174 Maitland Drive Residential Subdivision

Stormwater Management Report

Part of Lot 3, Concession 3
Former Thurlow Township
City of Belleville
Hastings County

September 2020

AINLEY GRAHAM & ASSOCIATES

CONSULTING ENGINEERS AND PLANNERS
COLLINGWOOD · BARRIE · BELLEVILLE · KINGSTON · OTTAWA

File No. 19628-1

Ainley GROUP CONSULTING ENGINEERS PLANNERS

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1.0 INTRODUCTION

Ainley Group has been retained to undertake engineering services necessary for the completion of a stormwater management study to support Draft Plan approval for the proposed 174 Maitland Drive residential development.

2.0 SITE DESCRIPTION

2.1 Existing Conditions

The property is legally described as part of Lot 3, Concession 3, former Township of Thurlow, now City of Belleville, Hastings County. The parcel of land is approximately 4.84 hectares (ha). The property is bounded to the west by existing Deerfield Park residential development, vacant lands to the east, to the north by Maitland Drive and to the south by Lowe's Company Canada. The property is currently used by Quinte Broadcasting Co. Ltd for a transmitting tower and building, surrounded by a dense wooded area. The site is predominately flat with a slope to the southeast.

A site location plan is attached to this report as **Figure 1**.

2.2 Proposed Conditions

The property is proposed to be developed with the following:

- Thirty-five (36) single family lots,
- Twenty-three (23) townhouse units,
- Thirty-eight (38) back-to-back units, and
- Approximately 450 m of Municipal Road Allowance with 20m width.

The current conceptual development plan is attached to this report as **Figure 2**.

3.0 PROPOSED STORM SEWER

Storm sewers will be provided to service the subject lands. Drainage will generally be conveyed toward the proposed SWM facility block within the property limits. It is proposed to provide quality and quantity control through the use of an extended detention wet pond facility. The design guidance provided in the MOE manual, section 4.6.2. has been utilized in the design of the SWM facility.

4.0 HYDROLOGY

4.1 Model Selection

Flow calculations for the post development conditions were carried out using the SWMHYMO computer program. This program is a complex hydrologic model used for the simulation and management of stormwater runoff in either small or large rural and urban areas.

4.2 Rainfall Distribution

The quality storm hyetograph was developed in accordance with a typical 4-hour distribution for the 25 mm rainfall event. Additionally, the 5 year 1-hour Chicago storm was analyzed for conveyance purposes through the SWM facility and the 100 year 1-hour Chicago distribution was evaluated for overland conveyance of runoff from the site. A 1-hour Chicago storm was selected by the designer based on the time to peak for the Area 201 catchment, which is 0.36 hours. The MTO IDF Look-up Tool was used to determine rainfall distribution and is included in **Appendix A**.

4.3 Model Parameters

The SWMHYMO model has been developed with consideration of the parameters interpreted from air photos, Ontario Soils Mapping, topographic information, and the designer's knowledge of the site based on visual observations. The soils within the subject site have been identified as Soil Group 'C', as they are comprised of Solmesville Clay Loam and Farmington Loam. Based on the existing topography and site conditions, the soils have been assigned a Curve Number of 71 and Runoff Coefficient of 0.35. Supporting documentation is enclosed in **Appendix A**.

An estimate of the contributing site impervious cover for each area has been prepared for use in the SWMHYMO modeling and evaluation of the MOE permanent pool guidelines. It has been estimated that the area requires quality treatment will be approximately 37% impervious, with 26% directly connected. Supporting calculations for the estimate of impervious cover are included in **Appendix A**.

4.4 Pre-Development

The following summaries the finding of the pre-development conditions;

- 5 year = 0.125 m^3/s
- 100 year = 0.319 m^3/s

The SWMHYMO output is enclosed in **Appendix B**.

4.5 Post Development

The post development SWMHYMO model was developed to evaluate the runoff rate and volume generated by the Quality (25mm), 5-year, and 100-year Quantity events from the proposed site. The SWMHYMO output is included in **Appendix B**. The following table outlines the post development discharge rates anticipated to be generated from the development site.

Table 1: Summary of Flows

Event	Post-development (m^3/s)
25mm	0.206
5 year	0.827
100 year	1.536

5.0 STORMWATER QUANTITY CONTROL

It is proposed to provide quantity control through the use of a wet pond facility. The design guidance provided in the MOE manual, section 4.6.2 has been utilized in the design of the SWM facility.

The facility will require and active pool volume of 853 m^3. A 575mm orifice will be used to control the 100-year flows to pre-development rates. The resulting peak discharge will be 0.309 m^3/s. Supporting calculations for the development of the discharge-storage curve used in the ROUTE RESERVOIR routine in SWMHYMO is enclosed in **Appendix B**.

A 3.5m wide weir is proposed to allow safe conveyance of the post development 100-year discharge of 1.536m^3/s in the event that the outlet becomes inundated. A copy of the SWMHYMO output file is enclosed in **Appendix B**.

6.0 STORMWATER QUALITY CONTROL

The minor flows generated from all events up to and including the 5-year event will be conveyed through the storm sewer systems. Quality control for the area will be managed through the SWM Facility located within the proposed SWM Block.

Using SWMHYMO it was estimated using ROUTE RESERVIOUR command that the 25mm event would require a storage volume of 505 m^3 to provide a 24 hour draw down of the stormwater runoff. A 56mm orifice will be used to control the 25mm event flows to pre-development rates. The resulting peak discharge rate will be 0.006m^3/s.

The SWMHYMO output file is enclosed in **Appendix B.**

7.0 POND DESIGN

Given the large area of the contributing site, 4.84 ha, it is proposed to provide quality controls through the use of an extended detention wet pond facility. The design guidance provided in the MOE manual, section 4.6.2 has been utilized in the design of the on-site SWM facility.

The facility will provide an active pool volume of approximately 356 m^3 (59 m^3 in the forebay, 297 m^3 in the main pond). The forebay and main pond have both been designed with a maximum permanent pool depth of 1.0 m.

Table 1 provides a summary of recommended design parameters (MOE) and the proposed pond design.

Table 2: Summary of Pond Design Requirements

Component	Recommended	Provided
Drainage Area	> 5 ha	4.84 ha
Treatment Volume (Table 3.2) @ 37.5 % imp.	708 m^3	1,494 m^3

Quality Treatment	40 m^3/ha	25 mm event
Permanent Volume	514 m^3	633 m^3
Active Volume (quality)	-	228 m^3
Active Volume (quantity)	194 m^3	861 m^3
Forebay Depth (permanent)	Min. 1 m	1.0 m
Main Depth (permanent)	Min. 1 m	1.0 m
Active Depth (quality)	Max 1.5	1.0 m
Active Depth (quantity)	-	1.2 m
Draw Down Time (quality)	24 hour	24 hour

8.0 MAINTENANCE

Based on the annual loading rates provided in the MOE manual it has been estimated that this site will generate approximately 20.0 m^3 of sediment per year that will accumulate in the SWM facility. It has been estimated that, at this rate, the forebay berm will require cleanout on a 2-year cycle and the main pond should have a cleanout on a minimum 20-year cycle.

The permanent pool portions of the forebay and main pond were sized with consideration for the loss of storage volume based on accumulated sediment.

Supporting calculations are provided in the pond calculations within **Appendix C**.

9.0 EROSION AND SEDIMENTATION CONTROL

An erosion and sediment control strategy will be implemented as per the plan included in the detailed engineering drawing package in order to minimize the transfer of silt off-site during construction. The following measures will be incorporated into the strategy as required:

- Environmental fencing and straw bales
- Regular inspection of the erosion and sediment control devices
- Removal and disposal of the erosion and sediment control devices after the site has been stabilized
- All exposed earth to be re-vegetated within thirty days

10.0 CONCLUSIONS

- Quantity control and quality control for the proposed development will be provided in the proposed wet pond facility.
- Silt fencing and straw bale barriers will be in place during construction.
- The forebay will require removal of accumulated sediment on a 2-year cycle and the main pond should have a cleanout on a minimum 20-year cycle.

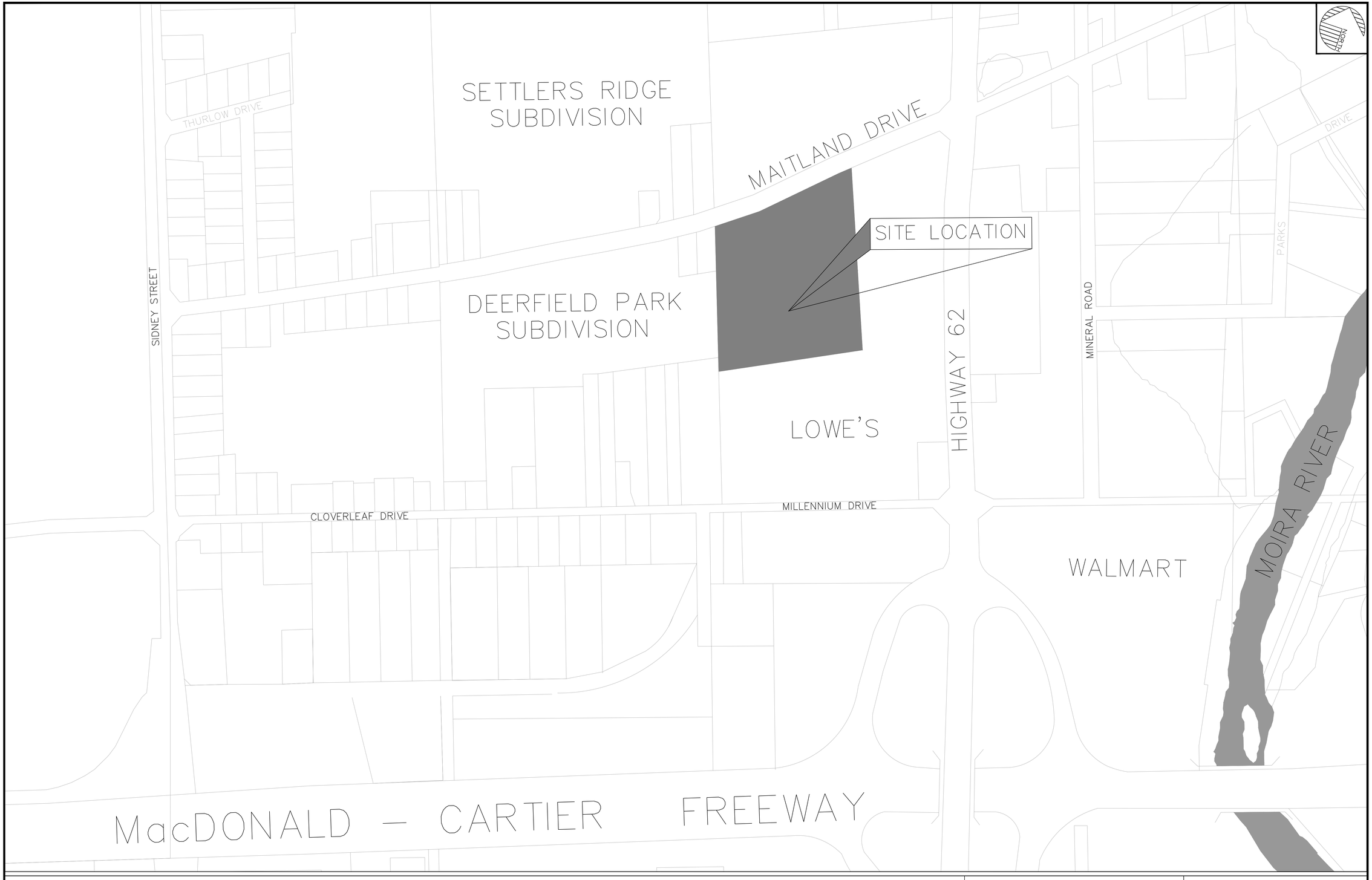
We trust the above information meets your needs at this time and should you have any further questions or concerns, please do not hesitate to contact our office.

Sincerely,
AINLEY GRAHAM & ASSOCIATES LIMITED

Prepared by:
Victoria Chapman
Engineering Intern

Reviewed by:
Adam Wilson, P. Eng.
Senior Engineer

FIGURES



174 MAITLAND DRIVE
CITY OF BELLEVILLE

FIGURE 1
KEY MAP

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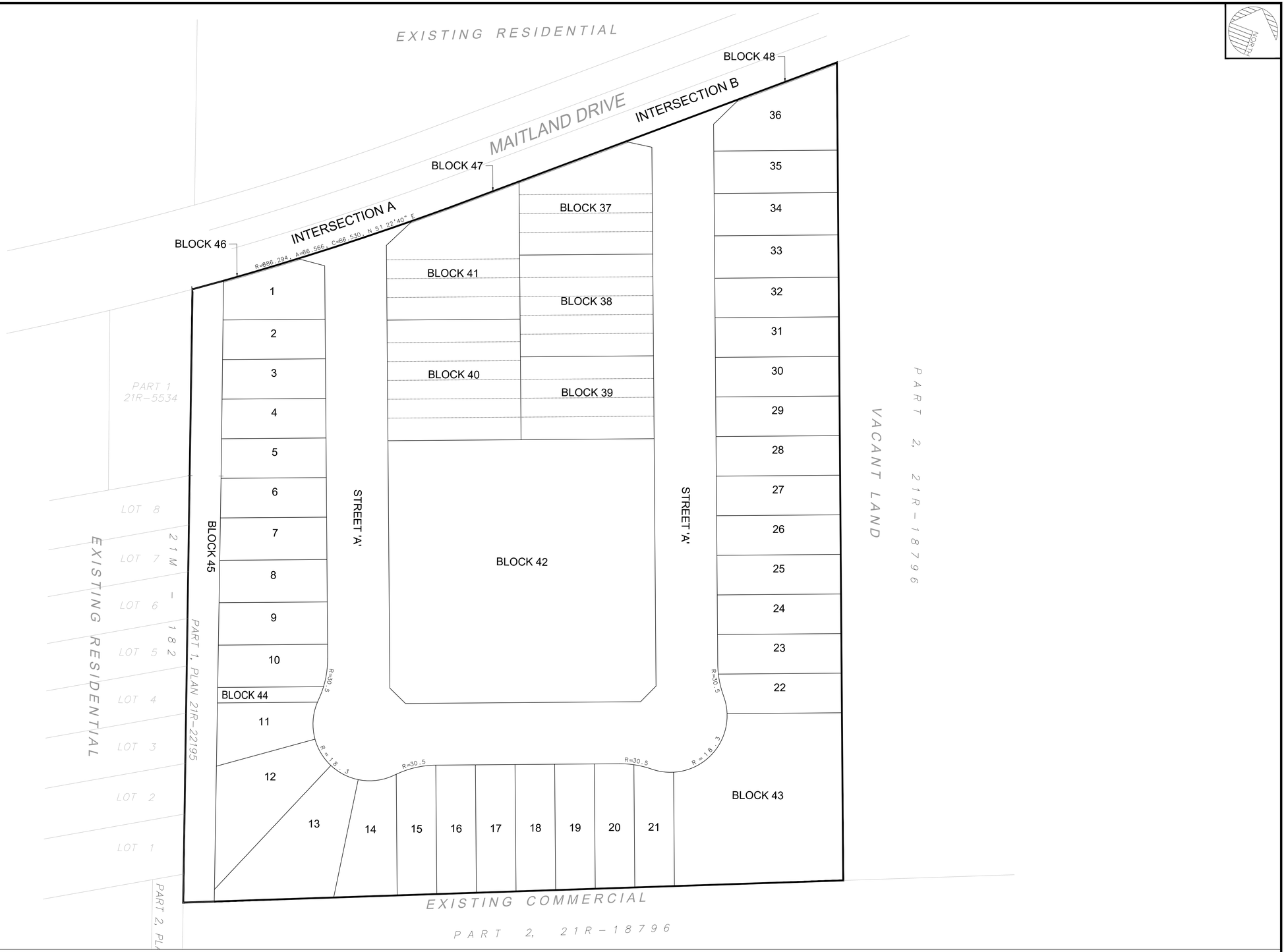

174 MAITLAND DRIVE
CITY OF BELLEVILLE

FIGURE 2
CONCEPT PLAN

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APPENDIX A

Model Parameters

Ontario IDF CURVE LOOKUP

Active coordinate

44° 11' 44" N, 77° 24' 15" W (44.195833,-77.404167)

Retrieved: Wed, 04 Dec 2019 16:07:22 GMT

Location summary

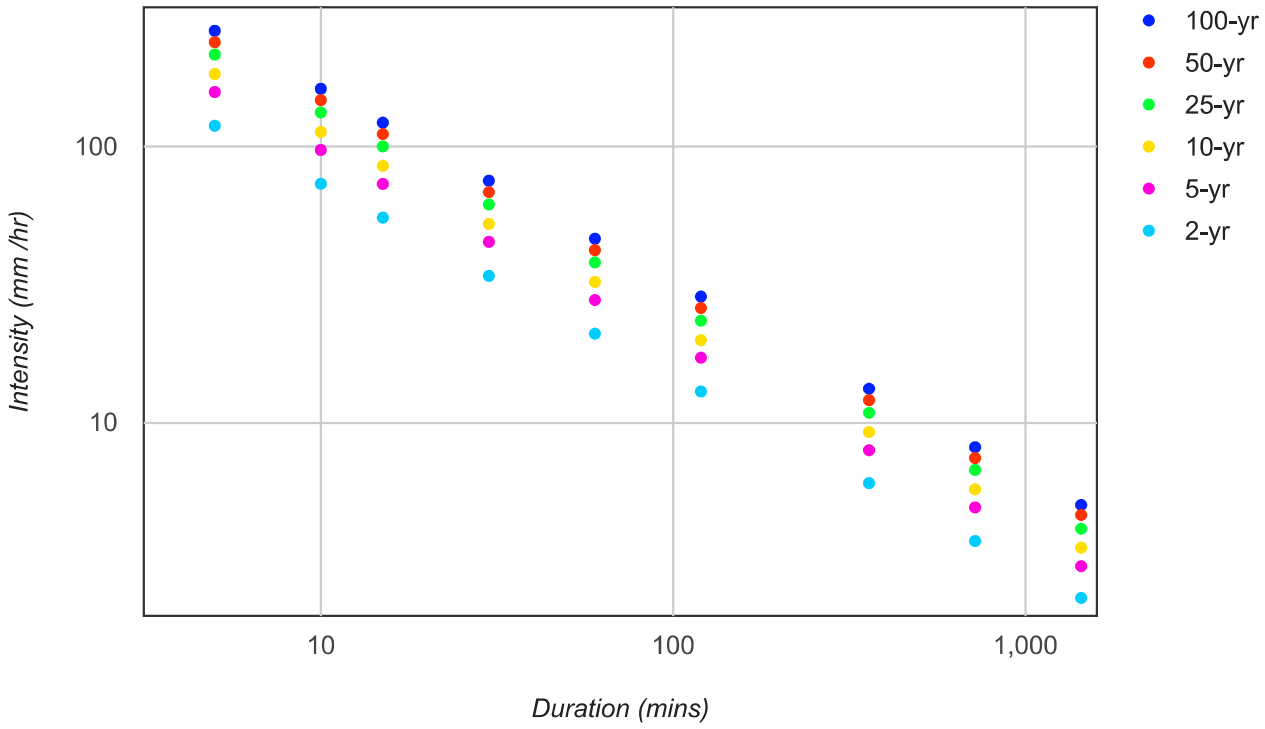
These are the locations in the selection.

IDF Curve: 44° 11' 44" N, 77° 24' 15" W (44.195833,-77.404167)

Results

An IDF curve was found.

Coordinate: 44.195833, -77.404167
IDF curve year: 2010



Coefficient summary

IDF Curve: 44° 11' 44" N, 77° 24' 15" W (44.195833,-77.404167)

Retrieved: Wed, 04 Dec 2019 16:07:22 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	20.9	27.7	32.2	37.9	42.0	46.2
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	118.7	73.1	55.1	33.9	20.9	12.9	6.0	3.7	2.3
5-yr	157.3	96.9	73.0	45.0	27.7	17.1	7.9	4.9	3.0
10-yr	182.9	112.7	84.9	52.3	32.2	19.8	9.2	5.7	3.5
25-yr	215.3	132.6	99.9	61.5	37.9	23.3	10.8	6.7	4.1
50-yr	238.6	147.0	110.7	68.2	42.0	25.9	12.0	7.4	4.6
100-yr	262.4	161.6	121.8	75.0	46.2	28.5	13.2	8.1	5.0

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	9.9	12.2	13.8	17.0	20.9	25.7	35.8	44.2	54.4
5-yr	13.1	16.2	18.2	22.5	27.7	34.1	47.5	58.5	72.1
10-yr	15.2	18.8	21.2	26.1	32.2	39.7	55.2	68.0	83.8
25-yr	17.9	22.1	25.0	30.8	37.9	46.7	65.0	80.1	98.6
50-yr	19.9	24.5	27.7	34.1	42.0	51.7	72.0	88.7	109.3
100-yr	21.9	26.9	30.4	37.5	46.2	56.9	79.2	97.6	120.3

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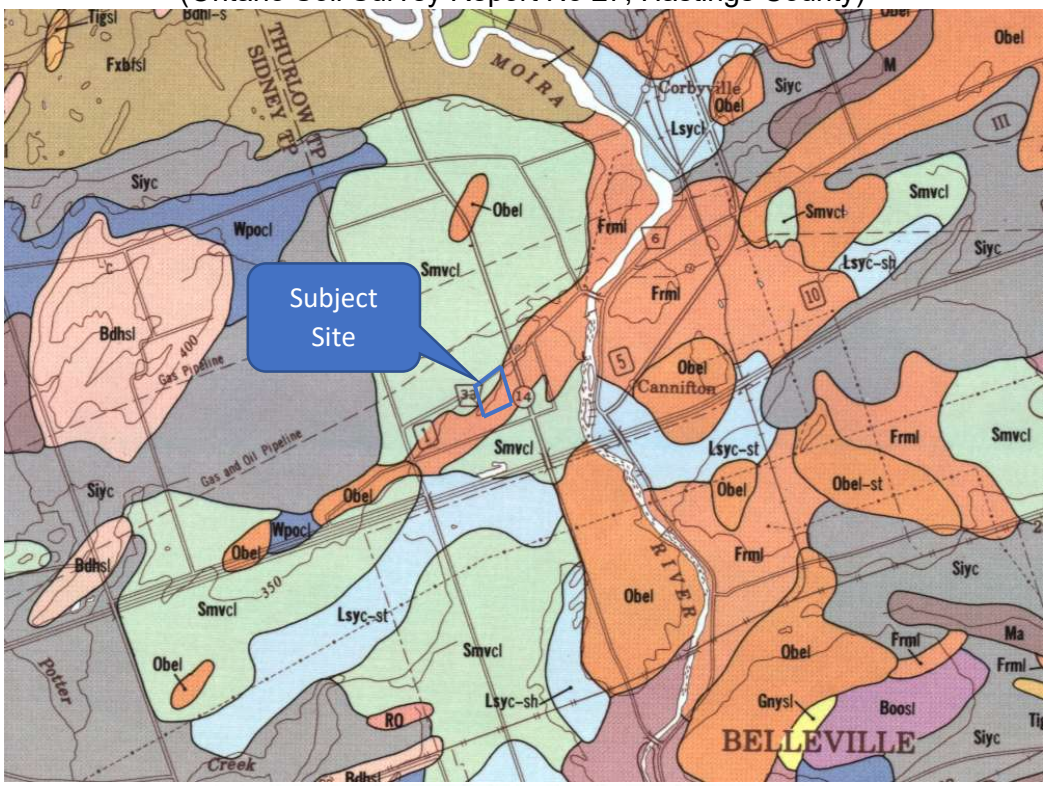
Last Modified: September 2016

Soil Classification
(Ontario Soil Survey Report No 27, Hastings County)



CONVENTION

Map symbol, surface texture, soil phase - Map symbol, surface texture, soil phase

SOIL TEXTURE

c	clay
l	loam
cl	clay loam
sl	sandy loam
sil	silt loam
fsl	fine sandy loam
gs	gravelly sand
ls	loamy sand

SOIL PHASE

b	bouldery
R	rock outcrop
s	steep
sh	shallow
st	stony

Eok	ELMBROOK	Gray-Brown Podzolic	Imperfect
Frm	FARMINGTON	Brown Forest	Variable
Fxb	FOXBORO	Dark Gray Gleysolic	Poor
Siy	SIDNEY	Dark Gray Gleysolic	Poor
Smv	SOLMESVILLE	Gray-Brown Podzolic	Imperfect
Str	ST PETERS	Podzol	Good to excessive

CN.

Design Chart 1.09: Soil Conservation Service Curve Numbers (Continued)

Land Use or Surface	Hydrologic Soil Group						
	A	AB	B	BC	C	CD	D
Fallow (special cases only)	77	82	86	89	91	93	94
Crop and other improved land	66** (62)	70** (68)	74	78	82	84	86 AMC I
Pasture & other unimproved land	58* (38)	62* (51)	65	71	76	79	81
Woodlots and forest	50* (30)	54* (44)	58	65	71	74	77
Impervious areas (paved)							98
Bare bedrock draining directly to stream by surface flow							98
Bare bedrock draining indirectly to stream as groundwater (usual case)							70
Lakes and wetlands							50

Notes

(i) All values are based on AMC II except those marked by * (AMC III) or ** (mean of AMC II and AMC III).

(ii) Values in brackets are AMC II and are to be used only for special cases.

(iii) Table is not applicable to frozen soils or to periods in which snowmelt contributes to runoff.

Design Chart 1.08: Hydrologic Soil Groups (Continued)

- Based on Soil Texture

Sands, Sandy Loams and Gravels	
- overlying sand, gravel or limestone bedrock, very well drained	A
- ditto, imperfectly drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium to Coarse Loams	
- overlying sand, gravel or limestone, well drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium Textured Loams	
- shallow, overlying limestone bedrock	B
- overlying medium textured subsoil	BC
Silt Loams, Some Loams	
- with good internal drainage	BC
- with slow internal drainage and good external drainage	C
Clays, Clay Loams, Silty Clay Loams	
- with good internal drainage	C
- with imperfect or poor external drainage	C
- with slow internal drainage and good external drainage	D

Source: U.S. Department of Agriculture (1972)

Design Chart 1.07: Runoff Coefficients (Continued)

- Rural RC

Land Use & Topography[3]	Soil Texture		
	Open Sand Loam	Loam or Silt Loam	Clay Loam or Clay
CULTIVATED			
Flat 0 - 5% Slopes	0.22	0.35	0.55
Rolling 5 - 10% Slopes	0.30	0.45	0.60
Hilly 10- 30% Slopes	0.40	0.65	0.70
PASTURE			
Flat 0 - 5% Slopes	0.10	0.28	0.40
Rolling 5 - 10% Slopes	0.15	0.35	0.45
Hilly 10- 30% Slopes	0.22	0.40	0.55
WOODLAND OR CUTOVER			
Flat 0 - 5% Slopes	0.08	0.25	0.35
Rolling 5 - 10% Slopes	0.12	0.30	0.42
Hilly 10- 30% Slopes	0.18	0.35	0.52
BARE ROCK	COVERAGE[3]		
	30%	50%	70%
Flat 0 - 5% Slopes	0.40	0.55	0.75
Rolling 5 - 10% Slopes	0.50	0.65	0.80
Hilly 10- 30% Slopes	0.55	0.70	0.85
LAKES AND WETLANDS	0.05		

[2] Terrain Slopes

[3] Interpolate for other values of % imperviousness

Sources: American Society of Civil Engineers - ASCE (1960)
U.S. Department of Agriculture (1972)

174 Maitland Drive

Estimate of Impervious Cover - Post-Development					CN	C	
Total Area			**4.84**	ha	71	0.35	Directly Connected or not
	#units	**Area (m2)**					
Driveway	59	24	*1416.00*	m2	98	0.95	y
Singles	36	135	*4860.00*	m2	98	0.95	y (50%)
Back-to-back Towns	38	60	*2280.00*	m2	98	0.95	y (50%)
Towns	23	120	*2760.00*	m2	98	0.95	y (50%)
			11316.00	m2			
Back-to-Back Sidewalk	-	414	*414.00*	m2	98	0.95	y (50%)
Back-to-Back Road	-	1559	*1559.00*	m2	98	0.95	y
Sidewalk	-	862	*862.00*	m2	98	0.95	y (50%)
Road	-	3983	*3983.00*	m2	98	0.95	y
Total			6818.00	m2			
		Total Impervious =	*18134.00*	m2			
			37.47	%			
		Directly Connected Impervious	12546.00	m2			
			25.92	%			

Average CN

	A	**CN**	**A*CN**	
Total Area	4.84			
Impervious Area	1.8134	98	177.71	
Pervious Area	3.0266	71	214.89	
		SUM	**392.60**	**81**

Average RC

	A	**C**	**A*C**	
Total Area	4.84			
Impervious Area	1.8134	0.95	1.72	
Pervious Area	3.0266	0.35	1.06	
		SUM	**2.78**	**0.57**

APPENDIX B

SWMHYMO Output

```
00001>  ================================================================================================
00002>
00003>  SSSSS   W   W   M   M   H   H   Y   Y   M   M    OOO          222     000    11   77777 =========
00004>  S       W W W   MM MM   H   H    Y Y    MM MM   O   O          2    0   0   11   7   7
00005>  SSSSS   W W W   M M M   HHHHH     Y     M M M   O   O          2    0   0   11       7 Ver4.05.0
00006>      S    W W    M   M   H   H     Y     M   M   O   O        222    0   0   11      7  APR 2017
00007>  SSSSS    W W    M   M   H   H     Y     M   M    OOO        2       0   0   11     7   =========
00008>                                                              2       0   0   11    7    # 2196493
00009>        StormWater Management HYdrologic Model                 222     000    11    7    =========
00010>
00011>  ************************************************************************************************
00012>  ************************************  SWMHYMO Ver4.05.0  ***********************************
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: Ainley Group                                  ++++++++++++++++++++
00025>  ++++++++++++++++++                 Belleville           SERIAL#:2196493        ++++++++++++++++++++
00026>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00027>
00028>  ************************************************************************************************
00029>  ******************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            ******************
00030>  ******************           Maximum value for ID numbers  :     11            ******************
00031>  ******************           Max. number of rainfall points: 105408            ******************
00032>  ******************           Max. number of flow points    : 105408            ******************
00033>  ************************************************************************************************
00034>
00035>  ************************************************************************************************
00036>  ************************************  SWMHYMO Ver4.05.0  ***********************************
00037>  ******************  A single event and continuous hydrologic simulation model  ******************
00038>  ******************     based on the principles of HYMO and its successors      ******************
00039>  ******************               OTTHYMO-83 and OTTHYMO-89.                    ******************
00040>  ************************************************************************************************
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00042>  ******************                   Ottawa,  Ontario: (613) 836-3884          ******************
00043>  ******************                   Gatineau, Quebec: (819) 243-6858          ******************
00044>  ******************                   E-Mail: swmhymo@jfsa.com                  ******************
00045>  ************************************************************************************************
00046>
00047>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00048>  ++++++++++++++++++ Licensed user: Ainley Group                                  ++++++++++++++++++++
00049>  ++++++++++++++++++                 Belleville           SERIAL#:2196493        ++++++++++++++++++++
00050>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00051>
00052>  ************************************************************************************************
00053>  ******************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            ******************
00054>  ******************           Maximum value for ID numbers  :     11            ******************
00055>  ******************           Max. number of rainfall points: 105408            ******************
00056>  ******************           Max. number of flow points    : 105408            ******************
00057>  ************************************************************************************************
00058>
00059>
00060>  ******************************   D E T A I L E D   O U T P U T   *******************************
00061>  ************************************************************************************************
00062>  *                 RUN DATE: 2020-09-29     TIME: 08:47:27     RUN COUNTER: 000001                *
00063>  ************************************************************************************************
00064>  * Input   file: V:\19628-1 Morton\SWM\SWMHYMO\Morton2.dat                                       *
00065>  * Output  file: V:\19628-1 Morton\SWM\SWMHYMO\Morton2.out                                       *
00066>  * Summary file: V:\19628-1 Morton\SWM\SWMHYMO\Morton2.sum                                       *
00067>  * User comments:                                                                               *
00068>  * 1:_____________________________________________________________________________________________*
00069>  * 2:_____________________________________________________________________________________________*
00070>  * 3:_____________________________________________________________________________________________*
00071>  ************************************************************************************************
00072>
00073> ------------------------------------------------------------------------------------------------
00074> R0001:C00001------------------------------------------------------------------------------------
00075> *#*********************************************************************
00076> *#  Project Name: [174 Maitland Drive]    Project Number: [19628-1]
00077> *#  Date        : 23-09-2020
00078> *#  Modeller    : Victoria Chapman
00079> *#  Company     : Ainley Group
00080> *#  License #   :  2196493
00081> *#*************************************************************************************************************************
00082> --------------------
00083> | START            | Project  dir.:V:\19628-1 Morton\SWM\SWMHYMO\
00084> -------------------- Rainfall dir.:V:\19628-1 Morton\SWM\SWMHYMO\
00085>     TZERO =   .00 hrs on        0
00086>     METOUT=   2 (output = METRIC)
00087>     NRUN  = 0001
00088>     NSTORM=   0
00089> ------------------------------------------------------------------------------------------------
00090> R0001:C00002------------------------------------------------------------------------------------
00091> *
00092> *************************************************************************************************************************
00093> *************************************************************************************************************************
00094> *25mm Quality Event
00095> *
```

```
00096> --------------------
00097> | READ STORM       |  Filename: V:\19628-1 Morton\SWM\SWMHYMO\25mm.STM
00098> | Ptotal=  25.00 mm|  Comments: Twenty-Five mm Four Hour Chicago Storm
00099> --------------------
00100>       TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN
00101>      hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr
00102>       0:10   2.071|   0:50   3.382|   1:30  50.214|   2:10   5.194|   2:50   3.252|   3:30   2.476
00103>       0:20   2.266|   1:00   4.175|   1:40  13.366|   2:20   4.466|   3:00   3.010|   3:40   2.346
00104>       0:30   2.524|   1:10   5.696|   1:50   8.286|   2:30   3.949|   3:10   2.799|   3:50   2.233
00105>       0:40   2.880|   1:20  10.777|   2:00   6.295|   2:40   3.560|   3:20   2.622|   4:00   2.136
00106>
00107> ---------------------------------------------------------------------------------------------------------
00108> R0001:C00003-----------------------------------------------------------------------------------------
00109> *
00110> ********************************** Pre-Development ********************************************************
00111> *
00112> --------------------------
00113> | CALIB NASHYD           |   Area    (ha)=    4.800   Curve Number   (CN)= 71.00
00114> | 03:201        DT= 1.00 |   Ia      (mm)=    1.000   # of Linear Res.(N)=  3.00
00115> --------------------------   U.H. Tp(hrs)=     .200
00116>
00117>      Unit Hyd Qpeak  (cms)=     .917
00118>
00119>      PEAK FLOW       (cms)=     .055 (i)
00120>      TIME TO PEAK    (hrs)=    1.700
00121>      DURATION        (hrs)=    5.400, (dddd|hh:mm:)=   0|05:24
00122>      AVERAGE FLOW    (cms)=     .011
00123>      RUNOFF VOLUME    (mm)=    4.508
00124>      TOTAL RAINFALL   (mm)=   24.996
00125>      RUNOFF COEFFICIENT   =     .180
00126>
00127>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00128>
00129> ---------------------------------------------------------------------------------------------------------
00130> R0001:C00004-----------------------------------------------------------------------------------------
00131> *
00132> ********************************** Post Development ********************************************************
00133> *
00134> --------------------------
00135> | CALIB STANDHYD         |   Area    (ha)=    4.80
00136> | 01:       201 DT= 1.00 |   Total Imp(%)=   37.00   Dir. Conn.(%)=   26.00
00137> --------------------------
00138>                             IMPERVIOUS    PERVIOUS (i)
00139>      Surface Area     (ha)=       1.78         3.02
00140>      Dep. Storage     (mm)=        .80         1.50
00141>      Average Slope     (%)=       2.00         2.00
00142>      Length            (m)=      10.00        25.00
00143>      Mannings n            =       .013         .250
00144>
00145>      Max.eff.Inten.(mm/hr)=      50.21        13.29
00146>                 over (min)        1.00        13.00
00147>      Storage Coeff.  (min)=        .69 (ii)   12.62 (ii)
00148>      Unit Hyd. Tpeak (min)=       1.00        13.00
00149>      Unit Hyd. peak  (cms)=       1.30          .09
00150>                                                        *TOTALS*
00151>      PEAK FLOW       (cms)=        .17          .07          .206 (iii)
00152>      TIME TO PEAK    (hrs)=       1.47         1.68         1.500
00153>      RUNOFF VOLUME    (mm)=      24.20         7.56        11.883
00154>      TOTAL RAINFALL   (mm)=      25.00        25.00        24.996
00155>      RUNOFF COEFFICIENT   =        .97          .30          .475
00156>
00157>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00158>            CN* =  81.0    Ia = Dep. Storage  (Above)
00159>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
00160>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00161>
00162> ---------------------------------------------------------------------------------------------------------
00163> R0001:C00005-----------------------------------------------------------------------------------------
00164> *
00165> * 24 HR DRAW DOWN = 562 cm / 24 HR / 60MIN / 60 SECS = 0.0065
00166> *
00167> --------------------
00168> | COMPUTE VOLUME   |
00169> | ID:01  (000201)  |             DISCHARGE      TIME
00170> --------------------               (cms)       (hrs)
00171>            START CONTROLLING AT     .000        .350
00172>            INFLOW HYD. PEAKS AT     .206       1.500
00173>            STOP  CONTROLLING AT     .000        .000
00174>
00175>            REQUIRED STORAGE VOLUME (ha.m.)=    .0570
00176>            TOTAL HYDROGRAPH VOLUME (ha.m.)=    .0570
00177>            % OF HYDROGRAPH TO STORE       =  99.9996
00178>
00179>            NOTE:  Storage was computed to reduce the Inflow
00180>
00181> ---------------------------------------------------------------------------------------------------------
00182> R0001:C00006-----------------------------------------------------------------------------------------
00183> *
00184> ------------------------
00185> |  ROUTE RESERVOIR -> |    Requested routing time step =  1.0 min.
00186> |  IN>01:       201   |
00187> | OUT<02:       200   | ========================  OUTLFOW STORAGE TABLE  ========================
00188> ------------------------ OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE
00189>                           (cms)    (ha.m.)|   (cms)    (ha.m.)|   (cms)    (ha.m.)|   (cms)    (ha.m.)
00190>                            .000 .0000E+00|    .004 .1640E-01|    .006 .4440E-01|    .316 .8610E-01
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00191>                          .002 .3000E-02|    .004 .2230E-01|    .006 .5340E-01|    .570 .9910E-01
00192>                          .003 .6800E-02|    .005 .2880E-01|    .007 .6330E-01|    .967 .1130E+00
00193>                          .003 .1130E-01|    .005 .3620E-01|    .225 .7420E-01|   1.456 .1280E+00
00194>
00195>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
00196>      ----------------------      (ha)     (cms)     (hrs)       (mm)
00197>      INFLOW > 01:       201     4.800      .206     1.500     11.883
00198>     OUTFLOW < 02:       200     4.800      .006     4.267     11.883
00199>
00200>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.896
00201>                    TIME SHIFT OF PEAK FLOW         (min)=   166.00
00202>                    MAXIMUM  STORAGE   USED       (ha.m.)=.5054E-01
00203>
00204> ----------------------------------------------------------------------------------------------------
00205> R0001:C00007-------------------------------------------------------------------------------------------
00206> *
00207> ********************************************************************************************************************
00208> * 5 yr Conveyence Check
00209> *
00210> * 5 year event
00211> *
00212> --------------------
00213> | CHICAGO STORM    |    IDF curve parameters: A= 569.052
00214> | Ptotal= 28.72 mm |                          B=   1.500
00215> --------------------                          C=    .725
00216>                          used in:   INTENSITY =  A / (t + B)^C
00217>
00218>                          Duration of storm  =  1.00 hrs
00219>                          Storm time step    =  2.00 min
00220>                          Time to peak ratio =   .33
00221>
00222>                     The CORRELATION coefficient is = .9996798
00223>
00224>                      TIME        ENTERED             COMPUTED
00225>                     (min)        (mm/hr)              (mm/hr)
00226>                        5.         157.30               146.48
00227>                       10.          96.90                96.86
00228>                       15.          73.00                74.55
00229>                       30.          45.00                46.65
00230>                       60.          27.70                28.72
00231>                      120.          17.10                17.53
00232>                      360.           7.90                 7.95
00233>                      720.           4.90                 4.82
00234>                     1440.           3.00                 2.92
00235>
00236>       TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN
00237>      hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr
00238>       0:02   9.186|   0:12  17.823|   0:22  91.299|   0:32  21.475|   0:42  13.285|   0:52   9.942
00239>       0:04  10.082|   0:14  22.926|   0:24  52.682|   0:34  18.979|   0:44  12.414|   0:54   9.491
00240>       0:06  11.216|   0:16  33.462|   0:26  37.779|   0:36  17.066|   0:46  11.667|   0:56   9.086
00241>       0:08  12.707|   0:18  71.562|   0:28  29.840|   0:38  15.549|   0:48  11.018|   0:58   8.719
00242>       0:10  14.765|   0:20 229.458|   0:30  24.882|   0:40  14.313|   0:50  10.448|   1:00   8.385
00243>
00244> ----------------------------------------------------------------------------------------------------
00245> R0001:C00008-------------------------------------------------------------------------------------------
00246> *
00247> ********************************** Pre-Development ************************************************************
00248> *
00249> --------------------------
00250> | CALIB NASHYD           |   Area    (ha)=    4.800   Curve Number   (CN)= 71.00
00251> | 03:201        DT= 1.00 |   Ia      (mm)=    1.000   # of Linear Res.(N)=  3.00
00252> --------------------------   U.H. Tp(hrs)=     .200
00253>
00254>      Unit Hyd Qpeak  (cms)=     .917
00255>
00256>      PEAK FLOW       (cms)=     .125 (i)
00257>      TIME TO PEAK    (hrs)=     .600
00258>      DURATION        (hrs)=    2.400, (dddd|hh:mm:)=   0|02:24
00259>      AVERAGE FLOW    (cms)=     .032
00260>      RUNOFF VOLUME    (mm)=    5.844
00261>      TOTAL RAINFALL   (mm)=   28.717
00262>      RUNOFF COEFFICIENT   =     .203
00263>
00264>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00265>
00266> ----------------------------------------------------------------------------------------------------
00267> R0001:C00009-------------------------------------------------------------------------------------------
00268> *
00269> ********************************** Post Development ************************************************************
00270> *
00271> --------------------------
00272> | CALIB STANDHYD         |   Area    (ha)=    4.80
00273> | 04:       201 DT= 1.00 |   Total Imp(%)=   37.00   Dir. Conn.(%)=   26.00
00274> --------------------------
00275>                               IMPERVIOUS    PERVIOUS (i)
00276>      Surface Area     (ha)=       1.78         3.02
00277>      Dep. Storage     (mm)=        .80         1.50
00278>      Average Slope     (%)=       2.00         2.00
00279>      Length            (m)=      10.00        25.00
00280>      Mannings n            =       .013         .250
00281>
00282>      Max.eff.Inten.(mm/hr)=     229.46        41.77
00283>                  over (min)       1.00         8.00
00284>      Storage Coeff.  (min)=        .37 (ii)    7.92 (ii)
00285>      Unit Hyd. Tpeak (min)=       1.00         8.00
```

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00286>      Unit Hyd. peak  (cms)=       1.58          .14
00287>                                                          *TOTALS*
00288>      PEAK FLOW       (cms)=        .79          .21           .827 (iii)
00289>      TIME TO PEAK    (hrs)=        .33          .48           .333
00290>      RUNOFF VOLUME    (mm)=      27.92         9.63         14.387
00291>      TOTAL RAINFALL   (mm)=      28.72        28.72         28.717
00292>      RUNOFF COEFFICIENT   =        .97          .34           .501
00293>
00294>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00295>            CN* =  81.0    Ia = Dep. Storage  (Above)
00296>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
00297>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00298>
00299> ------------------------------------------------------------------------------------------------------------
00300> R0001:C00010-----------------------------------------------------------------------------------------------
00301> *
00302> ************************************************************************************************************
00303> *
00304> ------------------------
00305> |  ROUTE RESERVOIR -> |    Requested routing time step =  1.0 min.
00306> |  IN>04:       201   |
00307> | OUT<05:       200   | ========================  OUTLFOW STORAGE TABLE  ========================
00308> ------------------------ OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE
00309>                           (cms)    (ha.m.)|   (cms)    (ha.m.)|   (cms)    (ha.m.)|   (cms)    (ha.m.)
00310>                           .000 .0000E+00|    .004 .1640E-01|    .006 .4440E-01|    .316 .8610E-01
00311>                           .002 .3000E-02|    .004 .2230E-01|    .006 .5340E-01|    .570 .9910E-01
00312>                           .003 .6800E-02|    .005 .2880E-01|    .007 .6330E-01|    .967 .1130E+00
00313>                           .003 .1130E-01|    .005 .3620E-01|    .225 .7420E-01|   1.456 .1280E+00
00314>
00315>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
00316>      ----------------------       (ha)     (cms)     (hrs)       (mm)
00317>      INFLOW > 04:       201     4.800      .827      .333     14.387
00318>     OUTFLOW < 05:       200     4.800      .034     1.150     14.387
00319>
00320>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.086
00321>                     TIME SHIFT OF PEAK FLOW         (min)=    49.00
00322>                     MAXIMUM  STORAGE   USED       (ha.m.)=.6467E-01
00323>
00324> ------------------------------------------------------------------------------------------------------------
00325> R0001:C00011-----------------------------------------------------------------------------------------------
00326> *
00327> ************************************************************************************************************
00328> *
00329> ************************************************************************************************************
00330> * 100 year event
00331> *
00332> --------------------
00333> | CHICAGO STORM    |    IDF curve parameters: A= 950.966
00334> | Ptotal= 47.79 mm |                          B=   1.500
00335> --------------------                          C=    .726
00336>                         used in:   INTENSITY =  A / (t + B)^C
00337>
00338>                         Duration of storm  =  1.00 hrs
00339>                         Storm time step    =  2.00 min
00340>                         Time to peak ratio =   .33
00341>
00342>                     The CORRELATION coefficient is = .9996881
00343>
00344>                      TIME        ENTERED             COMPUTED
00345>                     (min)        (mm/hr)              (mm/hr)
00346>                        5.         262.40               244.34
00347>                       10.         161.60               161.47
00348>                       15.         121.80               124.24
00349>                       30.          75.00                77.69
00350>                       60.          46.20                47.80
00351>                      120.          28.50                29.16
00352>                      360.          13.20                13.21
00353>                      720.           8.10                 8.00
00354>                     1440.           5.00                 4.84
00355>
00356>       TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN
00357>      hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr
00358>       0:02  15.239|   0:12  29.603|   0:22 152.131|   0:32  35.680|   0:42  22.053|   0:52  16.496
00359>       0:04  16.728|   0:14  38.095|   0:24  87.686|   0:34  31.526|   0:44  20.606|   0:54  15.747
00360>       0:06  18.614|   0:16  55.645|   0:26  62.839|   0:36  28.343|   0:46  19.363|   0:56  15.073
00361>       0:08  21.092|   0:18 119.193|   0:28  49.611|   0:38  25.818|   0:48  18.284|   0:58  14.463
00362>       0:10  24.514|   0:20 382.976|   0:30  41.353|   0:40  23.763|   0:50  17.336|   1:00  13.909
00363>
00364> ------------------------------------------------------------------------------------------------------------
00365> R0001:C00012-----------------------------------------------------------------------------------------------
00366> *
00367> ********************************** Pre-Development ************************************************************
00368> *
00369> --------------------------
00370> | CALIB NASHYD           |   Area    (ha)=    4.800   Curve Number   (CN)= 71.00
00371> | 06:201        DT= 1.00 |   Ia      (mm)=    1.000   # of Linear Res.(N)=  3.00
00372> --------------------------   U.H. Tp(hrs)=     .200
00373>
00374>      Unit Hyd Qpeak  (cms)=     .917
00375>
00376>      PEAK FLOW       (cms)=     .319 (i)
00377>      TIME TO PEAK    (hrs)=     .600
00378>      DURATION        (hrs)=    2.400, (dddd|hh:mm:)=   0|02:24
00379>      AVERAGE FLOW    (cms)=     .081
00380>      RUNOFF VOLUME    (mm)=   14.545
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00381>      TOTAL RAINFALL   (mm)=   47.793
00382>      RUNOFF COEFFICIENT   =     .304
00383>
00384>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00385>
00386> ------------------------------------------------------------------------------------------------------
00387> R0001:C00013-----------------------------------------------------------------------------------------
00388> *
00389> ********************************** Post Development ************************************************
00390> *
00391> --------------------------
00392> | CALIB STANDHYD         |   Area    (ha)=    4.80
00393> | 07:       201 DT= 1.00 |   Total Imp(%)=   37.00   Dir. Conn.(%)=   26.00
00394> --------------------------
00395>                             IMPERVIOUS    PERVIOUS (i)
00396>      Surface Area     (ha)=       1.78         3.02
00397>      Dep. Storage     (mm)=        .80         1.50
00398>      Average Slope     (%)=       2.00         2.00
00399>      Length            (m)=      10.00        25.00
00400>      Mannings n           =       .013         .250
00401>
00402>      Max.eff.Inten.(mm/hr)=     382.98       128.04
00403>                 over (min)       1.00         5.00
00404>      Storage Coeff.  (min)=        .30 (ii)    5.13 (ii)
00405>      Unit Hyd. Tpeak (min)=       1.00         5.00
00406>      Unit Hyd. peak  (cms)=       1.64          .22
00407>                                                        *TOTALS*
00408>      PEAK FLOW       (cms)=       1.33          .64          1.536 (iii)
00409>      TIME TO PEAK    (hrs)=        .33          .42           .333
00410>      RUNOFF VOLUME    (mm)=      46.99        22.25         28.684
00411>      TOTAL RAINFALL   (mm)=      47.79        47.79         47.793
00412>      RUNOFF COEFFICIENT   =        .98          .47           .600
00413>
00414>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00415>            CN* =  81.0    Ia = Dep. Storage  (Above)
00416>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
00417>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00418>
00419> ------------------------------------------------------------------------------------------------------
00420> R0001:C00014-----------------------------------------------------------------------------------------
00421> *
00422> ************************************************************************************************************
00423> *
00424> ------------------------
00425> |  ROUTE RESERVOIR -> |    Requested routing time step =  1.0 min.
00426> |  IN>07:       201   |
00427> | OUT<08:       200   | ========================  OUTLFOW STORAGE TABLE  ========================
00428> ------------------------ OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE| OUTFLOW   STORAGE
00429>                           (cms)   (ha.m.)|   (cms)   (ha.m.)|   (cms)   (ha.m.)|   (cms)   (ha.m.)
00430>                           .000 .0000E+00|    .004 .1640E-01|    .006 .4440E-01|    .316 .8610E-01
00431>                           .002 .3000E-02|    .004 .2230E-01|    .006 .5340E-01|    .570 .9910E-01
00432>                           .003 .6800E-02|    .005 .2880E-01|    .007 .6330E-01|    .967 .1130E+00
00433>                           .003 .1130E-01|    .005 .3620E-01|    .225 .7420E-01|   1.456 .1280E+00
00434>
00435>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
00436>      ----------------------      (ha)     (cms)     (hrs)       (mm)
00437>      INFLOW > 07:       201     4.800     1.536      .333     28.684
00438>     OUTFLOW < 08:       200     4.800      .309      .683     28.684
00439>
00440>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   20.154
00441>                    TIME SHIFT OF PEAK FLOW         (min)=    21.00
00442>                    MAXIMUM  STORAGE   USED       (ha.m.)=.8531E-01
00443>
00444> ------------------------------------------------------------------------------------------------------
00445> R0001:C00015-----------------------------------------------------------------------------------------
00446> *
00447> ************************************************************************************************************
00448> *
00449> --------------------
00450> | FINISH           |
00451> --------------------
00452> ------------------------------------------------------------------------------------------------------
00453> ************************************************************************************************
00454>      WARNINGS / ERRORS / NOTES
00455>      -------------------------
00456>    Simulation ended on 2020-09-29     at 08:47:28
00457> ============================================================================================
00458>
00459>
```

APPENDIX C
Pond Calculations

Stage-Storage-Discharge Relationship

1	**orifice**	*Q=cA(2gh)^0.5*			**overflow**	*Q=CLH^1.5*
	orifice diameter	0.056	c	0.6	c	1.67
	orifice radius	0.028	g	9.81	L	3.5
	orifice area	0.00246	2g	19.62	Leff	L-0.2H

2	**orifice**	*Q=cA(2gh)^0.5*	
	orifice diameter	0.575	c
	orifice radius	0.2875	g
	orifice area	0.25954	2g

					Quality Orifice 1	**Quantity Orifice 2**		**Weir**		
Description	**Stage**	**Storage (m3)**	**ha m**	**Head (m)**	**Discharge (m3/s)**					**Qt**	
bottom of pond	0.000	0	0.0000	0	0.0000					0.0000	
	0.100	30.24	0.0030	0.07	0.0018					0.0018	
	0.200	68.2	0.0068	0.17	0.0027					0.0027	
	0.300	112.98	0.0113	0.27	0.0034					0.0034	
	0.400	164.33	0.0164	0.37	0.0040					0.0040	
	0.500	222.65	0.0223	0.47	0.0045					0.0045	
	0.600	288.34	0.0288	0.57	0.0049					0.0049	
	0.700	361.84	0.0362	0.67	0.0054					0.0054	
	0.800	443.56	0.0444	0.77	0.0057					0.0057	
	0.900	533.88	0.0534	0.87	0.0061					0.0061	
Quality Control	1.000	633.19	0.0633	0.97	0.0065	0.0000	0.0000			0.0065	
	1.100	741.89	0.0742	1.07	0.0068	0.1000	0.2181			0.2249	
Quantity Control	1.200	861.28	0.0861	1.17	0.0071	0.2000	0.3085	0.0000	0.0000	0.3156	
	1.300	990.86	0.0991	1.27	0.0074	0.3000	0.3778	0.1000	0.1848	0.5700	Overflow Weir
	1.400	1130.13	0.1130	1.37	0.0077	0.4000	0.4363	0.2000	0.5228	0.9667	
Top of Free Board	1.500	1280.34	0.1280	1.47	0.0079	0.5000	0.4877	0.3000	0.9604	1.4561	

Morton

Sediment Accumulation

Initial Volume Available in Main Pond	540	cubic metres
Initial Volume Available in Forebay	93	cubic metres
Target Volume for Cleanout	75 % remaining	
Contributing Area	4.84	ha
Annual Loading @ 90%	4.13	cubic metres\ha
annual accumulation (site)	19.9892	cubic metres

Main Pond 20 % of sediment

Year	Volume Available	Accumulated Sediment	% Volume Remaining
0	540	0	100
1	536.0	4.0	99
2	532.0	8.0	99
3	528.0	12.0	98
4	524.0	16.0	97
5	520.0	20.0	96
6	516.0	24.0	96
7	512.0	28.0	95
8	508.0	32.0	94
9	504.0	36.0	93
10	500.0	40.0	93
11	496.0	44.0	92
12	492.0	48.0	91
13	488.0	52.0	90
14	484.0	56.0	90
15	480.0	60.0	89
16	476.0	64.0	88
17	472.0	68.0	87
18	468.0	72.0	87
19	464.0	76.0	86
20	460.0	80.0	85

Forebay 80 % of sediment

Year	Volume Available	Accumulated Sediment	% Volume Remaining
0	93	0	100
1	77.0	16.0	83
2	61.0	32.0	66
3	45.0	48.0	48
4	29.0	64.0	31
5	13.0	80.0	14
6	-2.9	95.9	-3
7	-18.9	111.9	-20
8	-34.9	127.9	-38
9	-50.9	143.9	-55
10	-66.9	159.9	**-72**
11	-82.9	175.9	-89
12	-98.9	191.9	-106