

FUNCTIONAL SERVICING REPORT

TAWNY RIDGE (PHASE 2)

November 11, 2022

INTRODUCTION

The purpose of this report is to address the servicing needs for the residential subdivision development, Tawny Ridge (Phase 2), located in the Town of Niagara-on-the-Lake. The subject lands comprise the second phase of the overall Tawny Ridge subdivision, which is located south of Warner Road, immediately west of Tanbark Road, and north of Tulip Tree Road.

The Phase 1 lands were comprised of 12 single family residential lots fronting on Tanbark Road. The Phase 2 lands, which are the subject of the current application for Draft Plan of Subdivision, are located immediately west of the Phase 1 lands, bound by Warner Road to the north and Tulip Tree Road to the south. Phase 2 consists of the 20 single-family residential dwellings, 6 blocks of townhouse dwellings and one medium density residential block (Block 27).

A separate Draft Plan of subdivision application was previously submitted for the Phase 1 lands (File No. OPA-03-2022, ZBA-12-2022, and 26T-18-22-02) which included a Functional Servicing Report concluding that the Municipal service for the Phase 1 lands would be independent from the Phase 2 lands. Therefore, for the purposes of this report, only the Phase 2 lands will be considered.

The objectives of this report are as follows:

1. Identify domestic and fire protection water servicing needs for Phase 2;
2. Identify sanitary servicing needs for Phase 2; and,
3. Identify stormwater management needs for Phase 2.

WATER SERVICING

There is an existing 150mm diameter watermain stub located on Chestnut Avenue, at the southern limit of the subject lands, and an existing 150mm diameter watermain located on Warner Road, at the northern limit of the subject lands. It is proposed to construct new 150mm diameter watermain connecting to the existing 150mm diameter watermains located on Chestnut Avenue and Warner Road to provide looped watermain system for domestic water supply and fire protection.

It is proposed to provide municipal fire hydrants connected to the proposed watermain within the site for the fire protection. Hydrant spacing and locations will be determined as part of the detailed engineering design.

Therefore, the proposed watermain will provide adequate domestic water supply and fire protection for the proposed development.

SANITARY SERVICING

There are two existing sanitary sewers adjacent to the subject lands which ultimately discharge sanitary flows to the existing sanitary sewers on Tanbark Road;

- i) The existing 200mm diameter sewer on Chestnut Avenue, flowing southerly in front of Lots 1 and 2;
- ii) The existing 200mm diameter sewer on Warner Road, flowing easterly.

It is proposed to connect the service for Lots 1 and 2 to the existing 200mm diameter sewer on Chestnut Avenue, which was previously designed to receive sanitary flows from this area as part of the Courtland Valley Subdivision. With an associated drainage area of 0.11 hectares and total population of 6 persons, the peak sanitary flow from Lots 1 and 2 is 0.13 L/s.

The remaining 2.96 hectares sanitary drainage area from the subject lands will convey sanitary flows to the existing 200mm diameter sanitary sewer on Warner Road. There is an additional 0.92 hectare external drainage area, assigned to the #687 Warner Road property, along the western limit of the subject lands which expected to develop as residential in the future. It is proposed to allocate capacity within the proposed internal sanitary sewers for this external area at an assumed density of 35 persons per hectare.

With a population of 216 persons from the subject lands and 32 persons assumed for the adjacent external area, the total peak sanitary flow expected to be conveyed to the Warner Road sanitary sewer is 5.22 L/s, which corresponds to approximately 13.1% of the full flow capacity of the existing 200mm diameter sanitary sewer on Warner Road.

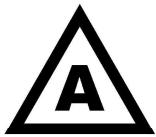
Therefore, there is expected to be adequate capacity within the existing Warner Road and Chestnut Avenue Sanitary sewer to service the subject lands.

STORMWATER MANAGEMENT

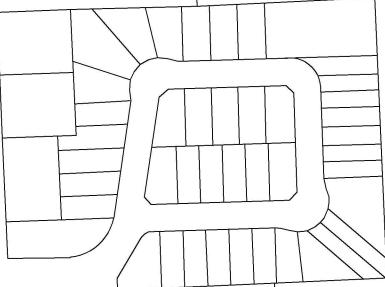
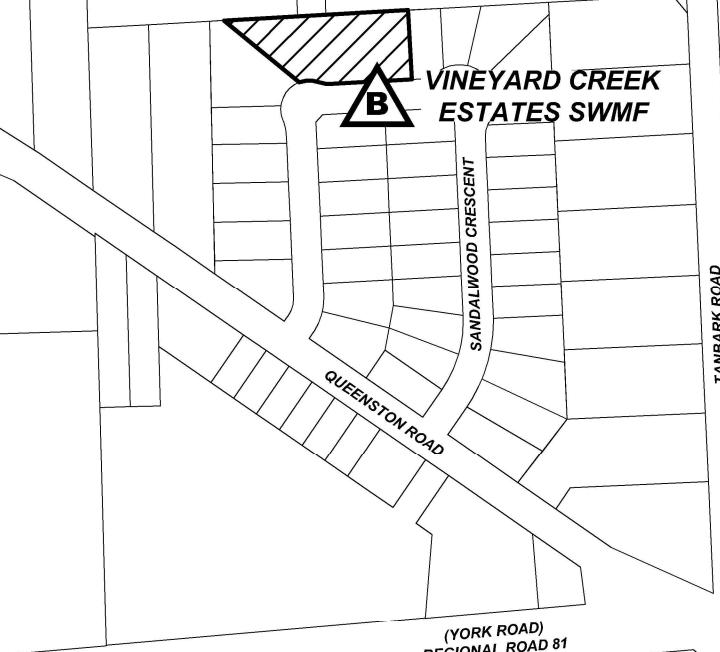
As shown in Figure 1, there are two existing stormwater management facilities located near the subject lands.

- A. The existing stormwater management wet pond facility on Warner Road (Outlet A); and,
- B. The existing Vineyard Creek Estates Stormwater Management Wet Pond Facility north of Sandalwood Crescent (Outlet B).

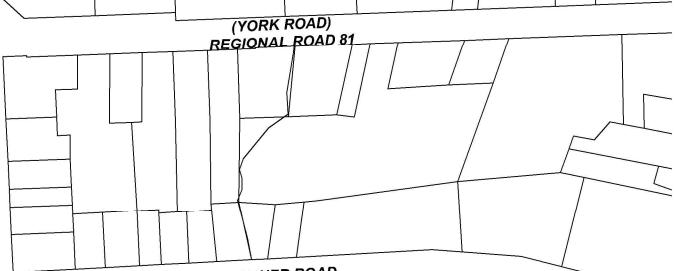
LEGEND



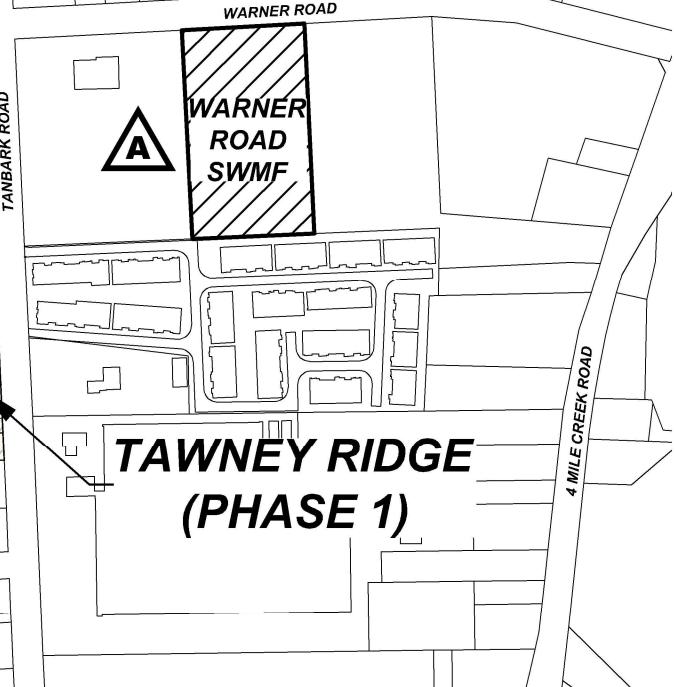
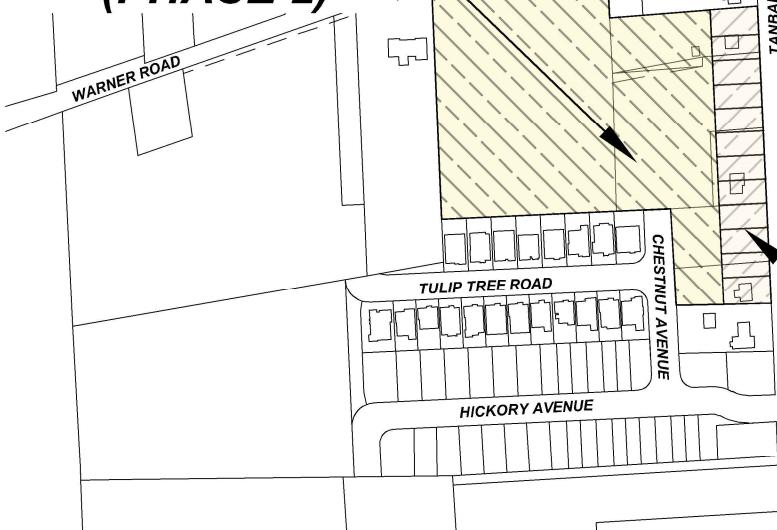
STORMWATER OUTLET



TANBARK ROAD



TAWNEY RIDGE (PHASE 2)



UPPER CANADA
CONSULTANTS
ENGINEERS / PLANNERS

TAWNEY RIDGE (PHASE 2) TOWN OF NIAGARA-ON-THE-LAKE SITE LOCATION PLAN

DATE	2022-11-14
SCALE	1:5000 m
REF No.	21178
DWG No.	FIGURE 1

A Stormwater Management Report was prepared by Kerry T. Howe Engineering Limited and approved for the existing Vineyard Creek Estates stormwater management facility (SWMF), dated June 2005. As outlined within the approved Stormwater Management Report, the Vineyard Creek Estates SWMF was designed to receive peak stormwater flows from the areas south of the York Road and west of Tanbark Road including the subject lands at an overall imperviousness of 30% (0.40 Runoff Coefficient). The facility was designed to provide stormwater quantity controls (storage) up to an including the 100 year design storm event and stormwater quality improvements to MECP Normal levels (70% TSS Removal) for the associated drainage area.

As a part of reconstruction works on Tanbark Road, a 600mm diameter storm sewer was constructed at the intersection of Warner Road to convey stormwater flows northerly to the existing Vineyard Creek SWM facility. The storm sewer system was designed and constructed to convey the stormwater flows from a portion of the areas allocated into Vineyard Creek Estates SWM facility including the subject lands, at a runoff coefficient of 0.40. The existing drainage area associated to the subject lands that was allocated to the existing 600mm diameter storm sewer on Tanbark Road is shown in Figure 2.

Table 1 below provides a summary of the existing and future stormwater drainage areas shown in Figure 2 and 3. As shown in Table 1, the overall future A*R values exceeds the existing value as a result of the proposed development. Therefore, stormwater management quantity and quality controls will be required for Area B10 before discharging to Warner Road, and Area B10 will continue to discharge uncontrolled.

The adjacent #687 Warner Road property is expected to be developed as residential in the future. Therefore, it is proposed to provide allocation for this property in the proposed stormwater management facility to provide a single controlled outlet for the associated drainage area.

Table 1. Hydrologic Parameters for Existing and Future Conditions			
Area No.	Area (A) (ha)	Runoff Co-efficient (R)	A*R
Existing Condition			
B1	3.65	0.40	1.46
Future Condition			
B10	3.58	0.65	2.33
B11	0.68	0.40	0.27
		Total	2.60

As shown in Modified Rational Method (MRM) Calculations enclosed in Appendix A, the peak 5 year flow under existing conditions is approximately 364.6 L/s. With an uncontrolled peak flow of 67.9 L/s from future area B11, the maximum allowable discharge from area B10 is 296.7 L/s.

To control future peak flows from area B10 to the allowable 296.7 L/s, it was calculated that a total stormwater storage volume of 106.7 m³ will be required within the subject lands which can be provided with an outlet control orifice and underground “super-pipe” storage. Detailed storage and sizing calculations will be provided as part of the detailed engineering design for the subject lands. Table 2 below provides a summary of the existing and future peak stormwater flows and volumes for the 5 year design storm event.

Table 2. Summary of Stormwater Flow for 5 Year Storm Event			
Existing Peak Flows (Area B1)	Future Peak Uncontrolled Flow (Area B11)	Allowable Future Peak Flow (Area B10)	Required 5 Year Storage Volume (Area B10)
389.6	67.9	296.7	106.7

The existing Vineyard Creek Estates SWMF provides stormwater quantity controls up to and including the 100 year design storm event. As summarized in the Vineyard Creek Estates Storm Water Management Report (Kerry T. Howe Engineering Limited, June 2005), the existing SWMF receive approximately 6,622 m³ of stormwater volume in the 100 year design storm event which corresponds to a maximum active water storage volume of 2,887 m³ and peak discharge of 1.262 m³/s. Table 3 below summarises the expected impact of the increased 100 year stormwater volume generated within the subject lands on the existing SWMF as shown in the MRM calculation found in Appendix B.

Table 3. Impact on Existing SWMF – 100 Year						
Condition	100 Year Storm Volume (m³)	100 Year Pond Volume (m³)	100 Year Peak Pond Discharge (m³/s)	Flow in Receiving Ditch (m³/s)	Pre-Development Flows in Receiving Ditch (m³/s)	Change (%)
Vineyard Creek Estates Design	6,622	2,887	1.262	1.346	1.424	-5.5
Future Tawny Ridge Design	6,751	2,943	1.346	1.436	1.424	+0.8

As summarised above, there is expected to be negligible impact on the receiving ditch north of the existing SWMF as a result of the proposed development (<1%). Therefore, stormwater management quality controls are not considered necessary for the 100 year design storm event.

Major overland flows will be conveyed northly to Warner Road, and ultimately to the existing Vineyard Creek Estates SWMF.

To improve stormwater quality level from the proposed development land, a manhole oil/grit separator (OGS) is proposed. The drainage area of the proposed development is 3.58 hectares, with an imperviousness of approximately 65% contributing to the oil/grit separator. The modelling for a Hydroworks unit has indicated that a HD 5 will provide approximately 72.6% TSS overall removal and capture 100% of the stormwater flows. Therefore, the Hydroworks HD 5 can be used to provide MECP Normal protection (70% TSS removal) for the proposed development on the subject land. Preliminary sizing software output file can be found in Appendix C for reference.

Maintenance of Oil/Grit Separator (OGS)

The future owners of a Hydroworks facility are provided with a Owner's Manual, which explains the function, maintenance requirements and procedures for this facility. In addition to the Owner's Manual, a site inspection report sheet is enclosed in Appendix D for future reference and maintenance activities.

Generally, the sediment which is removed from the oil/grit separator will not be contaminated to the point that it would be classified as hazardous waste. However, the sediment should be tested to determine disposal options. The Ministry of the Environment, Conservation and Parks publishes sediment disposal guidelines which should be consulted for current information pertaining to the exact parameters and acceptable levels for the various disposal options.

The function of the proposed stormwater quality protection facility, a stormwater oil/grit separator, will require maintenance on a regular basis. Areas prone to oil spills should be inspected frequently. The following is a summary of the maintenance activities required.

Regular inspections of the stormwater maintenance hole (MH) oil/grit interceptor will indicate whether maintenance is required. Post Construction the separator should be inspected every six months during the first year to establish the rate of sediment accumulation. If the unit is subject to oil spills or runoff from unstabilized sites it should be inspected more frequently.

Points of regular inspections are as follows:

- a) Is there sediment in the separator sump? The level of sediment can be measured from the surface without entry into the oil/grit separator with a Sludge Judge, Core Pro, AccuSludge or equivalent sampling device that allows the submerged sediment to be sampled. These clear

samplers are equipped with a ball valve that allows the inspector to get a core of the contents in the sump. Two or three should be taken in different areas of the sump to ensure samples are accurate.

- b) Is there oil in the separator sump? This can usually be seen from the surface and can be physically checked by lowering a sludge Judge about 300mm below the surface of the water and removing it. If an appreciable amount of oil has been captured, an oil layer will be floating on top of the water sample. The separator should be cleaned if an appreciable amount of oil (2.5 centimeters) has been captured.
- c) Is there debris or trash in the separator? This can be observed from the surface without entry into the unit. If a significant amount of trash has been captured, the unit should be cleaned to ensure it continues to operate at peak capacity.
- d) Completion of the Inspection Report (a sample report is included in Appendix D for reference purposes). These reports will provide details about the operation and maintenance requirements for this type of stormwater quality device. After an evaluation period (usually 2 years) this information will be used to maximize efficiency and minimize the costs of operation and maintenance for the maintenance hole oil/grit separator.

Typically, a stormwater MH oil/grit separators are cleaned out using vacuum pumping. No entry into the unit is required for maintenance. Cleaning should occur annually or whenever the accumulation reaches 15 percent of the sediment storage and after any major spills have occurred. The manufacturer provides an installation certificate which contains the separators capacities and sediment depths requiring maintenance. Oil levels greater than 2.5 centimeters should be removed immediately by a licensed waste management firm.

The preferred option is an off site disposal, arranged by a licensed waste management firm.

The future owners of a Hydroworks facility are provided with an Owner's Manual, which explains the function, maintenance requirements and procedures for the facility. In addition to the Owner's Manual, a site inspection report sheet is attached for future reference and maintenance activities.

LEGEND

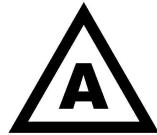
A0
0.00
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DRAINAGE AREA NUMBER

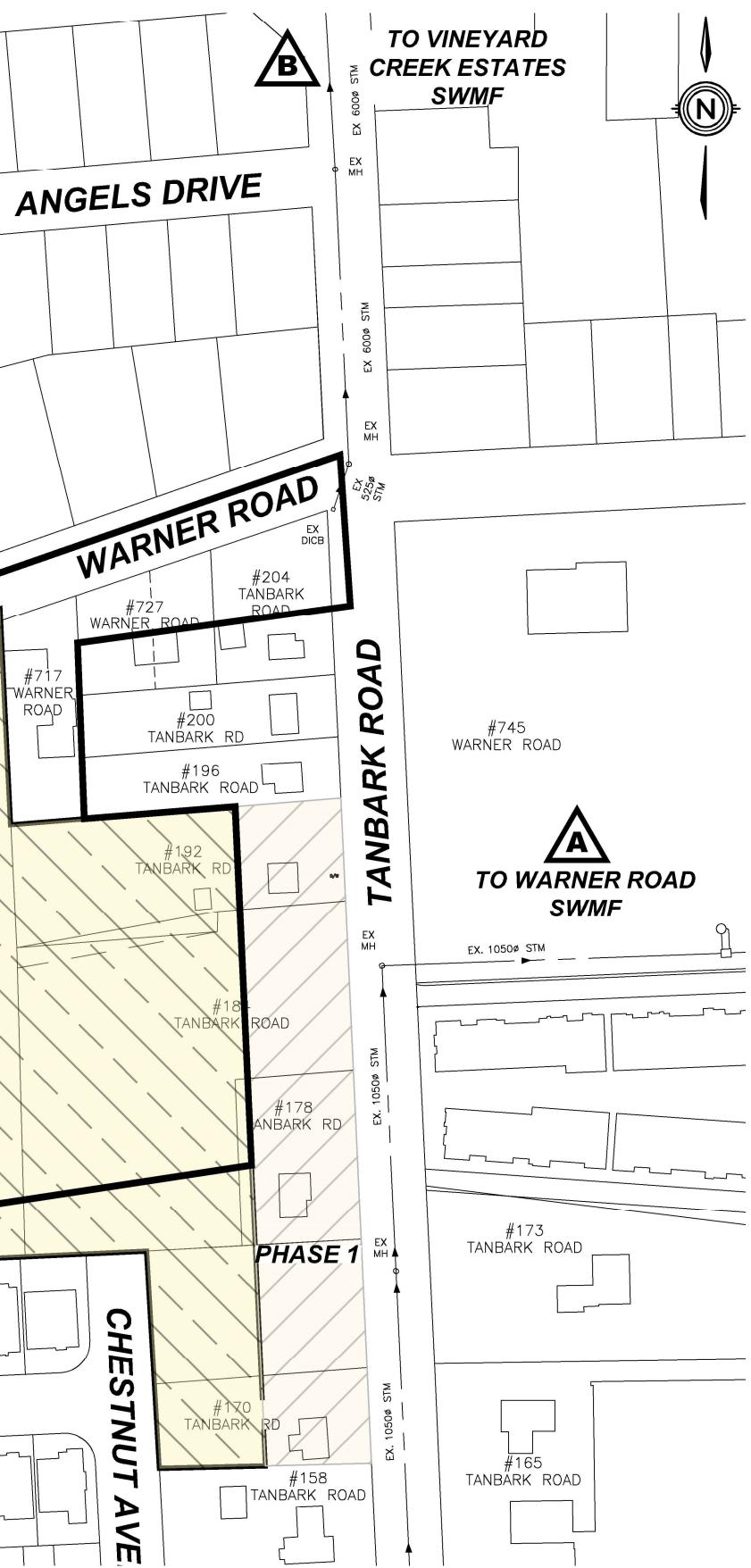
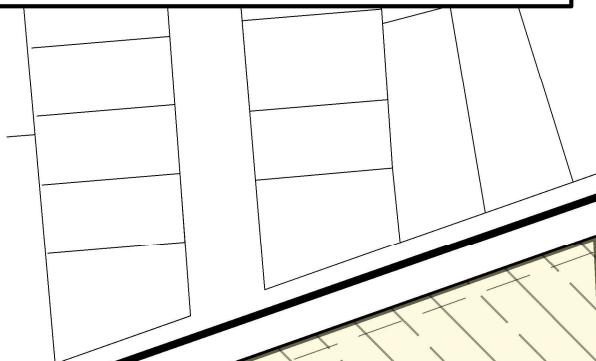
DRAINAGE AREA IN HECTARES

RUNOFF COEFFICIENT

DRAINAGE AREA BOUNDARY



STORMWATER OUTLET



UPPER CANADA
CONSULTANTS
ENGINEERS / PLANNERS

TAWNEY RIDGE (PHASE 2)
TOWN OF NIAGARA-ON-THE-LAKE
EXISTING STORM DRAINAGE AREA

DATE	2022-11-14
SCALE	1:2000 m
REF No.	21178
DWG No.	FIGURE 2

LEGEND

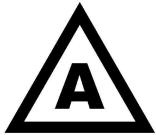
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0.00
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DRAINAGE AREA NUMBER

DRAINAGE AREA IN HECTARES

RUNOFF COEFFICIENT

DRAINAGE AREA BOUNDARY



STORMWATER OUTLET

ANGELS DRIVE

B11
0.68
0.40



TO VINEYARD
CREEK ESTATES
SWMF



UPPER CANADA
CONSULTANTS
ENGINEERS / PLANNERS

TAWNEY RIDGE (PHASE 2)
TOWN OF NIAGARA-ON-THE-LAKE
FUTURE STORM DRAINAGE AREA

DATE	2022-11-14
SCALE	1:2000 m
REF No.	21178
DWG No.	FIGURE 3

CONCLUSIONS AND RECOMMENDATIONS

Therefore, based on the above comments and design calculations provided for this site, the following summarizes the servicing for this site:

1. The subject lands will be serviced by a 150mm diameter watermain on Chestnut Avenue on the south side of the subject lands and a 150mm diameter watermain on Warner Road north side of the subject lands and will provide both domestic water supply and fire protection.
2. The receiving 200mm diameter sanitary sewers on Warner Road and Chestnut Avenue will have adequate capacity to service the Phase 2 lands.
3. On-site stormwater quantity controls can be provided to allowable levels up to the 5 year design storm. The Phase 2 lands will convey minor stormwater flows to the existing 600mm diameter storm sewers on Tanbark Road north of the Warner Road and ultimately to the Vineyard Creek Estates SWMF.
4. Stormwater quantity controls for the 100 year design storm event are not considered necessary.
5. Stormwater quality control can be provided to MECP Normal protection levels (70% TSS Removal) with a Hydroworks HD 5 oil/grit separator.
6. Major overland flows will be ultimately conveyed to the existing Vineyard Creek Estates SWMF.

Based on the above and the accompanying calculations, there exists adequate municipal servicing for this development. We trust the above comments and enclosed calculations are satisfactory for approval. If you have any questions or require additional information, please do not hesitate to contact our office.

Prepared By:



Keyur Prajapati, E.I.T.
November 11, 2022



Reviewed By:



Jason Schooley, P.Eng.

APPENDICES

APPENDIX A

Modified Rational Method – Peak Stormwater Flows for 5 Year Storm Event
Modified Rational Method – Storage Calculation for 5 Year Storm Event

Town of Niagara-on-the-Lake
STORM SEWER DESIGN SHEET

PROJECT / SUBDIVISION: TAWNEY RIDGE (PHASE 2)

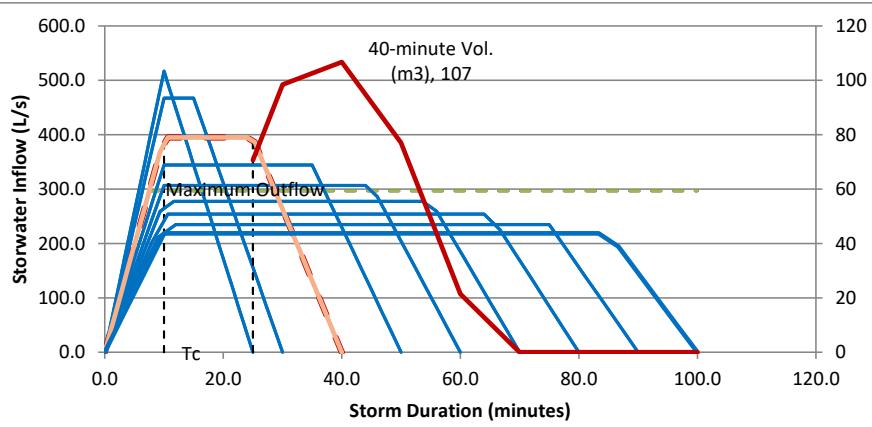
LOCATION						TIME OF FLOW		STORMWATER ANALYSIS				
DESCRIPTION	FROM M.H.	TO M.H.	PIPE LENGTH (m)	INCREMENT AREA (hectares)	TOTAL AREA (hectares)	TO UPPER END (min)	IN SECTION (min)	RUNOFF COEFF	SECTION A X R	ACCUMLD A x R	RAINFALL INTENSITY (mm/hr)	PEAK FLOW (L/s)
PRE-DEVELOPMENT CONDITIONS												
Existing site (B1)	SITE	OUTLET		3.65	3.65	10.00	0.00	0.400	1.460	1.460	89.884	364.63
POST-DEVELOPMENT CONDITIONS												
Uncontrolled (B11)	SITE	OUTLET		0.68	0.68	10.00	0.00	0.400	0.272	0.272	89.884	67.91
Future site (B10)	SITE	OUTLET		3.58	3.58	10.00	0.00	0.650	2.327	2.327	89.884	581.00
											Allowable 5 year flow from B10	296.72
DESIGN BY:	UPPER CANADA CONSULTANTS 3-30 HANNOVER DRIVE ST. CATHARINES, ON L2W 1A3					<u>RAINFALL PARAMETERS:</u>			a = 664.00 mm/hr	b = 4.70 minutes	c = 0.74	
DESIGN BY:	Keyur Prajapati, E.I.T.					Time to Upper End = 10 min.						

Modified Rational Method (MRM) Required Storage Volume

Project:	Tawney Ridge (Phase 2)
Project No:	21178
Date:	
Design By:	Keyur Prajapati, E.I.T.
Description:	Stormwater Management Plan, Quantity Control Storage Volume Calculation
Storm Event:	Town of Niagara-on-the-Lake - 5 Year IDF Curve
	a = 664.00 mm/hr
	b = 4.70 minutes
	c = 0.74
Critical Storm Duration:	40.00 minutes
Tc From Design:	10.00 minutes
Storm Tail Time:	25.00 minutes
Accumulated Area x R (Ha):	2.327 <- Area x Runoff Coefficient (Sewer Design Sheet)
Peak Rainfall Intensity:	61.09 mm/hr
Peak Inflow at Tc:	394.91 L/s
Maximum Release Rate:	296.72 <- Outlet Full Flow Capacity (Design Sheet)
Time When Outlet Exceeded:	7.51

Time (min)	Intensity (mm/hr)	Inflow (L/s)	Outflow (L/s)	Interval Volume (m3)	Total Required Volume (m3)
0.0	0.00	0.00	296.72	-17.8	0.0
1.3	8.15	52.65	296.72	-19.5	0.0
2.7	16.29	105.31	296.72	-15.3	0.0
4.0	24.44	157.96	296.72	-11.1	0.0
5.3	32.58	210.62	296.72	-6.9	0.0
6.7	40.73	263.27	296.72	-2.7	0.0
8.0	48.88	315.93	296.72	1.5	1.5
9.3	57.02	368.58	296.72	5.7	7.3
10.7	61.09	394.91	296.72	7.9	15.1
12.0	61.09	394.91	296.72	7.9	23.0
13.3	61.09	394.91	296.72	7.9	30.9
14.7	61.09	394.91	296.72	7.9	38.7
16.0	61.09	394.91	296.72	7.9	46.6
17.3	61.09	394.91	296.72	7.9	54.4
18.7	61.09	394.91	296.72	7.9	62.3
20.0	61.09	394.91	296.72	7.9	70.1
21.3	61.09	394.91	296.72	7.9	78.0
22.7	61.09	394.91	296.72	7.9	85.8
24.0	61.09	394.91	296.72	7.9	93.7
25.3	59.74	386.13	296.72	7.2	100.8
26.7	54.31	351.03	296.72	4.3	105.2
28.0	48.88	315.93	296.72	1.5	106.7
29.3	43.44	280.82	296.72	-1.3	105.5
30.7	38.01	245.72	296.72	-4.1	101.4
32.0	32.58	210.62	296.72	-6.9	94.5
33.3	27.15	175.51	296.72	-9.7	84.8
34.7	21.72	140.41	296.72	-12.5	72.3
36.0	16.29	105.31	296.72	-15.3	57.0
37.3	10.86	70.21	296.72	-18.1	38.9
38.7	5.43	35.10	296.72	-20.9	17.9
40.0	0.00	0.00	296.72	-23.7	0.0

Variable Storm Duration Storage Requirements					
Duration	Max Storage	Duration	Max Storage	Duration	Max Storage
25 Min	70.6 m3	50 Min	77.1 m3	80 Min	0.0 m3
30 Min	98.4 m3	60 Min	21.5 m3	90 Min	0.0 m3
40 Min	106.7 m3	70 Min	0.0 m3	100 Min	0.0 m3



APPENDIX B

Modified Rational Method – Peak Stormwater Flows for 100 Year Storm Event
Modified Rational Method – Storage Calculation for 100 Year Storm Event

Town of Niagara-on-the-Lake
STORM SEWER DESIGN SHEET

PROJECT / SUBDIVISION: TAWNY RIDGE (PHASE 2)

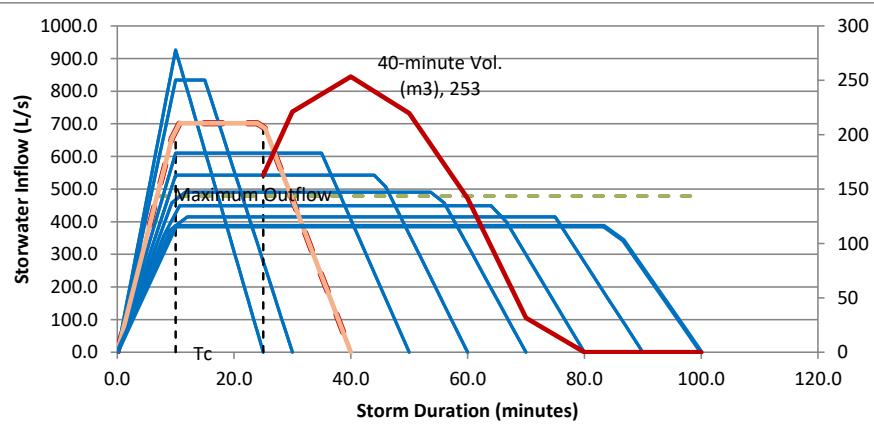
LOCATION						TIME OF FLOW		STORMWATER ANALYSIS				
DESCRIPTION	FROM M.H.	TO M.H.	PIPE LENGTH (m)	INCREMENT AREA (hectares)	TOTAL AREA (hectares)	TO UPPER END (min)	IN SECTION (min)	RUNOFF COEFF	SECTION A X R	ACCUMLD A x R	RAINFALL INTENSITY (mm/hr)	PEAK FLOW (L/s)
PRE-DEVELOPMENT CONDITIONS												
Existing site (B1)	SITE	OUTLET		3.65	3.65	10.00	0.00	0.400	1.460	1.460	145.017	588.29
POST-DEVELOPMENT CONDITIONS												
Uncontrolled (B11)	SITE	OUTLET		0.68	0.68	10.00	0.00	0.400	0.272	0.272	145.017	109.57
Future site (B10)	SITE	OUTLET		3.58	3.58	10.00	0.00	0.650	2.327	2.599	145.017	1046.94
									Allowable 100 Year flow from B10			478.72
DESIGN BY:	UPPER CANADA CONSULTANTS 3-30 HANNOVER DRIVE ST. CATHARINES, ON L2W 1A3					RAINFALL PARAMETERS:			a = 980.00 mm/hr	b = 3.70 minutes	c = 0.73	
DESIGN BY:	Keyur Prajapati, E.I.T.					Time to Upper End = 10 min.						
						Town of Niagara-on-the-Lake - 100 Year IDF						

Modified Rational Method (MRM) Required Storage Volume

Project:	Tawny Ridge (Phase 2)
Project No:	21178
Date:	
Design By:	Keyur Prajapati, E.I.T.
Description:	Stormwater Management Plan, Quantity Control Storage Volume Calculation
Storm Event:	Town of Niagara-on-the-Lake - 100 Year IDF Curve
	a = 980.00 mm/hr
	b = 3.70 minutes
	c = 0.73
Critical Storm Duration:	40.00 minutes
Tc From Design:	10.00 minutes
Storm Tail Time:	25.00 minutes
Accumulated Area x R (Ha):	2.599 <- Area x Runoff Coefficient (Sewer Design Sheet)
Peak Rainfall Intensity:	97.20 mm/hr
Peak Inflow at Tc:	701.72 L/s
Maximum Release Rate:	478.72 <- Outlet Full Flow Capacity (Design Sheet)
Time When Outlet Exceeded:	6.82

Time (min)	Intensity (mm/hr)	Inflow (L/s)	Outflow (L/s)	Interval Volume (m3)	Total Required Volume (m3)
0.0	0.00	0.00	478.72	-28.7	0.0
1.3	12.96	93.56	478.72	-30.8	0.0
2.7	25.92	187.13	478.72	-23.3	0.0
4.0	38.88	280.69	478.72	-15.8	0.0
5.3	51.84	374.25	478.72	-8.4	0.0
6.7	64.80	467.81	478.72	-0.9	0.0
8.0	77.76	561.38	478.72	6.6	6.6
9.3	90.72	654.94	478.72	14.1	20.7
10.7	97.20	701.72	478.72	17.8	38.6
12.0	97.20	701.72	478.72	17.8	56.4
13.3	97.20	701.72	478.72	17.8	74.2
14.7	97.20	701.72	478.72	17.8	92.1
16.0	97.20	701.72	478.72	17.8	109.9
17.3	97.20	701.72	478.72	17.8	127.8
18.7	97.20	701.72	478.72	17.8	145.6
20.0	97.20	701.72	478.72	17.8	163.4
21.3	97.20	701.72	478.72	17.8	181.3
22.7	97.20	701.72	478.72	17.8	199.1
24.0	97.20	701.72	478.72	17.8	217.0
25.3	95.04	686.13	478.72	16.6	233.5
26.7	86.40	623.75	478.72	11.6	245.1
28.0	77.76	561.38	478.72	6.6	251.8
29.3	69.12	499.00	478.72	1.6	253.4
30.7	60.48	436.63	478.72	-3.4	250.0
32.0	51.84	374.25	478.72	-8.4	241.7
33.3	43.20	311.88	478.72	-13.3	228.3
34.7	34.56	249.50	478.72	-18.3	210.0
36.0	25.92	187.13	478.72	-23.3	186.6
37.3	17.28	124.75	478.72	-28.3	158.3
38.7	8.64	62.38	478.72	-33.3	125.0
40.0	0.00	0.00	478.72	-38.3	86.7

Variable Storm Duration Storage Requirements					
Duration	Max Storage	Duration	Max Storage	Duration	Max Storage
25 Min	162.8 m3	50 Min	219.7 m3	80 Min	0.0 m3
30 Min	221.2 m3	60 Min	141.5 m3	90 Min	0.0 m3
40 Min	253.4 m3	70 Min	31.5 m3	100 Min	0.0 m3



APPENDIX C

Stormwater Quality Analysis

```
*****
*      Storm Water Management Sizing Model      *
*          Hydroworks, LLC                      *
*          Version 4.4                          *
*                                              *
*      Continuous Simulation Program           *
*          Based on SWMM 4.4H                  *
*          Hydroworks, LLC                      *
*          Graham Bryant                     *
*          2003 - 2021                         *
*****
```

Developed by

```
*****
*          Hydroworks, LLC                      *
*          Metcalf & Eddy, Inc.                 *
*          University of Florida                *
*          Water Resources Engineers, Inc.     *
*          (Now Camp Dresser & McKee, Inc.)   *
*          Modified SWMM 4.4                   *
*****
```

Distributed and Maintained by

```
*****
*          Hydroworks, LLC                      *
*          888-290-7900                        *
*          www.hydroworks.com                 *
*                                              *
*****
```

```
*****
*      If any problems occur executing this      *
*      model, contact Mr. Graham Bryant at    *
*      Hydroworks, LLC by phone at 888-290-7900 *
*      or by e-mail: support@hydroworks.com    *
*****
```

```
*****
*      This model is based on EPA SWMM 4.4      *
*      "Nature is full of infinite causes which   *
*      have never occurred in experience" da Vinci *
*****
```

```
*****
* Entry made to the Rain Block                 *
* Created by the University of Florida - 1988   *
* Updated by Oregon State University, March 2000 *
*****
```

TAWNY RIDGE PHASE 2
TOWN OF NIAGARA ON THE LAKE

HydroDome Simulation

```
#####
# Precipitation Block Input Commands #
#####

Station Name..... St. Catherines A
Station Location..... Ontario
Station, ISTA..... 7287
Beginning date, IYBEG (Yr/Mo/Dy)..... 1971/ 1/ 1
Ending date, IYEND (Yr/Mo/Dy)..... 2005/12/31
Minimum interevent time, MIT..... 1
Number of ranked storms, NPTS..... 10
NWS format, IFORM (See text)..... 1
Print storm summary, ISUM (0-No 1-Yes) 0
Print all rainfall, IYEAR (0-No 1-Yes) 0
Save storm event data on NSCRAT(1).... 0
(IFILE =0 -Do not save, =1 -Save data)

IDECID 0 - Create interface file
        1 - Create file and analyze
        2 - Synoptic analysis..... 2

Plotting position parameter, A..... 0.40
Storm event statistics, NOSTAT..... 1100

KODEA (from optional group B0)..... 2
= 0, Do not include NCDC cumulative values.
= 1, Average NCDC cumulative values.
= 2, Use NCDC cumulative value as inst. rain.
```

KODEPR (from optional group B0)..... 0
 Print NCDC special codes in event summary:
 = 0, only on days with events.
 = 1, on all days with codes present.
 Codes: A = accumulated value, I = incomplete value,
 M = missing value, O = other code present

 * Precipitation output created using the Rain block *
 * Number of precipitation stations... 1 *

Location	Station Number
-----	-----
1.	7287

STATION ID ON PRECIP. DATA INPUT FILE = 7287
 REQUESTED STATION ID = 7287 CHECK TO BE SURE THEY MATCH.

\$
 Note, 15-min. data are being processed, but hourly
 print-out, summaries, and statistics are based on
 hourly totals only. Data placed on interface file
 are at correct 15-min. intervals.
 \$

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

TAWNY RIDGE PHASE 2
 TOWN OF NIAGARA ON THE LAKE

Snowmelt parameter - ISNOW..... 0
 Number of rain gages - NRGAG..... 1
 Horton infiltration equation used - INFILM..... 2
 Maximum infiltration volume is limited to RMAXINF input on subcatchment lines.
 Infiltration volume regenerates during non rainfall periods.

Quality is simulated - KWALTY..... 1
 IVAP is negative. Evaporation will be set to zero
 during time steps with rainfall.

Read evaporation data on line(s) F1 (F2) - IVAP.. 1
 Hour of day at start of storm - NHR..... 1
 Minute of hour at start of storm - NMN..... 1
 Time TZERO at start of storm (hours)..... 1.017
 Use Metric units for I/O - METRIC..... 1
 ==> Ft-sec units used in all internal computations

Runoff input print control... 0
 Runoff graph plot control.... 1
 Runoff output print control.. 0
 Print headers every 50 lines - NOHEAD (0=yes, 1=no) 0
 Print land use load percentages -LANDUPR (0=no, 1=yes) 0

Limit number of groundwater convergence messages to 10000 (if simulated)

Month, day, year of start of storm is: 1/ 1/1971
 Wet time step length (seconds)..... 300.
 Dry time step length (seconds)..... 900.
 Wet/Dry time step length (seconds)... 450.

Simulation length is..... 20051231.0 Yr/Mo/Dy
 Percent of impervious area with zero detention depth 25.0

Horton infiltration model being used
 Rate for regeneration of infiltration = REGEN * DECAY
 DECAY is read in for each subcatchment
 REGEN = 0.01000

* Processed Precipitation will be read from file *

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

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

* C H A N N E L A N D P I P E D A T A *

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

* S U B C A T C H M E N T D A T A *

NOTE. SEE LATER TABLE FOR OPTIONAL SUBCATCHMENT PARAMETERS											
SUBCATCH- RATE GAGE MENT NO.	CHANNEL MAXIMUM VOLUME	WIDTH (M)	AREA (HA)	PERCENT	SLOPE	RESISTANCE IMPERV.	FACTOR	DEPRES.	STORAGE (MM)	INFILTRATION	DECAY
1	300	200	133.79	3.58	65.00	0.0200	0.015	0.250	0.510	5.080	63.50
											10.16
											0.00055

TOTAL NUMBER OF SUBCATCHMENTS...	1
TOTAL TRIBUTARY AREA (HECTARES) .	3.58
IMPERVIOUS AREA (HECTARES)	2.33
PERVIOUS AREA (HECTARES)	1.25
TOTAL WIDTH (METERS)	133.79
PERCENT IMPERVIOUSNESS.....	65.00

* U P S T R E A M S T O R A G E D A T A *

Storage (m3)	Flow (m3/s)
0.	0.000
4.	0.027
30.	0.110
73.	0.153
97.	0.186
101.	0.214
104.	0.239
107.	0.262
110.	282.700
111.	293.800

* G R O U N D W A T E R I N P U T D A T A *

SUB- CATCH NUMBER	CHANNEL OR INLET	E L E V A T I O N S				F L O W			C O N S T A N T S		
		GROUND (M)	BOTTOM (M)	STAGE (M)	BC (M)	TW (M)	A1 (MM/HR-M^B1)	B1	A2 (MM/HR-M^B2)	B2	A3 (MM/HR-M^2)
0	602	3.05	0.00	0.00	0.61	0.61	3.484E-04	2.600	0.000E+00	1.000	0.00E+00

* G R O U N D W A T E R I N P U T D A T A (CONTINUED) *

S O I L P R O P E R T I E S						E T P A R A M E T E R S					
SUBCAT.	SATURATED		HYDRAULIC	WILTING	FIELD	INITIAL	PERCOLATION		E T P A R A M E T E R S		
NO.	POROSITY	CONDUCTIVITY		POINT	CAPACITY	MOISTURE	MAX. DEEP	PARAMETERS	DEPTH	FRACTION OF ET	
0	.4000	127.000		.1500	.3000	.3000	5.080E-02	HCO PCO	OF ET TO UPPER ZONE	(m)	

* Arrangement of Subcatchments and Channel/Pipes *

* See second subcatchment output table for connectivity *

*
* of subcatchment to subcatchment flows. *

* Channel or Pipe

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

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

* Hydrographs will be stored for the following 1 INLETS *

200

Quality Simulation #

General Quality Control Data Groups #

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

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

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

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

Total Su

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

* Constant Groundwater Quality Concentration(s) *

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

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

CHANNEL/ CONSTITUENT
PIPE Total Susp

201 0.000

* Subcatchment surface quality on data group L1 *

No.	Land Usage	Land Use No.	Total	Number	Input
			Gutter Length Km	of Catch- basins	load/ha Total Su
1	300	Urban De 1	0.27	2.00	0.0E+00
Totals (Loads in kg or other)			0.27	2.00	0.0E+00

* DATA GROUP M1 *

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

* DATA GROUP M3 *

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

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

TAWNY RIDGE PHASE 2
TOWN OF NIAGARA ON THE LAKE

Rainfall Station St. Catherines A
State/Province Ontario

Rainfall Depth Summary (mm)

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

Total Rainfall Depth for Simulation Period 19310. (mm)

Rainfall Intensity Analysis (mm/hr)

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

Total # of Intensities 28803

Daily Rainfall Depth Analysis (mm)

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

Total # Days with Rain 2767

```
*****
*      End of time step DO-loop in Runoff      *
*****
```

Final Date (Mo/Day/Year) =	12/31/2005
Total number of time steps =	2056766
Final Julian Date =	2005365
Final time of day =	86399. seconds.
Final time of day =	24.00 hours.
Final running time =	306816.0000 hours.
Final running time =	12784.0000 days.

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

Subcatch	# Steps	# Calls	Subcatch	# Steps	# Calls	Subcatch	# Steps	# Calls
-----	-----	-----	-----	-----	-----	-----	-----	-----
300	6295163	1650269						

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

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

```
*****
*      Continuity Check for Surface Water      *
*****
```

		Millimeters over
	cubic meters	Total Basin
Total Precipitation (Rain plus Snow)	689594.	19263.
Total Infiltration	240690.	6723.
Total Evaporation	51855.	1448.
Surface Runoff from Watersheds	399016.	11146.
Total Water remaining in Surface Storage	0.	0.
Infiltration over the Previous Area...	240690.	19210.

Infiltration + Evaporation +		
Surface Runoff + Snow removal +		
Water remaining in Surface Storage +		
Water remaining in Snow Cover.....	691561.	19318.
Total Precipitation + Initial Storage.	689594.	19263.

The error in continuity is calculated as

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

* Precipitation + Initial Snow Cover *

Error..... -0.285 Percent

* Continuity Check for Channel/Pipes *

	cubic meters	Millimeters over Total Basin
Initial Channel/Pipe Storage.....	0.	0.
Final Channel/Pipe Storage.....	0.	0.
Surface Runoff from Watersheds.....	399016.	11146.
Baseflow.....	0.	0.
Groundwater Subsurface Inflow.....	0.	0.
Evaporation Loss from Channels.....	0.	0.
Channel/Pipe/Inlet Outflow.....	399016.	11146.
Initial Storage + Inflow.....	399016.	11146.
Final Storage + Outflow.....	399016.	11146.

* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
* Initial Channel/Pipe Storage *

* Final Storage + Outflow + Evaporation *

Error..... 0.000 Percent

* Continuity Check for Subsurface Water *

	cubic meters	Millimeters over Subsurface Basin
Total Infiltration	0.	0.
Total Upper Zone ET	0.	0.
Total Lower Zone ET	0.	0.
Total Groundwater flow	0.	0.
Total Deep percolation	0.	0.
Initial Subsurface Storage	32734.	914.
Final Subsurface Storage	32734.	914.
Upper Zone ET over Pervious Area	0.	0.
Lower Zone ET over Pervious Area	0.	0.

* Infiltration + Initial Storage - Final *
* Storage - Upper and Lower Zone ET - *
* Groundwater Flow - Deep Percolation *
* -----*
* Infiltration + Initial Storage *

Error 0.000 Percent

SUMMARY STATISTICS FOR SUBCATCHMENTS

SUBCATCH- MENT NO.	GUTTER NO.	PERVIOUS AREA			IMPERVIOUS AREA			TOTAL SUBCATCHMENT AREA		
		TOTAL AREA (HA)	SIMULATED PERCENT (MM)	TOTAL RAINFALL (MM)	TOTAL DEPTH (MM)	PEAK LOSSES (MM)	PEAK RATE (CMS)	DEPTH (MM)	PEAK RUNOFF (CMS)	DEPTH (MM)
		300	200	3.58	65.019262.47	50.101*****	0.18217116.432	1.247	11143.216	1.429
										144.905

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

SUMMARY STATISTICS FOR CHANNEL/PIPES

OF DEPTH	MAXIMUM		MAXIMUM		MAXIMUM		MAXIMUM		TIME OF	LENGTH OF	MAXIMUM SURCHARGE	RATIO OF	
	FULL	FULL	FULL	COMPUTED	COMPUTED	COMPUTED	COMPUTED	OF				MAX. TO MAX.	FULL FLOW
CHANNEL NUMBER	FLOW (CMS)	VELOCITY (M/S)	DEPTH (M)	INFLOW (CMS)	OUTFLOW (CMS)	DEPTH (M)	VELOCITY (M/S)	OCCURRENCE DAY HR.	SURCHARGE (HOUR)	VOLUME (CU-M)			
--	201			0.00				1/ 0/1900 0.00					
	200			1.43				8/14/1972 14.25					

TOTAL NUMBER OF CHANNELS/PIPES = 2

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

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

Total Su NDIM = 0
METRIC = 2

Total Su

Inputs

1. INITIAL SURFACE LOAD..... 78.
2. TOTAL SURFACE BUILDUP..... 56940.
3. INITIAL CATCHBASIN LOAD..... 0.
4. TOTAL CATCHBASIN LOAD..... 0.
5. TOTAL CATCHBASIN AND
SURFACE BUILDUP (2+4)..... 56940.

Remaining Loads

6. LOAD REMAINING ON SURFACE... 32.
7. REMAINING IN CATCHBASINS... 0.
8. REMAINING IN CHANNEL/PIPES... 0.

Removals

9. STREET SWEEPING REMOVAL.... 5291.
10. NET SURFACE BUILDUP (2-9)... 51649.
11. SURFACE WASHOFF..... 51601.
12. CATCHBASIN WASHOFF..... 0.
13. TOTAL WASHOFF (11+12)..... 51601.
14. LOAD FROM OTHER CONSTITUENTS 0.
15. PRECIPITATION LOAD..... 0.
15a. SUM SURFACE LOAD (13+14+15). 51601.
16. TOTAL GROUNDWATER LOAD..... 0.
16a. TOTAL I/I LOAD..... 0.
17. NET SUBCATCHMENT LOAD
(15a-15b-15c-15d+16+16a).... 51601.
>>Removal in channel/pipes (17a, 17b):
17a. REMOVE BY BMP FRACTION.... 0.
17b. REMOVE BY 1st ORDER DECAY... 0.
18. TOTAL LOAD TO INLETS..... 51600.
19. FLOW WT'D AVE. CONCENTRATION mg/l
(INLET LOAD/TOTAL FLOW)..... 129.

Percentages

20. STREET SWEEPING (9/2)..... 9.
21. SURFACE WASHOFF (11/2)..... 91.
22. NET SURFACE WASHOFF(11/10) .. 100.
23. WASHOFF/SUBCAT LOAD(11/17).. 100.
24. SURFACE WASHOFF/INLET LOAD
(11/18)..... 100.
25. CATCHBASIN WASHOFF/
SUBCATCHMENT LOAD (12/17) ... 0.
26. CATCHBASIN WASHOFF/
INLET LOAD (12/18)..... 0.
27. OTHER CONSTITUENT LOAD/
SUBCATCHMENT LOAD (14/17) ... 0.
28. INSOLUBLE FRACTION/
INLET LOAD (14/18)..... 0.
29. PRECIPITATION/
SUBCATCHMENT LOAD (15/17) ... 0.
30. PRECIPITATION/
INLET LOAD (15/18)..... 0.
31. GROUNDWATER LOAD/
SUBCATCHMENT LOAD (16/17) ... 0.
32. GROUNDWATER LOAD/
INLET LOAD (16/18)..... 0.
32a. INFILTRATION/INFLOW LOAD/
SUBCATCHMENT LOAD (16a/17).. 0.

32b. INFILTRATION/INFLOW LOAD/
INLET LOAD (16a/18).....0.
32c. CH/PIPE BMP FRACTION REMOVAL/
SUBCATCHMENT LOAD (17a/17)....0.
32d. CH/PIPE 1st ORDER DECAY REMOVAL/
SUBCATCHMENT LOAD (17b/17) ..0.
33. INLET LOAD SUMMATION ERROR
(18+8+6a+17a+17b-17)/17.....0.

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

Diameter (um)	%	Specific Gravity	Settling Velocity (m/s)	Critical Peclet Number
20.	20.0	2.65	0.000267	0.080977
30.	10.0	2.65	0.000597	0.104277
50.	10.0	2.65	0.001629	0.143403
100.	20.0	2.65	0.006044	0.220958
250.	20.0	2.65	0.026615	0.391296
1000.	20.0	2.65	0.111334	0.928988

* * * * * Summary of TSS Removal * * * * *

TSS Removal based on Lab Performance Curve

Model #	Low Q Treated (cms)	High Q Treated (cms)	Runoff Treated (%)	TSS Removed (%)
Unavailable	0.293	0.293	99.1	52.9
HD 4	0.293	0.293	99.1	64.5
HD 5	0.293	0.293	99.1	72.6
HD 6	0.293	0.293	99.1	78.2
Unavailable	0.293	0.293	99.1	82.6
HD 8	0.293	0.293	99.1	86.1
HD 10	0.293	0.293	99.1	90.8
HD 12	0.293	0.293	99.1	94.2

* * Summary of Annual Flow Treatment & TSS Removal * *

HD 4 Year	Flow Vol (m³)	Flow Treated (m³)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	607.	411.	6.	96.3	59.3
1972.	63883.	59002.	1361.	881.	480.	24.	92.4	63.6
1973.	63569.	63569.	1439.	917.	522.	0.	100.0	63.7
1974.	64848.	63884.	1504.	1059.	445.	10.	98.5	70.0
1975.	55207.	54229.	1310.	818.	492.	8.	98.2	62.1
1976.	82153.	80839.	1666.	1077.	589.	13.	98.4	64.1
1977.	87980.	86498.	1625.	924.	701.	16.	98.3	56.3
1978.	70302.	70302.	1549.	948.	601.	0.	100.0	61.2
1979.	84099.	82884.	1742.	1127.	614.	8.	98.6	64.4
1980.	67560.	67401.	1643.	1053.	589.	1.	99.8	64.1
1981.	93633.	93474.	1830.	1235.	595.	1.	99.8	67.4
1982.	65976.	65976.	1484.	1007.	477.	0.	100.0	67.8
1983.	87135.	86518.	1907.	1244.	664.	10.	99.3	64.9
1984.	69970.	69970.	1480.	934.	546.	0.	100.0	63.1
1985.	60880.	60880.	1436.	944.	492.	0.	100.0	65.7
1986.	89046.	89046.	1985.	1325.	660.	0.	100.0	66.7
1987.	92103.	91197.	2002.	1311.	691.	5.	99.0	65.3
1988.	73636.	73302.	1661.	1139.	522.	1.	99.5	68.6
1989.	81450.	80855.	1606.	1091.	515.	6.	99.3	67.7
1990.	92334.	92320.	2058.	1437.	621.	0.	100.0	69.8
1991.	86469.	85908.	1894.	1272.	622.	7.	99.4	66.9
1992.	109960.	109960.	2246.	1410.	836.	0.	100.0	62.8
1993.	74504.	74504.	1836.	1302.	534.	0.	100.0	70.9
1994.	79745.	77238.	1526.	946.	580.	27.	96.9	60.9
1995.	93020.	92859.	1857.	1148.	709.	4.	99.8	61.7
1998.	23554.	23554.	686.	430.	256.	0.	100.0	62.7
1999.	58440.	58440.	1420.	896.	524.	0.	100.0	63.1
2000.	67912.	67885.	1263.	705.	557.	0.	100.0	55.8
2001.	53338.	53338.	1150.	812.	338.	0.	100.0	70.6
2002.	55570.	55570.	1351.	906.	445.	0.	100.0	67.1
2003.	63303.	63303.	1385.	871.	513.	0.	100.0	62.9
2004.	76117.	76117.	1453.	906.	547.	0.	100.0	62.4
2005.	54747.	53002.	1093.	605.	488.	12.	96.8	54.8

HD 5 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	697.	320.	6.	96.3	68.1
1972.	63883.	59002.	1361.	978.	383.	24.	92.4	70.6
1973.	63569.	63569.	1439.	1037.	402.	0.	100.0	72.1
1974.	64848.	63884.	1504.	1171.	333.	10.	98.5	77.4
1975.	55207.	54229.	1310.	921.	389.	8.	98.2	69.9
1976.	82153.	80839.	1666.	1205.	461.	13.	98.4	71.7
1977.	87980.	86498.	1625.	1066.	560.	16.	98.3	64.9
1978.	70302.	70302.	1549.	1081.	468.	0.	100.0	69.8
1979.	84099.	82884.	1742.	1277.	465.	8.	98.6	73.0
1980.	67560.	67401.	1643.	1193.	450.	1.	99.8	72.5
1981.	93633.	93474.	1830.	1377.	452.	1.	99.8	75.2
1982.	65976.	65976.	1484.	1122.	362.	0.	100.0	75.6
1983.	87135.	86518.	1907.	1396.	511.	10.	99.3	72.8
1984.	69970.	69970.	1480.	1050.	430.	0.	100.0	70.9
1985.	60880.	60880.	1436.	1053.	383.	0.	100.0	73.3
1986.	89046.	89046.	1985.	1482.	503.	0.	100.0	74.7
1987.	92103.	91197.	2002.	1479.	523.	5.	99.0	73.7
1988.	73636.	73302.	1661.	1275.	386.	1.	99.5	76.7
1989.	81450.	80855.	1606.	1212.	393.	6.	99.3	75.2
1990.	92334.	92320.	2058.	1589.	469.	0.	100.0	77.2
1991.	86469.	85908.	1894.	1422.	472.	7.	99.4	74.8
1992.	109960.	109960.	2246.	1603.	643.	0.	100.0	71.4
1993.	74504.	74504.	1836.	1452.	384.	0.	100.0	79.1
1994.	79745.	77238.	1526.	1069.	457.	27.	96.9	68.8
1995.	93020.	92859.	1857.	1301.	556.	4.	99.8	69.9
1998.	23554.	23554.	686.	490.	196.	0.	100.0	71.4
1999.	58440.	58440.	1420.	1012.	407.	0.	100.0	71.3
2000.	67912.	67885.	1263.	819.	444.	0.	100.0	64.8
2001.	53338.	53338.	1150.	894.	255.	0.	100.0	77.8
2002.	55570.	55570.	1351.	1007.	343.	0.	100.0	74.6
2003.	63303.	63303.	1385.	992.	393.	0.	100.0	71.6
2004.	76117.	76117.	1453.	1022.	430.	0.	100.0	70.4
2005.	54747.	53002.	1093.	701.	392.	12.	96.8	63.4

HD 6 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	753.	265.	6.	96.3	73.5
1972.	63883.	59002.	1361.	1065.	296.	24.	92.4	76.9
1973.	63569.	63569.	1439.	1116.	323.	0.	100.0	77.5
1974.	64848.	63884.	1504.	1253.	251.	10.	98.5	82.8
1975.	55207.	54229.	1310.	995.	316.	8.	98.2	75.4
1976.	82153.	80839.	1666.	1310.	356.	13.	98.4	78.0
1977.	87980.	86498.	1625.	1169.	456.	16.	98.3	71.2
1978.	70302.	70302.	1549.	1170.	379.	0.	100.0	75.6
1979.	84099.	82884.	1742.	1372.	369.	8.	98.6	78.4
1980.	67560.	67401.	1643.	1278.	364.	1.	99.8	77.7
1981.	93633.	93474.	1830.	1479.	351.	1.	99.8	80.7
1982.	65976.	65976.	1484.	1202.	282.	0.	100.0	81.0
1983.	87135.	86518.	1907.	1514.	393.	10.	99.3	79.0
1984.	69970.	69970.	1480.	1136.	344.	0.	100.0	76.7
1985.	60880.	60880.	1436.	1138.	298.	0.	100.0	79.2
1986.	89046.	89046.	1985.	1595.	389.	0.	100.0	80.4
1987.	92103.	91197.	2002.	1591.	411.	5.	99.0	79.3
1988.	73636.	73302.	1661.	1357.	304.	1.	99.5	81.7
1989.	81450.	80855.	1606.	1303.	303.	6.	99.3	80.9
1990.	92334.	92320.	2058.	1697.	361.	0.	100.0	82.4
1991.	86469.	85908.	1894.	1522.	372.	7.	99.4	80.1
1992.	109960.	109960.	2246.	1724.	522.	0.	100.0	76.7
1993.	74504.	74504.	1836.	1536.	300.	0.	100.0	83.7
1994.	79745.	77238.	1526.	1158.	368.	27.	96.9	74.5
1995.	93020.	92859.	1857.	1409.	448.	4.	99.8	75.7
1998.	23554.	23554.	686.	530.	156.	0.	100.0	77.2
1999.	58440.	58440.	1420.	1093.	327.	0.	100.0	77.0
2000.	67912.	67885.	1263.	895.	368.	0.	100.0	70.8
2001.	53338.	53338.	1150.	962.	187.	0.	100.0	83.7
2002.	55570.	55570.	1351.	1089.	262.	0.	100.0	80.6
2003.	63303.	63303.	1385.	1063.	321.	0.	100.0	76.8
2004.	76117.	76117.	1453.	1104.	349.	0.	100.0	76.0
2005.	54747.	53002.	1093.	768.	325.	12.	96.8	69.5

HD 8 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	851.	167.	6.	96.3	83.1
1972.	63883.	59002.	1361.	1163.	198.	24.	92.4	84.0
1973.	63569.	63569.	1439.	1240.	199.	0.	100.0	86.1
1974.	64848.	63884.	1504.	1355.	149.	10.	98.5	89.5
1975.	55207.	54229.	1310.	1113.	197.	8.	98.2	84.4
1976.	82153.	80839.	1666.	1449.	217.	13.	98.4	86.3
1977.	87980.	86498.	1625.	1328.	298.	16.	98.3	80.9
1978.	70302.	70302.	1549.	1296.	253.	0.	100.0	83.7
1979.	84099.	82884.	1742.	1496.	246.	8.	98.6	85.5
1980.	67560.	67401.	1643.	1412.	230.	1.	99.8	85.9
1981.	93633.	93474.	1830.	1625.	205.	1.	99.8	88.7
1982.	65976.	65976.	1484.	1319.	165.	0.	100.0	88.9

1983.	87135.	86518.	1907.	1655.	252.	10.	99.3	86.3
1984.	69970.	69970.	1480.	1259.	222.	0.	100.0	85.0
1985.	60880.	60880.	1436.	1250.	186.	0.	100.0	87.0
1986.	89046.	89046.	1985.	1748.	236.	0.	100.0	88.1
1987.	92103.	91197.	2002.	1746.	256.	5.	99.0	87.0
1988.	73636.	73302.	1661.	1475.	186.	1.	99.5	88.8
1989.	81450.	80855.	1606.	1431.	174.	6.	99.3	88.8
1990.	92334.	92320.	2058.	1847.	211.	0.	100.0	89.8
1991.	86469.	85908.	1894.	1657.	237.	7.	99.4	87.2
1992.	109960.	109960.	2246.	1924.	322.	0.	100.0	85.7
1993.	74504.	74504.	1836.	1659.	177.	0.	100.0	90.4
1994.	79745.	77238.	1526.	1282.	244.	27.	96.9	82.6
1995.	93020.	92859.	1857.	1566.	291.	4.	99.8	84.1
1998.	23554.	23554.	686.	585.	101.	0.	100.0	85.3
1999.	58440.	58440.	1420.	1204.	216.	0.	100.0	84.8
2000.	67912.	67885.	1263.	1015.	248.	0.	100.0	80.3
2001.	53338.	53338.	1150.	1043.	107.	0.	100.0	90.7
2002.	55570.	55570.	1351.	1188.	163.	0.	100.0	87.9
2003.	63303.	63303.	1385.	1175.	210.	0.	100.0	84.8
2004.	76117.	76117.	1453.	1226.	227.	0.	100.0	84.4
2005.	54747.	53002.	1093.	868.	225.	12.	96.8	78.6

HD 10 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	893.	125.	6.	96.3	87.2
1972.	63883.	59002.	1361.	1239.	123.	24.	92.4	89.4
1973.	63569.	63569.	1439.	1307.	132.	0.	100.0	90.8
1974.	64848.	63884.	1504.	1421.	83.	10.	98.5	93.9
1975.	55207.	54229.	1310.	1183.	127.	8.	98.2	89.7
1976.	82153.	80839.	1666.	1527.	139.	13.	98.4	90.9
1977.	87980.	86498.	1625.	1415.	211.	16.	98.3	86.2
1978.	70302.	70302.	1549.	1373.	175.	0.	100.0	88.7
1979.	84099.	82884.	1742.	1575.	167.	8.	98.6	90.0
1980.	67560.	67401.	1643.	1482.	161.	1.	99.8	90.1
1981.	93633.	93474.	1830.	1711.	118.	1.	99.8	93.5
1982.	65976.	65976.	1484.	1394.	90.	0.	100.0	93.9
1983.	87135.	86518.	1907.	1750.	157.	10.	99.3	91.3
1984.	69970.	69970.	1480.	1333.	148.	0.	100.0	90.0
1985.	60880.	60880.	1436.	1325.	111.	0.	100.0	92.3
1986.	89046.	89046.	1985.	1853.	131.	0.	100.0	93.4
1987.	92103.	91197.	2002.	1826.	176.	5.	99.0	90.9
1988.	73636.	73302.	1661.	1539.	122.	1.	99.5	92.6
1989.	81450.	80855.	1606.	1498.	107.	6.	99.3	93.0
1990.	92334.	92320.	2058.	1933.	125.	0.	100.0	93.9
1991.	86469.	85908.	1894.	1741.	152.	7.	99.4	91.6
1992.	109960.	109960.	2246.	2024.	222.	0.	100.0	90.1
1993.	74504.	74504.	1836.	1727.	109.	0.	100.0	94.1
1994.	79745.	77238.	1526.	1351.	175.	27.	96.9	87.0
1995.	93020.	92859.	1857.	1647.	210.	4.	99.8	88.5
1998.	23554.	23554.	686.	614.	71.	0.	100.0	89.6
1999.	58440.	58440.	1420.	1280.	139.	0.	100.0	90.2
2000.	67912.	67885.	1263.	1083.	179.	0.	100.0	85.8
2001.	53338.	53338.	1150.	1091.	59.	0.	100.0	94.9
2002.	55570.	55570.	1351.	1251.	100.	0.	100.0	92.6
2003.	63303.	63303.	1385.	1240.	145.	0.	100.0	89.5
2004.	76117.	76117.	1453.	1311.	142.	0.	100.0	90.2
2005.	54747.	53002.	1093.	932.	161.	12.	96.8	84.4

HD 12 Year	Flow Vol (m3)	Flow Treated (m3)	TSS In (kg)	TSS Rem (kg)	TSS Out (kg)	TSS Byp (kg)	Flow Treated (%)	TSS Removal (%)
1971.	49885.	48023.	1018.	932.	85.	6.	96.3	91.1
1972.	63883.	59002.	1361.	1287.	75.	24.	92.4	92.9
1973.	63569.	63569.	1439.	1355.	85.	0.	100.0	94.1
1974.	64848.	63884.	1504.	1454.	49.	10.	98.5	96.1
1975.	55207.	54229.	1310.	1231.	80.	8.	98.2	93.3
1976.	82153.	80839.	1666.	1577.	89.	13.	98.4	93.9
1977.	87980.	86498.	1625.	1487.	139.	16.	98.3	90.6
1978.	70302.	70302.	1549.	1439.	110.	0.	100.0	92.9
1979.	84099.	82884.	1742.	1629.	113.	8.	98.6	93.1
1980.	67560.	67401.	1643.	1533.	110.	1.	99.8	93.2
1981.	93633.	93474.	1830.	1768.	62.	1.	99.8	96.5
1982.	65976.	65976.	1484.	1440.	44.	0.	100.0	97.1
1983.	87135.	86518.	1907.	1812.	95.	10.	99.3	94.5
1984.	69970.	69970.	1480.	1393.	88.	0.	100.0	94.1
1985.	60880.	60880.	1436.	1380.	56.	0.	100.0	96.1
1986.	89046.	89046.	1985.	1911.	73.	0.	100.0	96.3
1987.	92103.	91197.	2002.	1889.	113.	5.	99.0	94.1
1988.	73636.	73302.	1661.	1592.	68.	1.	99.5	95.8
1989.	81450.	80855.	1606.	1535.	71.	6.	99.3	95.2
1990.	92334.	92320.	2058.	1987.	71.	0.	100.0	96.5
1991.	86469.	85908.	1894.	1798.	96.	7.	99.4	94.6
1992.	109960.	109960.	2246.	2098.	148.	0.	100.0	93.4
1993.	74504.	74504.	1836.	1778.	58.	0.	100.0	96.8
1994.	79745.	77238.	1526.	1403.	123.	27.	96.9	90.3
1995.	93020.	92859.	1857.	1717.	140.	4.	99.8	92.2
1998.	23554.	23554.	686.	643.	43.	0.	100.0	93.7
1999.	58440.	58440.	1420.	1340.	80.	0.	100.0	94.4
2000.	67912.	67885.	1263.	1140.	123.	0.	100.0	90.2
2001.	53338.	53338.	1150.	1116.	34.	0.	100.0	97.0
2002.	55570.	55570.	1351.	1294.	56.	0.	100.0	95.8

2003.	63303.	63303.	1385.	1290.	94.	0.	100.0	93.2
2004.	76117.	76117.	1453.	1372.	81.	0.	100.0	94.4
2005.	54747.	53002.	1093.	986.	107.	12.	96.8	89.2

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

TAWNY RIDGE PHASE 2
TOWN OF NIAGARA ON THE LAKE

Date	Time	Flow	Total Su
Mo/Da/Year	Hr:Min	cum/s	mg/l
Flow wtd means.....		0.006	129.
Flow wtd std devs..		0.015	84.
Maximum value.....		1.710	1018.
Minimum value.....		0.000	0.
Total loads.....	398745.	51622.	
		Cub-Met	KILOGRAM

==> Runoff simulation ended normally.

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

* SWMM 4.4 Simulation Date and Time Summary *

* Starting Date... November 4, 2022	*
* Time... 10:15:50.401	*
* Ending Date... November 4, 2022	*
* Time... 10:15:53.241	*
* Elapsed Time... 0.047 minutes.	*
* Elapsed Time... 2.840 seconds.	*

APPENDIX D

OGS Inspection Report

SAMPLE INSPECTION REPORT

Owner:				
Location:				
Manhole Oil/Grit Separator:				
Type of Inspection	<input type="checkbox"/> Monthly		<input type="checkbox"/> Annually	
Inlet/Outlet Information				
	Inlet		Outlet	
Clear of Debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Build Up of Sediment	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Action Taken:				
Sediment Tank Information				
A. Manhole Sump Depth:	± m from cover rim (to be as-constructed verified)			
B. Measurement from Rim to Sediment Level	m			
C. Depth of Sediment:	m (A - B)			
Note: If the measured depth of sediment is greater than 350mm then sediment removal is required.				
Presence of Contaminants				
Oil	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Depth:	m
Foam	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Depth:	m
Action Taken:				
Name of Regulatory Agency			Telephone No.:	
			Transaction No.:	
Name of Licensed Waste Management Collector			Telephone No.:	
			Transaction No.:	
Owner Notification		<input type="checkbox"/> Yes	<input type="checkbox"/> No	Other:
		Time:		Date:
Name of Inspector:				
Signed:			Date:	