	100yr_3hr_Chicago	TankD_CB07
S-010	0.11	11.44	45.25	5.6740	100yr_3hr_Chicago	CB01
S-011	0.10	12.38	49.68	6.4410	100yr_3hr_Chicago	CB04
S-012	0.05	32.06	91.67	4.3700	100yr_3hr_Chicago	CB06
S-013	0.08	31.60	93.42	2.3870	100yr_3hr_Chicago	CB09
S-014	0.11	10.24	34.92	6.3810	100yr_3hr_Chicago	CB08
S-015	0.06	58.86	29.92	16.1910	100yr_3hr_Chicago	OF1
S-016	0.01	59.16	5.84	2.0000	100yr_3hr_Chicago	OF1
S-017	0.04	18.64	61.38	3.4660	100yr_3hr_Chicago	OF1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
CB010	JUNCTION	84.10	3.25	0.0	
CB011	JUNCTION	84.09	3.17	0.0	
CB012	JUNCTION	83.90	3.36	0.0	
CB014	JUNCTION	84.25	3.07	0.0	
CB02	JUNCTION	84.15	3.14	0.0	
CB03	JUNCTION	85.15	2.50	0.0	
CB05	JUNCTION	85.19	2.50	0.0	
CB08	JUNCTION	84.30	2.99	0.0	
CB09	JUNCTION	84.50	2.90	0.0	
J1	JUNCTION	83.73	3.76	0.0	
J2	JUNCTION	83.66	3.89	0.0	
J3	JUNCTION	83.51	4.08	0.0	
J4	JUNCTION	83.82	3.89	0.0	
J5	JUNCTION	83.71	3.96	0.0	
STMH101	JUNCTION	82.87	4.49	0.0	
STMH102	JUNCTION	83.53	4.08	0.0	
STMH103	JUNCTION	83.74	3.75	0.0	
STMH104	JUNCTION	83.84	3.78	0.0	
STMH105	JUNCTION	84.12	3.66	0.0	
STMH106	JUNCTION	84.20	3.41	0.0	
STMH107	JUNCTION	84.35	3.05	0.0	
STMH108	JUNCTION	83.90	3.84	0.0	
STMH109	JUNCTION	84.14	3.34	0.0	
OF1	OUTFALL	82.20	0.45	0.0	
CB01	STORAGE	84.21	2.98	0.0	
CB04	STORAGE	84.11	3.08	0.0	
CB06	STORAGE	84.45	3.37	0.0	
TankA	STORAGE	83.73	3.53	0.0	
TankB	STORAGE	83.98	3.37	0.0	
TankC	STORAGE	84.15	3.25	0.0	
TankD_CB07	STORAGE	84.16	3.61	0.0	
TankF	STORAGE	85.00	2.35	0.0	
TankG	STORAGE	83.98	3.31	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1_1	STMH102	J3	CONDUIT	1.8	0.9837	0.0130
C1_2	J3	STMH101	CONDUIT	21.2	1.0001	0.0130
C10	STMH109	STMH108	CONDUIT	11.7	1.0268	0.0130
C11_1	STMH108	J4	CONDUIT	25.6	0.3010	0.0130
C11_3	J4	J5	CONDUIT	38.5	0.3016	0.0130
C11_4	J5	STMH102	CONDUIT	48.6	0.3024	0.0130
C2	STMH107	STMH106	CONDUIT	25.8	0.4647	0.0130
C3	STMH106	STMH105	CONDUIT	13.1	0.4577	0.0130
C4	STMH101	OF1	CONDUIT	16.8	3.9941	0.0100
C4_2	STMH105	STMH104	CONDUIT	51.5	0.4462	0.0130
C5	STMH104	STMH103	CONDUIT	10.1	0.2977	0.0130
C6_1	STMH103	J1	CONDUIT	1.8	0.3343	0.0130
C6_3	J1	J2	CONDUIT	25.4	0.3070	0.0130
C6_4	J2	STMH102	CONDUIT	34.7	0.3053	0.0130
CB011	CB011	TankG	CONDUIT	8.5	1.2984	0.0130
CB012	CB012	TankA	CONDUIT	5.6	3.0601	0.0130
CB014	CB014	TankC	CONDUIT	8.7	1.1535	0.0130
CB02	CB02	TankG	CONDUIT	8.8	1.9326	0.0130
CB08	CB08	TankC	CONDUIT	14.9	1.0064	0.0130
CB09	CB09	TankC	CONDUIT	17.8	1.9639	0.0130
ICD_010	CB010	TankB	CONDUIT	6.5	1.2237	0.0130
ICD_03	CB03	TankF	CONDUIT	8.4	1.7907	0.0130
ICD_05	CB05	TankF	CONDUIT	24.4	0.7798	0.0130
ICD_06	CB06	STMH107	OUTLET			
ICD_A	TankA	J3	OUTLET			
ICD_B	TankB	J5	OUTLET			
ICD_C	TankC	J4	OUTLET			
ICD_CB01	CB01	CB04	OUTLET			
ICD_CB04	CB04	STMH104	OUTLET			
ICD_D	TankD_CB07	STMH109	OUTLET			
ICD_F	TankF	J1	OUTLET			
ICD_G	TankG	J2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1_1	CIRCULAR	0.45	0.16	0.11	0.45	1	0.28
C1_2	CIRCULAR	0.45	0.16	0.11	0.45	1	0.29
C10	CIRCULAR	0.25	0.05	0.06	0.25	1	0.06
C11_1	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
C11_3	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
C11_4	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
C2	CIRCULAR	0.25	0.05	0.06	0.25	1	0.04
C3	CIRCULAR	0.25	0.05	0.06	0.25	1	0.04
C4	CIRCULAR	0.45	0.16	0.11	0.45	1	0.74
C4_2	CIRCULAR	0.25	0.05	0.06	0.25	1	0.04
C5	CIRCULAR	0.30	0.07	0.07	0.30	1	0.05
C6_1	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
C6_3	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
C6_4	CIRCULAR	0.35	0.10	0.09	0.35	1	0.08
CB011	CIRCULAR	0.20	0.03	0.05	0.20	1	0.04
CB012	CIRCULAR	0.20	0.03	0.05	0.20	1	0.06
CB014	CIRCULAR	0.20	0.03	0.05	0.20	1	0.04
CB02	CIRCULAR	0.20	0.03	0.05	0.20	1	0.05
CB08	CIRCULAR	0.20	0.03	0.05	0.20	1	0.03
CB09	CIRCULAR	0.20	0.03	0.05	0.20	1	0.05
ICD_010	CIRCULAR	0.20	0.03	0.05	0.20	1	0.04
ICD_03	CIRCULAR	0.20	0.03	0.05	0.20	1	0.04
ICD_05	CIRCULAR	0.20	0.03	0.05	0.20	1	0.03

****
NOTE: The summary statistics displayed in this report are

based on results found at every computational time step,
not just on results from each reporting time step.

Analysis Options

Flow Units .... CMS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... YES
  Ponding Allowed .... YES
  Water Quality .... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date 11/10/2013 00:00:00
Ending Date 11/10/2013 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step .... 1.00 sec
Variable Time Step .... YES
Maximum Trials 20
Number of Threads 2
Head Tolerance .... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.089	71.677
Evaporation Loss	0.000	0.000
Infiltration Loss	0.017	13.640
Surface Runoff	0.071	57.651
Final Storage	0.001	1.100
Continuity Error (%)	-0.995	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.071	0.714
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.051	0.511
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.020	0.199
Continuity Error (%)	0.646	

Highest Continuity Errors

Node TankC (1.66%)
Node TankF (1.22%)
Node CB04 (-1.21%)

Time-Step Critical Elements

Link C1_1 (65.91%)

Highest Flow Instability Indexes

Link ICD_CB01 (32)
Link ICD_CB04 (12)

Routing Time Step Summary

Minimum Time Step   :   0.50 sec
Average Time Step   :   0.84 sec
Maximum Time Step   :   1.00 sec
Percent in Steady State   :   -0.00
Average Iterations per Step :   2.10
Percent Not Converging   :   0.02

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S-001	71.68	0.00	0.00	4.32	66.49	0.05	0.04	0.928
S-002	71.68	0.00	0.00	3.43	67.29	0.03	0.02	0.939
S-003	71.68	0.00	0.00	9.24	61.92	0.05	0.04	0.864
S-004	71.68	0.00	0.00	3.16	67.56	0.02	0.02	0.943
S-005	71.68	0.00	0.00	6.23	64.81	0.02	0.01	0.904
S-006	71.68	0.00	0.00	11.00	60.30	0.04	0.03	0.841
S-007	71.68	0.00	0.00	9.27	61.84	0.08	0.06	0.863
S-008	71.68	0.00	0.00	9.50	61.61	0.08	0.06	0.859
S-009	71.68	0.00	0.00	7.09	63.91	0.07	0.05	0.892
S-010	71.68	0.00	0.00	25.49	45.96	0.05	0.04	0.641
S-011	71.68	0.00	0.00	23.03	48.42	0.05	0.04	0.676
S-012	71.68	0.00	0.00	3.65	67.15	0.03	0.02	0.937
S-013	71.68	0.00	0.00	2.88	67.82	0.05	0.04	0.946
S-014	71.68	0.00	0.00	30.71	40.84	0.05	0.03	0.570
S-015	71.68	0.00	0.00	30.78	43.05	0.02	0.03	0.601
S-016	71.68	0.00	0.00	41.22	34.75	0.00	0.00	0.485
S-017	71.68	0.00	0.00	17.11	54.53	0.02	0.02	0.761

Node Depth Summary

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	hr:min	Reported Max Depth Meters
CB010	JUNCTION	0.70	1.54	85.64	0	01:33	1.54
CB011	JUNCTION	0.87	1.45	85.54	0	01:45	1.45
CB012	JUNCTION	0.69	1.32	85.22	0	01:41	1.32
CB014	JUNCTION	1.15	1.58	85.83	0	02:22	1.58
CB02	JUNCTION	0.82	1.39	85.54	0	01:45	1.39
CB03	JUNCTION	1.11	1.48	86.63	0	02:32	1.48
CB05	JUNCTION	1.10	1.53	86.72	0	01:10	1.53
CB08	JUNCTION	1.12	1.53	85.83	0	02:22	1.53
CB09	JUNCTION	0.94	1.33	85.83	0	02:22	1.33
J1	JUNCTION	0.08	0.25	83.98	0	01:12	0.24
J2	JUNCTION	0.09	0.24	83.90	0	01:12	0.23
J3	JUNCTION	0.08	0.17	83.68	0	01:13	0.17
J4	JUNCTION	0.06	0.08	83.90	0	01:47	0.08
J5	JUNCTION	0.07	0.10	83.80	0	01:45	0.10
STMH101	JUNCTION	0.05	0.10	82.97	0	01:13	0.10
STMH102	JUNCTION	0.08	0.17	83.70	0	01:13	0.16
STMH103	JUNCTION	0.07	0.25	83.99	0	01:12	0.24
STMH104	JUNCTION	0.05	0.23	84.07	0	01:11	0.23
STMH105	JUNCTION	0.03	0.06	84.18	0	01:39	0.06
STMH106	JUNCTION	0.03	0.06	84.26	0	01:23	0.06
STMH107	JUNCTION	0.03	0.06	84.41	0	01:23	0.06
STMH108	JUNCTION	0.04	0.06	83.96	0	01:34	0.06
STMH109	JUNCTION	0.03	0.05	84.19	0	01:34	0.05
OF1	OUTFALL	0.05	0.10	82.30	0	01:13	0.10
CB01	STORAGE	0.33	2.94	87.15	0	01:11	2.89
CB04	STORAGE	0.40	3.04	87.15	0	01:11	2.99
CB06	STORAGE	1.03	3.27	87.72	0	01:22	3.27
TankA	STORAGE	0.83	1.49	85.22	0	01:41	1.49
TankB	STORAGE	0.80	1.66	85.64	0	01:34	1.66
TankC	STORAGE	1.24	1.68	85.83	0	02:22	1.68
TankD_CB07	STORAGE	1.17	3.37	87.53	0	01:34	3.36
TankF	STORAGE	1.23	1.63	86.63	0	02:32	1.63
TankG	STORAGE	0.97	1.56	85.54	0	01:45	1.56

Node Inflow Summary

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CB010	JUNCTION	0.037	0.037	0	01:10	0.0476	0.0475	-0.068
CB011	JUNCTION	0.023	0.023	0	01:10	0.0319	0.0319	1.101
CB012	JUNCTION	0.040	0.040	0	01:10	0.0548	0.0548	0.022
CB014	JUNCTION	0.013	0.013	0	01:10	0.018	0.018	2.083
CB02	JUNCTION	0.029	0.029	0	01:10	0.0372	0.0372	0.952
CB03	JUNCTION	0.058	0.058	0	01:10	0.0758	0.0758	0.474
CB05	JUNCTION	0.060	0.060	0	01:10	0.0776	0.0776	0.774

CB08	JUNCTION	0.049	0.049	0	01:10	0.0701	0.0701	0.651
CB09	JUNCTION	0.039	0.039	0	01:10	0.0537	0.0537	0.937
J1	JUNCTION	0.000	0.070	0	01:12	0	0.195	0.078
J2	JUNCTION	0.000	0.073	0	01:12	0	0.25	0.240
J3	JUNCTION	0.000	0.086	0	01:13	0	0.464	0.080
J4	JUNCTION	0.000	0.009	0	01:46	0	0.12	0.344
J5	JUNCTION	0.000	0.013	0	01:44	0	0.166	0.332
STMH101	JUNCTION	0.000	0.086	0	01:13	0	0.463	0.023
STMH102	JUNCTION	0.000	0.082	0	01:13	0	0.414	0.078
STMH103	JUNCTION	0.000	0.067	0	01:11	0	0.132	0.041
STMH104	JUNCTION	0.000	0.067	0	01:11	0	0.133	0.096
STMH105	JUNCTION	0.000	0.005	0	01:23	0	0.0342	-0.351
STMH106	JUNCTION	0.000	0.005	0	01:23	0	0.0342	0.002
STMH107	JUNCTION	0.000	0.005	0	01:22	0	0.0342	0.001
STMH108	JUNCTION	0.000	0.005	0	01:34	0	0.0569	0.194
STMH109	JUNCTION	0.000	0.005	0	01:34	0	0.057	0.127
OF1	OUTFALL	0.045	0.121	0	01:10	0.0476	0.511	0.000
CB01	STORAGE	0.037	0.037	0	01:10	0.0512	0.0512	2.434
CB04	STORAGE	0.036	0.074	0	01:10	0.0472	0.0972	-1.199
CB06	STORAGE	0.025	0.025	0	01:05	0.0342	0.0342	0.024
TankA	STORAGE	0.000	0.040	0	01:10	0	0.0548	0.173
TankB	STORAGE	0.000	0.037	0	01:10	0	0.0476	-0.007
TankC	STORAGE	0.000	0.101	0	01:10	0	0.141	1.683
TankD_CB07	STORAGE	0.051	0.051	0	01:10	0.0674	0.0674	0.002
TankF	STORAGE	0.000	0.118	0	01:10	0	0.152	1.231
TankG	STORAGE	0.000	0.053	0	01:10	0	0.0684	0.728

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CB010	JUNCTION	3.79	1.338	1.712
CB011	JUNCTION	4.96	1.253	1.717
CB012	JUNCTION	4.26	1.122	2.038
CB014	JUNCTION	4.95	1.376	1.494
CB02	JUNCTION	4.95	1.193	1.747
CB03	JUNCTION	4.96	1.280	1.020
CB05	JUNCTION	4.97	1.326	0.974
CB08	JUNCTION	4.96	1.326	1.464
CB09	JUNCTION	4.93	1.126	1.574

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
CB01	0.000	7	0	0	0.001	75	0 01:11	0.039
CB04	0.000	10	0	0	0.001	83	0 01:11	0.062
CB06	0.002	6	0	0	0.012	33	0 01:22	0.005
TankA	0.020	24	0	0	0.036	42	0 01:41	0.003
TankB	0.014	24	0	0	0.030	49	0 01:34	0.004
TankC	0.082	38	0	0	0.111	52	0 02:22	0.004
TankD_CB07	0.026	30	0	0	0.044	50	0 01:34	0.005
TankF	0.092	52	0	0	0.122	69	0 02:32	0.004
TankG	0.029	29	0	0	0.047	47	0 01:45	0.004

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	95.17	0.028	0.121	0.511
System	95.17	0.028	0.121	0.511

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1_1	CONDUIT	0.082	0 01:13	1.51	0.29	0.37
C1_2	CONDUIT	0.086	0 01:13	1.57	0.30	0.38
C10	CONDUIT	0.005	0 01:34	0.76	0.09	0.20
C11_1	CONDUIT	0.005	0 01:34	0.39	0.07	0.20
C11_3	CONDUIT	0.009	0 01:47	0.48	0.11	0.25
C11_4	CONDUIT	0.013	0 01:45	0.66	0.16	0.31
C2	CONDUIT	0.005	0 01:23	0.60	0.13	0.24
C3	CONDUIT	0.005	0 01:23	0.60	0.13	0.24
C4	CONDUIT	0.086	0 01:13	3.11	0.12	0.23
C4_2	CONDUIT	0.005	0 01:24	0.59	0.13	0.49
C5	CONDUIT	0.067	0 01:11	1.23	1.27	0.72
C6_1	CONDUIT	0.067	0 01:11	0.93	0.80	0.71
C6_3	CONDUIT	0.070	0 01:12	0.98	0.87	0.70
C6_4	CONDUIT	0.073	0 01:12	1.14	0.91	0.64
CB011	CONDUIT	0.023	0 01:10	0.74	0.62	1.00
CB012	CONDUIT	0.040	0 01:10	1.28	0.70	1.00
CB014	CONDUIT	0.013	0 01:10	0.62	0.38	1.00
CB02	CONDUIT	0.029	0 01:10	0.93	0.64	1.00
CB08	CONDUIT	0.049	0 01:10	1.55	1.48	1.00
CB09	CONDUIT	0.039	0 01:10	1.24	0.85	1.00
ICD_010	CONDUIT	0.037	0 01:10	1.17	1.01	1.00
ICD_03	CONDUIT	0.058	0 01:10	1.86	1.33	1.00
ICD_05	CONDUIT	0.060	0 01:10	1.90	2.06	1.00
ICD_06	DUMMY	0.005	0 01:22			
ICD_A	DUMMY	0.003	0 01:41			
ICD_B	DUMMY	0.004	0 01:34			
ICD_C	DUMMY	0.004	0 02:22			
ICD_CB01	DUMMY	0.039	0 01:11			
ICD_CB04	DUMMY	0.062	0 01:11			
ICD_D	DUMMY	0.005	0 01:34			
ICD_F	DUMMY	0.004	0 02:32			
ICD_G	DUMMY	0.004	0 01:45			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		Fraction of Time in Flow Class								
C1_1	1.00	0.06	0.01	0.00	0.02	0.92	0.00	0.00	0.03	0.00
C1_2	1.00	0.06	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00
C10	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
C11_1	1.00	0.06	0.00	0.00	0.94	0.00	0.00	0.00	0.91	0.00
C11_3	1.00	0.06	0.00	0.00	0.94	0.00	0.00	0.00	0.92	0.00
C11_4	1.00	0.06	0.00	0.00	0.16	0.00	0.00	0.78	0.07	0.00
C2	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
C3	1.00	0.06	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00
C4	1.00	0.06	0.00	0.00	0.00	0.93	0.00	0.00	0.05	0.00
C4_2	1.00	0.06	0.00	0.00	0.16	0.00	0.00	0.78	0.11	0.00
C5	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
C6_1	1.00	0.06	0.01	0.00	0.93	0.00	0.00	0.00	0.01	0.00
C6_3	1.00	0.06	0.00	0.00	0.94	0.00	0.00	0.00	0.77	0.00
C6_4	1.00	0.06	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00
CB011	1.00	0.05	0.00	0.00	0.92	0.03	0.00	0.00	0.05	0.00
CB012	1.00	0.05	0.00	0.00	0.91	0.05	0.00	0.00	0.06	0.00
CB014	1.00	0.05	0.00	0.00	0.92	0.03	0.00	0.00	0.05	0.00
CB02	1.00	0.05	0.00	0.00	0.92	0.04	0.00	0.00	0.07	0.00
CB08	1.00	0.05	0.00	0.00	0.91	0.04	0.00	0.00	0.06	0.00
CB09	1.00	0.05	0.00	0.00	0.90	0.05	0.00	0.00	0.07	0.00
ICD_010	1.00	0.05	0.00	0.00	0.89	0.00	0.00	0.06	0.10	0.00
ICD_03	1.00	0.05	0.00	0.00	0.90	0.06	0.00	0.00	0.06	0.00
ICD_05	1.00	0.05	0.00	0.00	0.91	0.05	0.00	0.00	0.05	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C5	0.01	0.01	0.01	0.15	0.01
CB011	4.96	4.96	5.04	0.01	0.01
CB012	4.26	4.26	5.05	0.01	0.01
CB014	4.95	4.95	5.02	0.01	0.01

CB02	4.95	4.95	5.04	0.01	0.01
CB08	4.96	4.96	5.02	0.15	0.15
CB09	4.93	4.93	5.02	0.01	0.01
ICD_010	3.79	3.79	4.09	0.02	0.02
ICD_03	4.96	4.96	5.03	0.13	0.13
ICD_05	4.97	4.97	5.03	0.20	0.20

Analysis begun on: Mon Nov 29 16:04:59 2021
Analysis ended on: Mon Nov 29 16:05:00 2021
Total elapsed time: 00:00:01

APPENDIX

D SUPPORTING DOCUMENTS

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Rev. 9.9

Project Name:	**360 Kennedy Lane**	*Report Date:*	**3/22/2021**
Street:	**-**	*City:*	**Ottawa**
Province:	**ON**	*Country:*	**Canada**
Designer:	**Meaghan O'Neill**	*email:*	**Meaghan.Oneill@wsp.com**

Paste

Treatment Parameters:

Structure ID:	OGS	
TSS Goal:	80	% Removal
TSS Particle Size:	Fine	
Area:	1.2	ha
Percent Impervious:	65%	
Rational C value:	0.64	Calc. Cn
Rainfall Station:	Ottawa, ONT	MAP
Peak Storm Flow:	-	L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	**81.7%**	**97.6%**
FD-4HC	86.2%	99.5%
FD-5HC	90.1%	99.9%
FD-6HC	92.3%	100.0%
FD-8HC	95.2%	99.9%

Model Specification:

Model:	**FD-3HC**	
Diameter:	900	mm
Peak Flow Capacity:	425.00	L/s
Sediment Storage:	0.31	m^3
Oil Storage:	473.00	L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	*OK*
Inlet Pipe 1 Size:		mm	*OK*
Inlet Pipe 2 Size:		mm	*OK*
Inlet Pipe 3 Size:		mm	*OK*
Rim Level:		m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	*OK!*
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Designer Notes:

Net Annual Removal Model: FD-3HC

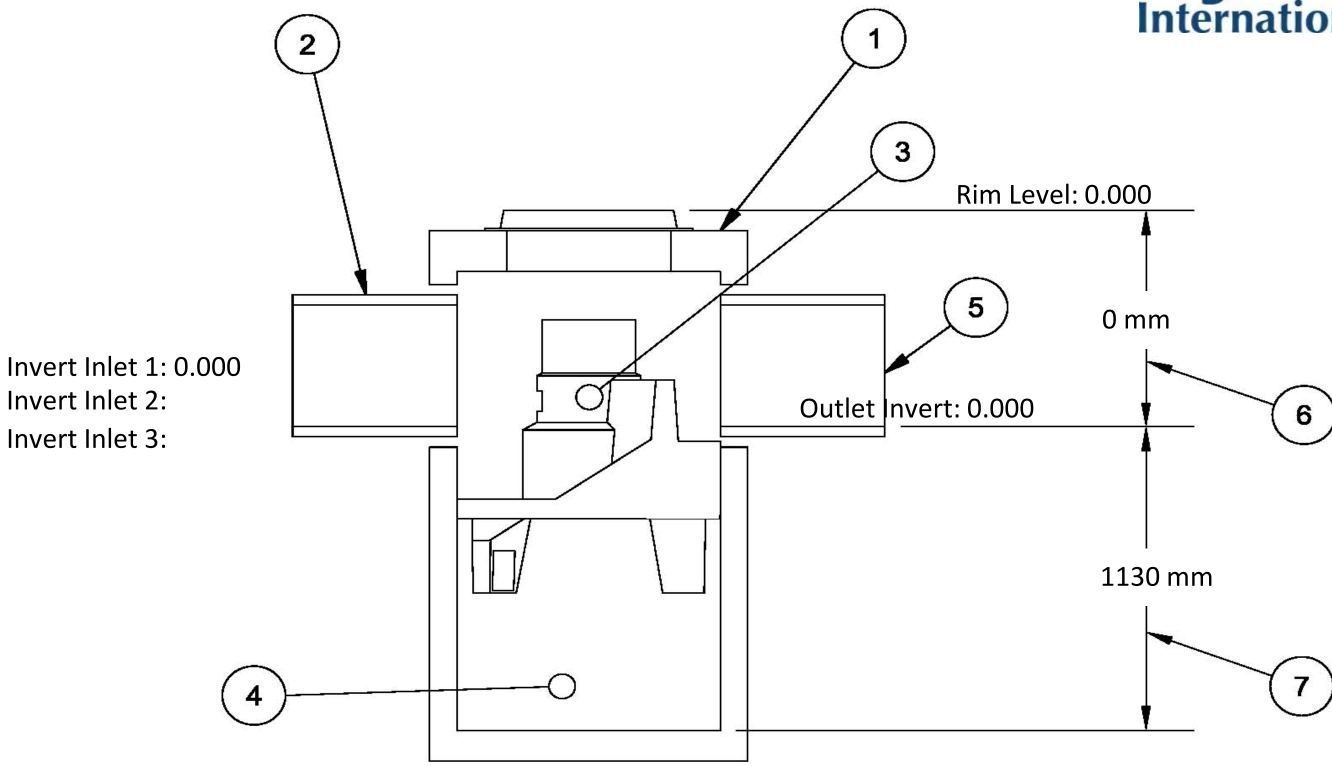
Intensity[1] (mm/hr)	Fraction of Rainfall[1] (%)	FD-3HC Removal Efficiency[2] (%)	Weighted Net Annual Efficiency (%)
0.50	0.1%	98.0%	0.1%
1.00	14.1%	91.9%	13.0%
1.50	14.2%	88.5%	12.6%
2.00	14.1%	86.1%	12.2%
2.50	4.2%	84.4%	3.5%
3.00	1.5%	82.9%	1.2%
3.50	8.5%	81.8%	7.0%
4.00	5.4%	80.7%	4.4%
4.50	1.2%	79.9%	0.9%
5.00	5.5%	79.1%	4.4%
6.00	4.3%	77.8%	3.4%
7.00	4.5%	76.7%	3.5%
8.00	3.1%	75.7%	2.3%
9.00	2.3%	74.9%	1.7%
10.00	2.6%	74.2%	1.9%
20.00	9.2%	69.5%	6.4%
30.00	2.6%	67.0%	1.8%
40.00	1.2%	65.2%	0.8%
50.00	0.5%	63.8%	0.3%
100.00	0.7%	59.9%	0.4%
150.00	0.1%	57.6%	0.0%
200.00	0.0%	56.1%	0.0%
Total Net Annual Removal Efficiency:			**81.7%**
Total Annual Runoff Volume Treated:			**97.6%**

1. Rainfall Data: 1960:2007, HLY03, Ottawa, ONT, 6105976 & 6105978.

2. Based on third party verified data and appoximating the removal of a PSD similar to the STC Fine distribution

3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Hydro First Defense® - HC



All drawing elevations are metres.

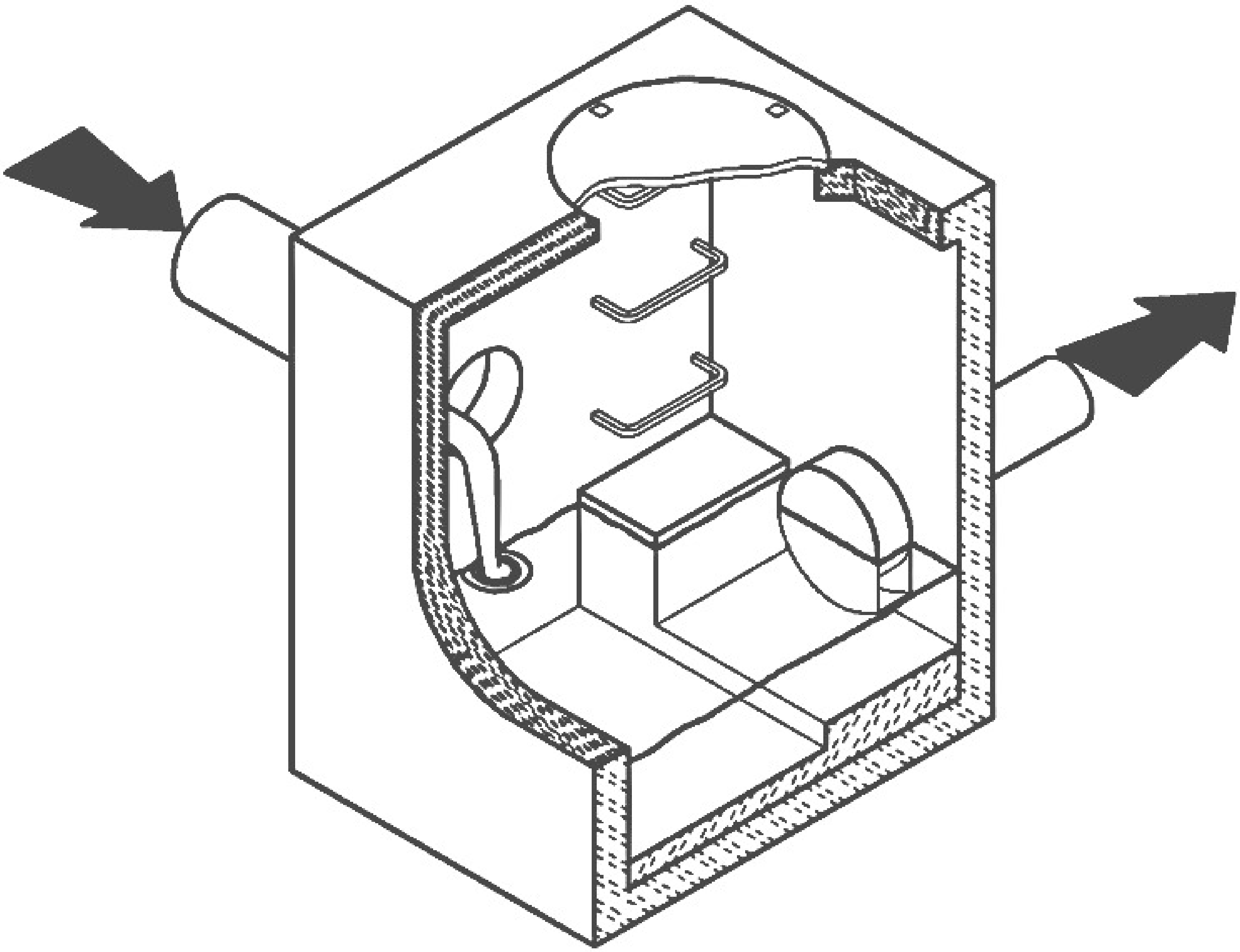
FD-3HC Specification

1	Vortex Chamber Diameter	900	mm
2	Inlet Pipe Diameter	0	mm
3	Oil Storage Capacity	473.00	L
4	Min. Provided Sediment Storage Capacity	0.31	m^3
5	Outlet Pipe Diameter	0	mm
6	Height(Final Grade to Outlet Invert)	0	mm

Notes:

7	Sump Depth(Outlet Invert to Sump)	1130	mm
	Total Depth	**1130**	**mm**

® HYDROVEX® VHV / SVHV
Vertical Vortex Flow Regulator



JOHN MEUNIER

APPLICATIONS

One of the major problems of urban wet weather flow management is the runoff generated after a heavy rainfall. During a storm, uncontrolled flows may overload the drainage system and cause flooding. Due to increased velocities, sewer pipe wear is increased dramatically and results in network deterioration. In a combined sewer system, the wastewater treatment plant may also experience significant increases in flows during storms, thereby losing its treatment efficiency.

A simple means of controlling excessive water runoff is by controlling excessive flows at their origin (manholes). **John Meunier Inc.** manufactures the **HYDROVEX® VHV / SVHV** line of vortex flow regulators to control stormwater flows in sewer networks, as well as manholes.

The vortex flow regulator design is based on the fluid mechanics principle of the forced vortex. This grants flow regulation without any moving parts, thus reducing maintenance. The operation of the regulator, depending on the upstream head and discharge, switches between orifice flow (gravity flow) and vortex flow. Although the concept is quite simple, over 12 years of research have been carried out in order to get a high performance.

The **HYDROVEX® VHV / SVHV** Vertical Vortex Flow Regulators **(refer to Figure 1)** are manufactured entirely of stainless steel, and consist of a hollow body (**1**) (in which flow control takes place) and an outlet orifice (**7**). Two rubber "O" rings (**3**) seal and retain the unit inside the outlet pipe. Two stainless steel retaining rings (**4**) are welded on the outlet sleeve to ensure that there is no shifting of the "O" rings during installation and use.

1. **BODY**
2. **SLEEVE**
3. **O-RING**
4. **RETAINING RINGS (SQUARE BAR)**
5. **ANCHOR PLATE**
6. **INLET**
7. **OUTLET ORIFICE**

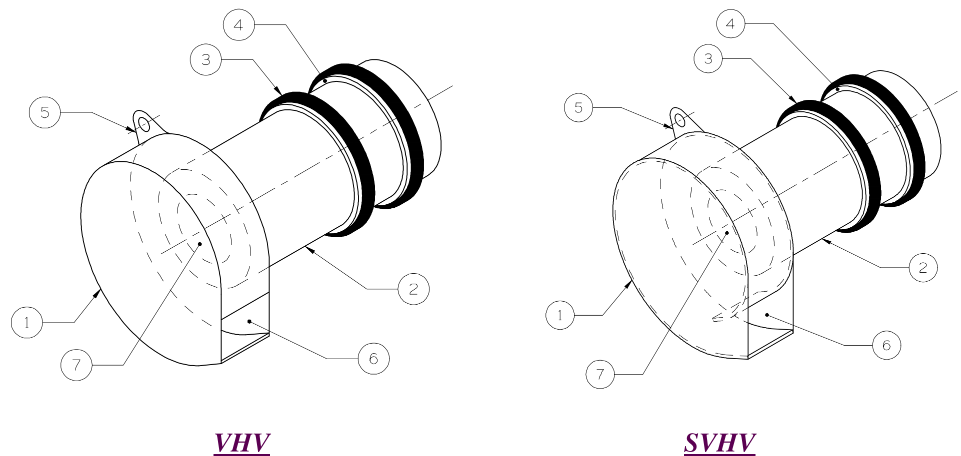


FIGURE 1: HYDROVEX® VHV-SVHV VERTICAL VORTREX FLOW REGULATORS

ADVANTAGES

- The **HYDROVEX® VHV / SVHV** line of flow regulators are manufactured entirely of stainless steel, making them durable and corrosion resistant.
- Having no moving parts, they require minimal maintenance.
- The geometry of the **HYDROVEX® VHV / SVHV** flow regulators allows a control equal to an orifice plate, having a cross section area 4 to 6 times smaller. This decreases the chance of blockage of the regulator, due to sediments and debris found in stormwater flows. **Figure 2** illustrates the comparison between a regulator model 100 SVHV-2 and an equivalent orifice plate. One can see that for the same height of water, the regulator controls a flow approximately four times smaller than an equivalent orifice plate.
- Installation of the **HYDROVEX® VHV / SVHV** flow regulators is quick and straightforward and is performed after all civil works are completed.
- Installation requires no special tools or equipment and may be carried out by any contractor.
- Installation may be carried out in existing structures.

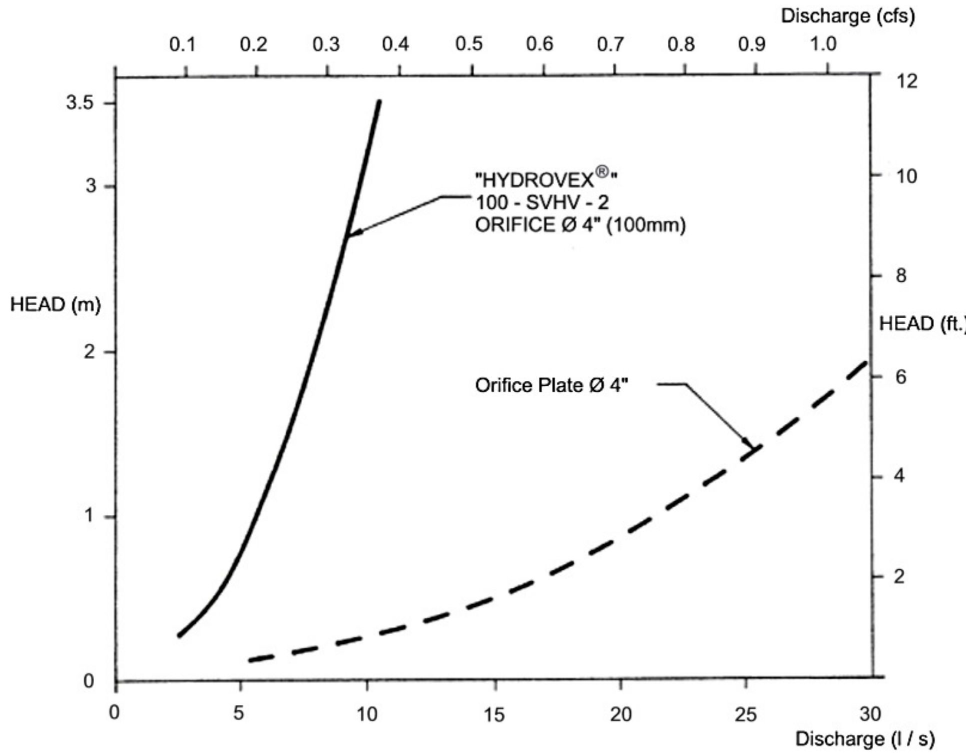


FIGURE 2: DISCHARGE CURVE SHOWING A HYDROVEX® FLOW REGULATOR VS AN ORIFICE PLATE

SELECTION

Selection of a **VHV or SVHV** regulator can be easily made using the selection charts found at the back of this brochure (see **Figure 3**). These charts are a graphical representation of the maximum upstream water pressure (head) and the maximum discharge at the manhole outlet. The maximum design head is the difference between the maximum upstream water level and the invert of the outlet pipe. All selections should be verified by John Meunier Inc. personnel prior to fabrication.

Example:

✓ Maximum design head	2m (6.56 ft.)
✓ Maximum discharge	6 L/s (0.2 cfs)
✓ Using **Figure 3** - VHV	model required is a **75 VHV-1**

INSTALLATION REQUIREMENTS

All **HYDROVEX® VHV / SVHV** flow regulators can be installed in circular or square manholes. **Figure 4** gives the various minimum dimensions required for a given regulator. ***It is imperative to respect the minimum clearances shown to ensure easy installation and proper functioning of the regulator.***

SPECIFICATIONS

In order to specify a **HYDROVEX®** regulator, the following parameters must be defined:

- The model number (ex: 75-VHV-1)
- The diameter and type of outlet pipe (ex: 6" diam. SDR 35)
- The desired discharge (ex: 6 l/s or 0.21 CFS)
- The upstream head (ex: 2 m or 6.56 ft.) *
- The manhole diameter (ex: 36" diam.)
- The minimum clearance "H" (ex: 10 inches)
- The material type (ex: 304 s/s, 11 Ga. standard)

* ***Upstream head is defined as the difference in elevation between the maximum upstream water level and the invert of the outlet pipe where the HYDROVEX® flow regulator is to be installed.***

PLEASE NOTE THAT WHEN REQUESTING A PROPOSAL, WE SIMPLY REQUIRE THAT YOU PROVIDE US WITH THE FOLLOWING:

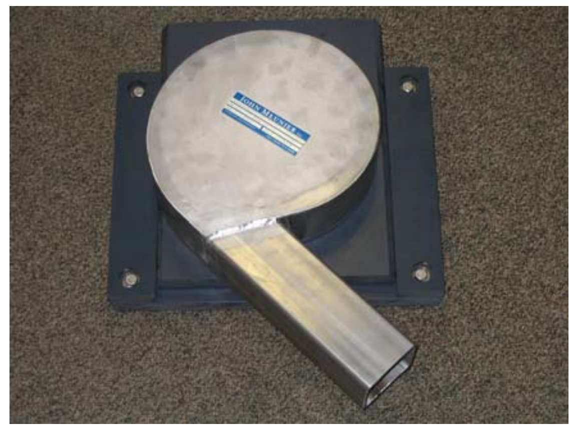
- ***project design flow rate***
- ***pressure head***
- ***chamber's outlet pipe diameter and type***

Typical VHV model in factory

OPTIONS

FV – SVHV (mounted on sliding plate)

VHV-1-O (standard model with odour control inlet)



FV – VHV-O (mounted on sliding plate with odour control inlet)

VHV with Gooseneck assembly in existing chamber without minimum release at the bottom

VHV with air vent for minimal slopes

HYDROVEX®

VHV Vertical Vortex Flow Regulator

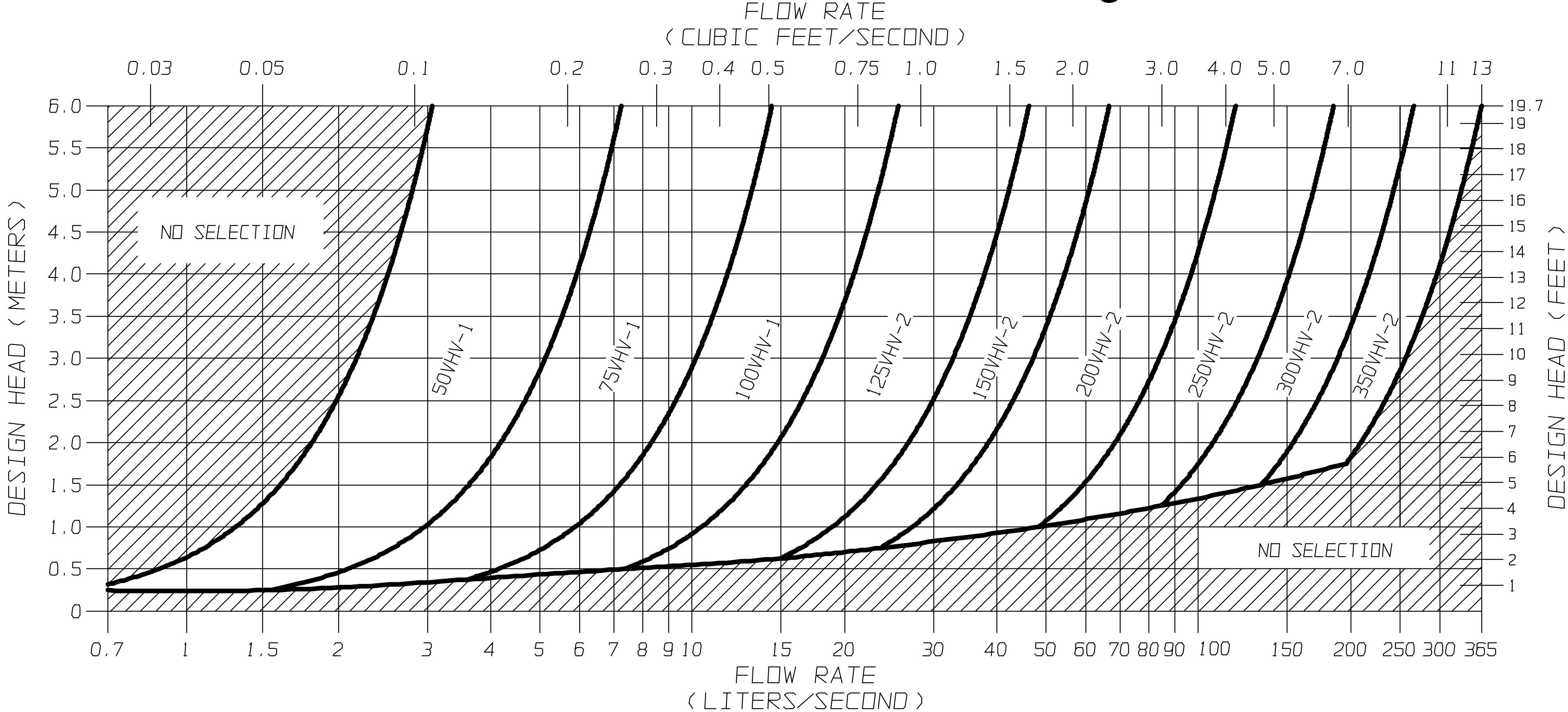


FIGURE 3 - VHV

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HYDROVEX®

SVHV Vertical Vortex Flow Regulator

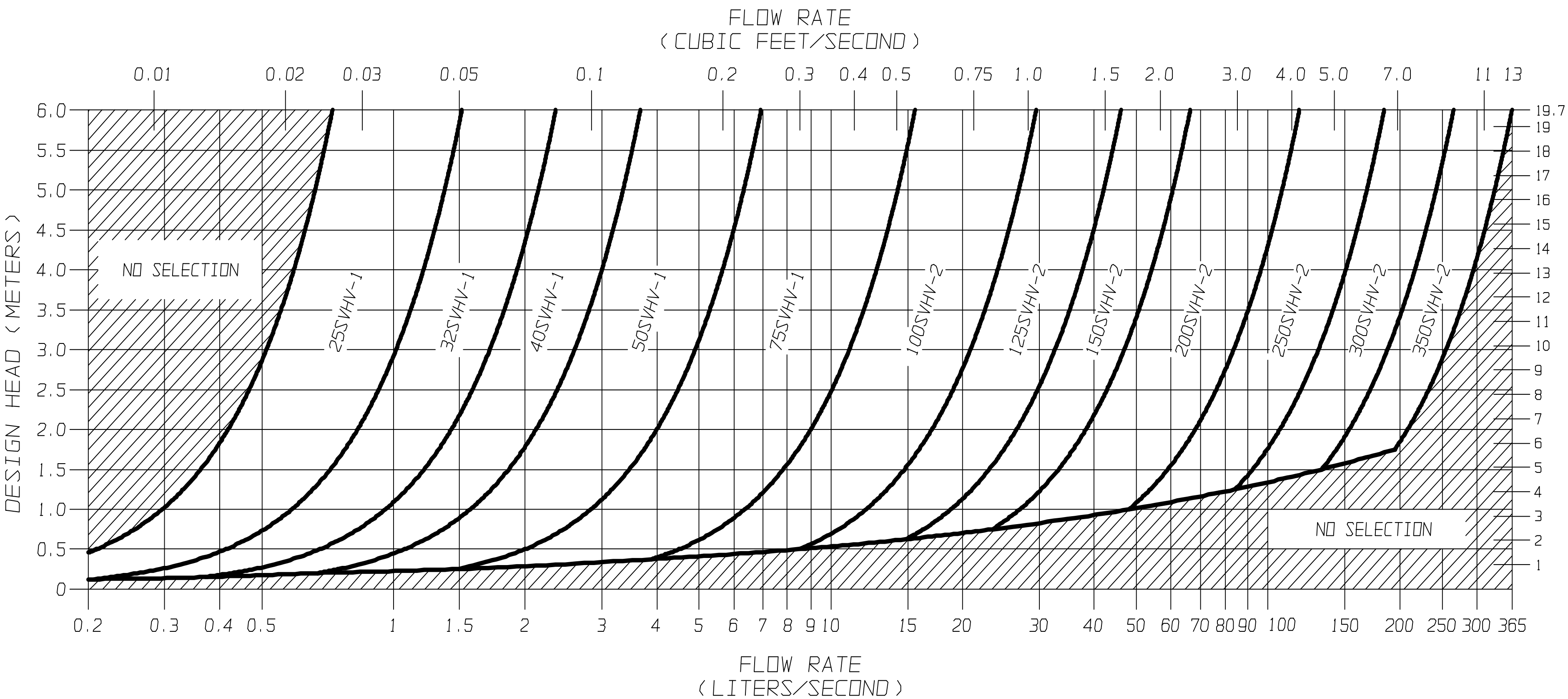
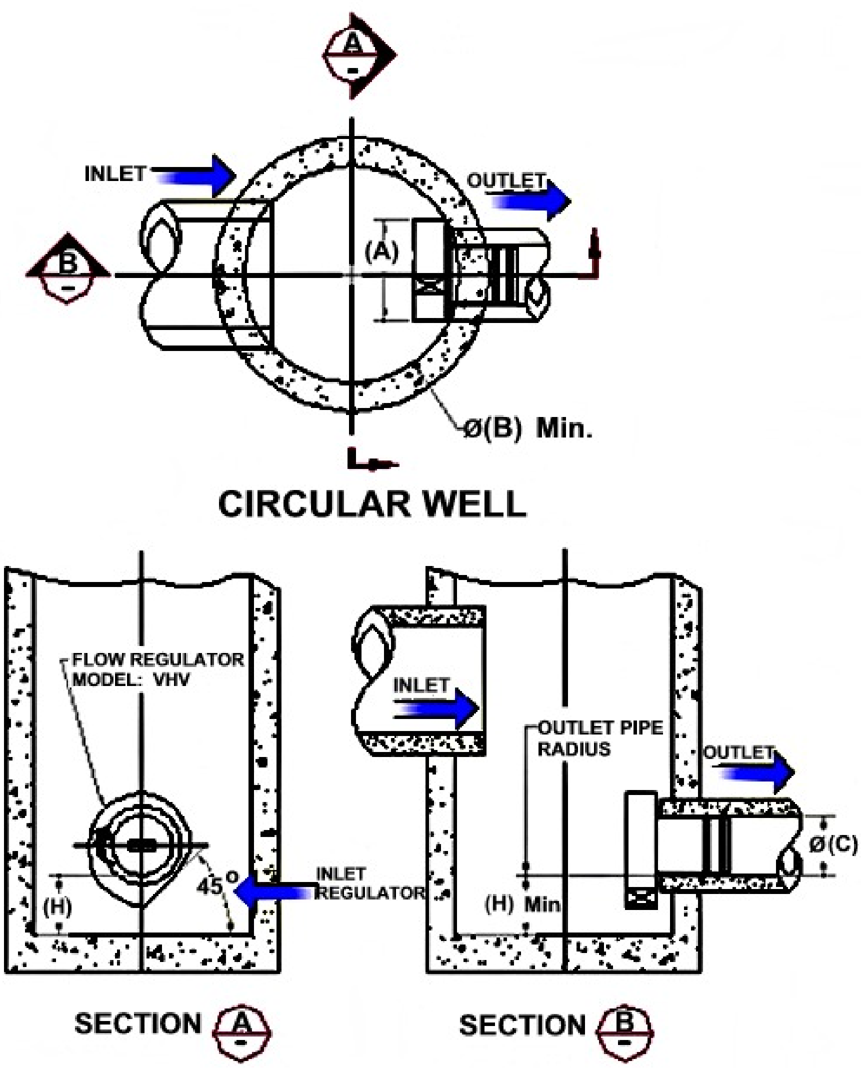


FIGURE 3 - SVHV

JOHN MEUNIER

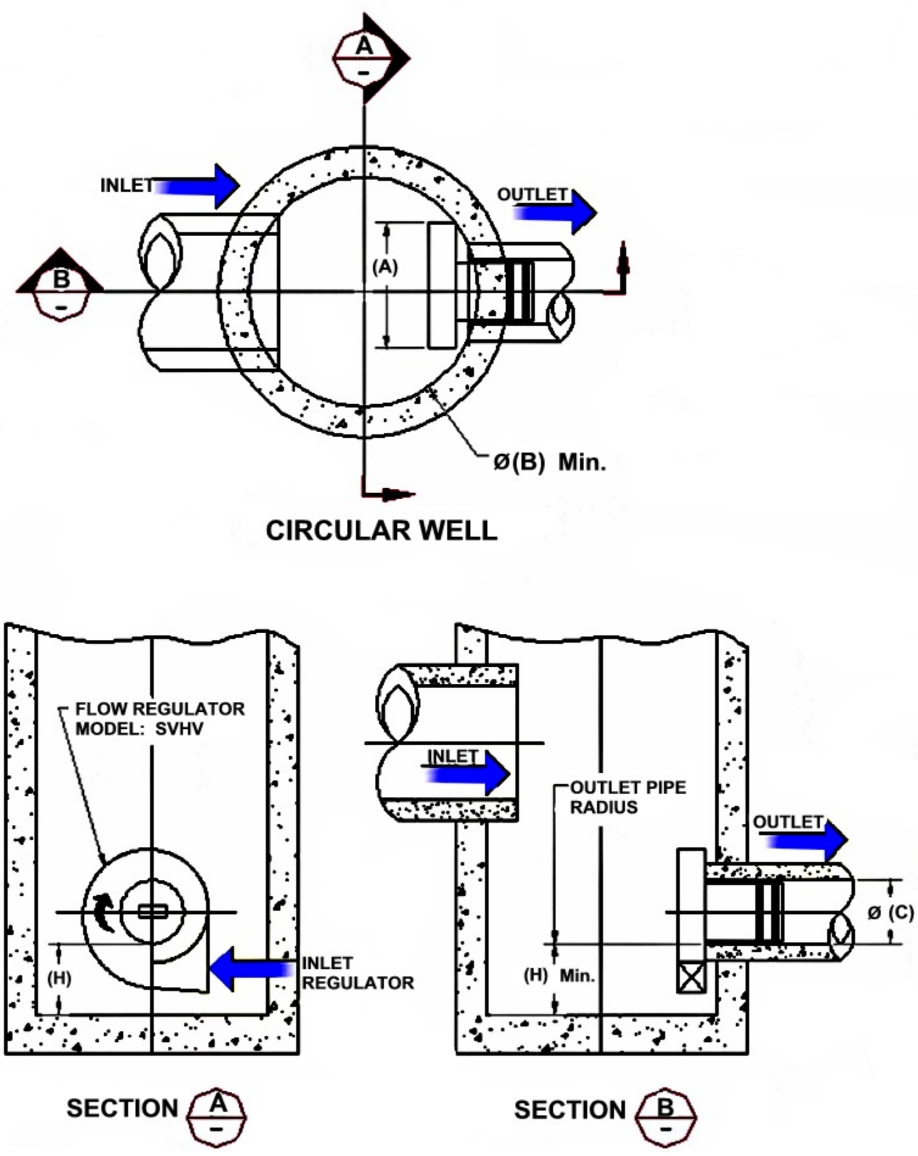
FLOW REGULATOR TYPICAL INSTALLATION IN CIRCULAR MANHOLE
FIGURE 4 (MODEL VHV)

Model Number	Regulator Diameter		Minimum Manhole Diameter		Minimum Outlet Pipe Diameter		Minimum Clearance	
	A (mm)	**A** (in.)	**B** (mm)	**B** (in.)	**C** (mm)	**C** (in.)	**H** (mm)	**H** (in.)
50VHV-1	150	6	600	24	150	6	150	6
75VHV-1	250	10	600	24	150	6	150	6
100VHV-1	325	13	900	36	150	6	200	8
125VHV-2	275	11	900	36	150	6	200	8
150VHV-2	350	14	900	36	150	6	225	9
200VHV-2	450	18	1200	48	200	8	300	12
250VHV-2	575	23	1200	48	250	10	350	14
300VHV-2	675	27	1600	64	250	10	400	16
350VHV-2	800	32	1800	72	300	12	500	20



FLOW REGULATOR TYPICAL INSTALLATION IN CIRCULAR MANHOLE
FIGURE 4 (MODEL SVHV)

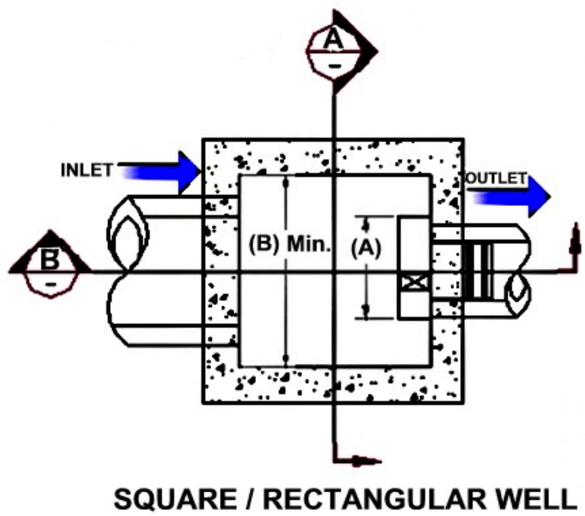
Model Number	Regulator Diameter		Minimum Manhole Diameter		Minimum Outlet Pipe Diameter		Minimum Clearance	
	A (mm)	**A** (in.)	**B** (mm)	**B** (in.)	**C** (mm)	**C** (in.)	**H** (mm)	**H** (in.)
25 SVHV-1	125	5	600	24	150	6	150	6
32 SVHV-1	150	6	600	24	150	6	150	6
40 SVHV-1	200	8	600	24	150	6	150	6
50 SVHV-1	250	10	600	24	150	6	150	6
75 SVHV-1	375	15	900	36	150	6	275	11
100 SVHV-2	275	11	900	36	150	6	250	10
125 SVHV-2	350	14	900	36	150	6	300	12
150 SVHV-2	425	17	1200	48	150	6	350	14
200 SVHV-2	575	23	1600	64	200	8	450	18
250 SVHV-2	700	28	1800	72	250	10	550	22
300 SVHV-2	850	34	2400	96	250	10	650	26
350 SVHV-2	1000	40	2400	96	250	10	700	28

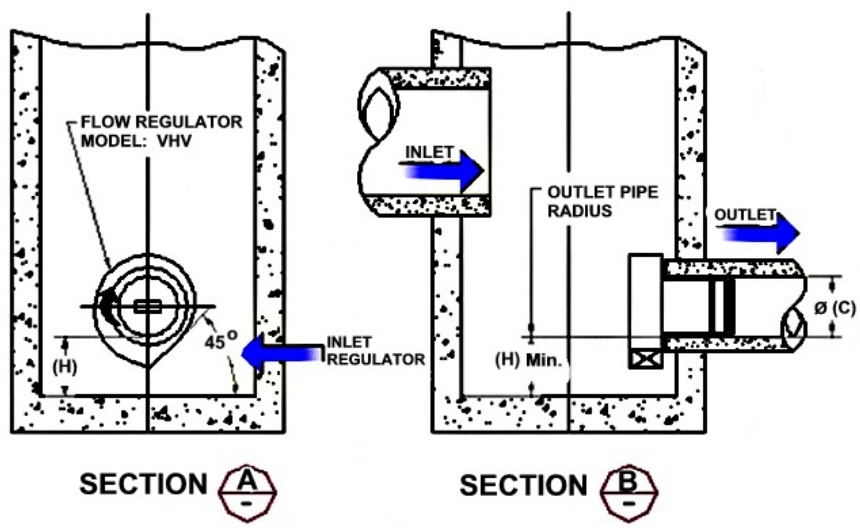


FLOW REGULATOR TYPICAL INSTALLATION IN SQUARE MANHOLE
FIGURE 4 (MODEL VHV)

Model Number	Regulator Diameter		Minimum Chamber Width		Minimum Outlet Pipe Diameter		Minimum Clearance	
	A (mm)	**A** (in.)	**B** (mm)	**B** (in.)	**C** (mm)	**C** (in.)	**H** (mm)	**H** (in.)
50VHV-1	150	6	600	24	150	6	150	6
75VHV-1	250	10	600	24	150	6	150	6
100VHV-1	325	13	600	24	150	6	200	8
125VHV-2	275	11	600	24	150	6	200	8
150VHV-2	350	14	600	24	150	6	225	9
200VHV-2	450	18	900	36	200	8	300	12
250VHV-2	575	23	900	36	250	10	350	14
300VHV-2	675	27	1200	48	250	10	400	16
350VHV-2	800	32	1200	48	300	12	500	20

NOTE: *In the case of a square manhole, the outlet flow pipe must be centered on the wall to ensure enough clearance for the unit.*

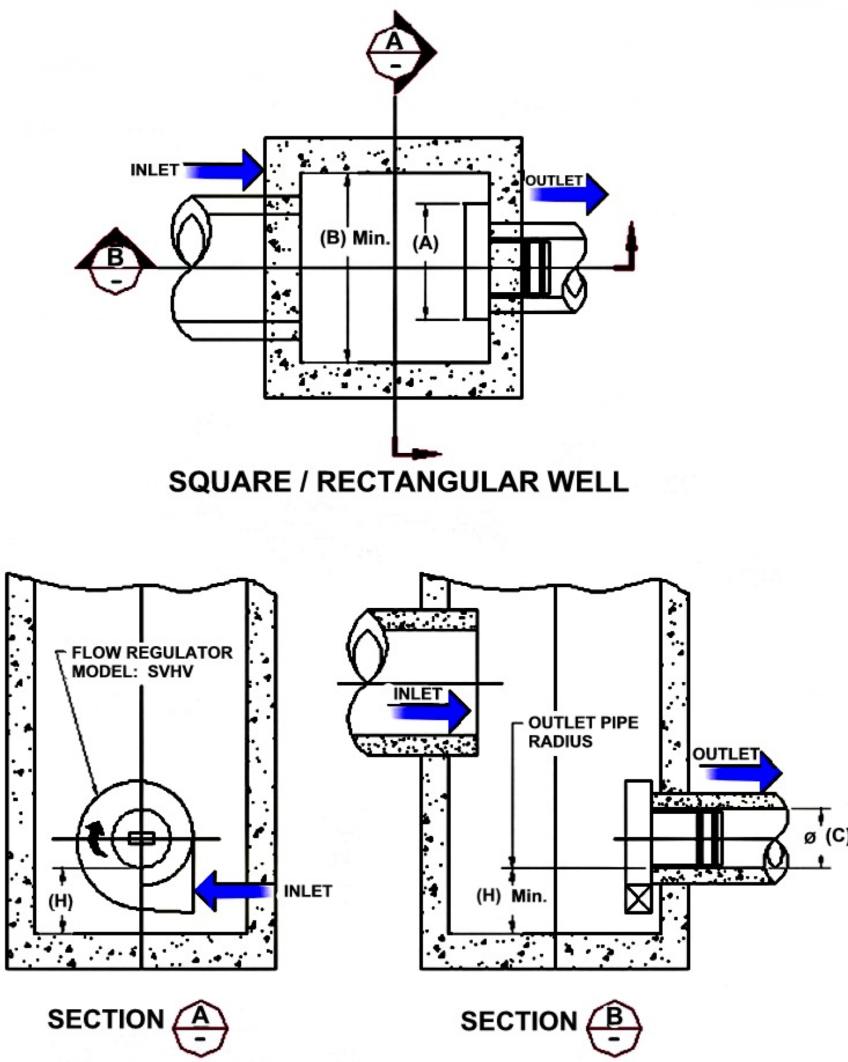




FLOW REGULATOR TYPICAL INSTALLATION IN SQUARE MANHOLE
FIGURE 4 (MODEL SVHV)

Model Number	Regulator Diameter		Minimum Chamber Width		Minimum Outlet Pipe Diameter		Minimum Clearance	
	A (mm)	**A** (in.)	**B** (mm)	**B** (in.)	**C** (mm)	**C** (in.)	**H** (mm)	**H** (in.)
25 SVHV-1	125	5	600	24	150	6	150	6
32 SVHV-1	150	6	600	24	150	6	150	6
40 SVHV-1	200	8	600	24	150	6	150	6
50 SVHV-1	250	10	600	24	150	6	150	6
75 SVHV-1	375	15	600	24	150	6	275	11
100 SVHV-2	275	11	600	24	150	6	250	10
125 SVHV-2	350	14	600	24	150	6	300	12
150 SVHV-2	425	17	600	24	150	6	350	14
200 SVHV-2	575	23	900	36	200	8	450	18
250 SVHV-2	700	28	900	36	250	10	550	22
300 SVHV-2	850	34	1200	48	250	10	650	26
350 SVHV-2	1000	40	1200	48	250	10	700	28

NOTE: *In the case of a square manhole, the outlet flow pipe must be centered on the wall to ensure enough clearance for the unit.*



INSTALLATION

The installation of a **HYDROVEX®** regulator may be undertaken once the manhole and piping is in place. Installation consists of simply fitting the regulator into the outlet pipe of the manhole. **John Meunier Inc.** recommends the use of a lubricant on the outlet pipe, in order to facilitate the insertion and orientation of the flow controller.

MAINTENANCE

HYDROVEX® regulators are manufactured in such a way as to be maintenance free; however, a periodic inspection (every 3-6 months) is suggested in order to ensure that neither the inlet nor the outlet has become blocked with debris. The manhole should undergo periodically, particularly after major storms, inspection and cleaning as established by the municipality

GUARANTY

The **HYDROVEX®** line of **VHV / SVHV** regulators are guaranteed against both design and manufacturing defects for a period of 5 years. Should a unit be defective, **John Meunier Inc.** is solely responsible for either modification or replacement of the unit.

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ISO 9001 : 2008

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