S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing Report

4063 UPPER MIDDLE ROAD

CITY OF BURLINGTON

January 2017

SLA File: 16115

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by thinkGiraffe Environmental Design to provide Consulting Engineering services for the proposed development at 4063 Upper Middle Road in the City of Burlington (see Figure 1.0 for location plan). This report will outline the functional servicing and stormwater management strategy for the proposed development.

The proposed development consists of constructing a 7-storey residential apartment building. The 7-storey building will contain a total of 32 residential units and a 3-level parking structure.

This Functional Servicing Report will provide detailed information of the proposed servicing scheme for this development. Please refer to the preliminary site engineering plans prepared by S. Llewellyn and Associates Limited and the preliminary site plan prepared by thinkGiraffe Environmental Design for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)

Ref. 2: City of Burlington Standard Drawings (City of Burlington, March 2004)

Ref. 3: Halton Region Water and Wastewater Linear Design Manual (Halton Region, May 2014)

Ref. 4: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)



Figure 1.0 – Location Plan

2.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the City of Burlington:

Quantity Control
The stormwater discharge rate for the proposed site shall be controlled to the 5-year pre-development condition discharge rate for all storm events up to and including the 100-year event.

Quality Control
The stormwater runoff from the prosed condition site must meet Level 1 (Enhanced) stormwater quality control (80% TSS removal, 90% average annual runoff treatment).

Erosion Control
Erosion and sediment control measures will be implemented in accordance with the standards of the City of Burlington.

2.1 EXISTING CONDITIONS

In the existing conditions, the subject land is currently a residential lot with gravel, grassed areas and an existing 1-story dwelling. The site is bound by Upper Middle Road to the south, and existing residential units to the north, east and west. Approximately half of the existing site drains to the 900mmø storm sewer along Upper Middle Road and the remaining half drains to Shoreacres Creek at the northeast portion of the property.

Two catchment areas, Catchment 101 and 102 have been identified in the existing condition. Catchment 101 represents the existing conditions discharging to Upper Middle Road, Catchment 102 represents the existing conditions discharging to Shoreacres Creek. See Table 2.1 below and the Pre-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.1- Pre-Development Catchment Areas

Catchment ID	Description	Area (ha)	% Imp.	Runoff Coefficient
101	To Upper Middle Road	0.313	21	0.39
102	To Shoreacres Creek	0.262	0	0.25

An analysis was performed on Catchment 101 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2-year to 100-year City of Burlington Design Storms. A summary of the results can be found in Table 2.2 below and the detailed SWMHYMO input/output information in Appendix B. Catchment 102 is not included in this analysis as it will remain unchanged from its existing condition.

Table 2.2 - Pre-Development Condition Site Discharge (Catchment 101)

Storm Event	Catchment 101 Discharge (m^3/s)
2-Yr Event	0.013
5-Yr Event	0.019
10-Yr Event	0.025
25-Yr Event	0.033
50-Yr Event	0.040
100-Yr Event	0.046

2.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a 7-storey residential apartment building which will contain a total of 32 residential units and underground parking. It is proposed to service the site with a private storm sewer system, designed and constructed in accordance with the City of Burlington Standards.

Three catchment areas, Catchment 201, 202 and 203 have been identified in the proposed condition. Catchment 201 represents drainage that is captured from the roof of the proposed building, the asphalt parking and landscape area around the building which

will outlet via the proposed 250mmø storm sewer and discharge to the existing 900mmø storm sewer along Upper Middle Road. Catchment 202 represents the existing conditions discharging to the creek that will remain unchanged. Catchment 203 represents the uncontrolled drainage at the frontage on the property that will drain to Upper Middle Road. See Table 2.3 below and the Post-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.3- Post-Development Catchment Area

Catchment ID	Description	Area (ha)	% Imp.	Runoff Coefficient
201	Controlled to Upper Middle Road	0.302	55	0.62
203	Uncontrolled to Upper Middle Road	0.011	66	0.68

Water Quantity Control

It is required to provide quantity control measures for the runoff from Catchment 201 by means of a 100mmø orifice pipe to restrict discharge from the area to 0.019m^3/s between storm MH1 and MH2. It is proposed to over control this area to include the runoff from Catchment 203. See Preliminary Site Servicing Plan for orifice pipe location.

With the installation of the quantity control measures, Catchment 201 will be required to provide stormwater storage during storm events. To provide the required storage for Catchment 201, it is proposed to install a StormTech MC-4500 tanks under the proposed asphalt parking area. It is determined that the tanks will provide a total of 70m^3 of storage volume which will accommodate the stormwater storage required during the 100-year event.

Details of the proposed storage tanks can be found in the Preliminary Site Servicing Plan. The stage-storage-discharge characteristics can be seen in Table 2.4 and Appendix A.

Table 2.4 - Post-Development Condition Stage-Storage-Discharge (Catchment 201)

Elevation (m)	Underground Storage (m^3)	Discharge (m^3/s)
135.35 (Orifice Invert)	0	0.0000
135.59 (Bottom of Tank)	0	0.0029
136.09 (0.5m Depth)	23	0.0094
136.59 (1.0m Depth)	46	0.0135
137.12 (Top of Tank)	70	0.0162

An analysis was performed on Catchment 201 & 203 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2-year to 100-year City of Burlington Design Storms. A summary of the results can be found in Table 2.5 below and the detailed SWMHYMO input/output information in Appendix B. Catchment 202 is not included in this analysis as it will remain unchanged from its existing condition.

Table 2.5 - Post-Development Condition Site Discharge					
Storm Event	Catchment 201 Discharge (m^3/s)	Catchment 203 Discharge (m^3/s)	Total Discharge (m^3/s)	Allowable Discharge Rate (Catchment 101) (m^3/s)	Required Storage (m^3)
2-Yr Event	0.009	0.001	0.009	0.019	20.7
5-Yr Event	0.011	0.002	0.011	0.019	30.3
10-Yr Event	0.012	0.002	0.013	0.019	37.9
25-Yr Event	0.014	0.003	0.014	0.019	48.1
50-Yr Event	0.015	0.003	0.015	0.019	56.1
100-Yr Event	0.016	0.003	0.017	0.019	64.6

This analysis determined the following:

- The proposed condition discharge rates will not exceed the existing 5-year discharge rate of $0.019m^3/s$ during the 2-year to 100-year design storms, with the installation of a 100mmø orifice pipe between storm MH1 and MH2.

- $64.7m^3$ of stormwater storage is required during the 100-year event, which can be accommodated by the proposed StormTech MC-4500 tanks.

Water Quality Control

The proposed development is required to achieve an "Enhanced" (80% TSS removal) level of water quality protection. To achieve this criteria, discharge from Catchment 201 will be subject to treatment from a Hydroguard oil/grit separator before ultimately discharging to the existing 900mmø storm sewer along Upper Middle Road. The Hydroguard sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a Hydroguard HG4 will provide 99% TSS removal and 99% average annual runoff treatment, which satisfies the requirements for an "Enhanced" level for quality control. See Hydroguard unit sizing procedures in Appendix C for details.

Hydroguard units require regular inspection and maintenance as per the manufacturer's specifications to ensure the unit operates properly. See Hydroguard Maintenance Manual in Appendix C for details.

2.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;

- Install sediment control (silt sacks) in the proposed catchbasins as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system

- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, outlets, vegetation, etc.) with follow up reports to the governing municipality; and

- The developer and/or his contractor shall be responsible for any costs incurred during the remediation of problem areas.

Details of the proposed erosion & sediment control measures will be provided on the Erosion and Sediment Control Plans, which will be provided upon final design.

3.0 SANITARY SEWER SERVICING

3.1 EXISTING CONDITIONS

The site is located on Upper Middle Road, north of Walkers Line with an existing 200mmø sanitary sewer located along the frontage of Upper Middle Road.

3.2 SANITARY DEMAND

Sanitary discharge from the site was estimated in accordance with the Halton Region Water and Wastewater Linear Design Manual (Ref. 3). Table 3.1 summarizes the sanitary sewer discharge rate from the subject lands.

Table 3.1 – Proposed Sanitary Sewer Discharge

Site Area	0.31 ha
Population [A] (Apartment)	32 units x 2 bedroom units = 64 persons
Average Dry Weather Flow [B]	275 l/cap/day x 64 persons = 0.204 l/s
Harmon Peaking Factor [C]	4.29
Infiltration Allowance [D]	0.003 l/s/ha x 0.31 ha = 0.0009 l/s
Design Flow	(0.204 x 4.29) + 0.0009 = **0.876 l/s**

[A] Type of Development to be Apartment
[B] Average demand = 275l/cap/day x population
[C] Peaking Factor = $(1 + (14/(4 + P_e^{0.5})))$ with P_e being the equivalent tributary population in thousands
[D] Infiltration based on 0.00318 l/s/ha infiltration rate

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed apartment building will be serviced by a private 150mmø sanitary sewer system, designed and constructed in accordance with the Halton Region standards. Drainage from this sewer will discharge to the existing 200mmø sanitary sewer along Upper Middle Road.

The minimum grade of the proposed 150mmø sanitary will be 1.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.015 m^3/s (15 l/s). Therefore, the proposed 150mmø sanitary sewer at 1.0% grade is adequately sized to service the proposed development.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 400mmø and 600mmø distribution watermain located along Upper Middle Road. The nearest existing municipal fire hydrant is located at 4045 Upper Middle Road approximately 33m west of the proposed development.

4.2 DOMESTIC WATER DEMAND

Water demand for the site was estimated in accordance with the Halton Region Water and Wastewater Linear Design Manual (Ref.3). Table 4.1 summarizes the domestic water demand requirements for the Average Daily, Maximum Daily and Peaking Hourly demand scenarios.

Table 4.1 – Proposed Development Domestic Water Demand

Total Population [A]	64 persons
Average Daily Demand [B]	0.204 l/s
Max. Daily Peaking Factor [C]	2.25
Max. Hourly Peaking Factor [C]	4.00
Max. Daily Demand	(0.204 L/s x 2.25) **= 0.459 L/s**
Max. Hourly Demand	(0.204 L/s x 4.00) **= 0.816 L/s**

[A] (32 units x 2 bedroom units) = 64 persons
[B] Average Daily Demand = 275 l/cap/day x population
[C] Max. Daily Peaking Factor = 2.25 (refer to sentence 2.4.1)
[D] Max. Hourly Peaking Factor = 4.00 (refer to Table 2-2)
[E] Max. Daily Demand = Average Daily Demand x Max. Daily Peaking Factor
[F] Max. Hourly Demand = Average Daily Demand x Max. Hourly Peaking Factor

4.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA).

At this stage of development it is understood that the proposed 7-storey apartment building will constructed of non-combustible construction (C=0.8), with limited combustible occupancy (-15% correction) and a fully supervised sprinkler system (-50% correction).

Based on the FUS, the fire flow demand required for the proposed site is **10,000 l/min (167 l/s).** See Fire Flow Demand Requirements in Appendix D for calculations and details.

4.4 PROPOSED WATER SERVICING AND ANALYSIS

The proposed water servicing for the subject site consists of installing a 150mmø watermain which will be split at property line to provide a 100mmø domestic and 150mmø fire water service for the proposed development. Water services for the site are to be designed and constructed in accordance with the Halton Region standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development of 421 - 431 Brant Street can be constructed to meet the requirements of the City of Burlington and Halton Region. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading Plan and the Preliminary Site Servicing Plan prepared by S.Llewellyn & Associates Limited;

- A 100mmø orifice pipe be installed as per the Preliminary Site Servicing Plan and this report to provide adequate quantity control;

- Stormtech MC-4500 tanks be installed as per the Preliminary Site Servicing Plan and this report to provide adequate stormwater storage during storm events;

- Erosion and sediment controls be installed as described in this report to meet City of Burlington requirements;

- The proposed sanitary and water servicing system be installed as per this report to adequately service the proposed development;

- This report be used as the basis for the servicing and stormwater management design. All design data, assumptions and calculations will be confirmed and/or updated as part of the future Site Plan Approval submission.

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

Prepared by:

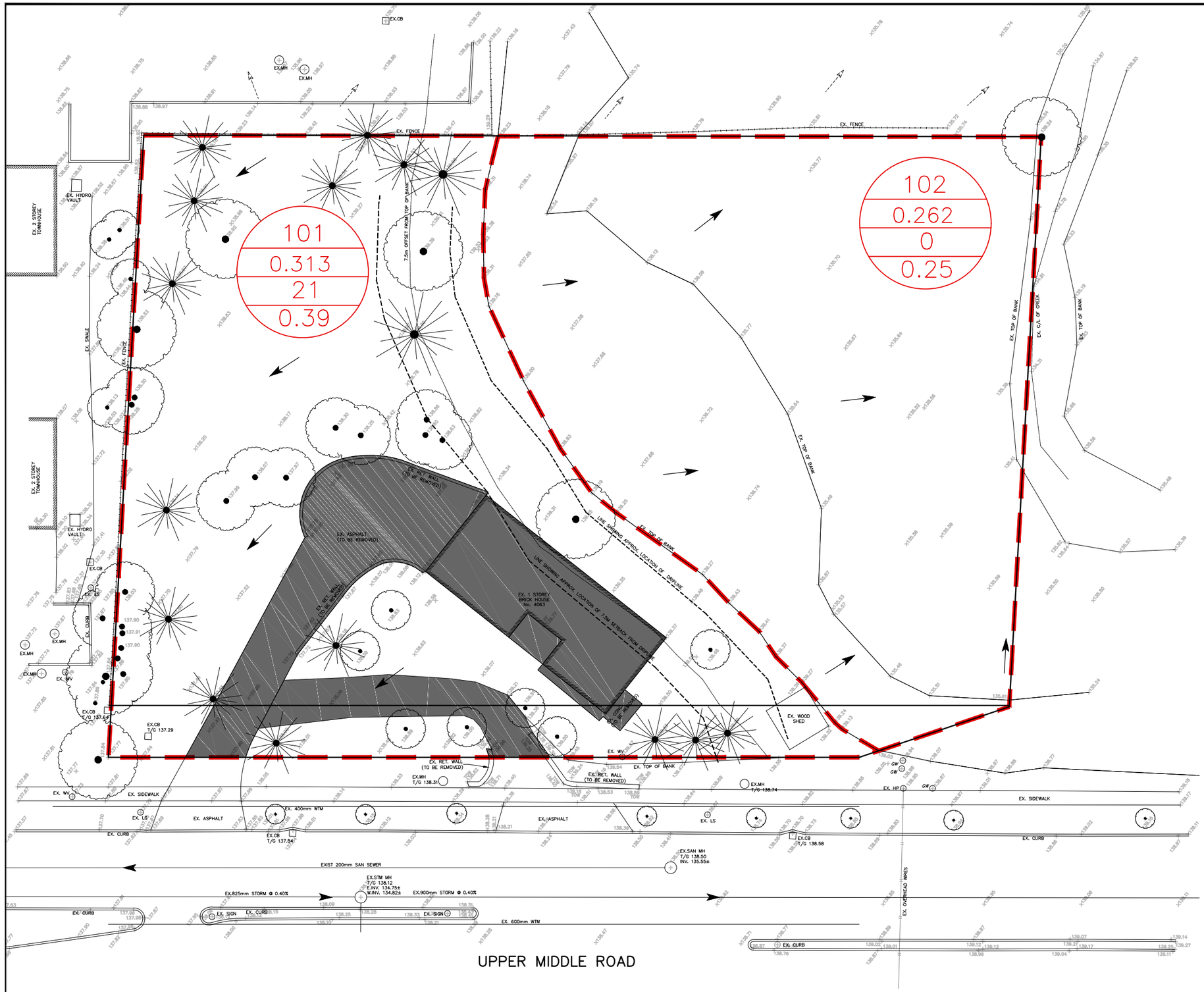
S. LLEWELLYN & ASSOCIATES LIMITED



M. Colosimo, Dipl.T.

S. Frankovich, P.Eng.

APPENDIX A
STORMWATER MANAGEMENT INFORMATION



LEGEND

DIRECTION OF SHEET FLOW

IMPERVIOUS AREA

101
0.313
21
0.39

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

FIGURE 1.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:400

PROJECT: 4063 UPPER MIDDLE ROAD
PROJECT No.: 16115

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LEGEND

DIRECTION OF SHEET FLOW

IMPERVIOUS AREA

201
0.299
55
0.63

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

202
0.262
0
0.25

203
0.011
66
0.68

201
0.302
55
0.62

STORAGE TANK STORMTECH MC-4500
(c/w INSPECTION PORTS & ISOLATOR ROW)
TANK VOLUME = 70m³
TOP OF TANK = 137.12
BOTTOM OF TANK = 135.59
(CONTRACTOR TO PROVIDE SHOP DWG'S)

EX.CB
EX.MH
EX.MH
EX. FENCE
EX. FENCE
EX. HYDRO VAULT
7.5m OFFSET FROM TOP OF BANK
EX. SWALE
EX. FENCE
3.0m-150mmø STM @ 1.0%
EX. HYDRO VAULT
EX.CB
EX. LS
2.0m-300mmø STM @ 1.0%
EX. CURB
EX.MH
EX.MH
EX.MH
EX. WV
2.0m-250mmø STM @ 2.0%
EX.CB T/G 137.67
EX.CB T/G 137.29
1.5m-250mmø STM @ 1.0%
17.0m-100mmø STM ORIFICE PIPE @ 0.8%
19.5m-250mmø STM @ 1.0%
EX. WV
EX. SIDEWALK
EX. LS
EX. ASPHALT
EX. 400mm WTM
EX. CURB
EX.CB T/G 137.84
EX.MH T/G 138.31
19.5m-250mmø STM @ 0.8%
EX. ASPHALT
EX. TOP OF BANK
LINE SHOWING APPROX. LOCATION OF DRIPLINE
LINE SHOWING APPROX. LOCATION OF 7.5M SETBACK FROM DRIPLINE
EX. TOP OF BANK
EX. C/L OF CREEK
EX. TOP OF BANK
EX. WV
EX. TOP OF BANK
GW
GW
EX. HP
EX.MH T/G 138.74
EX. SIDEWALK
EX. CURB
EX.CB T/G 138.58
EX.SAN MH T/G 138.50 INV. 135.55±
EX. OVERHEAD WIRES
EXIST 200mm SAN SEWER
EX.STM MH T/G 138.12 E.INV. 134.75± W.INV. 134.82±
EX.825mm STORM @ 0.40%
EX.900mm STORM @ 0.40%
EX. CURB
EX. SIGN
EX. CURB
EX. SIGN
EX. 600mm WTM
EX. CURB

UPPER MIDDLE ROAD

FIGURE 2.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:400

PROJECT: 4063 UPPER MIDDLE ROAD
PROJECT No.: 16115

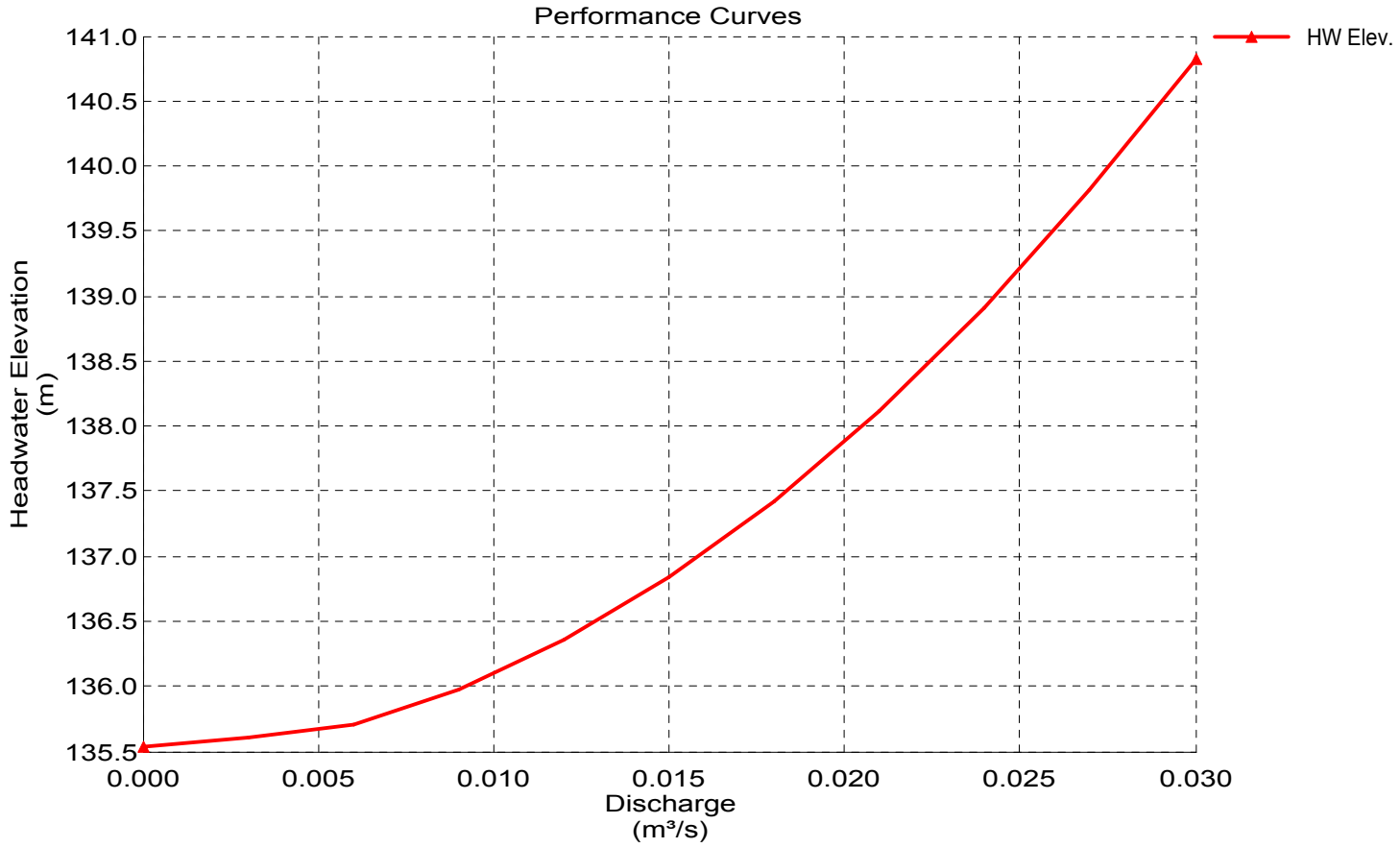
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Performance Curves Report
Worksheet-1

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	0.0300	0.0030	m³/s



4063 Upper Middle Rd
Burlington, Ontario

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

STAGE-STORAGE-DISCHARGE CALCULATIONS

Outlet Device No. 1 (Quantity)

Type:	Orifice Pipe
Diameter (mm)	100
Area (m^2)	0.00785
Invert Elev. (m)	135.35
C/L Elev. (m)	135.40

Number of Orifices: 1

		Underground Tank and Pipe Storage Volumes						Outlet No. 1		
	Elevation m	Tank 1 Area m^2	Tank 1 Increm. Volume m^3	Additional Incremental Surface m^3	Cumulative Volume m^3	Pipe Storage Volume m^3	**Total Active Storage Volume m^3**	H m	Discharge m^3/s	**Total Discharge m^3/s**
Orifice Pipe Invert	135.35	0	0	0	0	0	**0**	0.000	0.0000	**0.0000**
Bottom of Tank	135.59	0	0	0	0	0	**0**	0.190	0.0029	**0.0029**
0.5m Depth	136.09	91	23	0	23	0	**23**	0.690	0.0094	**0.0094**
1.0m Depth	136.59	91	46	0	46	0	**46**	1.190	0.0135	**0.0135**
Top of Tank	137.12	91	70	0	70	0	**70**	1.720	0.0162	**0.0162**

User Inputs

Chamber Model	MC-4500
Outlet Control Structure	Yes (Outlet)
Project Name	4063 Upper Middle Road
Project Location	Burlington Ontario
Project Date	01/06/2017
Engineer	Michael
Measurement Type	Metric
Required Storage Volume	66 cubic meters
Stone Porosity	40%
Stone Above Chamber	305 mm
Stone Foundation Depth	229 mm
Average Cover Over Chambers	610 mm
Design Constraint	WIDTH
Design Constraint Dimension	3.5 meters

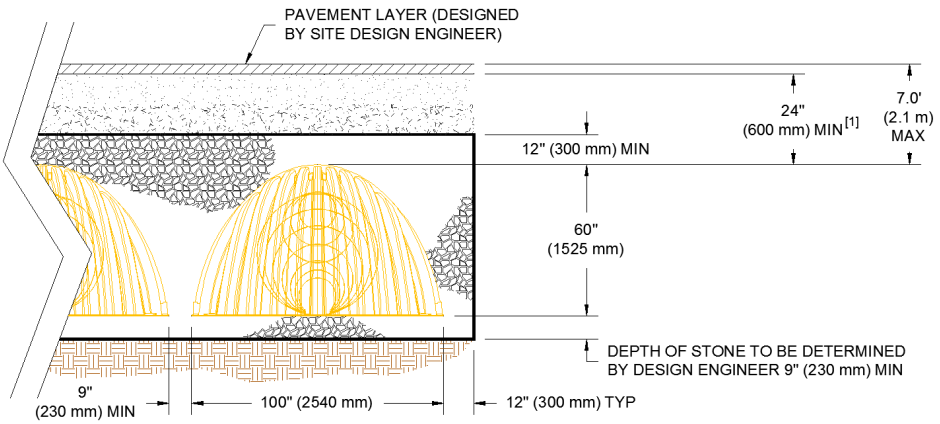
Results

System Volume and Bed Size

Installed Storage Volume	70 cubic meters
Storage Volume Per Chamber	4.6 cubic meters
Storage Volume Per End Cap	3.0 cubic meters
Number Of Chambers Required	14 each
Number Of End Caps Required	2 each
Rows/Chambers	1 row(s) of 14 chamber(s)
Maximum Length	20.44 meters
Maximum Width	3.33 meters
Approx. Bed Size Required	65 square meters

System Components

Amount Of Stone Required	90 cubic meters
Volume Of Excavation (Not Including Fill)	134 cubic meters
Non-woven Filter Fabric Required	223 square meters
Length Of Isolator Row	19.3 meters
Woven Isolator Row Fabric	121 square meters



[1] - TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

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APPENDIX B
SWMHYMO INPUT/OUTPUT INFORMATION

```
00001> 2     Metric units
00002> *#*************************************************************************|
00003> *#  Project Name: 4063 UPPER MIDDLE ROAD
00004> *#               BURLINGTON, ONTARIO
00005> *#  JOB NUMBER  : 16115
00006> *#       Date   : January 2017
00007> *#    Revised   :
00008> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00009> *#       File   : 16115.DAT
00010> *#*************************************************************************|
00011> *
00012> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
00013>                     BURL_002.stm
00014> *
00015> READ STORM          STORM_FILENAME "STORM.001"
00016> *
00017> *#*************************************************************************|
00018> *#
00019> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00020> *#        ============================================
00021> *#
00022> **#************************************************************************|
00023> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00024> *
00025> CALIB STANDHYD      ID=[1], NHYD=["101"], DT=[1](min), AREA=[0.313](ha),
00026>                     XIMP=[0.21], TIMP=[0.21], DWF=[0](cms), LOSS=[2],
00027>                     SCS curve number CN=[80],
00028>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[1.5](%),
00029>                                          LGP=[25](m), MNP=[0.250], SCP=[0](min),
00030>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.5](%),
00031>                                          LGI=[18](m), MNI=[0.015], SCI=[0](min),
00032>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00033> **#************************************************************************|
00034> *#
00035> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00036> *#        =============================================
00037> *#
00038> **#************************************************************************|
00039> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00040> *
00041> CALIB STANDHYD      ID=[2], NHYD=["201"], DT=[1](min), AREA=[0.302](ha),
00042>                     XIMP=[0.55], TIMP=[0.55], DWF=[0](cms), LOSS=[2],
00043>                     SCS curve number CN=[80],
00044>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[3.0](%),
00045>                                          LGP=[25](m), MNP=[0.250], SCP=[0](min),
00046>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[3.0](%),
00047>                                          LGI=[15](m), MNI=[0.015], SCI=[0](min),
00048>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00049> **#************************************************************************|
00050> ROUTE RESERVOIR     IDout=[3],   NHYD=["201"],  IDin=[2],
00051>                     RDT=[1](min),
00052>                           TABLE of ( OUTFLOW-STORAGE ) values
00053>                                    (cms) - (ha-m)
00054>                                      0.0    ,  0.0
00055>                                      0.0029 ,  0.0
00056>                                      0.0094 ,  0.0023
00057>                                      0.0135 ,  0.0046
00058>                                      0.0162 ,  0.0070
00059>                                        -1   ,  -1    (max twenty pts)
00060>                           IDovf=[4], NHYDovf=["OVF"]
00061> *%-----------------|-------------------------------------------------------|
00062> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
00063> *
00064> CALIB STANDHYD      ID=[5], NHYD=["203"], DT=[1](min), AREA=[0.011](ha),
00065>                     XIMP=[0.66], TIMP=[0.66], DWF=[0](cms), LOSS=[2],
```

```
00066>                     SCS curve number CN=[80],
00067>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[3.0](%),
00068>                                          LGP=[12](m), MNP=[0.250], SCP=[0](min),
00069>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[3.5](%),
00070>                                          LGI=[12](m), MNI=[0.015], SCI=[0](min),
00071>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00072> *%-----------------|-------------------------------------------------------------|
00073> ADD HYD             IDsum=[6], NHYD=["201 PLUS 203"], IDs to add=[3 4 5]
00074> **#*************************************************************************|
00075> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00076> *
00077> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
00078>                     BURL_005.stm
00079> *
00080> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
00081>                     BURL_010.stm
00082> *
00083> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
00084>                     BURL_025.stm
00085> *
00086> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
00087>                     BURL_050.stm
00088> *
00089> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
00090>                     BURL_100.stm
00091> *
00092> *%-----------------|-------------------------------------------------------------|
00093> FINISH
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00001> ================================================================================
00002>
00003>    SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
00004>    S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
00005>    SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
00006>        S  W W W  M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
00007>    SSSSS   W W   M   M  H   H    Y    M   M   OOO            9      9   =========
00008>                                                           9   9  9   9   # 3902680
00009>          StormWater Management HYdrologic Model            999    999    =========
00010>
00011> ********************************************************************************
00012> ***************************** SWMHYMO Ver/4.05  ********************************
00013> *********  A single event and continuous hydrologic simulation model  *********
00014> *********     based on the principles of HYMO and its successors      *********
00015> *********                    OTTHYMO-83 and OTTHYMO-89.                *********
00016> ********************************************************************************
00017> ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
00018> *********                  Ottawa,  Ontario: (613) 836-3884           *********
00019> *********                  Gatineau, Quebec: (819) 243-6858           *********
00020> *********                  E-Mail: swmhymo@jfsa.Com                   *********
00021> ********************************************************************************
00022>
00023> ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00024> +++++++++ Licensed user: S. Llewellyn & Associates Ltd                +++++++++
00025> +++++++++                Burlington           SERIAL#:3902680       +++++++++
00026> ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00027>
00028> ********************************************************************************
00029> *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *********
00030> *********           Maximum value for ID numbers  :     10            *********
00031> *********           Max. number of rainfall points: 105408            *********
00032> *********           Max. number of flow points    : 105408            *********
00033> ********************************************************************************
00034>
00035>
00036> *********************   D E T A I L E D   O U T P U T   **********************
00037> ********************************************************************************
00038> *         DATE: 2017-01-17     TIME: 13:19:34     RUN COUNTER: 000037         *
00039> ********************************************************************************
00040> * Input   filename: T:\PROJECTS\16115\SWMHYMO\16115.dat                        *
00041> * Output  filename: T:\PROJECTS\16115\SWMHYMO\16115.out                       *
00042> * Summary filename: T:\PROJECTS\16115\SWMHYMO\16115.sum                       *
00043> * User comments:                                                             *
00044> * 1:_____________________________________________________________________    *
00045> * 2:_____________________________________________________________________    *
00046> * 3:_____________________________________________________________________    *
00047> ********************************************************************************
00048>
00049> --------------------------------------------------------------------------------
00050> 001:0001--------------------------------------------------------------------------
00051> *#*************************************************************************|
00052> *#  Project Name: 4063 UPPER MIDDLE ROAD
00053> *#               BURLINGTON, ONTARIO
00054> *#  JOB NUMBER  : 16115
00055> *#       Date   : January 2017
00056> *#    Revised   :
00057> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00058> *#       File   : 16115.DAT
00059> *#*************************************************************************|
00060> *
00061>   ** END OF RUN :   1
00062>
00063> ********************************************************************************
00064>
00065>
00066>
00067>
00068>
00069> --------------------
00070> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
00071> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
00072>     TZERO =   .00 hrs on        0
00073>     METOUT=   2 (output = METRIC)
00074>     NRUN  = 002
00075>     NSTORM=   1
00076>              #  1=BURL_002.stm
00077> --------------------------------------------------------------------------------
00078> 002:0002--------------------------------------------------------------------------
00079> *#*************************************************************************|
00080> *#  Project Name: 4063 UPPER MIDDLE ROAD
00081> *#               BURLINGTON, ONTARIO
00082> *#  JOB NUMBER  : 16115
00083> *#       Date   : January 2017
00084> *#    Revised   :
00085> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00086> *#       File   : 16115.DAT
00087> *#*************************************************************************|
00088> *
00089> --------------------------------------------------------------------------------
00090> 002:0002--------------------------------------------------------------------------
00091> *
00092> --------------------
00093> | READ STORM       |    Filename: 2-YR BURLINGTON CHICAGO STORM (4-HR DURA
00094> | Ptotal=  32.34 mm|    Comments: 2-YR BURLINGTON CHICAGO STORM (4-HR DURA
00095> --------------------
00096>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00097>               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00098>               .17   2.193 |   1.17  17.083 |   2.17   5.221 |   3.17   2.635
00099>               .33   2.511 |   1.33  68.163 |   2.33   4.444 |   3.33   2.448
00100>               .50   2.955 |   1.50  22.413 |   2.50   3.884 |   3.50   2.289
00101>               .67   3.627 |   1.67  11.979 |   2.67   3.459 |   3.67   2.151
00102>               .83   4.775 |   1.83   8.270 |   2.83   3.126 |   3.83   2.031
00103>              1.00   7.239 |   2.00   6.374 |   3.00   2.857 |   4.00   1.925
00104>
00105> --------------------------------------------------------------------------------
00106> 002:0003--------------------------------------------------------------------------
00107> *
00108> *#*************************************************************************|
00109> *#
00110> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00111> *#        ==============================================
00112> *#
00113> **#************************************************************************|
00114> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00115> *
00116> ----------------------
00117> | CALIB STANDHYD     |   Area    (ha)=     .31
00118> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
00119> ----------------------
00120>                              IMPERVIOUS    PERVIOUS (i)
00121>      Surface Area     (ha)=        .07          .25
00122>      Dep. Storage     (mm)=       1.00         6.35
00123>      Average Slope     (%)=       2.50         1.50
00124>      Length            (m)=      18.00        25.00
00125>      Mannings n            =       .015         .250
00126>
00127>      Max.eff.Inten.(mm/hr)=      68.16        10.24
00128>                 over (min)        1.00        15.00
00129>      Storage Coeff.  (min)=        .88 (ii)   15.32 (ii)
00130>      Unit Hyd. Tpeak (min)=       1.00        15.00
00131>      Unit Hyd. peak  (cms)=       1.15          .07
00132>                                                          *TOTALS*
00133>      PEAK FLOW       (cms)=        .01          .00          .013 (iii)
00134>      TIME TO PEAK    (hrs)=       1.33         1.62         1.333
00135>      RUNOFF VOLUME    (mm)=      31.34         7.55         12.546
00136>      TOTAL RAINFALL   (mm)=      32.34        32.34         32.342
00137>      RUNOFF COEFFICIENT   =        .97          .23           .388
00138>
00139>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00140>            CN* =  80.0    Ia = Dep. Storage  (Above)
00141>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00142>            THAN THE STORAGE COEFFICIENT.
00143>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00144>
00145> --------------------------------------------------------------------------------
00146> 002:0004--------------------------------------------------------------------------
00147> **#************************************************************************|
00148> *#
00149> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00150> *#        ==============================================
00151> *#
00152> **#************************************************************************|
00153> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00154> *
00155> ----------------------
00156> | CALIB STANDHYD     |   Area    (ha)=     .30
00157> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
00158> ----------------------
00159>                              IMPERVIOUS    PERVIOUS (i)
00160>      Surface Area     (ha)=        .17          .14
00161>      Dep. Storage     (mm)=       1.00         6.35
00162>      Average Slope     (%)=       3.00         3.00
00163>      Length            (m)=      15.00        25.00
00164>      Mannings n            =       .015         .250
00165>
00166>      Max.eff.Inten.(mm/hr)=      68.16        10.94
00167>                 over (min)        1.00        12.00
00168>      Storage Coeff.  (min)=        .75 (ii)   12.17 (ii)
00169>      Unit Hyd. Tpeak (min)=       1.00        12.00
00170>      Unit Hyd. peak  (cms)=       1.25          .09
00171>                                                          *TOTALS*
00172>      PEAK FLOW       (cms)=        .03          .00          .032 (iii)
00173>      TIME TO PEAK    (hrs)=       1.33         1.52         1.333
00174>      RUNOFF VOLUME    (mm)=      31.34         7.55        20.635
00175>      TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
00176>      RUNOFF COEFFICIENT   =        .97          .23          .638
00177>
00178>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00179>            CN* =  80.0    Ia = Dep. Storage  (Above)
00180>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00181>            THAN THE STORAGE COEFFICIENT.
00182>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00183>
00184> --------------------------------------------------------------------------------
00185> 002:0005--------------------------------------------------------------------------
00186> **#************************************************************************|
00187> ----------------------
00188> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00189> |  IN>02:(201   )    |
00190> | OUT<03:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
00191> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00192>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
00193>                              .000  .0000E+00    |     .014  .4600E-02
00194>                              .003  .0000E+00    |     .016  .7000E-02
00195>                              .009  .2300E-02    |     .000  .0000E+00
00196>
00197>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00198>      --------------------       (ha)     (cms)     (hrs)       (mm)
00199>      INFLOW >02: (201   )        .30      .032     1.333     20.635
00200>      OUTFLOW<03: (201   )        .30      .009     1.533     20.639
00201>     OVERFLOW<04: (OVF   )        .00      .000      .000       .000
00202>
00203>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =       0
00204>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00205>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00206>
00207>
00208>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   27.114
00209>                    TIME SHIFT OF PEAK FLOW         (min)=    12.00
00210>                    MAXIMUM  STORAGE   USED       (ha.m.)=.2067E-02
00211>
00212> --------------------------------------------------------------------------------
00213> 002:0006--------------------------------------------------------------------------
00214> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
00215> *
00216> ----------------------
00217> | CALIB STANDHYD     |   Area    (ha)=     .01
00218> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
00219> ----------------------
00220>                              IMPERVIOUS    PERVIOUS (i)
00221>      Surface Area     (ha)=        .01          .00
00222>      Dep. Storage     (mm)=       1.00         6.35
00223>      Average Slope     (%)=       3.50         3.00
00224>      Length            (m)=      12.00        12.00
00225>      Mannings n            =       .015         .250
00226>
00227>      Max.eff.Inten.(mm/hr)=      68.16        13.88
00228>                 over (min)        1.00         7.00
00229>      Storage Coeff.  (min)=        .62 (ii)    7.31 (ii)
00230>      Unit Hyd. Tpeak (min)=       1.00         7.00
00231>      Unit Hyd. peak  (cms)=       1.36          .16
00232>                                                          *TOTALS*
00233>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
00234>      TIME TO PEAK    (hrs)=       1.28         1.43         1.333
00235>      RUNOFF VOLUME    (mm)=      31.34         7.55        23.252
00236>      TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
00237>      RUNOFF COEFFICIENT   =        .97          .23          .719
00238>
00239>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00240>            CN* =  80.0    Ia = Dep. Storage  (Above)
00241>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00242>            THAN THE STORAGE COEFFICIENT.
00243>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00244>
00245> --------------------------------------------------------------------------------
00246> 002:0007--------------------------------------------------------------------------
00247> ----------------------
00248> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00249> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
00250>                        ID1 03:201          .30      .009    1.53  20.64    .000
00251>                       +ID2 04:OVF          .00      .000     .00    .00    .000
00252>                       +ID3 05:203          .01      .001    1.33  23.25    .000
00253>                        ========================================================
00254>                        SUM 06:201 PLUS 2    .31      .009    1.50  20.73    .000
00255>
00256>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00257>
00258> --------------------------------------------------------------------------------
00259> 002:0008--------------------------------------------------------------------------
00260> **#************************************************************************|
00261> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00262> *
00263>   ** END OF RUN :   4
00264>
00265> ********************************************************************************
00266>
00267>
00268>
00269>
00270>
```

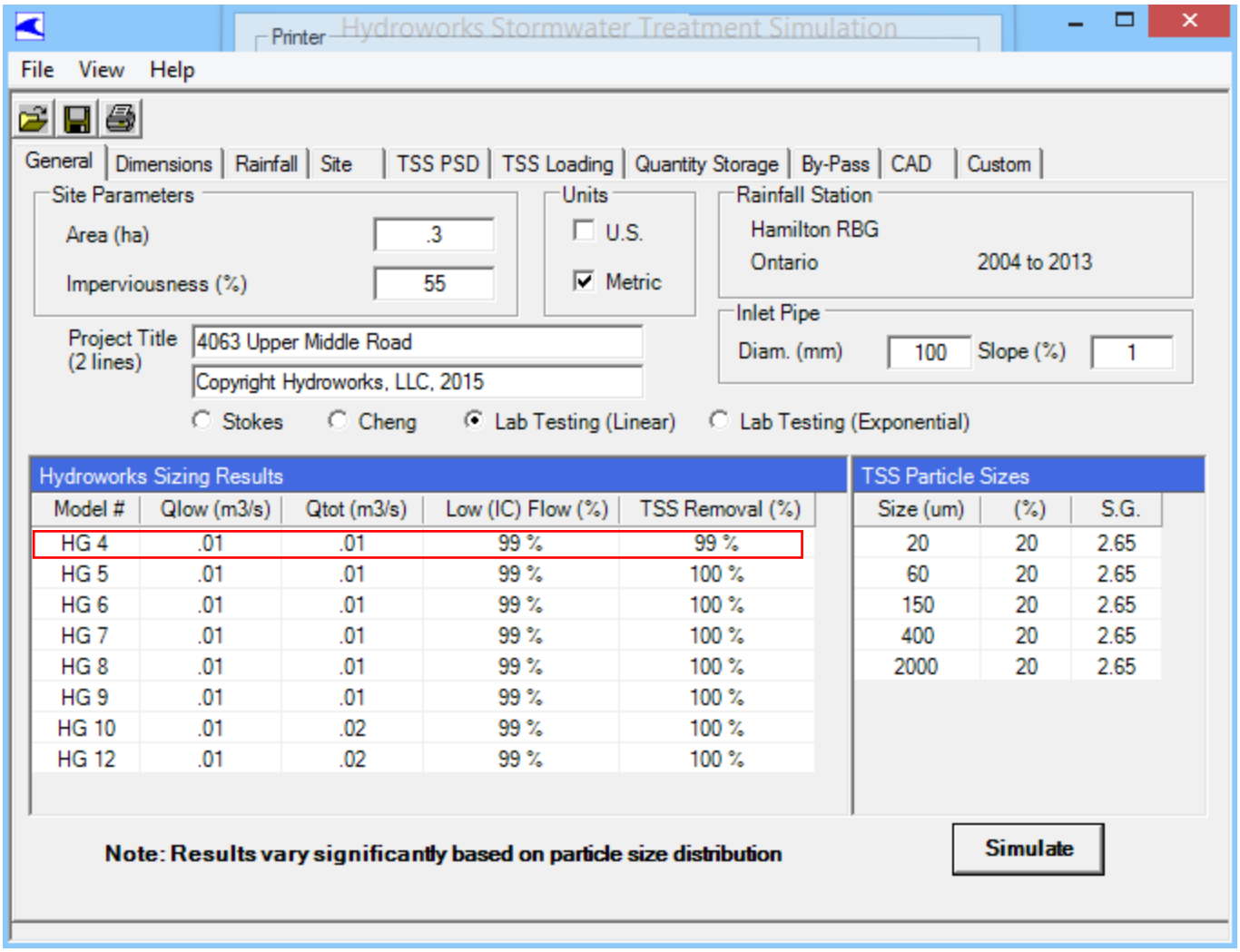
```
00271> --------------------
00272> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
00273> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
00274>     TZERO =   .00 hrs on        0
00275>     METOUT=   2 (output = METRIC)
00276>     NRUN  = 005
00277>     NSTORM=   1
00278>              #  1=BURL_005.stm
00279> ----------------------------------------------------------------------------
00280> 005:0002----------------------------------------------------------------------
00281> *#*************************************************************************|
00282> *#  Project Name: 4063 UPPER MIDDLE ROAD
00283> *#               BURLINGTON, ONTARIO
00284> *#  JOB NUMBER  : 16115
00285> *#       Date   : January 2017
00286> *#    Revised   :
00287> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00288> *#       File   : 16115.DAT
00289> *#*************************************************************************|
00290> *
00291> ----------------------------------------------------------------------------
00292> 005:0002----------------------------------------------------------------------
00293> *
00294> --------------------
00295> | READ STORM       |    Filename: 5-YR BURLINGTON CHICAGO STORM (4-HR DURA
00296> | Ptotal=  41.70 mm|    Comments: 5-YR BURLINGTON CHICAGO STORM (4-HR DURA
00297> --------------------
00298>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00299>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00300>                .17   2.963 |   1.17  21.285 |   2.17   6.805 |   3.17   3.535
00301>                .33   3.374 |   1.33  88.094 |   2.33   5.834 |   3.33   3.293
00302>                .50   3.946 |   1.50  27.774 |   2.50   5.128 |   3.50   3.087
00303>                .67   4.803 |   1.67  15.072 |   2.67   4.590 |   3.67   2.908
00304>                .83   6.247 |   1.83  10.561 |   2.83   4.165 |   3.83   2.751
00305>               1.00   9.295 |   2.00   8.234 |   3.00   3.820 |   4.00   2.612
00306>
00307> ----------------------------------------------------------------------------
00308> 005:0003----------------------------------------------------------------------
00309> *
00310> *#*************************************************************************|
00311> *#
00312> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00313> *#        ============================================
00314> *#
00315> **#************************************************************************|
00316> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00317> *
00318> ----------------------
00319> | CALIB STANDHYD     |   Area    (ha)=     .31
00320> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
00321> ----------------------
00322>                             IMPERVIOUS    PERVIOUS (i)
00323>      Surface Area     (ha)=        .07          .25
00324>      Dep. Storage     (mm)=       1.00         6.35
00325>      Average Slope     (%)=       2.50         1.50
00326>      Length            (m)=      18.00        25.00
00327>      Mannings n             =      .015         .250
00328>
00329>      Max.eff.Inten.(mm/hr)=      88.09        19.56
00330>                 over (min)        1.00        12.00
00331>      Storage Coeff.  (min)=        .80 (ii)   11.94 (ii)
00332>      Unit Hyd. Tpeak (min)=       1.00        12.00
00333>      Unit Hyd. peak  (cms)=       1.22          .09
00334>                                                          *TOTALS*
00335>      PEAK FLOW       (cms)=        .02          .01          .019 (iii)
00336>      TIME TO PEAK    (hrs)=       1.33         1.52         1.333
00337>      RUNOFF VOLUME    (mm)=      40.70        12.64        18.531
00338>      TOTAL RAINFALL   (mm)=      41.70        41.70        41.696
00339>      RUNOFF COEFFICIENT   =        .98          .30          .444
00340>
00341>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00342>            CN* =  80.0    Ia = Dep. Storage  (Above)
00343>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00344>            THAN THE STORAGE COEFFICIENT.
00345>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00346>
00347> ----------------------------------------------------------------------------
00348> 005:0004----------------------------------------------------------------------
00349> **#***********************************************************************|
00350> *#
00351> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00352> *#        =============================================
00353> *#
00354> **#***********************************************************************|
00355> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00356> *
00357> ----------------------
00358> | CALIB STANDHYD     |   Area    (ha)=     .30
00359> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
00360> ----------------------
00361>                             IMPERVIOUS    PERVIOUS (i)
00362>      Surface Area     (ha)=        .17          .14
00363>      Dep. Storage     (mm)=       1.00         6.35
00364>      Average Slope     (%)=       3.00         3.00
00365>      Length            (m)=      15.00        25.00
00366>      Mannings n             =      .015         .250
00367>
00368>      Max.eff.Inten.(mm/hr)=      88.09        22.49
00369>                 over (min)        1.00         9.00
00370>      Storage Coeff.  (min)=        .67 (ii)    9.24 (ii)
00371>      Unit Hyd. Tpeak (min)=       1.00         9.00
00372>      Unit Hyd. peak  (cms)=       1.31          .12
00373>                                                          *TOTALS*
00374>      PEAK FLOW       (cms)=        .04          .01          .044 (iii)
00375>      TIME TO PEAK    (hrs)=       1.32         1.45         1.333
00376>      RUNOFF VOLUME    (mm)=      40.70        12.64        28.070
00377>      TOTAL RAINFALL   (mm)=      41.70        41.70        41.696
00378>      RUNOFF COEFFICIENT   =        .98          .30          .673
00379>
00380>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00381>            CN* =  80.0    Ia = Dep. Storage  (Above)
00382>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00383>            THAN THE STORAGE COEFFICIENT.
00384>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00385>
00386> ----------------------------------------------------------------------------
00387> 005:0005----------------------------------------------------------------------
00388> **#***********************************************************************|
00389> --------------------
00390> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
00391> |  IN>02:(201   )   |
00392> | OUT<03:(201   )   |    =========  OUTLFOW STORAGE TABLE  =========
00393> --------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00394>                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
00395>                           .000  .0000E+00   |     .014  .4600E-02
00396>                           .003  .0000E+00   |     .016  .7000E-02
00397>                           .009  .2300E-02   |     .000  .0000E+00
00398>
00399>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00400>      --------------------       (ha)     (cms)     (hrs)        (mm)
00401>      INFLOW >02: (201   )        .30      .044     1.333      28.070
00402>      OUTFLOW<03: (201   )        .30      .011     1.667      28.073
00403>     OVERFLOW<04: (OVF   )        .00      .000      .000       .000
00404>
00405>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00406>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00407>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00408>
00409>
00410>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   24.557
00411>                    TIME SHIFT OF PEAK FLOW         (min)=    20.00
00412>                    MAXIMUM  STORAGE   USED       (ha.m.)=.3025E-02
00413>
00414> ----------------------------------------------------------------------------
00415> 005:0006----------------------------------------------------------------------
00416> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
00417> *
00418> ----------------------
00419> | CALIB STANDHYD     |   Area    (ha)=     .01
00420> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
00421> ----------------------
00422>                             IMPERVIOUS    PERVIOUS (i)
00423>      Surface Area     (ha)=        .01          .00
00424>      Dep. Storage     (mm)=       1.00         6.35
00425>      Average Slope     (%)=       3.50         3.00
00426>      Length            (m)=      12.00        12.00
00427>      Mannings n             =      .015         .250
00428>
00429>      Max.eff.Inten.(mm/hr)=      88.09        26.52
00430>                 over (min)        1.00         6.00
00431>      Storage Coeff.  (min)=        .56 (ii)    5.72 (ii)
00432>      Unit Hyd. Tpeak (min)=       1.00         6.00
00433>      Unit Hyd. peak  (cms)=       1.41          .19
00434>                                                          *TOTALS*
00435>      PEAK FLOW       (cms)=        .00          .00          .002 (iii)
00436>      TIME TO PEAK    (hrs)=       1.27         1.40         1.333
00437>      RUNOFF VOLUME    (mm)=      40.70        12.64        31.156
00438>      TOTAL RAINFALL   (mm)=      41.70        41.70        41.696
00439>      RUNOFF COEFFICIENT   =        .98          .30          .747
00440>
00441>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00442>            CN* =  80.0    Ia = Dep. Storage  (Above)
00443>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00444>            THAN THE STORAGE COEFFICIENT.
00445>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00446>
00447> ----------------------------------------------------------------------------
00448> 005:0007----------------------------------------------------------------------
00449> ------------------------
00450> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00451> ------------------------ (ha)     (cms)   (hrs)   (mm)    (cms)
00452>                        ID1 03:201          .30     .011    1.67  28.07    .000
00453>                      +ID2 04:OVF           .00     .000     .00   .00     .000
00454>                      +ID3 05:203           .01     .002    1.33  31.16    .000
00455>                       ========================================================
00456>                       SUM 06:201 PLUS 2     .31     .011    1.33  28.18    .000
00457>
00458>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00459>
00460> ----------------------------------------------------------------------------
00461> 005:0008----------------------------------------------------------------------
00462> **#***********************************************************************|
00463> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00464> *
00465> ----------------------------------------------------------------------------
00466> 005:0002----------------------------------------------------------------------
00467> *
00468>   ** END OF RUN :   9
00469>
00470> ****************************************************************************
00471>
00472>
00473>
00474>
00475>
00476> --------------------
00477> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
00478> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
00479>     TZERO =   .00 hrs on        0
00480>     METOUT=   2 (output = METRIC)
00481>     NRUN  = 010
00482>     NSTORM=   1
00483>              #  1=BURL_010.stm
00484> ----------------------------------------------------------------------------
00485> 010:0002----------------------------------------------------------------------
00486> *#*************************************************************************|
00487> *#  Project Name: 4063 UPPER MIDDLE ROAD
00488> *#               BURLINGTON, ONTARIO
00489> *#  JOB NUMBER  : 16115
00490> *#       Date   : January 2017
00491> *#    Revised   :
00492> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00493> *#       File   : 16115.DAT
00494> *#*************************************************************************|
00495> *
00496> ----------------------------------------------------------------------------
00497> 010:0002----------------------------------------------------------------------
00498> *
00499> --------------------
00500> | READ STORM       |    Filename: 10-YR BURLINGTON CHICAGO STORM (4-HR DUR
00501> | Ptotal=  48.00 mm|    Comments: 10-YR BURLINGTON CHICAGO STORM (4-HR DUR
00502> --------------------
00503>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00504>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00505>                .17   3.423 |   1.17  24.501 |   2.17   7.852 |   3.17   4.083
00506>                .33   3.898 |   1.33 101.139 |   2.33   6.733 |   3.33   3.805
00507>                .50   4.558 |   1.50  31.955 |   2.50   5.920 |   3.50   3.567
00508>                .67   5.545 |   1.67  17.363 |   2.67   5.300 |   3.67   3.360
00509>                .83   7.210 |   1.83  12.175 |   2.83   4.810 |   3.83   3.179
00510>               1.00  10.719 |   2.00   9.497 |   3.00   4.413 |   4.00   3.019
00511>
00512> ----------------------------------------------------------------------------
00513> 010:0003----------------------------------------------------------------------
00514> *
00515> *#*************************************************************************|
00516> *#
00517> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00518> *#        ============================================
00519> *#
00520> **#***********************************************************************|
00521> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00522> *
00523> ----------------------
00524> | CALIB STANDHYD     |   Area    (ha)=     .31
00525> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
00526> ----------------------
00527>                             IMPERVIOUS    PERVIOUS (i)
00528>      Surface Area     (ha)=        .07          .25
00529>      Dep. Storage     (mm)=       1.00         6.35
00530>      Average Slope     (%)=       2.50         1.50
00531>      Length            (m)=      18.00        25.00
00532>      Mannings n             =      .015         .250
00533>
00534>      Max.eff.Inten.(mm/hr)=     101.14        28.89
00535>                 over (min)        1.00        10.00
00536>      Storage Coeff.  (min)=        .75 (ii)   10.29 (ii)
00537>      Unit Hyd. Tpeak (min)=       1.00        10.00
00538>      Unit Hyd. peak  (cms)=       1.25          .11
00539>                                                          *TOTALS*
00540>      PEAK FLOW       (cms)=        .02          .01          .025 (iii)
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00541>      TIME TO PEAK    (hrs)=       1.32         1.47          1.333
00542>      RUNOFF VOLUME    (mm)=      47.00        16.50         22.906
00543>      TOTAL RAINFALL   (mm)=      48.00        48.00         48.004
00544>      RUNOFF COEFFICIENT   =        .98          .34           .477
00545>
00546>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00547>            CN* =  80.0    Ia = Dep. Storage  (Above)
00548>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00549>            THAN THE STORAGE COEFFICIENT.
00550>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00551>
00552> ---------------------------------------------------------------------------
00553> 010:0004-----------------------------------------------------------------
00554> **#*************************************************************************|
00555> *#
00556> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00557> *#        ==============================================
00558> *#
00559> **#*************************************************************************|
00560> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00561> *
00562> ----------------------
00563> | CALIB STANDHYD     |   Area    (ha)=     .30
00564> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
00565> ----------------------
00566>                             IMPERVIOUS    PERVIOUS (i)
00567>      Surface Area     (ha)=        .17          .14
00568>      Dep. Storage     (mm)=       1.00         6.35
00569>      Average Slope     (%)=       3.00         3.00
00570>      Length            (m)=      15.00        25.00
00571>      Mannings n            =       .015         .250
00572>
00573>      Max.eff.Inten.(mm/hr)=     101.14        32.26
00574>                   over (min)        1.00         8.00
00575>      Storage Coeff.  (min)=        .64 (ii)     8.05 (ii)
00576>      Unit Hyd. Tpeak (min)=       1.00         8.00
00577>      Unit Hyd. peak  (cms)=       1.34          .14
00578>                                                          *TOTALS*
00579>      PEAK FLOW       (cms)=        .05          .01          .052 (iii)
00580>      TIME TO PEAK    (hrs)=       1.32         1.43         1.333
00581>      RUNOFF VOLUME    (mm)=      47.00        16.50        33.277
00582>      TOTAL RAINFALL   (mm)=      48.00        48.00        48.004
00583>      RUNOFF COEFFICIENT   =        .98          .34          .693
00584>
00585>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00586>            CN* =  80.0    Ia = Dep. Storage  (Above)
00587>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00588>            THAN THE STORAGE COEFFICIENT.
00589>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00590>
00591> ---------------------------------------------------------------------------
00592> 010:0005-----------------------------------------------------------------
00593> **#*************************************************************************|
00594> ----------------------
00595> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00596> |  IN>02:(201   )    |
00597> | OUT<03:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
00598> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00599>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
00600>                              .000  .0000E+00   |     .014  .4600E-02
00601>                              .003  .0000E+00   |     .016  .7000E-02
00602>                              .009  .2300E-02   |     .000  .0000E+00
00603>
00604>      ROUTING RESULTS            AREA     QPEAK     TPEAK      R.V.
00605>      ---------------            (ha)     (cms)     (hrs)      (mm)
00606>      INFLOW >02: (201   )        .30      .052     1.333     33.277
00607>      OUTFLOW<03: (201   )        .30      .012     1.667     33.302
00608>     OVERFLOW<04: (OVF   )        .00      .000      .000       .000
00609>
00610>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00611>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00612>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00613>
00614>
00615>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   23.311
00616>                    TIME SHIFT OF PEAK FLOW         (min)=    20.00
00617>                    MAXIMUM  STORAGE   USED       (ha.m.)=.3789E-02
00618>
00619> ---------------------------------------------------------------------------
00620> 010:0006-----------------------------------------------------------------
00621> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
00622> *
00623> ----------------------
00624> | CALIB STANDHYD     |   Area    (ha)=     .01
00625> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
00626> ----------------------
00627>                             IMPERVIOUS    PERVIOUS (i)
00628>      Surface Area     (ha)=        .01          .00
00629>      Dep. Storage     (mm)=       1.00         6.35
00630>      Average Slope     (%)=       3.50         3.00
00631>      Length            (m)=      12.00        12.00
00632>      Mannings n            =       .015         .250
00633>
00634>      Max.eff.Inten.(mm/hr)=     101.14        36.87
00635>                   over (min)        1.00         5.00
00636>      Storage Coeff.  (min)=        .53 (ii)     5.06 (ii)
00637>      Unit Hyd. Tpeak (min)=       1.00         5.00
00638>      Unit Hyd. peak  (cms)=       1.44          .22
00639>                                                          *TOTALS*
00640>      PEAK FLOW       (cms)=        .00          .00          .002 (iii)
00641>      TIME TO PEAK    (hrs)=       1.27         1.38         1.333
00642>      RUNOFF VOLUME    (mm)=      47.00        16.50        36.632
00643>      TOTAL RAINFALL   (mm)=      48.00        48.00        48.004
00644>      RUNOFF COEFFICIENT   =        .98          .34          .763
00645>
00646>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00647>            CN* =  80.0    Ia = Dep. Storage  (Above)
00648>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00649>            THAN THE STORAGE COEFFICIENT.
00650>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00651>
00652> ---------------------------------------------------------------------------
00653> 010:0007-----------------------------------------------------------------
00654> ------------------------
00655> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00656> ------------------------ --------          (ha)     (cms)   (hrs)   (mm)   (cms)
00657>                      ID1 03:201             .30      .012    1.67   33.30    .000
00658>                     +ID2 04:OVF             .00      .000     .00     .00    .000
00659>                     +ID3 05:203             .01      .002    1.33   36.63    .000
00660>                      ============================================================
00661>                      SUM 06:201 PLUS 2      .31      .013    1.33   33.42    .000
00662>
00663>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00664>
00665> ---------------------------------------------------------------------------
00666> 010:0008-----------------------------------------------------------------
00667> **#*************************************************************************|
00668> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00669> *
00670> ---------------------------------------------------------------------------
00671> 010:0002-----------------------------------------------------------------
00672> *
00673> ---------------------------------------------------------------------------
00674> 010:0002-----------------------------------------------------------------
00675> *
00676>   ** END OF RUN :  24
00677>
00678> ***************************************************************************
00679>
00680>
00681>
00682>
00683>
00684> --------------------
00685> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
00686> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
00687>     TZERO =   .00 hrs on      0
00688>     METOUT=   2 (output = METRIC)
00689>     NRUN  = 025
00690>     NSTORM=   1
00691>               #  1=BURL_025.stm
00692> ---------------------------------------------------------------------------
00693> 025:0002-----------------------------------------------------------------
00694> *#*************************************************************************|
00695> *#  Project Name: 4063 UPPER MIDDLE ROAD
00696> *#               BURLINGTON, ONTARIO
00697> *#  JOB NUMBER  : 16115
00698> *#       Date   : January 2017
00699> *#    Revised   :
00700> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00701> *#       File   : 16115.DAT
00702> *#*************************************************************************|
00703> *
00704> ---------------------------------------------------------------------------
00705> 025:0002-----------------------------------------------------------------
00706> *
00707> --------------------
00708> | READ STORM      |    Filename: 25-YR BURLINGTON CHICAGO STORM (4-HR DUR
00709> | Ptotal=  56.03 mm|    Comments: 25-YR BURLINGTON CHICAGO STORM (4-HR DUR
00710> --------------------
00711>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00712>                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00713>                .17   4.010 |   1.17  28.592 |   2.17   9.185 |   3.17   4.782
00714>                .33   4.566 |   1.33 117.720 |   2.33   7.879 |   3.33   4.457
00715>                .50   5.337 |   1.50  37.274 |   2.50   6.929 |   3.50   4.178
00716>                .67   6.491 |   1.67  20.279 |   2.67   6.204 |   3.67   3.937
00717>                .83   8.435 |   1.83  14.230 |   2.83   5.632 |   3.83   3.725
00718>               1.00  12.531 |   2.00  11.105 |   3.00   5.167 |   4.00   3.538
00719>
00720> ---------------------------------------------------------------------------
00721> 025:0003-----------------------------------------------------------------
00722> *
00723> *#*************************************************************************|
00724> *#
00725> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00726> *#        ==============================================
00727> *#
00728> **#*************************************************************************|
00729> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00730> *
00731> ----------------------
00732> | CALIB STANDHYD     |   Area    (ha)=     .31
00733> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
00734> ----------------------
00735>                             IMPERVIOUS    PERVIOUS (i)
00736>      Surface Area     (ha)=        .07          .25
00737>      Dep. Storage     (mm)=       1.00         6.35
00738>      Average Slope     (%)=       2.50         1.50
00739>      Length            (m)=      18.00        25.00
00740>      Mannings n            =       .015         .250
00741>
00742>      Max.eff.Inten.(mm/hr)=     117.72        41.87
00743>                   over (min)        1.00         9.00
00744>      Storage Coeff.  (min)=        .71 (ii)     8.93 (ii)
00745>      Unit Hyd. Tpeak (min)=       1.00         9.00
00746>      Unit Hyd. peak  (cms)=       1.29          .13
00747>                                                          *TOTALS*
00748>      PEAK FLOW       (cms)=        .02          .02          .033 (iii)
00749>      TIME TO PEAK    (hrs)=       1.32         1.45         1.333
00750>      RUNOFF VOLUME    (mm)=      55.03        21.81        28.784
00751>      TOTAL RAINFALL   (mm)=      56.03        56.03        56.030
00752>      RUNOFF COEFFICIENT   =        .98          .39          .514
00753>
00754>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00755>            CN* =  80.0    Ia = Dep. Storage  (Above)
00756>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00757>            THAN THE STORAGE COEFFICIENT.
00758>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00759>
00760> ---------------------------------------------------------------------------
00761> 025:0004-----------------------------------------------------------------
00762> **#*************************************************************************|
00763> *#
00764> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00765> *#        ==============================================
00766> *#
00767> **#*************************************************************************|
00768> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00769> *
00770> ----------------------
00771> | CALIB STANDHYD     |   Area    (ha)=     .30
00772> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
00773> ----------------------
00774>                             IMPERVIOUS    PERVIOUS (i)
00775>      Surface Area     (ha)=        .17          .14
00776>      Dep. Storage     (mm)=       1.00         6.35
00777>      Average Slope     (%)=       3.00         3.00
00778>      Length            (m)=      15.00        25.00
00779>      Mannings n            =       .015         .250
00780>
00781>      Max.eff.Inten.(mm/hr)=     117.72        45.86
00782>                   over (min)        1.00         7.00
00783>      Storage Coeff.  (min)=        .60 (ii)     7.04 (ii)
00784>      Unit Hyd. Tpeak (min)=       1.00         7.00
00785>      Unit Hyd. peak  (cms)=       1.38          .16
00786>                                                          *TOTALS*
00787>      PEAK FLOW       (cms)=        .05          .01          .063 (iii)
00788>      TIME TO PEAK    (hrs)=       1.32         1.42         1.333
00789>      RUNOFF VOLUME    (mm)=      55.03        21.81        40.080
00790>      TOTAL RAINFALL   (mm)=      56.03        56.03        56.030
00791>      RUNOFF COEFFICIENT   =        .98          .39          .715
00792>
00793>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00794>            CN* =  80.0    Ia = Dep. Storage  (Above)
00795>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00796>            THAN THE STORAGE COEFFICIENT.
00797>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00798>
00799> ---------------------------------------------------------------------------
00800> 025:0005-----------------------------------------------------------------
00801> **#*************************************************************************|
00802> ----------------------
00803> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00804> |  IN>02:(201   )    |
00805> | OUT<03:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
00806> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00807>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
00808>                              .000  .0000E+00   |     .014  .4600E-02
00809>                              .003  .0000E+00   |     .016  .7000E-02
00810>                              .009  .2300E-02   |     .000  .0000E+00
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00811>
00812>     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00813>     --------------------       (ha)     (cms)     (hrs)       (mm)
00814>     INFLOW >02: (201   )        .30      .063     1.333     40.080
00815>     OUTFLOW<03: (201   )        .30      .014     1.683     40.082
00816>    OVERFLOW<04: (OVF   )        .00      .000      .000      .000
00817>
00818>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00819>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00820>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00821>
00822>
00823>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   21.863
00824>                    TIME SHIFT OF PEAK FLOW         (min)=    21.00
00825>                    MAXIMUM  STORAGE   USED       (ha.m.)=.4810E-02
00826>
00827> ------------------------------------------------------------------------------
00828> 025:0006------------------------------------------------------------------------
00829> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
00830> *
00831> ---------------------
00832> | CALIB STANDHYD     |   Area    (ha)=     .01
00833> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
00834> ---------------------
00835>                                IMPERVIOUS    PERVIOUS (i)
00836>     Surface Area     (ha)=        .01          .00
00837>     Dep. Storage     (mm)=       1.00         6.35
00838>     Average Slope     (%)=       3.50         3.00
00839>     Length            (m)=      12.00        12.00
00840>     Mannings n           =       .015         .250
00841>
00842>     Max.eff.Inten.(mm/hr)=     117.72        51.11
00843>                over (min)       1.00         4.00
00844>     Storage Coeff.  (min)=        .50 (ii)    4.47 (ii)
00845>     Unit Hyd. Tpeak (min)=       1.00         4.00
00846>     Unit Hyd. peak  (cms)=       1.47          .26
00847>                                                        *TOTALS*
00848>     PEAK FLOW       (cms)=        .00          .00          .003 (iii)
00849>     TIME TO PEAK    (hrs)=       1.30         1.37         1.333
00850>     RUNOFF VOLUME    (mm)=      55.03        21.81        43.734
00851>     TOTAL RAINFALL   (mm)=      56.03        56.03        56.030
00852>     RUNOFF COEFFICIENT   =        .98          .39          .781
00853>
00854>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00855>           CN* =  80.0    Ia = Dep. Storage  (Above)
00856>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00857>           THAN THE STORAGE COEFFICIENT.
00858>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00859>
00860> ------------------------------------------------------------------------------
00861> 025:0007------------------------------------------------------------------------
00862> ------------------------
00863> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00864> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
00865>                       ID1 03:201            .30     .014    1.68  40.08    .000
00866>                      +ID2 04:OVF            .00     .000     .00    .00    .000
00867>                      +ID3 05:203            .01     .003    1.33  43.73    .000
00868>                       ========================================================
00869>                       SUM 06:201 PLUS 2      .31     .014    1.50  40.21    .000
00870>
00871>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00872>
00873> ------------------------------------------------------------------------------
00874> 025:0008------------------------------------------------------------------------
00875> **#*************************************************************************|
00876> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00877> *
00878> ------------------------------------------------------------------------------
00879> 025:0002------------------------------------------------------------------------
00880> *
00881> ------------------------------------------------------------------------------
00882> 025:0002------------------------------------------------------------------------
00883> *
00884> ------------------------------------------------------------------------------
00885> 025:0002------------------------------------------------------------------------
00886> *
00887>   ** END OF RUN :  49
00888>
00889> ********************************************************************************
00890>
00891>
00892>
00893>
00894>
00895> --------------------
00896> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
00897> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
00898>     TZERO =   .00 hrs on        0
00899>     METOUT=   2 (output = METRIC)
00900>     NRUN  = 050
00901>     NSTORM=   1
00902>               #  1=BURL_050.stm
00903> ------------------------------------------------------------------------------
00904> 050:0002------------------------------------------------------------------------
00905> *#*************************************************************************|
00906> *#  Project Name: 4063 UPPER MIDDLE ROAD
00907> *#               BURLINGTON, ONTARIO
00908> *#  JOB NUMBER  : 16115
00909> *#       Date   : January 2017
00910> *#    Revised   :
00911> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00912> *#       File   : 16115.DAT
00913> *#*************************************************************************|
00914> *
00915> ------------------------------------------------------------------------------
00916> 050:0002------------------------------------------------------------------------
00917> *
00918> --------------------
00919> | READ STORM       |    Filename: 50-YR BURLINGTON CHICAGO STORM (4-HR DUR
00920> | Ptotal=  61.96 mm|    Comments: 50-YR BURLINGTON CHICAGO STORM (4-HR DUR
00921> --------------------
00922>              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00923>               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00924>               .17   4.451 |   1.17  31.613 |   2.17  10.180 |   3.17   5.306
00925>               .33   5.067 |   1.33 129.819 |   2.33   8.734 |   3.33   4.946
00926>               .50   5.921 |   1.50  41.194 |   2.50   7.683 |   3.50   4.637
00927>               .67   7.198 |   1.67  22.439 |   2.67   6.881 |   3.67   4.369
00928>               .83   9.350 |   1.83  15.757 |   2.83   6.247 |   3.83   4.135
00929>              1.00  13.879 |   2.00  12.303 |   3.00   5.733 |   4.00   3.927
00930>
00931> ------------------------------------------------------------------------------
00932> 050:0003------------------------------------------------------------------------
00933> *
00934> *#*************************************************************************|
00935> *#
00936> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00937> *#        ============================================
00938> *#
00939> **#*************************************************************************|
00940> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
00941> *
00942> ---------------------
00943> | CALIB STANDHYD     |   Area    (ha)=     .31
00944> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
00945> ---------------------
00946>                                IMPERVIOUS    PERVIOUS (i)
00947>     Surface Area     (ha)=        .07          .25
00948>     Dep. Storage     (mm)=       1.00         6.35
00949>     Average Slope     (%)=       2.50         1.50
00950>     Length            (m)=      18.00        25.00
00951>     Mannings n           =       .015         .250
00952>
00953>     Max.eff.Inten.(mm/hr)=     129.82        53.08
00954>                over (min)       1.00         8.00
00955>     Storage Coeff.  (min)=        .68 (ii)    8.16 (ii)
00956>     Unit Hyd. Tpeak (min)=       1.00         8.00
00957>     Unit Hyd. peak  (cms)=       1.31          .14
00958>                                                        *TOTALS*
00959>     PEAK FLOW       (cms)=        .02          .02          .040 (iii)
00960>     TIME TO PEAK    (hrs)=       1.32         1.43         1.333
00961>     RUNOFF VOLUME    (mm)=      60.96        25.96        33.314
00962>     TOTAL RAINFALL   (mm)=      61.96        61.96        61.962
00963>     RUNOFF COEFFICIENT   =        .98          .42          .538
00964>
00965>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00966>           CN* =  80.0    Ia = Dep. Storage  (Above)
00967>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00968>           THAN THE STORAGE COEFFICIENT.
00969>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00970>
00971> ------------------------------------------------------------------------------
00972> 050:0004------------------------------------------------------------------------
00973> **#*************************************************************************|
00974> *#
00975> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
00976> *#        ==============================================
00977> *#
00978> **#*************************************************************************|
00979> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
00980> *
00981> ---------------------
00982> | CALIB STANDHYD     |   Area    (ha)=     .30
00983> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
00984> ---------------------
00985>                                IMPERVIOUS    PERVIOUS (i)
00986>     Surface Area     (ha)=        .17          .14
00987>     Dep. Storage     (mm)=       1.00         6.35
00988>     Average Slope     (%)=       3.00         3.00
00989>     Length            (m)=      15.00        25.00
00990>     Mannings n           =       .015         .250
00991>
00992>     Max.eff.Inten.(mm/hr)=     129.82        55.25
00993>                over (min)       1.00         7.00
00994>     Storage Coeff.  (min)=        .58 (ii)    6.55 (ii)
00995>     Unit Hyd. Tpeak (min)=       1.00         7.00
00996>     Unit Hyd. peak  (cms)=       1.40          .17
00997>                                                        *TOTALS*
00998>     PEAK FLOW       (cms)=        .06          .01          .071 (iii)
00999>     TIME TO PEAK    (hrs)=       1.30         1.40         1.333
01000>     RUNOFF VOLUME    (mm)=      60.96        25.96        45.213
01001>     TOTAL RAINFALL   (mm)=      61.96        61.96        61.962
01002>     RUNOFF COEFFICIENT   =        .98          .42          .730
01003>
01004>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01005>           CN* =  80.0    Ia = Dep. Storage  (Above)
01006>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01007>           THAN THE STORAGE COEFFICIENT.
01008>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01009>
01010> ------------------------------------------------------------------------------
01011> 050:0005------------------------------------------------------------------------
01012> **#*************************************************************************|
01013> ---------------------
01014> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01015> |  IN>02:(201   )    |
01016> | OUT<03:(201   )    |    =========  OUTLFW STORAGE TABLE  =========
01017> ---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01018>                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
01019>                             .000  .0000E+00   |     .014  .4600E-02
01020>                             .003  .0000E+00   |     .016  .7000E-02
01021>                             .009  .2300E-02   |     .000  .0000E+00
01022>
01023>     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01024>     --------------------       (ha)     (cms)     (hrs)       (mm)
01025>     INFLOW >02: (201   )        .30      .071     1.333     45.213
01026>     OUTFLOW<03: (201   )        .30      .015     1.683     45.232
01027>    OVERFLOW<04: (OVF   )        .00      .000      .000      .000
01028>
01029>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01030>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01031>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01032>
01033>
01034>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   20.672
01035>                    TIME SHIFT OF PEAK FLOW         (min)=    21.00
01036>                    MAXIMUM  STORAGE   USED       (ha.m.)=.5612E-02
01037>
01038> ------------------------------------------------------------------------------
01039> 050:0006------------------------------------------------------------------------
01040> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
01041> *
01042> ---------------------
01043> | CALIB STANDHYD     |   Area    (ha)=     .01
01044> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
01045> ---------------------
01046>                                IMPERVIOUS    PERVIOUS (i)
01047>     Surface Area     (ha)=        .01          .00
01048>     Dep. Storage     (mm)=       1.00         6.35
01049>     Average Slope     (%)=       3.50         3.00
01050>     Length            (m)=      12.00        12.00
01051>     Mannings n           =       .015         .250
01052>
01053>     Max.eff.Inten.(mm/hr)=     129.82        61.08
01054>                over (min)       1.00         4.00
01055>     Storage Coeff.  (min)=        .48 (ii)    4.18 (ii)
01056>     Unit Hyd. Tpeak (min)=       1.00         4.00
01057>     Unit Hyd. peak  (cms)=       1.49          .27
01058>                                                        *TOTALS*
01059>     PEAK FLOW       (cms)=        .00          .00          .003 (iii)
01060>     TIME TO PEAK    (hrs)=       1.27         1.37         1.333
01061>     RUNOFF VOLUME    (mm)=      60.96        25.96        49.063
01062>     TOTAL RAINFALL   (mm)=      61.96        61.96        61.962
01063>     RUNOFF COEFFICIENT   =        .98          .42          .792
01064>
01065>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01066>           CN* =  80.0    Ia = Dep. Storage  (Above)
01067>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01068>           THAN THE STORAGE COEFFICIENT.
01069>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01070>
01071> ------------------------------------------------------------------------------
01072> 050:0007------------------------------------------------------------------------
01073> ------------------------
01074> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01075> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
01076>                       ID1 03:201            .30     .015    1.68  45.23    .000
01077>                      +ID2 04:OVF            .00     .000     .00    .00    .000
01078>                      +ID3 05:203            .01     .003    1.33  49.06    .000
01079>                       ========================================================
01080>                       SUM 06:201 PLUS 2      .31     .015    1.33  45.37    .000
```

```
01081>
01082>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01083>
01084> ------------------------------------------------------------------------------
01085> 050:0008------------------------------------------------------------------------
01086> **#*************************************************************************|
01087> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01088> *
01089> ------------------------------------------------------------------------------
01090> 050:0002------------------------------------------------------------------------
01091> *
01092> ------------------------------------------------------------------------------
01093> 050:0002------------------------------------------------------------------------
01094> *
01095> ------------------------------------------------------------------------------
01096> 050:0002------------------------------------------------------------------------
01097> *
01098> ------------------------------------------------------------------------------
01099> 050:0002------------------------------------------------------------------------
01100> *
01101>   ** END OF RUN :  99
01102>
01103> ******************************************************************************
01104>
01105>
01106>
01107>
01108>
01109> --------------------
01110> | START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
01111> --------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
01112>     TZERO =   .00 hrs on       0
01113>     METOUT=   2 (output = METRIC)
01114>     NRUN  = 100
01115>     NSTORM=   1
01116>               #  1=BURL_100.stm
01117> ------------------------------------------------------------------------------
01118> 100:0002------------------------------------------------------------------------
01119> *#*************************************************************************|
01120> *#  Project Name: 4063 UPPER MIDDLE ROAD
01121> *#               BURLINGTON, ONTARIO
01122> *#  JOB NUMBER  : 16115
01123> *#       Date   : January 2017
01124> *#    Revised   :
01125> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
01126> *#       File   : 16115.DAT
01127> *#*************************************************************************|
01128> *
01129> ------------------------------------------------------------------------------
01130> 100:0002------------------------------------------------------------------------
01131> *
01132> --------------------
01133> | READ STORM      |    Filename: 100-YR BURLINGTON CHICAGO STORM (4-HR DU
01134> | Ptotal=  67.72 mm|    Comments: 100-YR BURLINGTON CHICAGO STORM (4-HR DU
01135> --------------------
01136>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01137>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01138>                .17   4.865 |   1.17  34.553 |   2.17  11.126 |   3.17   5.800
01139>                .33   5.538 |   1.33 141.892 |   2.33   9.547 |   3.33   5.406
01140>                .50   6.472 |   1.50  45.024 |   2.50   8.397 |   3.50   5.068
01141>                .67   7.868 |   1.67  24.526 |   2.67   7.521 |   3.67   4.776
01142>                .83  10.219 |   1.83  17.223 |   2.83   6.828 |   3.83   4.519
01143>               1.00  15.170 |   2.00  13.447 |   3.00   6.266 |   4.00   4.292
01144>
01145> ------------------------------------------------------------------------------
01146> 100:0003------------------------------------------------------------------------
01147> *
01148> *#*************************************************************************|
01149> *#
01150> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
01151> *#        ============================================
01152> *#
01153> **#************************************************************************|
01154> *# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD)
01155> *
01156> ----------------------
01157> | CALIB STANDHYD     |   Area    (ha)=     .31
01158> | 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
01159> ----------------------
01160>                              IMPERVIOUS    PERVIOUS (i)
01161>      Surface Area     (ha)=       .07          .25
01162>      Dep. Storage     (mm)=      1.00         6.35
01163>      Average Slope     (%)=      2.50         1.50
01164>      Length            (m)=     18.00        25.00
01165>      Mannings n             =      .015         .250
01166>
01167>      Max.eff.Inten.(mm/hr)=    141.89        62.57
01168>                    over (min)       1.00         8.00
01169>      Storage Coeff.  (min)=       .66 (ii)    7.66 (ii)
01170>      Unit Hyd. Tpeak (min)=      1.00         8.00
01171>      Unit Hyd. peak  (cms)=      1.33          .15
01172>                                                        *TOTALS*
01173>      PEAK FLOW       (cms)=       .03          .03          .046 (iii)
01174>      TIME TO PEAK    (hrs)=      1.32         1.43         1.333
01175>      RUNOFF VOLUME    (mm)=     66.72        30.16        37.842
01176>      TOTAL RAINFALL   (mm)=     67.72        67.72        67.724
01177>      RUNOFF COEFFICIENT   =       .99          .45          .559
01178>
01179>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01180>            CN* =  80.0    Ia = Dep. Storage  (Above)
01181>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01182>            THAN THE STORAGE COEFFICIENT.
01183>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01184>
01185> ------------------------------------------------------------------------------
01186> 100:0004------------------------------------------------------------------------
01187> **#************************************************************************|
01188> *#
01189> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
01190> *#        =============================================
01191> *#
01192> **#************************************************************************|
01193> *# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
01194> *
01195> ----------------------
01196> | CALIB STANDHYD     |   Area    (ha)=     .30
01197> | 02:201    DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   55.00
01198> ----------------------
01199>                              IMPERVIOUS    PERVIOUS (i)
01200>      Surface Area     (ha)=       .17          .14
01201>      Dep. Storage     (mm)=      1.00         6.35
01202>      Average Slope     (%)=      3.00         3.00
01203>      Length            (m)=     15.00        25.00
01204>      Mannings n             =      .015         .250
01205>
01206>      Max.eff.Inten.(mm/hr)=    141.89        67.22
01207>                    over (min)       1.00         6.00
01208>      Storage Coeff.  (min)=       .56 (ii)    6.08 (ii)
01209>      Unit Hyd. Tpeak (min)=      1.00         6.00
01210>      Unit Hyd. peak  (cms)=      1.42          .19
01211>                                                        *TOTALS*
01212>      PEAK FLOW       (cms)=       .07          .02          .080 (iii)
01213>      TIME TO PEAK    (hrs)=      1.30         1.38         1.333
01214>      RUNOFF VOLUME    (mm)=     66.72        30.16        50.272
01215>      TOTAL RAINFALL   (mm)=     67.72        67.72        67.724
01216>      RUNOFF COEFFICIENT   =       .99          .45          .742
01217>
01218>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01219>            CN* =  80.0    Ia = Dep. Storage  (Above)
01220>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01221>            THAN THE STORAGE COEFFICIENT.
01222>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01223>
01224> ------------------------------------------------------------------------------
01225> 100:0005------------------------------------------------------------------------
01226> **#************************************************************************|
01227> --------------------
01228> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
01229> |  IN>02:(201   )   |
01230> | OUT<03:(201   )   |    =========  OUTLFOW STORAGE TABLE  =========
01231> --------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01232>                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
01233>                            .000  .0000E+00   |     .014  .4600E-02
01234>                            .003  .0000E+00   |     .016  .7000E-02
01235>                            .009  .2300E-02   |     .000  .0000E+00
01236>
01237>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01238>      --------------------       (ha)     (cms)     (hrs)       (mm)
01239>      INFLOW >02: (201   )        .30      .080     1.333     50.272
01240>      OUTFLOW<03: (201   )        .30      .016     1.683     50.274
01241>     OVERFLOW<04: (OVF   )        .00      .000      .000       .000
01242>
01243>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01244>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01245>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01246>
01247>
01248>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   19.445
01249>                    TIME SHIFT OF PEAK FLOW          (min)=   21.00
01250>                    MAXIMUM  STORAGE   USED       (ha.m.)=.6457E-02
01251>
01252> ------------------------------------------------------------------------------
01253> 100:0006------------------------------------------------------------------------
01254> *# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
01255> *
01256> ----------------------
01257> | CALIB STANDHYD     |   Area    (ha)=     .01
01258> | 05:203    DT= 1.00 |   Total Imp(%)=   66.00   Dir. Conn.(%)=   66.00
01259> ----------------------
01260>                              IMPERVIOUS    PERVIOUS (i)
01261>      Surface Area     (ha)=       .01          .00
01262>      Dep. Storage     (mm)=      1.00         6.35
01263>      Average Slope     (%)=      3.50         3.00
01264>      Length            (m)=     12.00        12.00
01265>      Mannings n             =      .015         .250
01266>
01267>      Max.eff.Inten.(mm/hr)=    141.89        71.35
01268>                    over (min)       1.00         4.00
01269>      Storage Coeff.  (min)=       .47 (ii)    3.94 (ii)
01270>      Unit Hyd. Tpeak (min)=      1.00         4.00
01271>      Unit Hyd. peak  (cms)=      1.50          .29
01272>                                                        *TOTALS*
01273>      PEAK FLOW       (cms)=       .00          .00          .003 (iii)
01274>      TIME TO PEAK    (hrs)=      1.27         1.35         1.333
01275>      RUNOFF VOLUME    (mm)=     66.72        30.16        54.294
01276>      TOTAL RAINFALL   (mm)=     67.72        67.72        67.724
01277>      RUNOFF COEFFICIENT   =       .99          .45          .802
01278>
01279>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01280>            CN* =  80.0    Ia = Dep. Storage  (Above)
01281>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01282>            THAN THE STORAGE COEFFICIENT.
01283>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01284>
01285> ------------------------------------------------------------------------------
01286> 100:0007------------------------------------------------------------------------
01287> ------------------------
01288> | ADD HYD (201 PLUS 2) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01289> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
01290>                        ID1 03:201           .30     .016    1.68  50.27    .000
01291>                       +ID2 04:OVF           .00     .000     .00    .00    .000
01292>                       +ID3 05:203           .01     .003    1.33  54.29    .000
01293>                        ==========================================================
01294>                        SUM 06:201 PLUS 2     .31     .017    1.33  50.42    .000
01295>
01296>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01297>
01298> ------------------------------------------------------------------------------
01299> 100:0008------------------------------------------------------------------------
01300> **#************************************************************************|
01301> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01302> *
01303> ------------------------------------------------------------------------------
01304> 100:0002------------------------------------------------------------------------
01305> *
01306> ------------------------------------------------------------------------------
01307> 100:0002------------------------------------------------------------------------
01308> *
01309> ------------------------------------------------------------------------------
01310> 100:0002------------------------------------------------------------------------
01311> *
01312> ------------------------------------------------------------------------------
01313> 100:0002------------------------------------------------------------------------
01314> *
01315> ------------------------------------------------------------------------------
01316> 100:0002------------------------------------------------------------------------
01317> *
01318>       FINISH
01319> ------------------------------------------------------------------------------
01320> ******************************************************************************
01321>      WARNINGS / ERRORS / NOTES
01322>      -------------------------
01323>    Simulation ended on 2017-01-17     at 13:19:35
01324> ==============================================================================
01325>
01326>
```

APPENDIX C
HYDROGUARD INFORMATION


Printer
Hydroworks Stormwater Treatment Simulation
File
View
Help
General
Dimensions
Rainfall
Site
TSS PSD
TSS Loading
Quantity Storage
By-Pass
CAD
Custom
Site Parameters
Area (ha)
.3
Imperviousness (%)
55
Units
U.S.
Metric
Rainfall Station
Hamilton RBG
Ontario
2004 to 2013
Inlet Pipe
Diam. (mm)
100
Slope (%)
1
Project Title
(2 lines)
4063 Upper Middle Road
Copyright Hydroworks, LLC, 2015
Stokes
Cheng
Lab Testing (Linear)
Lab Testing (Exponential)
Hydroworks Sizing Results
Model #
Qlow (m3/s)
Qtot (m3/s)
Low (IC) Flow (%)
TSS Removal (%)
HG 4 .01 .01 99 % 99 %
HG 5 .01 .01 99 % 100 %
HG 6 .01 .01 99 % 100 %
HG 7 .01 .01 99 % 100 %
HG 8 .01 .01 99 % 100 %
HG 9 .01 .01 99 % 100 %
HG 10 .01 .02 99 % 100 %
HG 12 .01 .02 99 % 100 %
TSS Particle Sizes
Size (um)
(%)
S.G.
20 20 2.65
60 20 2.65
150 20 2.65
400 20 2.65
2000 20 2.65
Note: Results vary significantly based on particle size distribution
Simulate



Hydroworks® Hydroguard

Maintenance Manual

Version 1.3

Introduction

The Hydroguard is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The Hydroguard is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their Hydroguard.

Hydroworks® HG Operation

The Hydroworks HG separator is unique since it treats both high and low flows in one device, but maintains separate flow paths for low and high flows. Accordingly, high flows do not scour out the fines that are settled in the low flow path since they are treated in a separate area of the device as shown in Figure 1.

The HG separator consists of three chambers:

1. an inner chamber that treats low or normal flows
2. a middle chamber that treats high flows
3. an outlet chamber where water is discharged to the downstream storm system

Under normal or low flows, water enters the middle chamber and is conveyed into the inner chamber by momentum. Since the inner chamber is offset to one side of the structure the water strikes the wall of the inner chamber at a tangent creating a vortex within the inner chamber. The vortex motion forces solids and floatables to the middle of the inner chamber. The water spirals down the inner chamber to the outlet of the inner chamber which is located below the inlet of the inner chamber and adjacent to the wall of the structure but above the floor of the structure. Floatables are trapped since the outlet of the inner chamber is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while the outlet of the inner chamber draws water from the wall of the inner chamber.

The water leaving the inner chamber continues into the middle chamber, again at a tangent to the wall of the structure. The water is then conveyed through an outlet baffle wall (high and low baffle). This enhances the collection of any floatables or solids not removed by the inner chamber. Water flowing through the baffles then enters the outlet chamber and is discharged into the downstream storm drain.

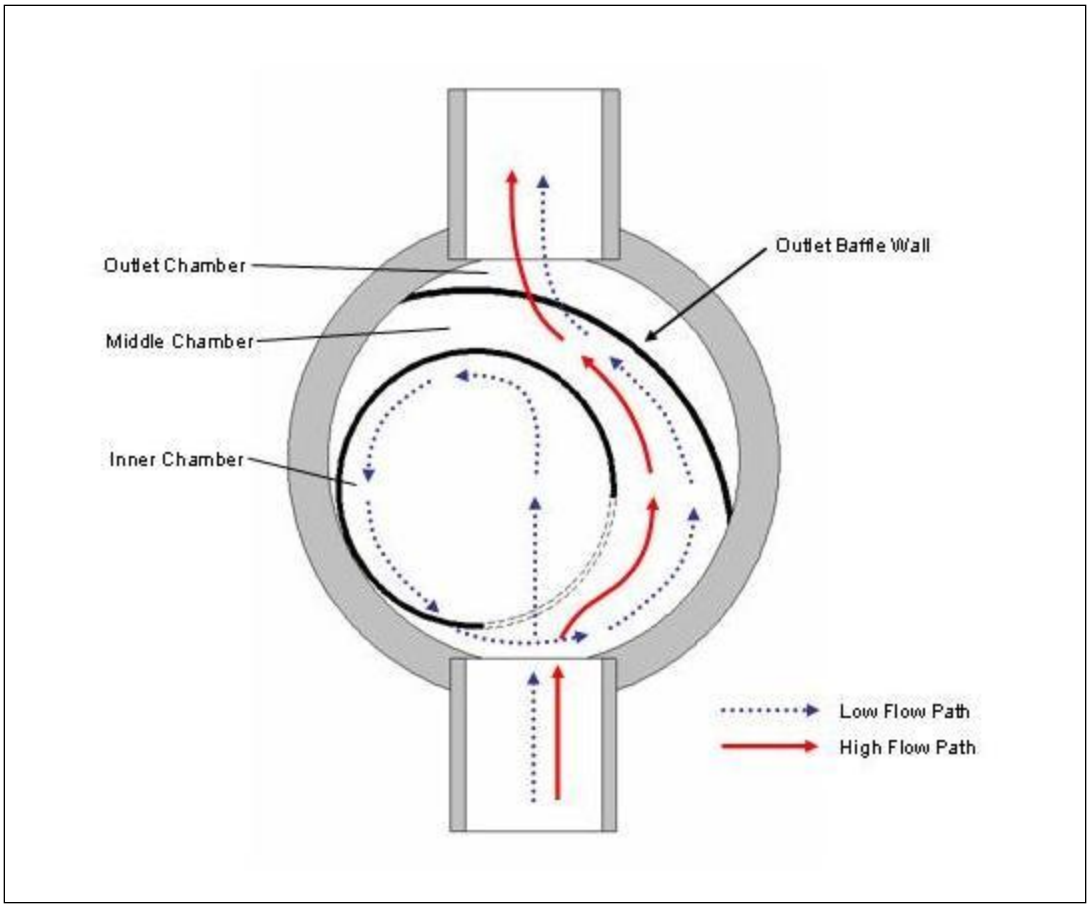


Figure 1. Hydroworks HG Operation – Plan View

During high flows, the flow rate entering the inner chamber is restricted by the size of the inlet opening to the inner chamber. This restriction of flow rate into the inner chamber prevents scour and re-suspension of solids from the inner chamber during periods of high flow. This is important since fines, which are typically considered highly polluted, are conveyed during low/normal flows.

The excess flow is conveyed directly into the middle chamber where it receives treatment for floatables and solids via the baffle system. This treatment of the higher flow rates is important since trash and heavier solids are typically conveyed during periods of higher flow rates. The Hydroworks HG separator is revolutionary since it incorporates low and high flow treatment in one device while maintaining separate low and high flow paths to prevent the scour and re-suspension of fines.

Figure 2 is a profile view of the HG separator showing the flow patterns for low and high flows.

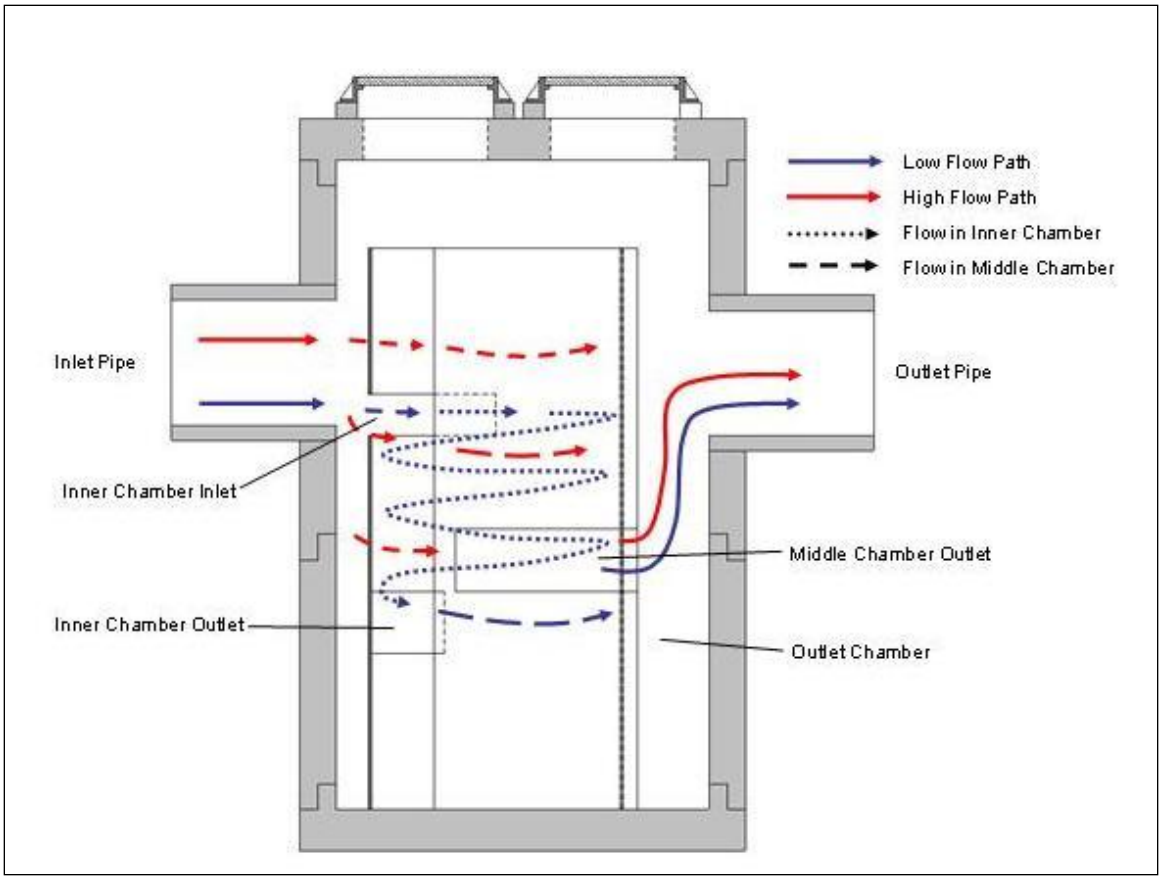
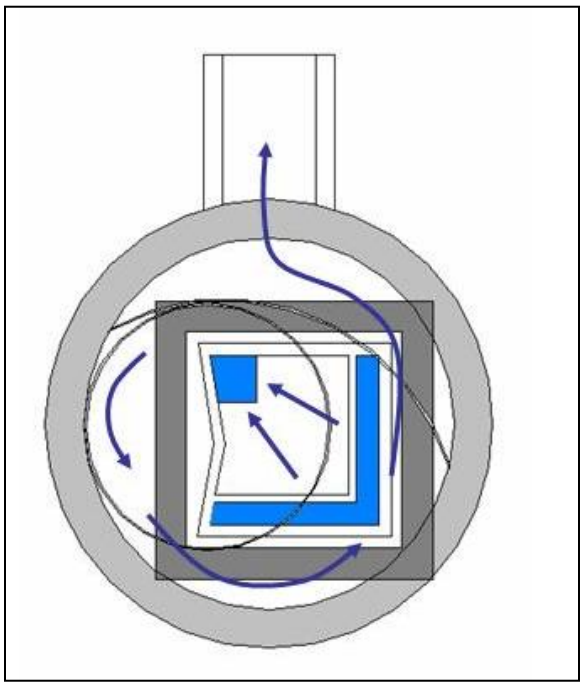


Figure 2. Hydroworks HG Operation – Profile View

The HG 4i is an inlet version of the HG 4 separator. There is a catch-basin grate on top of the HG 4i. Water flows directly into the inner chamber of the HG 4i through the catch-basin grate on top of the structure. The grate is oversized to allow maintenance of the entire structure. A funnel that sits underneath the grate on the top cap of the concrete itself directs the water into the inner chamber during normal flows and the middle chamber during high flows. Figures 3 and 4 show the flow paths for the HG 4i separator.

The inlet funnel is sloped towards the corner inlet and hence the wall of the inner chamber. Water moves in a circular direction in the inner chamber since water enters tangentially along the wall of the inner chamber due to the sloping funnel.

Water continues moving in a circular motion (vortex) through the rest of the structure (through the middle chamber and baffle wall) until it is discharged from the separator.



During periods of peak flow the water will back up from the corner inlet and overflow into two side overflow troughs which discharge directly into the middle chamber. These overflow troughs are covered from the surface such that water cannot directly fall through them (i.e. water must back up to enter the overflow troughs).

Accordingly this funnel provides the same separate flow paths for low and high flow as the other Hydroguard separators.

The whole funnel is removed for inspection and cleaning providing.

Figure 3. Hydroworks Hydroguard HG 4i Normal Flow Path

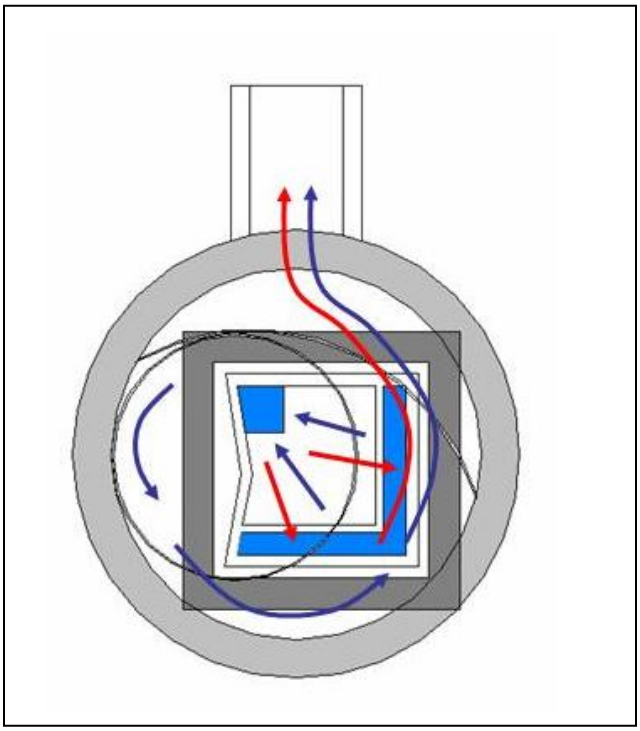


Figure 4. Hydroworks Hydroguard HG 4i Peak Flow Path

Inspection

Procedure

Although all parts of the Hydroguard should be inspected, inspection and maintenance should focus on the inner and middle chambers since this is where the pollutants (floatable and sinking) will accumulate.

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the separator. Multiple covers are provided on Hydroworks HG units to access all areas of the separator (The HG 4 may have a single larger 32” (800mm) cover due to the lack of space for multiple 24” (600mm) covers).

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HG separator should be inspected every two weeks and after every large storm (over 0.5” (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HG separator should be inspected once per year for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HG separator should be inspected more frequently (4 times per year). An initial annual inspection will indicate the required future frequency of maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HG unit is typically maintained using a vactor truck or clam shell bucket. There are numerous companies that can maintain the HG separator. Envirocalm, LLC, an affiliate company of Hydroworks offers inspection and maintenance services and can inspect and maintain the HG separator. (www.envirocalm.com).

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HG unit will typically take 1 to 2 hours.

Frequency

Construction Period

A HG separator can fill with construction sediment quickly during the construction period. The construction sediment will have a much coarser particle size distribution than the suspended solids during the post-development period. Accordingly, scour is not so much of a concern during the construction period compared to the separator filling up with solids. The Hydroguard must be maintained during the construction period when the depth of TSS/sediment reaches 27” (675 mm). This represents 75% of the maximum sediment storage capacity. It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the open water surface on the inlet side of the outlet baffle wall.

The HG separator should be maintained at the end of the construction period, prior to utilization for the post-construction period.

Post-Construction Period

The Hydroguard was independently tested by Alden Research Laboratory in 2008. A HG6 was tested for scour with initial sediment loads of 4.6 ft^3 and 9.3 ft^3. The results from these tests were almost identical. Therefore, the 9.3 ft^3 sediment load was used as 50% of the maximum sediment depth for maintenance in the calculation of the maintenance interval for the HG6 separator based on the NJDEP maintenance interval equation.

Maintenance Interval (months) = 3.565 x (Sediment Storage) / (MTFR x TSS Removal)

Maintenance Interval (HG6) = 3.565 x 9.3 / (1.67x 0.55) = 36 months

All values (flow, sediment storage) can be scaled by the surface area making the sediment depths and maintenance intervals equal for all separators.

The separator was loaded with the sediment in the inner chamber and middle chamber with the majority of sediment (80%) located in the inner chamber. The inner chamber for area represents approximately 44% of the separator surface area. The inner chamber is 4 ft (1200 mm) in diameter in the HG6. Therefore the 50% sediment depth for the HG6 in the inner chamber would be:

9.3 ft^3 x 0.80 / (3.14 x 4 ft^2) x 12 in/ft = 7.1 inches (175 mm)

Accordingly the 100% sediment volume would represent 14.2” (350 mm) of sediment depth in the inner chamber.

The HG separator must be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the open water surface on the inlet side of the outlet baffle wall. It should also be maintained once the accumulated TSS/sediment depths are greater than 14” (350 mm) in the inner chamber. For typical stabilized post-construction sites (parking lots, streets) it is anticipated that maintenance will be required annually or once every two years. More frequent or less frequent maintenance will be required depending on individual site conditions (traffic use, stabilization, storage piles, etc.). The long term maintenance frequency can be established based on the maintenance requirements during the first several years of operation if site conditions do not change.

HYDROGUARD INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

Hydroguard	**Yes**	**No**
Incorrect access orientation	☐ ***	☐
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐

Water level depth below outlet pipe invert _____"

Routine Measurements

Floating debris depth	**< 0.5" (13mm)**	☐	**>0.5" 13mm)**	☐*
Floating debris coverage	**< 25% of surface area**	☐	**> 25% surface area**	☐ *
Sludge depth	**< 14" (350mm)**	☐	**> 14" (350mm)**	☐ *****

Other Comments: _____
_____
_____

* Maintenance required
** Repairs required
*** Further investigation is required

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Hydroworks® Hydroguard

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks Hydroguard to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 50 S 21st St., Kenilworth, NJ 07033 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks Hydroguard are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the Hydroguard, or the cost of other goods or services related to the purchase and installation of the Hydroguard. For this Limited Warranty to apply, the Hydroguard must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the Hydroguard arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the Hydroguard, whether the claim is based upon contract, tort, or other legal basis.

APPENDIX D
WATER ANALYSIS INFORMATION

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Project Number: 16115
Project Name: 4063 Upper Middel Road
Date: 09-Jan-17

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 1999).

An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\sqrt{A} \qquad \textbf{(1)}$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible).
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

	Building Area				(1)		(2)			(3)		(4)		Final Adjusted Fire Flow	
Building / Location	Footprint Area (m^2)	# of Storeys	**Total GFA (m^2)**	Type of Construction	***Fire Flow "F"*** (l/min)	(l/s)	***Occupancy*** %	Adjustment (l/min)	**Adjusted Fire Flow (l/min)**	***Sprinkler*** %	Adjustment (l/min)	***Exposure*** %	Adjustment (l/min)	**(l/min)**	**(l/s)**
4063 Upper Middle Road	**7185**	**1**	**7185**	**0.8**	15000	250.0	**-15**	-2250.0	**12750.0**	**-50**	-6375.0	25	3187.5	**10000**	**167**

Total Area Calculation:

Floor	Area	Tot. Area	Cumm. Area
1-6	1047	6282	6282.0
7	903	903	7185.0

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

(3) Sprinkler

Minimum credit for systems designed to NFPA 13 is 30%.

If the domestic and fire services are supplied by the same municipal water system, then take an additional 10%.

If the sprinkler system is fully supervised (ie. annunciator panel that alerts the Fire Dept., such as a school), then an additional 10% can be taken. Maximum credit = 50%.

(4) Exposure

0 to 3m	25%	Calculate for all sides. Maximum charge shall not exceed 75%
3.1 to 10m	20%	
10.1 to 20m	15%	
20.1 to 30m	10%	
30.1 to 45m	5%	

Side	Exposure (m)	Charge (%)
North =	**22**	**10**
South =	**95**	**0**
East =	**none**	**0**
West =	**11**	**15**
Total Expoure =		***25***

APPENDIX E
PRELIMINARY ENGINEERING PLANS