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Clearview Commons

STORMWATER MANAGEMENT REPORT

Quanbury Contract Interiors

File 119055 | July 6, 2020

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Issue	Date	Description
1	July 6, 2020	First Submission

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1 Introduction

Tatham Engineering Limited has been retained by Quanbury Contract Interiors to prepare a stormwater management plan for the proposed condominium development referred to as Clearview Commons in the Town of Stayner, within the Township of Clearview. This stormwater management report has been prepared to present the recommended stormwater management plan for the development.

1.1 OBJECTIVE

The primary objective of this report is to analyze the potential impacts of the proposed development on the local drainage systems and to develop a stormwater management plan in accordance with all relevant municipal, regional and provincial guidelines to mitigate any adverse impacts.

1.2 BACKGROUND AND GUIDELINES

The proposed SWM Plan was developed recognizing the pertinent Municipal and Provincial guidelines on municipal design, water resources, and the environment, as well as other reports prepared in support of development in the surrounding area including the following:

- *Township of Clearview Engineering Standards*. Township of Clearview (March 22, 2017);
- *NVCA Stormwater Technical Guide*. Nottawasaga Valley Conservation Authority (December 2013);
- *Stormwater Management Planning and Design Manual*. Ministry of the Environment (March 2003); and
- *Detailed Stormwater Management Report Ridgeview Development, Stayner*. Richardson Foster (May 2008).

2 Development Site

2.1 SITE LOCATION AND DESCRIPTION

The property is approximately 1.23 ha (3.04 ac) with the legal description being part of Lot 51 South of Quebec Street, registered Plan 196 (51R-26086). The property is bounded by 2 residential lots to the north, Side Street and 2 residential lots to the west, Centre Street to the south, and 1 residential lot to the east. The location of the property is shown on Figure 1.

2.2 PROPOSED DEVELOPMENT

The proposed development includes four single detached lots with frontage on Side Street and two condominium buildings, each with 23 units. Access to the site will be provided via entrances on Side Street and Centre Street and by a private road. Three parking areas with a total of 88 spaces are provided. An existing municipal watermain on Centre Street will provide the water supply for the development. An internal sanitary sewer will convey sewage to an existing municipal sanitary sewer on Side Street. An internal storm sewer network, underground storage system and above ground storage will provide the requisite water quantity controls for the development. Water quality control will be provided off-site in the downstream stormwater management facility sized to service the development from a water quality perspective.

3 Existing Drainage Conditions

The site topography, ground cover, land use and drainage patterns of the subject property were established through site visitation, interpretation of topographic maps, aerial photography and a topographic survey. An Existing Drainage Plan (Drawing DP-1) illustrating the existing drainage conditions across the subject property and in the surrounding area is enclosed and should be referenced when reviewing this Section of the report. The subject property is represented by Catchment 101, Catchment 102, and Catchment 103.

The subject property is currently occupied by a single-family residential dwelling. The existing ground cover is a mix of grassed areas and trees. Ontario Soil Survey Report No. 29 (Simcoe County South) defines the site to be Alliston Sandy Loam (Ans). The existing drainage conditions across the subject property are summarized as follows:

- Catchment 101 has an area of approximately 0.94 ha which drains to the northeast corner of the property. Drainage is conveyed north to a ditch inlet catchbasin where it enters the Quebec Street storm sewer system and ultimately drains to the Ridgeview Subdivision stormwater management facility (SWMF).
- Catchment 102 has an area of approximately 0.08 ha which drains to the roadside ditch along the east side of Side Street. The roadside ditch flows north towards Quebec Street where it enters the Quebec Street storm sewer system and ultimately drains to the Ridgeview Subdivision SWMF.
- Catchment 103 has an area of approximately 0.21 ha which drains to the roadside ditch along the north side of Centre Street. The roadside ditch flows to the west to the intersection of Centre Street and Side Street.

To quantify the existing peaks flow draining from the site, the Rational Method was used. Rainfall data for the site was obtained from the MTO IDF Curve lookup tool. The existing peak flows for the 1:2-year through 1:100-year design storms are summarized in Table 1. The Rational Method calculations are included in Appendix A for reference.

Table 1: Existing Peak Flow Summary

DESIGN STORM	CATCHMENT 101 (m^3/s)	CATCHMENT 102 (m^3/s)	CATCHMENT 103 (m^3/s)	TOTAL RUNOFF (m^3/s)
1:2-year	0.029	0.003	0.007	0.039
1:5-year	0.040	0.004	0.009	0.053
1:10-year	0.047	0.004	0.010	0.061
1:25-year	0.061	0.006	0.013	0.080
1:50-year	0.073	0.007	0.016	0.096
1:100-year	0.084	0.008	0.018	0.110

4 Stormwater Management Plan

The SWM plan has been prepared in accordance with the MOE Stormwater Management Planning and Design Manual, Township of Clearview Engineering Standards and NVCA Stormwater Technical Guide as detailed in Section 1.2. The SWM plan is subject to review and approval by the Township, NVCA and MECP and is presented in the following sections.

4.1 DESIGN CRITERIA

Based on previous reports, the background information collected and our analysis of this information, a clear understanding of the potential impacts was gained. In summary, the following design criteria are to be satisfied in the proposed SWM plan:

- the stormwater management plan must maintain existing stormwater runoff rates at the site outlet by restricting post development peak flow rates to pre-development levels for the 1:2-year through 1:100-year design storms;
- the stormwater management plan must provide underground quantity control storage for storm events up to and including the 1:5-year design storm; and
- safe conveyance of the Regulatory storm event peak flows through the site to the downstream drainage system must be provided for surface runoff generated within the development.

As discussed, the Ridgeview Subdivision SWMF has been designed to provide the requisite water quality control for the subject development in the form of 80% total suspended solids removal. As such, water quality control is not required on-site.

4.2 PROPOSED SWM PLAN

A Proposed Drainage Plan (Drawing DP-2) illustrating the proposed drainage conditions for the development is enclosed and should be referenced when reviewing this Section of the report.

Under proposed conditions, the existing drainage patterns will generally be maintained as most of the site will continue to drain to the existing outlet at the northeast corner of the property. The proposed drainage conditions are summarized as follows:

- Catchment 201 has an area of approximately 0.728 ha which includes parking areas, drive lanes, grassed area, and buildings and will drain internally to a proposed storm sewer. The storm sewer system has been designed to collect and convey the peak flow from the 1:5-year design storm to an underground storage facility. During less frequent storm events, runoff will temporarily pond above ground in the parking areas at depths up to 250 mm. The

underground storage facility along with surface storage in the parking areas will provide the requisite peak flow attenuation in the form of post to pre-development peak flow matching for the development.

- A storm sewer will convey flow from the underground storage system through an easement and connect to the existing Quebec Street storm sewer system. The storm sewer has been sized to convey the 1:100-year design storm controlled peak flow from the development to Quebec Street. An overland flow route (swale) graded through the easement above the storm sewer will convey flows exceeding the capacity of the storm sewer to Quebec Street.
- Catchment 202 has an area of approximately 0.172 ha which includes the paved entrance off of Side Street, existing and proposed residential area and will drain uncontrolled to the roadside ditch along the east side of Side Street.
- Catchment 203 has an area of approximately 0.117 ha which includes the paved entrance off Centre Street, building, and grassed areas and will drain uncontrolled to the roadside ditch along the north side of Centre Street.
- Catchment 204 has an area of approximately 0.213 ha which includes buildings, residential, and grassed areas and will be collected by grassed swales and conveyed to a proposed ditch inlet included in the storm sewer network at the northeast corner of the site.

Storm sewer and swale conveyance capacity calculations are enclosed in Appendix B for reference. The proposed water quantity controls are discussed further in the following sections.

4.3 WATER QUANTITY CONTROL

Stormwater quantity control will be provided on-site via an underground storage system and surface storage in two of the proposed parking areas. An engineered outlet has been designed at the outlet of the underground storage system to control peak flows from the site to pre-development levels for the 1:2-year through 1:100-year design storms. The underground storage system with a footprint of approximately 140 m^2 will provide 99.1 m^3 of storage, with an additional 16.9 m^3 of pipe storage, for a total of 116 m^3 of underground storage, which is sufficient to provide quantity control for the 1:2-year through 1:5-year design storms. Additional storage (160 m^3) is provided in the parking areas (above ground storage) to achieve sufficient quantity control for the 1:10-year through 1:100-year design storms.

The proposed primary outlet from the underground storage system consists of an 80 mm diameter orifice which outlets to a 375 mm diameter storm sewer. In the event of an obstruction to the primary outlet, overflow weirs (curb cuts) have been included in the two parking areas used for surface storage to discharge off-site. The sill elevation of the overflow weirs has been set to limit the depth of ponding in the parking areas to 250 mm. The proposed underground

storage system and engineered outlet are shown on the Stormwater Management Plan (Drawing SWM-1) included in the Site Plan Engineering Drawing Set.

Post-development peak flows for each catchment were calculated using the Modified Rational Method. The Modified Rational Method calculations are included in Appendix A. The peak flows at the two site outlets are summarized in Table 2. Although there is an increase in flow to the Side Street ditch, the overall peak flow discharging from the site is decreased for all design storms.

Table 2: Proposed Peak Flow Summary

DESIGN STORM	NORTHEAST PROPERTY CORNER (m^3/s)	SIDE STREET ROADSIDE DITCH (m^3/s)	QUEBEC STREET STORM SEWER (m^3/s)	CENTRE STREET ROADSIDE DITCH (m^3/s)	TOTAL RUNOFF (m^3/s)
1:2-year	0.022 *(0.029)*	0.009 *(0.003)*	0.31 *(0.033)*	0.003 *(0.007)*	0.034 *(0.040)*
1:5-year	0.029 *(0.040)*	0.012 *(0.004)*	0.041 *(0.044)*	0.005 *(0.009)*	0.045 *(0.053)*
1:10-year	0.037 *(0.047)*	0.013 *(0.004)*	0.051 *(0.051)*	0.005 *(0.010)*	0.056 *(0.061)*
1:25-year	0.045 *(0.061)*	0.017 *(0.006)*	0.062 *(0.067)*	0.007 *(0.013)*	0.069 *(0.080)*
1:50-year	0.050 *(0.073)*	0.021 *(0.007)*	0.071 *(0.080)*	0.008 *(0.016)*	0.079 *(0.096)*
1:100-year	0.054 *(0.084)*	0.024 *(0.008)*	0.078 *(0.092)*	0.009 *(0.018)*	0.088 *(0.110)*

Note: *(0.030)* denotes pre-development peak flow
Northeast property corner = Catchment 201 + Catchment 204
Side Street roadside ditch = Catchment 202
Quebec Street storm sewer = Catchment 201 + Catchment 204 + Catchment 202
Centre Street roadside ditch = Catchment 203

A summary of the water levels, storage volumes, and discharge rates from the proposed storage system is provided in Table 3. Detailed stage-storage-discharge calculations are included in Appendix C for reference.

Table 3: Storage System Stage-Storage-Discharge Summary

DESIGN STORM	STAGE (m)	STORAGE REQUIRED (m^3)	STORAGE PROVIDED (m^3)	DISCHARGE (m^3/s)
1:2-year	223.01	82	116	0.011
1:5-year	223.40	110	116	0.013
1:10-year	224.48	115	276	0.019
1:25-year	224.91	162	276	0.021
1:50-year	224.95	215	276	0.021
1:100-year	224.99	263	276	0.022

Note: Underground storage volume = 116 m^3; Total storage = 276 m^3; Overflow weir sill elevation = 225.00 m; Catch basin top of grate elevation = 224.75 m.

4.4 WATER QUALITY CONTROL

Water quality control will be provided downstream of the site by the Ridgeview Subdivision SWMF. As discussed, the Ridgeview Subdivision SWMF has been sized to provide the requisite level of water quality control for the subject site in the form of 80% total suspended solids removal.

Although not required for water quality treatment, the underground storage system will be fitted with a separator row to capture sediment and debris. The separator row provides an isolated row of chambers with easy access for maintenance to capture sediment to prevent clogging of the underground storage system and its outlet. The separator row will require periodic maintenance to remove the accumulated sediment and debris.

5 Siltation and Erosion Control

Siltation and erosion control will be implemented for all construction activities, including topsoil stripping, material stockpiling, building construction and grading operations. A detailed Siltation and Erosion Control Plan (Drawing SC-1) is included in the Site Plan Engineering Drawing set for the development which illustrates the sediment and erosion control measures to be implemented during construction. The basic principles to be adhered to in order to minimize erosion and sedimentation and resultant negative environmental impacts include:

1. Minimize disturbance activities where possible;
2. Expose the smallest possible land area to erosion for the shortest possible time;
3. Institute erosion control measures as required immediately;
4. Implement sediment control measures before the outset of construction activities;
5. Carry out regular inspections of erosion/sediment control measures and repair or maintain as necessary; and
6. Carry out regular inspections and required maintenance of the bioretention SWMF.

The proposed grading, servicing and building construction should be carried out in such a manner that a minimum amount of erosion occurs and such that sedimentation facilities control any erosion that does occur. Additional erosion, sediment, and pollution control measures should include the following:

1. Placement of temporary swales and check dams to control runoff and lower velocities and promote settling of solids;
2. Erection of silt control fence below any grading operations to control sediment movement;
3. Provision of stone mud mats at construction vehicle entrances to minimize off-site tracking of material; and
4. Revegetate disturbed areas to enhance long-term siltation and erosion control.

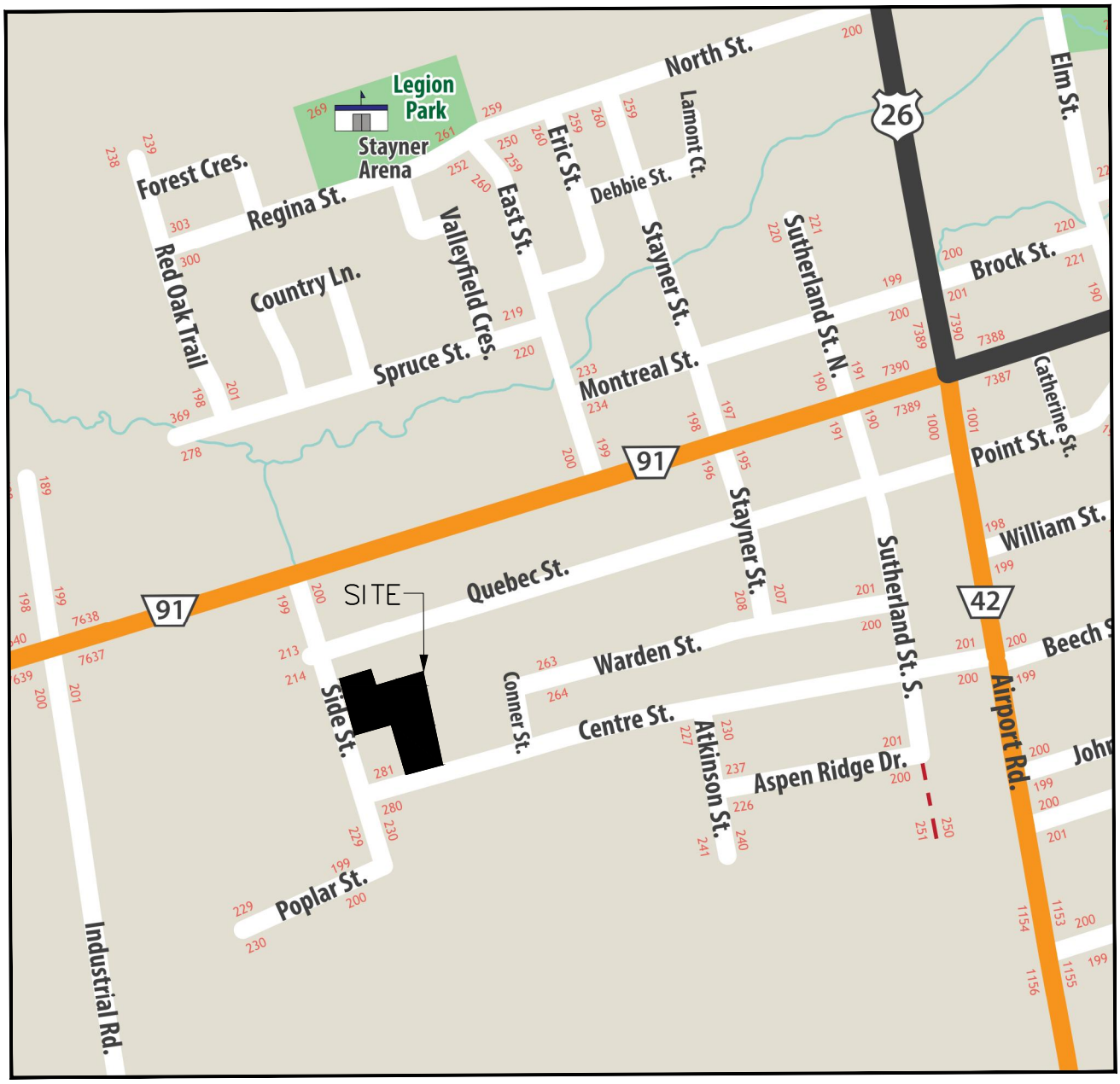
6 Summary

This report has been prepared in support of the Clearview Commons development considering design criteria from applicable approval agencies while recognizing pertinent guidelines on water resources and the environment. The proposed stormwater management plan will mitigate any potential impacts on receiving drainage systems. Under existing conditions, most of the site drains to the northeast corner of the property or the roadside ditch along Side Street and eventually to the Quebec Street storm sewer and Ridgeview Subdivision SWMF. The remainder of the site drains to the Centre Street roadside ditch.

Under proposed conditions, the existing drainage patterns will be generally maintained. A proposed underground storage system, complete with an engineered outlet and surface ponding in the parking lot will control discharges from the site to pre-development levels providing the requisite water quantity control for the development to provincial standards. The Ridgeview Subdivision stormwater management facility downstream of the site will provide the requisite water quality control for the development.

Throughout construction, siltation and erosion control measures will be inspected and maintained to reduce erosion and the transportation of sediment off-site. These measures will mitigate the environmental impacts downstream during construction.

In conclusion, the proposed stormwater management plan supports the concept of an environmentally sustainable development. The proposed plan will mitigate anticipated stormwater impacts associated with the development.



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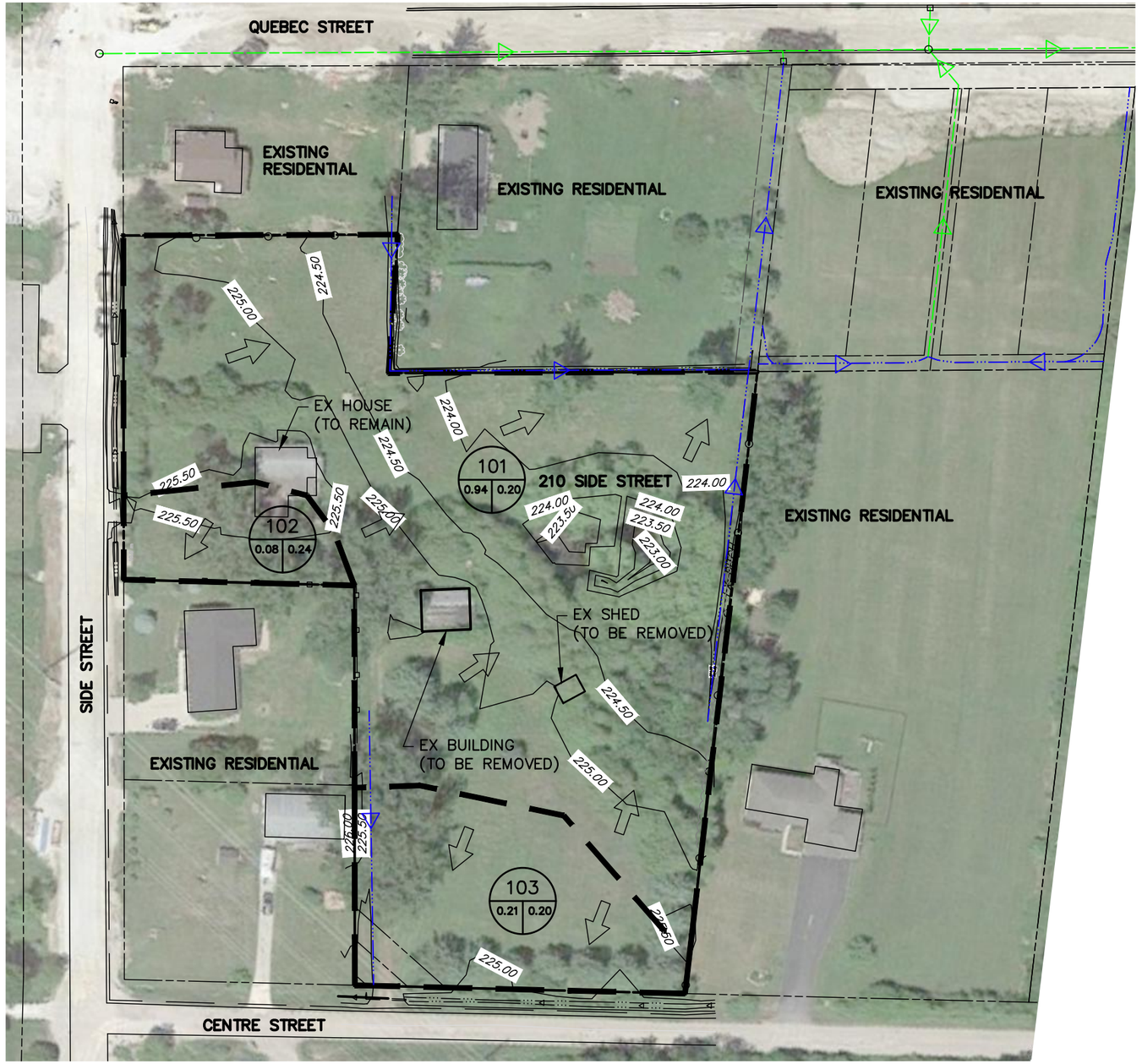
CLEARVIEW COMMONS
TOWNSHIP OF CLEARVIEW
SITE LOCATION PLAN

SCALE: N.T.S.	DATE: MAY/2020	DWG NO. FIG–1



LEGEND

- CATCHMENT ID → 101
- AREA IN HECTARES → 0.94
- RUNOFF COEFFICIENT → 0.20
- PRE-DEVELOPMENT CATCHMENT AREA
- EXISTING FLOW DIRECTION
- EXISTING STORM MAIN
- EXISTING SWALE

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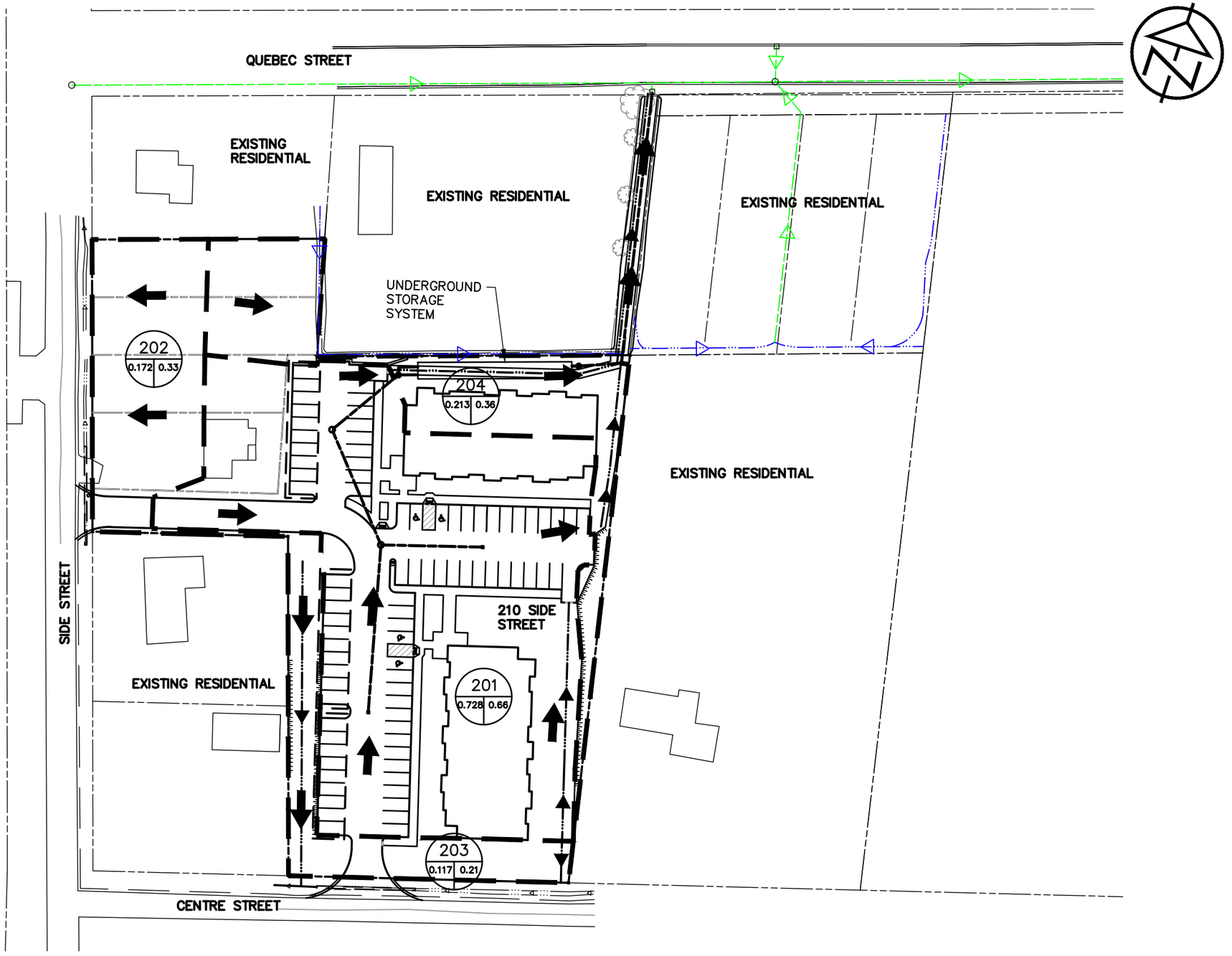
CLEARVIEW COMMONS
TOWNSHIP OF CLEARVIEW
EXISTING DRAINAGE PLAN

DWG. No. **DP-1**

SCALE: 1:1,000	DRAWN: JM	DATE: MAY/20	JOB NO. 119055

Drawing Name: 119055-DP01_FIG.dwg, Plotted: Jul 02, 2020



LEGEND

- CATCHMENT ID — 201
- AREA IN HECTARES — 0.595
- RUNOFF COEFFICIENT — 0.66
- SUBCATCHMENT BOUNDARY
- PROPOSED OVERLAND FLOW DIRECTION
- PROPOSED SWALE
- PROPOSED STORM MAIN
- EXISTING OVERLAND FLOW DIRECTION
- EXISTING STORM MAIN
- EXISTING SWALE

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TOWNSHIP OF CLEARVIEW
PROPOSED DRAINAGE PLAN

DWG. No. **DP-2**

SCALE: 1:1,000	DRAWN: JM	DATE: MAY/20	JOB NO. 119055

Appendix A:
Hydrologic Analysis

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PROJECT	210 Side Street	FILE	119055
		DATE	May 7, 2020
SUBJECT	Impervious Area Calculations	NAME	JM
		PAGE	1 OF 2

Existing Conditions

		Area (ha)	RC
Catchment 101	=	**0.940**	**0.20**
Impervious Area	=	0.019	0.90
Unimproved Area	=	0.875	0.20
Wetland/Lake/SWMF	=	0.046	0.00

		Area (ha)	RC
Catchment 102	=	**0.077**	**0.24**
Impervious Area	=	0.004	0.90
Unimproved Area	=	0.073	0.20

		Area (ha)	RC
Catchment 103	=	**0.211**	**0.20**
Impervious Area	=	0.000	0.90
Unimproved Area	=	0.211	0.20

TATHAM ENGINEERING

PROJECT	210 Side Street	FILE	119055
		DATE	May 7, 2020
SUBJECT	Impervious Area Calculations	NAME	JM
		PAGE	2 OF 2

Proposed Conditions

		Area (ha)	RC
Catchment 201	=	**0.728**	**0.66**
Impervious Area	=	0.504	0.90
Lawn Area	=	0.166	0.15
Residential Area	=	0.058	0.30

		Area (ha)	RC
Catchment 202	=	**0.172**	**0.33**
Impervious Area	=	0.011	0.90
Lawn Area	=	0.008	0.15
Residential Area	=	0.154	0.30

		Area (ha)	RC
Catchment 203	=	**0.117**	**0.21**
Impervious Area	=	0.010	0.90
Lawn Area	=	0.107	0.15

		Area (ha)	RC
Catchment 204	=	**0.213**	**0.36**
Impervious Area	=	0.044	0.90
Lawn Area	=	0.095	0.15
Residential Area	=	0.075	0.30

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PROJECT	210 Side Street	FILE	119055
		DATE	May 11, 2020
SUBJECT	Modified Rational Method	NAME	JM
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PRE DEVELOPMENT ANALYSIS CATCHMENT #101

Runoff Coefficient (Municipal Standard)

2 Year	0.20	
5 Year	0.21	
10 Year	0.21	
25 Year	0.23	=C5*1.10
50 Year	0.25	=C5*1.20
100 Year	0.26	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.0	27.8	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.3	mm/hr	T_C =	15
5 Year	73.3	mm/hr	T_C =	15
10 Year	85.4	mm/hr	T_C =	15
25 Year	100.4	mm/hr	T_C =	15
50 Year	111.5	mm/hr	T_C =	15
100 Year	122.5	mm/hr	T_C =	15

Drainage Area 0.940 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	Q_{101Ex}	
2 Year	0.029	m^3/s
5 Year	0.040	m^3/s
10 Year	0.047	m^3/s
25 Year	0.061	m^3/s
50 Year	0.073	m^3/s
100 Year	0.084	m^3/s

POST DEVELOPMENT ANALYSIS CATCHMENT #204 (UNCONTROLLED)

Runoff Coefficient (Municipal Standard)

2 Year	0.36	
5 Year	0.36	
10 Year	0.36	
25 Year	0.40	=C5*1.10
50 Year	0.43	=C5*1.20
100 Year	0.45	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.0	27.8	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.3	mm/hr	T_C =	15
5 Year	73.3	mm/hr	T_C =	15
10 Year	85.4	mm/hr	T_C =	15
25 Year	100.4	mm/hr	T_C =	15
50 Year	111.5	mm/hr	T_C =	15
100 Year	122.5	mm/hr	T_C =	15

Drainage Area 0.213 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	$Q_{204Uncontrolled}$	
2 Year	0.012	m^3/s
5 Year	0.016	m^3/s
10 Year	0.018	m^3/s
25 Year	0.024	m^3/s
50 Year	0.028	m^3/s
100 Year	0.033	m^3/s

POST DEVELOPMENT ANALYSIS CATCHMENT #201 (STORAGE)

Runoff Coefficient (Municipal Standard)

2 Year	0.66	
5 Year	0.66	
10 Year	0.66	
25 Year	0.73	=C5*1.10
50 Year	0.79	=C5*1.20
100 Year	0.83	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.0	27.8	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.3	mm/hr	T_C =	15
5 Year	73.3	mm/hr	T_C =	15
10 Year	85.4	mm/hr	T_C =	15
25 Year	100.4	mm/hr	T_C =	15
50 Year	111.5	mm/hr	T_C =	15
100 Year	122.5	mm/hr	T_C =	15

Drainage Area 0.728 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	$Q_{201Uncontrolled}$	$Q_{Allowable}$	Q_{DIS}	Reduction	
2 Year	0.074	0.011	**0.011**	0.001	m^3/s
5 Year	0.098	0.017	**0.013**	0.003	m^3/s
10 Year	0.114	0.020	**0.019**	0.000	m^3/s
25 Year	0.147	0.025	**0.021**	0.004	m^3/s
50 Year	0.179	0.031	**0.021**	0.009	m^3/s
100 Year	0.204	0.035	**0.022**	0.014	m^3/s

Required Storage Volumes

Dur.	2YR	5YR	10YR	25YR	50YR	100YR
30	67.7	90.3	100.3	134.8	169.1	197.7
60	77.3	103.4	112.3	153.7	195.7	230.9
90	80.9	108.7	**115.1**	160.7	208.1	247.8
120	**81.8**	**110.3**	113.6	**162.2**	213.8	257.0
150	81.0	109.7	109.6	160.4	**215.4**	261.5
180	79.0	107.5	103.8	156.3	214.3	**263.0**
210	76.2	104.3	96.7	150.5	211.1	262.1
240	72.8	100.2	88.6	143.5	206.5	259.4
270	68.9	95.5	79.8	135.4	200.6	255.4

Note: $Q_{Allowable} = Q_{101Ex} - Q_{204Uncontrolled} - Increase_{202}$

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PROJECT	210 Side Street	FILE	119055
		DATE	May 11, 2020
SUBJECT	Modified Rational Method	NAME	JM
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PRE DEVELOPMENT ANALYSIS
CATCHMENT # 102

Runoff Coefficient (Municipal Standard)

2 Year	0.24	
5 Year	0.24	
10 Year	0.24	
25 Year	0.26	=C5*1.10
50 Year	0.29	=C5*1.20
100 Year	0.30	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.1	27.9	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.6	mm/hr	T_C = 15
5 Year	73.5	mm/hr	T_C = 15
10 Year	85.4	mm/hr	T_C = 15
25 Year	100.4	mm/hr	T_C = 15
50 Year	111.5	mm/hr	T_C = 15
100 Year	122.5	mm/hr	T_C = 15

Drainage Area 0.077 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	Q_{102Ex}	
2 Year	0.003	m^3/s
5 Year	0.004	m^3/s
10 Year	0.004	m^3/s
25 Year	0.006	m^3/s
50 Year	0.007	m^3/s
100 Year	0.008	m^3/s

POST DEVELOPMENT ANALYSIS
CATCHMENT # 202

Runoff Coefficient (Municipal Standard)

2 Year	0.33	
5 Year	0.33	
10 Year	0.33	
25 Year	0.36	=C5*1.10
50 Year	0.40	=C5*1.20
100 Year	0.41	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.1	27.9	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.6	mm/hr	T_C = 15
5 Year	73.5	mm/hr	T_C = 15
10 Year	85.4	mm/hr	T_C = 15
25 Year	100.4	mm/hr	T_C = 15
50 Year	111.5	mm/hr	T_C = 15
100 Year	122.5	mm/hr	T_C = 15

Drainage Area 0.172 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	$Q_{202Uncontrolled}$	$Increase_{202}$	
2 Year	0.009	0.006	m^3/s
5 Year	0.012	0.008	m^3/s
10 Year	0.013	0.009	m^3/s
25 Year	0.017	0.012	m^3/s
50 Year	0.021	0.014	m^3/s
100 Year	0.024	0.016	m^3/s

TATHAM ENGINEERING

PROJECT	210 Side Street	FILE	119055
		DATE	May 11, 2020
SUBJECT	Modified Rational Method	NAME	JM
		PAGE	3 OF 3

PRE DEVELOPMENT ANALYSIS
CATCHMENT # 103

Runoff Coefficient (Municipal Standard)

2 Year	0.20	
5 Year	0.20	
10 Year	0.20	
25 Year	0.22	=C5*1.10
50 Year	0.24	=C5*1.20
100 Year	0.25	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.1	27.9	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.6	mm/hr	T_C = 15
5 Year	73.5	mm/hr	T_C = 15
10 Year	85.4	mm/hr	T_C = 15
25 Year	100.4	mm/hr	T_C = 15
50 Year	111.5	mm/hr	T_C = 15
100 Year	122.5	mm/hr	T_C = 15

Drainage Area 0.211 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	Q_{103Ex}	
2 Year	0.007	m^3/s
5 Year	0.009	m^3/s
10 Year	0.010	m^3/s
25 Year	0.013	m^3/s
50 Year	0.016	m^3/s
100 Year	0.018	m^3/s

POST DEVELOPMENT ANALYSIS
CATCHMENT # 203

Runoff Coefficient (Municipal Standard)

2 Year	0.21	
5 Year	0.21	
10 Year	0.21	
25 Year	0.23	=C5*1.10
50 Year	0.25	=C5*1.20
100 Year	0.26	=C5*1.25

Peak Rainfall Intensity Township of Clearview

	2YR	5YR	10YR	25YR	50YR	100YR
A	21.1	27.9	32.4	38.1	42.3	46.5
B	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

2 Year	55.6	mm/hr	T_C = 15
5 Year	73.5	mm/hr	T_C = 15
10 Year	85.4	mm/hr	T_C = 15
25 Year	100.4	mm/hr	T_C = 15
50 Year	111.5	mm/hr	T_C = 15
100 Year	122.5	mm/hr	T_C = 15

Drainage Area 0.117 ha

Peak Runoff Rate - Rational Method (Q=CiA/360)

	$Q_{203Uncontrolled}$	Reduction	
2 Year	0.004	0.003	m^3/s
5 Year	0.005	0.004	m^3/s
10 Year	0.006	0.004	m^3/s
25 Year	0.008	0.005	m^3/s
50 Year	0.009	0.007	m^3/s
100 Year	0.010	0.008	m^3/s

Appendix B: Conveyance Capacity Calculations

TATHAM ENGINEERING

Storm Sewer Design Sheet

Version Number: 1 **Version Date:** June 30, 2020

Project Information

Clearview Commons	119055

Drawing Reference

GS-1	June 25-20

Prepared By

JM	May 11-20

Reviewed By

DRT	June 30-20

Municipality

Township of Clearview

Runoff Coefficient Adjustment

Year	A	B
10	1.00	0.00
25	1.10	0.00
50	1.20	0.00
100	1.25	0.00

Manning's Coefficient

Pipe	Value
CSP	-
Concrete	0.013
PVC	0.013

Time of Concentration

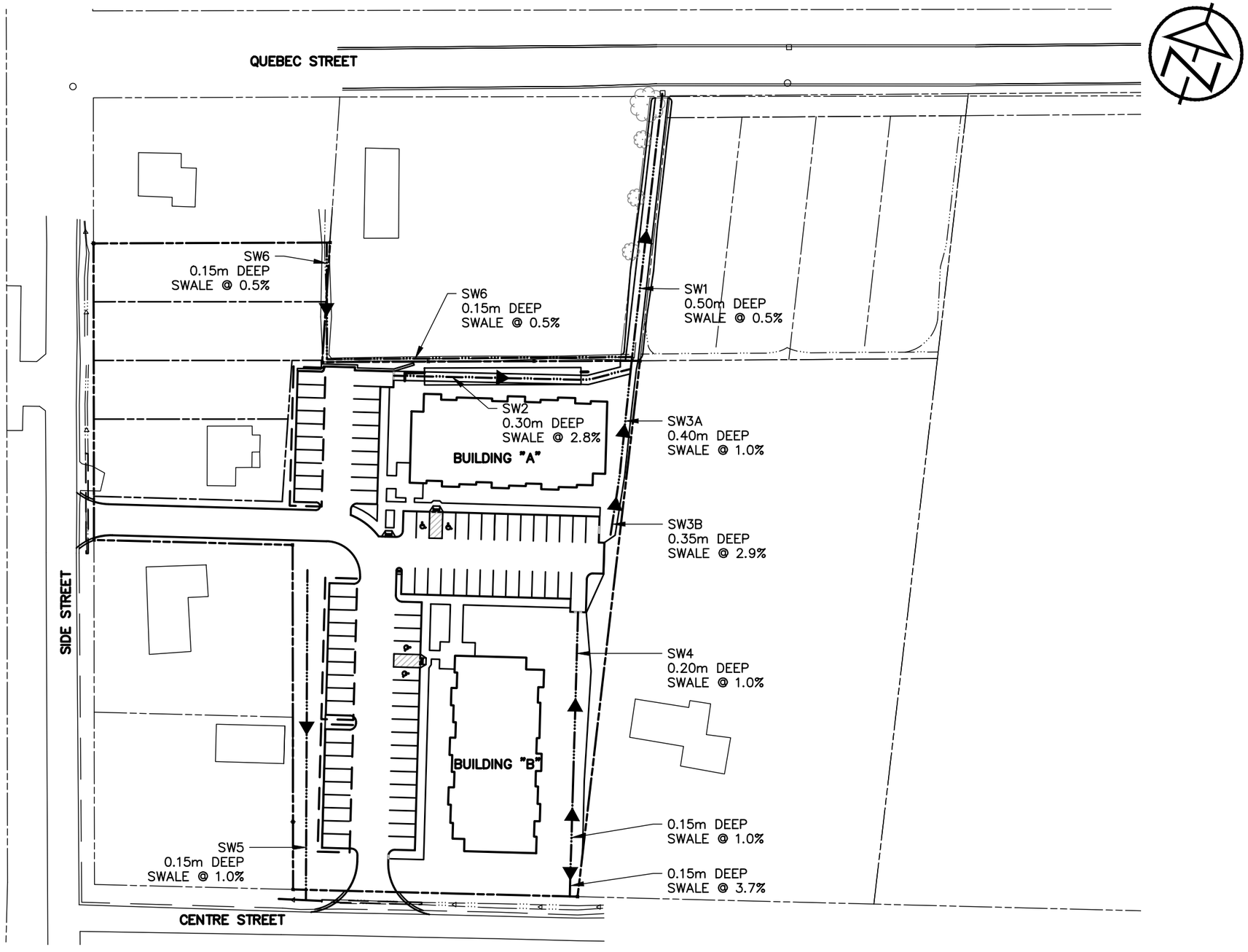
15 mins

IDF Curve Coefficients

Year	A	B	C
2	20.90	-0.70	-
5	27.60	-0.70	-
10	32.10	-0.70	-
25	37.70	-0.70	-
50	41.90	-0.70	-
100	46.00	-0.70	-

Engineer Stamp

Street Name	Area ID / Label	Upstream Maintenance Hole	Downstream Maintenance Hole	Area (ha)	5 Year Runoff Coefficient	Design Storm (Year)	Adjusted Runoff Coefficient	Area x Runoff Coefficient	Cumulative Area (ha)	Cumulative Area x Adjusted Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (mm/hr)	Peak Flow (m^3/s)	Manning's Roughness Coefficient	Sewer Length (m)	Sewer Slope (%)	Actual Sewer Diameter (mm)	Full Flow Velocity (m/s)	Full Flow Capacity (L/s)	Actual Velocity (m/s)	Travel Time (min)	Calculated Sewer Diameter (mm)	Percentage of Full Flow Capacity (%)	Total Time of Travel (min)
	201	CB7	CBMH4	0.17	0.79	5	0.79	0.13	0.17	0.13	15.00	72.74	0.027	0.013	39.2	0.3%	300	0.75	0.053	0.70	0.93	233	51.2%	15.93
	202	CB6	CBMH4	0.28	0.62	5	0.62	0.17	0.28	0.17	15.00	72.74	0.035	0.013	23.7	0.3%	300	0.75	0.053	0.75	0.53	257	66.2%	15.53
	203	CBMH4	CBMH3	0.11	0.83	5	0.83	0.09	0.56	0.40	15.93	69.74	0.077	0.013	29.2	0.3%	375	0.87	0.096	0.87	0.56	346	80.5%	16.49
	204	CBMH3	STM MH2	0.17	0.59	5	0.59	0.10	0.73	0.50	16.49	68.07	0.094	0.013	20.1	0.3%	375	0.87	0.096	0.87	0.39	373	98.4%	16.88
		STM MH1	DI1	-		100	0.00	-	-	-	15.00	121.23	0.022	0.013	10.0	0.5%	300	0.97	0.068	0.80	0.21	196	32.2%	15.21
	205	DI1	Ex DI	0.21	0.36	100	0.45	0.10	0.21	0.10	15.00	121.23	0.054	0.013	63.5	0.5%	300	0.97	0.068	0.97	1.09	275	79.4%	16.09



LEGEND

PROPOSED SWALE

TATHAM ENGINEERING

CLEARVIEW COMMONS

TOWNSHIP OF CLEARVIEW

SWALE CAPACITY LOCATION PLAN

DWG. No. **SWP-1**

SCALE: 1:1,000	DRAWN: JM	DATE: MAY/20	JOB NO. 119055

TATHAM ENGINEERING	PROJECT 210 Side Street	FILE	119055
		DATE	May 27, 2020
	SUBJECT Swale Capacity	NAME	JM
		PAGE	1 OF 4

Channel capacity calculations using Manning's Equation

Manning's Equation

$$Q = \frac{1}{n} A R^{2/3} s^{1/2}$$

SW1. Triangular Swale - Easement

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.005	m/m	
BOTTOM WIDTH	0.0		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.38	m	PROVIDE 0.50 m
FLOW AREA	0.433	m^2	
WETTED PERIMETER	2.403	m	
HYDRAULIC RADIUS	0.180	m	
FLOW CAPACITY	0.244	m^3/s	
REQUIRED CAPACITY	0.238	m^3/s	Post development uncontrolled 100-year flow to northeast corner of property

SW2. Triangular Swale - North Parking Lot to DI1

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.028	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.18	m	PROVIDE 0.30 m
FLOW AREA	0.097	m^2	
WETTED PERIMETER	1.138	m	
HYDRAULIC RADIUS	0.085	m	
FLOW CAPACITY	0.079	m^3/s	
REQUIRED CAPACITY	0.075	m^3/s	Post development uncontrolled 100-year flow from contributing areas of Catchment 201 and Catchment 204

Channel capacity calculations using Manning's Equation

Manning's Equation

$$Q = \frac{1}{n} A R^{2/3} s^{1/2}$$

SW3A. Triangular Swale - East Property Line to DI1

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.01	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.29	m	PROVIDE 0.40 m
FLOW AREA	0.252	m^2	
WETTED PERIMETER	1.834	m	
HYDRAULIC RADIUS	0.138	m	
FLOW CAPACITY	0.168	m^3/s	
REQUIRED CAPACITY	0.159	m^3/s	Post development uncontrolled 100-year flow from contributing areas of Catchment 201 and Catchment 204

SW3B. Triangular Swale - East Property Line to DI1

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.029	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.24	m	PROVIDE 0.35 m
FLOW AREA	0.173	m^2	
WETTED PERIMETER	1.518	m	
HYDRAULIC RADIUS	0.114	m	
FLOW CAPACITY	0.173	m^3/s	
REQUIRED CAPACITY	0.159	m^3/s	Post development uncontrolled 100-year flow from contributing areas of Catchment 201 and Catchment 204

Channel capacity calculations using Manning's Equation

Manning's Equation

$$Q = \frac{1}{n} A R^{2/3} s^{1/2}$$

SW4. Triangular Swale - East of Building "B" to CB6

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.01	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.14	m	PROVIDE 0.20 m
FLOW AREA	0.059	m^2	
WETTED PERIMETER	0.885	m	
HYDRAULIC RADIUS	0.066	m	
FLOW CAPACITY	0.024	m^3/s	
REQUIRED CAPACITY	0.021	m^3/s	Post development 100-year flow from contributing portion of Building "B" and grassed area

SW5. Triangular Swale - West of Parking Lot to Centre Street

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.01	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.08	m	PROVIDE 0.15 m
FLOW AREA	0.019	m^2	
WETTED PERIMETER	0.506	m	
HYDRAULIC RADIUS	0.038	m	
FLOW CAPACITY	0.008	m^3/s	
REQUIRED CAPACITY	0.007	m^3/s	Post development uncontrolled 100-year flow from contributing areas of Catchm

Channel capacity calculations using Manning's Equation

Manning's Equation

$$Q = \frac{1}{n} A R^{2/3} s^{1/2}$$

SW6. Triangular Swale - Rear Single Residential

CHANNEL PROPERTIES

MANNING'S COEFF	0.040		Grassed Channels and Swales - Kentucky bluegrass length 0.10 - 0.15m, greater than 0.20m flow depth (MTO Drainage Management Manual Design Chart 2.01)
SLOPE	0.005	m/m	
BOTTOM WIDTH	0.00		
RIGHT SIDE SLOPE	3.0	:1 H:V	
LEFT SIDE SLOPE	3.0	:1 H:V	
FLOW DEPTH	0.13	m	PROVIDE 0.15 m

FLOW AREA	0.051	m^2
WETTED PERIMETER	0.822	m
HYDRAULIC RADIUS	0.062	m

FLOW CAPACITY	0.014	m^3/s	
REQUIRED CAPACITY	0.014	m^3/s	Post development uncontrolled 100-year flow from contributing areas of Catchment 201 and Catchment 204

Appendix C: Detailed Stage-Storage-Discharge Calculations

TATHAM ENGINEERING

PROJECT	Clearview Commons	FILE	119055
		DATE	May 11, 2020
SUBJECT	Stage-Discharge Cultec Outlet	NAME	JM
		PAGE	1 OF 1

Orifice Outlet

	Orifice
Orifice/Pipe Size (mm)	80
Cross-sectional Area (sq.m)	0.00503
Orifice Coefficient	0.6
Invert Elevation (m)	222.35

Overflow Weirs

	Curb Cut 1	Curb Cut 2
Weir Width (m)	0.5	0.5
Weir Side Slopes (H:1V)	1.0	1.0
Weir Coefficient	1.7	1.7
Sill elevation (m)	225.00	225.00

Control Structure Configuration

Water Level	**Orifice**		**Overflow**		**Total Discharge**
	Head	Discharge	Head	Discharge	
(m)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)
222.35	0.00	0.0000	0.00	0.0000	0.0000
222.40	0.01	0.0013	0.00	0.0000	0.0013
222.50	0.11	0.0044	0.00	0.0000	0.0044
222.60	0.21	0.0061	0.00	0.0000	0.0061
222.70	0.31	0.0074	0.00	0.0000	0.0074
222.80	0.41	0.0085	0.00	0.0000	0.0085
222.90	0.51	0.0095	0.00	0.0000	0.0095
223.00	0.61	0.0104	0.00	0.0000	0.0104
223.10	0.71	0.0113	0.00	0.0000	0.0113
223.20	0.81	0.0120	0.00	0.0000	0.0120
223.30	0.91	0.0127	0.00	0.0000	0.0127
223.40	1.01	0.0134	0.00	0.0000	0.0134
223.42	1.03	0.0136	0.00	0.0000	0.0136
223.50	1.11	0.0141	0.00	0.0000	0.0141
223.60	1.21	0.0147	0.00	0.0000	0.0147
223.70	1.31	0.0153	0.00	0.0000	0.0153
223.80	1.41	0.0159	0.00	0.0000	0.0159
223.90	1.51	0.0164	0.00	0.0000	0.0164
224.00	1.61	0.0169	0.00	0.0000	0.0169
224.10	1.71	0.0175	0.00	0.0000	0.0175
224.20	1.81	0.0180	0.00	0.0000	0.0180
224.30	1.91	0.0185	0.00	0.0000	0.0185
224.40	2.01	0.0189	0.00	0.0000	0.0189
224.50	2.11	0.0194	0.00	0.0000	0.0194
224.60	2.21	0.0198	0.00	0.0000	0.0198
224.70	2.31	0.0203	0.00	0.0000	0.0203
224.80	2.41	0.0207	0.00	0.0000	0.0207
224.90	2.51	0.0212	0.00	0.0000	0.0212
225.00	2.61	0.0216	0.00	0.0000	0.0216
225.10	2.71	0.0220	0.10	0.0618	0.0838

TATHAM ENGINEERING

Project:	Clearview Commons
Date:	May 11, 2020
File No.:	119055
Designed By:	JM
Checked By:	DRT
Subject:	Storage Volume Table

Storage Volume

Underground Storage Invert	222.20 m
Underground Storage Obvert	223.42 m
Parking Storage	224.75 m
Overflow Weir Sill	225.00 m
Stage	0.10 m

Elev.	Depth	Cultec Storage	Sewer Storage	Parking Storage	Accum. Total
(m)	(m)	(m^3)	(m^3)	(m^3)	(m3)
222.20	**0.00**	**0.0**	**0.0**	**0.0**	**0.0**
222.30	0.10	0.0	0.0	0.0	0.0
222.40	0.20	5.7	0.0	0.0	5.8
222.50	0.30	17.1	0.6	0.0	17.7
222.60	0.40	28.2	2.0	0.0	30.3
222.70	0.50	39.2	4.7	0.0	43.9
222.80	0.60	49.7	7.8	0.0	57.6
222.90	0.70	59.9	10.1	0.0	70.0
223.00	0.80	69.6	10.9	0.0	80.6
223.10	0.90	78.6	11.3	0.0	90.0
223.20	1.00	86.4	11.8	0.0	98.2
223.30	1.10	92.5	12.2	0.0	104.6
223.40	1.20	98.1	12.4	0.0	110.5
223.42	**1.22**	**99.1**	12.6	**0.0**	**111.7**
223.50	1.30	99.1	13.0	0.0	112.1
223.60	1.40	99.1	13.3	0.0	112.5
223.70	1.50	99.1	13.7	0.0	112.9
223.80	1.60	99.1	14.1	0.0	113.2
223.90	1.70	99.1	14.4	0.0	113.5
224.00	1.80	99.1	14.7	0.0	113.8
224.10	1.90	99.1	15.0	0.0	114.1
224.20	**2.00**	**99.1**	15.2	0.0	**114.4**
224.30	2.10	99.1	15.5	0.0	114.6
224.40	2.20	99.1	15.7	0.0	114.9
224.50	**2.30**	**99.1**	16.0	0.0	**115.1**
224.60	2.40	99.1	16.2	0.0	115.3
224.70	2.50	99.1	16.4	0.0	115.5
224.80	2.60	99.1	16.4	2.0	117.6
224.90	2.70	99.1	16.4	42.9	158.5
225.00	2.80	99.1	16.4	160.3	275.9
225.10	2.90	99.1	16.4	333.8	449.4

Project:	Clearview Commons
Date:	May 11, 2020
File No.:	119055
Designed By:	JM
Checked By:	DRT
Subject:	SSD Table

STAGE-STORAGE-DISCHARGE

Underground Storage Invert	222.20 m
Underground Storage Obvert	223.42 m
Parking Storage	224.75 m
Overflow Weir Sill	225.00 m
Stage	0.10 m

Orifice	1
Diameter (mm)	80.00
Invert (m)	222.35
Weir	Overflow
Length(m)	0.50
Sill (m)	225.00

Water Level	Orifice 1 Discharge	Weir Overflow Discharge	Total Discharge	Volume			
				Cultec	Pipe	Parking	Total
(m)	(m^3/s)	(m3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
222.20	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0
222.30	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0
222.40	0.0013	0.0000	0.0013	5.7	0.0	0.0	5.8
222.50	0.0044	0.0000	0.0044	17.1	0.6	0.0	17.7
222.60	0.0061	0.0000	0.0061	28.2	2.0	0.0	30.3
222.70	0.0074	0.0000	0.0074	39.2	4.7	0.0	43.9
222.80	0.0085	0.0000	0.0085	49.7	7.8	0.0	57.6
222.90	0.0095	0.0000	0.0095	59.9	10.1	0.0	70.0
223.00	0.0104	0.0000	0.0104	69.6	10.9	0.0	80.6
223.10	0.0113	0.0000	0.0113	78.6	11.3	0.0	90.0
223.20	0.0120	0.0000	0.0120	86.4	11.8	0.0	98.2
223.30	0.0127	0.0000	0.0127	92.5	12.2	0.0	104.6
223.40	0.0134	0.0000	0.0134	98.1	12.4	0.0	110.5
223.42	0.0136	0.0000	0.0136	99.1	12.6	0.0	111.7
223.50	0.0141	0.0000	0.0141	99.1	13.0	0.0	112.1
223.60	0.0147	0.0000	0.0147	99.1	13.3	0.0	112.5
223.70	0.0153	0.0000	0.0153	99.1	13.7	0.0	112.9
223.80	0.0159	0.0000	0.0159	99.1	14.1	0.0	113.2
223.90	0.0164	0.0000	0.0164	99.1	14.4	0.0	113.5
224.00	0.0169	0.0000	0.0169	99.1	14.7	0.0	113.8
224.10	0.0175	0.0000	0.0175	99.1	15.0	0.0	114.1
224.20	0.0180	0.0000	0.0180	99.1	15.2	0.0	114.4
224.30	0.0185	0.0000	0.0185	99.1	15.5	0.0	114.6
224.40	0.0189	0.0000	0.0189	99.1	15.7	0.0	114.9
224.50	0.0194	0.0000	0.0194	99.1	16.0	0.0	115.1
224.60	0.0198	0.0000	0.0198	99.1	16.2	0.0	115.3
224.70	0.0203	0.0000	0.0203	99.1	16.4	0.0	115.5
224.80	0.0207	0.0000	0.0207	99.1	16.4	2.0	117.6
224.90	0.0212	0.0000	0.0212	99.1	16.4	42.9	158.5
225.00	0.0216	0.0000	0.0216	99.1	16.4	160.3	275.9
225.10	0.0220	0.0618	0.0838	99.1	16.4	333.8	449.4

CULTEC Stage-Storage Calculations

Date:	July 8, 2020

Project Information:
Clearveiw Commons
210 Side Street
Township of Clearview
Ontario L0M 1S0
Canada

Project Number:
119055

Chamber Model -	**Recharger 360HD**	
Number of Rows-	2	units
Total Number of Chambers -	62	units
HVLV FC-24 Feed Connectors-	2	units
Stone Void -	40	%
Stone Base -	152	mm
Stone Above Units -	152	mm
Area -	140.09	m2
Base of Stone Elevation -	222.20	

Recharger 360HD Incremental Storage Volumes

Height of System		Chamber Volume		HVLV Feed		Stone Volume		Cumulative		Total Cumulative		Elevation		
in	mm	ft³	m³	ft3	m3	ft³	m³	ft³	m³	ft³	m³	ft	m	
48.0	1219	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3793.11	107.41	4.000	223.42	Top of Stone Elevation
47.0	1194	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3742.85	105.99	3.920	223.39	
46.0	1168	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3692.58	104.56	3.830	223.37	
45.0	1143	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3642.32	103.14	3.750	223.34	
44.0	1118	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3592.06	101.72	3.670	223.32	
43.0	1092	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	3541.79	100.29	3.580	223.29	
42.0	1067	5.0	0.1	0.0	0.0	48.3	1.4	53.275	1.5	3491.53	98.87	3.500	223.27	Top of Chamber Elevation
41.0	1041	10.6	0.3	0.0	0.0	46.0	1.3	56.646	1.6	3438.25	97.36	3.420	223.24	
40.0	1016	15.8	0.4	0.0	0.0	43.9	1.2	59.753	1.7	3381.60	95.76	3.330	223.22	
39.0	991	26.7	0.8	0.0	0.0	39.6	1.1	66.312	1.9	3321.85	94.06	3.250	223.19	
38.0	965	33.8	1.0	0.0	0.0	36.8	1.0	70.528	2.0	3255.54	92.19	3.170	223.17	
37.0	940	39.1	1.1	0.0	0.0	34.6	1.0	73.695	2.1	3185.01	90.19	3.080	223.14	
36.0	914	43.4	1.2	0.0	0.0	32.9	0.9	76.329	2.2	3111.32	88.10	3.000	223.11	
35.0	889	47.2	1.3	0.0	0.0	31.4	0.9	78.609	2.2	3034.99	85.94	2.920	223.09	
34.0	864	50.6	1.4	0.0	0.0	30.0	0.9	80.629	2.3	2956.38	83.72	2.830	223.06	
33.0	838	53.6	1.5	0.0	0.0	28.8	0.8	82.444	2.3	2875.75	81.43	2.750	223.04	
32.0	813	56.4	1.6	0.0	0.0	27.7	0.8	84.095	2.4	2793.31	79.10	2.670	223.01	
31.0	787	58.9	1.7	0.0	0.0	26.7	0.8	85.601	2.4	2709.21	76.72	2.580	222.99	
30.0	762	61.2	1.7	0.0	0.0	25.8	0.7	87.012	2.5	2623.61	74.29	2.500	222.96	
29.0	737	63.4	1.8	0.0	0.0	24.9	0.7	88.294	2.5	2536.60	71.83	2.420	222.94	
28.0	711	65.4	1.9	0.0	0.0	24.1	0.7	89.480	2.5	2448.30	69.33	2.330	222.91	
27.0	686	67.2	1.9	0.0	0.0	23.4	0.7	90.587	2.6	2358.82	66.79	2.250	222.89	
26.0	660	68.9	2.0	0.0	0.0	22.7	0.6	91.624	2.6	2268.24	64.23	2.170	222.86	
25.0	635	70.6	2.0	0.0	0.0	22.0	0.6	92.598	2.6	2176.61	61.63	2.080	222.84	
24.0	610	72.1	2.0	0.0	0.0	21.4	0.6	93.512	2.6	2084.01	59.01	2.000	222.81	
23.0	584	73.5	2.1	0.0	0.0	20.9	0.6	94.353	2.7	1990.50	56.36	1.920	222.78	
22.0	559	74.8	2.1	0.0	0.0	20.3	0.6	95.166	2.7	1896.15	53.69	1.830	222.76	
21.0	533	76.1	2.2	0.0	0.0	19.8	0.6	95.939	2.7	1800.98	51.00	1.750	222.73	
20.0	508	77.3	2.2	0.0	0.0	19.3	0.5	96.666	2.7	1705.05	48.28	1.670	222.71	
19.0	483	78.5	2.2	0.0	0.0	18.9	0.5	97.353	2.8	1608.38	45.54	1.580	222.68	
18.0	457	79.5	2.3	0.0	0.0	18.5	0.5	97.979	2.8	1511.03	42.79	1.500	222.66	
17.0	432	80.6	2.3	0.0	0.0	18.0	0.5	98.595	2.8	1413.05	40.01	1.420	222.63	
16.0	406	81.5	2.3	0.0	0.0	17.7	0.5	99.177	2.8	1314.45	37.22	1.330	222.61	
15.0	381	82.4	2.3	0.0	0.0	17.3	0.5	99.706	2.8	1215.27	34.41	1.250	222.58	
14.0	356	83.3	2.4	0.0	0.0	17.0	0.5	100.225	2.8	1115.57	31.59	1.170	222.56	
13.0	330	84.1	2.4	0.0	0.0	16.6	0.5	100.718	2.9	1015.34	28.75	1.080	222.53	
12.0	305	84.9	2.4	0.0	0.0	16.3	0.5	101.182	2.9	914.63	25.90	1.000	222.50	
11.0	279	85.6	2.4	0.0	0.0	16.0	0.5	101.599	2.9	813.44	23.03	0.920	222.48	
10.0	254	86.2	2.4	0.0	0.0	15.8	0.4	102.010	2.9	711.84	20.16	0.830	222.45	
9.0	229	86.9	2.5	0.0	0.0	15.5	0.4	102.375	2.9	609.83	17.27	0.750	222.43	
8.0	203	87.5	2.5	0.0	0.0	15.3	0.4	102.745	2.9	507.46	14.37	0.670	222.40	
7.0	178	88.1	2.5	0.0	0.0	15.0	0.4	103.126	2.9	404.71	11.46	0.580	222.38	
6.0	152	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	301.59	8.54	0.500	222.35	Bottom of Chamber Elevation
5.0	127	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	251.32	7.12	0.420	222.33	
4.0	102	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	201.06	5.69	0.330	222.30	
3.0	76	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	150.79	4.27	0.250	222.28	
2.0	51	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	100.53	2.85	0.170	222.25	
1.0	25	0.0	0.0	0.0	0.0	50.3	1.4	50.265	1.4	50.26	1.42	0.080	222.23	
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	222.20	Bottom of Stone Elevation

TATHAM ENGINEERING

PROJECT	Clearview Commons	FILE	119055
		DATE	May 11, 2020
SUBJECT	Stage-Storage Parking Lot	NAME	JM
		PAGE	1 OF 1

Parking Lot storage calculations using the Average End Area Method

Parking Lot Above CBMH3

Stage	Increment	Area	Average Area	Incremental Volume	Cumulative Volume
224.75		0.00			
224.80	0.05	32.02	16.01	0.80	0.80
224.90	0.10	229.63	130.82	13.08	13.88
225.00	0.10	607.43	418.53	41.85	55.74
225.10	0.10			0.00	55.74

Parking Lot Above CB6

Stage	Increment	Area	Average Area	Incremental Volume	Cumulative Volume
224.75		0			
224.80	0.05	49.58	24.79	1.24	1.24
224.90	0.10	417.43	233.51	23.35	24.59
225.00	0.10	1004.92	755.58	75.56	100.15
225.10	0.10	1858.05	1735.20	173.52	273.67

Parking Lot Above CBMH4

Stage	Increment	Area	Average Area	Incremental Volume	Cumulative Volume
224.75		0			
224.80	0.05	0	0.00	0.00	0.00
224.90	0.10	88.8	44.40	4.44	4.44
225.00					4.44
225.10					4.44

Total Parking Storage Volume

Stage	Total Volume
224.75	0.00
224.80	2.04
224.90	42.91
224.97	160.32
225.10	333.84

TATHAM ENGINEERING

PROJECT	Clearview Commons	FILE	119055
		DATE	June 19, 2020
SUBJECT	Drawdown Time	NAME	JM
		PAGE	1 OF 1

DRAWDOWN TIME

Using the falling head orifice equation for total drawdown

$$t = \frac{2\,A_p}{C\,A_o\,(2g)^{0.5}}\,(h_1^{0.5} - h_2^{0.5})$$

		Value			
where t =	drawdown time in seconds				
A_p =	average surface area of pond (m^2)	475.0	m^2		
C =	discharge coefficient (orifice)	0.63			
A_o =	cross-sectional area of orifice (m^2)	0.0201		80	mm
g =	gravitational acceleration constant (9.81 m/s^2)	9.81	m/s^2		
h_1 =	starting water elevation above the orifice (m)	2.55	m	224.98	m
h_2 =	ending water elevation above the orifice (m)	0	m	222.35	m

t= 27038.15 seconds

t= **7.51** hours