RGH Developments

Rocky Acres Subdivision
Stormwater Management Report

Prepared by:

FOREFRONT Engineering Inc. **613 634 9009 tel**
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8

Date: September 2021

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Forefront Engineering Inc

1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8

613 634 9009 tel
888.884.9392 fax

September 16, 2021

RGH Developments
190 Pauline Tom Avenue
Kingston, ON
K7K 0G1

Regarding: Rocky Acres Subdivision
Stormwater Management Report

Dear Mr. Haynes

The enclosed report details the existing drainage conditions and provides recommendations for stormwater management and drainage for the proposed Rocky Acres Subdivision located in the Town of Gananoque.

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 26 single-detached lots and 2 semi-detached lots (4 units) for a total of 30 units. The development will include a new street with two connections to Garfield Street.

It is recommended that storm sewers and storm sewer services be installed along the proposed street with a connection to Maple Street storm sewers through an easement.

Development of the Rocky Acres Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. It is recommended that an oil grit separator be installed at the outlet to the Maple Street storm sewer to mitigate any adverse water quality effects that site run-off may have on downstream works. A dry pond stormwater management (SWM) facility is proposed to control post-development peak flows to pre-development levels.

Stormwater management details are contained in this Report along with recommended maintenance procedures.

Detailed subdivision and stormwater facility drawings are required.

This Report demonstrates that adequate stormwater management controls are available for the proposed development

If you have any inquiries or wish to discuss further, please contact this office.

Sincerely,

FOREFRONT Engineering Inc.

Kyle Nielissen, P.Eng.
Project Manager
Kyle.Nielissen@Forefronteng.ca

FOREFRONT Signatures

Report Prepared By:

Jeff Homer, P. Eng.

Report Review By:

Kyle Nielissen, P. Eng.

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1. Introduction

Forefront has assembled relevant supporting information for the proposed residential development at Part of Lots 2 and 71, Part of Old Kingston Road, Registered Plan 86 in the Town of Gananoque in the County of Leeds.

The proposed Rocky Acres Subdivision is located in the Town of Gananoque east of Garfield Street and west of Maple Street. The property is bounded by existing residential dwellings to the north, east, west and south. The property includes frontage on Garfield Street.

Figure 1: Site Location

The subject site is currently zoned Residential within the Town of Gananoque. The property is currently vacant with no existing structures.

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 26 single-detached lots and 2 semi-detached lots (4 units) for a total of 30 units. The development will include a new street with two connections to Garfield Street.

It is recommended that storm sewers and storm sewer services be installed along the proposed street with a connection to Maple Street storm sewers.

Development of the Rocky Acres Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This Report proposes a plan to address stormwater management concerns and minimize impacts on the natural drainage and environment.

Refer to Appendix A, **Concept Plan** for the proposed development plan.

2. Existing Site Conditions

The subject site and surrounding affected drainage area total approximately 2.81 hectares.

The existing topography of the site drains towards Maple Street. Rock outcrops are visible on the surface, suggesting relatively shallow bedrock. The subject site is currently vacant with no existing structures.

The subject site drains north-easterly in a shallow depression to a buried pipe located adjacent to 180 Maple Street North. Drainage from the site and developed lands to the north is directed to an existing storm sewer and catch basin system (*west ward storm sewer system*) along Maple Street North that eventually outlets from an existing 900mm diameter storm sewer on River Street to the Gananoque River (**Outlet 1**).

Drainage from lands to the southwest of the development, including Garfield Street, is collected by the King Street West storm sewer system and outlets direct to the St. Lawrence River near the intersection of King Street West and Elm Street (**Outlet 2**).

In order to service the proposed Rocky Acres Subdivision, existing downstream storm sewers were reviewed to both the Gananoque River (**Outlet 1**) and the St. Lawrence River (**Outlet 2**).

The Gananoque River outlet (**Outlet 1**) is within the Gananoque Intake Protection Zone 2 (IPZ-2). The Cataraqui Source Protection Plan approved in 2014 and effective as of 2015 recommends that developed areas within the IPZ-2 be designed for an ‘enhanced’ level of stormwater treatment.

The Soil Survey of Leeds County identifies the soil cover in this area of Gananoque as primarily Napanee Clay (Nc) with a rock class of 8 or “very rocky”. Napanee clay is considered poorly draining clay and provides little opportunity for infiltration during storm events.

Please refer to Appendix A, **Figure 2**: Pre-Development Catchment Areas and **Figure 4**: Gananoque West Ward Storm Sewer Catchment Areas for existing condition details.

3. Proposed Development

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 26 single-detached lots and 2 semi-detached lots (4 units) for a total of 30 units. The development will include a new street with two connections to Garfield Street.

Please refer to Appendix A, **Figure 3**: Post-Development Catchment Areas for proposed condition details.

3.1 Drainage Plan

Asphalt road with curb and gutter and storm sewers are proposed throughout the development. Grading for the development should incorporate lot level conveyance controls minimizing grades to promote reduced peak flows, retention and infiltration.

The proposed storm sewer system is to be sized to convey the minor event and connect to the existing 600mm storm sewer system on Maple Street North conveying drainage to **Outlet 1**.

Quantity and quality controls are proposed for this development.

Post-development minor event stormwater flows are to be controlled to the pre-development level via an orifice plate installed at the outlet of the storm sewer system. Post-development major event peak flows are to be overcontrolled at the outlet to the pre-development 10-year storm event peak flow as the downstream west ward storm sewer system is adequately sized for the 10-year event.

Quantity control storage is provided by the storm sewer system and a dry pond stormwater management (SWM) facility located at the west property boundary.

Controlled minor and major stormwater flows are to be directed to the Gananoque River (**Outlet 1**) via the west ward storm sewer system.

For stormwater quality control for the subject site, enhanced protection (80% suspended solids removal) is required as the site is within the Gananoque Intake Protection Zone 2. An approximate drainage area of 2.81 ha is directed towards Maple Street. An oil grit separator sized for enhanced protection is proposed at the site discharge point prior to flow entering the 600mm diameter Maple Street storm sewer from the subject site.

Lot level conveyance controls and further details will be provided during detailed design of the grading and drainage of these areas, these details will be depicted on the final engineering drawings.

3.2 Water Quantity

Urbanization leads to an increase in impermeable surfaces (rooftops and parking areas). The resultant increased peak flows increase the risk to life, environment and property damage. Water quantity control is generally required when there will be downstream quantity impacts.

Consistent with general stormwater management practices, stormwater quality is proposed for the site. Quantity control is recommended. Minor storm sewer systems will be designed for the 5-year design event. Overland flow paths are to convey the 100-year storm event.

3.2.1 Analysis

The Rational Method will be utilized to design the proposed drainage conveyances onsite.

3.2.2 Rational Method

The rational method calculates the peak flow rate at a specific location in a catchment due to the runoff contributed from the entire upstream catchment area. The rational method is represented by then following equation:

$$Q = 2.78AIR$$

where Q = Design flow in L/s,
A = area in hectares
I = rainfall intensity in mm/hr, and
R = runoff coefficient.

A minimum time of concentration of 15 minutes is proposed onsite given the calculated times of concentration for the site is less than 15 minutes.

3.2.3 Design Storm Events

Quality Event

The Ministry of Environment Stormwater Management Manual refers to a 12.5mm to 25mm 4 hour Chicago storm event for sizing quality treatment facilities in Ontario that are not included in table 3.2 of the manual.

The following formula has been developed for a 25mm- 4 hr Chicago Design storm for this area:

$$I_{25mm} = \frac{498}{(t_c+9.7)^{0.825}}$$

Minor Event and Major Event

Storm sewers are proposed along the proposed street. The storm sewer will be designed for the 5-year design storm and provide surcharge protection for all major flow events. The storm sewer shall be designed using Manning's equation and intensities based on the MTO IDF curve for the area. Refer to Appendix B for IDF curve details.

The proposed storm sewer system is to connect to the existing 600mm storm sewer system on Maple Street North conveying drainage to **Outlet 1**.

Major flows are to be directed via overland flow to the dry pond stormwater management facility. Sag points should be incorporated in the right-of-way to allow time for flows to be captured by the storm sewer system and ensure major flows are conveyed to the SWM facility and the storm sewer.

Post-development minor and major stormwater flows are to be controlled to the pre-development level via an orifice plate installed at the outlet of the storm sewer system. Post-development major storm event peak flows are to be over controlled at the outlet to the pre-development 10-year storm event peak flow as the downstream west ward storm sewer system is adequately sized for the 10-year event. Refer to Appendix B for the west ward storm sewer design sheet and hydraulic grade line calculations.

3.2.4 Hydrology

Runoff Coefficients

The runoff coefficient (C) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well vegetated areas (forest, flat land). Coefficients were assigned based on surface cover and soil conditions as follows.

Urban			
Land Use & Topography	**Runoff Coefficients**		
Asphalt, concrete, roof areas	0.9		
Grassed area, parkland	0.25		
Commercial	0.8		
Industrial	0.7		
Residential			
Single family (>400 m^2)	0.4		
Single family (<400 m^2)	0.5		
Semi-detached	0.5		
Townhouses	0.6		
Apartments	0.6		
Institutions	0.55		
Rural			
	Soil Texture		
Land Use & Topography	**Open Sand Loam**	**Loam or Silt Loam**	**Clay Loam or Clay**
Cultivated			
Flat 0-5% Slopes	0.22	0.35	0.55
Rolling 5-10% Slopes	0.3	0.45	0.6
Hilly 10-30% Slopes	0.4	0.65	0.7
Pasture			
Flat 0-5% Slopes	0.1	0.28	0.4
Rolling 5-10% Slopes	0.15	0.35	0.45
Hilly 10-30% Slopes	0.22	0.4	0.55
Woodlands and Cutover			
Flat 0-5% Slopes	0.08	0.25	0.35
Rolling 5-10% Slopes	0.12	0.3	0.42
Hilly 10-30% Slopes	0.18	0.35	0.52
Bare Rock	**Coverage**		
	30%	50%	70%
Flat 0-5% Slopes	0.4	0.55	0.75
Rolling 5-10% Slopes	0.5	0.65	0.8
Hilly 10-30% Slopes	0.55	0.7	0.85
Lakes and Wetlands	0.05		
Note: Values are a combination of the City of Kingston Subdivision Guidelines and Ministry of Transportation Design Chart 1.07			

To reflect the unique hydrologic properties within each sub-catchment, a variety of surface cover types were defined. A runoff coefficient of 0.25 is to be used for grassed and soft landscape surfaces, and 0.9 is proposed for asphalt and rooftops. A coefficient of 0.70 for bare rock with slopes at 5-15% and 60% coverage are utilized for the pre-development catchment area. A coefficient of 0.35 is considered appropriate for areas with grassed surfaces on shallow rock areas in the post development site. Refer to the composite runoff coefficient calculations in Appendix B for further details.

3.2.5 Pre-Development Flows

Runoff coefficients and catchment characteristics were assigned for the existing catchments and are summarized in Table 3-1 below.

Table 3-1 Existing Conditions

Hydrologic Units - Existing Conditions									
Hydrologic Unit	Description	Est'd C	Area (ha)	Length (m)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc (Airport Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)
E1 + E2 + E3	Outlet 1	0.37	2.61	140	6.45	4.05	See below*	**23.3**	2.68
Tc Calculation Airport Method									
Tc.1	Rock Outcrop, 5-15% Rolling Slopes 60% Coverage	0.70	0.68	80	2.93	1.31	5.3		
Tc.2	Flat Low lying wet area	0.25	1.93	60	2.88	2.16	18.0		
							23.3		

Results shown in Table 3-2 quantify the pre-development peak rate of surface runoff that has been routed through the drainage system, eventually discharging to outlets downstream. Results are grouped by outlet location for all the rainfall events.

Table 3-2 Peak Flows in Pre-Development Conditions

Peak Flows in Pre-Development Conditions (LPS)				
Description	**2 Year Design Storm**	**5 Year Design Storm**	**10 Year Design Storm**	**100 Year Design Storm**
	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)
Site to Outlet 1	108	145	166	237

3.2.6 Post-Development Flows

The development of this site will have a minor increase the imperviousness of the site and hence the runoff. Runoff coefficients and catchment characteristics were assigned for the proposed catchments and are detailed in Table 3-3. Refer to the subdivision storm sewer design sheet in Appendix B for the calculated time of concentration.

Table 3-3 Proposed Conditions

Hydrologic Units - Proposed Conditions								
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Width (m)	Average Grade (%)	Tc Proposed	Indiv. 2.78 AC (ha)
P1	Minor & Major to Outlet 1	0.53	2.81	140	100	2.61	**19.5**	4.14

Results shown in Table 3-4 quantify the peak rate of surface runoff calculated with the rational method and assigned catchment characteristics. The pre-development, post-uncontrolled and post-controlled flow rates are calculated.

Table 3-4 Peak Flows in Post Development Conditions

Peak Flows in Post-Development Conditions (LPS)					
Description	**25 mm Quality Event**	**2 Year Design Storm**	**5 Year Design Storm**	**10 Year Design Storm**	**100 Year Design Storm**
	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)
Pre-Development	NR	108	145	166	237
Uncontrolled Post-Development	127	189	249	290	416
Controlled Post-Development	NR	108	145	166	166

NR = Not Required

As noted above, the proposed storm sewer is to be sized to convey the minor storm event. The major overland flow for catchment area P1 is to be maintained within the right of way and directed towards sag points in the proposed right of way allowing time for surface runoff to be captured by the storm sewer system and backflow into the proposed stormwater management facility. An orifice plate installed at the storm sewer outlet at MH11 and dry pond stormwater management facility located at the west property boundary are proposed to limit post-development flows shown in Table 3-4 to pre-development levels. Major flows greater than the 10-year event up to the 100-year event are to be overcontrolled by an orifice plate to the pre-development 10-year storm event flow.

Quantity control volumes required based on the 2-year, 5-year, 10-year and 100-year design storms are 96m³, 130m³, 148m³ and 312m³. The total quantity control volume proposed is 312m³, of which 44m³ is provided by the proposed storm sewer system and the remaining 268m³ is provided by the proposed dry pond SWM facility. Refer to Appendix B, Modified Rational Method calculations for the 5-year and 100-year storage calculations. There is sufficient volume available for this development based on the proposed SWM facility and pipe storage characteristics listed in Table 3-5.

Table 3-5 Dry Pond Stormwater Management Facility Stage – Storage Relationship

Elevation (m)	Side Slope (1:run)	SWMF Volume (m³)	Pipe Storage Volume (m³)	Total Volume (m³)	Orifice Release Rate (LPS)	Comment
89.65	0	0	0	0	0	Pond Bottom
89.84	5	63	33	96	108	2yr Event
89.88	5	86	44	130	145	5yr Event
89.95	5	104	44	148	166	10yr Event
90.45	5	224	44	268	166	100yr Event
90.75	3	NA	NA	NA	NA	Freeboard (0.3m)

The proposed dry pond includes the following features:

- A highwater depth of 0.8m.
- The side slopes are 5:1 (H:V) unless otherwise noted.
- Minor and major flows will be directed to the facility by a storm sewer and road network.
- Major flows will be conveyed to the stormwater management facility overland via the roadway system. Sag points in the road will allow time for the major flow events to be captured by the storm sewer system and backflow into the facility while being restricted by the orifice at MH11.
- A 3.5m wide maintenance access to the facility outlet area will be from the proposed street.
- The facility will be located in a block dedicated to the municipality.
- 0.3m of freeboard has been incorporated.
- Under storm events in excess of the 100 year the facility will outlet to the right of way via the maintenance access.

As demonstrated in the hydraulic grade line calculations in Appendix B, the HGL of the proposed storm sewer system during the 100-year event reaches a highwater level of 90.45 at the SWM facility and approximately follows the grade of the storm sewer system down to MH11 to a maximum HGL elevation of 88.51 at MH11. Storm services where required by the municipality are to be installed with a sump pump and outlet above the hydraulic grade line. The maximum depth of ponding within the right of way will not exceed 300mm.

The existing and future drainage areas and storm sewer from Maple Street North to River Street (west ward storm sewer system) were reviewed as part of the analysis. Detailed calculations in Appendix B demonstrate that the full buildout of the west ward storm sewer is capable of conveying up to the 10-year storm event out to Gananoque River (**Outlet 1**). Refer to Appendix B Existing and Proposed Storm Sewer Design Sheets for further details.

Refer to the Rational Method Calculations for the 25mm-4 hour, 2 year, 5 year, 10 year and 100 year event in Appendix B for the peak flow calculations.

Drainage from catchment area P1 is to be conveyed to an oil grit separator prior to outletting to the 600mm diameter storm sewer on Maple Street towards **Outlet 1**.

Note, the King Street West storm sewer system was analyzed from Garfield Street to **Outlet 2** as part of the storm sewer review and the results are available upon request. The King Street West storm sewer system was found to have insufficient capacity for the proposed development.

Major flows greater than the 100-year event and flow under blocked outlet conditions will be directed to King Street West and **Outlet 2** via overland flow.

Low Impact Development (LID) Discussion

Low Impact Development (LID) is a stormwater management strategy that seeks to mitigate the impacts of stormwater runoff as close to its source as possible. LIDs primarily focus on small scale structural practices through infiltration, harvesting, filtration and detention of stormwater and using a treatment train approach. Benefits of LID technologies outside of the conventional end-of-pipe practices include water conservation, reduction and reuse, increase in pervious surfaces, aesthetic improvements, habitat creation and green space creation.

Lot level conveyance controls are proposed within the lots. It is understood the Town of Gananoque Public Works do not currently support the use of LIDs within the municipal right of way. Technical barriers limiting the use of LIDs within the proposed subdivision include shallow bedrock and tight soils.

3.3 Water Quality

The Stormwater Management Planning and Design Manual by the Ministry of the Environment, Conservation, and Parks (MECP) describes various levels of protection of water quality based on a general relationship between the end-of-pipe stormwater management facilities long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life.

Based on the characteristics of the receiving watercourse, Level 1 or Enhanced Protection (corresponding to the end-of-pipe storage volumes required for the long-term removal of 80% of suspended solids) is required. Stormwater management measures will be implemented to provide in excess of 80% long-term removal of suspended solids.

3.3.1 Oil Grit Separator

The proposed storm sewer network will outlet to an oil grit separator. The proposed oil grit separator will provide in excess of 82% suspended solids removal.

A Contech precast concrete CDS Model PMSU3020_6m Oil and Grit Separator is proposed for quality control from catchment area P1.

Refer to Appendix B: Echelon Environmental Sizing Report and Cumulative Volume Calculations for further details.

3.4 Maintenance

Dry pond and Oil Grit Separator

The oil grit separator will separate the oils and sediment from runoff onsite and will require annual maintenance and pumper truck access.

Periodic maintenance inspection of the facilities is the responsibility of the Owner. A summary of observations during inspection of the facility over the course of the year should be provided. These observations should include comments on the:

- hydraulic operation of the facilities (detention time, evidence or occurrence of overflows)
- occurrence of obstructions at the inlet and outlet
- evidence of spills and oil/grease contamination
- frequency of trash build-up
- measured sediment depths in the facilities
- maintenance and operational control undertaken during the year
- recommendations for inspection and maintenance program for the coming year

The dry pond will require routine periodic maintenance including grass cutting and wee control. Trash removal will be required several times per year. Removal of sediment in the pond itself will be required.

The pipe system will require routine periodic maintenance including hydro vacuuming, flushing and debris removal annually. Removal of accumulated sediment will be required.

3.5 Quality Control (Short Term)

Silt fencing is to be provided at all side slopes and down gradient locations to ensure sediment and erosion control during construction. Other control devices such as straw bales will also be provided where drainage is concentrated. Sediment and erosion management measures also serve to provide a limit to the grading operations.

Straw bale filters are to be provided in overland swale systems.

The timeframe for land to remain exposed before it is stabilized with sod, mulch, or hydroseeding is to be minimized. Topsoil is to be stockpiled away from watercourses and wetlands. Rock check dams or straw bale filters are to be provided in overland swale and ditch systems.

Inspection of the sediment control works should be undertaken before and after all rainfall (and snowmelt) events. Maintenance is to be undertaken as required to ensure the proper operation of all sediment and erosion controls. Inspection and maintenance are the Owner's responsibility.

4. Conclusions

It is recommended that the Rocky Acres Subdivision proceed with the mitigation measures detailed in this report to address stormwater quality and quantity and erosion concerns on site.

The development is to be designed in accordance with the Ministry of the Environment, Conservation, and Parks, Town of Gananoque Public Works, and CRCA guidelines.

Stormwater runoff within the Rocky Acres Subdivision is to be directed to a dry pond stormwater management facility and oil grit separator prior to flow discharging to the storm sewer on Maple Street.

Detailed subdivision and stormwater facility drawings are required prior to Final Plan of Subdivision Approval. An Environmental Compliance Approval is required prior to construction.

Appendix A

Concept Plan
Figure 2: Pre-development Catchment Areas
Figure 3: Post-development Catchment Areas
Figure 4: Gananoque West Ward Storm Sewer Catchment Areas

0 12.5 25 m H=1:500

Benchmark

No.	Revision/Issue	Date

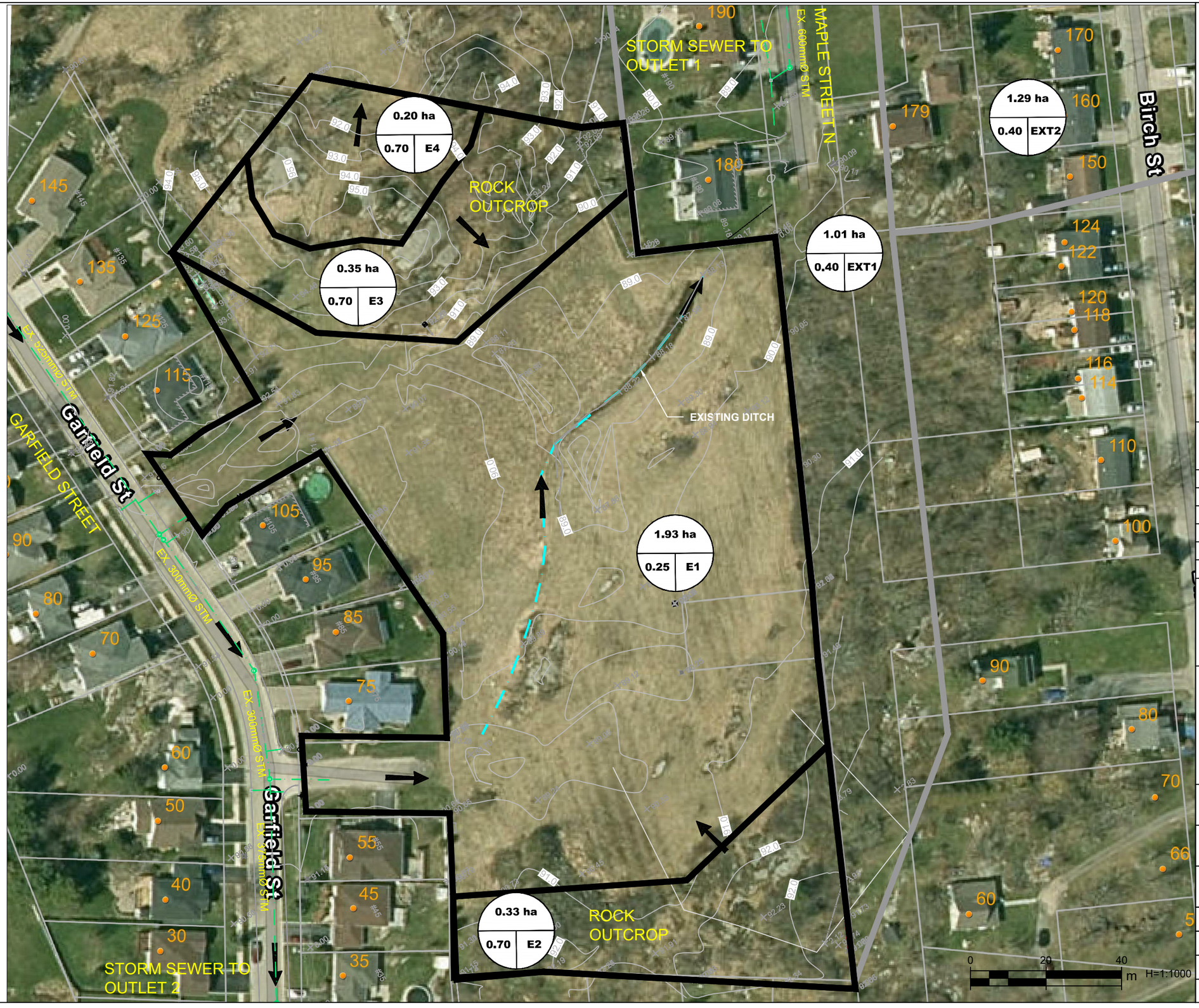
Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
RGH DEVELOPMENTS

Project
ROCKY ACRES DEVELOPMENT

Drawing
CONCEPT PLAN

Drawn by:	Checked by:	Project No.
CGD	JH	
Designed by:	Approved by:	Drawing No.
KMN	KMN	CP
Date: JULY 2021		
Scale: 1:500		



MAJOR FLOW ARROW

CATCHMENT AREA IN HECTARES
##.##ha
#.## ##
RUNOFF COEFFICIENT
CATCHMENT AREA ID

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

1329 Gardiners Road. Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client
RGH DEVELOPMENTS

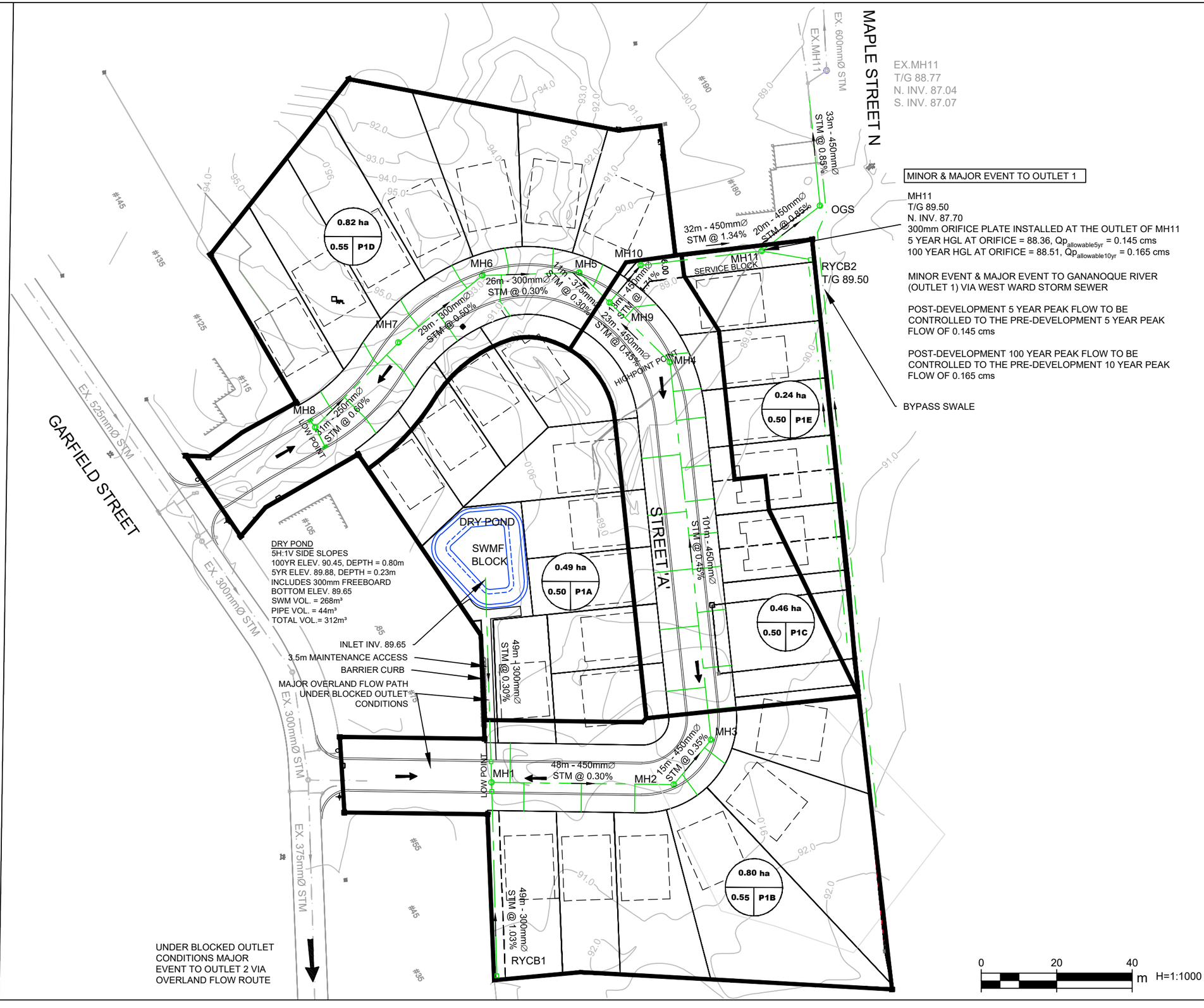
Project
ROCKY ACRES SUBDIVISION

Drawing
PRE-DEVELOPMENT CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.2

Date: APRIL 2021

Scale: 1:1000



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Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: RGH DEVELOPMENTS

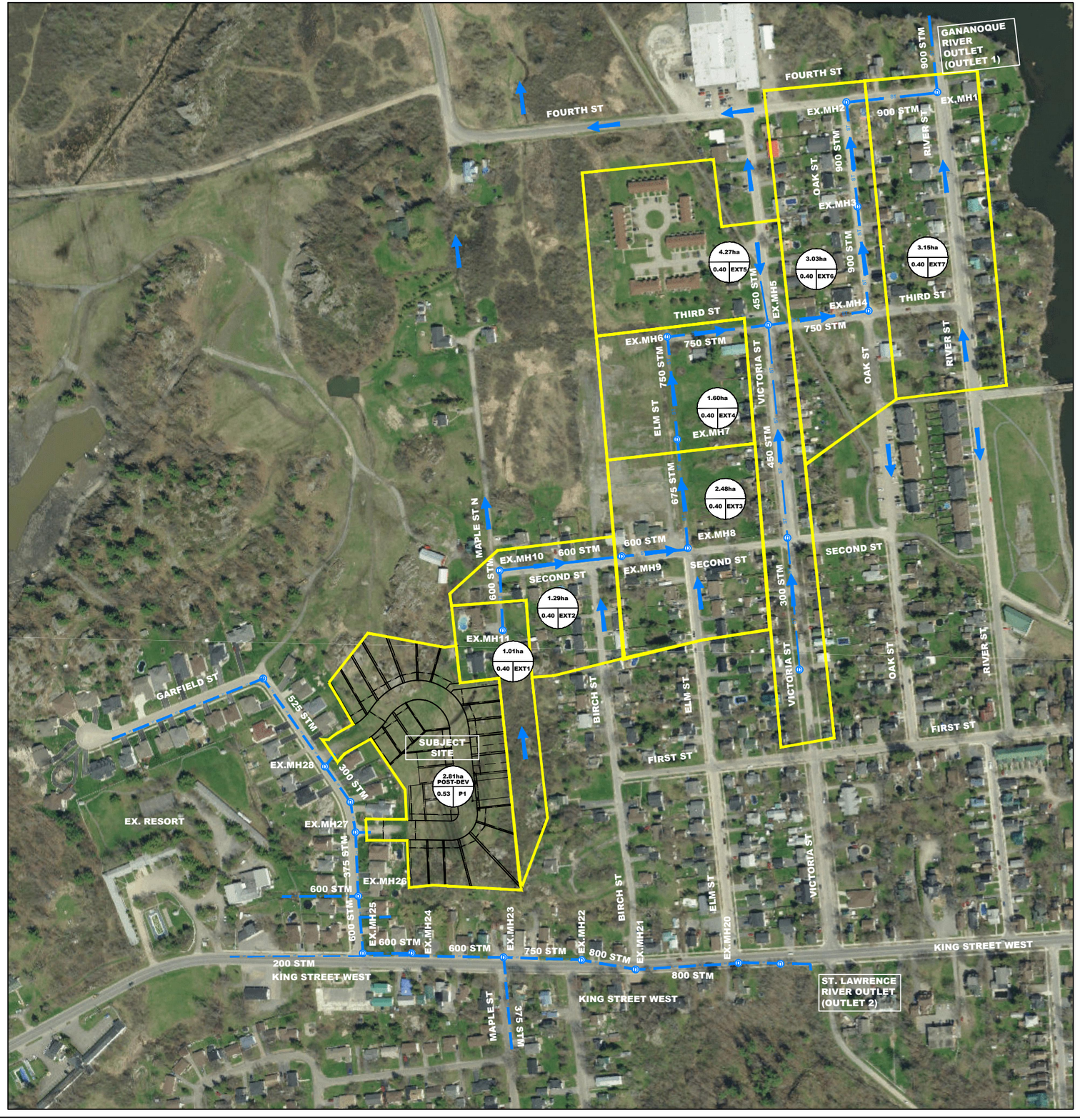
Project: ROCKY ACRES SUBDIVISION

Drawing: POST-DEVELOPMENT CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.3

Date: APRIL 2021

Scale: 1:1000



GANANOQUE RIVER OUTLET (OUTLET 1)

EX. STM MAIN

MAJOR FLOW ARROW

CATCHMENT AREA IN HECTARES

##.##ha

#.## ##

RUNOFF COEFFICIENT

CATCHMENT AREA ID

0 80 160 m H=1:4000

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Forefront Engineering Inc

1329 Gardiners Road. Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: RGH DEVELOPMENTS

Project: ROCKY ACRES SUBDIVISION

Drawing: GANANOQUE WEST WARD STORM SEWER CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.4
Date: APRIL 2021		
Scale: 1:4000		

Appendix B

MTO Gananoque Look Up Curve
Composite Runoff Coefficient Calculations
Storm Sewer Design Sheets
- Rocky Acres Subdivision 1:5yr Storm Sewer DS
- Rock Acres Subdivision 1:5yr Strom Sewer HGL
- Rock Acres Subdivision 1:100yr Strom Sewer HGL
- West Ward Storm Sewer Existing 1:10yr Storm Sewer DS
- West Ward Storm Sewer Existing 1:10yr Storm Sewer HGL

Rational Method Calculations
Modified Rational Method Calculations
OGS Calculations

Ontario IDF CURVE LOOKUP

Active coordinate

44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Retrieved: Thu, 08 Apr 2021 12:50:57 GMT

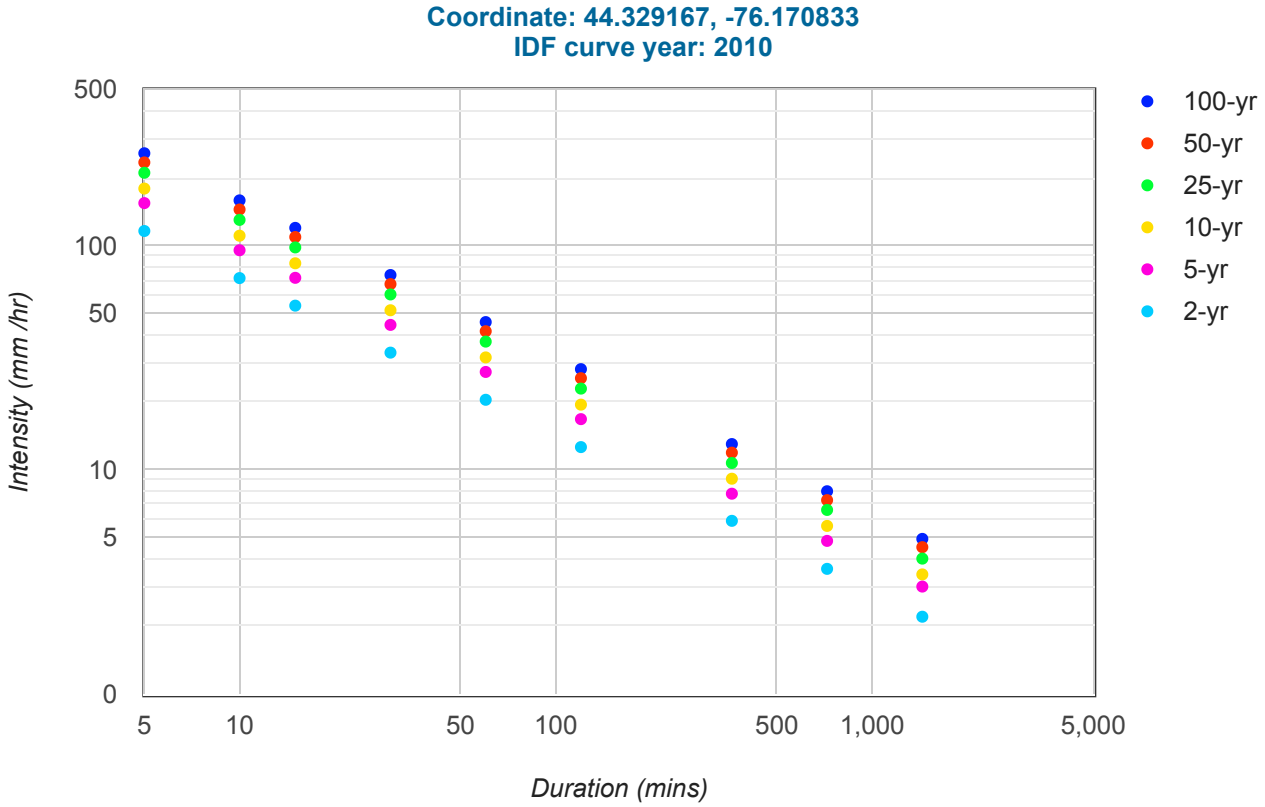
Location summary

These are the locations in the selection.

IDF Curve: 44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Retrieved: Thu, 08 Apr 2021 12:50:57 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	20.5	27.3	31.7	37.3	41.5	45.6
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	116.4	71.7	54.0	33.3	20.5	12.6	5.9	3.6	2.2
5-yr	155.1	95.5	71.9	44.3	27.3	16.8	7.8	4.8	3.0
10-yr	180.1	110.9	83.5	51.5	31.7	19.5	9.1	5.6	3.4
25-yr	211.9	130.5	98.3	60.6	37.3	23.0	10.7	6.6	4.0
50-yr	235.7	145.2	109.4	67.4	41.5	25.6	11.9	7.3	4.5
100-yr	259.0	159.5	120.2	74.0	45.6	28.1	13.0	8.0	4.9

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	9.7	12.0	13.5	16.6	20.5	25.3	35.2	43.3	53.4
5-yr	12.9	15.9	18.0	22.2	27.3	33.6	46.8	57.7	71.1
10-yr	15.0	18.5	20.9	25.7	31.7	39.1	54.4	67.0	82.5
25-yr	17.7	21.8	24.6	30.3	37.3	46.0	64.0	78.8	97.1
50-yr	19.6	24.2	27.3	33.7	41.5	51.1	71.2	87.7	108.0
100-yr	21.6	26.6	30.0	37.0	45.6	56.2	78.2	96.3	118.7

Terms of Use

Composite Runoff Coefficients			
Rocky Acres Subdivsion			
Hydrologic Units - Existing Conditions			
Drainage Area No.	**Total Area (ha)**	**Runoff Coefficient -C**	**Description**
EX2 & E3	0.6800	0.70	Bare Rock, Slopes 5 - 15%, 60% Rock Coverage (MTO Manual)
E1	1.9300	0.25	Low lying area
Total	**2.61**	**0.37**	*Excluding area E4

Hydrologic Units - Proposed Conditions			
Drainage Area No.	**Total Area (ha)**	**Runoff Coefficient -C**	**Description**
P1			
Grass	1.110	0.25	
Grass on Shallow Rock	0.600	0.35	
Asphalt/Concrete	0.505	0.90	
Building Roof Top	0.591	0.90	
Total	**2.81**	**0.53**	

Hydrologic Units - Proposed Conditions			
Drainage Area No.	**Total Area (ha)**	**Runoff Coefficient -C**	**Description**
P1A	0.490	0.50	
P1B	0.800	0.55	Shallow rock
P1C	0.460	0.50	
P1D	0.820	0.55	Shallow rock
P1E	0.240	0.50	
Total	**2.81**	**0.53**	

Weighted Product Equation

$$C_{weighted} = \frac{C_1 * A_1 + C_2 * A_2 + C_3 * A_3 \ldots + C_n * A_n}{A_1 + A_2 + A_3 \ldots A_n}$$

PROPOSED STORM SEWER DESIGN SHEET (ROCKY ACRES SUBDIVISION)
5 YEAR STORM EVENT

CLIENT
PROJECT NAME — Rocky Acres Subdivision — Min. V = 0.75 m/s — DESIGN FREQUENCY 5
DATE — September 2021 — Max. V = 6 m/s — RAINFALL STATIONS Gananoque MTO - Look Up
DESIGNED 'n' 0.013

LOCATION: ROCKY ACRES SUBDIVISION — DRAINAGE AREA = 2.81 ha — RUNOFF 3 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	5 Year R = 0.25 ha	R = 0.35 ha	R = 0.55 ha	R = 0.50 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)	US Inv (m)	DS Inv (m)
0.51	Coachmans Court	P1A	SWM IN	MH1				0.510	0.708	0.708	15.0	70	49	HDPE	300	54	0.30%	53	0.75	1.20	0.93	0.85	229	89.72	0.16	89.65	89.49
0.40	Coachmans Court	P1B	RCYB1	MH1			0.400		0.611	0.611	15.0	70	43	HDPE	300	50	1.00%	97	1.37	0.61	0.44	1.32	138	89.74	0.50	90.10	89.60
0.20	Coachmans Court	P1B	MH1	MH2			0.200		0.306	1.625	16.2	67	109	HDPE	450	50	0.30%	156	0.98	0.85	0.70	1.06	276	89.46	0.15	89.34	89.19
0.20	Coachmans Court	P1B	MH2	MH3			0.200		0.306	1.931	17.0	65	126	HDPE	450	15	0.35%	169	1.06	0.24	0.74	1.16	289	89.37	0.05	89.14	89.09
0.46	Coachmans Court	P1C	MH3	MH4				0.460	0.639	2.569	17.3	65	166	HDPE	450	101	0.45%	191	1.20	1.40	0.87	1.35	324	88.90	0.45	89.04	88.58
	Coachmans Court		MH4	MH9						2.569	18.7	62	159	HDPE	450	23	0.45%	191	1.20	0.32	0.83	1.34	311	88.74	0.10	88.55	88.43
0.40	Coachmans Court	P1D	MH8	MH7			0.400		0.611	0.611	15.0	70	43	HDPE	250	31	0.60%	46	0.94	0.55	0.93	1.06	189	89.65	0.19	89.65	89.46
0.20	Coachmans Court	P1D	MH7	MH6			0.200		0.306	0.917	15.6	69	63	HDPE	300	29	0.50%	68	0.97	0.50	0.92	1.10	226	89.53	0.15	89.44	89.30
0.20	Coachmans Court	P1D	MH6	MH5			0.200		0.306	1.222	16.1	67	82	HDPE	375	26	0.30%	96	0.87	0.50	0.86	0.98	267	89.47	0.08	89.28	89.20
	Coachmans Court		MH5	MH9						1.222	16.5	66	81	HDPE	375	11	0.30%	96	0.87	0.21	0.84	0.97	262	89.41	0.03	89.18	89.15
	Service Block		MH9	MH10						3.792	19.0	61	231	HDPE	450	13	1.72%	374	2.35	0.09	0.62	2.47	254	88.44	0.22	88.41	88.19
0.24	Service Block	P1E	MH10	MH11				0.240	0.333	4.125	19.1	61	251	HDPE	450	32	1.42%	340	2.14	0.25	0.74	2.34	287	88.00	0.45	88.17	87.71
	Easement		MH11	OGS1						4.125	19.3	60	249	HDPE	450	20	0.85%	263	1.65	0.20	0.95	1.88	349	87.89	0.17	87.70	87.54
	Maple Street		OGS1	EX.MH11						4.125	19.5	60	248	HDPE	450	33	0.85%	263	1.65	0.33	0.94	1.88	346	87.58	0.28	87.52	87.24

Proposed 5yr Hydraulic Gradeline Calculation Sheet - Site

Project Name : Rocky Acres
Location: Gananoque River Outlet

Designed by : JH
Reviewed by : KMN
Design Event : 5 Year Storm

n = 0.013 for minor losses
C = 120
Min Velocity = 0.75 m/s

Date : 2021/09/20
HGL Depth at MH11 = 88.36

Losses in Manholes (m) = 0.04

	Pipe Parameters													Flow Characteristics							Total												
Location	Manhole Number		Invert Elevation			Obvert at connection	Dia	Width	Length	Slope	A_full	Rh_full	Qcap	V_full	Total Pipe Flow	Qpipe/ Qcap	Normal Depth	Full Flow Conditions	V actual Q/a	V Qpipe/ A_full	Hazen-Williams (HW)		Darcy-Weisbach (DW)		Method Used	Friction Losses	Sum of Minor Losses	Losses	Surch.	Surch.	HGL	HGL at connection	HGL
	(u/s)	(d/s)	(u/s)	(d/s)	Δ inverts																Sf	Hl=Sf * L	f	Hl						(u/s)		(d/s)
			(m)	(m)	(m)	(m)	(mm)	(mm)	(m)	(m/m)	(m^2)	(m)	(m^3/s)	(m/s)	(m^3/s)		(mm)		(m/s)	(m/s)	(m/m)	(m)		(m)		(m)	(m)	(m)	(m)		(m)		(m)
Coachmans Court	SWM IN	MH1	89.65	89.49	0.162	89.95	300	N/A	54.00	0.0030	0.071	0.075	0.053	0.75	0.05	0.93	229	Laminar	0.85	0.700	0.002	0.124	0.031	0.141	HW	0.124	0.040	0.164	-0.07		89.88		89.61
Coachmans Court	RCYB1	MH1	90.10	89.60	0.500	90.40	300	N/A	50.00	0.0100	0.071	0.075	0.097	1.37	0.04	0.44	138	Laminar	1.32	0.604	0.007	0.350	0.031	0.097	HW	0.350	0.040	0.390	-0.16		90.24		89.61
Coachmans Court	MH1	MH2	89.34	89.19	0.150	89.79	450	N/A	50.00	0.0030	0.159	0.113	0.156	0.98	0.11	0.70	276	Laminar	1.06	0.683	0.002	0.118	0.027	0.073	HW	0.118	0.046	0.164	-0.17		89.61		89.44
Coachmans Court	MH2	MH3	89.14	89.09	0.052	89.59	450	N/A	15.00	0.0035	0.159	0.113	0.169	1.06	0.13	0.74	289	Laminar	1.16	0.790	0.003	0.041	0.027	0.029	HW	0.041	0.040	0.081	-0.15		89.44		89.36
Coachmans Court	MH3	MH4	89.04	88.58	0.454	89.49	450	N/A	101.00	0.0045	0.159	0.113	0.191	1.20	0.17	0.87	324	Laminar	1.35	1.044	0.003	0.347	0.027	0.342	HW	0.347	0.040	0.387	-0.13		89.36		88.89
Coachmans Court	MH4	MH9	88.55	88.43	0.121	89.00	450	N/A	23.00	0.0045	0.159	0.113	0.191	1.20	0.16	0.83	311	Laminar	1.34	0.997	0.003	0.079	0.027	0.071	HW	0.079	0.040	0.119	-0.11		88.89		88.77
Coachmans Court	MH8	MH7	89.65	89.46	0.186	89.90	250	N/A	31.00	0.0060	0.049	0.063	0.046	0.94	0.04	0.93	189	Laminar	1.06	0.870	0.004	0.133	0.033	0.160	HW	0.133	0.040	0.173	-0.03		89.87		89.69
Coachmans Court	MH7	MH6	89.44	89.30	0.145	89.74	300	N/A	29.00	0.0050	0.071	0.075	0.068	0.97	0.06	0.92	226	Laminar	1.10	0.889	0.004	0.107	0.031	0.123	HW	0.107	0.040	0.147	-0.05		89.69		89.55
Coachmans Court	MH6	MH5	89.28	89.20	0.078	89.65	375	N/A	26.00	0.0030	0.110	0.094	0.096	0.87	0.08	0.86	267	Laminar	0.98	0.745	0.002	0.061	0.029	0.057	HW	0.061	0.043	0.103	-0.11		89.55		89.44
Coachmans Court	MH5	MH9	89.18	89.15	0.033	89.56	375	N/A	11.00	0.0030	0.110	0.094	0.096	0.87	0.08	0.84	262	Laminar	0.97	0.732	0.002	0.026	0.029	0.023	HW	0.026	0.040	0.066	-0.11		89.44		88.77
Service Block	MH9	MH10	88.41	88.19	0.224	88.86	450	N/A	13.00	0.0172	0.159	0.113	0.374	2.35	0.23	0.62	254	Turbulent	2.47	1.453	0.012	0.154	0.027	0.085	DW	0.085	0.040	0.125	-0.09		88.77		88.65
Service Block	MH10	MH11	88.17	87.71	0.454	88.62	450	N/A	32.00	0.0142	0.159	0.113	0.340	2.14	0.25	0.74	287	Turbulent	2.34	1.581	0.010	0.318	0.027	0.249	DW	0.249	0.040	0.289	0.03	yes	88.65		88.36
Easement	MH11	OGS1	87.70	87.54	0.166	88.15	450	N/A	19.50	0.0085	0.159	0.113	0.263	1.65	0.25	0.95	349	Laminar	1.88	1.566	0.006	0.121	0.027	0.149	HW	0.121	0.066	0.187	0.21	yes	88.36		87.86
Maple Street	OGS1	EX.MH11	87.52	87.24	0.278	87.97	450	N/A	32.70	0.0085	0.159	0.113	0.263	1.65	0.25	0.94	346	Laminar	1.88	1.556	0.006	0.202	0.027	0.247	HW	0.202	0.040	0.242	-0.10		87.86		87.42

Proposed 100yr Hydraulic Gradeline Calculation Sheet - Site

Project Name : Rocky Acres
Location: Gananoque River Outlet

Designed by : JH
Reviewed by : KMN
Design Event : 100 Year Storm

n = 0.013 for minor losses
C = 120
Min Velocity = 0.75 m/s

Date : 2021/09/20
HGL Depth at MH11 = 88.51

Losses in Manholes (m) = 0.04

	Pipe Parameters													Flow Characteristics							Total												
Location	Manhole Number		Invert Elevation			Obvert at connection	Dia	Width	Length	Slope	A_full	Rh_full	Qcap	V_full	Total Pipe Flow	Qpipe/ Qcap	Normal Depth	Full Flow Conditions	V actual Q/a	V Qpipe/ A_full	Hazen-Williams (HW)		Darcy-Weisbach (DW)		Method Used	Friction Losses	Sum of Minor Losses	Losses	Surch. (u/s)	Surch.	HGL (u/s)	HGL at connection	HGL (d/s)
	(u/s)	(d/s)	(u/s)	(d/s)	Δ inverts	(m)	(mm)	(mm)	(m)	(m/m)	(m^2)	(m)	(m^3/s)	(m/s)	(m^3/s)		(mm)		(m/s)	(m/s)	Sf (m/m)	HI=Sf * L (m)	f	HI (m)		(m)	(m)	(m)	(m)		(m)	(m)	(m)
			(m)	(m)	(m)																												
Coachmans Court	SWM IN	MH1	89.65	89.49	0.162	89.95	300	N/A	54.00	0.0030	0.071	0.075	0.053	0.75	0.09	1.61	300	Laminar	0.75	1.205	0.002	0.124	0.031	0.419	HW	0.124	0.040	0.164	0.50	yes	90.45		90.28
Coachmans Court	RCYB1	MH1	90.10	89.60	0.500	90.40	300	N/A	50.00	0.0100	0.071	0.075	0.097	1.37	0.07	0.76	195	Laminar	1.50	1.040	0.007	0.350	0.031	0.289	HW	0.350	0.040	0.390	0.27	yes	90.67		90.28
Coachmans Court	MH1	MH2	89.34	89.19	0.150	89.79	450	N/A	50.00	0.0030	0.159	0.113	0.156	0.98	0.19	1.19	450	Laminar	0.98	1.164	0.002	0.118	0.027	0.211	HW	0.118	0.053	0.171	0.49	yes	90.28		90.11
Coachmans Court	MH2	MH3	89.14	89.09	0.052	89.59	450	N/A	15.00	0.0035	0.159	0.113	0.169	1.06	0.21	1.26	450	Laminar	1.06	1.338	0.003	0.041	0.027	0.084	HW	0.041	0.040	0.081	0.52	yes	90.11		90.03
Coachmans Court	MH3	MH4	89.04	88.58	0.454	89.49	450	N/A	101.00	0.0045	0.159	0.113	0.191	1.20	0.28	1.47	450	Laminar	1.20	1.766	0.003	0.347	0.027	0.980	HW	0.347	0.040	0.387	0.55	yes	90.03		89.64
Coachmans Court	MH4	MH9	88.55	88.43	0.121	89.00	450	N/A	23.00	0.0045	0.159	0.113	0.191	1.20	0.27	1.39	450	Laminar	1.20	1.672	0.003	0.079	0.027	0.200	HW	0.079	0.040	0.119	0.64	yes	89.64		89.53
Coachmans Court	MH8	MH7	89.65	89.46	0.186	89.90	250	N/A	31.00	0.0060	0.049	0.063	0.046	0.94	0.07	1.60	250	Laminar	0.94	1.497	0.004	0.133	0.033	0.474	HW	0.133	0.040	0.173	0.11	yes	90.01		89.84
Coachmans Court	MH7	MH6	89.44	89.30	0.145	89.74	300	N/A	29.00	0.0050	0.071	0.075	0.068	0.97	0.11	1.58	300	Laminar	0.97	1.524	0.004	0.107	0.031	0.360	HW	0.107	0.040	0.147	0.10	yes	89.84		89.69
Coachmans Court	MH6	MH5	89.28	89.20	0.078	89.65	375	N/A	26.00	0.0030	0.110	0.094	0.096	0.87	0.14	1.46	375	Laminar	0.87	1.272	0.002	0.061	0.029	0.167	HW	0.061	0.042	0.102	0.04	yes	89.69		89.59
Coachmans Court	MH5	MH9	89.18	89.15	0.033	89.56	375	N/A	11.00	0.0030	0.110	0.094	0.096	0.87	0.14	1.43	375	Laminar	0.87	1.245	0.002	0.026	0.029	0.068	HW	0.026	0.040	0.066	0.03	yes	89.59		89.53
Service Block	MH9	MH10	88.41	88.19	0.224	88.86	450	N/A	13.00	0.0172	0.159	0.113	0.374	2.35	0.39	1.03	450	Turbulent	2.67	2.431	0.012	0.154	0.027	0.239	DW	0.239	0.040	0.279	0.67	yes	89.53		89.25
Service Block	MH10	MH11	88.17	87.71	0.454	88.62	450	N/A	32.00	0.0142	0.159	0.113	0.340	2.14	0.42	1.24	450	Turbulent	2.14	2.644	0.010	0.318	0.027	0.696	DW	0.696	0.040	0.736	0.63	yes	89.25		88.51
Easement	MH11	OGS1	87.70	87.54	0.166	88.15	450	N/A	19.50	0.0085	0.159	0.113	0.263	1.65	0.42	1.58	450	Laminar	1.65	2.615	0.006	0.121	0.027	0.415	HW	0.121	0.085	0.206	0.36	yes	88.51		87.93
Maple Street	OGS1	EX.MH11	87.52	87.24	0.278	87.97	450	N/A	32.70	0.0085	0.159	0.113	0.263	1.65	0.41	1.57	450	Laminar	1.65	2.597	0.006	0.202	0.027	0.686	HW	0.202	0.040	0.242	-0.04		87.93		87.45

EXISTING STORM SEWER DESIGN SHEET - GANANOQUE RIVER OUTLET (OUTLET 1)
10 YEAR STORM EVENT

CLIENT
PROJECT NAME — Rocky Acres Subdivision — Min. V = 0.75 m/s — DESIGN FREQUENCY 10
DATE — Sept 2021 — Max. V = 6 m/s — RAINFALL STATIONS Gananoque MTO - Look Up
DESIGNED 'n' 0.013

LOCATION: ROCKY ACRES SUBDIVISION — DRAINAGE AREA = 19.44 ha — RUNOFF 4 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	R = 0.25 ha	R = 0.37 ha	R = 0.40 ha	R = 0.50 ha	10 Year Indiv. 2.78AC ha	10 Year Accum. 2.78AC ha	Time of Conc. (min)	10 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)
2.61	Maple Street	From Site	Inlet	EX.MH11		2.610			2.683	2.6825	23.3	62	166												
1.01	Maple Street	EXT.1	EX.MH11	EX.MH10			1.010		1.122	3.805	23.3	62	235	Conc.	600	56	0.25%	307	1.09	0.86	0.77	1.20	393	87.34	0.140
1.29	Second Street	EXT.2	EX.MH10	EX.MH9			1.290		1.433	5.238	24.2	60	316	Conc.	600	92	0.40%	388	1.37	1.12	0.81	1.53	410	86.69	0.368
	Second Street		EX.MH9	EX.MH8					0.000	5.238	25.3	58	306	Conc.	600	93	0.40%	388	1.37	1.13	0.79	1.52	400	86.00	0.372
2.48	Elm Street	EXT.3	EX.MH8	EX.MH7			2.480		2.756	7.994	26.4	57	452	Conc.	675	128	0.50%	594	1.66	1.28	0.76	1.83	439	84.89	0.640
1.60	Elm Street	EXT.4	EX.MH7	EX.MH6			1.600		1.778	9.771	27.7	55	535	Conc.	750	75	0.30%	610	1.38	0.91	0.88	1.56	542	84.70	0.225
	Third Street		EX.MH6	EX.MH5					0.000	9.771	28.6	54	523	Conc.	750	92	0.35%	659	1.49	1.03	0.79	1.65	503	84.34	0.322
4.27	Third Street	EXT.5	EX.MH5	EX.MH4			4.270		4.744	14.516	29.6	52	757	Conc.	750	96	0.45%	747	1.69	0.95	1.01	1.93	750	84.16	0.432
	Oak Street		EX.MH4	EX.MH3					0.000	14.516	30.6	51	742	Conc.	900	98	0.30%	992	1.56	1.05	0.75	1.71	578	83.63	0.294
3.03	Oak Street	EXT.6	EX.MH3	EX.MH2			3.030		3.367	17.883	31.6	50	891	Conc.	900	105	0.30%	992	1.56	1.12	0.90	1.76	665	83.41	0.315
	Fourth Street		EX.MH2	EX.MH1					0.000	17.883	32.7	49	870	Conc.	900	88	0.30%	992	1.56	0.94	0.88	1.76	651	83.13	0.264
3.15	River Street	EXT.7	EX.MH1	OUTLET			3.150		3.500	21.383	33.7	48	1021	Conc.	900	63	0.30%	992	1.56	0.67	1.03	1.77	900	82.89	0.189

Existing 10yr Hydraulic Gradeline Calculation Sheet - Gananoque River Outlet (Outlet 1)

Project Name : Rocky Acres
Location: Gananoque River Outlet

Designed by : JH
Reviewed by : KMN
Design Event : 10 Year Storm

n = 0.013 for minor losses
C = 120
Min Velocity = 0.75 m/s

Date : 2021/09/17
Normal Depth at Outlet = 82.36
Losses in Manholes (m) = 0.04

Location	Pipe Parameters													Flow Characteristics						Total															
	Manhole Number		Invert Elevation			Obvert at connection	Dia	Width	Length	Slope	A_full	Rh_full	Qcap	V_full	Total Pipe Flow	Qpipe/ Qcap	Normal Depth	Full Flow Conditions	V actual Q/a	V Qpipe/ A_full	Hazen-Williams (HW)		Darcy-Weisbach (DW)		Method Used	Friction Losses	Sum of Minor Losses	Losses	Surch. (u/s)	Surch.	HGL (u/s)	HGL at connection	HGL (d/s)
	(u/s)	(d/s)	(u/s)	(d/s)	Δ inverts	(m)	(mm)	(mm)	(m)	(m/m)	(m^2)	(m)	(m^3/s)	(m/s)	(m^3/s)		(mm)		(m/s)	(m/s)	Sf (m/m)	Hl=Sf * L (m)	f	Hl (m)		(m)	(m)	(m)	(m)		(m)	(m)	(m)
			(m)	(m)	(m)																														
Maple Street	EX.MH11	EX.MH10	87.10	86.95	0.150	87.70	600	N/A	56.00	0.0025	0.283	0.150	0.307	1.09	0.24	0.77	393	Laminar	1.20	0.832	0.002	0.114	0.025	0.082	HW	0.114	0.040	0.154	-0.21		87.49		87.06
Second Street	EX.MH10	EX.MH9	86.65	86.28	0.370	87.25	600	N/A	92.00	0.0040	0.283	0.150	0.388	1.37	0.32	0.81	410	Laminar	1.53	1.116	0.003	0.289	0.025	0.243	HW	0.289	0.040	0.329	-0.19		87.06		86.37
Second Street	EX.MH9	EX.MH8	85.97	85.60	0.370	86.57	600	N/A	93.00	0.0040	0.283	0.150	0.388	1.37	0.31	0.79	400	Laminar	1.52	1.082	0.003	0.292	0.025	0.231	HW	0.292	0.040	0.332	-0.20		86.37		85.61
Elm Street	EX.MH8	EX.MH7	85.09	84.45	0.640	85.77	675	N/A	128.00	0.0050	0.358	0.169	0.594	1.66	0.45	0.76	439	Laminar	1.83	1.262	0.004	0.498	0.024	0.370	HW	0.498	0.040	0.538	-0.15		85.61		85.07
Elm Street	EX.MH7	EX.MH6	84.38	84.16	0.220	85.13	750	N/A	75.00	0.0030	0.442	0.188	0.610	1.38	0.54	0.88	542	Laminar	1.56	1.212	0.002	0.183	0.023	0.173	HW	0.183	0.049	0.232	-0.06		85.07		84.84
Third Street	EX.MH6	EX.MH5	84.16	83.84	0.320	84.91	750	N/A	92.00	0.0035	0.442	0.188	0.659	1.49	0.52	0.79	503	Laminar	1.65	1.185	0.003	0.259	0.023	0.203	HW	0.259	0.040	0.299	-0.07		84.84		84.54
Third Street	EX.MH5	EX.MH4	83.84	83.41	0.430	84.59	750	N/A	96.00	0.0045	0.442	0.188	0.747	1.69	0.76	1.01	750	Laminar	1.93	1.714	0.004	0.341	0.023	0.444	HW	0.341	0.040	0.381	-0.05		84.54		84.00
Oak Street	EX.MH4	EX.MH3	83.34	83.05	0.290	84.24	900	N/A	98.00	0.0030	0.636	0.225	0.992	1.56	0.74	0.75	578	Laminar	1.71	1.166	0.002	0.242	0.022	0.164	HW	0.242	0.048	0.290	-0.24		84.00		83.71
Oak Street	EX.MH3	EX.MH2	83.05	82.75	0.300	83.95	900	N/A	105.00	0.0030	0.636	0.225	0.992	1.56	0.89	0.90	665	Laminar	1.76	1.401	0.002	0.259	0.022	0.255	HW	0.259	0.040	0.299	-0.24		83.71		83.39
Fourth Street	EX.MH2	EX.MH1	82.74	82.48	0.260	83.64	900	N/A	88.00	0.0030	0.636	0.225	0.992	1.56	0.87	0.88	651	Laminar	1.76	1.368	0.002	0.217	0.022	0.203	HW	0.217	0.040	0.258	-0.25		83.39		83.09
River Street	EX.MH1	OUTLET	82.18	81.99	0.189	83.08	900	N/A	63.00	0.0030	0.636	0.225	0.992	1.56	1.02	1.03	900	Laminar	1.77	1.605	0.002	0.156	0.022	0.200	HW	0.156	0.040	0.196	0.01	yes	83.09		82.36
																														Wtr Lvl	82.36		

RATIONAL METHOD CACULATIONS

Project: Rocky Acres Subdivision

Date: September 2021

Hydrologic Units - Existing Conditions										**25mm Quality Event**		**2 Year Design Storm**		**5 Year Design Storm**		**10 Year Design Storm**		**100 Year Design Storm**	
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc (Airport Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)
E1 + E2 + E3	Outlet 1	0.37	2.61	140	6.45	4.05	See below*	**23.3**	2.68	NA	NA	40.1	108	53.88	145	61.67	166	88.39	237
Tc Calculation Airport Method																			
Tc.1	Rock Outcrop, 5-10% Rolling Slopes 60% Coverage	0.70	0.68	80	2.93	1.31	5.3												
Tc.2	Flat Low lying wet area	0.25	1.93	60	2.88	2.16	18.0												
Tc.1 + Tc.2							**23.3**												

*Note, Catchment Area E4 is excluded from calculations

Hydrologic Units - Proposed Conditions										**25mm Quality Event**		**2 Year Design Storm**		**5 Year Design Storm**		**10 Year Design Storm**		**100 Year Design Storm**	
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc Proposed*	Indiv. 2.78 AC (ha)		Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)
P1	Minor & Major to Outlet 1	0.53	2.81	140	8.27	6.63	**19.5**	4.14		30.78	127	45.5	189	60.20	249	70.09	290	100.48	416

*Tc from storm sewer design sheet

Rational Method Calculations

Formula:

Q (LPS) = 2.78* C * I * A

Where:

Q = Peak runoff rate, LPS

C = Composite runoff coefficient

I = Rainfall intensity, mm/hr,
MTO Gananoque IDF Look Up Curve (Quantity Event)

$$\frac{498}{(tc + 9.7)^{0.825}}$$

t_c = Time of Concentration, (15 minute minimum)

Kirpich Method $0.0192[L^{0.77}/S_{(m/m)}^{0.385}]$

Airport Method $3.26(1.1 - C)* L^{0.5}/ S_w^{0.33}$

A = Drainage area, ha

MODIFIED RATIONAL METHOD CACULATIONS &
STORAGE VOLUMES FOR SMALL SITES

Project: Rocky Acres Subdivision
Date: September 2021

5 Year Return Period

Pre-development Runoff	
C	0.37
t_c (min)	23.3
Area (ha)	2.61
Intensity (mm/hr)	54.02
Q (m^3/s)	0.145

Post-development Characteristics			
Description	C	Area (ha)	CxA
P1	0.53	2.81	1.49
Total	0.53	2.81	1.49

Post-development Peak Flow	
C	0.53
t_c (min)	19.5
Area (ha)	2.81
Intensity (mm/hr)	60.20
Q_{Peak} (m^3/s)	0.249

Formulas:

I= MTO Lookup Curve

Q = 0.0028 * C * I * A

$S_d = Q_p t_d - Q_d((t_d+t_c)/2)$

*Storage Formula (Aron and Kibler, 1990)

Where:

Q=Peak runoff rate (m^3/s)
C=Composite runoff coefficient
I=Rainfall intensity (mm/hr)
A=Drainage area (ha)
tc= Time of Concentration (min)
td = Duration of Storm (min)
Qp = Peak Flow (m^3/s)
Q_d = Discharge Rate (m^3/s)
Sd = Required Storage Volume (m^3)

Orifice Equation

$Q = 0.65\ A\ (2gH)^{1/2}$

where A = orifice area; g = gravity; and H=head above centre of orifice (m)

Storage

Duration td (min)	Intensity (mm/hr)	CxA	Q_p- Uncontrolled Runoff Rate (m^3/s)	Q_d-Allowable Outflow (m^3/s)	Peak Storage Rate (m^3/s)	Storage Volume Total (m^3)	Comments
10	86.62	1.49	0.361	0.145	0.216	88.4	
15	69.85	1.49	0.291	0.145	0.146	112.1	
20	59.29	1.49	0.247	0.145	0.102	124.8	
25	51.70	1.49	0.216	0.145	0.071	129.8	
30	46.06	1.49	0.192	0.145	0.047	130.3	Storage Required
35	41.67	1.49	0.174	0.145	0.029	127.8	
40	38.15	1.49	0.159	0.145	0.014	122.9	
45	35.25	1.49	0.147	0.145	0.002	116.3	

Orifice Diameter (m)	Water Surface Elevation (m) At MH11 (HGL)	Invert of Orifice (m)	Centreline of Orifice Elevation (m)	Head (m)	Release Rate (m^3/s)	Required Release (m^3/s)	Velocity m/s	Comments
0.300	88.360	87.700	87.850	0.510	0.145	0.145	2.06	Proposed 5 year and 100 year orifice

Storage Provided

Pipe Storage	44m^3
SWM Facility @ 0.23m depth	86m^3
Total	**130m^3**

MODIFIED RATIONAL METHOD CACULATIONS &
STORAGE VOLUMES FOR SMALL SITES

Project: Rocky Acres Subdivision
Date: September 2021

10 Year Return Period

Pre-development Runoff	
C	0.37
t_c (min)	23.3
Area (ha)	2.61
Intensity (mm/hr)	61.86
Q_{10yr} (m^3/s)	0.166

Post-development Characteristics			
Description	C	Area (ha)	CxA
P1	0.53	2.81	1.49
Total	0.53	2.81	1.49

100 Year Return Period

Post-development Peak Flow	
C	0.53
t_c (min)	19.5
Area (ha)	2.81
Intensity (mm/hr)	100.48
$Q_{peak\text{-}100yr}$ (m^3/s)	0.416

Storage

Duration td (min)	Intensity (mm/hr) **(1:100)**	CxA	Q_p- Uncontrolled Runoff Rate (m^3/s)	Q_d-Allowable Outflow (m^3/s)	Peak Storage Rate (m^3/s)	Storage Volume Total (m^3)	Comments
15	120.27	1.49	0.502	0.166	0.335	279.5	
20	98.70	1.49	0.412	0.166	0.246	297.1	
25	84.38	1.49	0.352	0.166	0.186	306.1	
30	74.24	1.49	0.310	0.166	0.144	310.6	
35	66.62	1.49	0.278	0.166	0.112	311.9	Storage Required
40	60.66	1.49	0.253	0.166	0.087	310.7	
45	55.85	1.49	0.233	0.166	0.067	307.4	
50	51.87	1.49	0.216	0.166	0.050	302.6	

Orifice Diameter (m)	Water Surface Elevation (m) At MH11	Invert of Orifice (m)	Centreline of Orifice Elevation (m)	Head (m)	Release Rate (m^3/s)	Required Release (10Yr) (m^3/s)	Velocity m/s	Comments
0.300	88.510	87.700	87.850	0.660	0.165	0.166	2.34	Proposed 5 year and 100 year orifice

Storage Provided

Pipe Storage:	44m^3
SWM Facility @ 0.80m depth:	268m^3
Total	**312m^3**

Note, the 100 year storm event is controlled to the pre-development 10 year storm event peak flow

Formulas:

I= MTO Lookup Curve

$Q = 0.0028 * C * I * A$

$S_d = Q_p t_d - Q_d((t_d+t_c)/2)$

*Storage Formula (Aron and Kibler, 1990)

Where:

Q=Peak runoff rate (m^3/s)
C=Composite runoff coefficient
I=Rainfall intensity (mm/hr)
A=Drainage area (ha)
tc= Time of Concentration (min)
td = Duration of Storm (min)
Qp = Peak Flow (m^3/s)
Q_d = Discharge Rate (m^3/s)
Sd = Required Storage Volume (m^3)

Orifice Equation

$Q = 0.65\ A\ (2gH)^{1/2}$

where A = orifice area; g = gravity; and H=head above centre of orifice (m)

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: Rocky Acres Subdivision
Location: Ganaoque, ON
OGS #: 1

Engineer: **Forefront Engineering INC**
Contact: Jeff Homer, P.Eng
Report Date: 14-Apr-21

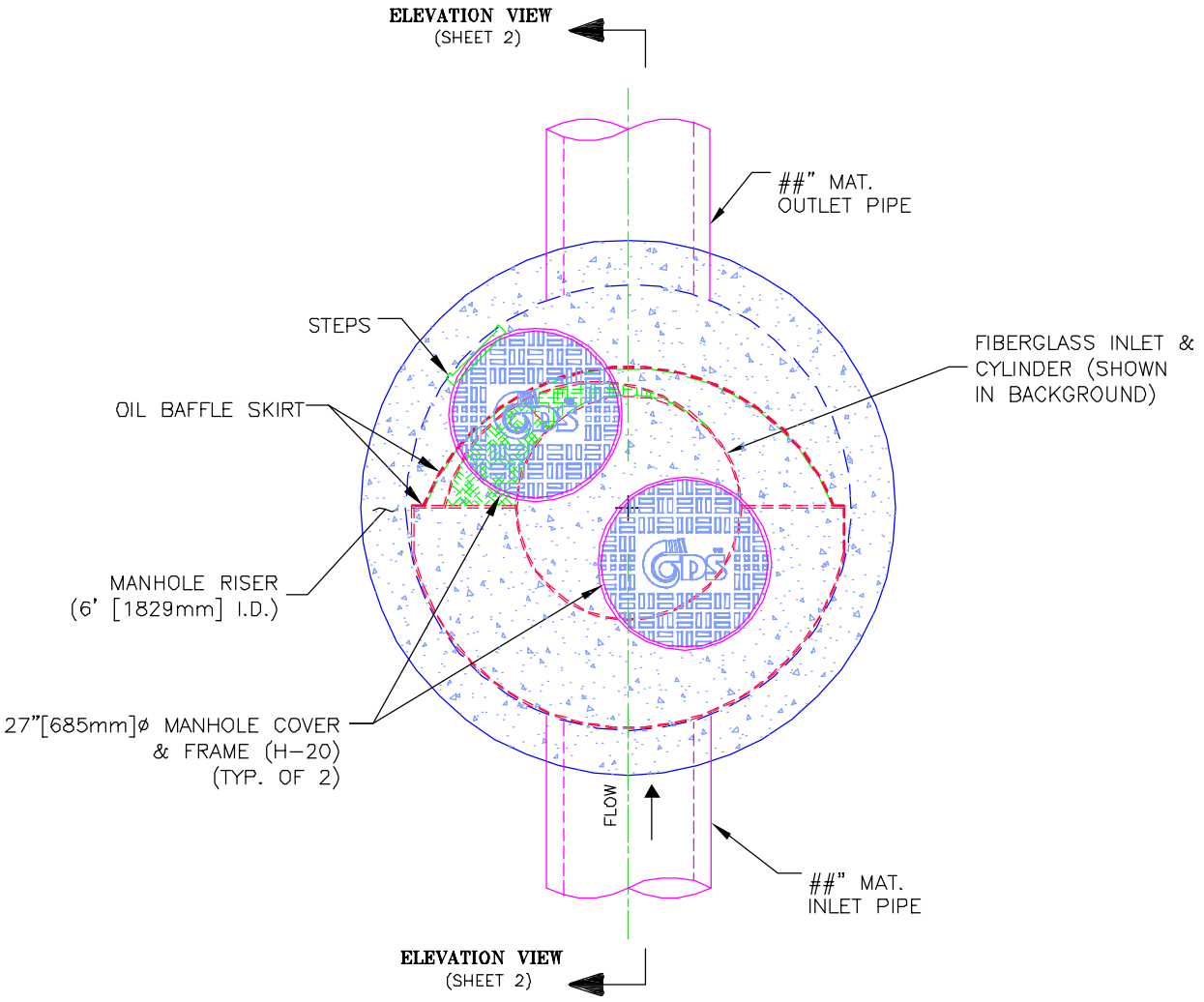
Area	2.75	ha	**Rainfall Station #**	214	
Weighted C	0.50		**Particle Size Distribution**	FINE	
CDS Model	3020		**CDS Treatment Capacity**	57	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
1.0	10.8%	20.7%	3.8	3.8	6.7	96.9	10.5
1.5	10.1%	30.8%	5.7	5.7	10.0	96.0	9.7
2.0	9.1%	39.9%	7.6	7.6	13.3	95.0	8.6
2.5	7.0%	46.9%	9.4	9.4	16.7	94.1	6.6
3.0	6.9%	53.9%	11.3	11.3	20.0	93.1	6.4
3.5	4.5%	58.4%	13.2	13.2	23.3	92.2	4.2
4.0	4.5%	62.9%	15.1	15.1	26.7	91.2	4.1
4.5	4.1%	67.0%	17.0	17.0	30.0	90.3	3.7
5.0	3.8%	70.8%	18.9	18.9	33.3	89.3	3.4
6.0	5.7%	76.5%	22.7	22.7	40.0	87.4	4.9
7.0	4.5%	81.0%	26.4	26.4	46.7	85.5	3.9
8.0	3.6%	84.5%	30.2	30.2	53.4	83.6	3.0
9.0	2.3%	86.8%	34.0	34.0	60.0	81.7	1.8
10.0	1.9%	88.7%	37.8	37.8	66.7	79.7	1.5
15.0	6.1%	94.8%	56.7	56.6	100.0	70.2	4.3
20.0	2.6%	97.5%	75.5	56.6	100.0	52.6	1.4
25.0	2.0%	99.4%	94.4	56.6	100.0	42.1	0.8
30.0	0.4%	99.9%	113.3	56.6	100.0	35.1	0.2
35.0	0.1%	100.0%	132.2	56.6	100.0	30.1	0.0
40.0	0.0%	100.0%	151.1	56.6	100.0	26.3	0.0
45.0	0.0%	100.0%	170.0	56.6	100.0	23.4	0.0
50.0	0.0%	100.0%	188.9	56.6	100.0	21.1	0.0
							88.8

Removal Efficiency Adjustment[2] = 6.5%
Predicted Net Annual Load Removal Efficiency = 82.3%
Predicted Annual Rainfall Treated = 98.2%

1 - Based on 44 years of hourly rainfall data from Canadian Station 6104175, Kingston ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

PLAN VIEW

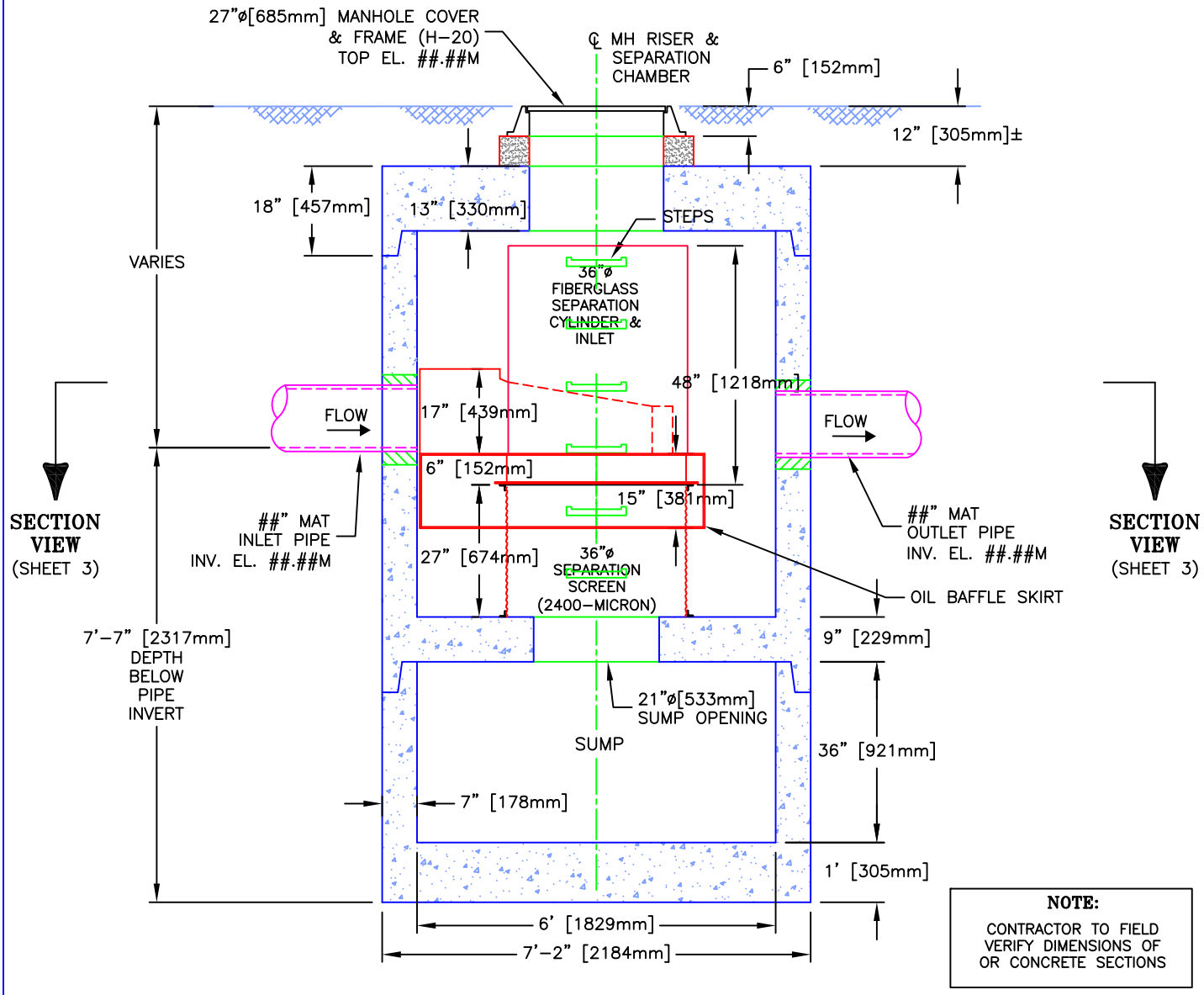


CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 2.5'
		DATE ##/##/##	SHEET 1
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



NOTE:
CONTRACTOR TO FIELD VERIFY DIMENSIONS OF OR CONCRETE SECTIONS

CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET 2
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955